CONSULTATION REPORT: 5.1 APPENDICES VOL. 3.1 PEIR PART 3

DECARBONISATION

Cory Decarbonisation Project

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DECARBONISATION

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT: VOLUME 3: TECHNICAL APPENDICES

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TECHNICAL APPENDIX 5-1: CONSTRUCTION DUST ASSESSMENT

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APPENDIX 5-1: CONSTRUCTION DUST ASSESSMENT

METHODOLOGY

STEP 1 – SCREENING THE NEED FOR A DETAILED ASSESSMENT

An assessment will normally be required where there are:

- ‘Human receptors’ within approximately 350m of the Site Boundary; or within approximately 50m of the route(s) used by construction vehicles on the public highway, up to approximately 500m from the site entrance(s); and/or
- ‘Ecological receptors’ within approximately 50m of the Site Boundary; or within approximately 50m of the route(s) used by construction vehicles on the public highway, up to approximately 500m from the site entrance(s).

Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is ’negligible’.

STEP 2A – DEFINE THE POTENTIAL DUST EMISSION MAGNITUDE

The following are examples of how the potential dust emission magnitude for different activities can be defined (note that not all the criteria need to be met for a particular class). Other criteria may be used if justified in the assessment.

Table 1: Magnitude Examples (Dust Emissions)

Dust Emission Magnitude	Activity
Large	Demolition: >50,000m^3 building demolished, dusty material (e.g., concrete), onsite crushing/screening, demolition >20m above ground level.
	Earthworks: >10,000m^2 site area, dusty soil type (e.g., clay). >10 earth moving vehicles active simultaneously. >8m high bunds formed, >100,000 tonnes material moved.
	Construction: >100,000m^3 building volume, onsite concrete batching, sandblasting.
	Trackout: >50 HDV out / day, dusty surface material (e.g., clay), >100m unpaved roads.

Dust Emission Magnitude	Activity
Medium	Demolition: 20,000 - 50,000m^3 building demolished, dusty material (e.g., concrete). 10-20m above ground level.
	Earthworks: 2,500 - 10,000m^2 site area, moderately dusty soil (e.g., silt), 5-10 earth moving vehicles active simultaneously, 4m - 8m high bunds, 20,000 - 100,000 tonnes material moved.
	Construction: 25,000 - 100,000m^3 building volume, dusty material e.g., concrete, onsite concrete batching.
	Trackout: 10 - 50 HDVs out / day, moderately dusty surface material (e.g., clay), 50 - 100m unpaved roads.
Small	Demolition: <20,000m^3 building demolished, non-dusty material (e.g., metal cladding), <10m above ground level, work during wetter months.
	Earthworks: <2,500m^2 site area, soil with large grain size (e.g., sand), <5 earth moving vehicles active simultaneously, <4m high bunds, <20,000 tonnes material moved, earthworks during wetter months.
	Construction: <25,000m^3, non-dusty material (e.g., metal cladding or timber).
	Trackout: <10 HDV out / day, non-dusty soil, < 50m unpaved roads.
	HDV = heavy delivery vehicle(s)

STEP 2B – DEFINE THE SENSITIVITY OF THE AREA

The tables below present the IAQM dust guidance[a] methodology to determine the sensitivity of the area to dust soiling, human health and ecological impacts respectively. The IAQM dust

[a] Institute of Air Quality Management. (2016). 'Guidance on the Assessment of Dust from Demolition and Construction'. Available at: https://iaqm.co.uk/text/guidance/construction-dust-2014.pdf

guidance provides guidance for the sensitivity of individual receptors to dust soiling and health impacts to assist in the assessment of the overall sensitivity of the Study Area.

Table 2: Sensitivity of the Area to Dust Soiling Impacts

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 3: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32	>10	Medium	Low	Low	Low	Low

Receptor Sensitivity	Annual Mean PM_{10} Concentration ($\mu g/m^3$)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
		1-10	Low	Low	Low	Low	Low
	24-28	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table 4: Sensitivity of the Area to Ecological Impacts

Receptor Sensitivity*	Distance from the Sources (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

***Receptor sensitivity judged using the following metrics:**

High sensitivity receptor:

- locations with an international or national designation and the designated features may be affected by dust soiling; or
- locations where there is a community of a particularly dust sensitive species such as vascular species included in the Red Data List For Great Britain.

Medium sensitivity receptor:

- locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or
- locations with a national designation where the features may be affected by dust deposition.

Low sensitivity receptor:

- locations with a local designation where the features may be affected by dust deposition.

STEP 2C – DEFINE THE RISK OF IMPACTS

The dust emissions magnitude determined at Step 2A should be combined with the sensitivity of the area determined at Step 2B to determine the risk of impacts without mitigation applied. For those cases where the risk category is 'negligible' no mitigation measures beyond those required by legislation will be required.

Table 5: Risk of Dust Impacts

Sensitivity of surrounding Area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible
Earthworks and Construction			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Trackout			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

STEP 3 – SITE SPECIFIC MITIGATION

Having determined the risk categories for each of the four activities it is possible to determine the site-specific mitigation measures to be adopted. These measures will be related to whether the site is considered to be a low, medium or high risk site. The IAQM Dust Guidance[a] details the mitigation measures required for high, medium and low risk sites as determined in Step 2C.

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TECHNICAL APPENDIX 5-2: OPERATION PHASE ASSESSMENT

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APPENDIX 5-2: OPERATION PHASE ASSESSMENT

INTRODUCTION

Atmospheric dispersion modelling was performed using the Cambridge Environmental Research Consultants (CERC) Atmospheric Dispersion Modelling System (ADMS 6.0)[1] including the amine chemistry module. This model uses detailed information regarding the pollutant releases, local building effects and local meteorological conditions to predict pollution concentrations at specific locations selected by the user. It has been validated against both field studies and wind tunnel studies of dispersion and is widely used for air quality impact assessment in the UK. The CERC amine chemistry module reflects the latest understanding of the atmospheric degradation of amines. The modelling inputs and assumptions used are detailed in the following sections.

SCOPE

The dispersion modelling undertaken to inform **Chapter 5: Air Quality (Volume 1)** covers operational emissions from waste incineration only (existing emissions), and the impact of the installation of the Carbon Capture Facility on the dispersion of emissions from operations at the Riverside Campus.

KEY DISPERSION MODEL INPUTS

MODELLED SCENARIOS

The scenarios modelled cover the combined continuous operation of Riverside 1 and Riverside 2 at full load, with annual waste incineration at their maximum permitted level, 850,000 tonnes per annum (tpa) and 805,920 tpa respectively. Specifically, two scenarios are modelled:

- Baseline: Operation without the Carbon Capture Facility; and
- With the Proposed Scheme: Operation with the Carbon Capture Facility.

The impact of the inclusion of the Carbon Capture Facility is defined as the difference between the Proposed Scheme and Baseline scenarios (Proposed Scheme minus the Baseline).

STACK PARAMETERS

The stack parameters for Riverside 1 and Riverside 2, with and without the Proposed Scheme, are set out in **Table 1**.

Under existing operations, Riverside 1 has three waste incineration streams, all of equal capacity and each discharging into an individual flue. The three flues are contained within a common wind shield (one stack) of height 88m (above ground level (agl)). By design, Riverside 2 has two waste streams, with equal capacity, discharging into separate flues. The two flues are contained within two common wind shields (two stacks) of height 90m (agl).

With the Carbon Capture Facility in operation, the exhaust gases from Riverside 1 and Riverside 2 will be treated in two separate Carbon Capture Plants. For both Riverside 1 and Riverside 2, the exhaust gases from all waste streams (three and two respectively) will be merged prior to treatment and post the carbon capture process, will discharge through their own new dedicated stack i.e., one stack for Riverside 1, one stack for Riverside 2. The stacks will each be mounted on top of their respective CO_2 absorber column. Further information on the Carbon Capture Facility is provided in **Chapter 2: Site and Proposed Scheme Description (Volume 1)**.

The Baseline scenario has been modelled with two sources i.e., a source representing Riverside 1 and a separate source representing Riverside 2. This representation of the emissions is based on the assumption that the exhaust gases from the individual flues in each incineration plant will merge shortly after exit to ambient air. This is a conservative assumption in the context of this assessment. It minimises ground level concentrations for the Baseline since the plume resulting from the merging of flue gases has greater effective buoyancy than individual plumes from each flue. If ground level concentrations are minimised in the Baseline, the impact of the addition of carbon capture will be maximised since the impact is calculated as the difference between the Proposed Scheme and Baseline scenarios. Post the carbon capture process, the exhaust gases from each Carbon Capture Plant (encompassing the flues from Riverside 1 and Riverside 2) are fed through two individual Absorber Stacks mounted on top of the Absorber Columns and no assumptions regarding plume merging are required. Based on the design of the Proposed Scheme as described in **Chapter 2: Site and Proposed Scheme Description (Volume 1)** these flues are too far apart to model as merged plumes.

Pollutant emission concentrations and rates (**Table 2**) are based on the respective Emission Limit Values (ELV) set out in the Environmental Permits for Riverside 1 (BK0825IU/V009) and Riverside 2 (GP3535QS). They align with ELV in the Industrial Emissions Directive (IED, Council of the European Union, 2010)[2] and/or associated EU Best Available Techniques (BAT) associated emission levels (BAT-AELs)[3].

BAT-AELs have not yet been specified for the release of amines and degradation products and aldehydes from the carbon capture process. As such, the emission limits for these pollutants are set at values specified by potential technology suppliers.

For pollutants emitted by Riverside 1 and future Riverside 2 (i.e., all pollutants except amines/aldehydes), the mass emission rate of pollutants is assumed to be unaffected by the carbon capture process. This effectively assumes that, under the facility's Environmental Permit(s), the emissions limit compliance assessment for any future process with carbon capture will be undertaken pre-carbon capture. It is possible that some pollutants will be removed with the CO_2 but to ensure a conservative assessment, it is assumed that all pollutants are retained within the exhaust gases. As such, the same mass emission rates are assumed for these pollutants in both the Baseline and with the Proposed Scheme scenarios.

For those pollutants introduced by the carbon capture process, namely amines and aldehydes, the emissions limit compliance assessment must apply post the carbon capture process, and this is reflected in the release rates set out in **Table 2**.

The IED sets an ELV for the aggregate concentration of nine Group 3 metals. For this assessment, Environment Agency guidance on assessing Group 3 metal stack emissions from incinerators[4] has been followed to provide a case specific screening of impacts from the individual named metals (Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel and Vanadium and their compounds). The guidance acknowledges that a worst-case assessment of impacts based on each metal individually comprising 100% of the ELV is theoretical only and likely to be overly conservative. As such, the guidance provides a method for producing a case specific screening that retains a degree of conservatism but uses more realistic emission rates than this theoretical worst-case. The case specific screening is, following the guidance, based on the maximum monitored emissions concentrations from 34 samples of municipal waste incinerators between 2007 and 2015 and the assumption that this provides a realistic upper bound on likely worst-case emissions (**Table 3**). Monitored concentrations of metals at Riverside 1 have, for the past 3 years, been well below these screening ELV and the assessment is robust.

Table 1: Bulk Exhaust Parameters (per Incineration Unit and as Modelled, Pre and Post the Carbon Capture Process)

Metric	Pre-Carbon Capture Process				Post-Carbon Capture Process	
	Riverside 1		Riverside 2		Riverside 1	Riverside 2
	Per Unit	Combined Plume (as modelled)	Per Unit	Combined Plume (as modelled)	Per Unit	Per Unit
No of Units	3	1	2	1	1	1
Actual Flow (Nm^3/hr)	75.4	226.3	76.99	154.0	134.09	102.2
Temperature (°C)	140		125		80	80
O_2 (%, actual)	6.3		5.5		8.5	7.3
H_2O (% actual)	21.0		20.1		6.7	6.4
Normalised Flow (Nm^3/s, 11% O_2,dry)	51.3	154.0	59.7	119.4	115.5	97.5
Easting	-	549699	-	549455	549612	549530
Northing	-	180577	-	180757	180473	180484
Stack Diameter (m)	2.3	3.98[a]	2.2	3.11	3.1[a]	2.5
Stack Height (m)	-	88	-	90	100[b]	100[b]
Exit Velocity (m/s)	-	18.2	-	20.3	17.8	20.8

a. Effective flue diameter for merged plume based on area of 3 x flues of diameter 2.3m (Riverside 1), and 2 x flues of diameter 2.2m (Riverside 2). Volume flow rate is based on combined volume flow rate from 3 flues or 2 flues respectively.

b. Stack heights tested from 70m to 130m.

Table 2: Pollutant Emission Rates

Metric	Riverside 1			Riverside 2		
	Emission Limit (mg/Nm^3)	Emission Rate (per Unit) (g/s)	Emission Rate (per modelled source) (g/s)	Emission Limit (mg/Nm^3)	Emission Rate (per Unit) (g/s)	Emission Rate (per modelled source) (g/s)
Existing Exhaust Gas Pollutants (Baseline and With Scheme)						
PM (30min)	30	1.54	4.62	30	1.79	3.58
PM (daily)	5	0.26	0.77	5	0.30	0.60
HCl (30min)	60	3.08	9.24	60	3.58	7.16
HCl (daily)	8	0.41	1.23	6	0.36	0.72
HF (30mins)	1	0.05	0.15	1	0.06	0.12
CO (10mins)	150	7.70	23.10	150	8.95	17.90
CO (daily)	50	2.57	7.70	50	2.98	5.97
SO_2 (30 min)	200	10.27	30.80	200	11.94	23.87
SO_2 (daily)	40	2.05	6.16	30	1.79	3.58
NOx (30min)	400	20.53	61.60	400	23.87	47.74
NOx (daily)	180	9.24	27.72	75	4.48	8.95
Cd + Th (30mins)	0.02	1.03E-03	3.08E-03	0.02	1.19E-03	2.39E-03
Hg (30mins)	0.02	1.03E-03	3.08E-03	0.02	1.19E-03	2.39E-03

Metric	Riverside 1			Riverside 2		
	Emission Limit (mg/Nm^3)	Emission Rate (per Unit) (g/s)	Emission Rate (per modelled source) (g/s)	Emission Limit (mg/Nm^3)	Emission Rate (per Unit) (g/s)	Emission Rate (per modelled source) (g/s)
Sb,As,Pb,Cr,Co,Cu,Mn,Ni,V (30min)*See paragraph on EA Guidance above	0.3	0.02	0.05	0.3	0.02	0.04
NH_3 (daily)	15	0.77	2.31	10	0.60	1.19
Dioxins and furans (ITEQ)	6E-08	3.08E-09	9.24E-09	4E-08	2.39E-09	4.77E-09
Emissions Associated with the Proposed Scheme Only*						
Primary Amine (daily)	2	0.10	0.31	2	0.12	0.24
Primary Amine (annual)	1	0.05	0.15	1	0.06	0.12
Nitrosamines	0.0001	5.13E-06	1.54E-05	0.0001	5.97E-06	1.19E-05
Secondary Amine (daily)	2	0.10	0.31	2	0.12	0.24
Secondary Amine (annual)	1	5.13E-02	1.54E-01	1	5.97E-02	1.19E-01
nitrosamines	0.0001	5.13E-06	1.54E-05	0.0001	5.97E-06	1.19E-05
Aldehydes (annual)	5	0.26	0.77	5	0.30	0.60
Aldehydes (daily)	10	0.51	1.54	10	0.60	1.19
*Emissions post-carbon capture process are indicative, based on information provided by technology suppliers.						

Table 3: Modelled Emission Rates for Metals

Pollutant	EA Max % of the IED Group 3 Emis. Limit Value	Riverside 1		Riverside 2	
		Emission Rate (per Unit) (g/s)	EmissionRate (per modelled source) (g/s)	Emission Rate (per Unit) (g/s)	EmissionRate (per modelled source) (g/s)
Antimony	2.3%	3.54E-04	1.06E-03	4.12E-04	8.24E-04
Arsenic	5.0%	7.70E-04	2.31E-03	8.95E-04	1.79E-03
Total Chromium	18.4%	2.83E-03	8.50E-03	3.29E-03	6.59E-03
Chromium VI	0.03%	4.62E-06	1.39E-05	5.37E-06	1.07E-05
Cobalt	1.1%	1.69E-04	5.08E-04	1.97E-04	3.94E-04
Copper	5.8%	8.93E-04	2.68E-03	1.04E-03	2.08E-03
Lead	10.1%	1.56E-03	4.67E-03	1.81E-03	3.62E-03
Manganese	12.0%	1.85E-03	5.54E-03	2.15E-03	4.30E-03
Nickel	44.0%	6.78E-03	2.03E-02	7.88E-03	1.58E-02
Vanadium	1.2%	1.85E-04	5.54E-04	2.15E-04	4.30E-04

Where emission limit values are provided at 30 minute and daily averaging periods e.g. PM, SO_2, NO_X etc, impacts with averaging periods less than 24 hours are assessed on the basis of the peak permitted 30 minute emission rate, and impacts with averaging periods of 24 hours or longer are assessed on the basis of the maximum daily average emissions. These are conservative assumptions in that pollutants will not be at their emission limits continuously.

KEY MODEL INPUTS

The general model inputs used in the air quality assessment are summarised in **Table 4** below.

Table 4: Key Model Inputs

Variable	Input	Commentary
Meteorological Data	5 years of hourly sequential data from London City Airport, 2018 to 2022	London City Airport is around 7.5km west of the Site Boundary and representative of conditions to the east of central London. Wind roses are shown in **Figure 1: Wind Roses for London City Airport (Volume 3)** of this appendix. The prevailing wind is from the south-west in all years.
Surface Roughness at Site	1.0m	1.0m is the recommended value for 'cities' in ADMS. Sensitivity testing was undertaken for surface roughness between 0.3m to 1.0m. The selected value is conservative in that it gives the highest ground level impacts.
Surface Roughness of Met Site (London City Airport)	0.5m	London City Airport itself has an open aspect hence the roughness length was reduced to ADMS recommendation for 'open suburbia' for the meteorological site.
Minimum Monin-Obukhov Length at Site	100m	Selected value is the ADMS recommended values for large conurbations >1million population. Both Met Site and process Site are located within the overall London conurbation.
Minimum Monin-Obukhov Length at Met Site	100m	
Building Downwash	Included in the Baseline: Riverside 1 and Riverside 2 housing units.	Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in relatively elevated pollutant concentrations in the wake of the building. Buildings are included where they are within 5L of an emission point, where L is the lesser or the building height or

Variable	Input	Commentary
	With the Proposed Scheme (as above plus): 2x Solvent Regeneration Systems 2 x Direct Contact Coolers 2 x Absorber Columns 1 x Chemical Storage and Distribution Handling Facilities 1 x Liquified CO_2 Storage area.	crosswind width, and greater than 1/3rd of the stack height. This follows best practice guidance[5]. Building parameters are provided in **Table 5** and visualised in **Figures 2: Modelled Building Layouts (Baseline) (Volume 3)** and **Figure 3: Modelled Building Layouts (with Carbon Capture) (Volume 3)** of this appendix. The ADMS 'Main building' is source specific and set to be the housing unit for Riverside 1 and Riverside 2 in the Baseline, and to the Absorber Columns with the Carbon Capture Facility.
Receptors	Gridded at variable resolution (100m within 5km, 250m to 15km)	Receptors set at height 1.5m. Resolution of fine grid is within the recommended minimum resolution of 1.5 x stack height (150m). Impacts on human health are assessed against the maximum impact in the Study Area, irrespective of the presence of properties at the point of maximum impact. Impacts on ecological receptors are assessed at grid points within each habitats site.
Terrain Data	Not included	No significant terrain gradients within the Study Area, so no requirement to model terrain.
Deposition	No plume depletion	The Study Area is largely built up and there will be minimal plume depletion onto man-made surfaces. Deposition of pollutants to habitats sites is modelled using deposition velocity approach using the dry deposition velocities given by Environment Agency Guidance[5] (**Table 6**).
Amine Chemistry	ADMS Amine Chemistry module	Details below.

Table 5: Buildings Included in the Modelling for the Baseline and with Proposed Scheme Scenarios

Building	Shape	Easting	Northing	Height	Length	Width	Angle
Existing Buildings (Baseline and With Proposed Scheme scenarios)							
Riverside 1	Rectangular	594438	180670	65	107	170	90.4
Riverside 2	Rectangular	549692	180657	50	126	148	90.4
New Buildings (With Proposed Scheme only)							
Solvent Reg1	Rectangular	549593	180445	50	30	45	10
Solvent Reg2	Rectangular	549541	180455	50	30	45	10
Contact Cool1	Rectangular	549615	180488	30	10	10	10
Contact Cool2	Rectangular	549534	180501	30	10	10	10
Absorb-Col1*	Rectangular	549612	180473	73	10	10	10
Absorb-Col2*	Rectangular	549531	180485	73	10	10	10
Chem Store1	Rectangular	549587	180491	25	10	5	10
Chem Store2	Rectangular	549568	180495	25	10	5	10
CO_2 Store	Rectangular	549537	180302	75	68	83	10
***The post-carbon capture process exhaust gases are released from flues mounted on top of the Absorber Columns. In the stack height sensitivity tests, the height of the Absorber Column is reduced to 2m below the stack height for stacks less than 80m tall.**							

Table 6: Dry Deposition Velocities used in Post-processing Model Outputs

Chemical Species	Vegetation Type	Deposition Velocity (mm/s)
NO_2	Short Vegetation	1.5
	Forest Vegetation	3
SO_2	Short Vegetation	12
	Forest Vegetation	24
NH_3	Short Vegetation	20
	Forest Vegetation	30
HCl	Short Vegetation	25
	Forest Vegetation	60
Amines and Degradation Products*	Short Vegetation	20
	Forest Vegetation	30
*Amines and degradation products modelled using deposition velocity for ammonia.		

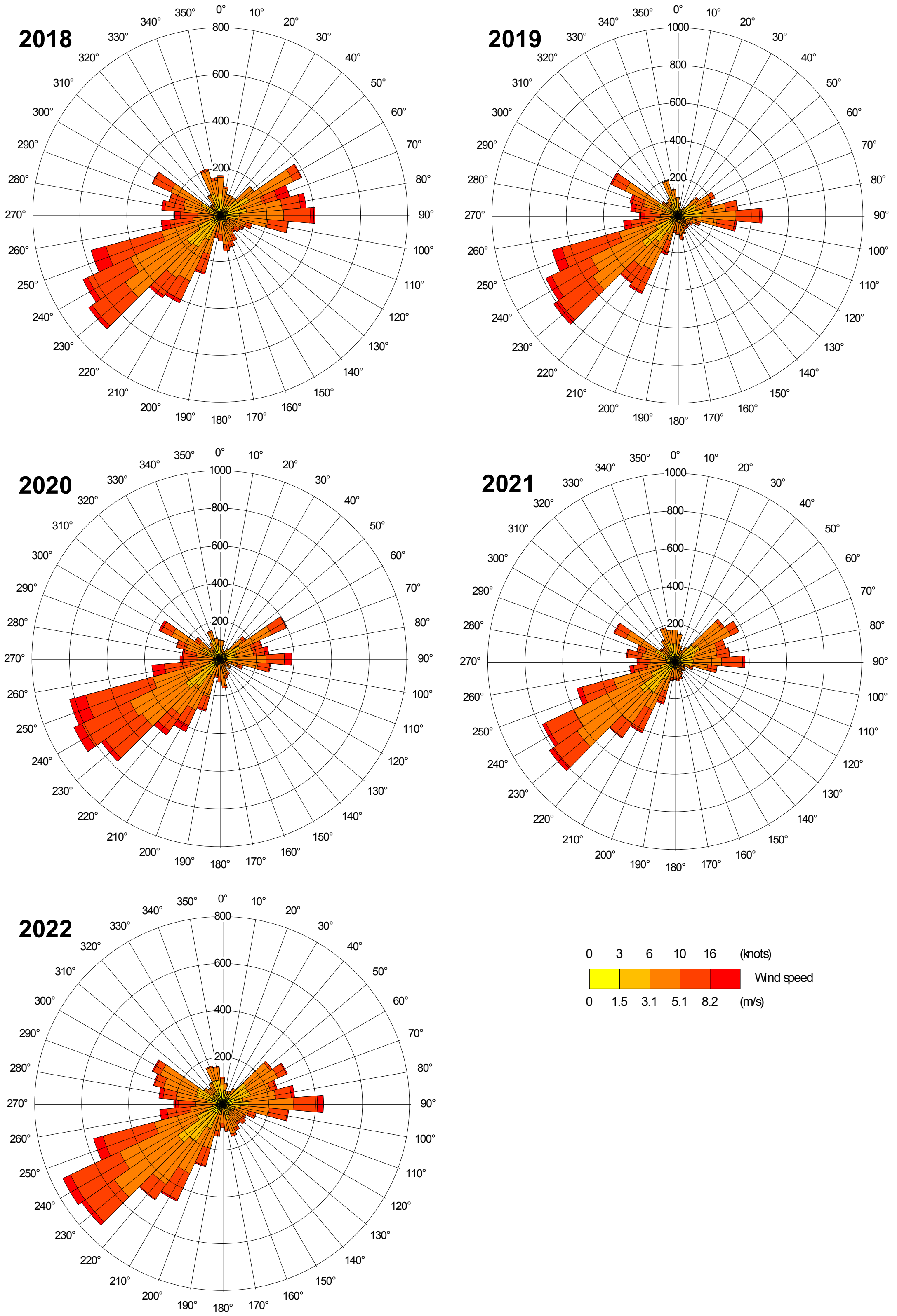

Figure 1: Wind Roses for London City Airport

Figure 2: Indicative Modelled Building Layouts (Baseline) (Riverside 1 and Riverside 2 Modelled Stacks shown as Red Stars)

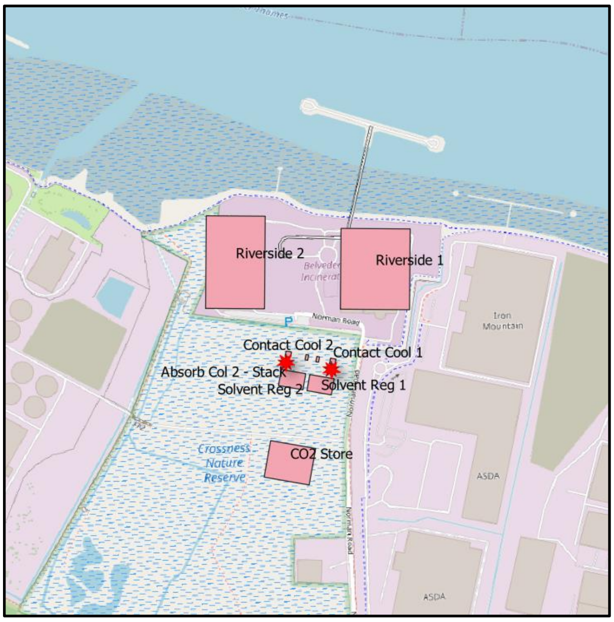

Figure 3: Modelled Building Layouts (with the Proposed Scheme) (Post carbon capture Riverside 1 and Riverside 2 Modelled Stacks shown as Red Stars)

POST PROCESSING

SUB-HOURLY IMPACTS

Meteorological data is input to the model as hourly mean data. It is not, therefore, possible to directly model 15 minute peak concentrations, required for SO_2, since the variability of meteorological data on sub-hourly timescales is not represented in the model inputs. Environment Agency provide scaling factors to adjust from hourly to sub-hourly peak concentrations and, as such, the 99.9th percentile of 15 minute SO_2 concentrations for assessment against the 15 minute air quality objective is modelled by using the model to output the 99.9th percentile of hourly mean concentrations and using the EA's scaling factor of 1.34 to convert to a 15 minute averaging period. This approach results in higher, more conservative, modelled concentrations than directly outputting 15 minute average concentrations from the model itself.

ATMOSPHERIC CHEMISTRY

ATMOSPHERIC CHEMISTRY – NO_X TO NO_2

Emissions of NO_X from combustion sources include both nitrogen dioxide NO_2 and nitric oxide (NO), with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the more significant health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using the worst-case assumptions set out in Environment Agency guidance[6], namely that:

- For the assessment of long term (annual mean) impacts, at receptors 70% of NO_X is NO_2; and
- For the assessment of short term (hourly mean) impacts, at receptors 35% of NO_X is NO_2.

The oxidation of NO to NO_2 is not, however, an instantaneous process, thus the Environment Agency worst-case assumptions are very conservative for modelled impacts within a few hundred metres of any stack.

Amines are organic derivatives of ammonia (NH_3), wherein one or more of the hydrogen (H) atoms are replaced by a substituent organic group (R). The type of amine can be defined as primary, secondary, or tertiary, based on the number of H atoms that are replaced:

- Primary amine (R-NH2) where 1 H-atom is replaced:
  - e.g., Monoethanolamine, MEA.
- Secondary amine (R2-NH) where 2 H-atoms are replaced:
  - e.g., Dimethylamine, DMA.
- Tertiary amine (R3-N) where 3 H-atoms are replaced:
  - e.g., Trimethylamine, TMA.

Amine-based solvents are used in the carbon capture process to remove carbon dioxide (CO_2) from combustion flue gases (i.e., for the Proposed Scheme, removal of CO_2 from post-combustion gases associated with Riverside 1 and Riverside 2). The amine compounds included within the solvent make-up can react with substances other than CO_2 to create new, potentially harmful compounds (e.g., nitrosamines and nitramines). These reactions can occur both within the carbon capture process itself and in the atmosphere following release of the treated post-combustion flue gases. Therefore, it is important that emissions to atmosphere, associated chemical transformations, and dispersion and deposition within the Study Area are represented within the air quality model.

Nitrosamines and nitramines are organic compounds, formed by reactions with nitrogen monoxide (NO) and nitrogen dioxide (NO_2), respectively. The chemical structure of nitrosamines is $R_2N\text{-}NO$ and nitramines is $R_2N\text{-}NO_2$, formed from the original amine, where R is usually an alkyl group. Nitrosamines are susceptible to photodegradation and therefore generally short-lived in the atmosphere (~5 min). In contrast, nitramines are more stable and will have longer atmospheric residence times (~2 days). As such, the stability of nitramines indicates an increased potential for accumulation in the atmosphere relative to nitrosamines.

ADMS Chemistry Module

Direct emissions of amines and nitrosamines associated with potential solvent loss, degradation within the carbon capture process and entrainment within the flue gas, are expected to be low. Nevertheless, the ADMS Amine Chemistry Module[7] has been used to model the chemical reactions associated with the release of amine compounds and the formation of associated nitrosamines and nitramines in the atmosphere.

Whilst the Environment Agency acknowledge that the uncertainty associated with modelling of amines is likely to be very high, the Environment Agency's latest draft guidance[8] on the assessment of impacts to air quality from amine-based post-combustion carbon capture plants states "…*the only commercially available modelling software to evaluate the potential impacts from amines and amine degradation products releases is the amines module within ADMS. The amines chemistry module is based on established science considering published research on mechanisms of formation of toxic compounds. Although the validation of the module is not possible at the moment, the ADMS air dispersion modelling algorithms are continually validated against real world situations, field campaigns and wind tunnel experiments"*.

The mechanisms for the formation of nitrosamines and nitramines in the atmosphere are complex. However, the main initial reaction of amines in the atmosphere is with hydroxyl (OH) radicals and it is this reaction on which the ADMS amine chemistry scheme is based (CERC[7]). As described above, the subsequent formation of nitrosamines and nitramines are attributed to reactions with NO and NO_2, however, they can further degrade in the atmosphere (e.g., through photo-oxidation and subsequent reaction with oxygen molecules to form imines, which are relatively stable and non-toxic compounds (Manzoor, 2015[9])

Primary amines do not form stable nitrosamines, meaning that any such nitrosamines would be rapidly isomerised to the respective imine. However, secondary and tertiary amines do form stable nitrosamines. The ADMS module includes an option to allow only unstable nitrosamines to be created (i.e., assuming emissions of primary amines only) which, if selected by the model user, sets all nitrosamine outputs to zero and only nitramines will form. This option was not selected for this assessment to ensure that the degradation of amines (primary, secondary or tertiary) is taken into account, but nitrosamines formed from the degradation of primary amines were not considered in the assessment. This follows the approach taken by CERC[10].

The general reaction scheme simulated by the ADMS amines module is as follows:

AMINE + hydroxyl radical (•*OH*)	→	amino RADICAL + H_2O	(1a)
	→	non-amine radical ($RN(H)C^{\bullet}H_2$) + H_2O	(1b)
amino RADICAL + O_2	→	imine + hydroperoxyl (HO_2)	(2)
amino RADICAL + *NO*	→	NITROSAMINE	(3)
amino RADICAL + NO_2	→	NITRAMINE	(4a)
	→	imine + nitrous acid (*HONO*)	(4b)
NITROSAMINE	*hυ* →	amino RADICAL	(5)

Notes: R represents an alkyl group.

Terms in capitals are the generic names given to the respective compounds for which input data are required for modelling in ADMS.

The amount of nitrosamine and nitramine formed in the atmosphere is dependent on the initial reaction of the amine with the OH radical – specifically the branching ratio of the abstraction of an H atom from the amino group (N-H) (i.e. forming the amino RADICAL) to the abstraction from the methyl group (C-H) (i.e. forming the non-amine radical) – where a lower branching ratio will result in fewer amino radicals being made available and thus fewer nitrosamine / nitramine compounds being formed. However, other variables play an essential role in the potential formation of nitrosamines and nitramines in the atmosphere and are required for the ADMS amine chemistry module to run, including:

- Ambient concentrations of the OH radical:
  - A representative annual average OH radical concentration for the UK was sourced from published research (Walker, 2015)[11], based on measurements taken from a series of daytime and night-time flights over the UK in summer 2010 and winter 2011 using the fluorescence assay by gas expansion (FAGE) technique. In the absence of sunlight, OH is not formed at night and therefore OH was not detected above the instrument's limit of detection during any of the night-time or winter daytime flights.
  - An upper limit OH concentration of 1.8×10^6 molecules cm^{-3} is reported, which is calculated based on summer daytime flights only.
  - This is the value used to feed into the amine chemistry modelling and is likely to be conservative (skewed high) as an annual average (i.e., if more OH radicals are available in the atmosphere, daytime amine degradation increases, resulting in increased production of nitrosamine / nitramine compounds).
- Photolysis rates applicable to the region of study:
  - The ADMS meteorological pre-processor provides hourly information with respect to incoming solar radiation (*K*) specific to the met year data and latitude. A subsequent calculation is completed using the K values to derive hourly photolysis rates, which are then used to calculate an annual average rate constant for of NO_2 (jNO2) (CERC[1]).
  - The meteorological data used in the amines chemistry module aligns with that used for modelling of all other non-amine related pollutants, comprising hourly data for years 2018-2022 inclusive from London City Airport.
- Ambient concentrations of ozone (O_3) and NO_x (i.e., NO and NO_2):
  - The amine reaction scheme requires hourly background levels of NO_x and O_3 equivalent to the year of meteorological data. Hourly data for these species were sourced from Defra's London Bloomsbury AURN monitoring site, representing urban background levels, for the years 2018-2022 inclusive.
  - Background NO_X concentrations are used to dictate the availability of NO and NO_2 in the formation of nitrosamines and nitramines, respectively, on an hourly basis.
  - The hydroxyl radical concentration varies based on a number of factors, including solar radiation, latitude, and background levels of O_3. The ADMS amine module requires a constant, '*c*', which is used to calculate hourly varying OH radical concentrations for the region of study. The value for *c* is derived based on the relationship between annual average values for jNO_2, O_3 and OH radical concentrations as described above.

The reaction rates and associated kinetic parameters input to ADMS v6.0 need to be defined by the model user.

The technology supplier for the two Carbon Capture Plants has not yet been selected. As such, the post-carbon capture process emissions, set out in **Table 1** and **Table 2** are indicative and estimated from information provided by various suppliers. Furthermore, since the specific details of the process solvents for each supplier are confidential, the assessment has been undertaken on the basis that all of the amine releases are either MEA (primary amine) or DMA (secondary amine). Reaction rate data for these species are available, albeit with some variability, in publicly available literature. The values used are provided in **Table 7**. Acknowledging the uncertainty associated with modelling amines and their degradation, additional sensitivity testing is underway and will be reported in the ES (as set out in **Table 7**).

The general description of the ADMS amine chemistry scheme can be summarised in five steps:

1. On an hourly basis, ADMS uses the above input parameters to model concentrations of the species of interest as well as the age of the primary pollutants (e.g., amines) at each receptor /grid point using the standard ADMS dispersion algorithms.
2. Using the 'dilution and entrainment' scheme within the ADMS amines module, the primary pollutant concentrations are adjusted to removed dilution effects (i.e., becoming increasingly conservative with distance from stack exit).
3. The chemistry reaction scheme requires consideration of timescales, so that after each hourly dispersion calculation, the 'age' of the pollutants is calculated based on the plume travel time. The chemical reaction equations are applied to all pollutants from the source.
4. At this point, the 'dilution and entrainment' scheme is used to dilute all pollutants as ambient air, containing the background pollutants, is entrained into the plume.
5. Steps 3 and 4 are repeated for each time step until time becomes equal to the pollutant 'age'.

Modelling Deposition of Amines in ADMS

CERC[1]recommend the following method for calculating deposition of amines and associated products (nitrosamines, nitramines) in ADMS was undertaken based on the following approach:

1. Run the respective amine chemistry model runs with amine chemistry switched on and deposition switched off (i.e., as detailed above).
2. Run the same model set up as in Step 1, but with the amine chemistry switched off and deposition switched on.
3. Run the same model set up as in Steps 1 and 2, but with both amine chemistry and deposition switched off.

Based on the outputs from Step 2 (deposition switched on) and Step 3 (deposition switched off), the ratio of the concentration to deposition flux was calculated for each amine and at each receptor / grid location. This ratio is then multiplied by the concentration output from Step 1 (amine chemistry switched on) to derive the amine deposition fluxes at all receptor and grid locations.

This approach has not been followed in this assessment since, as for other pollutants, deposition will be limited within the Study Area due to the predominance of man made rather than vegetated surfaces. This has no material impact on the assessment but, if anything, it ensures a degree of conservatism in the output.

Research published by Karl *et al (2009)*[12], which reports on worst-case studies for assessing deposition of amines from the carbon capture process, adopted a deposition velocity of 10 mm/s for amines and 30 mm/s for nitrosamines and nitramines. This reflects that the solubility of amines is relatively lower than that of nitrosamines and nitramines. However, in the absence of recommended deposition velocities for these compounds, a conservative approach has been adopted for the assessment of the Proposed Scheme, whereby the deposition velocity for all amine, nitrosamine, and nitramine compounds is assumed to be equivalent to that for ammonia (20mm/s or 30 mm/s depending on vegetation type) (i.e., all gaseous amine compounds assumed to be highly soluble).

Table 7: ADMS Amine Module Reaction Rate Coefficients

Parameter	Units	Notes	PEIR Input	Ongoing Sensitivity Testing for Reporting in ES
Amine emission	g/s	Emission rate for amine compounds. Annual mean rate based on typical release given by technology suppliers. Daily mean rate assumed double typical release. For modelling, emissions are assumed to be either all MEA or all DMA.	As per **Table 2**	N / A
Direct nitrosamine emission	g/s	Emission rate for nitrosamine compounds, based on typical release given by technology suppliers, with emissions assumed to be associated with either MEA or DMA as relevant to the amine species.	As per **Table 2**	N / A
NO_x emission	g/s	Emission rate for NO_x, based on daily mean emission limits for each Riverside 1 and Riverside 2 as set in existing environmental permit.	As per **Table 2**	N / A
% NO_x emission as NO_2 in flue gas	%	Proportion of NO_x assumed to be as NO_2 in flue gas at Absorber Stack exit.	5%	Testing at 10% to be considered.
Amine / OH reaction rate constant, *k1*	/ppb/s	Relating to the reaction of the emitted amine with the OH radical.	MEA: 2.07 DMA: 1.59	Tested to be undertaken on basis of range of published data* from CERC 2012[13], Manzoor
Amino radical / O_2 reaction rate constant, *k2*	/ppb/s	Relating to the reaction of the amino radical with oxygen (forming imine).	MEA: 4.96×10^{-8} DMA: 4.6×10^{-8}	

Parameter	Units	Notes	PEIR Input	Ongoing Sensitivity Testing for Reporting in ES
Rate constant for formation of nitrosamine, *k3*	/ppb/s	Relating to the formation of nitrosamine from the reaction of the amino radical with NO.	MEA: 0.0037 DMA: 0.0021	2015[9], Nielsen 2011[14]
Rate constant for formation of nitramine, *k4a*	/ppb/s	Relating to the formation of nitramine from the reaction of the amino radical with NO_2.	MEA: 0.004 DMA: 0.0078	
Amino radical / NO_2 reaction rate constant, *k4*	/ppb/s	Relating to the reaction of the amino radical with NO_2 (forming imine or nitramine).	MEA: 0.0045 DMA: 0.0097	
Branching ratio for amine / OH reaction	Dimensionless	The ratio of H atom abstraction from amino group (N-H) to the methyl group (C-H).	MEA: 0.1 DMA: 0.4	
Ratio of j(nitrosamine) / jNO_2	Dimensionless	Ratio of photolysis rate constants for the nitrosamine and NO_2.	MEA: 0 DMA: 0.39	
Constant, *c*, for OH concentration calculations	s	Constant for calculating hourly varying OH concentrations, based on relationship between annual average jNO_2, O_3 and OH concentrations.	0.003	Testing of background pollutant data (specifically O_3) will require *c* to be recalculated.
Atmospheric O_2 concentration	ppb	Concentration of oxygen in air (equivalent to 21% mixing ratio).	209,406,000 ppb	n/a

Parameter	Units	Notes	PEIR Input	Ongoing Sensitivity Testing for Reporting in ES
Background NO_x / NO_2 concentrations	µg/m^3	Ambient hourly concentrations for each species sourced from representative monitoring location.	Defra AURN urban background monitoring site at London Bloomsbury (aligned with meterological years, 2018 – 2022)	Testing of background NO_x / NO_2 /O_3 levels from Thurrock urban background AURN site to be considered.
Background O_3 concentrations	µg/m^3			
***MEA and DMA represent two of the most studied amine compounds relating to emissions from the carbon capture process, thus resulting in greater data availability relating to their respective reaction schemes. Specifically, DMA is a secondary amine from which the nitrosamine, NDMA, is formed. The assumption that all modelled direct and indirect nitrosamine (from secondary amine only) and nitramine parameters associated with the Proposed Scheme will be equivalent to NDMA represents a worst-case approach in terms of assessment versus the EAL, given that NDMA is considered to be one of the most toxic nitrosamines.**				

ASSESSMENT STANDARDS FOR AMINES

At present the Environment Agency has established EAL (non-statutory Environmental Assessment Levels) for MEA and NDMA only. This assessment assumes that the EAL for MEA can be applied to MEA and DMA, and that the EAL for NDMA can be applied to all stable nitrosamines (from DMA only) and nitramines.

Existing toxicological data indicates that most nitrosamines are carcinogenic, with the most widely researched nitrosamine being N-nitrosodimethylamine (NDMA), formed from DMA, due to its toxicity. Accordingly, the EAL established by the Environment Agency for the assessment of nitrosamines is derived for NDMA. Less is known about nitramines, but they have the potential to be mutagenic and carcinogenic although typically less potent than nitrosamines, with some research studies indicating that nitramines are at least six times less toxic (Gjernes, 2013[15]) and fifteen times less mutagenic (Wagner, 2014[16]) than nitrosamines.

POST CARBON CAPTURE STACK HEIGHT ASSESSMENT

The two new stacks for the venting of exhaust gases post the carbon capture process are located on top of the Absorber Columns. In the parameters provided by technology suppliers, the height of the Absorber Columns varied from 50m to over 70m. Initial model testing was undertaken to determine an appropriate stack height based on NO_2 impacts as a compound representative of both short and long term exposure to pollution. The results of the testing from 70m to 130m are shown in Error! Reference source not found.: **Stack Height Testing for Annual and Hourly Mean NO2 (Volume 3).**

Ground level impacts decrease rapidly as the stack height increases from 70m (approximately the height of the absorber column) to 100m, but then decrease more slowly with further increases in height. Taking into consideration the height of the existing stack on site (Riverside 1, ~90m) and constraints on stack height at the site location, the selected stack height is a minimum of 100m.

The sensitivity testing indicated that the ground level impacts were materially affected by the offset in height between the Absorber Column and associated stack exits. This distance should be 20m to 30m to achieve good dispersion of the gases. This implies that:

- minor adjustments to the site layout will not materially affect results, since the dominant impact is that of the Absorber Columns on which the stacks are located; and
- if the selected technology supplier uses a short Absorber Column, it may be possible to slightly reduce the proposed stack height.

All results presented in **Chapter 5: Air Quality (Volume 1)** and this technical appendix relate to a 100m post carbon capture stack height (unless otherwise stated), of which 80m is the Absorber Column height.

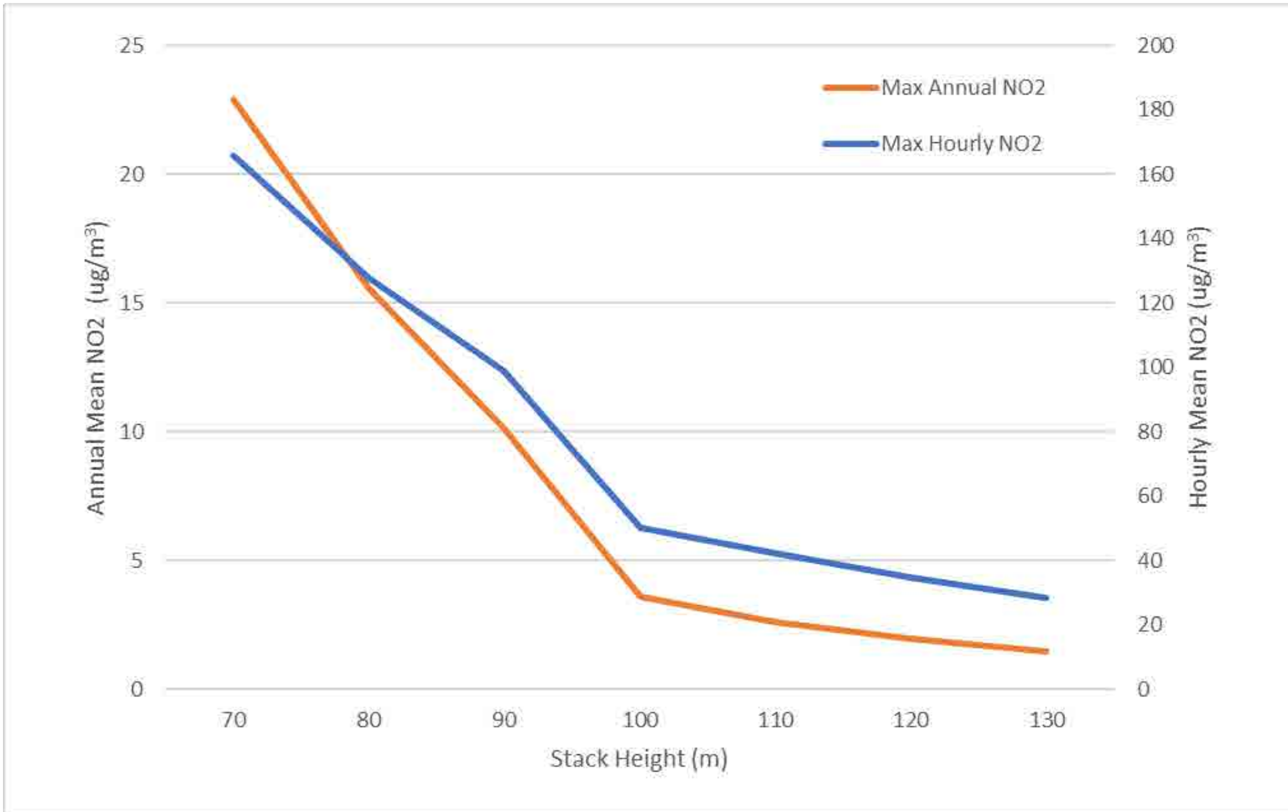

Figure 4: Stack Height Testing for Annual and Hourly Mean NO_2

MODEL RESULTS OVERVIEW AND EXPLANATION

The likely potential significant effects for air quality associated with the operation phase of the Proposed Scheme are summarised in **Chapter 5: Air Quality (Volume 1)**, with further model results provided in **Appendix 5-3: Detailed Model Pollutant Results (Volume 3)**. **Figures 5-4** to **5-13 (Volume 3)** show the spatial distribution of modelled impacts that do not screen as negligible against IAQM criteria.

In this section, a description and explanation of the spatial distribution of modelled impacts is provided to aid interpretation of the model results tables and figures. For existing pollutants, this description is made with reference to impacts on annual mean and hourly mean NO_2. They serve to illustrate the modelled long term (annual mean) and short term (hourly, sub-hourly) impacts on concentrations of other pollutants emitted by the existing incineration process.

As set out in **Table 1**, the bulk exhaust flue gas parameters will change with the Proposed Scheme due to the removal of CO_2 from the existing flue gas lines and the cooling of the exhaust gases prior to carbon capture. Furthermore, the distribution of impacts from the exhaust gases will change with the shift in release location from the existing Riverside 1 stack and under-construction Riverside 2 stack, to the post-carbon capture stacks.

In combination, these changes result in impacts that are, in places, adverse i.e., tending to increase pollutant concentrations, and, in other places, beneficial i.e., tending to reduce pollutant concentrations. The reasoning for this is set out below.

Figure 5 shows the distribution of annual mean NO_2 resulting from the baseline operation of Riverside 1 and Riverside 2 individually, as modelled using 2020 meteorological data which was representative for all 5 years of meteorological data used in the modelling. The figure also shows the wind rose for 2020, reproduced from

Figure 1: Wind Roses for London City Airport

and is shown with base mapping to facilitate the interpretation of the contours themselves.

The maximum impacts occur around 800m and 500m north-east of the existing stacks for Riverside 1 and Riverside 2 respectively. These maxima reflect the dispersion of pollutants on the prevailing south-westerly winds. Secondary maxima occur to the south-east of each stack driven by the north-easterly winds that occur less frequently than south-westerly winds but more frequently than winds from other directions and there is also a slight increase in pollutant concentrations to the south-east of the stack as a result of the approximately 300 hours of north-westerly winds that occurred in 2020. Overall impacts from Riverside 1 exceed those of Riverside 2. This is due in part to the greater capacity of Riverside 1 but also to the fact that the permit emission limit for NOx for Riverside 2 is lower than for Riverside 1.

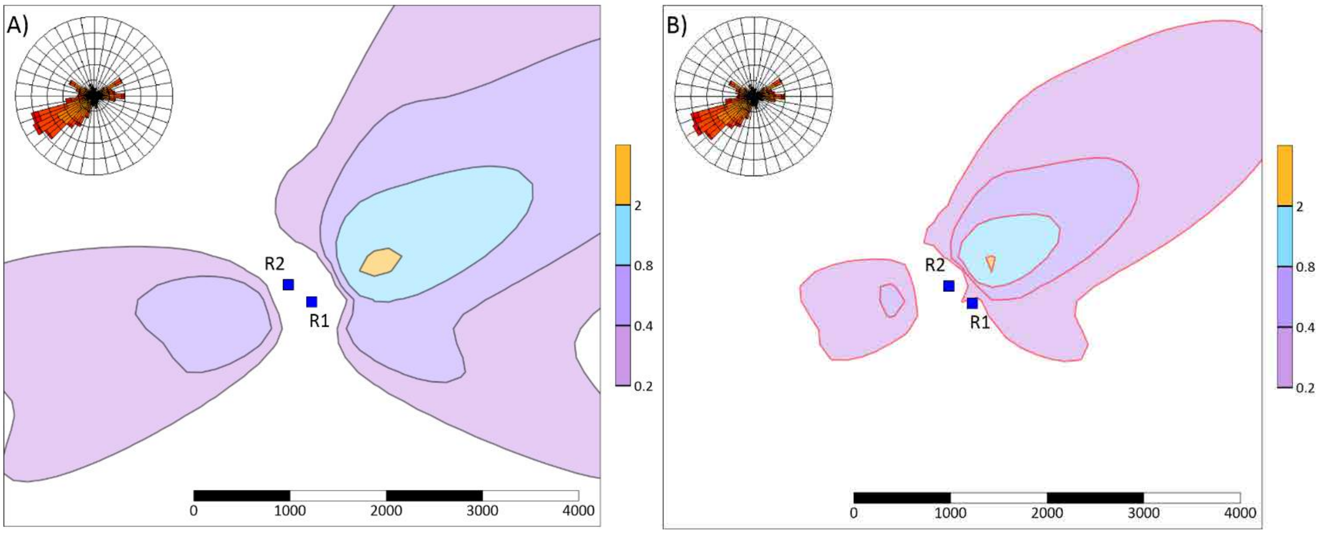

Figure 5: Distribution of pre-carbon capture ground level concentrations of annual mean NO2 (µg/m^3) resulting from the full load operation of A) Riverside 1 (R1) and B) Riverside 2 (R2), modelled using meteorological data for 2020. The stacks are shown as blue squares

The spatial offset in the points of maximum impacts between the impacts of Riverside 1 and 2 is seen in **Figure 6A**, which shows the same contours as in **Figure 5A and 5B**, but overlayed on top of one another, whilst **Figure 6B** shows the cumulative impact of the two facilities. The spatial offset is driven in part by the physical separation of the Riverside 1 and Riverside 2 stacks, and in part by the greater buoyancy of the Riverside 1 plume due to its higher temperature and greater volumetric flow than Riverside 2 (**Table 1**). The greater buoyancy of the Riverside 1 plume means that the plume rises higher after leaving the stack and the pollutants take longer to disperse back to ground level resulting in the point of maximum impact being further from the stack than that from Riverside 2.

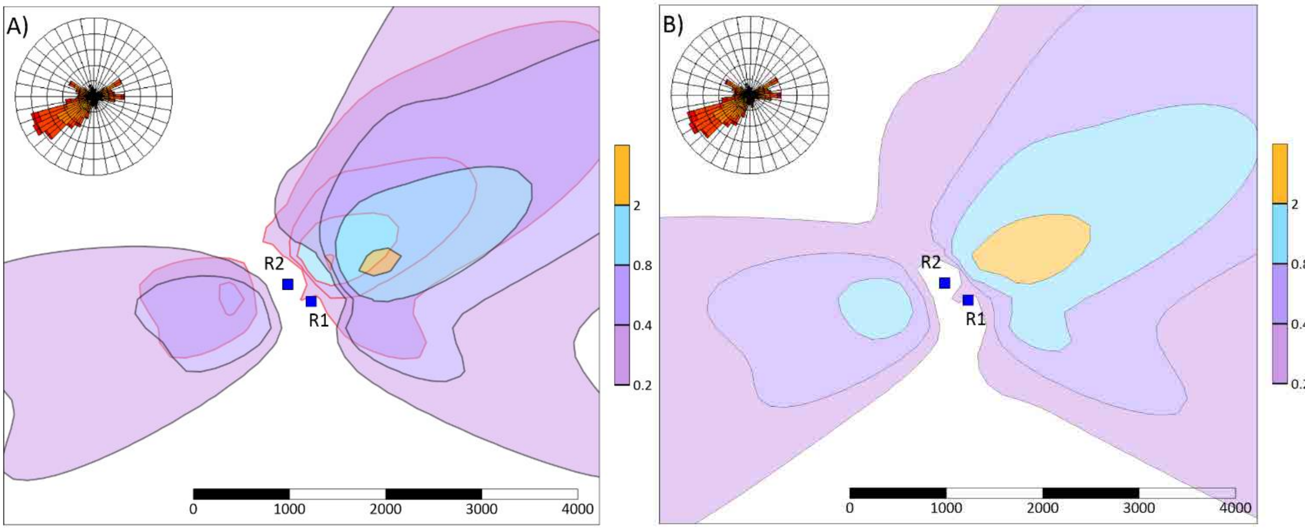

Figure 6: Distribution of pre-carbon capture ground level concentrations of annual mean NO_2 (µg/m^3) resulting from the full load operation of A) Riverside 1 (R1) and Riverside 2 (R2) individually and B) Riverside 1 and Riverside 2 cumulatively, modelled using meteorological data for 2020

Figure 7 and **Figure 8** show the equivalent plots for the impacts of the plumes from the Riverside Campus, post carbon capture. The impacts of Riverside 2 remain lower than those of Riverside 1, but the spatial offset of the impacts is much reduced from the pre-carbon capture scenario since the stacks associated with the absorber columns are much closer together and there is less difference in the buoyancy of the plumes.

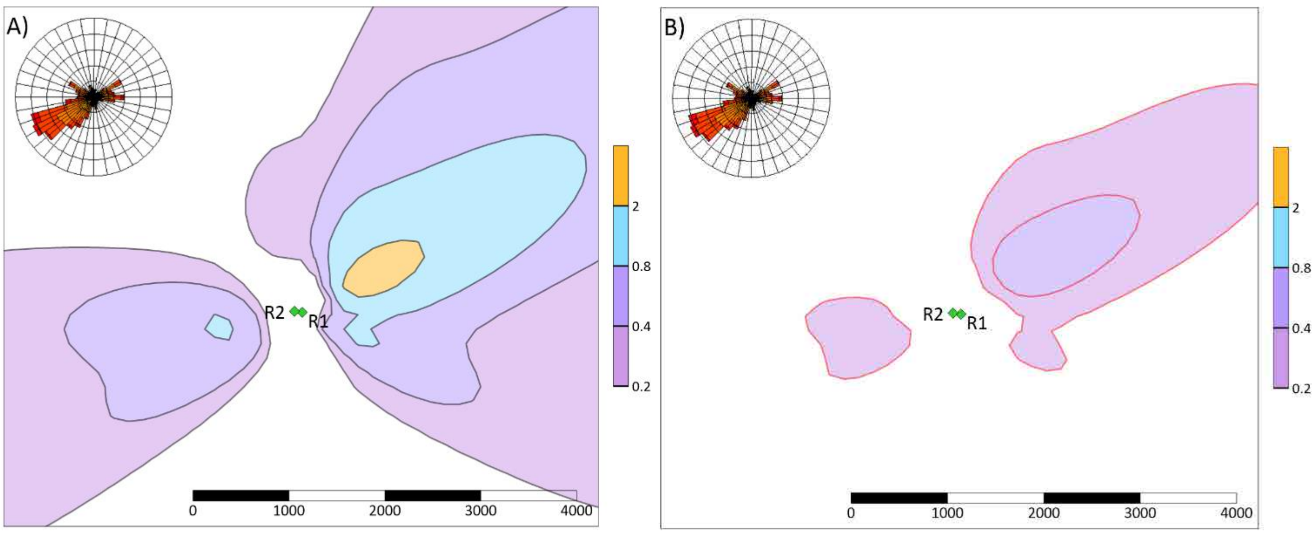

Figure 7: Distribution of Proposed Scheme ground level concentrations of annual mean NO_2 (µg/m^3) resulting from the full load operation of A) Riverside 1 (R1) and B) Riverside 2 (R2) with carbon capture, modelled using meteorological data for 2020. The new stacks are shown as green diamonds.

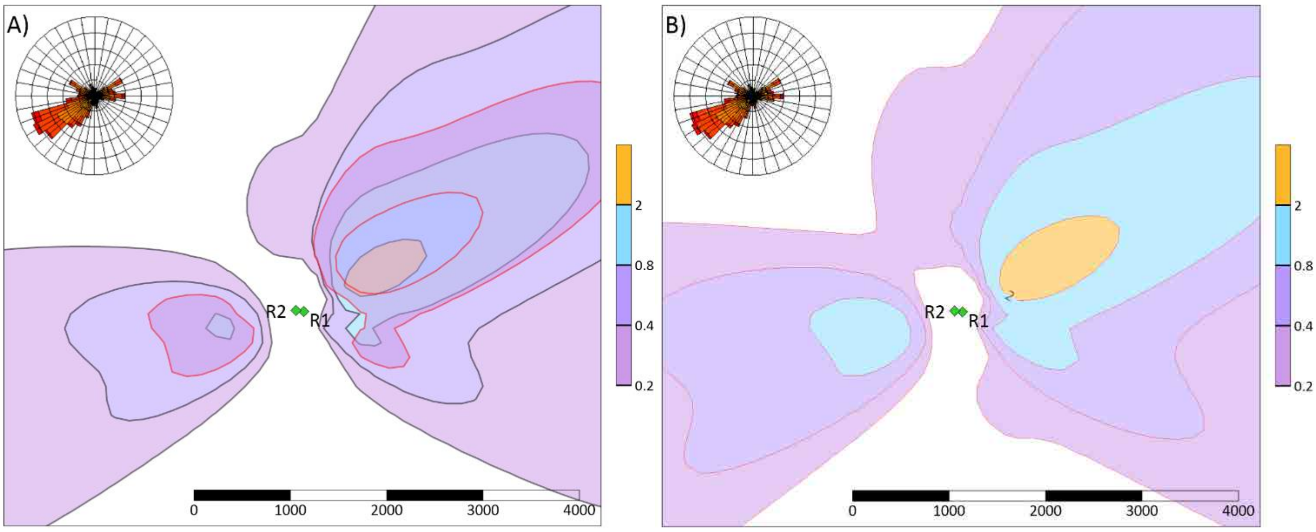

Figure 8: Distribution of Proposed Scheme ground level concentrations of annual mean NO_2 (µg/m^3) resulting from the full load operation of A) Riverside 1 (R1) and Riverside 2 (R2) individually and B) Riverside 1 and Riverside 2 cumulatively with carbon capture, modelled using meteorological data for 2020.

Figure 9 shows the cumulative impacts of Riverside 1 and Riverside 2 as modelled for the pre and post carbon capture process, and the net impact resulting from the Proposed Scheme i.e. post carbon capture contribution to ground level concentrations minus the pre-carbon capture contribution (**Figure 6B** to **Figure 8B**)

The small offset in the points of maximum impact from the operation of the Riverside Campus pre and post carbon capture is apparent in **Figure 9A**, and this results in a net impact (**Figure 9B**) which shows both adverse (increases) and beneficial (decreases) in ground level concentrations.

Firstly, to the north-east of the new stacks, the point of maximum cumulative impacts with the Proposed Scheme (post carbon capture) under the prevailing south-westerly winds lies slightly to the south-east of the point of maximum cumulative impacts pre-carbon capture (**Figure 9A)**. This results in an increase in pollutant concentrations in this area (shown in red shading in **Figure 9B**).

In contrast, to the north-north-east of the new stacks, the opposite is true and the point of maximum impact pre-carbon capture lies slightly to the north-west of the point of maximum impact with the Proposed Scheme (**Figure 9A**). In this case, the offset between pre- and post-carbon capture impacts results in a reduction in pollutant concentrations (shown in blue shading in **Figure 9B**).

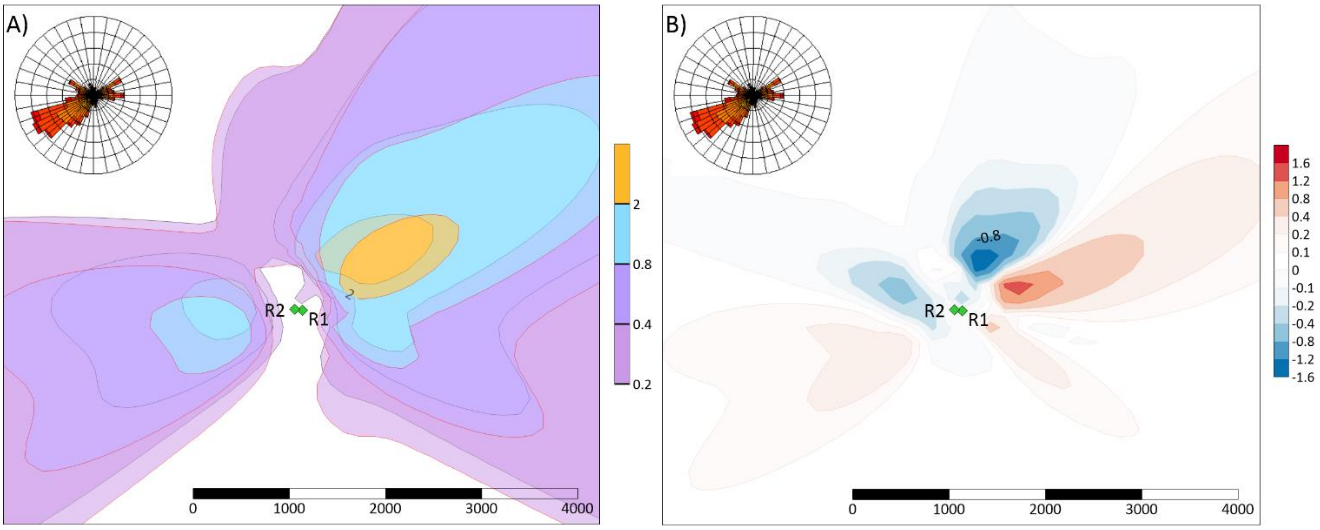

Figure 9: Distribution of A) cumulative ground level concentrations of annual mean NO_2 (µg/m^3) resulting from the full load operation of Riverside 1 (R1) and Riverside 2 (R2) with (red contours) and without (black contours) the Proposed Scheme and B) Net change in ground level concentrations of annual mean NO_2 with the Proposed Scheme, all modelled using 2020 meteorological data.

Similar effects occur to the south-west and west of the new stacks with areas of increased and decreased concentrations and, to a lesser extent to the south-east and south of the stacks.

The contours shown in **Figure 9** are also shown in **Figures 5-4** to **5-13 (Volume 3)** with base mapping.

Table 8 shows the modelled annual mean NO_2 concentrations pre and post carbon capture in for all modelled meteorological years. The absolute maximum annual mean NO_2 pre carbon capture (Baseline) is 3.2µg/m^3. With the Proposed Scheme (post carbon capture), the maximum modelled concentration increases slightly to 3.6µg/m^3. This is a difference of 0.4µg/m^3, just 1% of the air quality standard of 40µg/m^3 (**Table 5-5** in **Chapter 5: Air Quality (Volume 1)**). However, due to the offset in the location of the maximum impacts, the maximum adverse impact of the Proposed Scheme at any specific location is 1.6µg/m^3, which is 4.1% of the objective and cannot be screened as negligible. Equally, the maximum beneficial impact at any specific location is 1.6µg/m^3.

Figure 10 shows the modelled hourly mean NO_2 concentrations pre and post carbon capture, modelled with meteorological data for 2020. In contrast to the annual mean concentrations, the distribution of maximum hourly mean concentrations is broadly concentric about the stacks. This is because poor dispersion conditions can occur under winds from any direction.

Maximum impacts occur around 500 to 600m from the stacks pre-carbon capture and 600 to 800m from the stacks with the Proposed Scheme. There is some influence of the buildings in the vicinity of the stacks and the peak concentrations occur to the south-east and north-west pre-carbon capture, and to the south-west and north-east post carbon capture. The offset in the location of maximum impacts drives the pattern of adverse and beneficial impacts seen in **Figure 10c.**

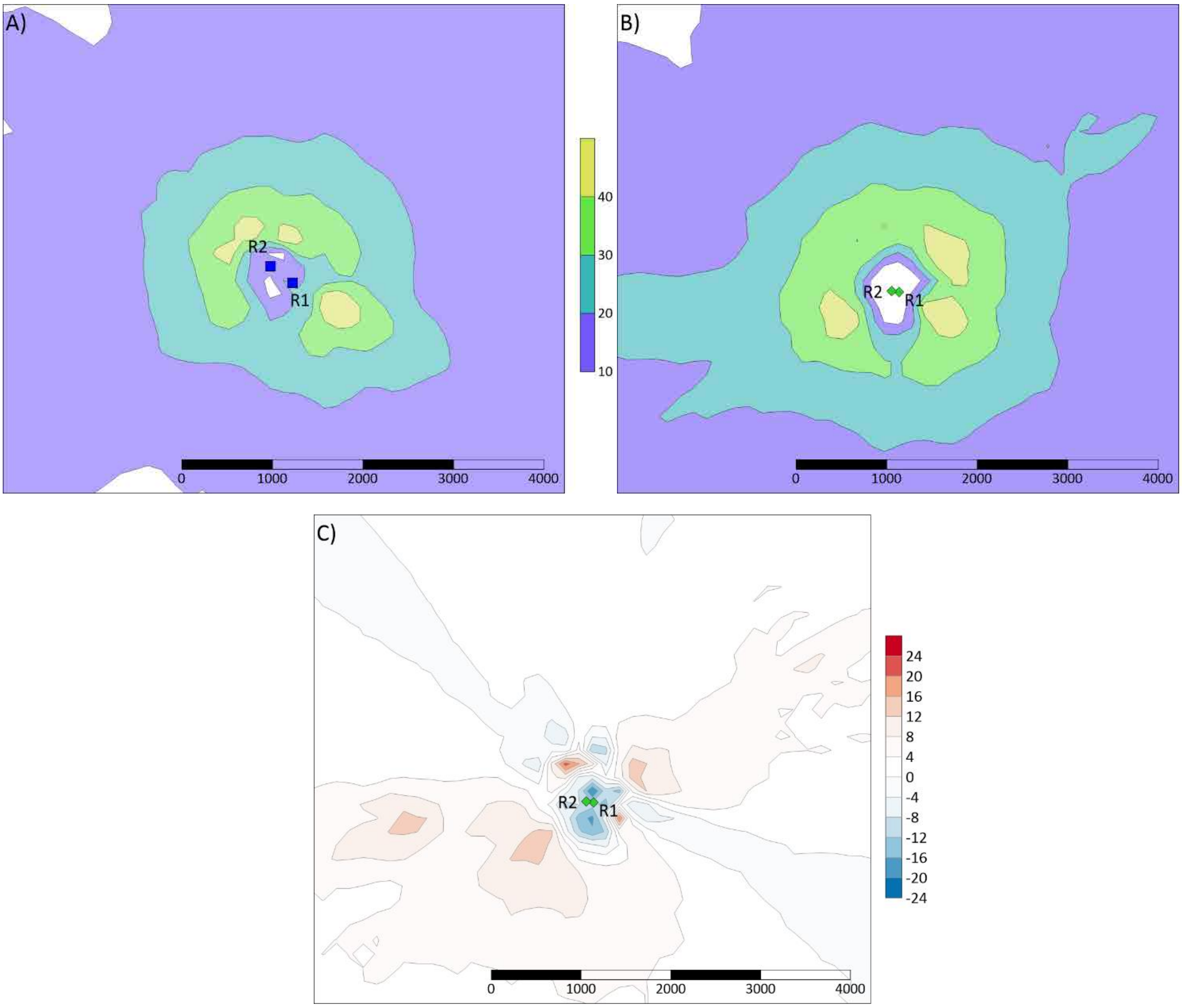

Figure 10: Distribution of cumulative ground level concentrations of 99.79th percentile of hourly mean NO_2 ($\mu g/m^3$) resulting from the full load operation of Riverside 1 (R1) and Riverside 2 (R2) for A) the pre-carbon capture scenario and B) the post carbon capture scenario. Net change in ground level concentrations of hourly mean NO_2 with the Proposed Scheme is shown in C). All modelled using 2020 meteorological data.

The maximum modelled hourly mean NO_2 concentration at ground level with the operation of the Proposed Scheme is 55.9µg/m^3 over the modelled meteorological years (**Table 9)** and the maximum PEC with the Proposed Scheme is 92.1µg/m^3 which is well within the air quality standard. The maximum adverse impact is 31.6µg/m^3, which is 15.8% of the objective; the maximum beneficial impact is 23.2µg/m^3.

The annual mean and hourly mean NO_2 impacts can, as stated above, be taken to illustrate the impacts of the Proposed Scheme on long and short term pollutant concentrations respectively.

For those pollutants that are only emitted with the Proposed Scheme (amines and aldehydes), the impact distribution is adverse over the study area since the offset between points of maximum impacts does not apply to these pollutants i.e., the pre-carbon capture concentrations are zero everywhere.

Table 8 and **Table 9** show that interannual variability in modelled pollutant concentrations does not affect the conclusions set out above. The variability is less than +/-25% in terms of maximum modelled concentrations and maximum impacts, but, for NO_2, cannot be screened as negligible in any year. The assessment of significance of effects on human health during operation presented in **Chapter 2: Air Quality (Volume 2)** is, in any case, always based on the maximum modelled impact over the 5 meteorological years tested.

Table 8: Maximum Ground Level Annual Mean NO_2 Concentrations as a Function of Meteorological Year (Background is Taken at the Point of Maximum Impact)

Year	Baseline Max PC (µg/m³)	With Development Max PC (µg/m³)	Max Adverse Impact (µg/m³)	Max Beneficial Impact (µg/m³)	Adverse Impact % of Objective (40µg/m³)	Beneficial Impact % of Objective (40µg/m³)	2023 Background NO_2 (µg/m³)	Max PEC	PEC % of Objective (40µg/m³)
2018	2.4	2.7	1.1	-1.2	2.8%	-3.0%	18.1	20.8	52.1%
2019	2.8	3.2	1.4	-1.4	3.4%	-3.5%	18.1	21.3	53.3%
2020	3.2	3.6	1.6	-1.6	4.1%	-4.1%	18.1	21.7	54.2%
2021	2.4	2.6	1.6	-1.3	4.1%	-3.1%	18.1	20.7	51.8%
2022	2.4	2.8	1.2	-1.2	3.0%	-3.0%	18.1	20.9	52.2%

Table 9: Maximum Ground Level Hourly Mean NO_2 Concentrations as a Function of Meteorological Year (Background is Taken at the Point of Maximum Impact)

Year	Baseline Max PC (µg/m^3)	With Development Max PC (µg/m^3)	Max Adverse Impact (µg/m^3)	Max Beneficial Impact (µg/m^3)	Adverse Impact % of Objective (200µg/m^3)	Beneficial Impact % of Objective (200µg/m^3)	2023 Background NO_2 (µg/m^3)	Max PEC	PEC % of Objective (200µg/m^3)
2018	50.6	52.6	27.3	-22.6	13.7%	-11.3%	18.09	88.8	44.4%
2019	50.5	49.6	22.2	-20.1	11.1%	-10.0%	18.09	85.8	42.9%
2020	50.8	50.4	22.1	-23.2	11.0%	-11.6%	18.09	86.5	43.3%
2021	49.4	55.9	25.5	-21.7	12.7%	-10.8%	18.09	92.1	46.1%
2022	50.4	54.5	31.6	-20.2	15.8%	-10.1%	16.52	87.5	43.7%
Background concentration is doubled for inclusion in the PEC, as per Environment Agency Guidance[6].									

REFERENCES

[1] Cambridge Environmental Research Consultant, ADMS 6. Available at [redacted]

[2] European Union. (2010.) 'Directive 2010/75EU if the European Parliament and of the Council'. Available at [redacted]

[3] European IPPC Bureau. (2019). 'Waste Incineration BAT reference documents'. Available at [redacted]

[4] Environment Agency. (2016). 'Releases from municipal waste incinerator – Guidance to applicants on impact assessment for group 3 metals stack emissions'. Available at https://www.gov.uk/government/publications/waste-incinerators-guidance-on-impact-assessment-for-group-3-metals-stack

[5] Environment Agency. (2014). 'AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air'.

[6] Environment Agency. (2023). 'Air emissions risk assessment for your environmental permit'. Available at https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[7] CERC. (2023). 'ADMS 6 Amine chemistry user guide supplement'. Available at [redacted]

[8] Environment Agency. (2021). 'AQMAU recommendations for the assessment and regulation of impacts to air quality from amine-based post-combustion carbon capture plants'.

[9] Manzoor, S. S. (2015). 'A theoretical study of the reaction kinetics of amines released into the atmosphere from CO2 capture'. International Journal of Greenhouse Gas Control, 41, 219-228. Retrieved from [redacted]

[10] CERC. (2012). 'Atmospheric Chemistry Modelling – Activity 1: Gaseous Phase Chemistry Modelling (initiated by hydroxyl radical) Final Report'. Available at: [redacted]

[11] Walker, H. S. (2015). 'Night-time measurements of HOx during the RONOCO project and analysis of the sources of HO_2'. Atmos. Chem. Phys. , 15, 8179–8200. Available at [redacted]

[12] Karl, M., Wright, R.F., Berglen, T.F. and Denby, B. (2009). 'Worst Case study method to assess the environmental impact of amine emissions from a CO2 capture plant'. Available at [redacted]

[13] CERC. (2012). 'Contract number 257430174: Atmospheric Chemistry Modelling Activity 1: Gaseous Phase Chemistry Modelling (initiated by hydroxyl radical)'. CERC

[14] Neilsen, C.J. et al, (2011). 'Atmospheric Degradation of Amines (ADA) Summary report from atmospheric chemistry studies of amines, nitrosamines, nitramines and amides'.

[15] Gjernes, E., Helgesen, L.I. and Maree, Y. (2013). 'Health and environmental impact of amine based post combustion CO2 capture'. Energy Procedia, 37, pp.735–742

[16] Wagner, E. O. (2014). 'Comparative In Vitro Toxicity of Nitrosamines and Nitramines Associated with Amine-Based Carbon Capture and Storage'. Environmental Science & Technology, 48, 8203–8211. doi:10.1021/es5018009

TECHNICAL APPENDIX 5-3: DETAILED MODEL POLLUTANT RESULTS

DECARBONISATION

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APPENDIX 5-3: DETAILED MODEL POLLUTANT RESULTS

HUMAN RECEPTORS

The maximum PC for all pollutants in the Baseline scenario for each of the modelled meteorological years (2018-2022) is shown in **Table 1**.

The maximum PC for all pollutants in the Proposed Scheme scenario for each of the modelled meteorological years (2018-2022) is shown in **Table 2**.

The maximum impact (Proposed Scheme PC – Baseline PC) for all pollutants with the Proposed Scheme for each of the modelled meteorological years (2018-2022) is shown in **Table 3**.

The data shown represent the maximum impacts anywhere within the model domain, irrespective of the presence of receptors at that location.

Within **Table 1** to **Table 3** all concentrations are shown in µg/m^3 except nitrosamines and nitramines which use the unit ng/m^3.

The maximum ground level impacts stated in **Table 3** are presented as a percentage of Environmental Assessment Levels / air quality standards for the protection of human health.

Table 1: Maximum Ground Level Concentrations of Pollutants Across the Receptor Grid for Each Modelled Meteorological Year in the Baseline Scenario

Pollutant	Averaging period	Max PC 2018	Max PC 2019	Max PC 2020	Max PC 2021	Max PC 2022
NO_2	1hr	50.6	50.5	50.8	49.4	50.4
	Annual	2.4	2.8	3.2	2.4	2.4
PM_{10}	24hr	0.6	0.7	0.7	0.6	0.6
	Annual	0.2	0.2	0.2	0.2	0.2
$PM_{2.5}$	Annual	0.2	0.2	0.2	0.2	0.2
SO_2	15 minutes	103.4	103.7	100.9	100.4	102.0
	1hr	71.3	70.3	71.0	69.4	69.9
	24hr	6.5	6.2	6.7	6.9	6.4
CO	8hr	53.5	49.1	54.0	49.8	47.1
HF	1hr	0.4	0.4	0.4	0.4	0.4
HCl	1hr	26.0	26.6	25.1	26.0	25.0
	Annual	0.2	0.3	0.3	0.2	0.2
NH3	1hr	6.5	6.7	6.3	6.5	6.3

Pollutant	Averaging period	Max PC 2018	Max PC 2019	Max PC 2020	Max PC 2021	Max PC 2022
	Annual	0.4	0.4	0.5	0.4	0.4
Arsenic	Annual	0.0005	0.0006	0.0007	0.0005	0.0006
Cadmium	Annual	0.0007	0.0009	0.0009	0.0007	0.0007
Lead	Annual	0.0011	0.0013	0.0014	0.0011	0.0011
Nickel	Annual	0.0047	0.0057	0.0061	0.0048	0.0049
Antimony	1hr	0.0030	0.0031	0.0029	0.0030	0.0029
	Annual	0.0002	0.0003	0.0003	0.0002	0.0003
Chromium III	1hr	0.0239	0.0245	0.0231	0.0239	0.0230
	Annual	0.0020	0.0024	0.0026	0.0020	0.0020
Chromium VI	Annual	0.000003	0.000004	0.000004	0.000003	0.000003
Copper	1hr	0.0075	0.0077	0.0073	0.0075	0.0073
	Annual	0.0006	0.0007	0.0008	0.0006	0.0006
Manganese	1hr	0.0156	0.0160	0.0150	0.0156	0.0150
	Annual	0.0013	0.0015	0.0017	0.0013	0.0013
Mercury	1hr	0.0087	0.0089	0.0084	0.0087	0.0083
	Annual	0.0007	0.0009	0.0009	0.0007	0.0007
Vanadium	24hr	0.1579	0.2047	0.1668	0.2554	0.2114
Amine 1	1hr	-	-	-	-	-
	24hr	-	-	-	-	-
Amine 2	1hr	-	-	-	-	-
	24hr	-	-	-	-	-
Nitrosamine 2	Annual	-	-	-	-	-
Nitramine 1	Annual	-	-	-	-	-
Nitramine 2	Annual	-	-	-	-	-
Aldehyde	1hr	-	-	-	-	-
	Annual	-	-	-	-	-

Table 2: Maximum Ground Level Concentrations of Pollutants Across the Receptor Grid for Each Modelled Meteorological Year in the Proposed Development Scenario

Pollutant	Averaging Period	Max PC 2018	Max PC 2019	Max PC 2020	Max PC 2021	Max PC 2022
NO_2	1hr	52.6	49.6	50.4	55.9	54.5
	Annual	2.7	3.2	3.6	2.6	2.8
PM_{10}	24hr	0.5	0.5	0.6	0.5	0.5
	Annual	0.1	0.2	0.2	0.1	0.1
$PM_{2.5}$	Annual	0.1	0.2	0.2	0.1	0.1
SO_2	15 minutes	117.0	109.5	101.7	113.0	122.4
	1hr	71.5	69.6	70.0	75.9	73.7
	24hr	6.0	6.0	7.1	6.5	6.3
CO	8hr	43.3	42.3	44.5	53.8	40.6
HF	1hr	0.6	0.7	0.5	0.6	0.6
HCl	1hr	33.6	42.0	32.9	33.9	33.8
	Annual	0.2	0.2	0.3	0.2	0.2
NH3	1hr	8.4	10.5	8.2	8.5	8.4
	Annual	0.4	0.4	0.5	0.4	0.4
Arsenic	Annual	0.0004	0.0005	0.0006	0.0004	0.0004
Cadmium	Annual	0.0006	0.0007	0.0007	0.0005	0.0006
Lead	Annual	0.0008	0.0010	0.0011	0.0008	0.0009
Nickel	Annual	0.0037	0.0043	0.0049	0.0036	0.0038
Antimony	1hr	0.0039	0.0048	0.0038	0.0039	0.0039
	Annual	0.0002	0.0002	0.0003	0.0002	0.0002
Chromium III	1hr	0.0310	0.0386	0.0303	0.0311	0.0311
	Annual	0.0015	0.0018	0.0020	0.0015	0.0016
Chromium VI	Annual	0.000003	0.000003	0.000003	0.000002	0.000003
Copper	1hr	0.0098	0.0122	0.0095	0.0098	0.0098
	Annual	0.0005	0.0006	0.0006	0.0005	0.0005
Manganese	1hr	0.0202	0.0252	0.0198	0.0203	0.0203
	Annual	0.0010	0.0012	0.0013	0.0010	0.0010

Pollutant	Averaging Period	Max PC 2018	Max PC 2019	Max PC 2020	Max PC 2021	Max PC 2022
Mercury	**1hr**	0.0112	0.0140	0.0110	0.0113	0.0113
	Annual	0.0006	0.0007	0.0007	0.0005	0.0006
Vanadium	**24hr**	0.1730	0.2345	0.1867	0.2781	0.2267
Amine 1	**1hr**	1.104	1.022	1.037	0.982	1.287
	24hr	0.441	0.373	0.453	0.452	0.383
Amine 2	**1hr**	1.11	1.11	1.05	1.00	1.30
	24hr	-	0.37	-	-	-
Nitrosamine 2	**Annual**	0.00794	0.00916	0.00939	0.00820	0.00832
Nitramine 1	**Annual**	0.00143	0.00153	0.00182	0.00141	0.00112
Nitramine 2	**Annual**	0.01089	0.01167	0.01397	0.01078	0.00861
Aldehyde	**1hr**	5.6	7.0	5.5	5.6	5.6
	Annual	0.14	0.16	0.18	0.13	0.14

Table 3: Maximum Ground Level Pollutant Impacts Across the Receptor Grid for Each Modelled Meteorological Year with the Proposed Development Scenario

Pollutant	Averaging Period	Max Impact 2018	Max Impact 2019	Max Impact 2020	Max Impact 2021	Max Impact 2022	Max Impact	Air Quality Standard	Impact as % of Standard
NO_2	1hr	27.3	22.2	22.1	25.5	31.6	31.6	200	15.8%
	Annual	1.1	1.4	1.6	1.1	1.2	1.6	40	4.1%
PM_{10}	24hr	0.1	0.2	0.2	0.1	0.1	0.2	50	0.4%
	Annual	0.0	0.0	0.1	0.0	0.0	0.1	40	0.1%
$PM_{2.5}$	Annual	0.0	0.0	0.1	0.0	0.0	0.1	20	0.3%
SO_2	15 minutes	58.6	52.1	50.2	47.9	66.8	66.8	266	25.1%
	1hr	38.1	33.9	30.4	31.0	39.7	39.7	350	11.4%
	24hr	2.3	3.2	3.5	2.4	1.6	3.5	125	2.8%
CO	8hr	19.2	19.5	21.3	25.9	17.0	25.9	10000	0.3%
HF	1hr	0.4	0.5	0.4	0.5	0.4	0.5	160	0.3%
HCl	1hr	21.7	31.7	21.1	27.5	21.8	31.7	750	4.2%
	Annual	0.1	0.1	0.1	0.1	0.1	0.1	16	0.6%
NH3	1hr	5.4	7.9	5.3	6.9	5.4	7.9	2500	0.3%
	Annual	0.1	0.2	0.2	0.1	0.1	0.2	180	0.1%
Arsenic	Annual	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.006	3.0%
Cadmium	Annual	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.005	4.7%

Pollutant	Averaging Period	Max Impact 2018	Max Impact 2019	Max Impact 2020	Max Impact 2021	Max Impact 2022	Max Impact	Air Quality Standard	Impact as % of Standard
Lead	**Annual**	0.0002	0.0003	0.0004	0.0002	0.0002	0.0004	0.25	0.1%
Nickel	**Annual**	0.0009	0.0012	0.0016	0.0010	0.0010	0.0016	0.02	7.8%
Antimony	**1hr**	0.0025	0.0036	0.0024	0.0032	0.0025	0.0036	150	0.002%
	Annual	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	5	0.002%
Chromium III	**1hr**	0.0200	0.0292	0.0194	0.0253	0.0200	0.0292	150	0.019%
	Annual	0.0004	0.0005	0.0007	0.0004	0.0004	0.0007	5	0.013%
Chromium VI	**Annual**	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.00025	0.4%
Copper	**Annual**	0.0063	0.0092	0.0061	0.0080	0.0063	0.0092	200	0.005%
	1hr	0.0001	0.0002	0.0002	0.0001	0.0001	0.0002	10	0.002%
Manganese	**1hr**	0.0130	0.0190	0.0126	0.0165	0.0131	0.0190	1500	0.001%
	Annual	0.0003	0.0003	0.0004	0.0003	0.0003	0.0004	0.15	0.3%
Mercury	**1hr**	0.0072	0.0106	0.0070	0.0092	0.0073	0.0106	7.5	0.1%
	Annual	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.25	0.1%
Vanadium	**24hr**	0.0151	0.0298	0.0198	0.0227	0.0154	0.0298	1	3.0%
Amine 1	**1hr**	1.104	1.022	1.037	0.982	1.287	1.2874	400	0.3%
	24hr	0.441	0.373	0.453	0.452	0.383	0.4533	100	0.5%
Amine 2	**1hr**	1.11	1.11	1.05	1.00	1.30	1.3000	400	0.3%
	24hr	-	0.37	-	-	-	0.3741	100	0.4%

Pollutant	Averaging Period	Max Impact 2018	Max Impact 2019	Max Impact 2020	Max Impact 2021	Max Impact 2022	Max Impact	Air Quality Standard	Impact as % of Standard
Nitrosamine 2	**Annual**	0.00794	0.00916	0.00939	0.00820	0.00832	0.0094	0.2	4.7%
Nitramine 1	**Annual**	0.00143	0.00153	0.00182	0.00141	0.00112	0.0018	0.2	0.9%
Nitramine 2	**Annual**	0.01089	0.01167	0.01397	0.01078	0.00861	0.0140	0.2	7.0%
Aldehyde	**1hr**	5.61	7.00	5.49	5.64	5.63	6.9982	100	7.0%
	Annual	0.14	0.16	0.18	0.13	0.14	0.1839	5	3.7%

ECOLOGICAL RECEPTORS

The maximum PC for NO_x in the Baseline and Proposed Scheme scenarios for each of the modelled meteorological years (2018-2022) at each of the designated ecological sites is shown in **Table 4**.

The maximum PC for NH_3 in the Baseline and Proposed Scheme scenarios for each of the modelled meteorological years (2018-2022) at each of the designated ecological sites is shown in **Table 5**.

The maximum PC for SO_2 in the Baseline and Proposed Scheme scenarios for each of the modelled meteorological years (2018-2022) at each of the designated ecological sites is shown in **Table 6**.

The maximum PC for nitrogen deposition in the Baseline and Proposed Scheme scenarios for each of the modelled meteorological years (2018-2022) at each of the designated ecological sites is shown in

Table 7.

The maximum PC for acid deposition in the Baseline and Proposed Scheme scenarios for each of the modelled meteorological years (2018-2022) at each of the designated ecological sites is shown in **Table 8**.

For NO_x, NH_3, SO_2, nitrogen and acid deposition at each designated ecological site, the maximum impact (Proposed Scheme PC – Baseline PC) with the Proposed Scheme each of the modelled meteorological years (2018-2022) is shown within **Table 4** to **Table 8** respectively.

The assessment standards for the designated ecological sites can be found in **Table 5-5** within the **Chapter 5: Air Quality (Volume 1)**. Local Nature Reserves within 2km of the Proposed Scheme are included in **Table 4** to **Table 8.**

Table 4: Modelled Maximum Baseline and Proposed Scheme PC and Impacts at Ecological Receptors for Annual Mean NO_x

Ecological Site	Max Baseline PC NO_x ($\mu g/m^3$)	Max Proposed Scheme PC NO_x ($\mu g/m^3$)	Max Impact NO_x ($\mu g/m^3$)
Epping Forest – SAC, SSSI	0.1	0.1	0.01
Grays Thurrock Chalk Pits - SSSI	0.2	0.2	0.01
Ingrebourne Marshes - SSSI	1.5	1.8	0.3
Inner Thames Marshes - SSSI	2.3	3.1	0.8
Oxleas Woodlands - SSSI	0.2	0.3	0.1
West Thurrock Lagoon and Marshes - SSSI	0.2	0.2	0.02
Crossness - LNR	0.8	1.1	0.4

Ecological Site	Max Baseline PC NO_x (µg/m³)	Max Proposed Scheme PC NO_x (µg/m³)	Max Impact NO_x (µg/m³)
Lesnes Abbey Woods - LNR	0.3	0.4	0.1
Rainham Marshes - LNR	2.3	3.1	0.8

Table 5: Modelled Maximum Baseline and Proposed PC and Impacts at Ecological Receptors for Annual Mean NH_3

Ecological Site	Max Baseline PC NH_3 (µg/m³)	Max Proposed Scheme PC NH_3 (µg/m³)	Max Impact NH_3 (µg/m³)
Epping Forest – SAC, SSSI	0.01	0.01	0.001
Grays Thurrock Chalk Pits - SSSI	0.01	0.02	0.002
Ingrebourne Marshes - SSSI	0.14	0.17	0.03
Inner Thames Marshes - SSSI	0.24	0.29	0.05
Oxleas Woodlands - SSSI	0.02	0.03	0.004
West Thurrock Lagoon and Marshes - SSSI	0.02	0.02	0.001
Crossness - LNR	0.09	0.11	0.02
Lesnes Abbey Woods - LNR	0.03	0.04	0.01
Rainham Marshes - LNR	0.24	0.29	0.05

Table 6: Modelled Maximum Baseline and Proposed Scheme PC and Impacts at Ecological Receptors for Annual Mean SO_2

Ecological Site	Max Baseline PC SO_2 (µg/m³)	Max Proposed Scheme PC SO_2 (µg/m³)	Max Impact SO_2 (µg/m³)
Epping Forest – SAC, SSSI	0.02	0.02	0.002
Grays Thurrock Chalk Pits - SSSI	0.04	0.04	0.003
Ingrebourne Marshes - SSSI	0.4	0.5	0.1
Inner Thames Marshes - SSSI	0.6	0.8	0.2
Oxleas Woodlands - SSSI	0.1	0.1	0.01

Ecological Site	Max Baseline PC SO_2 (µg/m^3)	Max Proposed Scheme PC SO_2 (µg/m^3)	Max Impact SO_2 (µg/m^3)
West Thurrock Lagoon and Marshes - SSSI	0.1	0.1	0.005
Crossness - LNR	0.2	0.3	0.1
Lesnes Abbey Woods - LNR	0.1	0.1	0.0
Rainham Marshes - LNR	0.6	0.8	0.2

Table 7: Modelled Maximum Baseline and Proposed Scheme PC and Impacts at Ecological Receptors for Annual Mean Nitrogen Deposition

Ecological Site	Max Baseline PC Nitrogen Deposition (kg N/ha/yr)	Max Proposed Scheme PC Nitrogen Deposition (kg N/ha/yr)	Max Impact Nitrogen Deposition (kg N/ha/yr)
Epping Forest – SAC, SSSI	0.06	0.07	0.01
Grays Thurrock Chalk Pits - SSSI	-	-	-
Ingrebourne Marshes - SSSI	0.89	1.06	0.17
Inner Thames Marshes - SSSI	1.50	1.84	0.34
Oxleas Woodlands - SSSI	0.24	0.29	0.05
West Thurrock Lagoon and Marshes - SSSI	0.13	0.13	0.004
Crossness - LNR	0.55	0.68	0.14
Lesnes Abbey Woods - LNR	0.32	0.40	0.08
Rainham Marshes - LNR	1.50	1.84	0.34

Table 8: Modelled Maximum Baseline and Proposed Scheme PC and Impacts at Ecological Receptors for Annual Mean Acid Deposition

Ecological Site	Max Baseline PC Acid Deposition (keq/ha/yr)	Max Proposed Scheme PC Acid Deposition (keq/ha/yr)	Max Impact Acid Deposition (keq/ha/yr)
Epping Forest – SAC, SSSI	0.009	0.010	0.001
Grays Thurrock Chalk Pits - SSSI	-	-	-
Ingrebourne Marshes - SSSI	0.111	0.131	0.020
Inner Thames Marshes - SSSI	0.177	0.228	0.051
Oxleas Woodlands - SSSI	0.034	0.040	0.006
West Thurrock Lagoon and Marshes - SSSI	0.016	0.016	0.001
Crossness - LNR	0.063	0.085	0.022
Lesnes Abbey Woods - LNR	0.043	0.055	0.012
Rainham Marshes - LNR	0.177	0.228	0.051

CORY

TECHNICAL APPENDIX 6-1: NOISE AND VIBRATION TERMINOLOGY

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APPENDIX 6-1: NOISE AND VIBRATION TERMINOLOGY

NOISE

Noise is defined as unwanted sound. Human hearing is able to respond to sound in the frequency range 20 Hz (low frequency/deep bass) to 20,000 Hz (high frequency/high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used, which reduces the importance of lower and higher frequencies in a similar manner to human hearing.

The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

The subjective response to a noise is dependent not only upon the sound pressure level and its frequency, but also its intermittency. Various indices have been developed to try and correlate annoyances with the noise level and its fluctuations.

- Sound Pressure: Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
- Sound Pressure Level (Sound Level): The sound level is the sound pressure relative to a standard reference pressure of 20 Pa ($20x10^{-6}$ Pascals) on a decibel scale.
- Sound Power: The sound energy radiated per unit time by a sound source. Measured in Watts (W).
- Sound Power Level, L_W: Sound power measured on a decibel scale, relative to a reference value of 10^{-12} W.
- Decibel (dB): A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 $\log_{10}$ (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20 Pa.
- A-weighting, dB(A): The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.

- Noise Level Indices: Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
- $L_{eq,T}$: A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
- $L_{max,T}$: A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
- $L_{90,T}$: A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
- $L_{10,T}$: A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
- L_{AE} (or SEL): A noise level index. Equivalent to the $L_{Aeq,T}$ condensed into a one second period. Typically used when dealing with noise events where the activity duration is not necessary the same as under the conditions the source data was obtained.
- Free-Field: Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5 metres away.
- Façade: At a distance of 1 metre in front of a large sound reflecting object such as a building façade.
- Slow and Fast Time Weightings: Averaging times used in sound level meters.

DECARBONISATION

TECHNICAL APPENDIX 6-2: NOISE MONITORING

Cory Decarbonisation Project

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FIGURE

APPENDIX 6-2: NOISE MONITORING

This appendix identifies the locations and full results of the noise monitoring that has been carried out on the Site, and **Figure 6-1: Noise Survey Monitoring Locations (Volume 2)** shows the location of each of the three monitoring locations.

NOISE MONITORING POSITION DESCRIPTION

Table 1 provides a description of each noise monitoring positions.

Table 1: Noise Monitoring Position Description

Measurement Position	Description	Photo
MP1	Microphone installed on a pole at a height of 4m on southern boundary fence of Gannon land. Measurements taken between 11:00 on Thursday 16th March until 11:00 on Tuesday 21st March 2023. Location is considered representative of the ambient noise levels incident upon the London Belvedere Travelodge, and other residential dwellings located to the south east on the opposing side of the A2016.	
MP2	Microphone installed on a tripod at a height of 1.5m to the southwest of the Site, within the Crossness Sewage Treatment Works site, and overlooking Crossness LNR to the east. Measurements taken between 14:00 on Thursday 16th March until 11:00 on Monday 20th March 2023. Location is considered representative of the ambient	

Measurement Position	Description	Photo
	noise levels close to the A2016 Eastern Way.	
MP3	Microphone installed on fence at a height of 2.5m. Measurements taken between 10:00 on Thursday 16th March until 10:00 on Tuesday 21st March 2023. Location is considered representative of the ambient noise levels at the Crossness LNR.	

NOISE MONITORING SUMMARY DATA

Tables 2 to **4** provide a summary of the measured noise levels at each measurement position.

Table 2: MP1 Data Summary

Date	Daytime Noise Level (07:00 – 23:00) $L_{AEq, 16hr}$	Night-time Noise Level (23:00 – 07:00) $L_{AEq, 8hr}$	Typical Daytime Background Sound Level (07:00 – 23:00), $L_{A90, 1hr}$	Typical Night-time Background Sound Level (23:00 – 07:00), $L_{A90, 15 mins}$	Typical Daytime Max Noise Level, $L_{Amax, 5 mins}$	Typical Night-time Max Noise Level, $L_{Amax, 5 mins}$
16/03/2023	61[1]	55	57	47	80	68
17/03/2023	60	56	57	49	76	68
18/03/2023	58	54	53	49	72	66
19/03/2023	60	56	52	46	80	69
20/03/2023	60	56	56	47	76	69
21/03/2023	62[2]	-	56	-	75	-

[1]Partial daytime measurement period between 11:00 to 23:00.
[2]Partial daytime measurement period between 07:00 to 11:00.

Table 3: MP2 Data Summary

Date	Daytime Noise Level (07:00 – 23:00) $L_{AEq, 16hr}$	Night-time Noise Level (23:00 – 07:00) $L_{AEq, 8hr}$	Typical daytime background sound level (07:00 – 23:00), $L_{A90, 1hr}$	Typical Night-time Background Sound Level (23:00 – 07:00), $L_{A90, 15 mins}$	Typical Daytime Max Noise Level, $L_{Amax, 5 mins}$	Typical Night-time Max Noise Level, $L_{Amax, 5 mins}$
16/03/2023	63[1]	55	60	46	76	67
17/03/2023	62	57	58	48	75	68
18/03/2023	61	57	55	47	73	71
19/03/2023	61	56	57	46	76	72
20/03/2023	63	-	58	-	77	-

[1]Partial daytime measurement period between 14:00 to 23:00.

Table 4: MP3 Data Summary

Date	Daytime Noise Level (07:00 – 23:00) $L_{AEq, 16hr}$	Night-time Noise Level (23:00 – 07:00) $L_{AEq, 8hr}$	Typical Daytime Background Sound Level (07:00 – 23:00), $L_{A90, 1hr}$	Typical Night-time Background Sound Level (23:00 – 07:00), $L_{A90, 15 mins}$	Typical Daytime Max Noise Level, $L_{Amax, 5 min}$	Typical Night-time Max Noise Level, $L_{Amax, 5 min}$
16/03/2023	57[1]	52	51	49	76	61
17/03/2023	56	51	52	50	74	67
18/03/2023	53	52	51	49	70	63
19/03/2023	54	51	50	48	73	65
20/03/2023	61	52	52	48	81	67
21/03/2023	59[2]	-	53	-	65	-

[1]Partial daytime measurement period between 10:00 to 23:00.

[2] Partial daytime measurement period between 07:00 to 10:00.

NOISE MONITORING GRAPHS

The graphs in **Figures 1** to **6** identify the typical background sound levels at each of the measurement positions, during the daytime and night-time periods.

Figure 1: MP1 Daytime Typical Background Sound Levels

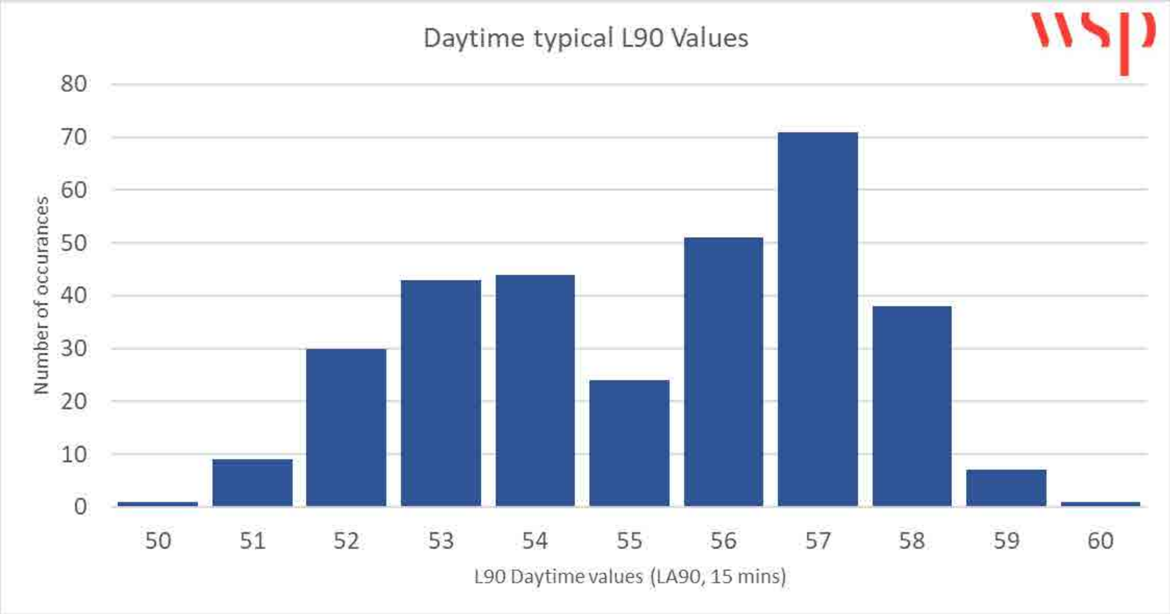


Figure 2: MP1 Night-Time Typical Background Sound Levels

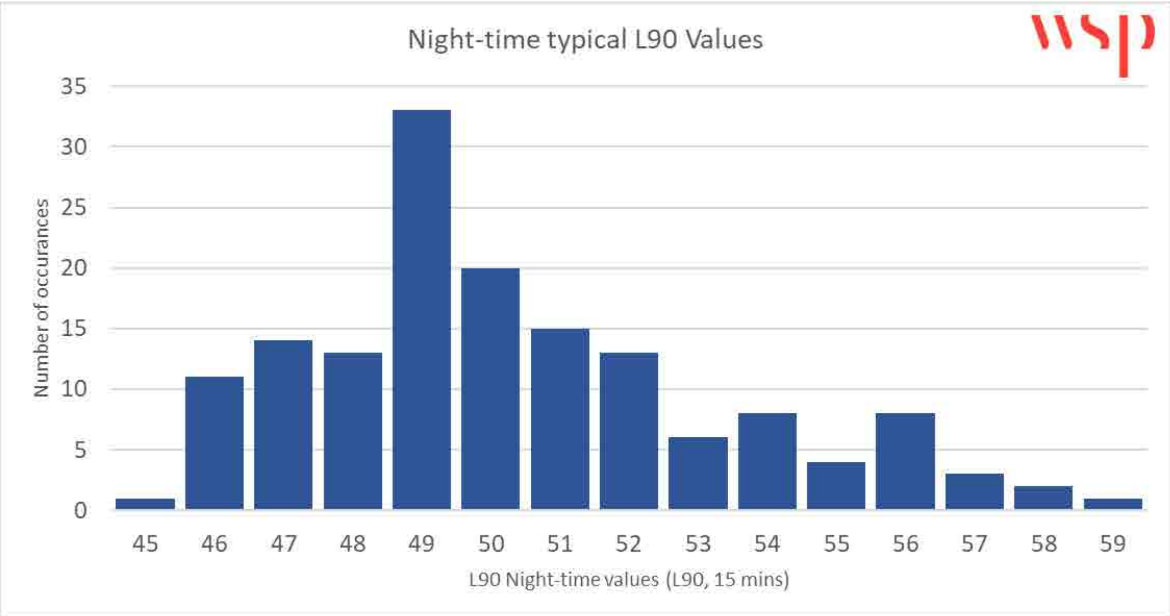


Figure 3: MP2 Daytime Typical Background Sound Levels

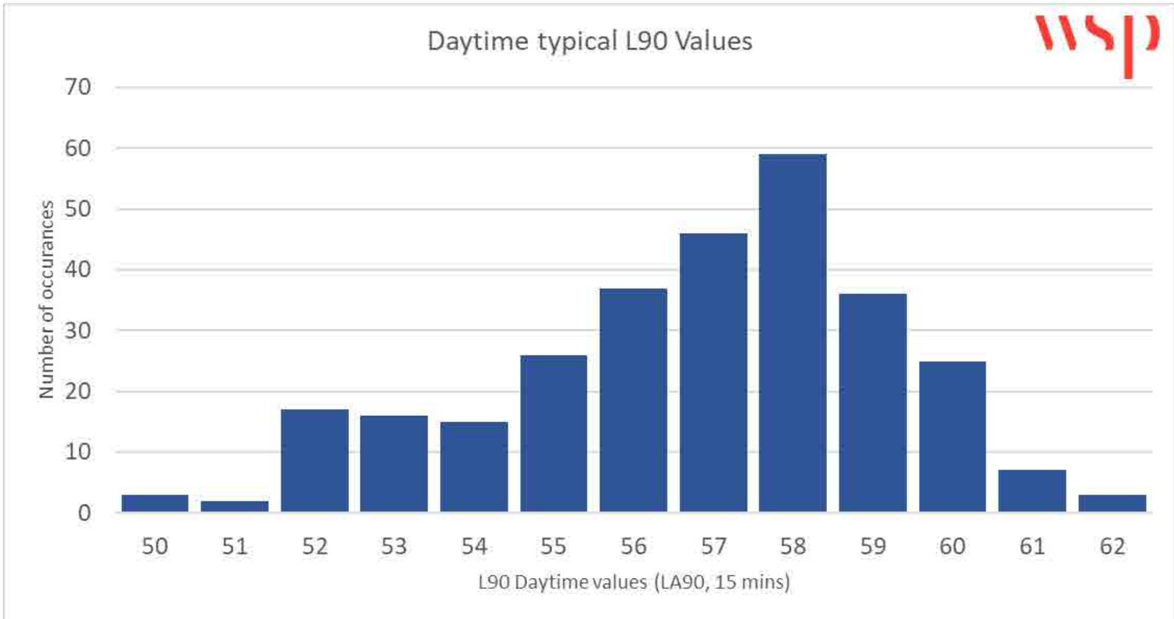


Figure 4: MP2 Night-Time Typical Background Sound Levels

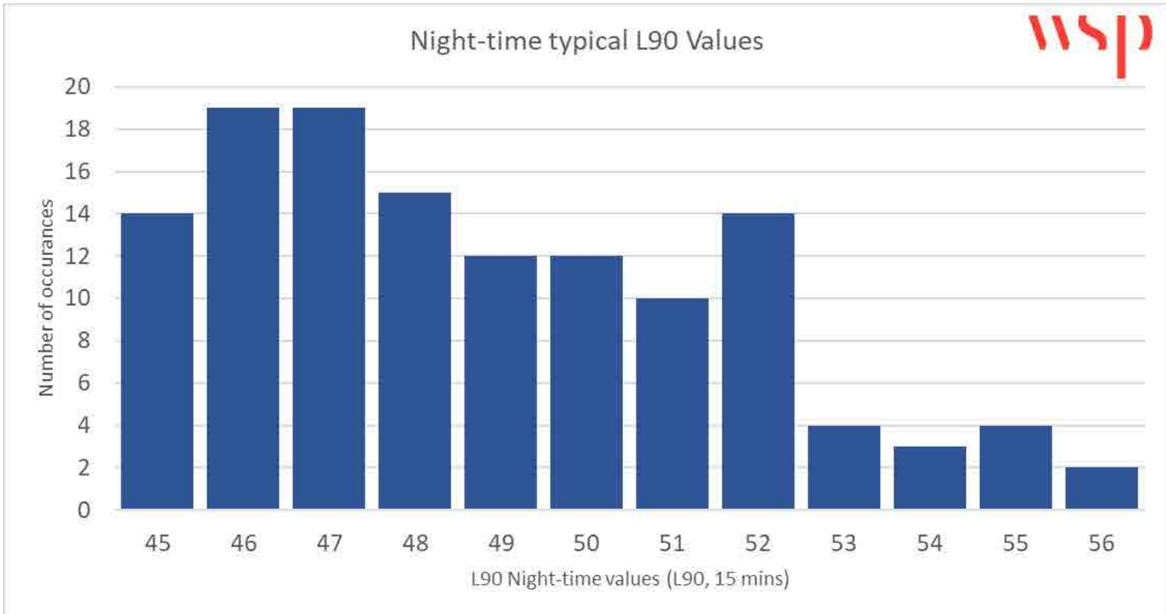


Figure 5: MP3 Daytime Typical Background Sound Levels

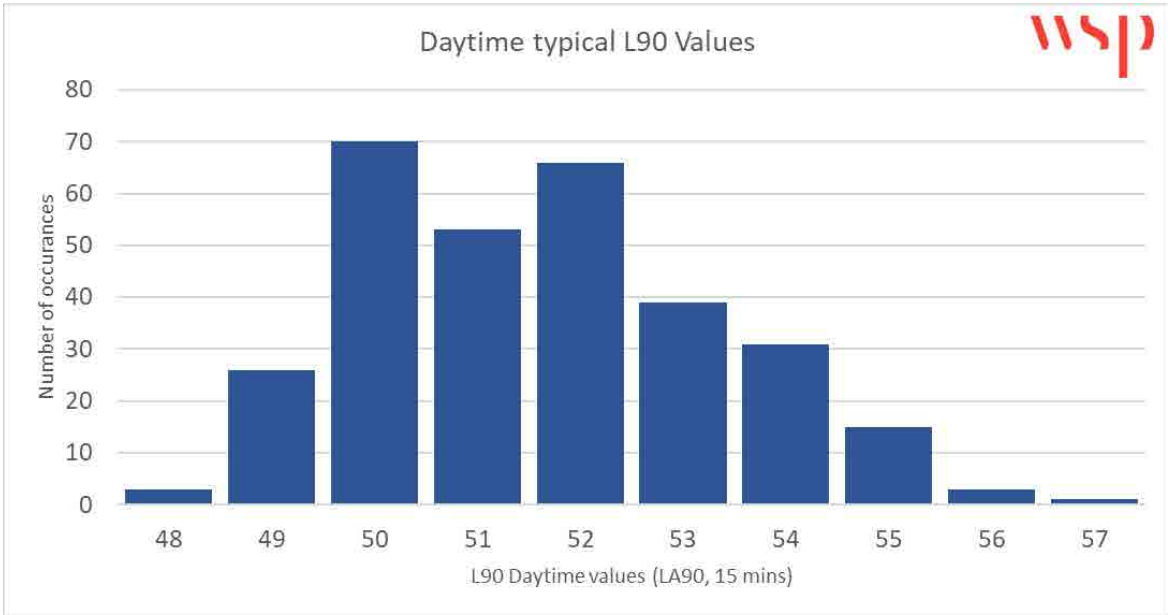
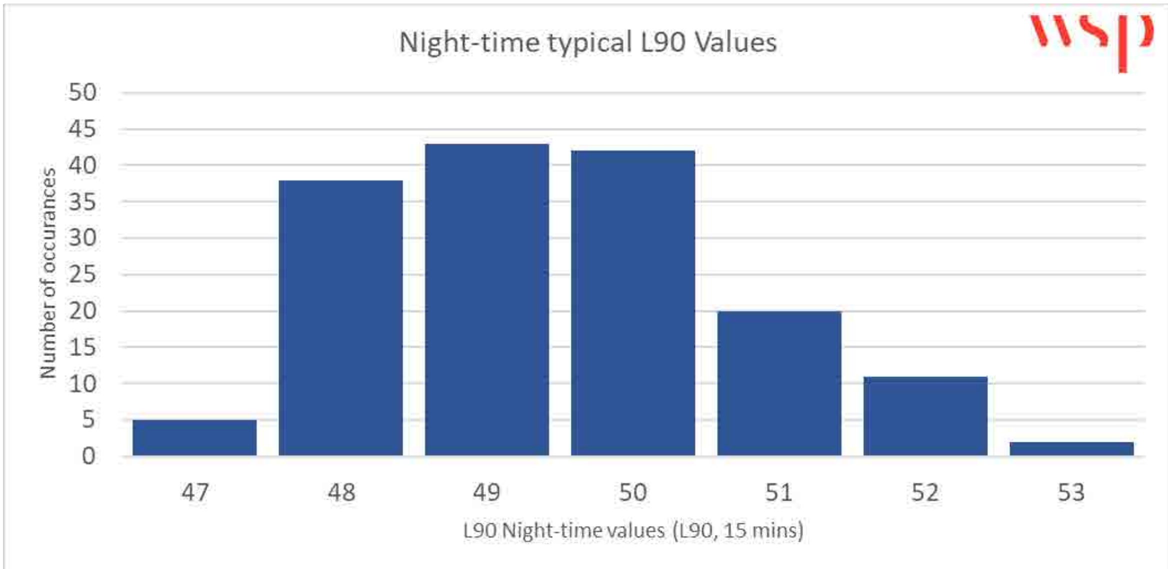


Figure 6: MP3 Night-Time Typical Background Sound Levels



NOISE MONITORING FORMS

The noise monitoring forms in **Figures 7** to **9** identify the monitoring results at each noise monitoring position.

Figure 7: MP1 Noise Monitoring Form

Noise Monitoring Form

Project Name:	Cory CCU		**Project No:**	70090329
Location:	MP1		**Engineer:**	Will Sterlini
Equipment:	01dB Duo	[serial no 10594]	**Weather:**	Moderate wind, 100% cloud cover, temperature range between 7°C and 14°C over measurement period
Pre-Calibration Level:	93.9			
Post-Calibration Level:	94.0			
Additional Comments:				
Measurement Period			**Description of Audible Noise**	
Date	**Start / Stop Time**	**Measurement Intervals**	Dominated by road noise from the A2016. Bird song, occassional noise from recycling vans and overhead aircraft movements. Noise from ind turbine on Crossness site audible during lulls in the traffic.	
16/03/2023	11:00	1 hour		
21/03/2023	11:00			

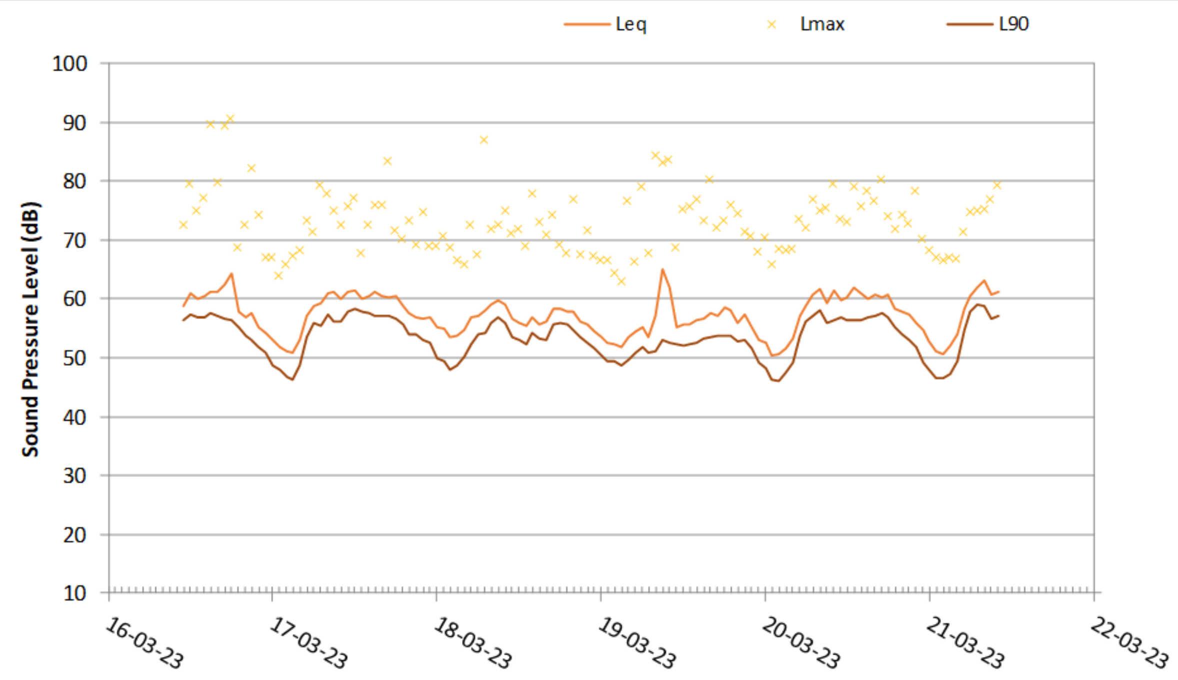


Figure 8: MP2 Noise Monitoring Form

Noise Monitoring Form

Project Name:	CORY CCUS		**Project No:**	70090329
Location:	MP2		**Engineer:**	Will Sterlini
Equipment:	01dB Solo	[serial no 61331]	**Weather:**	Moderate wind, 100% cloud cover, temperature range between 7°C and 14°C over measurement period
Pre-Calibration Level:	113.9			
Post-Calibration Level:	114.0			
Additional Comments:				

Measurement Period			**Description of Audible Noise**
Date	**Start / Stop Time**	**Measurement Intervals**	Dominated by road noise from the A2016. Bird song, very occassional vehicle movement on access road to sewege treatment works
16/03/2023	14:00	1 hour	
20/03/2023	23:00		

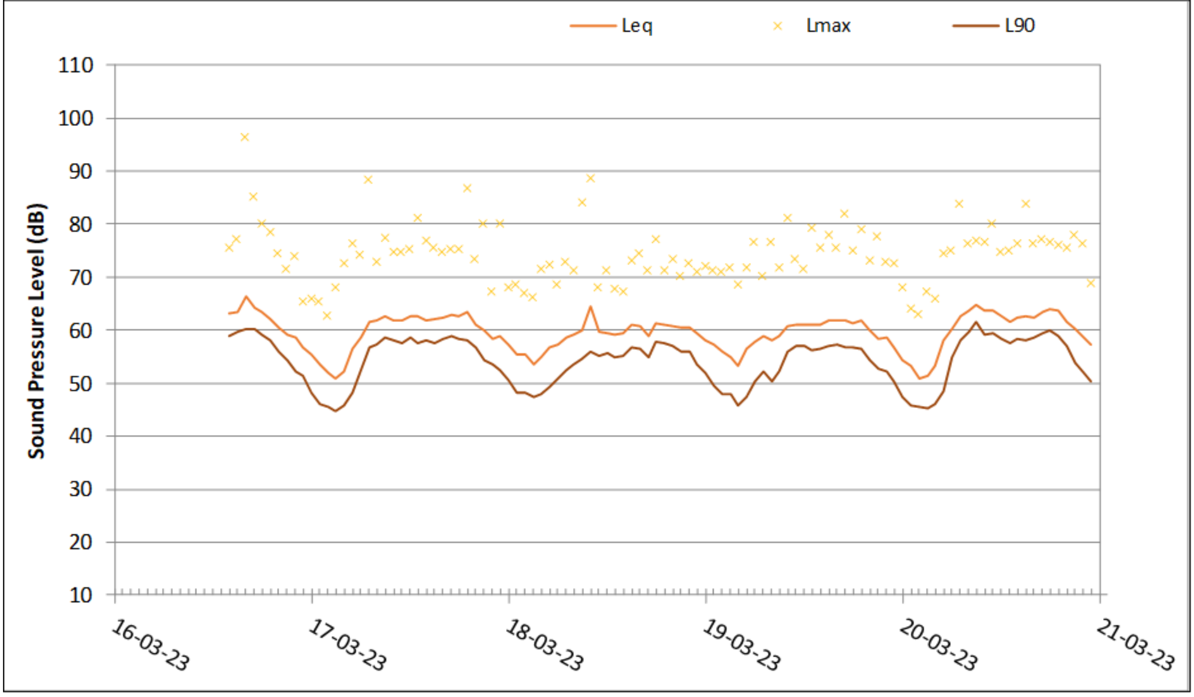
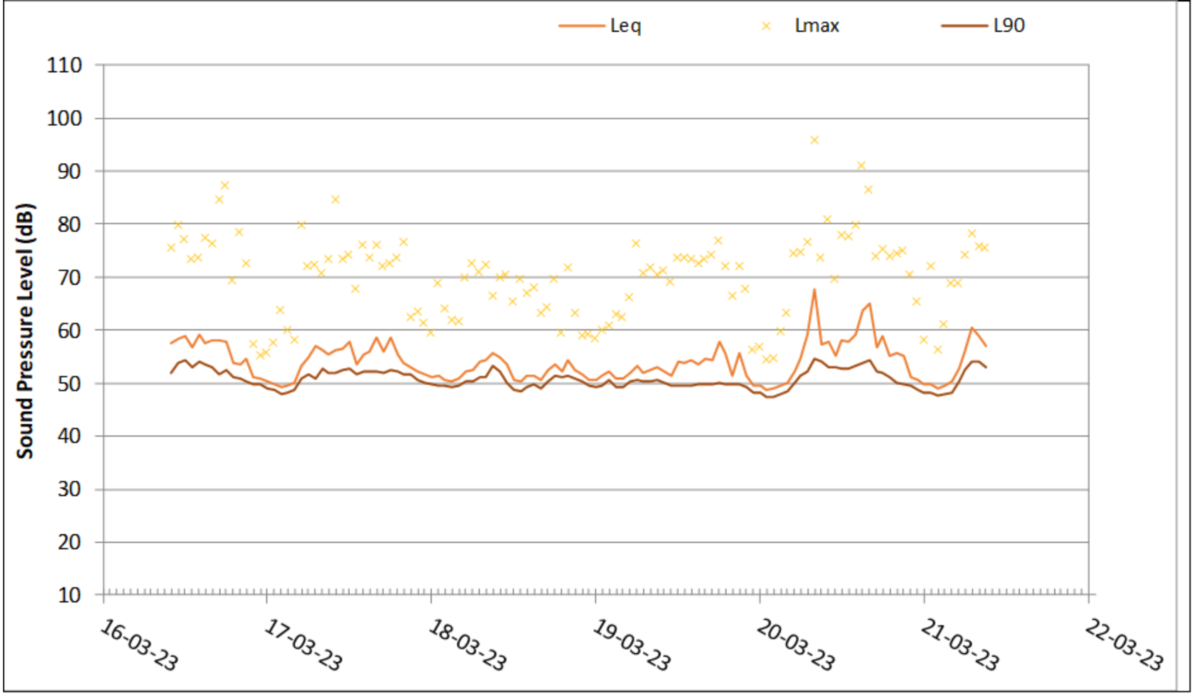


Figure 9: MP3 Noise Monitoring Form

Noise Monitoring Form

Project Name:	CORY CCUS		**Project No:**	70090329
Location:	MP3		**Engineer:**	Will Sterlini
Equipment:	01dB Duo	[serial no 10616]	**Weather:**	Moderate wind, 100% cloud cover, temperature range between 7°C and 14°C over measurement period
Pre-Calibration Level:	113.9			
Post-Calibration Level:	114.0			
Additional Comments:				

Measurement Period			**Description of Audible Noise**
Date	**Start / Stop Time**	**Measurement Intervals**	Noise from vehicle movements on local road to the east of measurement positon, road noise from A2016. Construction noise from site located to the east of measurment position also present. Noise from large fans located on Cory site, birdsong and occassional overhead aircraft passby
16/03/2023	10:00	1 hour	
21/03/2023	10:00		



NOISE MONITORING EQUIPMENT DETAILS

The table below presents the details of the equipment used whilst undertaking the noise monitoring works. Certification of calibration is available upon request.

Table 5: Noise Monitoring Equipment Details

Measurement Location	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date
MP1	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10594	16 May 2024
	Pre-amplifier	01dB-Stell PRE 22 Preamplifier	1507076	
	Microphone	G.R.A.S Type 40CD Condenser Microphone	224313	
	Calibrator	01dB Cal 21	34924020	
MP2	Sound Level Meter	01dB-METRAVIB Blue Solo 'Datalogging Integrating Sound Level Meter'	61331	22 October 2023
	Pre-amplifier	01dB-METRAVIB PRE 21 S	14575	
	Microphone	01dB Mereavib MCE 212 Microphone	92344	
	Calibrator	Norsonic type 1251 Sound Calibrator	31460	26 September 2023
MP3	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10616	1 June 2023[1]
	Pre-amplifier	01dB-Stell PRE 22 Preamplifier	10180	
	Microphone	G.R.A.S Type 40CD Condenser Microphone	154423	
	Calibrator	01dB Cal 21	34924053	13 May 2023

[1]Calibration due date at time of survey, equipment has since been calibrated prior to the issue of this report

TECHNICAL APPENDIX 6-3: SUPPLEMENTARY ACOUSTICS GUIDANCE AND POLICY INFORMATION

DECARBONISATION

Cory Decarbonisation Project

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APPENDIX 6-3: SUPPLEMENTARY ACOUSTICS GUIDANCE AND POLICY INFORMATION

This appendix provides a full description of international and national legislation, national policy and guidance, and technical guidance relevant to the noise and vibration assessment.

INTERNATIONAL LEGISLATION

DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT, 2002

This Directive relates to the assessment and management of environmental noise, and it is commonly referred to as the Environmental Noise Directive (END). It promotes the implementation of a three-step process:

- Undertake strategic noise mapping to determine exposure to environmental noise;
- Ensure information on environmental noise is made available to the public; and
- Establish Action Plans based on the strategic noise mapping results, to reduce environmental noise where necessary, and to preserve environmental noise quality where it is good.

EU Directive 2002/49/EC has been transposed into UK law as the Environmental Noise (England) Regulations 2006 (as amended). As part of this process, noise mapping has been undertaken and Noise Important Areas (NIA) have been identified at locations where the 1% of the population that are affected by the highest noise levels are located, to identify the areas that require potential action.

DIRECTIVE 2014/52/EU OF THE EUROPEAN PARLIAMENT, 2014

This Directive, published on 16 April 2014, amends Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

It was considered necessary to amend the 2011 Directive to strengthen the quality of the environmental impact assessment procedure, align that procedure with current best practice and other relevant legislation and policies developed by the European Union and Member States.

An Environmental Impact Assessment report prepared under this legislation should include, inter alia, a description of the likely significant effects of the project and the measures envisaged to avoid, reduce or, if possible, offset any identified significant adverse effects on the environment.

NATIONAL LEGISLATION

CONTROL OF POLLUTION ACT 1974

The principal legislation covering demolition and construction noise is the Control of Pollution Act 1974, Part III. Sections 60 and 61 of the Act give local authorities special powers for controlling noise arising from construction and demolition works, regardless of whether a statutory nuisance has been caused or is likely to be caused. Works within the scope of these provisions include repair and maintenance work and road works. These powers may be exercised either before works start or after they have started.

Section 60 of the 1974 Act enables a local authority in whose area work is going to be carried out, or is being carried out, to serve a notice of its requirements for the control of Site noise on the person who appears to the local authority to be carrying out the works. Such a notice may also be served on others appearing to the local authority to be responsible for, or to have control over, the carrying out of the works.

This notice can:

- Specify the plant or machinery that is or is not to be used;
- Specify the hours during which the construction work can be carried out;
- Specify the level of noise that can be emitted; and
- Provide for any changes of circumstances.

Section 61 of the Act provides a mechanism for the contractor or developer to take the initiative and approach the local authority to ascertain its noise requirements before construction work starts. If a formal application for ‘prior consent’ is received by the local authority it is obliged to give a decision within 28 days; failure to do so or the attachment of unnecessary or unreasonable conditions are grounds for appeal by the applicant.

In cases where the local authority determines that the proposals for minimising the noise of the construction activities are adequate it will issue a consent although this may be subject to conditions limiting certain aspects of the consent such as hours of use, noise levels for particular activities, etc. Provided that the applicant takes all reasonable steps to operate within the terms of the consent, even if the local authority subsequently decides to take proceedings under section 60(8), the applicant should be able to rely on the defence provided in the Act and prove that the alleged contravention amounted to the carrying out of works in accordance with a consent given under section 61.

The application of these provisions to the Proposed Scheme will be considered as part of the production of the draft DCO for the Proposed Scheme and the associated OCoCP.

NATIONAL POLICY AND GUIDANCE

NOISE POLICY STATEMENT FOR ENGLAND (NPSE), 2010

The NPSE seeks to ensure that noise issues are considered at the right time during the development of policy and decision making, and not in isolation. It highlights the underlying principles on noise management already found in existing legislation and guidance.

The NPSE sets out the long-term vision of Government noise policy as follows:

> *"Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."*

This long-term vision is supported by the following aims:

> *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life*."

To assist in the understanding of the terms 'significant adverse' and 'adverse', the NPSE acknowledges that there are concepts that are currently being applied to noise impacts, for example, by the World Health Organisation (WHO). They are:

- NOEL - No Observed Effect Level - This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise;
- LOAEL - Lowest Observable Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL - Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.

However, the NPSE goes on to state that:

> *"it is acknowledged within the NPSE that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."*

The adopted threshold value for the SOAEL is based on the '*Specified Noise Level*', as set out in the *Noise Insulation Regulations 1975* (NIR). This is the level of noise that would (provided that other criteria are met) trigger entitlement to the provision of sound insulated glazing (and, where necessary, ventilation) for residential properties located within 300 m of a new road scheme. The Specified Noise Level specified in the NIR is 68 dB $L_{A10,18h}$.

The adopted threshold value for the LOAEL is based on guidance contained within the *WHO*. This states that the lowest observed threshold for the onset of community annoyance occurs for situations where the outside free-field noise level exceeds 50dB $L_{Aeq,16h}$ (07.00 to 23.00 hours). This uses a different noise metric ($L_{Aeq,16h}$ which is used as a general measure of noise from all sources) and time period to that used to quantify road traffic noise (the $L_{A10,18h}$ (06.00 to 24.00 hours)).

NATIONAL PLANNING POLICY FRAMEWORK (NPPF), 2023

The NPPF was introduced in March 2012 and last updated in September 2023 and is a key part of the reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The NPPF includes an overarching presumption in favour of sustainable development that should be the basis of every plan and every decision.

The NPPF states that planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the Site or the wider area to impacts that could arise from the development (Paragraph 185) and specifically to:

- *"mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise from giving rise to significant adverse impacts on health and quality of life[65]; and*
- *identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".*

The footnote to the policy ([65]), directs the reader to the Explanatory Note to the Noise Policy Statement for England (NPSE) Explanatory Note, which sets out more information on how the 'adverse effects' and 'significant adverse effects' referred to in the NPPF should be considered.

The NPPF emphasises that planning policies and decisions should take account of existing businesses and other organisations when locating new noise sensitive development nearby, so that development does not create noise complaint conditions to the detriment of those existing operations. Paragraph 187 states:

> *"Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed."*

PLANNING PRACTICE GUIDANCE, 2019

This web-based resource was issued for use by the Department for Communities and Local Government (DCLG). The purpose of the guidance is to complement the NPPF and provide advice on how to deliver its policies.

The section on noise (https://www.gov.uk/guidance/noise--2) was last updated on the 22nd July 2019. This includes guidance including a table that summarises "*the noise exposure hierarchy, based on the likely average response*" and which offers examples of outcomes relevant to the NOEL, LOAEL and SOAEL effect levels described in the NPSE (see above). The term Unacceptable Adverse Effect (UAE) level is introduced which equates to noise perceived as "Present and very disruptive". It is stated that UAEs should be prevented. These outcomes are in descriptive form and there is still no numerical definition of the NOEL, LOAEL and SOAEL, or detailed advice regarding methodologies for their determination. There is also no reference to the further research that was identified as necessary in the NPSE regional planning policy.

These outcomes are in descriptive form and there is no numerical definition of the NOEL, LOAEL and SOAEL (or UAE), or detailed advice regarding methodologies for their determination. There is also no reference to the further research that is identified as necessary in the NPSE. The noise exposure hierarchy table is duplicated in **Table 1**.

Table 1: Noise Exposure Hierarchy Based on the Likely Average Response

Perception	Examples of Outcomes	Increasing Effect Levels	Action
No Observed Effect Level			
Not noticeable	No effect.	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g., turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g., avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g., regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g., auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

TECHNICAL GUIDANCE

HIGHWAYS ENGLAND DESIGN MANUAL FOR ROADS AND BRIDGES, LA 111 REVISION 2. NOISE AND VIBRATION 2020 (LA 111)

LA 111 sets out the methodology for assessing road traffic noise and vibration in terms of significance of effect and magnitude of impact.

For the assessment of noise impacts, consideration is given to the noise level changes that will arise in the short-term as a starting point for determining significance.

The short-term scheme impacts are derived by comparing the ‘Do Minimum’ scenario (i.e., without the Proposed Scheme) in the ‘opening year’, with the ‘Do Something’ scenario (i.e., with the Proposed Scheme) in the same year.

Further details of the technical content of LA 111 and how it has been applied to the assessment of traffic noise from the Proposed Scheme are set out in the Methodology section of **Chapter 6: Noise and Vibration (Volume 1).**

CALCULATION OF ROAD TRAFFIC NOISE (CRTN), 1988

The former Department of Transport/Welsh Office technical memorandum Calculation of Road Traffic Noise (CRTN) methodologies have been adopted.

The factors which may influence road traffic noise levels at source can be divided into two groups:

- Road related factors - gradient and surface type; and
- Traffic related factors - flow, speed and the proportion of heavy-duty vehicles.

The propagation of noise is also covered in CRTN and can influence the noise levels at receptor locations.

BS 5228-1:2009+A1:2014

Code of practice for Noise and Vibration Control on Construction and Open Sites: Part 1 Noise

This Standard provides the latest recommendations for basic methods of noise control where there is a need for the protection of persons living and working in the vicinity of, and those working on, construction and open sites.

The Standard includes guidance on assessing the significance of noise effects. In particular, Annex E provides a discussion on the different approaches to the assessment of construction noise, giving consideration to absolute noise levels (in section E2) and to two different approaches to setting criteria based on the ambient noise level ($L_{Aeq,T}$) in the absence of construction noise (in section E3).

Table 2 (Table E.2 in sub-clause E.4 of the Standard) defines the noise levels used as limits above which noise insulation would be provided, subject to the temporal conditions described in **Table 2**.

Table 2: Examples of Time Periods, Averaging Times and Noise Levels Associated with the Determination of Eligibility for Noise Insulation

Time	Relevant time period	Averaging time, 'T'	Noise insulation trigger level dB $L_{Aeq,T}$ (A)
Monday to Friday	07.00 – 08.00	1 h	70
	08.00 – 18.00	10 h	75
	18.00 – 19.00	1 h	70
	19.00 – 22.00	3 h	65
	22.00 – 07.00	1 h	55
Saturday	07.00 – 08.00	1 h	70
	08.00 – 13.00	5 h	75
	13.00 – 14.00	1 h	70
	14.00 – 22.00	3 h	65
	22.00 – 07.00	1 h	55
Sunday and Public Holidays	07.00 – 21.00	1 h	65
	21.00 – 07.00	1 h	55

Notes:

(A) All noise levels are predicted or measured at a point 1 m in front of the most exposed of any windows and doors in any façade of any eligible dwelling.

The Standard suggests that where, in spite of the mitigation measures applied, the combined construction and baseline noise levels exceed 75 dB(A) (for a period of ten or more days of working in any fifteen consecutive days or for a total of days exceeding 40 in any six month period), a scheme for the installation of noise insulation or the reasonable costs thereof will be implemented by the developer or promoter.

In sub-clause E.3 an alternative approach is described based on considering the change in the ambient noise level that the construction noise causes. This approach is used commonly in EIA. Two methods are described.

The first is the ABC method an example of which is set out in **Table 3** (Table E.1 in the Standard). Three categories, A, B and C are described in terms of threshold noise levels for a daytime (07:00 to 19:00 weekdays, 07:00 to 13:00 Saturday), evening and weekend, and finally a night-time period (23:00 to 07:00). If the combined ambient noise and construction noise exceed the relevant threshold level this is deemed a 'significant effect'.

Table 3: Example Threshold of Potential Significant Effect at Dwellings

Assessment category and threshold value period	Threshold value, in decibels (dB $L_{Aeq,T}$)		
	Category A (A)	Category B (B)	Category C (C)
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (D)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

Notes:

[1] A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the Site exceeds the threshold level for the category appropriate to the ambient noise level.

[2] If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to Site noise.

[3] Applied to residential receptors only.

(A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

(B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.

(C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

(D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The second method states that "N*oise levels generated by site activities are deemed to be potentially significant if the total noise (pre-construction ambient plus site noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut off values of 65 dB, 55 dB and 45 dB* $L_{Aeq,T}$ *from site noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact*."

These criteria may be applied not just to residential buildings, but also to hotels and hostels and buildings in religious, educational and health/community use.

The +5 dB criterion for a period of one month or more, might also be deemed to cause significant effects in public open space. However, the extent of the area impacted relative to the total available area also needs to be considered.

Annex F of the Standard provides guidance on estimating noise from construction sites. The estimation procedures described in this Annex take into account the more significant factors:

- the sound power outputs of processes and plant;
- the periods of operation of processes and plant;
- the distances from source to receiver;
- the presence of screening by barriers;
- the reflections of sound; and
- attenuation from absorbent ground.

Four discrete prediction methods are described: two for stationary plant, the activity $L_{Aeq,T}$ method and the plant sound power method; and two for mobile plant,– the method for mobile plant in a defined area and the method for haul roads.

BS 4142 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

BS 4142 describes methods for rating and assessing the following:

- sound from industrial and manufacturing processes;
- sound from fixed installations which comprise mechanical and electrical plant and equipment;
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train movements on or around an industrial and/or commercial site.

The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes and upon which sound is incident.

The Standard effectively compares and rates the difference between the specific sound level of the source ($L_{Aeq,T}$) and the typical background sound level ($L_{A90,T}$) in the absence of the specific sound. If appropriate, the specific sound level is corrected, by the application of one or more corrections for acoustic features such as tonal qualities and/or distinct impulses, to give a 'rating' level ($L_{Ar,Tr}$).

The Standard allows the following additive corrections for character: 0 dB to +6 dB for tonality and 0 dB to +9 dB for impulsivity. Where the specific sound features characteristics that are neither tonal nor impulsive, but otherwise are readily distinctive, a penalty of +3 dB can be applied. Finally, should the specific sound contain identifiable on/off conditions and so be readily distinctive, a penalty of +3 dB can be applied.

The Standard advises that the time interval of the background sound measurement should be sufficient to obtain a representative or typical value of the background sound level at the time(s) the source in question operates or is proposed to operate in the future. The specific sound level should be evaluated over a one-hour period during the day and over a 15 minute period during the night.

Comparing the rating level with the background sound level, the Standard states:

- "*Typically, the greater this difference, the greater the magnitude of impact.*
- *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
- *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
- *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context*.

TECHNICAL APPENDIX 6-4: OPERATIONAL NOISE MODELLING

DECARBONISATION

Cory Decarbonisation Project

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APPENDIX 6-4: OPERATIONAL NOISE MODELLING

Table 1 identifies the assumptions made for sound power levels and heights of each noise source that has been modelled for the operation phase of the Proposed Scheme, based on the evolving design.

Table 1: Operation Noise Source Assumptions

Noise Source	Sound Power Level L_{WA} dB (A)	Height (m)	Information Source
Absorber Stack	103	60	Sound power level equivalent to the stack for Riverside 2. Height as per BIM model dated May 2023.
Flue Gas Fan	85	9.8	Based on similar development (professional judgement).
Pumps	104	1	WKC Group Pump Noise Calculator, 450kW rich solution pump, assumed worst-case speed range.
Pumps associated with solvent/waste tanks	96	1	WKC Group Pump Noise Calculator, 100kW pump, assumed 1500rpm speed range.
Back Pressure turbines	85	6	Based on similar development (professional judgement).
33/11kV Transformers	78	6	Based on NEMA TR1 and IEEE standards for specifying sound pressure and converting to sound power.
132/33kV Transformers	86	6	Based on NEMA TR1 and IEEE standards for specifying sound pressure and converting to sound power.
CO_2 Venting	110	11.6	Based on similar development (professional judgement).
CO_2 Compressors	90	11	Provided by Design Team.
Refrigeration Package	98	1	Based on similar development (professional judgement).
Cooling Solution	93	15	Provided by Design Team.

Noise Source	Sound Power Level L_{WA} dB (A)	Height (m)	Information Source
Heat Transfer Station Cooling Fans	98	7.75	Provided by Design Team, height assumed to be 2.5m above the roof of building as a worst-case.

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TECHNICAL APPENDIX 6-5: CONSTRUCTION NOISE AND VIBRATION

Cory Decarbonisation Project

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APPENDIX 6-5: CONSTRUCTION NOISE AND VIBRATION

CONSTRUCTION PLANT MACHINERY

Tables 1 to **6** identify the assumed plant and machinery that will be used during each phase of construction and demolition activities.

Table 1: Jetty Demolition (if undertaken)

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 unless otherwise stated)	On-time (%)
Large excavator mounted breaker^	1	82	Table. C.5, ref 3	20
Hand held circular saw	1	91	Table. C.4, ref 70	15
Crane (barge mounted / land-based)	1	84	Table. C.3, ref 28	20
Diamond wire saw	1	78*	Modern Concrete Drill Cut Co., Ltd.	15
Tracked excavator loading dump truck	1	85	Table C.1, ref 10	20
Note: ^ Mobile plant. *Quoted 76-81dB at 7m (higher figure used).				

Table 2: Earthworks and Jetty Construction

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 unless otherwise stated)	On-time (%)
17t Scraper^	1	90	Table D.9, ref 12	60
28t Dozer^	2	79	Table C.2, ref 11	80
44t Tracked excavator^	2	82	Table C.1, ref 12	80
4t Vibratory roller^	1	74	Table C.2, ref 38	60
50t mobile telescopic crane^	1	67	Table C.4, ref 46	20

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 unless otherwise stated)	On-time (%)
Diesel water pump	2	68	Table C.4, ref 88	20
Pulverizer mounted on excavator (rock breaker)	2	76	Table C.1, ref 4	60
Tracked semi-mobile crusher^	1	90	Table C.9, ref 14	20
Dredging - Nordic Giant (backhoe dredger)	1	88	Intersona (measured)	20
Piling rig (vibratory)	1	88	Table. C.3, ref 8	20
Crane (barge mounted / land-based)	2	84	Table. D.7, ref 104	20
Note: ^ Mobile plant.				

Table 3: Site Clearance and Enabling Works (Proposed Scheme)

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 unless otherwise stated)	On-time (%)
Large excavator mounted breaker^	1	82	Table. C.5, ref 3	20
44t Tracked excavator^	1	82	Table C.1, ref 12	80
Hand held circular saw	1	91	Table. C.4, ref 70	15
Dozer^	1	75	Table. C.2, ref 1	25
Vibratory roller	1	75	Table. C.5, ref 20	30
Lorry (unloading)^	1	80	Table. C.2, ref 34	40
Road sweeper^	1	76	Table. C.4, ref 90	5
Note: ^ Mobile plant.				

Table 4: Substructure and Superstructure (Proposed Scheme)

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 Unless Otherwise Stated)	On-time (%)
Concrete mixer truck^	2	75	Table. C.4, ref 18	25
Small breaker (hand held)	1	86	Table C.5, ref 4	20
Compressor	1	65	Table C.5, ref 5	70
Lorry (unloading)^	2	80	Table. C.2, ref 34	40
Hand held circular saw	1	91	Table. C.4, ref 70	40
Tracked excavator^	2	82	Table C.1, ref 12	80
Dumper trucks^	2	78	Table C.4, ref 2	30
Poker vibrator	2	69	Table C.4, ref 34	40
Mobile crane^	1	70	Table C.4, ref 30	100
Telescopic fork lift^	1	88	Table D.7, ref 94	80
Hand tool (hammers)	8	69	Table C.1, ref 19	80
MEWP - cherry picker Genie	2	67	Table C.4, ref 57	60
Lorry mounted concrete pump	1	67	Table C.4, ref 24	70
<u>Note</u>: ^ Mobile plant.				

Table 5: Excavation (Access Road Works)

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 Unless Otherwise Stated)	On-time (%)
Tracked excavator 14t^	1	70	Table C.2, ref 7	80
Wheeled backhoe loader 8t^	1	68	Table C.2, ref 8	80
Hydraulic vibratory compactor (tracked excavator)^	1	78	Table C.2, ref 42	50
Dozer 11t^	1	78	Table C.2, ref 13	80
Lorry^	1	80	Table C.2, ref 34	20
<u>Note</u>: ^ Mobile plant.				

Table 6: Pavement Works (Access Road Works)

Plant Item	Number	Sound Pressure Level, L_{PA} at 10m (dB)	Data Source (BS5228 unless otherwise stated)	On-time (%)
Road planer^	1	82	Table C.5, ref 7	75
Dozer - spreading chip and fill^	1	77	Table C.5, ref 12	50
Vibratory roller^	1	75	Table C.5, ref 20	60
Asphalt paver and tipper lorry^	1	75	Table C.5, ref 30	40
Vibratory compactor^	1	82	Table C.5, ref 29	60
Lorry^	1	80	Table C.2, ref 34	20

Note:
^ Mobile plant.

CORY

TECHNICAL APPENDIX 6-6: UNCERTAINTY MATRIX

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APPENDIX 6-6: UNCERTAINTY MATRIX

Table 1 below identifies the process WSP has undertaken to reduce uncertainty in the BS4142 assessment for the Proposed Scheme.

Table 1: WSP Uncertainty Assessment Matrix

Uncertainty Control Measures	Applicable?	Adopted?/Comments
Measurement		
Only use in calibration Type/Class 1 equipment and check (and record) calibration level before and after measurements.	✓	Yes
Take measurements using the time and frequency weighting specified by the relevant standard.	✓	Yes
Make detailed notes, including details of the equipment, weather, survey positions (including approximate distances), contributing noise sources, presence of screening etc.	✓	Yes
Take photographs, and record survey locations.	✓	Yes
Avoid standing waves/interference – listen for effects, take spatial average from several locations or conduct a sweep.	✓	External measurements only.
Take measurements at different distances to establish propagation.	✓	Measurements taken in multiple locations.
Take measurements at different heights where relevant.	×	N/A
Don’t just measure at the “noisiest” parts of site, but establish how “quiet” it is, too, where relevant to the assessment.	×	N/A
Measure under different operating conditions relevant to your assessment / adopt worst case if known.	×	N/A
Measure more than one cycle/ event (ideally at least three).	×	N/A
Determine state of repair of any associated source, where relevant.	×	N/A
Use a windshield and avoid windy conditions (i.e. gusts regularly exceeding 5 m/s).	✓	Windshield was utilised, exposure to high wind

Uncertainty Control Measures	Applicable?	Adopted?/Comments
		speed was minimised as far as practicable.
Avoid wet conditions (particularly in terms of rain on the windshield/mic and on neighbouring surfaces).	✓	Yes
Avoid electrical and electromagnetic interference (such as from power cables and radio transmitters).	×	N/A
Avoid extreme temperatures – traffic conditions can be different in freezing conditions, whilst meters can overheat and fail in a case when in direct sunlight during the summer.	✓	Yes
Make measurements during different weather conditions (particularly relevant in terms of wind direction for sites affected by aircraft movements, but also for sites affected by other distant, but significant, sources of noise, in different directions.	×	N/A
Where only one source is dominant (such as a main road), as a minimum, measure during conditions favourable to propagation (i.e. when wind direction is within +/-45° of the line between the source and receiver or during temperature inversion, such as on clear calm nights).	×	N/A
Avoid tree/leaf (movement) sound where possible – ideally take measurements at comparable distance to receptor locations.	✓	Yes
Avoid dawn chorus sound where possible – ideally take measurements the same distance from trees and bushes as any receptors of interest.	×	N/A
Measure outside the receptor in question where possible; however, it is worst case typically to measure under free-field conditions and apply +3 dB correction to convert to “façade” where applicable – for most planning (new residential development) assessments, free-field is preferable.	×	N/A

Uncertainty Control Measures	Applicable?	Adopted?/Comments
Where it is not possible to install a meter outside the receptor in question, install a meter elsewhere and undertake additional attended measurements, either outside the receptor or at a representative location (when not adequately covered by the installed meter).	✓	Yes
Avoid atypical traffic conditions (such as during school holidays and road works – road traffic incidents can significantly affect flows, but which can't be predicted, and their occurrence can't always be established after the survey – check the data for anomalies).	✓	Yes
Avoid presence of you and/or the microphone resulting in atypical conditions.	✓	Yes
Data Handling		
Download data immediately after survey and process promptly whilst details are fresh in your head.	✓	Yes
Use digital transfer methods and double check data read-off manually.	✓	Yes
Look at the time-history (in as fine a resolution as possible) for any unexpected events – preferably with active spectral data (i.e. in dBTRAIT).	✓	Yes
If removing any data (due to an atypical event, for example), 'save as' a new file and provide a note to the data.	✓	Yes
Prediction		
Use measurement data at different distances to verify propagation.	✓	Yes
Different height measurements to verify screening effects, if relevant.	×	N/A
Use propagation calculation procedure relevant to source and distance.	✓	Yes
Use detailed traffic flow data applicable to the methodology.	×	N/A

Uncertainty Control Measures	Applicable?	Adopted?/Comments
Use detailed sound source data (including octave-bands levels), accounting for size, height and directivity, where known.	✓	Yes
Use detailed topographical data and base mapping.	✓	Yes
Identify different ground types.	✓	Yes
Apply an order of reflections of at least one.	✓	Yes
Use 3D view feature to check model accuracy of the model.	✓	Yes
Produce contour plots as a further means of identifying any abnormalities or errors in the model.	×	N/A

DECARBONISATION

TECHNICAL APPENDIX 7-1: CONSULTATION WITH THAMES WATER

Cory Decarbonisation Project

Joyce, Paul

From: Karen Sutton [redacted]
Sent: 17 February 2023 13:11
To: Joyce, Paul
Cc: Cox, Phoebe; Bramall, Tim; Johnson, Katie
Subject: Re: Crossness Nature Reserve warden contact details

Hi Paul,

Good to hear from you, I hope the surveys have been going well.

No we do not have Great Crested Newt on the reserve, just [redacted].

We also have reptiles: Slow Worm and Grass Snake. There's anecdotal evidence of Adder, but I'm not convinced by Adder presence.

I hope that helps.

Kind regards

Karen

Get [Outlook for iOS]

From: Joyce, Paul [redacted]
Sent: Friday, Febr[redacted]
To: Karen Sutton [redacted]
Cc: Cox, Phoebe [redacted] Bramall, Tim [redacted] Johnson, Katie [redacted]
Subject: Crossness Nature Reserve warden contact details

Hi Karen,

Sorry to bother you again following the below (many thanks for the gate code last year!).

We're planning upcoming monitoring work around the Riverside Energy Park and are thinking about great crested newts. I know they have been scoped out from other studies as not present but just want to check this is still the case. Could you confirm whether any are present on the reserve?

Many thanks for your help!

Paul

Paul Joyce
Associate Director, Ecology
[redacted]

[redacted]

wsp.com

From: Karen Sutton [redacted]
Sent: 24 November 2022 10:24
To: Bramall, Tim [redacted]
Cc: Joyce, Paul [redacted] Cox, Phoebe [redacted]
Subject: RE: Crossness Nature Reserve warden contact details

Morning Tim,

Glad the info was useful. Yes, those Peregrines are almost always on the Cory facility, usually on the chimney or on the west face, or otherwise huddled up roosting in bad weather in a corner of the east facing wall of the RRRL facility.

Good luck with the surveys. That would be great if you can let me know of anything special sighted – thank you.

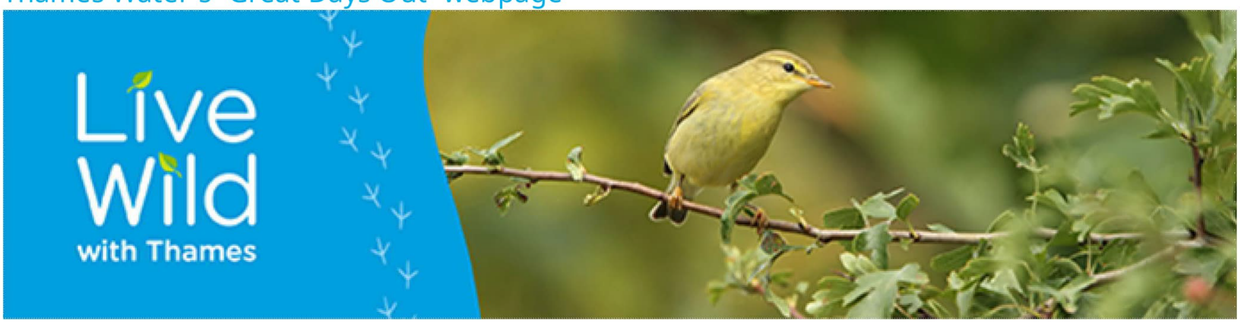
Kind regards

Karen

Karen Sutton
Crossness Nature Reserve Manager

[redacted]

Thames Water's 'Great Days Out' webpage



Thames Water

From: Bramall, Tim [redacted]
Sent: 24 November 2022 09:14

To: Karen Sutton [redacted]
Cc: [redacted] Cox, Phoebe [redacted]
Subject: RE: Crossness Nature Reserve warden contact details

Morning Karen,

Many thanks for all this info, that's great! Yes, we had some nice sightings on Tuesday, Paul managed to spot the peregrine on top of Cory facility which was good to see. It's great to hear the recent sightings, we will be sure to let you know if we find anything special! Yes you are correct these will be wintering bird surveys for the Cory Riverside Energy Park development, so we will be popping along once/twice a month until March 2023. Thanks for the maps, I have no doubt they will be very useful going forwards.

Kind regards,

Tim Bramall
Grauduate Ecologist
[redacted]

wsp.com

From: Karen Sutton [redacted]
Sent: 23 November 2022 17:15
To: Bramall, Tim [redacted]
Cc: Joyce, Paul [redacted] Cox, Phoebe [redacted]
Subject: RE: Crossness Nature Reserve warden contact details

Hi Tim,

Yes, the area behind the keycode gate is part of Crossness Nature Reserve, and accessible to members of the Friends of Crossness Nature Reserve scheme. The code to access this area is [redacted] If you have any issues, just press the reset button and try again. This will give you access to the bird hide, boardwalk through reedbeds, scrub at the bottom of the Protected Area etc.

Unfortunately, the area beyond the next set of gates is part of Crossness Sewage Treatment Works and you would not be able to access from the nature reserve.

I assume that this is the wintering birds survey taking place for the Cory Riverside Energy Park development? There's been some nice sightings recently: Dartford Warbler on the West Paddock; Spoonbill and Curlew Sandpiper on the foreshore a few weeks back, Kingfishers from the bird hide, so fingers crossed something nice turns up your visits.

Schematic maps attached showing the nature reserve and southern marsh boundaries which might prove helpful.

Kind regards

Karen

Karen Sutton
Crossness Nature Reserve Manager
[redacted]

Thames Water's 'Great Days Out' webpage

From: Bramall, Tim [redacted]
Sent: 23 November 2022 16:48
To: Karen Sutton [redacted]
Cc: [redacted] Cox, Phoebe [redacted]
Subject: RE: Crossness Nature Reserve warden contact details

Hi Karen,

Thanks for getting in touch! Paul, Phoebe and myself are all part of the WSP London Ecology Team and we are currently carrying out some ecological surveys on the Crossness Nature Reserve and surrounding land. However, when out on Site yesterday we encountered a locked gate with a coded keypad, which seemed to be bordering Thames Water land. Upon further inspection we did notice that there were several signs pointing in the direction of the land behind the gate, stating that the land was a 'members only' area. Is this related to the Crossness Nature Reserve itself and if so, would we be able to have the access code for the gate?

Please see attached several pictures of the locked gate in question. On the map, the small circle is the location of the locked gate, and the large red circle is the area of land that we would like access to, including the bird hide which lies within this land. Would it be possible to access this land behind the gate or is this managed by someone else? If so, do you know who? Please advise.

Please feel free to get in touch if you have any questions!

Kind regards,

Tim Bramall

Grauduate Ecologist
[redacted]

wsp.com

From: Karen Sutton [redacted]
Sent: 23 November [redacted]
To: Bramall, Tim [redacted]
Cc: Joyce, Paul [redacted]
Subject: RE: Crossness Nature Reserve warden contact details

Hi Tim,

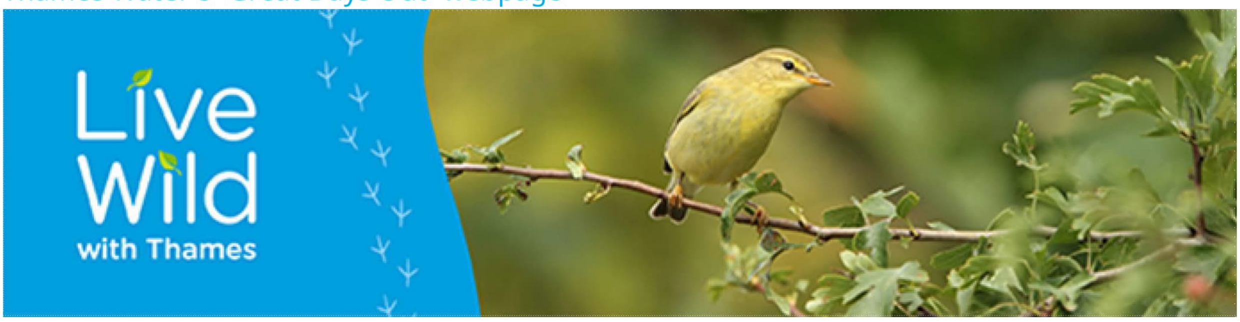
Charlie Burgess forwarded me your email as I take care of Crossness Nature Reserve. Feel free to drop me a line regarding your ecological surveys and hopefully I can help.

Kind regards

Karen

Karen Sutton
Crossness Nature Reserve Manager
[redacted]

Thames Water's 'Great Days Out' webpage



5

From: Bramall, Tim [redacted]
Sent: 23 November 2022 11:24
To: Charlie Burgess [redacted]
Cc: [redacted]
Subject: Crossness Nature Reserve warden contact details

Hello Charlie,

I hope you are well! Paul Joyce has kindly put me in touch with yourself (we are both part of the WSP London Ecology team). I am just writing to ask if you would be able to provide us with the contact details for the warden of Crossness Nature Reserve, where we are currently carrying out some ecological surveys. We were having some issues in accessing one area of the site and would like to get in touch with the reserve warden to see if it could be possible to resolve this.

Any questions please do not hesitate to get in touch!

Kind regards,

Tim Bramall
Grauduate Ecologist
[redacted]
wsp.com

-LAEmHhHzdJzBITWfa4Hgs7pbKI

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TECHNICAL APPENDIX 7-2: INFORMATION TO INFORM A HABITATS REGULATION ASSESSMENT: STAGE 1: SCREENING

DECARBONISATION

Cory Decarbonisation Project

Cory Environmental Holdings Limited

CORY DECARBONISATION PROJECT

Information to Inform a Habitat Regulations Assessment: Stage 1 - Screening

70087219-HRA
JUNE 2023

PUBLIC

Cory Environmental Holdings Limited

CORY DECARBONISATION PROJECT

Information to Inform a Habitat Regulations Assessment: Stage 1 - Screening

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PROJECT NO. 70030329

OUR REF. NO. 70087219-HRA

DATE: JUNE 2023

PUBLIC

Cory Environmental Holdings Limited

CORY DECARBONISATION PROJECT

Information to Inform a Habitat Regulations Assessment: Stage 1 - Screening

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QUALITY CONTROL

Issue/Revision	First Issue	Revision 1	Revision 2	Revision 3
Remarks	Final			
Date	June 2023			
Prepared By	Justin Moncy			
Signature	[redacted]			
Checked By	Kusha Manikumar			
Signature	[redacted]			
Authorised By	Paul Joyce			
Signature	[redacted]			
Project Number	70030329			
Report Number	Information to Inform a Habitat Regulations Assessment: Stage 1 - Screening			

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TABLES

APPENDICES

EXECUTIVE SUMMARY

Cory Environmental Holdings Limited (Cory) is part of the Cory Group, one of the UK's leading resource management companies. Its core activity, recovering energy from residual waste, is undertaken at the Riverside Campus, located adjacent to the River Thames at Belvedere in the London Borough of Bexley (LBB). Riverside 1, an energy from waste (EfW) facility generating up to 80.5 megawatt (MW) of electricity, has been operational since 2011. Riverside 2, an EfW facility with a generating capacity of approximately 76MW is currently under construction and anticipated to be operational in 2026.

Cory (hereafter referred to as 'the Applicant') intends to construct and operate the Cory Decarbonisation Project to be linked with the River Thames, comprising two key projects: the Carbon Capture and Storage Project; and the Hydrogen Project. Together, the Carbon Capture and Storage Project, the Hydrogen Project, the Proposed Jetty and the ancillary infrastructure and equipment are referred to as the 'Proposed Scheme'. Further information is provided in **Chapter 1: Introduction** and **Chapter 2: Site and Proposed Scheme Description** of the Environmental Impact Assessment (EIA) Scoping Report[1].

This report comprises a preliminary Habitats Regulations Assessment (HRA) screening assessment. Following engagement with Natural England and ongoing development of the Proposed Scheme, it will be updated and submitted with the DCO application to provide the competent authority with the information it needs to inform an assessment of Likely Significant Effects (LSEs) associated with the Proposed Scheme) on National Network sites, to make an appropriate assessment of the implications of the Proposed Scheme (and other schemes that could act in-combination with the Proposed Scheme) on National Network sites in view of the sites' conservation objectives, and whether mitigation can offset these effects. The competent authority may agree to the Proposed Scheme only after having ascertained that it will not adversely affect the integrity of the National Network sites. This report will also determine whether further HRA stages need to be applied to achieve compliance with legislation. However, it should be noted that the conclusions of the assessment may change as the design of the Proposed Scheme develops. One National Network site was identified in the Study Area, Epping Forest Special Area of Conservation. The following LSEs were identified:

- Operational Phase: Changes in Air Quality.

Stage 2 Appropriate Assessment will be undertaken to provide the required information for the competent authority to make an informed decision on the Proposed Scheme. The Appropriate Assessment process will examine in more detail the LSEs identified above, as well as potential in-combination effects with other schemes, and whether they would lead to adverse effects on the National Network site as a result of the Proposed Scheme.

[1] WSP. (2023). Environmental Impact Assessment Scoping Report.

1 INTRODUCTION

1.1 BACKGROUND

1.1.1. Cory Environmental Holdings Limited (Cory) is part of the Cory Group, one of the UK's leading resource management companies. Its core activity, recovering energy from residual waste, is undertaken at the Riverside Campus, located adjacent to the River Thames at Belvedere in the London Borough of Bexley (LBB). Riverside 1, an EfW facility generating up to 80.5 megawatt (MW) of electricity, has been operational since 2011. Riverside 2, an EfW facility with a generating capacity of approximately 76MW is currently under construction and anticipated to be operational in 2026.

1.1.2. Cory (hereafter referred to as 'the Applicant') intends to construct and operate the Cory Decarbonisation Project to be linked with the River Thames. It comprises two key projects:

- the Carbon Capture and Storage Project: the construction of infrastructure to capture at least 95% of carbon emissions from Riverside 1 and Riverside 2. The Carbon Capture and Storage Project will be one of the largest carbon capture and storage (CCS) projects in the UK; and
- the Hydrogen Project: utilising up to 50MW of the electricity generated by Riverside 1 and Riverside 2 (which is already low carbon and with the installation of CCS will become carbon negative), through an electrolyser, to produce 39MW of hydrogen production (21.6 tonnes per day of hydrogen).

1.1.3. Both of these projects will be supported by the use of a new jetty for the onward transportation of the captured carbon and potentially hydrogen (the 'Proposed Jetty').

1.1.4. Together, the Carbon Capture and Storage Project, the Hydrogen Project, the Proposed Jetty and the ancillary infrastructure and equipment are referred to as the 'Proposed Scheme'. Further information is provided in **Chapter 1: Introduction** and **Chapter 2: Site and Proposed Scheme Description** of the Environmental Impact Assessment (EIA) Scoping Report[1]. The extent of the Proposed Scheme is referred to as the 'Site Boundary' which is shown in **Figure 1**, within **Appendix A**.

1.2 PURPOSE OF THIS REPORT

1.2.1. The Proposed Scheme lies along the southern bank of the River Thames between Crossness Sewage Treatment Works and Crossness Local Nature Reserve to the west, Iron Mountain Records Storage Facility and Asda Belvedere Distribution Centre to the east, with the River Thames to the north and the A2016 to the south. It is located at Norman Road North, Lower Belvedere, London, DA17 6JY (centred on National Grid reference: TQ 4967 8066 and extending to 60.11ha).

1.2.2. This report comprises a preliminary Habitats Regulations Assessment (HRA) screening assessment. Following engagement with Natural England and ongoing development of the Proposed Scheme, it will be updated and submitted with the DCO application to provide the competent authority with the information it needs to inform an assessment of Likely Significant Effects (LSEs) associated with the Proposed Scheme on National Network sites, to make an appropriate assessment of the implications of the Proposed Scheme (and other schemes that could act in-combination with the Proposed Scheme) on National Network sites in view of the sites' conservation objectives, and whether mitigation can offset these effects. The competent authority may agree to the Proposed

Scheme only after having ascertained that it will not adversely affect the integrity of the National Network sites. This report will also determine whether further HRA stages need to be applied to achieve compliance with legislation. However, it should be noted that the conclusions of the assessment may change as the design of the Proposed Scheme develops.

2 DESCRIPTION OF THE PROPOSED SCHEME

2.1.1. The UK Government has recognised that the installation of new renewable electricity production can only go 'so far' to meet the net zero target and avoid major climate change impacts, with these impacts further heightened in the context of the Intergovernmental Panel on Climate Change (IPCC) 2022 report[2]. As such, a key part of achieving net zero and mitigating the future impacts of climate change is the introduction of carbon capture and storage infrastructure, both to decarbonise existing industrial emitters and to facilitate the provision of negative emissions to offset industries that cannot decarbonise completely. Carbon capture and storage infrastructure is recognised by the Government as key in the net zero transition in the:

- Energy White Paper;
- Clean Growth Strategy (including its CCS Action Plan);
- Industrial Decarbonisation Strategy;
- Draft Overarching National Policy Statement for Energy (EN-1);
- Draft National Policy Statement for Renewable Energy Infrastructure (EN-3);
- British Energy Security Strategy; and
- Powering Up Britain.

2.1.2. In this context, it is notable that by 2026 (when Riverside 2 is expected to be operational), the combined emissions of Riverside 1 and Riverside 2 will be responsible for the single largest source of EfW derived CO_2 emissions in the UK, being up to 1.66 million tonnes (Mt) of CO_2 per year. Combined, the facilities of the Riverside Campus are a key CO_2 emitter within the UK[1].

2.1.3. The Carbon Capture and Storage Project will capture up to 95% of these emissions, the equivalent to approximately 1.3Mt CO2 per year. Furthermore, with the feedstock to Riverside 1 and Riverside 2 comprising approximately 50% biogenic content, the Carbon Capture and Storage Project has the potential to result in net-negative CO_2 emissions, of approximately 0.6Mt per year of CO_2[3].

2.1.4. As such, the Proposed Scheme will be part of a regional effort to enable the decarbonisation of emissions in London and the Southeast of England.

2.1.5. The Carbon Capture and Storage Project will broadly consist of the following stages:

- Stage 1 – Flue Gas Supply;
- Stage 2 – Carbon Capture Plant;
- Stage 3 – Compression, Conditioning and Liquefaction;
- Stage 4 – Liquefied CO_2 Buffer Storage; and
- Stage 5 – Liquefied CO_2 Loading System.

2.1.6. It is proposed that the Carbon Capture and Storage Project is a 2-train design with two independent systems for Stages 1 to 3 that could be applied separately to Riverside 1 and 2. The Liquefied CO_2

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[2] IPCC. (2022). IPCC Sixth Assessment Report. Available at: https://www.ipcc.ch/report/ar6/wg2/

[3] Cory. (2022). 'Cory Decarbonisation Project Section 35 Request'. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1109718/cory-decarbonisation-project-section-35-request.pdf

Buffer Storage (Stage 4) and Liquid CO_2 Loading System (Stage 5) shall be common for the Carbon Capture and Storage Project.

2.1.7. A new jetty within the River Thames (the Proposed Jetty) is required to export the CO_2. The loading platform would be installed in close proximity to the on-site buffer storage. The Proposed Jetty would include pedestrian access and potentially vehicle access.

2.1.8. In addition to the Carbon Capture and Storage Project, Cory is considering obtaining development consent to construct, operate and maintain a Hydrogen production plant to produce 39MWof hydrogen.

2.1.9. The Hydrogen Project will broadly consist of the following steps:

- Stage 1 – Electricity Supply;
- Stage 2 – Water Treatment;
- Stage 3 – Electrolysis Plant;
- Stage 4 – Scrubbing, Dehydration, Deoxidising and Purification;
- Stage 5 – Hydrogen Storage; and
- Stage 6 – Hydrogen Export / Use.

2.1.10. A range of hydrogen export uses are being considered, including transport and/or fuelling by vessel, and therefore the Proposed Jetty may also be used for Hydrogen Project purposes.

2.1.11. Both the Carbon Capture and Storage Project and the Hydrogen Project are required to be taken through the Planning Act 2008 process due to a Section 35 Direction having been granted for them by the Secretary of State.

2.1.12. Ancillary infrastructure and equipment likely to be included within the Proposed Scheme are listed in **Chapter 2: Site and Proposed Scheme Description** of the **EIA Scoping Report**[1]. This includes a backup power supply, for example a battery energy storage system and/or emergency standby generator. The use of a battery energy storage system would also provide resilience to the National Grid and support the movement towards zero-carbon electricity.

2.1.13. In addition to the above, there will be consideration of a heat recovery and thermal storage system that will redirect heat produced from the Carbon Capture and Storage processes into the proposed Riverside Heat Network. This approach will benefit the scale and availability of the Riverside Heat Network.

3 HRA PROCESS

3.1 LEGISLATIVE AND PLANNING POLICY CONTEXT

Habitats Regulations Assessment

3.1.1. The Conservation of Habitats and Species Regulations 2017 (as amended, hereafter referred to as the Habitats Regulations) protects a national network of sites within the UK consisting of Special Areas of Conservation ('SAC'; focussed on intrinsically important habitats and biological populations other than birds) and Special Protection Areas ('SPA'; focussed on protecting important bird populations and the habitats that support them). This National Site Network, termed the Natura 2000 network prior to the UK's departure from the European Union, supports and forms part of a wider network of sites within Europe.

3.1.2. As a result of the 2019 Habitats Regulations references to Natura 2000 in the 2017 Regulations, and in guidance, are now taken to refer to the 'National Site Network'.

3.1.3. Maintaining a coherent network of protected sites with overarching conservation objectives is still required to:

- fulfil the commitment made by government to maintain environmental protections; and
- continue to meet our international legal obligations, such as the Bern Convention, the Oslo and Paris (OSPAR) Conventions, Bonn and Ramsar Conventions.

3.1.4. Regulation 63 (1) of the Habitats Regulations states that *'A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which—*

(a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and

(b) is not directly connected with or necessary to the management of that site,

—must make an Appropriate Assessment of the implications for that site in view of that site's conservation objective".

3.1.5. Where effects on a habitats site are likely to be significant, they must be subject to the second stage of the HRA process, Appropriate Assessment. Conservation of Habitats and Species Regulations 2017 (as amended) also make allowance for projects or plans to be completed if they satisfy 'imperative reasons of overriding public interest (IROPI)'[4]. Regulations 64 and 68 cover such situations.

3.1.6. Although the UK has now left the European Union, Court of Justice of the European Union (CJEU) decisions issued prior to 1st January 2021 remain binding until subsequent UK court decisions overrule them. Further to the case of *Harris v Environment Agency*, it is clear that article 6(2) of the Habitats Directive still continues to take effect.

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[4] *'(a) reasons relating to human health, public safety or beneficial consequences of primary importance to the environment; or .*

(b) any other reasons which the competent authority, having due regard to the opinion of the European Commission, consider to be imperative reasons of overriding public interest.'

National Planning Policy Framework 2021 (NPPF)

3.1.7. The NPPF sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development (for the purposes of this assessment the Proposed Scheme is considered to be a development) can be produced. It must be considered in preparing the development plan and is a material consideration in planning decisions.

3.1.8. The NPPF (at para 179) states that when considering the conservation and enhancement of the natural environment, with regard to habitats and biodiversity, the Local Planning Authority should:

"…protect and enhance biodiversity and geodiversity, plans should:

- *a) Identify, map and safeguard components of local wildlife-rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity; wildlife corridors and stepping stones that connect them; and areas identified by national and local partnerships for habitat management, enhancement, restoration or creation; and*
- *b) promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and identify and pursue opportunities for securing measurable net gains for biodiversity".*

3.1.9. Para 181 to 182 of the NPPF states: The following should be given the same protection as habitats sites:

181:

- *a) "potential Special Protection Areas and possible Special Areas of Conservation;*
- *b) listed or proposed Ramsar sites; and*
- *c) sites identified, or required, as compensatory measures for adverse effects on habitats sites, potential Special Protection Areas, possible Special Areas of Conservation, and listed or proposed Ramsar sites".*

182: *"The presumption in favour of sustainable development does not apply where the plan or project is likely to have a significant effect on a habitats site (either alone or in combination with other plans or projects), unless an appropriate assessment has concluded that the plan or project will not adversely affect the integrity of the habitats site".*

3.2 STAGES OF HABITATS REGULATIONS ASSESSMENT

3.2.1. Although no clarification has been provided by the UK Government or its agencies (e.g. Natural England) on the applicability of existing guidance following the UK's withdrawal from the European Union (EU), the EU (Withdrawal) Act 2018 likely supports the use of such guidance documents through Section 6(2) which states:

"[domestic courts and tribunals] may have regard to anything done by the CJEU or another EU entity [i.e. the European Commission] … so far as it is relevant to any matter before the court or tribunal"

3.2.2. Thus, existing guidance on the assessment of effects of plans or projects on Natura 2000 sites (now National Network sites in the UK) issued by the European Commission[5] has been used by this

[5] European Commission (2018) Managing Natura 2000 Sites: the provisions of Article 6 of the Habitats Directive 92/43/CEE. Brussels: European Commission.

assessment, alongside guidance issued by the Planning Inspectorate in National Infrastructure Planning Advice Note 10[6] (AN10). These documents set out the step-wise approach which should be followed to enable competent authorities to discharge their duties under the Habitats Regulations. The process used is usually summarised in four distinct stages of assessment which are described below and shown in **Figure 2**, within **Appendix A**.

- **Screening (Stage 1):** the process to identify the likely effects of a plan or project upon the qualifying features and conservation objectives of a National Network sites, either alone or in combination with other plans or projects and consider whether there will be a LSE.
- **Appropriate Assessment (Stage 2):** detailed consideration of LSEs and whether they would lead to significant adverse effects on the integrity of the National Network sites, either alone or in combination with other plans and projects. Where there are adverse effects, mitigation is considered to offset them. Consent may only be granted at this stage if the Appropriate Assessment can conclude beyond reasonable scientific doubt that the plan or project will not have adverse effects (alone or in-combination with other plans or projects). If the mitigation options cannot avoid adverse effects, then development consent can only be given if Stages 3 and 4 are followed.
- **Assessment of Alternative Solutions (Stage 3):** the process which examines alternative ways of achieving the objectives of the plan or project that avoid or have lesser adverse effects on the integrity of the National Network sites.
- **Imperative Reasons of Overring Public Interest (IROPI) (Stage 4):** the assessment where no alternative solutions exist and where adverse effects remain: an assessment of whether the development is necessary for IROPI and, if so, of the compensatory measures needed to maintain the overall coherence of the site or integrity of the National Network sites.

3.2.3. The method for assessing the likely significance of an effect will be based on the environmental sensitivity (or value / importance) of a receptor (the site concerned) and the magnitude of change from baseline conditions. There is no specific definition of what constitutes a LSE, but case law (CJEU C-127/02[7]) clarified that in the context of an HRA, a LSE is one whose occurrence cannot be excluded based on objective information.

3.2.4. The preliminary information and conclusions provided by this assessment will be updated and finalised as the Proposed Scheme progresses, with final information to be presented as required by Section 6 of AN10 and its associated template matrices.

3.3 SCREENING (STAGE 1)

3.3.1. An initial broad screening of National Network sites to investigate the potential for effects pathways linking them the Proposed Scheme has been undertaken and is referred to as ‘screening’. The screening process was wide-ranging and took into consideration the sensitivity and mobility of National Network site Qualifying Features, e.g. marine mammal and bat species, as well as the nature of the proposed works and working methods.

[6] Planning Inspectorate (2022). Advice Note 10: Habitats Regulations Assessment relevant to nationally significant infrastructure projects. Available at: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-ten/

[7] CJEU - C-370/12 / Judgment Thomas Pringle v Government of Ireland and Others.

3.3.2. Its purpose is to identify the likely impacts upon a National Network site of a project or a plan, either alone or in combination with other plans or projects and considers whether these impacts are likely to be significant. It will include:

- determining whether the plan is directly connected with or necessary for the management of applicable sites (SAC, SPA, Ramsar);
- describing the project/plan that may have the potential for significant effects upon applicable sites;
- undertaking an initial scoping for potential direct and indirect impacts upon applicable sites;
- assessing the likely significance of any potential effects identified as resulting from these impacts, both alone and in-combination with other plans and projects; and
- excluding sites where it can be objectively concluded that there will be no significant effects.

3.3.3. Results of the screening assessment are set out in Section 4. It should be noted that due to the early stage of assessment no list of plans or projects that could act in-combination with the Proposed Scheme is available at this time. The assessment in relation to in-combination effects will be undertaken in later versions of this assessment.

3.3.4. Following the judgement handed down by the CJEU in Case C-323/17[8], it is no longer appropriate to consider measures taken specifically to reduce a project's potential impact on European designated sites into account at the screening stage. Accordingly, no reference to mitigation is made, or relied upon, in this screening assessment.

3.4 FURTHER HRA STAGES (STAGE 2, 3 AND 4)

3.4.1. Stages 2, 3 and 4 are outside of the purpose of this report, which covers only Stage 1 (screening). The findings of this report will define the scope of the assessment of LSEs through an Appropriate Assessment (Stage 2) if they are identified. The Appropriate Assessment would, where necessary, identify alternative solutions to the Proposed Scheme (Stage 3), and also inform any IROPI arguments at Stage 4 that may be required. If options identified at Stage 2 cannot avoid or mitigate adverse effects, then development consent can only be given if Stages 3 and 4 are followed and passed.

[8] Case C-323/17 People Over Wind & Peter Sweetman v Coillte Teoranta ('People over Wind').

4 IDENTIFICATION OF NATIONAL NETWORK SITES

4.1 STUDY AREA AND SITES IDENTIFIED

4.1.1. This defines the geographic limits from the Proposed Scheme used to identify National Network sites to be considered within the HRA process and to be screened for LSEs. The Study Area reflects the high sensitivity of qualifying features of National Network sites and the fact they often support species that are mobile and widely ranging, such as birds.

4.1.2. The principal criterion defining the Study Area is a zone of 15km surrounding the Site Boundary, a distance appropriate to encompass possible effect pathways from the Proposed Scheme to National Network sites. This zone has been informed by guidance issued by the Environment Agency in relation to emissions of power generation facilities of 50MW capacity or more, which require a 15km Study Area to account for effects of the emissions plume[9]. This has been taken into account particularly given that the application of the Carbon Capture and Storage Project is likely to impact the characteristics of the plume arising from the Riverside Campus as compared to the plumes currently arising from Riverside 1 and predicted to arise from Riverside 2, and this change will need to be considered as an effect. All National Network sites within this zone have been included into this stage of the HRA process and are subject to screening for LSEs.

4.1.3. One National Network site was identified during the Screening stage within 15km of the Site Boundary, Epping Forest SAC, which lies approximately 14km to the north of the Site Boundary, across the River Thames. The location of the Epping Forest SAC is shown within **Figure 3** within **Appendix A**.

4.2 REASONS FOR DESIGNATION

4.2.1. Epping Forest SAC is designated on the basis that it supports habitats and populations of species that are of importance at an international / European level. The qualifying features are set out in **Table 4-1**, below.

Table 4-1 Epping Forest SAC Qualifying Features

Qualifying Feature	Description[10]
Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrub layer (*Quercion robori-petraeae* or *Ilici-Fagenion*)	This Annex I type comprises beech *Fagus sylvatica* forests with holly *Ilex*, growing on acid soils, in a humid Atlantic climate. Sites of this habitat type often are, or were, managed as wood-pasture systems, in which pollarding of beech and oak *Quercus spp*. was common. This is known to prolong the life of these trees.
Lucanus cervus - Stag beetle	The stag beetle *Lucanus cervus* is the UK's largest terrestrial beetle, and amongst the most spectacular, reaching 7cm in length. Larvae develop in decaying tree stumps and fallen timber of broad-leaved trees in contact with the ground, especially of apple Malus spp., elm *Ulmus spp*., lime *Tilia spp*., beech *Fagus sylvatica* and oak *Quercus*

[9] Environment Agency (2021). Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

[10] Joint Nature Conservation Committee. Available at: https://sac.jncc.gov.uk/habitat/.

Qualifying Feature	Description[10]
	spp. Such timber is an essential feature for conservation of structure and function of the habitat for this species. Development takes around 3-4 years. Adults are active on warm evenings, but probably only the males fly regularly and come readily to lights. Adults have been recorded from May to September or even October, though they are most abundant in early summer.
Northern Atlantic wet heaths with *Erica tetralix*	Wet heath usually occurs on acidic, nutrient-poor substrates, such as shallow peats or sandy soils with impeded drainage. The vegetation is typically dominated by mixtures of cross-leaved heath *Erica tetralix*, heather *Calluna vulgaris*, grasses, sedges and *Sphagnum* bog-mosses.
European dry heaths	European dry heaths typically occur on freely-draining, acidic to circumneutral soils with generally low nutrient content. Ericaceous dwarf-shrubs dominate the vegetation. The most common is heather *Calluna vulgaris*, which often occurs in combination with gorse *Ulex spp*., bilberry *Vaccinium spp*. or bell heather *Erica cinerea*, though other dwarf-shrubs are important locally. Nearly all dry heath is semi-natural, being derived from woodland through a long history of grazing and burning.

4.3 CONSERVATION OBJECTIVES

4.3.1. Conservation objectives for Epping Forest SAC comprise the following:

- Maintain or restore the extent and distribution of qualifying habitats and habitats of qualifying species.
- Maintain or restore the structure and function (including typical species) of qualifying natural habitats.
- Maintain or restore the structure and function of the habitats of qualifying species.
- Maintain or restore the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
- Maintain or restore the populations of qualifying species.
- Maintain or restore the distribution of qualifying species within the site.

4.4 SUPPLEMENTARY ADVICE ON CONSERVATION OBJECTIVES

4.4.1. In England, the conservation objectives should be read in conjunction with the Supplementary Advice on Conservation Objectives ('SACO') published by Natural England. The supplementary advice sets out how the Conservation Objectives for each qualifying interest can be met, in relation to various different criteria. For example, SACO may set out the population size a qualifying interest species needs to reach in order to meet the Conservation Objective "maintain or restore the populations of qualifying interest species".

4.4.2. Where a Conservation Objective is being met, SACO provide advice on how the Conservation Objective can be maintained. Where a Conservation Objective is not being met, SACO provide advice on the steps needed to restore the qualifying interest concerned.

4.4.3. Relevant SACO for Epping Forest SAC have been reviewed on the Natural England website[11] and are reported in **Table 4-2** below.

Table 4-2 Epping Forest SAC Supplementary Advice on Conservation Objectives

Qualifying Interest	Supplementary Advice on Conservation Objectives
Northern Atlantic wet heaths with *Erica tetralix*; wet heathland with cross-leaved heath	Supporting processes (on which the feature relies): Air Quality. Restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (APIS)[12].
	Supporting processes (on which the feature relies): soils, substrate and nutrient cycling. Restore the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the H4010 wet heath habitat. '*…further work is likely to be necessary to address the background environmental pressures such as excessive nitrogen deposition and increasing recreational impacts (e.g., excessive dog-waste, intensive mountain-biking etc)…*'
European Dry Heaths	Restore as necessary, the concentrations and deposition of air pollutants to, at or below the site-relevant Critical Load or Level values given for this feature of the site on the APIS.
Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrub layer (*Quercion robori-petraeae* or *Ilici-Fagenion*)	Structure and function (including its typical species): Soils, substrate and nutrient cycling. Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the H9120 habitat. '*…Threats to the soil quality include:* *(a) Nutrient enrichment from elevated atmospheric nitrogen deposition, sewage spills and excessive dog waste.* *(b) Excessive compaction through uncontrolled development, heavy vehicles, intensive footfall and recreational activities.* *Pollution from fly-tipping, abandoned vehicles, road run-off and litter, waste from adjacent developments and residential areas.*'
	Structure and function (including its typical species): root zones of ancient trees Maintain roots and good soil structure within and around the root zones of the mature and ancient tree cohort. '*…Unless carefully managed, activities such as construction, forestry management, mountain biking, and intensive trampling (by grazing*

[11] https://publications.naturalengland.org.uk/publication/5908284745711616

[12] www.apis.ac.uk

Qualifying Interest	Supplementary Advice on Conservation Objectives
	livestock and human feet during recreational activity) may all contribute to root damage and excessive soil compaction around ancient trees.’
	Restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this H9120 woodland feature of the site on the APIS.
Stag beetle	Supporting processes (on which the feature and/or its supporting habitat relies): Air quality. Maintain or, where necessary, restore concentrations and deposition of air pollutants to, at or below the site-relevant Critical Load or Level values given for this feature of the site on the APIS.

5 SCREENING ASSESSMENT

5.1 NATIONAL NETWORK SITE MANAGEMENT STATEMENT

5.1.1. The Proposed Scheme is not directly connected with, or necessary for, the management of Epping Forest SAC, identified in **Section 4** as within the HRA Study Area. The Proposed Scheme has not been conceived solely to further the conservation of these sites and nor is it essential to the management of this site.

5.2 IDENTIFICATION OF IMPACTS

5.2.1. Although the EIA Scoping Report[1] identified a variety of construction phase impacts of the Proposed Scheme, these will all be confined to its local area and not be transmitted over a long distance. Effects of habitat loss and fragmentation, noise and vibration, dust, surface water run-off and lighting associated with the Proposed Scheme would not be transmitted over the 14km distance between it and Epping Forest SAC. The large area of urban Greater London in the intervening landscape and lack of hydrological or other connections between the Proposed Scheme and the SAC would act as a barrier to effects of these impacts. Therefore, no construction phase impacts have been identified through the HRA process.

5.2.2. The same conclusion has been adopted for the operation phase where noise and vibration, maintenance activities, surface water run-off and lighting are all considered to be local impacts that would not act at distance. In addition, no impacts on road traffic patterns during construction and operation would occur over the 14km distance between the Proposed Scheme and Epping Forest SAC that could lead to effects through air quality changes. Similarly, changes in vessel movement frequency during operation would not lead to air quality changes over the 14km distance. Consequently, these are not considered operation phase impacts. However, air quality changes as a result of the Proposed Scheme could occur and act at distance, and thus one impact has been identified for the operation phase:

- **Changes in air quality (operation phase)** – Air quality changes may result from the Proposed Scheme. Therefore, there is potential for long term impacts within the Site Boundary, immediate surroundings, and further afield such as at Epping Forest SAC.

5.2.3. Any decommissioning would be likely to be completed in less time than the construction of the Proposed Scheme and, whilst the Applicant has no plans to decommission and remove the Proposed Scheme, were it to be removed, it would be likely to require a similar degree of plant, equipment and disturbance to that predicted during construction. Given that the Applicant has no plans to decommission the Proposed Scheme, further consideration of decommissioning is not considered appropriate.

5.3 CONSIDERATION OF EFFECTS

5.3.1. Relevant threats and pressures identified for Epping Forest SAC, the only National Network site in the Study Area, have been considered against impacts of the Proposed Scheme, and information included within Section 2 of this report describing it, to screen for potentially significant effects on Qualifying Features and Conservation Objectives.

5.3.2. Results of this screening process are presented in **Table 5-1** (operational phase).

Table 5-1 Epping Forest SAC; Screening for LSEs at the Proposed Scheme Operational Phase

Qualifying Feature	Impact	LSE?	Reasoning
Northern Atlantic wet heaths	Changes in air quality	Yes	Air quality changes from operational emissions from the Hydrogen Project, and from changes to the emissions arising from the Riverside Campus as a result of the Carbon Capture and Storage Project may be transmitted to and/or affect disposition levels at Epping Forest SAC.. Such operation phase air quality changes represent a likely effect of the Proposed Scheme on northern Atlantic wet heaths during the operational phase and will be taken forward for further consideration at Stage 2.
European dry heaths	Changes in air quality	Yes	Air quality changes from operational emissions from the Hydrogen Project, and from changes to the emissions arising from the Riverside Campus as a result of the Carbon Capture and Storage Project may be transmitted to and/or affect disposition levels at Epping Forest SAC. There may also be emissions from increased levels of vessel movements supplying the Proposed Scheme. Such operation phase air quality changes represent a likely effect of the Proposed Scheme on European dry heaths during the operational phase and will be taken forward for further consideration at Stage 2.
Atlantic acidophilous beech forests	Changes in air quality	Yes	Air quality changes from operational emissions from the Hydrogen Project, and from changes to the emissions arising from the Riverside Campus as a result of the Carbon Capture and Storage Project may be transmitted to and/or affect disposition levels at Epping Forest SAC. Such operation phase air quality changes represent a likely effect of the Proposed Scheme on Atlantic acidophilous beech forests during the operational phase and will be taken forward for further consideration at Stage 2.
Stag beetle	Changes in air quality	Yes	Air quality changes from operational emissions from the Hydrogen Project, and from changes to the emissions arising from the Riverside Campus as a result of the Carbon Capture and Storage Project may be transmitted to and/or affect disposition levels at Epping Forest SAC. Such operation phase air quality changes represent a likely effect of the Proposed Scheme on Stag beetle during the operational phase and will be taken forward for further consideration at Stage 2 at this National Network site.

6 RESULTS OF SCREENING AND CONCLUSIONS

6.1.1. A LSE were identified which could potentially affect the Epping Forest SAC. This comprises of:

- Operation Phase: Changes in Air Quality

6.1.2. Stage 2 Appropriate Assessment will be undertaken to provide the required information for the competent authority to make an informed decision on the Proposed Scheme. The Appropriate Assessment process will examine in more detail the LSEs identified above, as well as potential in-combination effects with other schemes, and whether they would lead to adverse effects on National Network sites as a result of the Proposed Scheme.

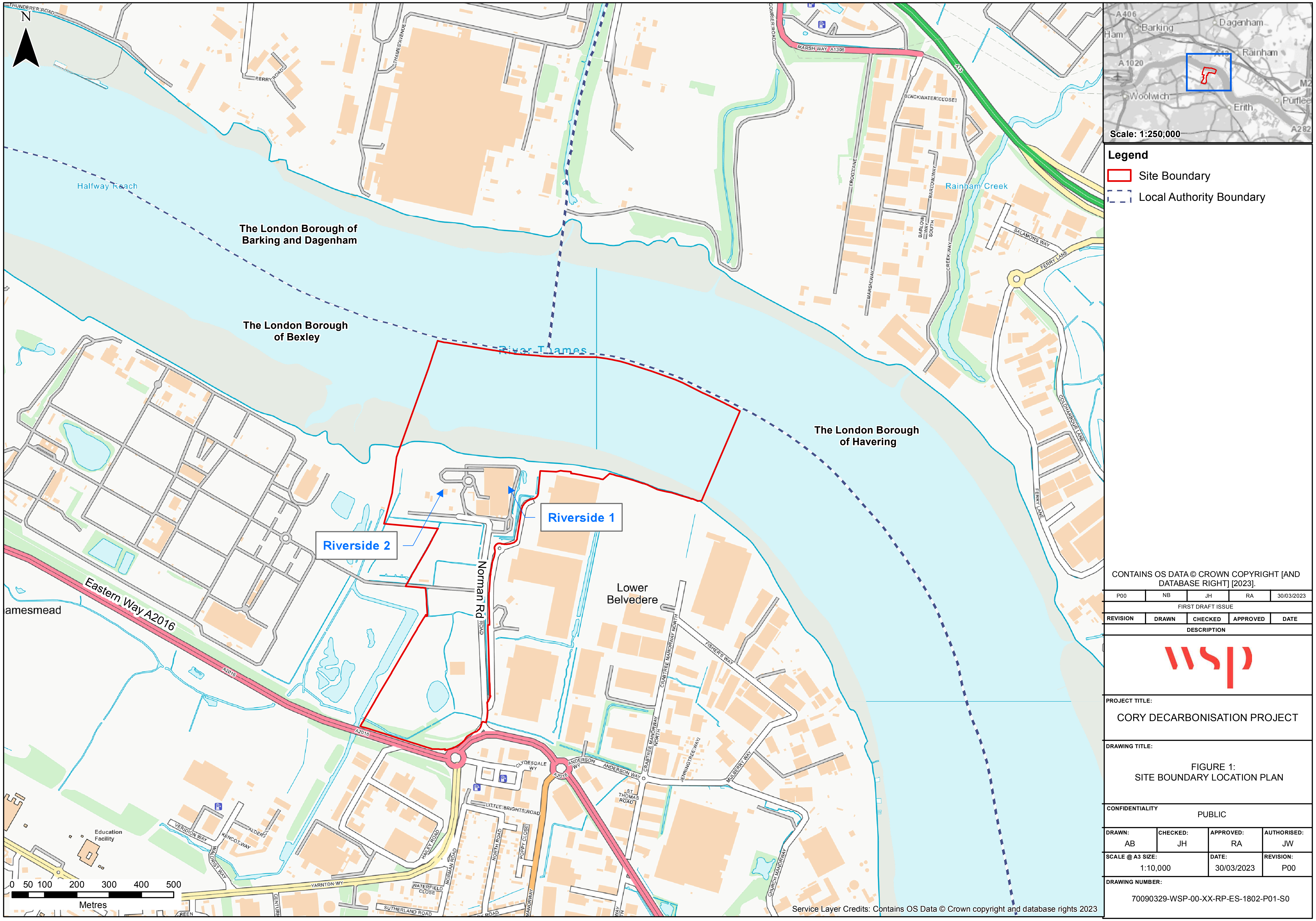
6.1.3. LSEs have been identified in the absence of mitigation. A ruling by the Court of Justice of the European Union (CJEU)[13] requires that mitigation measures should only be considered at Stage 2 Appropriate Assessment and not at screening stage or as an embedded element of a project. However, suitable measures to avoid and mitigate LSEs can be applied at Stage 2 Appropriate Assessment stage and LSEs that have been identified could be managed through the application of good working practices that would mitigate for potential adverse effects during the operation stage.

[13] Case C-258/11, Sweetman v. An Bord Pleanála, CJEU judgment 11 April 2013

Appendix A

FIGURES

Public



\\uk.wspgroup.com\central data\Projects\70090xxx\70090329 - Cory CCUS DCO Delivery\03 WIP\GIS\13_GSS\132_GIS\ArcGIS\MXDs\EIA Scoping Report\Figure 1-1 Site Boundary Location Plan.mxd

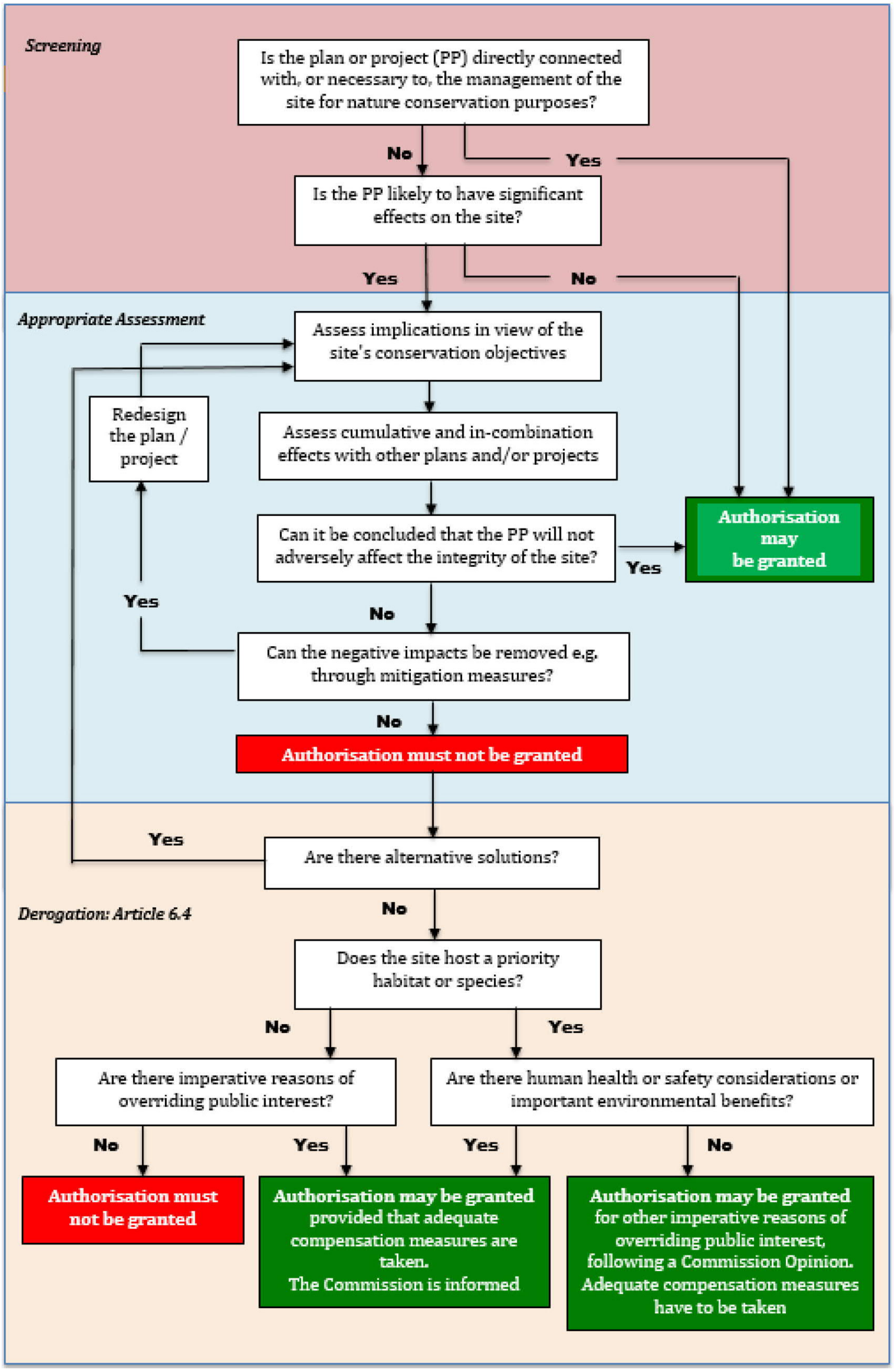


Figure 2 – Outline of the HRA process

LEGEND:

- Site Boundary
- 15km Study Area
- Special Area of Conservation

0 3.5 7 km

STATUS: FOR INFORMATION ONLY

wsp

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London, EC2M 4YE
Tel: +44 (0) 20 7337 1700
www.wsp.com

CLIENT: Cory Group

PROJECT: Cory Decarbonisation Project

TITLE: Figure 3: National Network Site within Study Area - Epping Forest SAC

SCALE @A3:	DRAWN:	APPROVED:
1:120,000	JM	PJ
VERSION:	DATE:	DATE:
1	29/03/23	29/03/23
PROJECT No:	DRAWING No:	
70087219	-	

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TECHNICAL APPENDIX 7-3: INFORMATION TO INFORM A HABITATS REGULATION ASSESSMENT: STAGE 1: SCREENING, NATURAL ENGLAND RESPONSE

DECARBONISATION

Cory Decarbonisation Project

Date: 29 September 2023
Our ref: 439006
Your ref: HRA Screening

Hornbeam House
Crewe Business Park
Electra Way
Crewe
Cheshire
CW1 6GJ

T 0300 060 3900

BY EMAIL ONLY

Dear Sir/Madam,

HRA Screening - WSP working on behalf Cory Environmental Holdings Ltd - Cory Decarbonisation Project. Riverside Resource Recovery Facility, Norman Road North, Belvedere, DA17 6JY

Thank you for your consultation on the above.

Natural England is a non-departmental public body. Our statutory purpose is to ensure that the natural environment is conserved, enhanced, and managed for the benefit of present and future generations, thereby contributing to sustainable development.

Screening Request: Habitats Regulations Assessment (HRA)

It is Natural England's advice, on the basis of the material supplied with the consultation, that we agree with the conclusion of the HRA screening that there is a potential likely significant effect on Epping Forest SAC and that an Appropriate Assessment should be carried out.

Please send any new consultations, or further information on this consultation to consultations@naturalengland.org.uk.

.

Yours faithfully

Bella Jack
Thames Solent Area Team

CORY

TECHNICAL APPENDIX 9-1: HISTORIC ENVIRONMENT BASELINE REPORT

DECARBONISATION

Cory Decarbonisation Project

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APPENDICES

1. EXECUTIVE SUMMARY

WSP has been commissioned by Cory Environmental Holdings Limited to prepare an historic environment baseline report in advance of a proposed development at Norman Road, Belvedere in the London Borough of Bexley (LBB).

Cory (hereafter referred to as the Applicant) intends to construct and operate the Proposed Scheme, which will be physically linked with the River Thames. It comprises of four key zones:

- Carbon Capture Facility;
- Proposed Jetty;
- Mitigation Area; and
- Temporary Construction Compounds.

Together, the Carbon Capture Facility, the Proposed Jetty, the Mitigation Area, the Temporary Construction Compounds and ancillary infrastructure related to those activities are referred to as the 'Proposed Scheme'. The land upon which the Proposed Scheme is to be located is referred to as the 'Site' and the extent referred to as the 'Site Boundary'.

This document forms an appendix to the Preliminary Environmental Information Report (PEIR) which provides the preliminary impact assessment on buried heritage assets (archaeological remains) and above ground heritage assets (structures and landscapes of heritage interest). The PEIR will also consider the impact of the Proposed Scheme on the historic character and setting of designated assets within and beyond the Site (e.g., views to and from listed buildings and conservation areas).

There are not nationally designated (protected) heritage assets such as scheduled monuments or listed buildings within the Site Boundary. There are no locally listed assets within the Site Boundary.

ABOVE GROUND HERITAGE ASSETS

Above ground heritage assets that may be affected by the proposals comprise:

- **Crossness Pumping Station:** A mid-19th century pumping station comprising a Grade I listed building and two Grade II listed buildings, the closest of which is located 900m to the west of the Site Boundary. The buildings lie within the Crossness Conservation Area and, as a group, are of high heritage value. The Pumping Station is on the Historic England Heritage at Risk Register;
- **No. 4 Jetty and Approach at Dagenham Dock:** A Grade II listed building dating to the late-19th and early-20th centuries, located 750m to the north-west of the Site Boundary; and
- **Belvedere Power Station Jetty (disused):** An undesignated jetty dating to the 1950s-60s of low heritage value in the north-east of the Site Boundary.

BURIED HERITAGE ASSETS

The Proposed Scheme lies on the Thames floodplain, within an Archaeological Priority Area known to have a high level of preservation for archaeological and environmental remains due to the wet conditions of the underlying geology. Archaeological evaluation within the northern part of the Site revealed a typical deposit sequence over floodplain gravel of Neolithic to Iron Age alluvial deposits (intercalated clays and peat) covered by made ground associated with the former 20th century Borax Works. Within the alluvial deposits, the remains of fallen trees suggest a probably Bronze Age alder carr landscape (waterlogged and wooded terrain) though no evidence of archaeological activity (finds nor features) were recorded.

Buried heritage assets that may be affected by the Proposed Scheme comprise:

- **Previously unrecorded palaeoenvironmental remains:** There is a known, high potential for palaeoenvironmental remains to survive within the Site Boundary based on previous investigations onsite and in the surroundings. It is likely that any environmental evidence within the lower part of the deposit sequence (e.g., within peat and the lower clay) would remain intact due to their depth. Such remains would be of low or medium heritage value.
- **Previously unrecorded prehistoric and Roman remains**: There is a low to moderate potential for prehistoric and Roman remains to survive within the Site Boundary. This is based on evidence recorded within the 1km Study Area and the fact that the riverside location would have provided opportunities for the exploitation of natural resources. Such remains would likely be limited to localised findspots (i.e., flint tools or artefacts), of low or medium heritage value.
- **Previously unrecorded medieval remains**: There is a low potential for medieval remains to survive within the Site Boundary. The marshland was reclaimed in stages from as early as the 13th century to create suitable land for rearing animals and cultivating crops, and medieval sea walls may therefore survive. Evidence relating to land reclamation and agricultural utilisation, including field boundaries, droveways and drainage ditches, may survive. Such remains would be of low or medium heritage value. Evidence of former medieval sea walls would be of higher value, dependent on preservation and extent.
- **Previously unrecorded post-medieval and modern remains, recorded structures, field boundaries and drainage ditches**: There is a high potential for post-medieval and modern remains to survive within the Site Boundary, based on historic mapping and documentary evidence. Remains of field boundaries, drainage ditches and the sea wall shown on historic maps may survive. The remains of buildings and structures dating from the mid-19th century onwards shown on historic maps are likely to survive. However, surviving remains of former industrial buildings would likely be limited to wall footings and padding due to removal by modern development and site stripping. Post-medieval remains would be of low heritage value and modern remains would be of negligible or low value.

- **Possible marine obstructions from all periods, including the remains of wrecks, former jetties and barge beds**: There is an uncertain potential for such remains of medieval or earlier date to survive within the Site Boundary within the foreshore and the Thames, although there is a low to moderate potential for post-medieval and modern remains based on recorded obstructions within and around the Site. Remains associated with the wreck of a Second World War tug boat, which was lifted in 1970, may survive in the northern marine part of the Site. The value of such remains would depend on their nature and extent, but in all likelihood would be low or potentially medium.

Given the extent of the Site and the nature of the Proposed Scheme, which encompasses both a terrestrial and marine environment, the depth of archaeological deposits is anticipated to be highly variable. Past ground disturbance within the Site from mid-19th and 20th century developments may have compromised archaeological survival of shallow surviving remains, particularly in the northern terrestrial part of the area of the Proposed Scheme. The waterlogged conditions of the intertidal area within the Site and the former marshland, particularly where alluvium is present, will have promoted organic preservation. The height of archaeological deposits and alluvium are likely to vary across the site and will be buried at depth in some parts lying underneath modern made ground (between 1.0 and 4.0m thick).

2. INTRODUCTION

2.1. PROJECT BACKGROUND

WSP has been commissioned by Cory Environmental Holdings Limited (the Applicant) to prepare an historic environment baseline report in advance of a proposed development at Norman Road, Belvedere in the London Borough of Bexley (LBB; National Grid Reference/NGR 549572, 180512; **Figure 1**). The following master figures are also available in the PEIR:

- **Figure 1-1: Site Boundary Location Plan (Volume 2)**;
- **Figure 1-2: Satellite Imagery of the Site Boundary Plan (Volume 2)**; and
- **Figure 1-3: Indicative Site Layout Plan (Volume 2)**.

Cory (hereafter referred to as the Applicant) intends to construct and operate the Proposed Scheme to be linked with the River Thames. It comprises of four key zones:

- The Carbon Capture Facility: the construction of infrastructure to capture a minimum of 95% of carbon dioxide (CO_2) emissions from Riverside 1 and 95% of CO_2 emissions from Riverside 2 once operational, which is equivalent to approximately 1.3Mt CO_2 per year. The capture rate is the annual average. The Carbon Capture Facility will be one of the largest carbon capture projects in the UK;
- The Proposed Jetty: A new and dedicated export structure within the River Thames is required to export the CO_2 captured as part of the Carbon Capture Facility;
- The Mitigation Area: Land provisionally identified as part of the ongoing Biodiversity Net Gain (BNG) Assessment to provide habitat compensation; and
- The Temporary Construction Compounds: These areas will be used during construction for, including but not limited to, offices, warehouses, workshops, open air storage and car parking. The areas will be reinstated to their original use following completion of the construction works for the Proposed Scheme or utilised as part of the Proposed Scheme.

Together, the Carbon Capture Facility, the Proposed Jetty, the Mitigation Area, the Temporary Construction Compounds and ancillary infrastructure related to those activities are referred to as the 'Proposed Scheme'. The land upon which the Proposed Scheme is to be located is referred to as the 'Site' and the extent referred to as the 'Site Boundary'.

2.2. SCOPE

For the purposes of this report, heritage 'significance', as defined in the Overarching National Policy Statement (NPS) for Energy (EN-1; Department of Energy & Climate Change, 2011 and 2023) and the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, revised 2023), will be referred to as 'value' hereafter.

The report provides a baseline of known or potential buried heritage assets (archaeological remains) and above ground heritage assets (structures and landscapes of heritage interest) within or immediately around the Site. These are identified as having a degree of heritage value (significance) meriting consideration in planning decisions and includes designated heritage assets and assets identified by the local planning authority (including locally listed buildings), and non-designated heritage assets.

Professional expert opinion has been used to assess heritage value, based on historic, archaeological, architectural or artistic interest, considering past ground disturbance which may have compromised asset survival.

Chapter 9: Historic Environment (Volume 1) of the PEIR presents the preliminary impact assessment on buried heritage assets and above ground heritage assets within or immediately around the Site. The PEIR also considers the impact of the Proposed Scheme on the historic character and setting of designated assets within and beyond the Site Boundary (e.g. views to and from listed buildings and conservation areas). The PEIR includes measures to mitigate any adverse effects (e.g., site-based investigation and/or design changes), where identified.

An assessment of the impact on the value of known buried heritage remains through possible changes to setting has only been undertaken where there is sufficient information to establish the likely contribution of setting to heritage value, and where the value of the asset warranted this.

2.3. AIMS AND OBJECTIVES

The aim of this report is to assess the heritage baseline of the Proposed Scheme. This aim is achieved through three objectives:

- identify the presence of any known or potential heritage assets that may be affected by the Proposed Scheme;
- describe the value of such assets, in accordance with the NPS EN-1 (2011), the NPPF (2023) and relevant Historic England guidance (2017, 2019), considering factors which may have compromised asset survival; and
- determine the contribution to which setting makes to the value of the identified heritage assets.

2.4. KEY HERITAGE CONSTRAINTS

The Site does not contain any nationally designated (protected) heritage assets such as scheduled monuments, listed buildings or registered parks and gardens. The Site does not lie within a conservation area. No locally listed buildings are situated within the Site Boundary.

The Site lies within an Archaeological Priority Area (APA), as defined by LBB. This is the Thamesmead and Erith Marshes Tier 3 APA. Tier 3 APA are typically defined by geological, topographical or land use consideration. The Erith Marshes Tier 3 APA is an area of marshland that would have been regularly flooded during the prehistoric period and ideal for the exploitation of natural resources including waterfowl, fish, wood and reeds. Prehistoric finds within the marshland mostly comprise flint tools, but typically there is potential for former forest or built wooden structures to be preserved (Historic England, 2020).

There are four listed buildings to the west and northwest of the Site. These are:

- Grade I listed mid-19th century Crossness Pumping Station, dating to 1865 and located 920m to the west of the Site Boundary (National Heritage List for England /NHLE ref: 1064241).
- Grade II listed mid-19th century Workshop Range to the southeast of the Main Engine House at Crossness Pumping Station, dating to the 1860s and located 870m to the west of the Site Boundary (NHLE ref: 1064216).
- Grade II listed mid-19th century Workshop Range to the southwest of the Main Engine House at Crossness Pumping Station, dating to the 1860s and located 980m to the west of the Site Boundary (NHLE ref: 1250557).
- Grade II listed No. 4 Jetty and Approach at Dagenham Dock, dating to the late-19th and early-20th centuries and located 750m to the northwest of the Site Boundary (NHLE ref: 1391706).

The three listed buildings at Crossness Pumping Station are situated with the Crossness Conservation Area. Crossness Pumping Station is also on the Historic England Heritage at Risk Register (NHLE ref: 1064241).

3. PLANNING FRAMEWORK

A list of the policy, legislation and guidance relevant to the assessment of the historic environment for the Proposed Scheme is provided below.

A detailed summary of the policy, legislation and guidance is provided in **Section 9.2** of **Chapter 9: Historic Environment (Volume 1)** of the PEIR.

LEGISLATIVE BACKGROUND

Listed Buildings and Conservation Areas:

- *Planning (Listed Buildings and Conservation Areas) Act 1990; and*
- *Arrangements for Handling Heritage Applications: Notification to Historic England and National Amenity Societies and the Secretary of State (England) Direction 2021*.

PLANNING POLICY

NPS:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change, 2011); and
- Draft Overarching NPS for Energy (EN-1) (Department for Energy Security & Net Zero, 2023).

NPPF:

- NPPF (Ministry of Housing, Communities and Local Government, revised 2023).

Local planning policy:

- Spatial Development Strategy for Greater London (The London Plan) (Mayor of London, 2021); and
- Bexley Local Plan (London Borough of Bexley, 2023), which replaces the Bexley Core Strategy 2012, the saved polices of the Bexley Unitary Development Plan 2004 and the London Borough of Bexley Draft Local Plan 2021.

HERITAGE SECTOR GUIDANCE

Historic England Guidance:

- Historic England Good Practice Advice (GPA), particularly: *GPA2 - Managing Significance in Decision-taking* (March 2015) and *GPA3 - The Setting of Heritage Assets (2nd Edition)* (December 2017).

Chartered Institute of Archaeologists

- The baseline study has been undertaken in accordance with guidance published by the Chartered Institute for Archaeologists (CIfA), specifically the standard and guidance for historic environment desk-based assessment (CIfA, 2020).

4. SOURCES AND METHODOLGY

4.1. DATA SOURCES

In order to determine the full historic environment potential of the Site, a broad range of standard documentary and cartographic sources, including results from any archaeological investigations within the Site Boundary and a 1km Study Area around it were examined in order to determine the likely nature, extent, preservation and value (significance) of any known or possible heritage assets that may be present within or adjacent to the Site.

The Study Areas used for the above ground heritage asset settings assessment in **Chapter 9: Historic Environment (Volume 1)** of the PEIR comprise:

- Designated above ground heritage assets up to 1km from the Site Boundary. This Study Area has been informed by a digital ZTV which indicates likely visibility of the Proposed Scheme within the surrounding area. Professional judgement has been applied when scoping designated heritage assets potentially affected through changes to setting and, where relevant, assets beyond the 1km Study Area have been considered.
- Non-designated above ground heritage assets up to 500m from the Site Boundary, specifically locally listed buildings.

Occasionally there is reference to assets beyond these Study Areas, where appropriate, e.g. where such assets are particularly significant and/or where they contribute to current understanding of the historic environment.

Table 1 below provides a summary of the key data sources.

Table 1: Data Sources Consulted

Source	Data	Comment
Historic England	National Heritage List for England (NHLE) (with information on statutorily designated heritage assets)	Statutory designations (scheduled monuments; statutorily listed buildings; registered parks and gardens; historic battlefields) can provide a significant constraint to development.
	Greater London Historic Environment Record (GLHER)	Primary repository of archaeological information. Includes information from past investigations, local knowledge, find spots, and documentary and cartographic sources.
	National Record of the Historic Environment (NRHE)	National database maintained by Historic England. Not as comprehensive as the HER but can occasionally contain additional information. Accessible via Pastscape website.

Source	Data	Comment
LBB	Archaeological Priority Area	Area of interest identified by the local authority. There is likely to be a requirement for archaeological investigation (initially a desk-based assessment) as part of any planning process.
	Conservation Area	An area of special architectural or historic interest the character or appearance of which it is desirable to preserve or enhance.
	Locally Listed Building	Building of local importance designated by the local planning authority due to architectural and/or historic significance and a positive contributor to the character of an area. Whilst not statutorily protected, a building's inclusion on the list means that it is a material consideration in the planning process.
British Geological Survey (BGS)	Solid and Drift Geology Digital Map	Subsurface deposition, including buried geology and topography, can provide an indication of potential for early human settlement, and potential depth of archaeological remains.
	Online BGS Geological Borehole Record Data	
United Kingdom Hydrographic Office (UKHO)	Marine Wrecks and Obstructions Data	Data set of recorded charted, uncharted, live and dead wrecks and obstructions from around the world.
Groundsure	Ordnance Survey Maps (from the 1st edition (1860–70s) to present day)	Provides a good indication of past land use and impacts which may have compromised archaeological survival. Provides an indication of the possible date of any buildings within the Site.
Bexley Local Studies and Archive Centre	Historic Maps (e.g., Tithe, enclosure, estate), Published Journals and Local History	Baseline information on the historic environment.
Internet	Web-published local history	Many key documentary sources, such as the Victoria County History, the Survey of London, and local and specialist studies are

Source	Data	Comment
	Archaeological Data Service	now published on the web and can be used to inform the archaeological and historical background. The Archaeological Data Service includes an archive of digital fieldwork reports.
Various	Previous Geotechnical Data from Adjacent Schemes	The information can be very useful in enhancing understanding of the nature and depth of natural geology (see above) and any made ground, whether it is modern or of potential archaeological interest.
The Applicant	Topographical Survey Data	Survey data can provide an indication of the impact of past land use, e.g., ground raising or lowering, which is useful for understanding possible truncation and likely depth of archaeological remains.
WSP	Bathymetry Data	Bathymetry data is used in marine archaeology to create images and models of underwater surfaces. This can be used to identify areas of archaeological potential and to determine the likely depth of archaeological remains.

Figure 3 shows the location of known historic environment features within the Study Area, as identified by the sources above, the walkover, or during the course of research for this preliminary assessment. These have been allocated a unique 'assessment' reference number (**A1, 2,** etc.), which is listed in a gazetteer in Appendix A and is referred to in this report. Where there are a considerable number of listed buildings in the Study Area, only those within the vicinity of the Site (i.e., within 50m) are included, unless their inclusion is considered relevant to the study. Conservation areas are not shown. Archaeological Priority Zones are shown where appropriate. All distances quoted in the text are approximate (within 5m).

4.2. WALKOVER

The assessment included a walkover carried out on the 3rd of March 2023 to determine the topography of the Site and existing land use, the nature of the existing buildings, identify any visible heritage assets (e.g., structures and earthworks), and assess factors that may have affected the survival or condition of any known or potential assets.

The walkover also extended beyond the Site Boundary for the purposes of scoping built heritage assets and their intervisibility with the Proposed Scheme, as required by Historic England guidance (Historic England, 2017), and for the settings assessment itself.

Due to its location on a private road, the Grade II listed No. 4 Jetty and Approach at Dagenham Dock, which is situated approximately 750m to the northwest of the Site Boundary, could not be accessed during the walkover. As a result, photographs of this heritage asset could only be taken from the opposite side of the River Thames. The view from this asset towards the Site could not be photographed.

The internal areas of Crossness Sewage Treatment Works were not accessed during the walkover. As this was not required to assess the contribution of setting to baseline heritage value, the locally listed 'police box' style concrete structures located here were also not accessed.

4.3. ASSESSING ARCHAEOLOGICAL POTENTIAL

Section 6 presents an assessment of archaeological potential for each chronological period, based on the archaeological and historical background of the area, its geology, topography and hydrology, the likelihood for evidence of past activity, and considering past disturbance which may have affected survival. For example, the Site may have high potential for activity of a particular period, but with a low level of survival. **Section 6** also includes professional opinion on likely heritage value, where there is low to moderate, or higher, potential for remains to be present. Where potential is low, heritage value is not assessed, as this implies that remains from the period are not present.

4.4. ASSESSING HERITAGE VALUE (SIGNIFICANCE)

NPS EN-1 (2011) defines heritage assets as those elements of the historic environment that hold value to this and future generations because of their historic, archaeological, architectural or artistic interest (paragraph 5.8.2). Value derives not only from a heritage asset's physical presence, but also from its setting. The determination of the value (significance) is based on statutory designation and/or professional judgement against these heritage values (which are also identified in Historic England Statements of Heritage Significance (Historic England, 2019).

Each asset is evaluated against these criteria on a case-by-case basis. Unless the nature and exact extent of buried archaeological remains within any given area has been determined through prior investigation, value is often uncertain.

In relation to valuable heritage assets, the assessment considers the contribution which the historic character and setting makes to the overall significance of the asset.

Table 2 below gives examples of the heritage value (significance) of designated and non-designated heritage assets.

Table 2: Value of Heritage Assets

Heritage Asset Description	Value (significance)
World Heritage Sites	Very High
Scheduled Monuments **Grade I Listed Buildings** **Grade II* Listed Buildings** **Grade II Listed Buildings with exceptional qualities in fabric, historical association, and/or association/group value with heritage assets of high significance** **Protected Wrecks** **Registered Battlefield** **Conservation Areas containing very important (Grade I / II*) listed buildings.** **Grade I and II* Registered Parks and Gardens** **Protected heritage landscapes (e.g., ancient woodland or historic hedgerows, heritage Sites of Special Scientific Interest)** **Burial grounds** **Non-designated heritage assets (above ground structures, landscape, townscape, buried remains) of national importance.**	High
Grade II Listed Buildings which can be shown to have qualities in their fabric or historical association of regional importance only **Conservation Areas containing primarily Grade II listed or Locally Listed Buildings** **Grade II Registered Parks and Gardens** **Locally Listed Buildings** **Non-designated heritage assets (above ground structures, landscape, townscape, buried remains) of regional importance.**	Medium
Non-designated heritage assets (above ground structures, landscape, townscape, buried remains) of local importance.	Low
Item with no significant heritage value or interest	Negligible
Heritage assets that have a clear potential, but for which current knowledge is insufficient to allow significance to be determined.	Uncertain

5. HISTORIC ENVIRONMENT BASELINE

5.1. SITE LOCATION

Chapter 2: Site and Proposed Scheme Description (Volume 1) provides an overview of the Site location surroundings. The Site Boundary is located off Norman Road, Belvedere in the London Borough of Bexley (NGR 549572, 180512; **Figure 1**).

The Site Boundary falls within the historic parish of Erith, which lay within the county of Kent prior to being absorbed into the administration of LBB and becoming part of Greater London.

5.2. TOPOGRAPHY

Topography can provide an indication of suitability for settlement, and ground levels can indicate whether the ground has been built up or truncated, which can have implications for archaeological survival (see **Section 5.6**).

The Site is located on the modern waterfront of the southern bank of the River Thames, within a former wide floodplain of the estuarine Thames. Formerly, the floodplain comprised localised areas of gravel highs interwoven by wetland, marsh and channels. As sea and river levels rose over the last ten thousand years, the floodplain would have been inundated with increasing frequency, infilling channels with alluvium and overtopping the islands from the prehistoric period onwards. Evidence for prehistoric and early historic human occupation is therefore most likely on areas of higher ground (Historic England, 2020), and structures relating to channel management, fishing, fowling and environmental remains preserved in areas of lower ground. During the medieval period, wetlands were drained and reclaimed to be used as pasture.

The topography of the area is relatively flat. Based on available topographic survey data the elevation ranges from 0.1m above Ordnance Datum (OD) in the south of the Site to 6.0m OD in the north. Ditches within the Site reach elevations of -1.0m OD (Maltby Surveys, 2021, drawing no. 21/110/100-Overview). This increase in elevation closer to the River Thames is a result of the historic banking up of land here to form flood defences.

5.3. GEOLOGY AND SOILS

Geology can provide an indication of suitability for early settlement, and potential depth of remains. A summary of the geology and soils present within the Site is presented below. Further information is presented in **Chapter 17: Ground Conditions and Soils (Volume 1)**.

British Geological Survey (BGS) data records the bedrock geology of the Site as London Clay Formation in the north and Lambeth Group Clay, Silt and Sand in the south. Both are Palaeogene deposits (c 50 million years Before Present/BP) that pre-date human evolution and have no archaeological potential. The Site lies on the estuarine Thames floodplain, and superficial deposits are mapped as alluvium (clay, silt, sand and peat). Alluvium dates to the Holocene (the current warm stage covering the last ten thousand years of human history) and overlies Shepperton Gravel. Made ground is also recorded across much of the terrestrial part of the Site.

Staircases of river terraces are important archives of climate driven change (sediment supply, discharge, or base level that result in channel incision or aggradation) and tectonically driven long-term uplift that results in channel incision (Merritts, 2007), and provide a stratigraphic framework for regional geochronology and correlation. The Thames terraces have been extensively studied (Gibbard, 1985; 1994; Bridgland, 1994; 1995; Bridgland et al, 1995), and the Shepperton Gravel is known to be the first (lowest and youngest) terrace in the sequence, deposited during the last ice age (the Devensian). Channel incision took place during the coldest part of the Devensian (when base levels were low) and gravel deposition took place during deglaciation (15,000 –10,000 BP).

The topography of the gravel surface therefore forms the ‘template’ for subsequent Holocene sedimentation. Holocene sedimentation in the Thames estuary is characterised by a series of changes in river levels, or relative sea level (RSL) as deglaciation (ice melt) raised sea levels globally.

In the 1970s, Devoy undertook seminal work on the sediments at the typesite of Tilbury (Devoy, 1979). Five phases of marine transgression (Thames I-V) represented by clay/silt units were identified, and five marine regressions (Tilbury I-V) represented by peat units. He constructed two age-altitude curves of relative sea level movement, one for Tilbury (outer estuary) and one for Crossness, Dartford and Broadness (inner estuary). The model suggests RSL rise in the following periods:

- Early Mesolithic period (RSL rise from -25.5m to -8.9m OD);
- Late Mesolithic/Early Neolithic periods (RSL rise from -10.1m to -5.0m OD);
- throughout the Bronze Age (RSL rise to between -1.4m and -2.5m OD);
- Middle Iron Age; and (RSL rise to 0.4m OD); and
- beginning of the 4th century AD.

Bates’ (1999) modelling of progressive inundation broadly agrees with Devoy’s model but emphasises that local conditions will have been an important factor influencing sediment deposition. Bates ascribed ages to datums from various sites in the Lower Thames estuary and suggests the following submergence of the gravel topography (these levels and dates will vary to some extent in an upstream-downstream direction and with distance away from the contemporary river channels):

- Submerged to –15 m Ordnance Datum (OD) by c 8300 BP;
- Submerged to –12 m OD by 7750 BP;
- Submerged to –8 m OD by 6670 BP;
- Submerged to –4 m OD by 5610 BP; and
- Submerged to –3 m OD by 5340 BP.

Subsequent work examined the unrepresentative nature of the typesite[a] (Sidell, 2003) and suggested a tripartite model for the estuarine Thames between the City of London to the border with Kent and Essex. This comprises an initial Early Holocene RSL rise (marine transgression) followed by a slowing in the rate of RSL rise and concurrent expansion of freshwater peat (wood peat and then alder carr) from c 6800-5000 BP (Neolithic and Bronze Age), and lastly a second marine transgression starting at approximately 3500 BP and still in progress today (Iron Age onwards).

In 2022, Quaternary Scientific (Quest) produced a Geoarchaeological and Palaeoenvironmental Analysis Report for the Riverside 2 and the surrounding area. The work entailed a review and collation of nearly 150 geotechnical logs to create an archaeological deposit model. Ground investigation was also undertaken in the foreshore part of the Site in 2007 (Soil Mechanics, 2007). The number and spread of the geotechnical logs meant that the deposit model was produced with a high level of confidence. The report provided the following summary of the geology of the Site and its immediate vicinity, that compares well with the tripartite model (Sidell, 2003):

> "*In summary, the Shepperton Gravel was deposited during the late Devensian (ca. 15-10,000 years ago). Following a hiatus in deposition of at least ca. 3000 years, several metres of Lower Alluvium were deposited relatively rapidly under tidal lagoon, and later supratidal environment. Peat formed from around 4800 to 3500-3250 years ago, most likely under freshwater conditions and supporting the growth of alder dominated woodland, with evidence for the colonisation of yew, and later elm woodland. The peat was overlain by silty clay deposits of the Upper Alluvium, accumulating once again in a supratidal environment as a consequence of both sea level rise and deforestation on the dryland."* (Quaternary Scientific, 2022).

The Shepperton Gravel rests on London Clay bedrock between -12.0m and -14.0m OD across the northern part of the Site. Towards the centre and south of the Site, however, the gravel thickens and reaches bedrock at up to -20.0m OD. This change in thickness could represent the infill of a former Pleistocene channel. The height of the gravel surface is relatively even across the Site, ranging between -6.0m and -9.5m OD but gradually decreasing in height towards the north and east. In the southern part of the Site, this surface rises gently to between -7.0m and -6.0m OD. **Figure 5** shows the Shepperton Gravel surface across the Site and surrounding area (Quest, 2022).

[a] A term used to define a distinct archaeological culture or period.

The surface of Lower Alluvium lies at between -3.0m and -4.0m OD and frequently contains detrital wood or plant remains. The overlying peat ranges in thickness across the Site from 1.0m to 3.0m (with a surface height between -1.0m and -2.0m). Peat represents the development of Neolithic and Bronze Age sedge fen / reed swamp, associated with RSL stabilisation. A number of geotechnical logs did not contain peat, particularly in eastern parts of the Site, perhaps due to deeper active channels where the gravel topography is low (-9m OD, **Figure 5**) and a west-east channel may traverse the Site. **Figure 6** shows the peat thickness across the Site in the deposit model, with red stars indicating boreholes where peat was apparently absent.

The Upper Alluvium generally ranges between 1-5m thick (greater thickness are recorded in the Thames channel), and blankets the floodplain, meaning the surface of the Upper Alluvium is generally level at approximately 1-3m OD (**7**). Where untruncated, Upper Alluvium is predicted to lie between -0.1m and -6.0m OD beneath modern made ground.

Made ground (1-4m thick) caps the alluvial sequence in parts of the Site, with greater thicknesses at the northern end.

The following is a summary of the level of superficial geology within the northern terrestrial part of the Site:

- current ground level lies at 0.1–6.0m OD, with an increase in elevation closer to the River (however, ditches within the Site reach elevations of -1.0m OD);
- top of untruncated upper alluvium lies at -1.0 – 2.0m OD;
- top of untruncated peat (where present) lies at -2.0 and -1.0m OD;
- top of untruncated lower alluvium lies at -4.0 – -8.0m OD; and
- top of untruncated Shepperton Gravel lies at -9.5 – -7.5m OD.

5.4. OVERVIEW OF PAST ARCHAEOLOGICAL INVESTIGATIONS

Although a limited number of archaeological investigations have been undertaken within the Site, the area is relatively well understood, with 51 recorded investigations within the 1km Study Area. These include watching briefs, geoarchaeological surveys, trial trench evaluations and targeted excavations. Those investigations undertaken within the Site are discussed first in this section.

In addition to the geotechnical investigations discussed above, geotechnical monitoring within the Site was undertaken in 1994 (**A1b**), and Quest used geoarchaeological borehole data to create a deposit model of the western part of the Site and land to the west in 2011 (**A1c**). The model identified layers of alluvium and peat.

An archaeological trial trench evaluation was undertaken within the northern part of the Site in 2007 (**A1a**). The nine 4.0m x 4.0m trenches excavated revealed the tripartite alluvial sequence over gravel of lower clay, peat and upper clay capped by made ground (**Section 5.3**) (**Figure 2**). Column and bulk samples were taken from each trench and the peat assessed as likely to be Early Neolithic to Iron Age in date.

A single unstratified rim sherd of a Roman greyware necked jar, dated to AD 60-160, was recovered from the top of the alluvial sequence. No other archaeological remains were encountered. It was concluded that the lack of archaeological evidence predating the post-medieval period may indicate the site's historical unsuitability for human occupation due to wet, marshy conditions. Made ground dating to the 19th and 20th centuries was encountered in all of the trenches, and elements likely relating to the former 20th century Borax Works were identified. These could not be investigated further due to contaminants within the made ground. No evidence of a medieval revetment or sea wall was encountered.

Within the alluvial deposits, the remains of fallen trees suggest a probably Bronze Age alder carr landscape (waterlogged and wooded terrain). A geoarchaeological study of borehole data at the Middleton Jetty to the north (prior to construction) revealed a comparable tripartite stratigraphic sequence (Pre-Construct Archaeology, 2008).

A watching brief carried out in 1997 30m to the south-east of the Site (**A20**) revealed a Mesolithic or Early Neolithic broken crested blade made of flint in the lower sand. Core sampling and analysis of environmental samples undertaken here in 2008 (**A11**) showed that this site was a semi-terrestrial fen carr woodland and a semi-aquatic reef or sedge swamp during the Middle Holocene (5000-2000 BC). The results of a borehole survey and geoarchaeological assessment in 2014 (**A29**) provide a useful palaeoenvironmental context for archaeology in the local area. However, no archaeological remains or artefacts were recovered from the core samples.

Deposit modelling was undertaken for a site at Burt's Wharf to the immediate south of the Site in 2016 (**A9**) which showed that it has a similar geoarchaeological make-up to others in the Lower Thames valley. Based on the likely depth of sediments, the archaeological potential of the Site was considered to be low. A geoarchaeological survey was carried out here in 2020, the results of which determined that the Pleistocene floodplain gravel consists of underlying deposits of archaeological interest.

In 1995 a watching brief took place 40m to the south of the Site (**A12**). A peaty layer was identified, although this proved not to be a peat horizon and no datable features or finds were recovered.

A watching brief undertaken 80m to the west of the Site in 1997 (**A35**) revealed a backfilled ditch of unknown date.

Trial trenching undertaken at Crossness Sewage Treatment Works and Crossness Local Nature Reserve (LNR) revealed a preserved prehistoric forest, 460m to the west of the Site which may date to the Late Mesolithic (**A15**). Well-preserved peat deposits were encountered across the site and evidence of episodic flooding events was identified. A total of nine driven timber posts, likely to be post-medieval in date, were uncovered here during groundworks in 2007 and analysed in 2010.

In 1885 a logboat of probable Bronze Age date was found 800m to the east of the Site (**A21**). A polished flint axehead and scraper of possible Neolithic date were found inside the boat, though it is stated in the HER entry that these may be later forgeries. There is no further information in the entry to confirm this. A series of archaeological investigations have been carried at this location between 2007 and 2012, comprising geoarchaeological evaluations, borehole surveys, a watching brief and geophysical surveys. A possible Early Neolithic timber trackway was also identified along with a peat deposit of Bronze Age date.

Early Bronze Age peat deposits assessed by pollen analysis were encountered during an auger survey 970m to the south-west of the Site in 1993 (**A10**). No archaeological features were identified during a trial trench evaluation here in the same year.

A pollen assessment was undertaken on samples from boreholes in 1994, 630m to the west of the Site (**A32**), which provided an approximate date later than 6,500 BC for the base of the sediment sequence.

A watching brief carried out in 1995-96 along Bronze Age Way 300m to the south-east of the Site (**A16**) revealed a section of a Bronze Age hurdle-built trackway and worked wood. Extensive evidence of a Late Mesolithic flint industry was identified below the peat and fragments of Neolithic pottery were also recovered.

Organic mud encountered with wood and plant fragments during an evaluation undertaken 320m to the south-east of the Site in 1996 (**A17**) were radiocarbon dated to the Mesolithic. A borehole survey carried out here in the same year (**A18**) revealed fluvial gravels overlaid by Neolithic to Iron Age peat. A possible Mesolithic land surface was identified during an auger survey carried out 900m to the east of the Site in 2005 (**A14**). A Bronze Age woodland and Iron Age meadow land were also identified.

In 2005 a trial trench evaluation was undertaken 420m to the south-east of the Site (**A25**). Although no archaeological finds or features of note were encountered, peat deposits dating from the Mesolithic to the Bronze Age were recorded.

A watching brief and geoarchaeological evaluation undertaken on land 300m to the east of the Site between 2015 and 2018 (**A7**) revealed a peat landscape thought to represent marshy woodland, perhaps dated to the Bronze Age with alluvial or tidal clays encountered possibly marking post-medieval land reclamation.

In 2012 geoarchaeological fieldwork and deposit modelling were undertaken for land 330m to the east of the Site (**A8**). This showed that this site has potential for palaeobotanical and zooarchaeological remains. The deposit sequence also suggested the presence of Mesolithic and later Neolithic to Bronze Age semi-terrestrial land surfaces that are comparable with the tripartite model (Sidell, 2003).

Geoarchaeological investigations undertaken at Alchemy Park 270m to the east of the Site between 2016 and 2018 (**A24**) revealed a deep west-east orientated palaeochannel. Peat dated from the Late Mesolithic to the Bronze Age was recorded.

A possible Bronze Age peat deposit was revealed during a watching brief 700m to the south of the Site in 2001 (**A19**) along with two undated linear features thought to be drainage ditches or natural water channels. During a watching brief undertaken 110m to the south-east of the Site in 2001-02 (**A26**), evidence was encountered for yew colonisation which possibly spread to the peatland from the Early Bronze Age.

A series of archaeological investigations were undertaken 500m to the south-west of the Site between 2003 and 2006, comprising two trial trench evaluations and a watching brief (**A13**). Two levels of peat were recorded, and one deposit contained several Roman finds. The peat deposits were radiocarbon dated to between the Late Mesolithic and the Bronze Age. A ditch, likely related to the post-medieval draining and division of Erith Marsh, was recorded.

Deposit modelling of geotechnical work undertaken 320m to the west of the Site in 2016 (**A36**) identified intertidal creeks of the late prehistoric period which have scoured away deposits from earlier periods.

The results of these investigations, along with other known sites and finds within the Study Area, are discussed by period, below. The date ranges below are approximate.

5.5. ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

PREHISTORIC (800,000 BC–AD 43)

Section 5.3 of this appendix describes the sediment sequence and time periods relevant to the Site, and it is clear that Lower (800,000–250,000 BP) and Middle Palaeolithic deposits (250,000–40,000 BP) are not present onsite. The Shepperton Gravel was laid down during the late Devensian (late Upper Palaeolithic c. 40,000–12,000 BP), and although flint tools dating to this period have been found in the vicinity of the town of Erith to the south-east of the Site there are no known Palaeolithic finds within the Study Area.

The Early Holocene Mesolithic hunter-gatherer communities inhabited a largely wooded environment (10,000–4000 BC) and river valleys and coastlines would have been favoured in providing 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.

The Thames estuary experienced rising river levels throughout the Holocene as the climate warmed and global ice melt raised sea levels (see reference to tripartite sequence in **Section 5.3** above). Rapid river level rise caused a marine transgression in the Mesolithic. This stabilised in the Neolithic to Bronze Age periods when peat formed and was followed by renewed RSL rise in the late prehistoric (Iron Age onwards) characterised by alluvial clay/silt deposition.

Evidence of Late Mesolithic forest, representing the earliest known colonisation of yew woodland on the southern bank of the Thames during the Late Holocene (6,203 BP), was found during trial trenching 460m to the west of the Site (**A15**). A Mesolithic bone awl was found within one of the peat layers demonstrating local human presence.

A significant number of prehistoric flint tools have been recovered within the Thamesmead and Erith Marshes APA, many of which date to the Mesolithic. During the construction of Bronze Age Way 300m to the south-east of the Site in 1995-96 (**A16**), evidence of a likely tool production centre was found within peat. The flint scatter of more than 3,000 artefacts included tranchet axes, cores, flakes, scrapers and awls (Historic England, 2020). A broken crested flint blade, which is either Mesolithic or Early Neolithic in date, was found during a watching brief 40m to the south-east of the Site in 1997 (**A20**). Due to its depth and location, however, the blade is not considered to be an indicator of human activity in this location. The number of microlith assemblages recorded across Kent suggests that there was a marked increase in population during the Later Mesolithic (Scott, 2004).

The Neolithic (4000–2200 BC) is usually seen as the time when the hunter-gatherer lifestyle gave way to farming and settled communities, concomitant with forest clearance for crop cultivation and construction of monuments. Pollen records indicate forest clearance over large areas of the British Isles during this period.

There are no Neolithic finds or features recorded within the Site. Within the Study Area large timbers which possibly formed part of an Early Neolithic trackway (**A21**) were recorded during an excavation 650m to the south-east of the Site in 2007 and a complete Neolithic carinated bowl was found during works at Bronze Age Way 300m south-east of the Site in 1995-96 (**A16**; Historic England, 2020).

The Bronze Age (2200–600 BC) is characterised by technological change, when copper and then bronze eventually replaced flint and stone as the main material for everyday tools. It is seen as a period of increasing social complexity and organised landscapes, probably due to increasing pressure on available resources. A considerable expansion in settlement in the Thames valley took place during the Bronze Age, with newly established communities farming the land and making the most of access to overseas trade. Evidence from elsewhere in Kent shows that the estuary foreshore was considered ideal for settlement (Yates, 2004).

No Bronze Age finds or features are recorded within the Site though remains are recorded within the Study Area. A Bronze Age logboat was found in two fragments during ditch digging through peat 820m to the east of the Site in 1885 (**A21**). A polished flint axe and scraper, possibly of Neolithic date, were found inside the boat, although these have since been interpreted as possible forgeries (see paragraph 0). Worked wood and a section of a Bronze Age hurdle-built trackway were found in deep peat deposits during a watching brief 300m to the south-east of the Site in 1995-96 (**A16**). Timber structures such as these would have enabled access across boggy marshland. A number of well-preserved examples have been found elsewhere on both sides of the River Thames (MoLAS, 2005).

As part of the palaeoenvironmental analysis undertaken by Quest in 2022, samples of twigs and sedge remains from the boreholes drilled within the Site were taken for radiocarbon dating. The results indicate that the Lower Alluvium began to accumulate during the Late Mesolithic, while the accumulation of peat began between the late Neolithic and Neolithic-Bronze Age transition. Twig wood from the organic material within the Upper Alluvium was radiocarbon dated to the Late Bronze Age.

Results of pollen analysis indicate that during the formation of the Lower Alluvium, alder dominated the wetland environment. The transition to peat is characterised by a decline of lime, elm, pine and hazel and an increase of sedges and ferns. An expansion of yew woodland on the floodplain surface also likely took place at this time. With the deposition of the Upper Alluvium came a transition from a freshwater peat to saltmarsh conditions (Quest, 2022). Possible prehistoric antler fragments, shells, nuts and wood fragments (**A51**) were recorded at a depth of 8.5–9.4m, 150m to the south of the Site.

Buried peat horizons dating from the Early Mesolithic to Bronze Age periods have been recorded across the Study Area and provide evidence of what the prehistoric environment would have been like, representing the terrestrial or semi-terrestrial land surfaces during these periods (Historic England, 2020). These have been recorded 145m, 410m and 320m to the south-east of the Site (**A11**, **A25**, **A17**), 1km to the south-west (**A10**), 770m to the south (**A19**), 550m to the west (**A13**), 690m and 940m to the east (**A39**, **A14**), 260m to the east (**A24**), and 380m to the north-east (**A27**). Evidence for yew tree colonisation, which likely spread to the peatland from the Early Bronze Age, was encountered during a watching brief 200m to the south-east of the Site in 2001-02 (**A26**).

Due to the intertidal marshland landscape within the Site, permanent occupation of the Site would have been challenging and likely limited to areas of higher ground and along the edges of river channels. Nonetheless, the marshland would have provided many opportunities for fishing, hunting, collecting reeds, wood and salt production.

This would have been possible during periods of slowing, stabilised or falling RSL when the landscape was more accessible, and possibly suitable for exploitation or semi-permanent occupation. Activities such as fowling, grazing, fishing and pottery manufacture are more likely to have occurred during these periods (Museum of London Archaeology Service, 2008).

During the Iron Age (800 BC–AD 43), the climate deteriorated with wetter, colder weather. The period is characterised by expanding population, which necessitated the intensification of agricultural practices and the utilisation of marginal land. Hillforts were established in lowland Britain, linked to tribal land ownership.

ROMAN (AD 43–410)

Britain was conquered by Rome in the early 1st century AD and the city of *Londinium* was established 16km to the west of the Site. *Londinium* required resources from surrounding areas and a network of roads was built to facilitate a smooth flow of trade into and out of the city. Watling Street, which is situated 4.5km to the south of the Site, would likely have been one of the first Roman Roads to have been built in *Cantium* (Kent). This was an important route, connecting *Londinium* to the logistics base of *Rutupiae* (Richborough). Another Roman Road ran 3km to the north of the Site, eastwards out of *Londiunium* (Andrews, 2004).

Caesar described Kent *Cantium* as "*thickly studded with farmsteads*". Indeed, major population growth in the Late Iron Age meant that a great deal of land in the county would have been under cultivation. During the Roman period, most of the population would have lived in isolated farmsteads comprising circular or rectangular huts. However, *Cantinium* became the industrial heartland of *Britannia* in the early Roman period, with iron and pottery production being particularly important (Andrews, 2004).

An unstratified rim sherd of Roman greyware pottery was recovered from the top of the alluvial sequence during a trial trench evaluation within the Site in 2007 (**A1a**). This artefact, which was dated to AD 60-160, was not located within a discrete feature and was likely deposited by water action (Pre-Construct Archaeology, 2008). A local enthusiast, J. Spurrell, noted unspecified "*Roman remains*" on the intertidal zone of the River within the Site in 1885 (**A1f**). A field investigation at this location in 1964 found nothing or archaeological interest to confirm the documentary reference.

There are limited other Roman finds and features recorded in the Study Area with evidence of occupation mainly found on areas of higher ground. The most significant area of occupation was excavated at Summerton Way, Thamesmead 1.5km to the west of the Site in 1997. Evidence for 3rd and 4th century field systems and land divisions recorded here suggests that the area was used for farming (Andrews, 2004). Although the location of the contemporary Roman settlement associated with this farmstead is unknown, it is possible that it is close to Crossness based on antiquarian records of pottery, building material and a cinerary urn containing bones being uncovered during the digging of the southern outfall sewer around 1km to the west of the Site in 1865 (**A89**). Roman finds were identified in a peat deposit during a trial trench evaluation 550m to the west of the Site in 2006, although they may not have been in-situ (**A13**). The HER description of this evaluation does not provide any further detail on the nature and extent of these finds.

Further evidence of Roman settlement has been found at Erith on higher ground to the south of the Site and on the opposite side of the Thames at Rainham. Roman finds recovered during works in Rainham 1km to the east of the Site in 1961 include cooking pot sherds, fragments of mortaria, the decorated rim of a buff vessel and the screw neck of a flagon, all of which were dated to the 1st century AD (**A44**). Based on these finds and the use of Roman building material in the construction of the nearby church of St Helen and St Giles, it is possible that there was a Roman settlement at Rainham ferry (Lewis, 2008).

The Romans drained fenland in several parts of the country using engineering technology developed in the Mediterranean, and it is possible that attempts were made to drain the low-lying areas in and around the Site. This might have involved the construction of banks along the edge of mudflats. Evidence of salt-making industry, which likely started in the Iron Age, has been found in similar marshes elsewhere in Kent and Essex in the form of earthwork mounds that would have been used for salt evaporation (Museum of London Archaeology Service, 2008).

The depth of the Roman archaeological evidence recorded in this area suggests that the level of the Thames was significantly lower by the end of the Roman period than it is at present, and the termination of activity here around this time was probably due to a marine transgression which is marked by approximately 4m of alluvial flood deposits (Museum of London Archaeology Service, 2008).

EARLY MEDIEVAL (AD 410–1066)

Following the withdrawal of the Roman army from England in the early 5th century AD the whole country fell into an extended period of socio-economic decline. In the 9th and 10th centuries, the Saxon Minster system began to be replaced by local parochial organisation, with formal areas of land centred on nucleated settlements served by a parish church.

According to the Anglo-Saxon Chronicle, Kent was claimed by the Anglo-Saxons shortly after a battle at Crayford, 6.5km to the south-east of the Site, in AD 455 (Levick, 2021). It is likely that a Saxon church existed in the village of Erith 2km to the south-east of the Site.

The name Erith is mentioned as early as AD 677 (as "*Earhyth*") and is thought to mean 'muddy or gravelly landing-place' (Mills, 2011). Erith is likely to have arisen as a settlement due to its suitability as a small port, since boats could only moor in places where the River cut into the gravel at this time.

The parish was also known by the name Lesnes during this period, deriving from the old British word for pastures, although Erith eventually became the official name for the parish (Hasted, 1797).

During this period the Site would likely have comprised marginal marshland as a result of rising river levels. There are no Early Medieval finds or features recorded within the Site or Study Area.

MEDIEVAL (AD 1066–1540)

During this period the Site would have lain within the manor of Lesnes (Humphery Smith 1984), which also gave its name to the surrounding 'hundred' (early medieval administrative area). The parish later became known as Erith, of which the village core would have been situated approximately 2.5km to the south-east of the Site. Based on the distance from the known foci of settlement, the Site is likely to have lain on the periphery of the estate in what was low-lying marshland.

The parish was under the ownership of Azor de Lesneie at the time of the Domesday Book of 1086. It was then given to William the Conqueror's half-brother, Odo, Bishop of Bayeux and Earl of Kent. Following Odo's imprisonment for planning a military expedition to Italy, William seized his English estates and the ownership of the parish of Erith reverted to the crown (Hasted, 1797).

Richard de Lucy acquired ownership of the parish in the 12th century. Richard founded the Augustinian Abbey at Lesnes, the remains of which lie 1.7km to the south-west of the Site. (Hasted, 1797). The abbot and convent of Lesnes Abbey built sea walls in the Plumstead marshes approximately 3 to 4km to the west of the Site between 1230 and 1240.

Prior to the draining and reclamation of the marshland in the medieval period, a large inlet, which was the mouth of a large creek, was located an unknown distance to the west of the Site. By the end of the 13th century, much of the marshland had been reclaimed in order to create suitable land for rearing animals and cultivating crops (Hasted, 1797). Much of the Erith Marshes, and likely the Site, were managed by the monks of the Abbey. This marshland was therefore likely reclaimed around the same time, protected from the River and tides by manmade embankments. It is known that in 1338, 244 acres of arable marshland around Erith belonged to the holding of Giles de Badlesmere and were valued at 36 pence per acre. This made the marshland six times more valuable per acre than arable land on neighbouring uplands, showing how fertile the alluvial marsh soils were (Galloway, 2010).

The reclamation of the Erith Marshes likely took place in stages, with several sea walls being built successively. It is therefore probable that different parts of the Site were reclaimed at different times, with the northernmost terrestrial part of the Site potentially reclaimed in the late medieval or early post-medieval period. J. Spurrell supposedly saw the oldest of a network of medieval river walls 650m to the south of the Site in 1885, which he believed may have dated to the 13th century (**A70**; Spurrell, 1885). A network of drainage ditches would have divided the marshland into individual parcels. Within these, activities such as arable cultivation and animal husbandry would have taken place. This landscape may also have been used for brick and pottery manufacture. However, the marshland was still regularly flooded, occasionally laying the pasture to waste (Museum of London Archaeology Service, 2005).

Norman Road, which runs along the eastern part of the Site, was originally called Picardy Manorway, named after the manor house of Picardy. Although the exact location of a medieval manor house of Picardy is unknown, Picardy House is shown 1km to the south of the Site on the Erith tithe map of 1843 (**Figure 10**) and was likely on the site of, or close to, the original house. The trackway would likely have been a raised droveway, used for transporting livestock between the marshland and the higher ground to the south (Museum of London Archaeology Service, 2005).

A 14th century dagger was found during the construction of a house 950m to the south-east of the Site (**A65**).

A stop for the Long Ferry, which was mentioned in a document from 1531, was likely situated off Ferry Lane 950m to the east of the Site (**A48**).

POST-MEDIEVAL (AD 1540–1900)

During the Tudor Period, King Henry VIII established a naval dockyard at Erith, 2.5km to the south-east of the Site. The *Henry Grâce à Dieu*, which at the time was the largest warship in the world, was launched at Erith in 1514. The area between Woolwich to the west of the Site and Erith to the south-east subsequently became a significant military and naval centre, frequently used for weapons testing (Dear and Kemp, 2006).

In 1524 Cardinal Wolsey suppressed Lesnes Abbey along with many other monasteries with fewer than eight canons. The Abbey's land was subsequently divided and sold. However, the embankments along the Thames repeatedly burst in the following years. Thomas Cromwell, who at this time was legal secretary to Cardinal Wolsey, wrote in 1529 following a visit to the flooded Lesnes marshland: "*I have been at Lysenes where I saw one of the most pyteous and greuous sightes that ever I saw… concernyng the breche out of the Thames into the marshes at Lyesnes, which be all ouerflowen and drowned.*" (Galloway, 2010). The embankments again burst in the 1530s and much of the marshland was reclaimed by the River Thames for a number of years. It is likely that these floods occurred partially as a result of the cessation of maintenance by the tenants of Lesnes Abbey, who in the 15th century had paid 4d per acre for the maintenance of the marsh defences. Following Cardinal Wolsey's fall from power, the Lesnes marshlands belonged to the royal family (Galloway, 2010).

A map of 1588 (not reproduced) shows the location of two breaches of the embankments which had occurred between Erith and Woolwich. The larger of the two, labelled "*the great Breache"* appears to have taken place in and around the Site and had not been repaired by this date. J. A. Galloway (2010) argues that this is likely to have been referring to a flooding event in 1530 when the Thames breached the marsh walls at Plumstead, Lesnes and Erith. According to a petition to Parliament in 1561, 2,000 acres of land in Erith, Plumstead and Lesnes had been "*laid waste by breaches and inundations of the Thames*" during the previous 30 years (Galloway, 2010).

Repairs were eventually made in the 17th century and a set-back wall was built around the hole which had been scoured out by tidal waters during the breach (Galloway, 2010). This area is visible on the Erith tithe map of 1843 (**Figure 10**) and the Ordnance Survey 1st edition 6": mile map of 1866-69 to the immediate east of the Site (**Figure 11**).

Frequent storms and floods along the River Thames likely resulted in numerous shipwrecks during this period. An unknown number of wooden sailing vessels were lost during the Great Storm of 1703, although it is likely to have been several hundred. An English wherry (cargo boat) was wrecked in this part of the Thames following a collision and the wreck site has tentatively been recorded as 360m to the west of the Site (**A92**). The wreck of a wooden vessel which collided with ice in the Thames in 1709 is also recorded in this location (**A93**). A total of 85 documented maritime wreck events, dating from 1654 to 1940, have been recorded in the Thames without an exact location and some of these may have occurred within the Study Area (**A94**). These include sailing vessels, wherries, cargo vessels, barges, lighters, passenger vessels, paddle steamers, schooners and military training ships.

The Andrews, Dury and Herbert 1769 map of Kent (**Figure 8**) shows a sea wall crossing through the northern part of the Site which likely forms part of the existing modern defences. A "*Powder House*" is shown within, or to the west of, the Site. Although not labelled, two structures are shown here on Hasted's 1798 map of Bexley and Dartford (not reproduced; Bexley Archive ref. RT/2/9/52). The remainder of the Site comprised marshland on both maps, some of which was divided by linear drainage ditches. The Ordnance Survey Drawing of 1799 (**Figure 9**) shows the building to the immediate west of the Site labelled "*Erith Magazine*".

The Erith tithe map of 1843 (**Figure 10**) shows three small buildings, two of which lay within/on the western part of the Site. According to the tithe apportionment, a "*House & Garden*" lay within the Site and a "*Magazine & Grounds"*, owned by Pigeon and Wilks, sat to the immediate west. "*Magazine Marsh*" was situated to the south of this. The sea wall running across the Site is described as a "*wall slip*" owned by J. Renshaw and another "*Magazine & Ground*" was situated to the immediate south of the easternmost part of the Site, with an associated pier encroaching into the Site. A "*Cottage & Garden*" was located to the south of this magazine. The remainder of the Site is described as grass and arable land under several different ownerships. The marshland was used for farming and reed growing into the 19th century.

Post-medieval timber driven posts were discovered during groundworks 490m to the west of the Site in 2007 (**A15**) and a possible backfilled ditch of unknown date was identified during a watching brief 140m to the west of the Site in 1997 (**A35**). These likely relate to the agricultural use of the Site.

It is recorded that 750 barrels of gunpowder contained within a magazine in this area exploded in 1864, which was supposedly heard from 40 miles away (Kentish Chronicle, 1864). It is possible that this was one of the magazines to the west of the Site. A nearby magazine and two barges transporting gunpowder also exploded in the incident, which resulted in at least 12 deaths. According to an article in the Kentish Chronicle, "*there was scarcely a house that had not suffered more or less*" in the districts of Erith, Belvedere and Plumstead, with windows and shutters blown out in many (Kentish Chronicle, 1864). Part of the river wall was breached as a result of the explosion and several barges were destroyed. Approximately two thousand troops and navvies were required to rebuild the embankment (Kentish Chronicle, 1864).

The opening of the North Kent Railway in 1849 (**A87**) 640m to the south of the Site accelerated the rate of industrialisation in the area, with factories subsequently being constructed along the Thameside in the following decades.

Prior to construction and operation of the Crossness Sewage Treatment Works in 1865, untreated sewage was discharged continuously into the Thames, frequently travelling upstream to the city centre and resulting in cholera outbreaks. At Crossness Sewage Treatment Works, the sewage was pumped into the river just after high tide and carried out into the North Sea. A large underground reservoir was constructed so the sewage could be stored until high tide. The Crossness Sewage Works was designed by Sir Joseph Bazalgette, the chief engineer of London's Metropolitan Board of Works, and architect Charles Henry Driver to solve London's sanitation problem. Bazalgette was also responsible for the sewage works on the north side of the River at Barking.

Originally the Crossness Sewage Treatment Works comprised 6.5 acres of storage tanks and the Grade I listed Victorian Romanesque style engine house (920m to the west of the Site), which houses four beam engines designed by James Watt & Son (**A3**; Cherry and Pevsner, 1983). Other buildings at the works included workshops, outbuildings and houses for the workmen. A 63m tall chimney, in the form of a campanile, formerly stood within the sewage works site. The two workshop ranges either side of the engine house were built between 1862-65 by William Webster to Bazalgette and Driver's designs and both are Grade II listed (**A2**, **A4**). Untreated sewage was initially discharged directly into the river, but sedimentation channels were introduced in 1887 to separate the solid sludge from the liquid effluent. Only the latter was discharged into the River Thames thereafter.

The Ordnance Survey 1st edition 6": mile map of 1866-69 (**Figure 11**) shows the terrestrial part of the Site mostly comprising parcels of land within Erith Marshes divided by various ditches and trackways. Picardy Manor Way (now Norman Road) is labelled on this map. The road ran along the eastern part of the Site and led to a *Manure Works* at the northern end of the terrestrial part of the Site, where glue manufacture was also undertaken. This comprised approximately six buildings adjacent to the sea wall and two small piers. A pier was also located on the easternmost part of the sea wall within the Site. Three terraced houses sat 60m to the south of the Manure Works, just off Picardy Manor Way. Another building, possibly another house, sat to the west of these. A road or trackway with an east-west alignment met Picardy Manor Way in the centre of the Site and joined a number of other paths to the west of the Site. A footpath with a north-west to south-east alignment passed through the southern part of the Site. A small building, possibly a powder magazine, with a square plan was situated just inside the western boundary of the Site adjacent to the sea wall. A powder magazine lay 60m to the west of the Site Boundary and another is shown to the immediate south of the Site Boundary, adjacent to the sea wall in the east. The surrounding landscape is broadly similar to that of the Site, mostly comprising marshland and drainage ditches. More powder magazines were situated along the foreshore to the east and a floodgate is labelled 1.2km to the east of the Site Boundary.

The Ordnance Survey 2nd edition 6": mile map of 1895 (**Figure 12**) shows that the works at the northern end of the terrestrial part of the Site had expanded, with the main building enlarged, two large buildings constructed to the west and a small number of ancillary buildings constructed around them. The works are now labelled "*Belvedere Mills*". Two additional piers had been erected off the sea wall to the north of these works and a footpath also ran along the route of the sea wall. The empty plot to the east of Belvedere Mills is labelled "*Bovril. Disused*." In the north-western corner of the terrestrial part of the Site, the "*Thames Fish, Guano, & Oil Works*" had been constructed and was used to process imported guano (seabird excrement) for fertiliser (Bexley Archive ref. LAER/DC/4/5/2). Further terraced housing had been built to the south of Belvedere Mills. *Orient House* had been constructed off Picardy Manor Way within the centre of the Site along with two ancillary buildings.

The Grade II listed No. 4 Jetty and Approach at Dagenham Dock, located approximately 750m to the northwest of the Site Boundary, was constructed between 1899 and 1903 for Samuel Williams & Sons Ltd (**A5**). The jetty was built to designs by L. G. Mouchel & Partners and is one of Britain's earliest surviving reinforced-concrete structures. Four early 20th century concrete structures, similar in style to police boxes, are located at the Crossness Sewage Treatment Works and are locally listed buildings (**A46**). The closest of these is situated 490m to the west of the Site Boundary.

MODERN (1901–PRESENT)

During the 20th century the Site and surrounding area retained a mix of industrial and agricultural uses reflecting the marginal location of the Site.

Borax Consolidated, a chemical manufacturer, took the site over in 1899, with borax being transported to the processing plant by river. By the Ordnance Survey 3rd edition 6": mile map of 1907 (**Figure 13**), Belvedere Mills had expanded further. Three buildings had been constructed in the east and the westernmost large building had been extended. A new road had been laid to the east of the works, presumably to provide access to these new buildings. A Beer House is shown to the south of the works. The Ordnance Survey 25": mile map of 1909 (not reproduced) has labelled this building as "*Marsh Tavern*" and shows allotment gardens to the south, adjacent to the terraced houses. Cranes are also labelled on the piers to the north, and the mills are labelled "*Belvedere Mills (Borax)*".

A rectangular plan structure had also been constructed to the west at the Belvedere Fish Guano Works. A footbridge is shown which probably connected the footpath to the south of the works to that along the sea wall. To the south, a large rectangular plot had been laid out to the north of Orient House and a small ancillary structure, possibly a shed, had been constructed to the west. Based on the tree symbols depicted within it, the square plot of land between the ancillary structures and Orient House was likely used as an orchard. A lighthouse had been constructed 200m to the east of the Site and a significant amount of industrial development had taken place in the south-eastern part of the study area, mostly at a "*Cable Construction Works*". Residential development was also beginning to take place 300m to the south of the Site off Picardy Manor Way.

The only change within the Site on the 1938 1: 10,000 scale Ordnance Survey map (not reproduced) is the apparent removal of the pier in its north-eastern section. The Ford car factory at Dagenham had been constructed 400m to the north of the Site across the Thames by this time.

The Ordnance Survey 1:10,000 scale map of 1966-69 (**Figure 14**) shows significant change within the Site and its immediate vicinity. The works in the northern part of the Site had expanded and were now simply labelled "*Mill*". Existing buildings had been extended and several new buildings had been constructed. The Fish Guano Works is no longer labelled, and other buildings had been demolished in this part of the Site, including the Marsh Tavern and some of the terraced houses to the south-east.

Figure 14 also shows construction of the Belvedere Power Station Jetty (disused) (**A1g**) within the Thames in the northern part of the Site. The 180m long jetty remains extant within the Site but is disused. It was likely used as a fuelling jetty for the power station. Other structures constructed along the foreshore within the Site comprise a pontoon and small jetty in the west and two wharfs, one in the western half and a larger one in the easternmost part of the Site. In the southern part of the Site, a large electrical substation had been constructed to the west of Norman Road. Two pylons are shown in the western part of the Site. Orient House and its associated and ancillary structures and garden had been demolished by this time, and this area now comprised a spoil/slag heap or a landfill site, bounded to the north, south and west by roads/tracks and drains. The footpath in the southern half of the Site had been realigned and two field boundaries/ditches had been removed. The structure, which may have been a powder magazine, on the western edge of the Site had been demolished.

Considerable development had also taken place to the immediate east of the Site. Belvedere Power Station was built here between 1954 and 1960 (**A1h**). This is labelled as "*Works*" on the map, comprising several large buildings and a depot. Four of these buildings encroached onto the eastern part of the Site. An access road to these new works had been constructed to the east of and parallel to Norman Road. To the west, the Crossness sewage treatment works had expanded significantly. The modern sewage treatment plant began operation in 1963, making use of large reinforced concrete primary sludge digestion tanks (Cherry and Pevsner, 1983). A fleet of boats was used to transport the solid sludge out to sea for disposal until 1998 (Museum of London Archaeology Service, 2005).

The Ordnance Survey 1: 2,500 scale maps 1957-62 and 1970 (not reproduced) show houses including "*Moore House*" and "*Borax Cottage*" within the northern part of the Site amongst the industrial buildings. The latter, however, was demolished by the time of the 1970 map. A tennis court is also shown to the east of Norman Road in the northern part of the Site.

Fewer changes are shown within the Site on the Ordnance Survey 1:10,000 scale map of 1973-74 (not reproduced). A rectangular plan industrial building in the north-western part of the Site, first shown on the 1966-69 map (**Figure 14**), was demolished and another was constructed to its north. A drain running westerly from Norman Road was shortened and a larger drain had been constructed to the west of the Site.

The Ordnance Survey 1:10,000 scale map of 2002 (not reproduced) shows that all but one of the industrial buildings in the northern part of the Site had been demolished following the closure of the Borax works in 1990, although the Belvedere Power Station buildings in the eastern extent of the Site remained. Two more smaller depot buildings had been constructed to the west. A new drain at the southern end of the Site, to the south of the substation, is shown on this map. To the immediate south of the Site, the A2016 Picardy Manorway had been constructed. Belvedere Power Station to the east of the Site was demolished in 1993-94.

Historical satellite imagery (not reproduced) shows that work on Riverside 1, and its associated Middleton Jetty, in the northern part of the Site began in 2008 and that the electrical substation in the southern part of the Site was demolished in around 2010-11. The extant warehouse in the southern part of the Site to the west of Norman Road, which is currently used by Munster Joinery, was erected sometime between 2015 and 2017. Plots of land to the north of this (currently named Borax North and Borax South) were previously used as laydown areas and were subsequently stripped of topsoil.

The wreck site of a tugboat named the Regency is recorded at the northern end of the Site within the River Thames (**A1e**). The boat was sunk by a mine while towing barges during the Second World War, resulting in the death of one crew member and one lighterman. The wreck was raised from this location in 1970. An unclassified obstruction, identified in 1998, is recorded on the UKHO database on the foreshore within the Site (**A1d**). This is recorded as a 'dead' obstruction, meaning it has not been found in recent surveys, potentially because it has been buried in mobile sediments or because it is no longer there. Submerged ground tackle remains were identified 40m to the north of the Site after the removal of a mooring buoy in 1999 (**A83**).

The Historic England National Marine Heritage Record (NMHR) records a total of 19 early 20th century aircraft crashes within the wider area (**A95**). These date between 1927 and 1944 and are recorded in the River Thames without an exact location. As such it is uncertain how many of these actually lie within the Study Area. The vast majority of these, however, were likely shot down over the Thames Estuary. These include a Vickers Virginia, Supermarine Spitfires, Hawker Hurricanes, a Bristol Blenheim, a Blackburn Roc and a North American Mustang.

At the time of writing, Riverside 2 is being constructed in the northern terrestrial part of the Site; Borax North and Borax South are again being used as temporary construction compounds.

5.6. FACTORS AFFECTING ARCHAEOLOGICAL SURVIVAL

Past ground disturbance within the Site from mid-19th and 20th century developments may have compromised archaeological survival, e.g., building foundations, identified primarily from historic maps, site walkover survey, and information on the likely depth of deposits.

Given the extent of the Site and the nature of the Proposed Scheme, which encompasses both the terrestrial and marine environment, archaeological survival is anticipated to be highly variable.

The waterlogged conditions of the intertidal part of the Site and the marshland within which much of the Site is located, particularly where alluvium is present, may promote high levels of preservation of organic materials, including any wooden structures. Prehistoric wooden trackways, for example, have been discovered in this part of the Thames estuary and where prehistoric remains are present, these could be buried at substantial depth, at the interface between peat and upper clay.

PREDICTED LEVEL OF ARCHAEOLOGY

The level of superficial geology within the Site is summarised in **Section 5.3**.

Between the top of the superficial deposits and the current ground level is modern made ground and undated made ground. The latter may potentially contain remains of archaeological interest (i.e., significant artefacts within ground raising deposits). The thickness of made ground ranges from 0.0 – 4.5m across the Site.

The height of archaeological deposits is likely to vary across the Site, with peat deposits buried at depth in some parts and eroding out of the foreshore or very near surface in the intertidal area. Within the intertidal and marine parts of the Site, potential archaeological finds or features would be present at riverbed level, which varies across the Site, or submerged within wet alluvium at a greater depth.

PAST IMPACTS AND IMPLICATIONS FOR ARCHAEOLOGICAL SURVIVAL

Archaeological survival is anticipated to be varied across the Site. Archaeological survival in the northern terrestrial part of the Site, which has seen significant 19th and 20th century industrial and residential development, is expected to be low for near-surface remains due to the increased thickness of made ground. The same is expected to be true in the south-eastern part of the Site where the former electrical substation was situated. Across the Site, the level of survival for earlier remains (i.e., palaeoenvironmental and/or prehistoric remains) is likely to be higher, as these would survive at a much greater depth.

The primary impact from modern buildings derives from foundations, areas of hardstanding, and site preparation/historic demolition which would have partially truncated or removed potential shallow remains within the footprint of the works. The construction of roads, jetties, piers and pylons and the excavation of drains and for services would also likely have involved the truncation and/or destruction of any near-surface archaeological remains in these locations. Made ground was encountered in all of the trenches excavated in the northern part of the Site in 2007, including elements likely related to the former Borax Works (Pre-Construct Archaeology, 2008). Archaeological survival of near-surface remains is also expected to be low for the Borax North and Borax South areas to the west of Norman Road, which were previously used as laydown areas and have recently been stripped of topsoil again. However, building foundations would have had minimal impact on potential archaeological remains preserved at substantial depths.

The south-western part of the Site and the area to the west of the northern end of Norman Road appear to have remained largely free from modern disturbance. Archaeological survival is therefore expected to be higher in these parts of the Site.

Erosion, both natural and as a result of activities such as propeller wash and anchoring, in the Thames are likely to have impacted the archaeological resource within the intertidal and marine zones of the Site. Dredging activities to ensure the navigability of this part of the River for ships would also likely have impacted the archaeological resource. Elsewhere, deposition may have occurred which would bury and thus preserve archaeological remains. The extent to which intertidal action has eroded/scoured out or buried possible archaeological remains is not currently known.

6. BURIED HERITAGE ASSETS: STATEMENT OF VALUE (SIGNIFICANCE)

6.1. PALAEOENVIRONMENT

The Site has a high potential for palaeoenvironmental remains.

The Site is located on the River Thames floodplain within a Tier 3 APA defined by good preservation of palaeoenvironmental remains. Within the Site, the remains of fallen trees were found within alluvial deposits during an excavation in 2007, and pollen analysis suggested an alder carr wetland, with nearby dryland on the interfluves to the south dominated by oak, lime, hazel and heather (Pre-Construct Archaeology, 2008). A remnant of preserved Late Mesolithic forest was also encountered during trial trenching 460m to the west of the Site.

Alluvium (clay/silt) and peat deposits may contain well-preserved environmental remains. Minerogenic deposits such as alluvial silts and clays have potential for the preservation of diatoms, ostracods and molluscs, the assessment of which can provide information on the salt or freshwater nature of deposits. Peat deposits preserve pollen, seeds and plant fragments, and can also be dated by radiocarbon techniques, important for establishing the chronology for the depositional sequence. It is likely that environmental evidence is present within Holocene alluvium.

Such remains have evidential value for the past environment in which prehistoric and later people lived, and would be of **low** or **medium** value, derived from archaeological interest.

6.2. PREHISTORIC

The Site has a low to moderate potential to contain prehistoric remains.

The Site would have been inundated as a result of marine transgression during the Mesolithic. It would have been wetland in the Neolithic and Bronze Age and inundated again from the Iron Age onwards. Permanent occupation of the Site would therefore have been limited to areas of higher ground along the edges of river channels, but the marshland would have provided opportunities for fishing, hunting, wood and reed collection, pottery manufacture and salt production particularly during periods of RSL stabilisation (Neolithic and Bronze Age).

Evidence of prehistoric marshland exploitation survives in the Study Area in the form of flint tools and Early Neolithic and Bronze Age timber structures and trackways, which would have enabled access across boggy areas. The discovery of a Bronze Age logboat 820m to the east of the Site also highlights the importance of the River Thames to prehistoric communities.

There is a low potential for the remains of boats and other marine obstructions of prehistoric date in the intertidal and marine parts of the Site.

Any remains present within the lower part of the Holocene sequence (e.g., peat and lower alluvium) would likely remain intact across the Site due to their depth. However, no prehistoric archaeological remains were encountered during the 2007 archaeological excavation (Pre-Construct Archaeology, 2008).

If present, prehistoric remains would be of **low**, **medium** or **high** value, depending on preservation and extent, derived from archaeological interest. The Archaeological Priority Areas Appraisal for LBB states that the value of the Tier 3 APA within which the Site is located is *"particularly high for the prehistoric periods"* (Historic England, 2020).

6.3. ROMAN

The Site has a low to moderate potential to contain Roman remains.

Although a sherd of Roman greyware pottery was recovered from the top of the alluvial sequence during a trial trench evaluation within the Site in 2007, this artefact was not located within a discrete feature and was likely deposited by water action. None of the unspecified 'Roman remains' identified onsite by a local enthusiast in 1885 were found during a field investigation at this location in 1964. In the surrounding area, evidence of occupation has mainly been found on areas of high ground, including the Roman field systems 1.5km to the west of the Site Boundary. It is possible that there was also a Roman settlement close to Crossness to the west of the Site. As with the prehistoric period, any Roman remains within the Site are more likely to relate to the exploitation of resources, such as fishing and salt production, than permanent settlement and would probably take the form of localised find spots (pottery sherds or artefacts) rather than extensive remains.

There is a low potential for the remains of boats and other marine obstructions of Roman date in the intertidal and marine parts of the Site.

If present, such remains would be of **low**, **medium** or **high** value, depending on preservation and extent, derived from archaeological interest.

6.4. EARLY MEDIEVAL

The Site has a low potential to contain early medieval remains.

There are no heritage assets dating to this period recorded within the Study Area. However, it is possible that flood management and land reclamation in the former marsh began during this period.

There is a low potential for the remains of boats and other marine obstructions of early medieval date in the intertidal and marine parts of the Site.

6.5. MEDIEVAL

The Site has low potential to contain medieval remains.

Much of the marshland was reclaimed and managed from at least the 13th century to create suitable land for rearing animals and cultivating crops, and 14th century records show that the fertile alluvial marsh soils here were particularly valuable. The reclamation of the marshes likely took place in stages, with several sea walls being built successively. It is likely that different parts of the Site were reclaimed at different times throughout the medieval and post-medieval periods. J. Spurrell supposedly saw the oldest of a network of medieval river walls 650m to the south of the Site in 1885, which he believed may date to the 13th century (Spurrell, 1885). Any surviving medieval archaeological remains within the Site will likely relate to its reclamation and agricultural utilisation, such as field boundaries, droveways and drainage ditches. Evidence of medieval sea walls and embankments may also survive, including repairs after breaches, although no such evidence was encountered during excavations in the northern terrestrial part of the Site (Pre-Construct Archaeology, 2008). There is also a potential for evidence of medieval brick and pottery manufacture.

There is an uncertain, but possibly low potential for the remains of wrecks, former jetties and other marine obstructions of medieval date in the intertidal and marine parts of the Site.

If present, remains are likely to be agricultural in nature and would be of **low** or **medium** value, depending on preservation and extent, from derived from archaeological and historical interest. Evidence of former medieval sea walls would be of higher value, though this would depend on preservation and extent.

6.6. POST-MEDIEVAL

The Site has high potential to contain post-medieval remains.

Evidence relating to the continued maintenance and repair of the sea wall and the agricultural utilisation of the Site may survive. Field boundaries and drainage ditches, for example, are shown on historic mapping from this period.

The earliest available map to show a sea wall within the Site is the Andrews, Dury and Herbert 1769 map of Kent (**Figure 8**). This shows the wall crossing the northern part of the Site, along the line of the existing modern defences. However, as discussed above, the reclamation of the marshland likely took place in stages, with several sea walls being built successively. There is therefore a potential for early post-medieval sea wall remains to survive within the Site.

There is a low to moderate potential for the remains of wrecks, former jetties, barge beds and other marine obstructions of post-medieval date in the intertidal and marine parts of the Site.

Remains of wooden sailing vessels lost during the Great Storm of 1703, for example, may survive at riverbed level or below.

Post-medieval remains would be of **low** value, derived from archaeological and historic interest. Agricultural remains would be of **low** or **negligible** value.

6.7. MODERN

The Site has high potential to contain modern remains.

Historic mapping shows buildings and structures within the Site from the mid-to-late-19th century, including the Manure Works, Belvedere Mills, the Fish Guano Works, the Borax Works, the Belvedere Power Station, an electrical substation and associated infrastructure, houses, piers, jetties, pontoons, wharfs and the sea wall. Made ground was encountered in all of the trenches excavated in the northern part of the Site in 2007, including elements likely related to the former Borax Works (Pre-Construct Archaeology, 2008).

Industrial remains dating to the modern period have been demolished across the Site following recent development and site stripping. As such, any surviving remains would be limited to wall footings and other foundations of **negligible** value, derived from archaeological and historic interest.

There is a low to moderate potential for the remains of wrecks, former jetties, barge beds and other marine obstructions of modern date in the intertidal and marine parts of the Site.

The wreck site of a tugboat named the Regency is recorded at the northern end of the Site within the Thames, although the wreck was raised from this location in 1970. The UKHO records a ‘dead’ unclassified obstruction on the foreshore within the Site, meaning it has not been found in recent surveys, potentially because it has been buried in mobile sediments or because it is no longer there. The value of potential wrecks, jetties and other marine obstructions would depend on their nature and extent, but in all likelihood would be **low** or potentially **medium**.

7. ABOVE GROUND HERITAGE ASSETS: STATEMENT OF VALUE (SIGNIFICANCE)

Following Step 1 of the Historic England guidance (Historic England, 2017), Table 3 below indicates which heritage assets have been scoped out of the assessment as their value would not be affected at all by the Proposed Scheme, in terms of material changes to their setting and how the asset in understood and appreciated. This is based on the distance of the asset from the Site Boundary; the asset's location, scale and orientation, and the nature, extent and scale of intervening built form, vegetation and topography between asset and the Site.

The assets scoped out in Table 3: are not assessed further in **Chapter 9: Historic Environment (Volume 1)**.

Table 3: Setting of Heritage Assets: Assets Scoped Out

Assessment ref.		Rationale for exclusion
A46	Crossness Sewage Treatment Works (Early 20th Century Police Boxes)	• Four locally listed early 20th century concrete structures, similar in style to police boxes, are located at the Crossness Sewage Treatment Works, the closest of which is situated 490m to the west of the Site. These non-designated heritage assets are defined and experienced by their relationship to each other and to the surrounding industrial landscape. • While the Proposed Scheme may be visible in the long view out from the assets towards the east, this view does not contribute to the assets' value. • The Proposed Scheme would not affect the relationship of the assets to each other or to the surrounding industrial landscape. The Proposed Scheme would not result in a material change to the assets' setting or value.
1002025 and 1359415	Lesnes Abbey	• The surviving remains of the Augustinian Abbey of St Thomas the Martyr, now known as Lesnes Abbey, is a scheduled monument (NHLE ref: 1002025) and listed Grade II (NHLE ref: 1359415). The abbey was founded in 1178 and suppressed by Cardinal Wolsey in 1524. The building was subsequently converted into a mansion, which was demolished in 1844. The remains, which are situated 1.7km to the south-west of the Site, include upstanding stone walls, foundations and archaeological remains relating to the use and history of the abbey. The upstanding remains of the abbey are Grade II listed. The Abbey church to the south is included in the scheduling. • The assets at Lesnes Abbey are defined and experienced by their relationship to each other and to the surrounding landscape, particularly Lesnes Abbey Woods to the south.

Assessment ref.		Rationale for exclusion
		• A digital Zone of Theoretical Visibility (ZTV) model prepared by shows that the Absorber Stack would be visible in the long view from the northern and western parts of the scheduled monument towards the north-east. It can be assumed that the Proposed Jetty would also be visible in this view. However, views towards the Site do not contribute to the assets' value. • The Proposed Scheme would not affect the relationship of the assets to each other or to the surrounding landscape. The Proposed Scheme would not result in a material change to the assets' setting or value.

7.1. ABOVE GROUND HERITAGE ASSETS WITHIN THE SITE

There is one above ground heritage asset within the Site. This is the Belvedere Power Station Jetty (disused), which is a non-designated heritage asset.

BELVEDERE POWER STATION JETTY (DISUSED)

The Belvedere Power Station Jetty (disused) (**A1g**) in the north-east of the Site (**Figure 25**) first appears on the 1966-69 6": mile Ordnance Survey map (**Figure 14**) and was likely constructed between 1954 and 1960 as a fuelling jetty along with the rest of the power station to the immediate east of the Site. The Jetty is disused at the time of writing and may be demolished as part of the Proposed Scheme, although this will be assessed and confirmed in the ES.

The Jetty's value is derived from its historic interest as the last surviving element of the former Belvedere Power Station. It is a good example of a post-war industrial jetty, constructed of both concrete and timber. A two-storey brick-built structure sits on the centre of the Jetty and a metal loading bridge with concrete supports connects it to the land. Two octagonal plan concrete and timber dolphins are situated off both ends of the Jetty. The Ordnance Survey 1: 1,250 scale map of 1963-64 (not reproduced) shows that the dolphins were used to house navigation lights. Cranes and bollards are also labelled on the Jetty on this map.

As a non-designated heritage asset of local importance, the Jetty is an asset of **low** value.

The Jetty is defined and experienced by its industrial location and its visual and functional relationship with the River Thames. The Jetty is located on the southern foreshore of the River Thames, where it is visible from the north foreshore and the England Coast Path along the south bank. Although its historic setting has been diminished by the demolition of the associated Belvedere Power Station, the Jetty retains its relationship with the River Thames and the surrounding industrial landscape. The setting of the Jetty makes a **medium** contribution to the asset's value.

7.2. ABOVE GROUND HERITAGE ASSETS BEYOND THE SITE BOUNDARY

CROSSNESS PUMPING STATION

There are four separate designated heritage assets at Crossness Sewage Treatment Works, the closest of which is approximately 900m to the west of the Site Boundary, comprising three listed buildings and a Conservation Area (**Figure 26**). Further detail is provided in **Section 5.5** above.

Workshop Range to South East of Main Engine House (A2)

Workshop Range to south east of main engine house at Crossness Pumping Station (**A2**) dates to the 1860s and built by William Webster to the designs of Sir Joseph Bazalgette and Charles Henry Driver. The building is constructed of yellow brick in a Flemish bond.

The asset has historic and architectural interest as a component part of a Victorian pumping station, designed to improve the disposal of sewage required by the ever-growing population of London. Its historic interest is enhanced by its connection to Bazalgette. It was listed at Grade II in 1990 (NHLE ref: 1064216). As a Grade II listed building it is a heritage asset of **medium** value, although it is associated with a Grade I listed building described below.

Crossness Pumping Station (A3)

Crossness Pumping Station (**A3**) dates to 1865 and was built to the designs of Sir Joseph Bazalgette. The building is of two storeys and constructed of yellow brick. It contains four beam engines by James Watt and Co, which were converted from single to twin cylinders in 1909-10 (Cherry and Pevsner, 1983). The asset has high historic and architectural interest as an outstanding example of a Victorian pumping station, designed to improve the disposal of sewage and meet the needs of the ever-growing population of London. Its historic interest is enhanced by its connection to Bazalgette. It was listed at Grade I in 1970 (NHLE ref: 1064241). As a Grade I listed building it is a heritage asset of **high** value.

Workshop Range to South West of Main Engine House (A4)

Workshop Range to south west of main engine house at Crossness Pumping Station (**A4**) is a Grade II listed building dating to the 1860s and built by William Webster to the designs of Sir Joseph Bazalgette and Charles Henry Driver. The building is constructed of yellow brick in a Flemish bond. The asset has historic and architectural interest as a component part of a Victorian pumping station, designed to improve the disposal of sewage required by the ever-growing population of London. Its historic interest is enhanced by its connection to Bazalgette. It was listed at Grade II in 1990 (NHLE ref: 1250557). As a Grade II listed building it is a heritage asset of **medium** value, although it is associated with a Grade I listed building described above.

Crossness Conservation Area (A6)

Crossness Conservation Area (**A6**) incorporates the three listed buildings at the mid-Victorian sewage works. Other significant heritage assets within the Conservation Area include the brick vaulted subterranean reservoir, the storm water pumping station, the centrifugal engine house and the precipitation engine house. The conservation area was designated in 1997 and is described by LBB as *"South East London's most important site for industrial archaeology"* (LBB, 2009). As a Conservation Area, it is a heritage asset is of **medium** value.

The setting of the Conservation Area is defined by its relationship to the listed buildings at Crossness Sewage Treatment Works and by the relationship of these buildings to each other. The setting of the asset is defined by its location on the Thames riverside and the surrounding remnants of the original rural landscape. The conservation area's most significant views are outlined in the Conservation Area Appraisal and Management Plan (LBB, 2009). These include those from the River Thames and the ECP towards the listed buildings, the view from Crossness Pumping Station to the south, the view from the open space to the west towards the conservation area and the view to the northeast along the entrance driveway towards the listed buildings. However, the concrete river flood defence wall (which stands 2.5 – 3m OD) to the north of the listed buildings obscures historic views of the River Thames. As stated in the Conservation Area Appraisal and Management Plan, this wall has '*partially severed*' the link between the buildings and the river (LBB, 2009). Therefore, taken overall, the asset's setting makes a **medium** contribution to its value.

This view eastward towards the Proposed Scheme is interrupted by intervening industrial buildings and chimney stacks (**Figure 27**, **28**) and therefore is not considered to make a significant contribution to the value of the Conservation Area, nor the Grade II listed buildings within it.

NO. 4 JETTY AND APPROACH

No. 4 Jetty and Approach, formerly at Samuel Williams and Company, Dagenham Dock (**A5**), was constructed between 1899 and 1903 to designs by L. G. Mouchel & Partners and extended in 1906-07 (**Figure 29**, **Figure 30**). The asset, which is located 750m to the northwest of the Site Boundary, has historic interest as being among Britain's earliest surviving reinforced-concrete structures which uses Samuel Williams' patented system for the horizontal casting of reinforced-concrete piles. It was listed at Grade II in 2006 (NHLE ref: 1391706). As a Grade II listed building it is a heritage asset of **medium** value.

The setting of No. 4 Jetty and Approach is experienced by its industrial location at Dagenham Dock on the north bank of the River Thames. The asset is defined by its relationship to the wider group of jetties, warehouses and other industrial buildings at Dagenham Dock. The jetty's setting makes a **medium** contribution to its value, as it retains its historical relationship to the River Thames to the south and the industrial landscape of Dagenham Dock to the north. The Proposed Scheme would be visible in long views out from the asset towards the southeast. However, this view does not contribute to the asset's value.

8. CONCLUSION

This document forms an appendix to the PEIR which provides the preliminary impact assessment on buried heritage assets and above ground heritage assets. The PEIR also considers the impact of the Proposed Scheme on the historic character and setting of designated assets within and beyond the Site (e.g., views to and from listed buildings and conservation areas).

The Site does not contain any nationally designated (protected) heritage assets such as scheduled monuments, listed buildings or registered parks and gardens. The Site does not lie within a conservation area and no locally listed buildings are situated within the Site Boundary.

The closest designated assets to the Site comprise a group of three listed buildings and a conservation area associated with the mid-19th century Crossness Pumping Station, including the Grade I listed pumping station itself (**A3**), located 900m to the west of the Site.

Given the extent of the Site and the nature of the Proposed Scheme, which encompasses both a terrestrial and marine environment, archaeological survival is anticipated to be highly variable. Past ground disturbance within the Site from mid-19th and 20th century developments may have compromised archaeological survival, particularly in the northern part of the Site. The waterlogged conditions of the intertidal part of the Site and the marshland within which much of the Site is located, particularly where alluvium is present, may promote high levels of preservation of organic materials. The height of archaeological deposits is likely to vary across the Site, with modern made ground capping the full alluvial sequence between 1.0-4.0m thick.

Table 4 below summarises the known or possible heritage assets identified within and outside of the Site potentially impacted by the Proposed Scheme. The table also includes the known or likely asset value.

Table 4: Known or Possible Heritage Assets and Value (Significance)

Known or Potential Heritage	Heritage Value (Significance)
Above Ground Heritage Assets	
Belvedere Power Station Jetty (disused) (A1g)	Low
Workshop Range to the South-East of the Main Engine House at Crossness Pumping Station (A2)	Medium
Crossness Pumping Station (A3)	High
Workshop Range to the South-West of the Main Engine House at Crossness Pumping Station (A4)	Medium
Crossness Conservation Area (A6)	Medium
No. 4 Jetty and Approach at Dagenham Dock (A5)	Medium
Below Ground Heritage Assets (Potential Archaeological Remains)	
Previously Unrecorded Palaeoenvironmental Remains (high potential)	Such remains would be of **low** or **medium** heritage value.
Previously Unrecorded Prehistoric and Roman Remains (low to moderate potential)	Likely remains would be limited to localised findspots comprising flint tools or artefacts, of **low** or **medium** heritage value.
Previously Unrecorded Medieval Remains (low potential)	Such remains would be of **low** or **medium** heritage value (depending on nature and extent).
Previously Unrecorded Post-medieval and Modern Remains, recorded structures, field boundaries and drainage ditches (high potential)	Post-medieval remains would be of **low** heritage value and modern remains would be of **negligible** or **low** value (depending on nature and extent).
Possible Marine Obstructions from All Periods, including the remains of wrecks, former jetties and barge beds (uncertain potential for such remains of medieval or earlier date, low to moderate potential for post-medieval and modern remains)	The value of such remains would depend on their nature and extent, but in all likelihood would be **low** or potentially **medium**.

9. REFERENCES

Andrews, C., 2004, 'Roman Kent' in *An Historical Atlas of* Kent, Lawson, T. & Killingray, D. eds.

Bates, M. R [CTRL Union Railways (North/South) Ltd], 1999, *A Geoarchaeological Evaluation of the Thames/Medway Alluvial Corridor of the Channel Tunnel Rail Link*

Bridgland, D. R., 1994, *Quaternary of the Thames*

Bridgland, D. R., Allen, P. and Haggart, B. A. (eds.), 1995, *The Quaternary of the Lower Reaches of the Thames: Field Guide*

Cherry, B. and Pevsner, N., 1983, *The Buildings of England – London 2: South*

CIfA [Chartered Institute for Archaeologists], Dec 2020a, *Standards and guidance for commissioning work or providing consultancy advice on archaeology and the historic environment*, Reading

CIfA [Chartered Institute for Archaeologists], Dec 2020b, *Standards and guidance for historic environment desk-based assessment*, Reading

CIfA [Chartered Institute for Archaeologists], Dec 2020c, *Standards and guidance for the archaeological investigation and recording of standing buildings or structures*, Reading

Dear, I. C. B., and Kemp, P., 2006, *The Oxford Companion to Ships and the Sea* (2nd edn.), https://www.oxfordreference.com/display/10.1093/acref/9780199205684.001.0001/acref-9780199205684, accessed 16 March 2023

Department of Energy & Climate Change, 2011, *Overarching National Policy Statement for Energy (EN-1)*

Department for Energy Security & Net Zero, 2023, *Overarching National Policy Statement for Energy (EN-1)*

Devoy, R. J., 1979, 'Flandrian sea level changes and vegetation history of the lower Thames estuary', *Philosophical Transactions of the Royal Society* B285355–407

Devoy, R. J., 1980, 'Post-glacial Environmental Change and Man in the Thames Estuary: a Synopsis' in Thompson, F. (eds.) *Archaeology and Coastal Change. Society of Antiquities London Occasional Paper*

'Dreadful Explosion of Gunpowder at Erith', *Kentish Chronicle*, 8 October 1864, available at http://www.dover-kent.com/Other-info/1864-Erith-Explosion.html, accessed 24 March 2023

Galloway, J. A., 2010, ''Piteous and Grievous Sights': The Thames Marshes at the Close of the Middle Ages', in Galloway, J. A. (eds.) *Tides and Floods: New Research on London and the Tidal Thames from the Middle Ages to the Twentieth Century*

Gibbard, P. L., 1985, *The Pleistocene History of the Middle Thames Valley*

Gibbard, P. L., 1994, *The Pleistocene History of the Lower Thames Valley*

Greater London Authority, 2021, *The London Plan – The Spatial Development Strategy for Greater London, March 2021*

Hasted, E., 1797, 'Parishes: Erith' in *The History and Topographical Survey of the County of Kent: Volume 2*

Historic England, 2008, *Conservation principles, policies and guidance*, Swindon

Historic England, 2017, *The setting of heritage assets. Historic Environment Good Practice Advice in Planning Note 3*

Historic England, 2017, *Conservation principles, policies and guidance. Consultation Draft*, Swindon

Historic England, 2019, *Statements of Heritage Significance: Historic England Advice Note* 12

Historic England, 2020, *London Borough of Bexley – Archaeological Priority Areas Appraisal*

Humphery-Smith, C., 1984, *The Phillimore Atlas and Index of Parish Registers*

Landscape Institute and Institute of Environmental Management and Assessment, 2013, *Guidelines for Landscape and Visual Impact Assessment 3rd Edition* (GLVIA3)

Levick, B., 2021, 'Saxon Kent', *Cliffe History*, [redacted] accessed 16 March 2023

Lewis, F., 2008, *A History of Rainham, with Wennington and South Hornchurch*

London Borough of Bexley Council, 2004, *Unitary Development Plan*

London Borough of Bexley Council, 2009, *Crossness Conservation Area – Area Appraisal and Management Plan*

London Borough of Bexley Council, 2012, *Local Development Framework – Development Plan Document: Bexley Core Strategy*

London Borough of Bexley Council, 2021, *Draft Local Plan – Proposed Submission Document, Regulation 19 Stage*

London Borough of Bexley Council, 2021, *Locally Significant Views within the London Borough of Bexley technical paper*

Maltby Surveys Ltd, 2021, *Norman Road, Belvedere, DA17 6JY – Topographical Survey*

Margary ID, 1967, *Roman Roads In Britain*

Merritts, D. J., 2007, 'Terrace Sequences' In Elias S. A. (ed) *Encyclopaedia of Quaternary Science* (Elsevier)

MHCLG [Ministry of Housing, Communities and Local Government], July 2018, *Conserving and Enhancing the Historic Environment: Planning Practice Guide*

MHCLG [Ministry of Housing, Communities and Local Government], September 2021, *National Planning Policy Framework*

Mills, A. D., 2011, *A Dictionary of British Place Names*

Museum of London Archaeology Service, 2005, *Crossrail – Assessment of Archaeology Impacts, Technical Report. Part 4 of 6, South-East Route Section* (ref. 1E0318-E2E00-00001)

Museum of London Archaeology Service, 2008, *Crossness Engines Trust – Archaeological desk-based assessment* (ref. BEXL/1076)

Orion Heritage, 2018, *Riverside Energy Park, London Borough of Bexley and associated Electrical Connection Route, Dartford, Kent – Heritage Desk Based Assessment*

Pre-Construct Archaeology, 2007, *An Archaeological Evaluation at Crossness Sewage Treatment Works, Thamesmead, London Borough of Bexley*

Pre-Construct Archaeology, 2008, *Land at Norman Road (North), Belvedere, London Borough of Bexley – An Archaeological Evaluation*

Quaternary Scientific (Quest), 2022, *Riverside Energy Park, London Borough of Bexley – Geoarchaeological & Palaoenvironmental Analysis Report*

Scott, B., 2004, 'Kentish Evidence of the Palaeolithic and Mesolithic Periods' in *An Historical Atlas of* Kent, Lawson, T. & Killingray, D. eds.

Sidell, E. J., 2003, *Holocene sea level change and archaeology in the inner Thames estuary, London, UK* Doctoral Thesis

Soil Mechanics, 2007, *Riverside Resource Recovery Facility, Belvedere, Kent – Factual Report on Ground Investigation* (ref. A7007)

Spurrell, F. C. J., 1885, 'Early Sites and Embankments on the Margins of the Thames Estuary', *The Archaeological Journal*, 42, pp. 269-302

Yates, D., 2004, 'Kent in the Bronze Age: Land, Power and Prestige c.1500-c.700 BC' in *An Historical Atlas of* Kent, Lawson, T. & Killingray, D. eds.

OTHER SOURCES

Bexley Local Studies and Archive Centre

British Geological Survey

Greater London Historic Environment Record

Historic England designation data

CARTOGRAPHIC SOURCES

Ordnance Survey mapping from the 1st edition to the present day

APPENDIX A
HISTORIC ENVIRONMENT GAZETTEER

The table below represents a gazetteer of known historic environment sites and finds within the Study Area. Each entry has an assessment (A) reference number. The gazetteer should be read in conjunction with the historic environment features map.

Abbreviations:

HER - Historic Environment Record

NHLE - National Heritage List for England

NRHE - National Record of the Historic Environment

UKHO - United Kingdom Hydrographic Office

Table 5: Historic Environment Gazetteer

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A1a	**Trial Trench at Norman Road** Trial trench evaluation by Pre-Construct Archaeology in 2007, comprising nine trenches. A single rim sherd of Roman pottery was found. The peat is likely to be of early Neolithic to Iron Age in date.	Early Neolithic – Iron Age Roman	156002
A1b	**Geotechnical Survey at Former Belvedere Power Station** Geotechnical monitoring by Lawson Price Environmental in 1994. The works did not disturb any archaeological deposits.	None	168633
A1c	**Geomorphological Survey at Crossness** Quaternary Scientific used geoarchaeological borehole data to create a deposit model in 2011. The model identified layers of naturally deposited alluvium and peat.	None	160508
A1d	**Obstruction** UKHO Wreck / Obstruction. Obstruction / ruin identified in 1998.	Unknown	13389
A1e	**Regency wreck site** UKHO Wreck / Obstruction. Wreck site of the Regency, a tug boat which was sunk by a mine off Dagenham while towing barges during the Second World War. One crew member and one lighterman were lost. The wreck was raised in 1970.	Modern	69978
A1f	**Roman remains** 'Roman remains' noted in the river off Brown's Manure Works in 1885. Field investigation in 1964 found nothing at the location.	Roman	408168

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A1g	**Belvedere Power Station Jetty** Likely constructed between 1954 and 1960 as a fuelling jetty along with the rest of Belvedere Power Station.	Modern	N/a
A1h	**Belvedere Power Station** Belvedere Power Station was built in 1954-60 and demolished in 1993-4.	Modern	965443
A2	**Workshop range to south-east of main engine house Crossness Pumping Station** Grade II listed workshop range, built in 1862-65 by William Webster to the designs of Sir Joseph Bazalgette and Charles Henry Driver.	Post-medieval	1064216
A3	**Crossness Pumping Station** Grade I listed pumping station, built to the designs of Sir Joseph Bazalgette and completed in 1865.	Post-medieval	1064241
A4	**Workshop range to south-west of main engine house Crossness Pumping Station** Grade II listed workshop range, built in 1862-65 by William Webster to the designs of Sir Joseph Bazalgette and Charles Henry Driver.	Post-medieval	1250557
A5	**No. 4 Jetty and approach, formerly at Samuel Williams and Company, Dagenham Dock** Grade II listed coaling jetty, built in 1899-1903 for Samuel Williams & Sons Ltd. and extended in 1906-07. The jetty is one of Britain's earliest surviving reinforced-concrete structures.	Modern	1391706

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A6	**Crossness Conservation Area** Conservation area incorporating the mid-Victorian Crossness Pumping Station complex. This conservation area includes three listed buildings.	Post-medieval	4840
A7	**Watching Brief and Geoarchaeological Evaluation at Anderson Way and Bronze Age Way** A watching brief and a geoarchaeological evaluation by Canterbury Archaeological Trust between 2015 and 2018. One of the earliest identified phases was a peat horizon and a solid wooden object, which is thought to be the trunk of a fallen tree. A series of interdigitated peats and inorganic silts were thought to represent early Holocene marshy woodland and alluvial flooding or tidal inundation. Alluvial or tidal clays are thought to mark late Holocene marine transgression or deliberate post-medieval land reclamation.	Prehistoric Post-medieval	152205 153694
A8	**Auger Survey and Deposit Modelling at Crabtree Manorway North** Geoarchaeological fieldwork and deposit modelling by Quaternary Scientific in 2012. Six boreholes were located across the site, which showed that the site has potential for paleobotanical and zooarchaeological remains. The deposit sequence suggested the presence of Mesolithic and later Neolithic to Bronze Age semi-terrestrial land surfaces.	Prehistoric	152663 123606
A9	**Geoarchaeological Deposit Modelling and Borehole Survey at Burt's Wharf** Geoarchaeological deposit modelling at Burt's Wharf by Quaternary Scientific in 2016. The model shows that the site has a similar geoarchaeological make-up to others in the Lower Thames valley. On the basis of the likely depth of sediments, the archaeological potential of the site was considered low. A geoarchaeological survey was carried out here by the Museum of London Archaeology in 2020. The results determined that the Pleistocene floodplain gravel consist of underlying	None	153427 155352

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
	deposits of archaeological interest. This layer of floodplain gravels were overlain by a 7.5m layer of Holocene floodplain deposits.		
A10	**Auger Survey, Monolith Sampling and Trial Trenching at 109-137 Abbey Road** Auger survey, monolith sampling and trial trench evaluation by Wessex Archaeology in 1993. Peat deposits were dated by pollen assessment to the Early Bronze Age.	Early Bronze Age	153662 114505
A11	**Core Sampling at Imperial Gateway** Specialist environmental archaeological assessment by ArchaeoScape in 2008. Boreholing was undertaken and data from previous boreholes included. Analysis of samples indicated that the site was a semi-terrestrial fen carr woodland and semi-aquatic reed or sedge swamp during the Middle Holocene.	Late Mesolithic – Early Bronze Age	154580 130931
A12	**Watching Brief at Fisher's Way** Watching brief by Museum of London Archaeology Service in 1995. No datable features or finds were recovered.	None	154796
A13	**Trial Trench and Watching Brief at East Thamesmead Business Park** Trial trench evaluation by Oxford Archaeology in 2003. No archaeological deposits were uncovered. Oxford Archaeology conducted a watching brief here in 2005. No archaeological finds or features were recorded. Oxford Archaeology conducted another trial trench evaluation here in 2006. Two levels of peat were recorded. One deposit contained a number of Roman finds, although it is not known if they were in-situ. The peat deposits were radio-carbon dated to the Late Mesolithic	Late Mesolithic – Bronze Age Roman Post-medieval	155628 164867 165900 135476 108224

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
	to Bronze Age. A ditch was encountered, likely to be associated with the post-medieval draining and division of Erith Marsh.		
A14	**Auger Survey at former Murex site, Ferry Lane** Geoarchaeological evaluation by the Museum of London Archaeology Service in 2005. A possible land surface was identified of a Mesolithic date, along with a Bronze Age woodland and Iron Age meadow land.	(Likely) Mesolithic Bronze Age Iron Age	156056 108098
A15	**Trial Trench and Timber Sampling at Eastern Way** Trial trench evaluation by Pre-Construct Archaeology in 2007. A remnant of a preserved prehistoric forest was revealed which may date to the Late Mesolithic. This represents the earliest known colonisation of yew woodland on the southern bank of the Thames during the Late Holocene. One of the peat layers contained a Mesolithic bone awl. Drive timber posts found here were assessed in 2010. They were in good condition and had been squared off and tapered at the base to a sharp point. Their profile suggests a post-medieval date. The tow of posts likely extends beyond the limits of the pit.	Late Mesolithic Post-medieval	156640 124456 166321 130184
A16	**Watching Brief at Bronze Age Way** Watching brief in 1995-96. Within the deep peat deposits, worked wood and a section of a hurdle-built trackway were revealed. These were confirmed as Bronze Age in date. Systematic sampling of sand below the peat identified extensive Late Mesolithic flint industry, suggesting the manufacture of tranchet axes. Carbon dating of fragments of pottery indicate a Neolithic date. The investigations also recorded caves, possibly used as air raid shelters in the Second World War.	Late Mesolithic Neolithic Bronze Age (Likely) Modern	156673

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A17	**Evaluation at Silvertown West Radiocarbon Dating** Evaluation undertaken in 1996. Involved analysis of organic material. Dark grey/brown organic mud encountered with wood and plant fragments within grey sands and gravels of the Shepperton Terrace. Radiocarbon date of 10,310 before present.	Mesolithic	157743
A18	**Borehole Survey at Royal Victoria Dock** Borehole survey in 1996. Fluvial gravels were overlaid by Neolithic to Iron Age peat. Above ephemeral peat of the medieval period was upcast from the dock excavations of the 1850s.	Neolithic Iron Age Medieval Post-medieval	158274
A19	**Watching Brief at former Football Ground** Watching brief by Museum of London Archaeology Service in 2001. Two undated linear features were recorded which may be drainage ditches or natural water channels. A probable Bronze Age peat deposit was uncovered and a number of woody inclusions were also present within the deposit.	Unknown (Likely) Bronze Age	158889 112734 142275
A20	**Watching Brief at Norman Park** Watching brief by Museum of London Archaeology Service in 1997. A Mesolithic or Early Neolithic broken crested blade made of flint was recovered from the lower sand in one of the test pits. The location and depth of the site was considered to be too low lying for human exploitation in the prehistoric period, so the blade is not considered to be an indicator of any activity.	Mesolithic / Early Neolithic	159602 102736 108850
A21	**Surveys at Church Manorway and Green Level Pumping Station**	(Likely) Neolithic Bronze Age	160042 163584 120813

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
	A logboat thought to date to the Bronze Age was found here in 1885 during ditch digging through peat. A polished flint axehead and scraper were found inside the boat. These are possibly of Neolithic date, although they may be forgeries. Geoarchaeological evaluation, a borehole survey and a watching brief by the Museum of London Archaeology Service between 2007 and 2010. The basal deposits across the site consisted of the Late Pleistocene floodplain gravels, overlain by Early Holocene fluvial sands. These areas would have been favourable to Early Mesolithic hunter-gatherers. Large timbers were recorded suggesting a timber structure forming part of a possible Early Neolithic trackway. A peat deposit dating from the Bronze Age was also found. Geophysical survey, borehole survey, ground penetrating radar survey, geotechnical test pits and core sampling by Fugro Engineering Services in 2008. An environmental archaeological assessment was undertaken by Quest here in 2012 and six boreholes were sunk.		161322 161732 161986 107656 143658 168791 149413 147071 148482 206874
A22	**Geomorphological Survey at Veridion Park** Geoarchaeological deposit modelling by Quaternary Scientific in 2012/13. The model identified a sequence of natural gravel overlain by two layers of peat separated and sealed by alluvial deposits.	None	160294
A23	**Watching Brief at Beam Reach** Watching brief by the Museum of London Archaeology Service between 2006 and 2007. No archaeological features or deposits were recorded.	None	161588

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A24	**Borehole Survey at Alchemy Park** Geoarchaeological investigations by QUEST between 2016 and 2018. A deep west-east orientated palaeochannel was revealed. Peat was dated from the Late Mesolithic to the Bronze Age.	Late Mesolithic – Bronze Age	162064 163789
A25	**Trial Trench at Crabtree Manorway South** Trial trench evaluation by the Museum of London Archaeological Services in 2005. No archaeological features or finds of note were discovered. Peat deposits dating from the Mesolithic to the Bronze Age were recorded.	Mesolithic – Bronze Age	162545 96924
A26	**Watching Brief at Eastern Way/Picardy Manorway/Anderson Way** Watching brief by Compass Archaeology in 2001-02. Groundworks monitored for a distance of 1.25km. Evidence for yew colonisation was encountered, which may have spread to the peatland from the Early Bronze Age.	(Likely) Bronze Age	162868 140215
A27	**Heritage Activity at Biossence (East London) Limited** Borehole survey by the Museum of London Archaeology in 2013. The boreholes provided a record of the landscape change from the Mesolithic through to the medieval period.	Mesolithic	163332
A28	**Field Observation (Monitoring) at Rainham Marsh Local Nature Reserve** Archaeological monitoring of groundworks by Essex County Council in 2010. No archaeological remains were observed within the deposits.	None	163496
A29	**Borehole Survey and Geoarchaeological Assessment at Marston's Brewery** Borehole survey and geoarchaeological assessment by Wessex Archaeology in 2014. No archaeological remains or artefacts were recovered from the core samples, but the sequences have good potential to inform our knowledge of the landscape in prehistory.	None	164152

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A30	**Evaluation at 85 Ferry Lane** Evaluation in 1991. Piling of foundations by continuous auguring identified no archaeological features. Extensive peat deposits were sampled.	None	166819
A31	**Watching Brief at Poppy Close** Watching brief by Pre-Construct Archaeology in 2001. No archaeological features were exposed and the deposits were largely sterile.	None	166984
A32	**Pollen Assessment at Crossness Sewage Works** Pollen assessment carried out by the Archaeological Palynology Unit on samples from boreholes in 1994. The results approximately date the base of the boreholes to post-6,500 BC. The upper units of the boreholes are likely post-500 BC.	Prehistoric	167298
A33	**Borehole Survey at Stolthaven Dagenham Limited** Geotechnical investigations by the Museum of London Archaeology in 2014.	None	167523
A34	**Borehole Survey at Crabtree Manorway North and Bronze Age Way** Window sampling by Wardell Armstrong in 2017. A deposit model was also created. The geoarchaeological and palaeoenvironmental potential of the deposits was found to be limited.	None	167586
A35	**Watching Brief at Thames Water Sewage Treatment Works** Watching brief by Pre-Construct Archaeology in 1997. The site did not show any significant archaeological deposits and only one possible feature was visible. This was a backfilled ditch of unknown date.	Unknown	167754 136217

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A36	**Heritage Activity at Belvedere Road** Monitoring and deposit modelling of geotechnical work by the Museum of London Archaeology in 2016. The report found the sediments on the site to represent intertidal creeks of the late prehistoric/historic period which have scoured away deposits from earlier periods. The boreholes contained neither natural deposits of high palaeoenvironmental value, nor artefactual remains.	None	168606
A37	**Assessment at Rainham Road South** Historical overview of the surviving physical evidence of the unfinished Victorian Romford Canal by Oxford Archaeological Unit in 2001. The on site assessment found that only very limited evidence of the former canal survived, and apparently none of the structures previously referred to were still in existence.	Post-medieval	168692 210681
A38	**Borehole Survey at Bronze Age Way and Anderson Way** Geoarchaeological evaluation and palaeoenvironmental assessment by Dalcour Maclaren in 2020.	None	169709
A39	**Watching Brief at Merchant Waste Treatment Plant** Watching brief by Pre-Construct Archaeology in 2011. The alluvial deposits were overlain by approximately 3m of modern made ground. The peat deposits were thought to date back into the post-glacial prehistoric period.	Prehistoric	169757
A40	**Deposit Modelling at Picardy Manorway and Bronze Age Way** Archaeological and palaeoenvironmental deposit modelling by Wardell Armstrong in 2017.	None	170519

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A41	**Barlow Way South Rainham Geoarchaeological Fieldwork and Deposit Modelling Report** Geoarchaeological fieldwork and deposit modelling by Touchstone Archaeology in 2022. The results of the investigation reveal a sequence of Holocene alluvium and peat overlain by a substantial thickness (ca. 8-12m) of made ground consequent of artificial ground raising.	None	212028
A42	**14 Lower Park Road (Victorian Semi Detached House)** Locally listed building. Unusual semi-detached 'back to back' two storey with attic residential property in yellow brick with red dressings. Mid-19th century in date.	Post-medieval	96077
A43	**85 Ferry Lane (Buried Land Surface of Uncertain Date)** Extensive peat deposits of unknown date were sampled.	Unknown	100081
A44	**Murex Works Rainham (Roman Findspot)** Unspecified works near here in 1961 revealed fragments of Roman pottery, including fragments of mortaria, cooking pot sherds, the screw neck of a flagon and the decorated rim of a buff vessel. All finds were dated to the 1st century AD. Based on these finds and the Roman building material reused in the construction of the nearby church of St Helen and St Giles, a Roman settlement may be sited at Rainham ferry. It may have been a causeway and quay in this period.	Roman	102325 111068
A45	**23 Picardy Road (Victorian Semi Detached House)** Locally listed building. Mid-19th century 'back to back' house of two storeys in yellow brick with unusual mix of windows to symmetrical facade.	Post-medieval	103365

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A46	**Crossness Sewage Treatment Works (Early 20th Century Police Box)** Locally listed buildings. Four early concrete 'police' style boxes at Crossness Sewage Works. Use and date of construction unknown.	Modern	104049
A47	**Manor Way (Second World War Anti Aircraft Gun Post)** Site of Second World War Light Anti-Aircraft guns, positioned to defend Vulnerable Point no. 116, the Murex works at Rainham.	Modern	104336
A48	**Ferry Lane (Late Medieval Ferry Crossing)** Stop for Long Ferry in around 1279/1850s. Mentioned by name in 1531. Ferry from Erith to Rainham in 1890s.	Medieval	104823
A49	**8 Halt Road (Victorian Semi Detached House)** Locally listed building. One of a pair of semi-detached houses constructed circa 1860. It is built from yellow and red brick, with stucco and a gabled concrete tile roof.	Post-medieval	110818
A50	**Crossness Sewage Treatment Works (Victorian Pump House)** Locally listed building. Storm water pumping house at Crossness Sewage Treatment Works. Built probably in the early 20th Century in a similar style to earlier neighbouring buildings.	Modern	110885
A51	**Belvedere Power Station (Findspot & Findspot of Uncertain Date)** Antler fragments, mollusc shells, fossil, nuts and wood fragments including silver birch.	(Likely) Prehistoric	115038
A52	**St Augustine's School (Victorian School)** Locally listed building. St Augustine's School, Belvedere was built in the 1890's and appears to have initially been a boys school.	Post-medieval	116411

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A53	**Eleanor Villas, 17-18 Lower Park Road, Belvedere, Bexley (Victorian Semi Detached House)** Locally listed buildings. A pair of semi-detached houses known as Eleanor Villas that were built in the 1870s.	Post-medieval	116575 116989
A54	**Rainham Marshes (Early 20th Century Firing Range)** 20th century rifle range built on park of Rainham Marsh. Shown in use on the 1915 and 1951 Ordnance Survey Maps. Date of construction and closure not known but sometime between 1910 and 1967.	Modern	117265
A55	**Manor Way (Post Medieval Waste Disposal Site)** Site of landfill taken from British Geological Survey data supplied to the Environment Agency. It is not known whether this site was made or worked land, and the date of infill is unknown, although all are of 19th / 20th century date.	Post-medieval / modern	120128
A56	**Methodist Chapel (Victorian Methodist Chapel)** Locally listed building. The Methodist Chapel at 12 Picardy Road, Belvedere was constructed in 1876 by Habershon & Pite.	Post-medieval	120265
A57	**The Chequers (Georgian Public House)** The Chequers Public House at 51 Picardy Road, Belvedere was built in the mid-19th century.	Post-medieval	121902
A58	**Ferry Lane (Post Medieval Waste Disposal Site)** Site of Salamons Way Industrial Area landfill site taken from British Geological Survey data supplied to the Environment Agency. It is not known whether this site was made or worked land. The date of infill is unknown, although all are of 19th / 20th century date.	Post-medieval	121999

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A59	**Sweetloves Bay Rainham (Post Medieval Well)** Artesian well found in a clump of trees near the beam river.	Post-medieval	122196
A60	**7 Halt Road (Victorian Semi Detached House)** Locally listed building. One of a pair of semi-detached houses built in the 1860s. It is constructed from yellow and red brick with stucco and a gabled concrete tile roof.	Post-medieval	132549
A61	**The Belvedere (Victorian Public House)** Locally listed building. Public house built circa 1860. It has three storeys with walls of yellow brick, a rendered and rusticated ground floor and rendered details, and a hipped slate roof.	Post-medieval	133225
A62	**Franks Park (Early 20th Century Public Park)** 20th Century public park, created after 1920, on the former woodland grounds of Belvedere Park estate. It is named after Frank Beadle, a local philanthropist, who donated money for its purchase by Erith Council.	Modern	133347
A63	**Crossness Sewage Treatment Works (Victorian Boiler House)** Locally listed building. Single storey former engine house and boiler house complex built in 1891. Built of yellow stocks with red brick detailing.	Post-medieval	134449
A64	**Hornchurch Marshes (Post Medieval Waste Disposal Site)** Site of landfill taken from British Geological Survey data supplied to the Environment Agency. It is not known whether this site was made or worked land, and the date of infill is unknown, although all are of 19th / 20th century date.	Post-medieval	136393
A65	**Belvedere (Medieval Findspot)** 14th century dagger found during the construction of a property.	Medieval	137244

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A66	**Mitchell Close (Georgian Lamp Post)** Locally listed structures. Four 19th century cast iron lamp columns are located on Mitchells Close, Belvedere.	Post-medieval	138509
A67	**15 Lower Park Road (Georgian Semi Detached House)** Locally listed building. Unusual semi-detached 'back to back' two storey with attic residential property in yellow brick with red dressings. Mid-19th century in date.	Post-medieval	138831
A68	**Site of Dagenham Ice House (Post Medieval Icehouse)** The Dagenham Ice House was built to serve the Barking fishery trade. It was presumably demolished in the 1850s or 1860s, after the collapse of the Barking fishery trade.	Post-medieval	138942
A69	**Frog Island (Second World War Anti Aircraft Gun Post)** Site of Light Anti-Aircraft guns, positioned to defend Vulnerable Point no. 116, the Murex works at Rainham.	Modern	139713
A70	**Belvedere Station (Medieval Flood Defences & Embankment)** Oldest of a network of river walls seen by Spurrell in 1885.	Medieval	140382
A71	**Chequers Lane (Post Medieval House & Clubhouse)** Erected in c.1714-20 for John Perry while working on the breach sewers commission meeting place.	Post-medieval	142523
A72	**6 Picardy Road (Victorian Semi-Detached House)** Locally listed building. Unusual mid-19th century semi-detached 'back to back' two storey dwelling in yellow brick with a few red brick courses. Symmetrical frontage features sash windows and oddly-placed gabled dormer.	Post-medieval	142909

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A73	**Ferry Larainham (Tudor Public House)** First mentioned in 1531. By 1769 it had become the French Horn and the Three Crowns in 1772. It was rebuilt in 1834.	Post-medieval	148471
A74	**Site of House (Post Medieval House)** One of two cottages. This one was used as a holiday home by the Fry family between 1824 and 1833.	Post-medieval	150852
A75	**Remains of mooring** UKHO Wreck / Obstruction. Ground tackle remains identified in 1999.	Unknown	57500
A76	**Part of mooring** UKHO Wreck / Obstruction. Part of mooring identified in 2010.	Unknown	79605
A77	**Mooring buoy and ground tackle** UKHO Wreck / Obstruction. Mooring buoy and ground tackle identified in 1998. The buoy has been removed but the ground tackle remains.	Unknown	56983
A78	**Marine obstruction** UKHO Wreck / Obstruction identified in 1978.	Unknown	12937
A79	**Marine obstruction** UKHO Wreck / Obstruction identified in 1978.		12967
A80	**Mooring tackle** UKHO Wreck / Obstruction. Mooring tackle identified in 1998/99. A buoy was also removed from this location.	Unknown	13387 57499

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A81	**Mooring tackle** UKHO Wreck / Obstruction. Mooring tackle identified in 1998. A buoy was also removed from this location.	Unknown	13388
A82	**Ruined jetty** UKHO Wreck / Obstruction. Foul ground around the end of ruined jetty identified in 1999.	Unknown	57501
A83	**Ground tackle** UKHO Wreck / Obstruction. Ground tackle remains here after the removal of a mooring buoy in 1999.	Unknown	57847
A84	**Marine obstruction** UKHO Wreck / Obstruction identified in 1978.	Unknown	12961
A85	**Wreckage** UKHO Wreck / Obstruction. Area of wreckage located by a diver in 1999.	Unknown	57783
A86	**Remains of barges** UKHO Wreck / Obstruction. Remains of at least three barges sticking out of the mud, identified from aerial photography / satellite imagery identified from aerial photographs taken in 1973.	Unknown	12965
A87	**North Kent Railway** The South Eastern Railway Company's North Kent Line was constructed between the North Kent East Junction near London Bridge via Lewisham, Woolwich, Erith and Dartford to Gravesend. It was fully opened in 1849. The company wanted to extend its operation to	Post-medieval	1357891

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
	Dover, but its plans were thwarted in 1855 by the London Chatham and Dover Railway (the Chatham Line), built by the East Kent Railway Company between 1853-8.		
A88	**Dagenham National Cartridge And Box Repair Factory** A First World War National Cartridge and Box Repair Factory was established at Dagenham Dock in 1916 (exact location uncertain). The factory repaired cartridge cases and ammunition boxes under the direct control of the Ministry of Munitions.	Modern	1573416
A89	**Roman finds** Roman pottery, mortar and tiles along with a cinerary urn containing bones were found circa 1865 near the 'southern outfall'.	Roman	408165
A90	**Belvedere Station** A Railway station on the North Kent Railway: the line opened in 1849 but the station is believed to have been added in 1859.	Post-medieval	508177
A91	**Erith Heavy Anti Aircraft Battery** General location of the site of a First World War heavy anti aircraft battery at Erith explosives works which was armed with a 4-inch gun in 1916 and a 3-inch gun in 1917.	Modern	1473931
A92	**English wherry wreck** 1703 wreck of an English wherry which was wrecked in the River Thames following a collision during the Great Storm. An unknown number (likely several hundred) of other wooden sailing vessels of this type were lost in this incident.	Post-medieval	1432276

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
A93	**1709 wreck** 1709 wreck of at least one craft which foundered in the Thames after being "cut to pieces" by the ice in the "late frost" at a time when the Thames was frozen over above Woolwich. Such a vessel is likely to have been a sailing craft, constructed of wood.	Post-medieval	1481701
A94	**Thames maritime wrecks** A number of documented wreck events have been recorded in the Thames, some of which may have occurred in this general location. These include sailing vessels, wherries, cargo vessels, barges, lighters, passenger vessels, paddle steamers, schooners and military training ships which sank between 1654 and 1940.	Post-medieval Modern	1248964 897420 901985 1206465 1248963 1434856 1252886 896291 896227 1458778 1438625 1187545 1327047 1210100 1408364 893716 897568

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
			896804 1206445 1481903 893768 1355418 1438626 898500 893706 1183592 1315344 893757 893736 896290 1368687 1319063 893718 1434859 1368699 1443076 896912 1187292

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
			1329224 893746 896261 1206506 1395610 1434854 893739 896220 1483356 1336174 898487 1254808 1408351 1432277 1434843 1438267 1368540 893714 1443079 893726 1366169

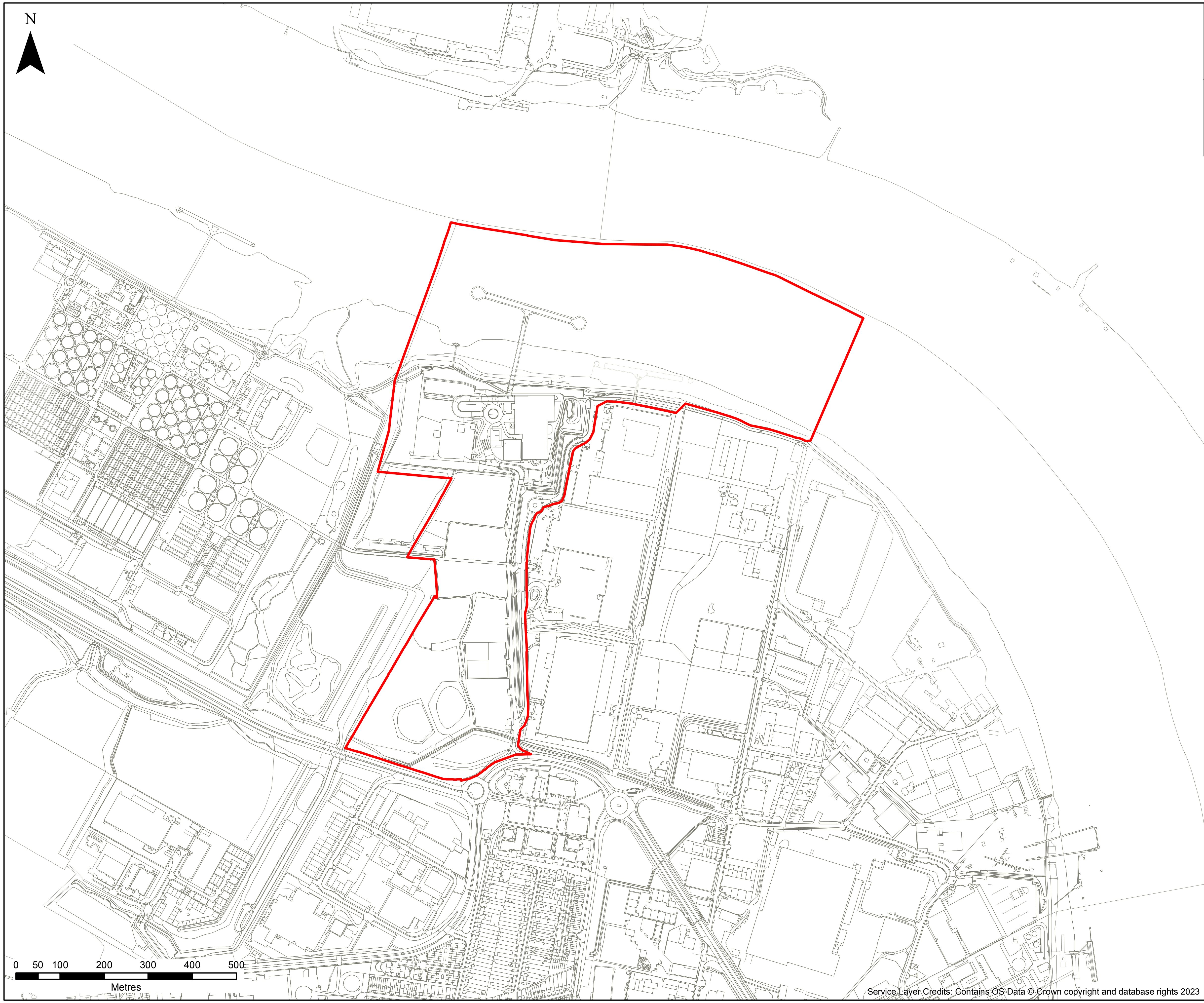
Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
			893772 1434866 1187412 1210107 1206425 893728 1368684 1368539 1443080 1442925 1187453 897555 1210114 1187542 1183614 897418 1344534 1438268 893742 1210046 897486

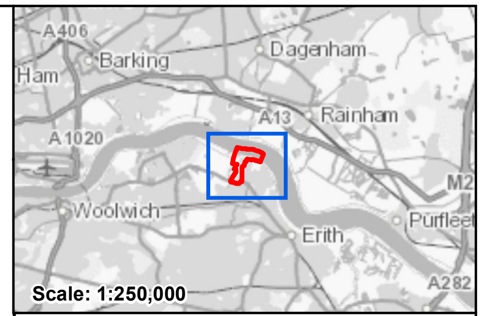
Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
			896805 893756 1206385 893720 1207651
A95	**Thames aircraft crashes** A number of documented aircraft crashes have been recorded in or near to the Thames, some of which may have occurred in this general location. The vast majority, however, were shot down over the Thames Estuary. These include a Vickers Virginia, Supermarine Spitfires, Hawker Hurricanes, a Bristol Blenheim, a Blackburn Roc and a North American Mustang which crashed between 1927 and 1944.	Modern	1329119 1320803 1318828 1323824 1325438 1323448 1324381 1319322 1320067 1323943 1323919 1319084 1323441 1320731 1340673 1328491

Assess. (A) ref.	Description		HER / NHLE / NHRE / UKHO ref.
			1323936 1320807 1322702
A96	**Lesnes Abbey** Scheduled monument which includes Augustinian Abbey of St Thomas the Martyr, now known as Lesnes Abbey, surviving as upstanding stone remains and archaeological remains. It is situated on low-lying ground at the northern edge of Lesnes Abbey Woods.	Medieval	1002025

APPENDIX B

FIGURES





Legend

Site Boundary

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P00	RK	JS	MR	14/09/2023
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DESCRIPTION				

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PROJECT TITLE:

CORY DECARBONISATION PROJECT

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FIGURE 1
SITE LOCATION PLAN

CONFIDENTIALITY: PUBLIC

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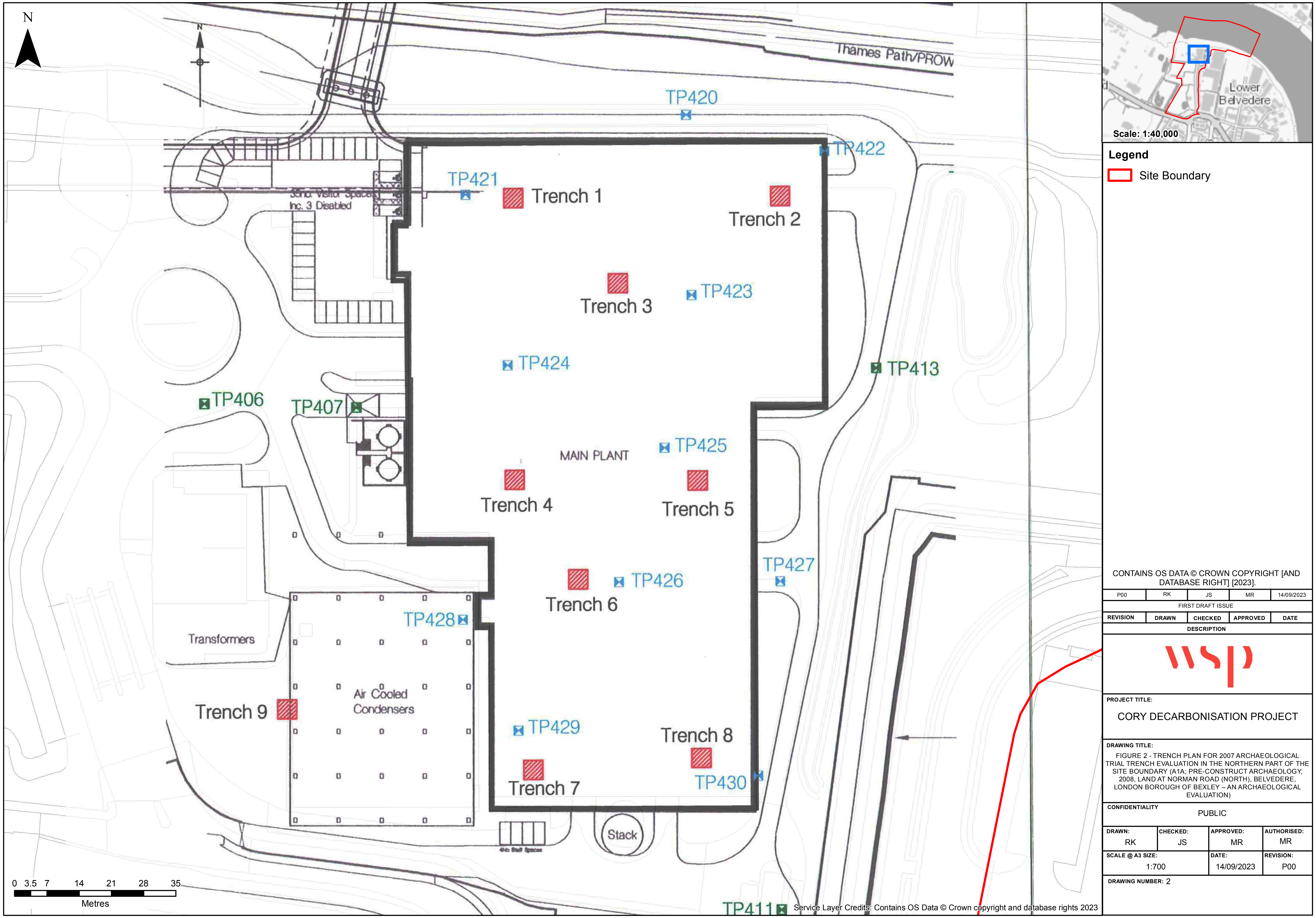
N
Thames Path/PROW
TP420
TP421
Trench 1
TP422
Trench 2
35no. Visitor Spaces
Inc. 3 Disabled
Trench 3
TP423
TP424
TP413
TP406
TP407
MAIN PLANT
TP425
Trench 4
Trench 5
TP427
Trench 6
TP426
TP428
Transformers
Air Cooled
Condensers
Trench 9
TP429
Trench 8
Trench 7
TP430
Stack
TP411
0 3.5 7 14 21 28 35
Metres
Service Layer Credits: Contains OS Data © Crown copyright and database rights 2023
Lower
Belvedere
Scale: 1:40,000
Legend
Site Boundary
CONTAINS OS DATA © CROWN COPYRIGHT [AND DATABASE RIGHT] [2023].
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PROJECT TITLE:
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FIGURE 2 - TRENCH PLAN FOR 2007 ARCHAEOLOGICAL TRIAL TRENCH EVALUATION IN THE NORTHERN PART OF THE SITE BOUNDARY (A1A; PRE-CONSTRUCT ARCHAEOLOGY, 2008, LAND AT NORMAN ROAD (NORTH), BELVEDERE, LONDON BOROUGH OF BEXLEY – AN ARCHAEOLOGICAL EVALUATION)
CONFIDENTIALITY
PUBLIC
DRAWN: RK
CHECKED: JS
APPROVED: MR
AUTHORISED: MR
SCALE @ A3 SIZE: 1:700
DATE: 14/09/2023
REVISION: P00
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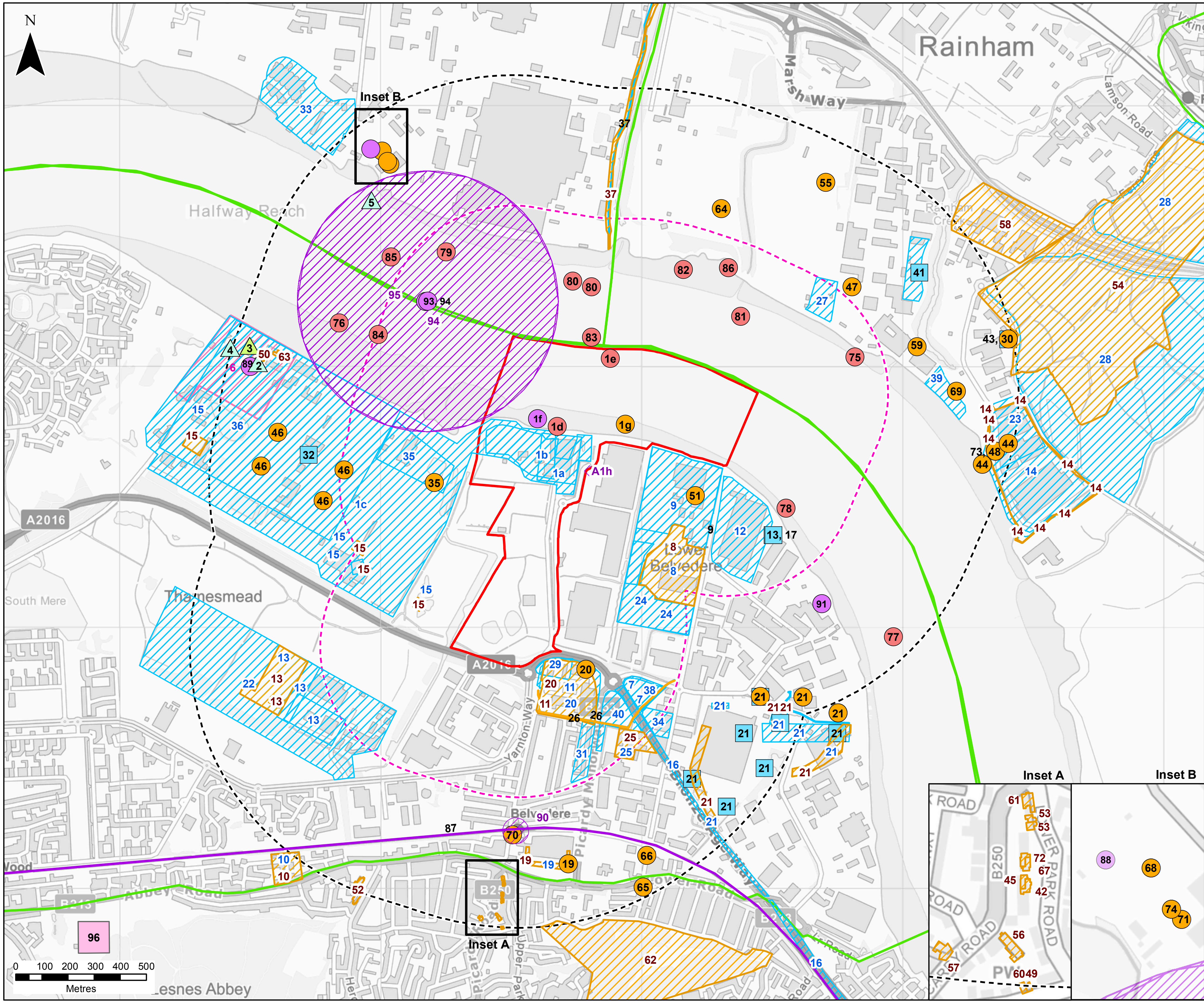

Legend

- Site Boundary
- 500m Study Area
- 1km Study Area
- Scheduled Monument
- Grade I Listed Building
- Grade II Listed Building
- Conservation area
- Heritage at risk
- Archaeological feature/findspot (point)
- Archaeological feature/findspot (line)
- Archaeological feature/findspot (area)
- Previous archaeological investigation (point)
- Previous archaeological investigation (line)
- Previous archaeological investigation (area)
- Archaeological priority area
- United Kingdom Hydrographic Office site (point)
- National Record of Historic Environment site (point)
- National Record of Historic Environment site (line)
- National Record of Historic Environment site (area)

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FIGURE 3
HISTORIC ENVIRONMENT FEATURES MAP

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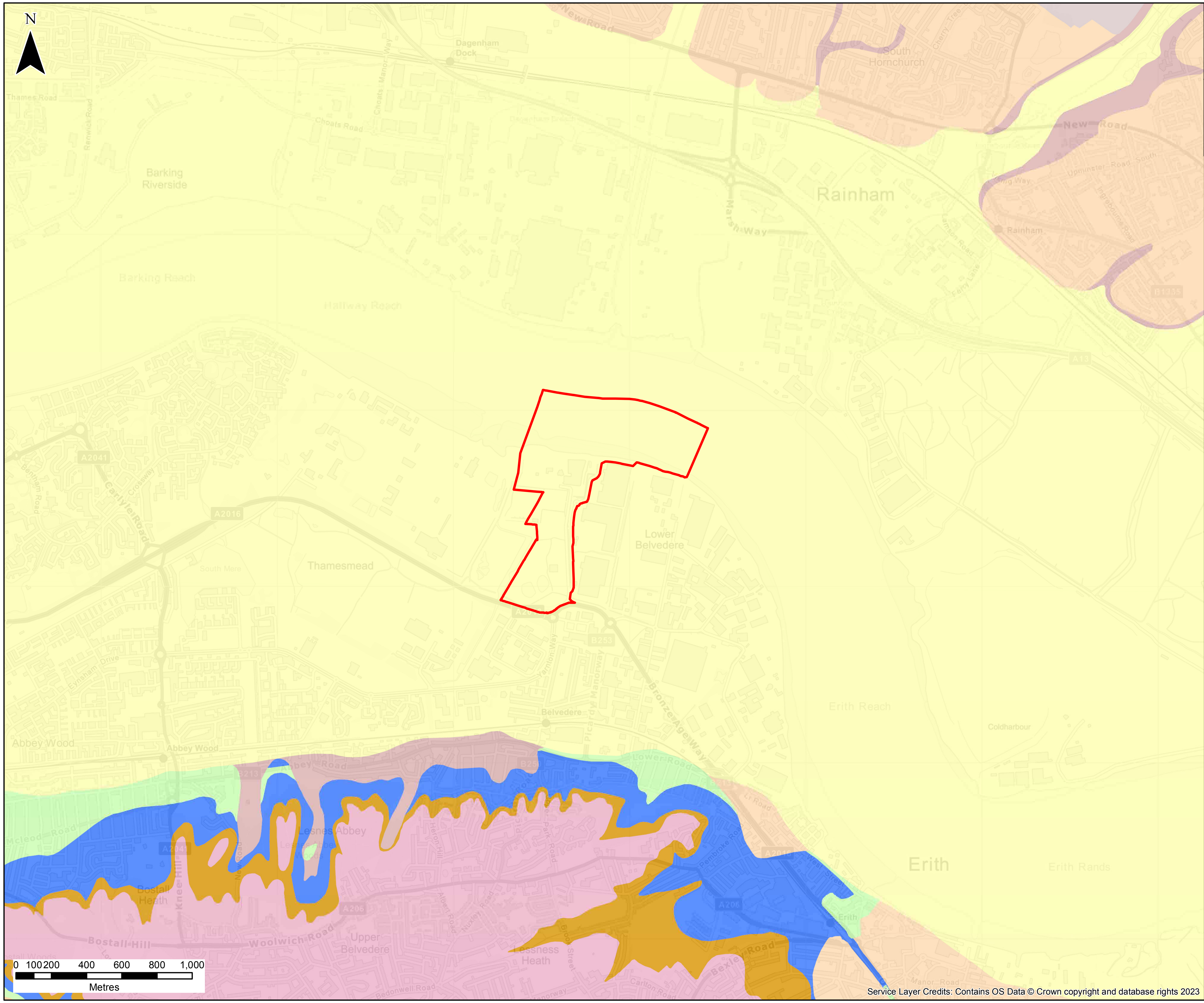

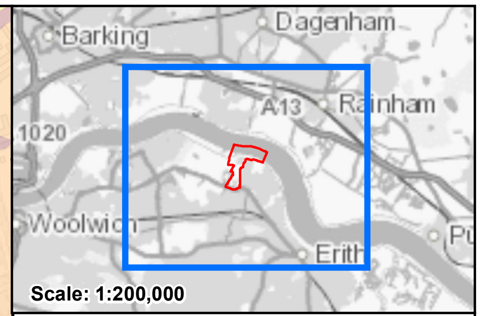

Legend

Site Boundary

Superficial deposits

- Alluvium - Clay, silt, sand and peat
- Taplow Gravel Member - Sand and grave
- Head - Clay, silt, sand and gravel

Bedrock Geology

- Thanet Formation - Sand
- Lambeth Group - Sand, silt and clay
- Harwich Formation - Sand and gravel

Note:
Bedrock geology key is not included, as superficial deposit is completely overlying the bedrock geology

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FIGURE 4
GEOLOGY MAP
(BRITISH GEOLOGICAL SURVEY)

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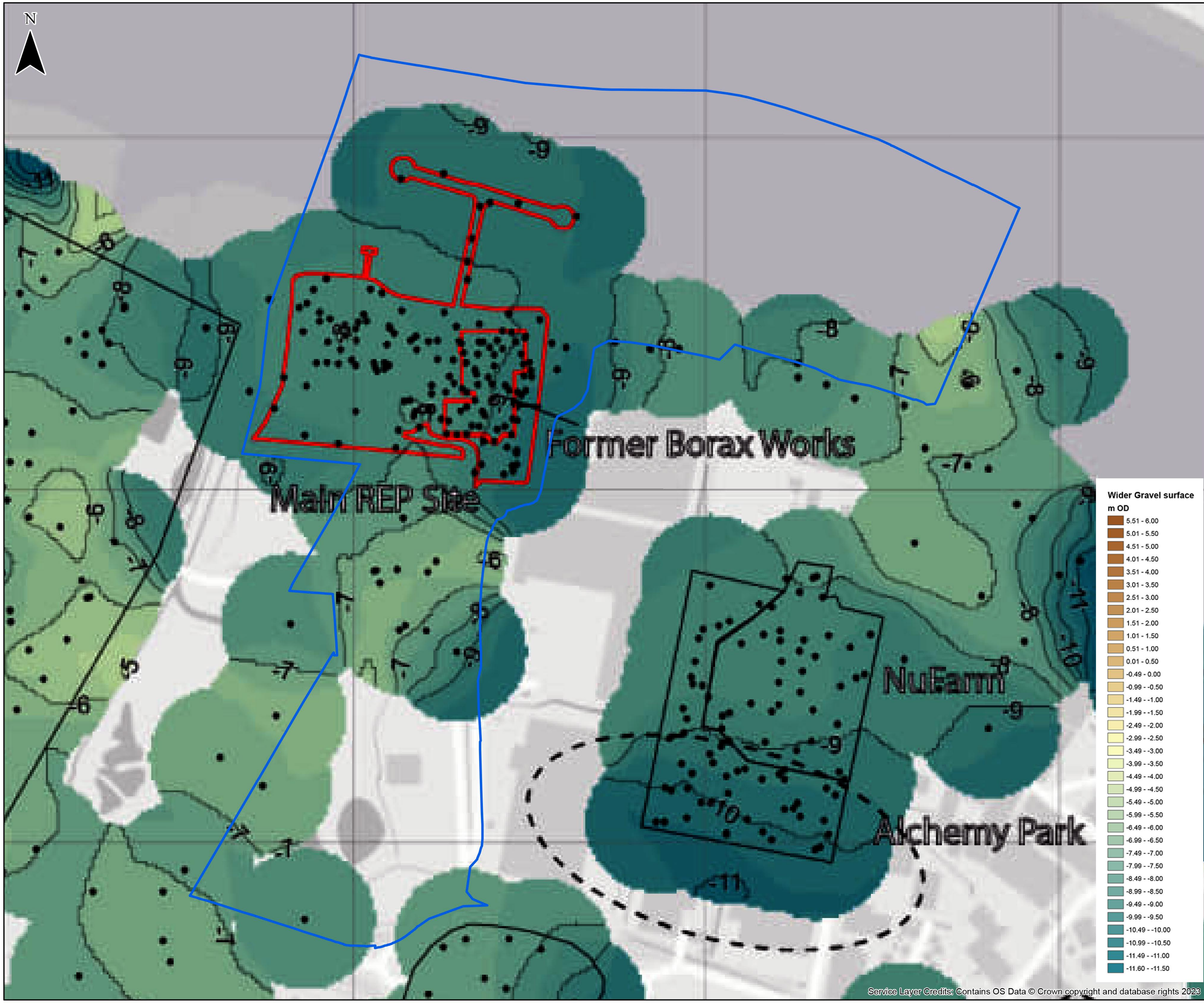

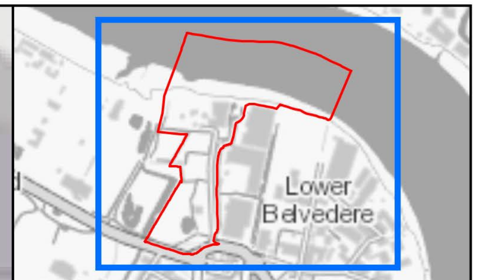

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Legend

- Site Boundary
- Site Boundary from Riverside 2 DCO Application (separate scheme under construction)

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FIGURE 5 - GEOARCHAEOLOGICAL DEPOSIT MODEL – TOP OF THE SHEPPERTON GRAVEL (M OD) (SOURCE: QUEST QUATERNARY SCIENTIFIC (QUEST), 2022, RIVERSIDE ENERGY PARK, LONDON BOROUGH OF BEXLEY – GEOARCHAEOLOGICAL & PALAEOENVIRONMENTAL ANALYSIS REPORT)

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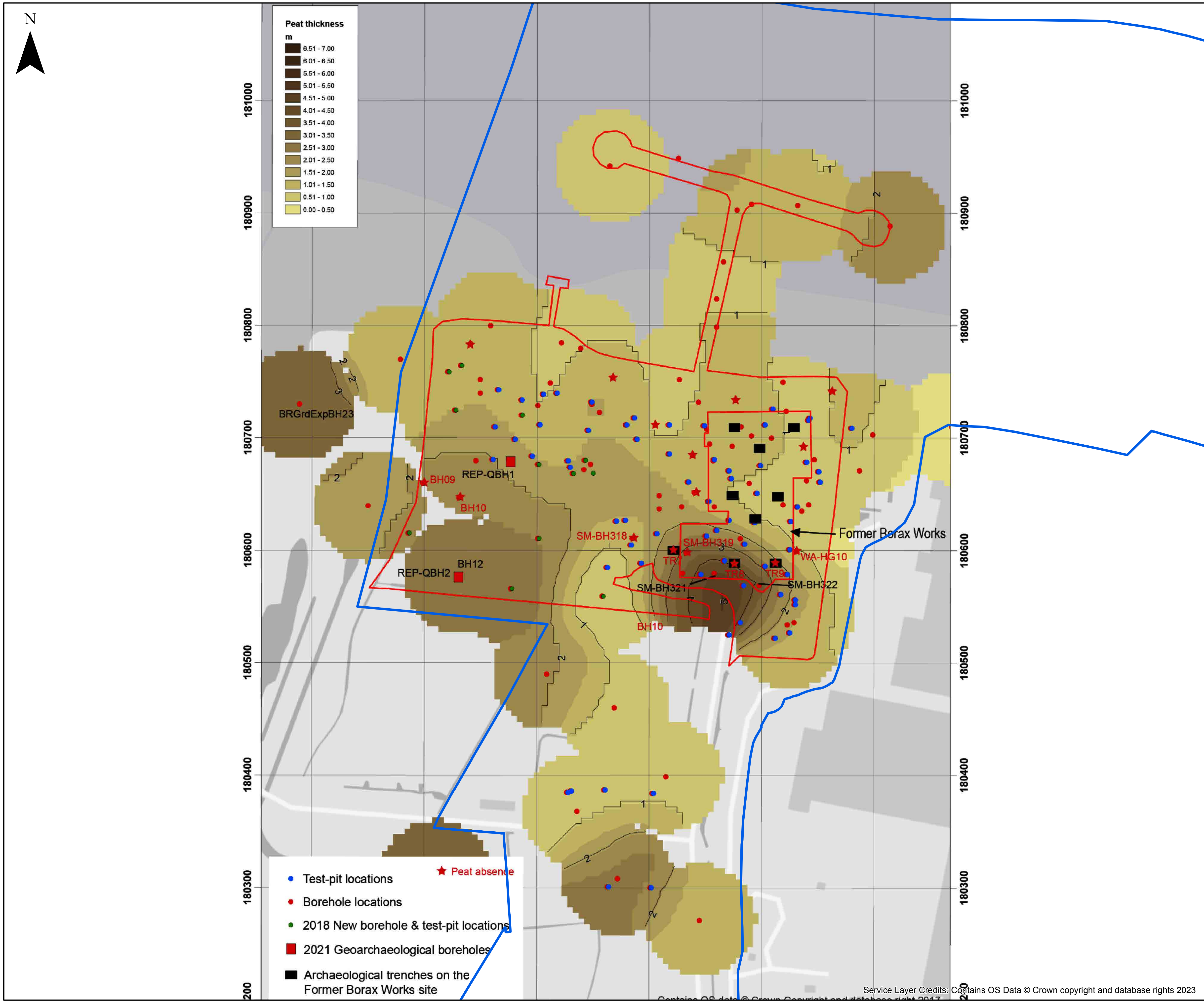

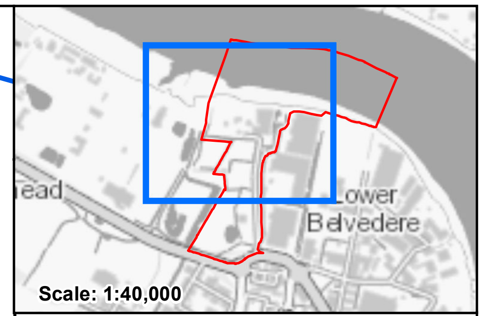

Legend

- Site Boundary
- Site Boundary from Riverside 2 DCO Application (separate scheme under construction)

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FIGURE 6 - GEOARCHAEOLOGICAL DEPOSIT MODEL – THICKNESS OF PEAT (M) (SOURCE: QUEST QUATERNARY SCIENTIFIC (QUEST), 2022, RIVERSIDE ENERGY PARK, LONDON BOROUGH OF BEXLEY – GEOARCHAEOLOGICAL & PALAEOENVIRONMENTAL ANALYSIS REPORT)

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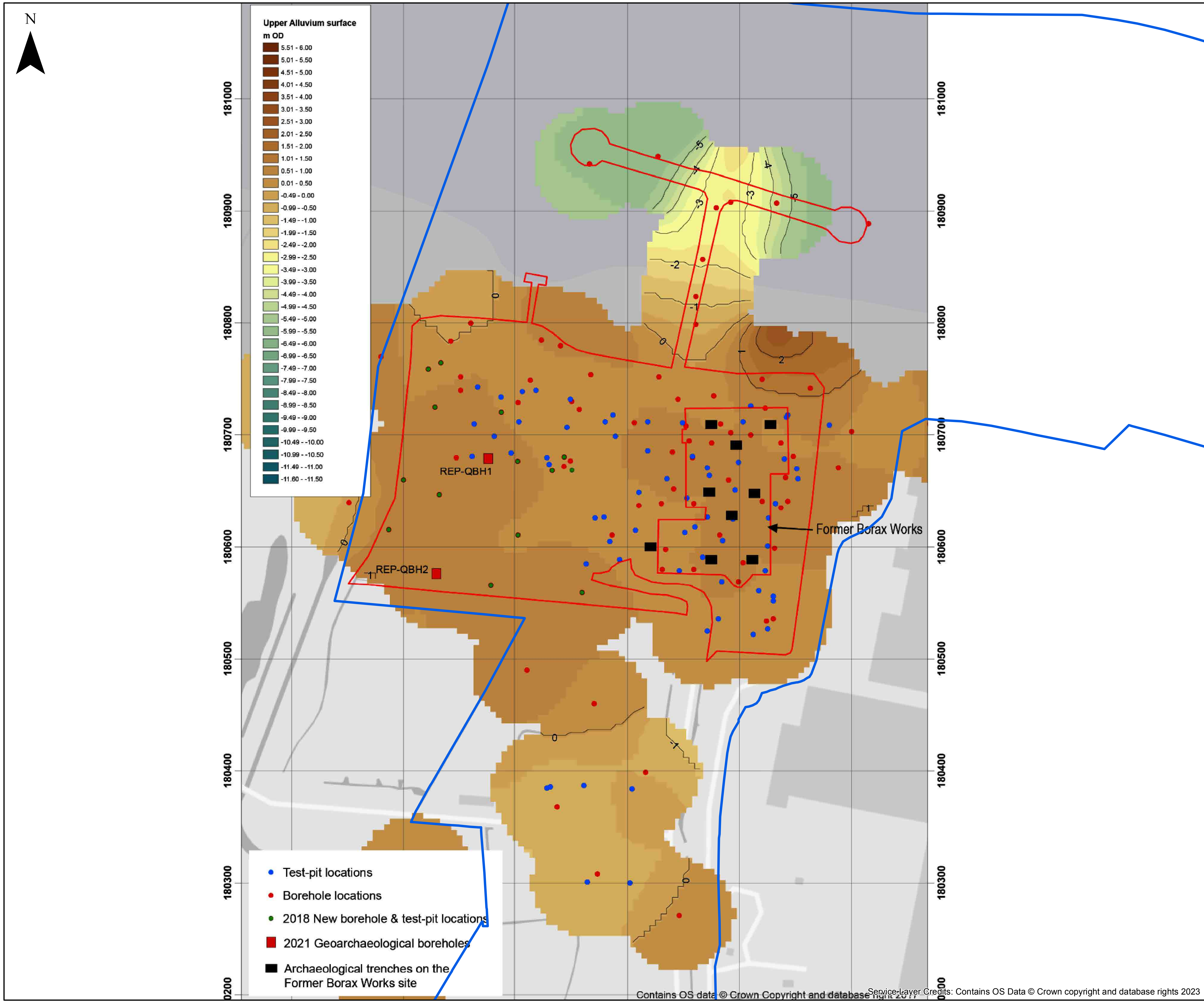

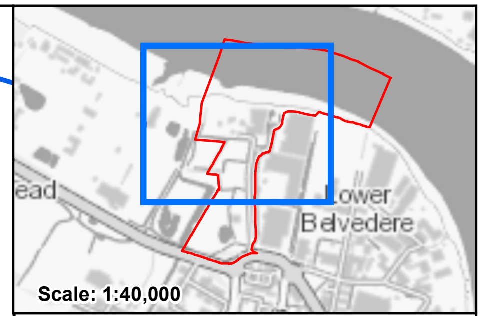

Legend

- Site Boundary
- Site Boundary from Riverside 2 DCO Application (separate scheme under construction)

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FIGURE 7 - GEOARCHAEOLOGICAL DEPOSIT MODEL – TOP OF THE UPPER ALLUVIUM (M OD) (SOURCE: QUEST QUATERNARY SCIENTIFIC (QUEST), 2022, RIVERSIDE ENERGY PARK, LONDON BOROUGH OF BEXLEY – GEOARCHAEOLOGICAL & PALAEOENVIRONMENTAL ANALYSIS REPORT)

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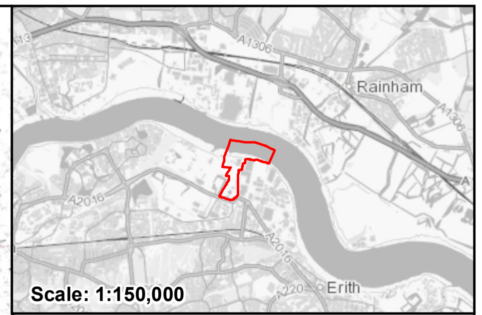

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Approximate Site Location

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FIGURE 8 – THE ANDREWS, DURY AND HERBERT MAP OF KENT, 1769 (© BEXLEY ARCHIVE REF. CSSLS/B/2/2)

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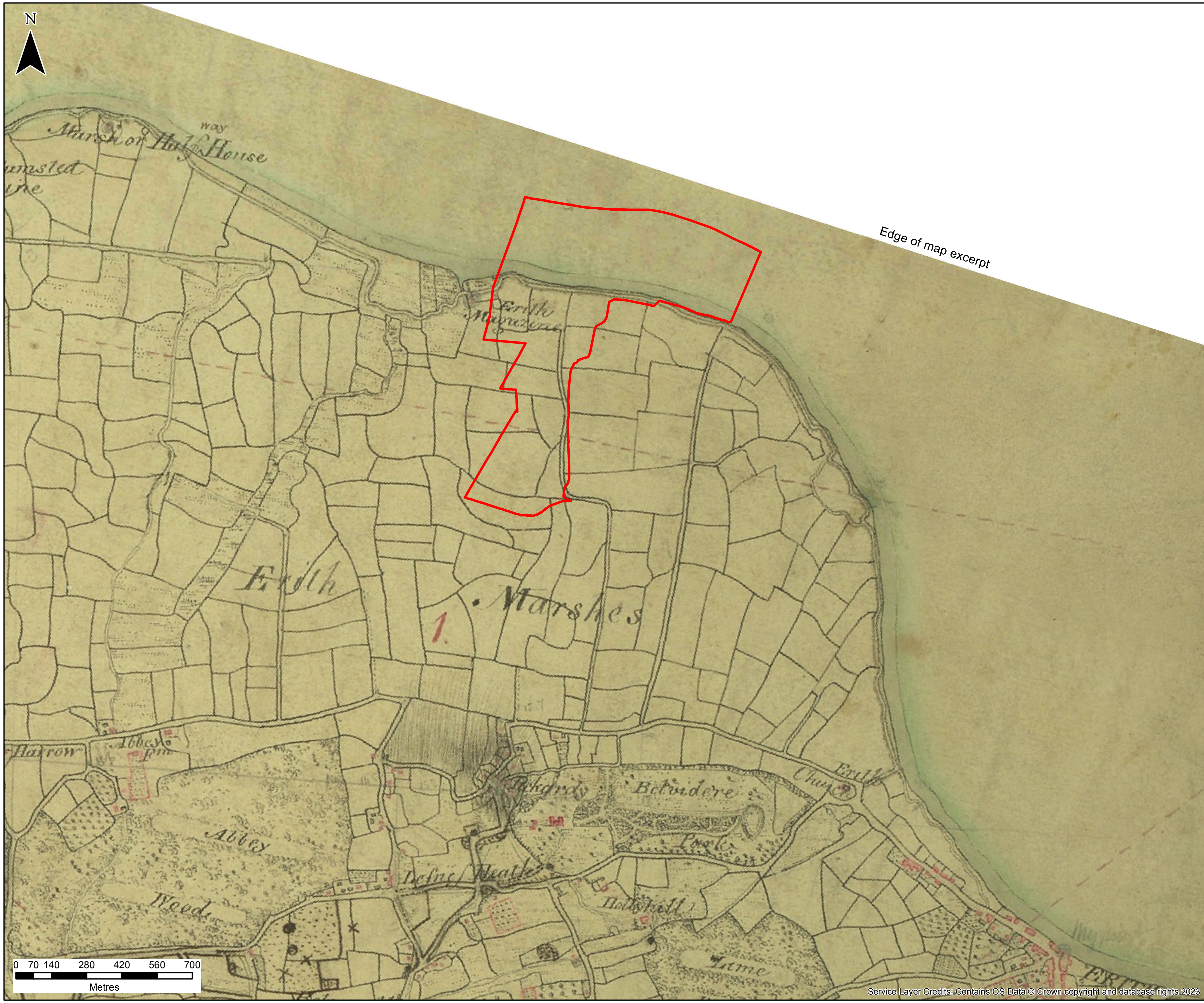

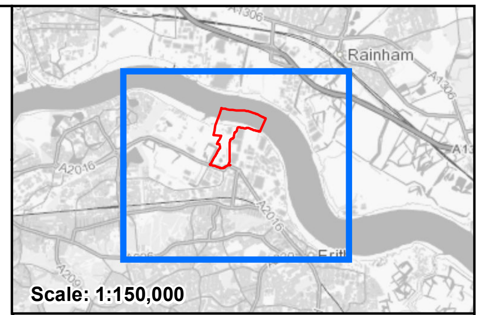

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Site Boundary

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FIGURE 9 – ORDNANCE SURVEY DRAWINGS – WOOLWICH, 1799 (© BRITISH LIBRARY, MAPS OSD 130)

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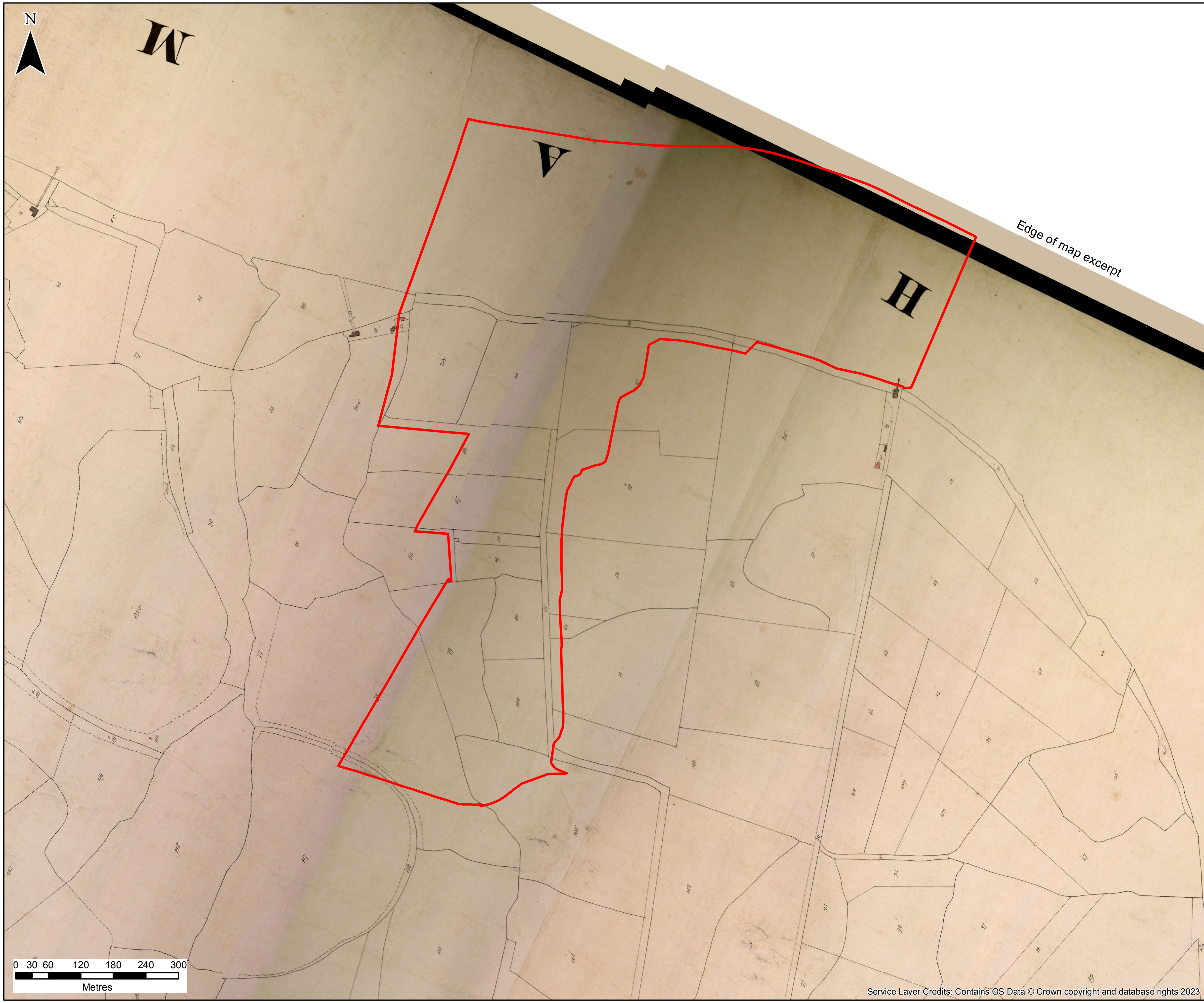

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PROJECT TITLE:

CORY DECARBONISATION PROJECT

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FIGURE 10
ERITH TITHE MAP OF 1843 (BEXLEY ARCHIVE REF. PA137/27/A/1)

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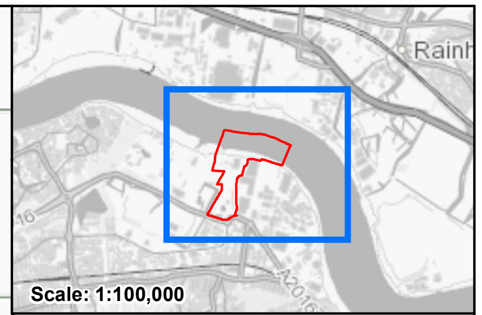

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FIGURE 11
ORDNANCE SURVEY 1ST EDITION 6": MILE MAP OF 1866-69 (NOT TO SCALE)

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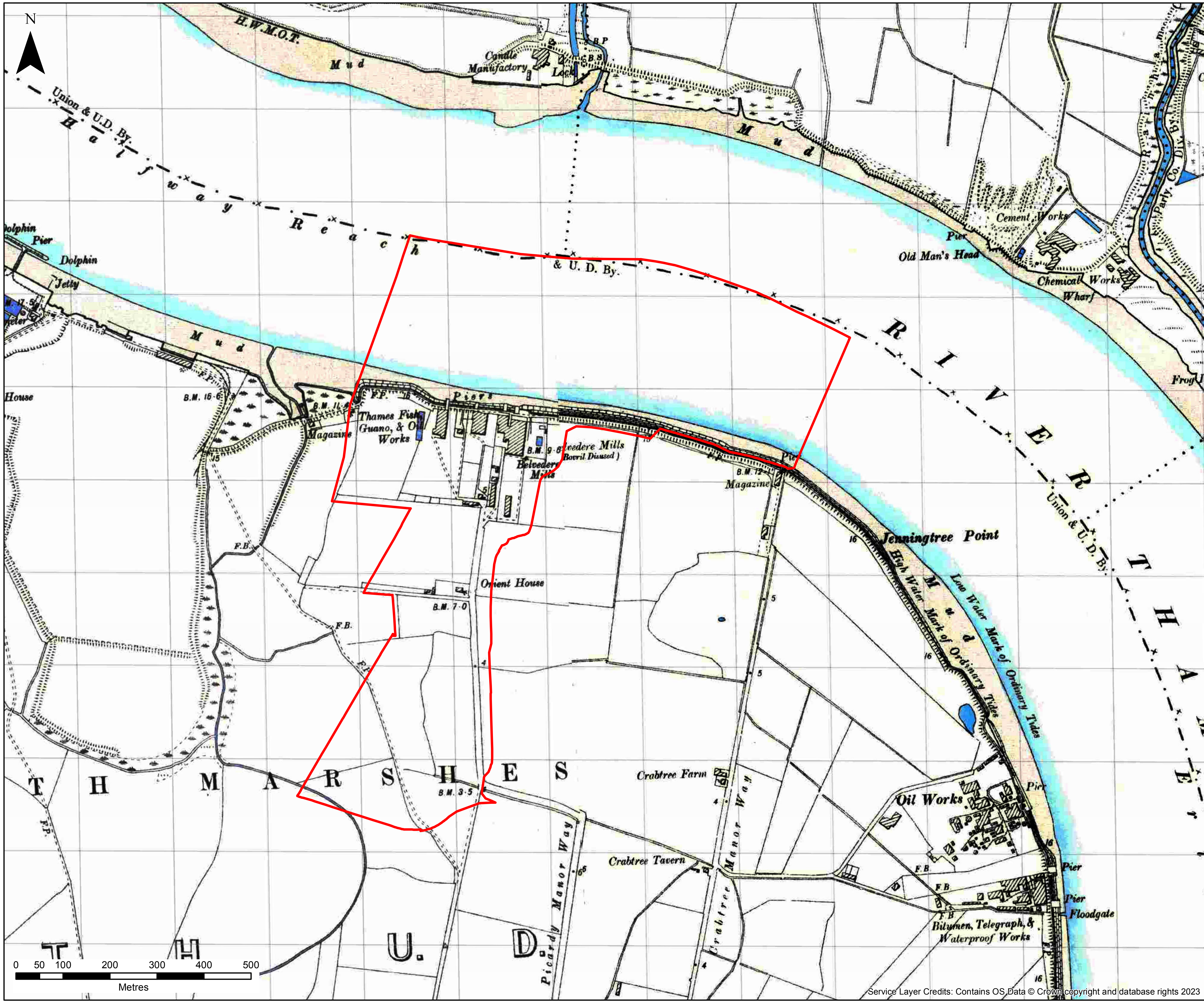

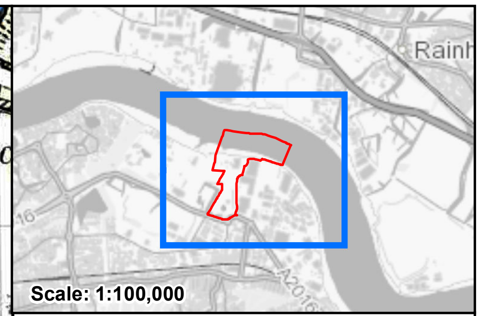

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Site Boundary

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FIGURE 12
ORDNANCE SURVEY 2ND EDITION 6":
MILE MAP OF 1895 (NOT TO SCALE)

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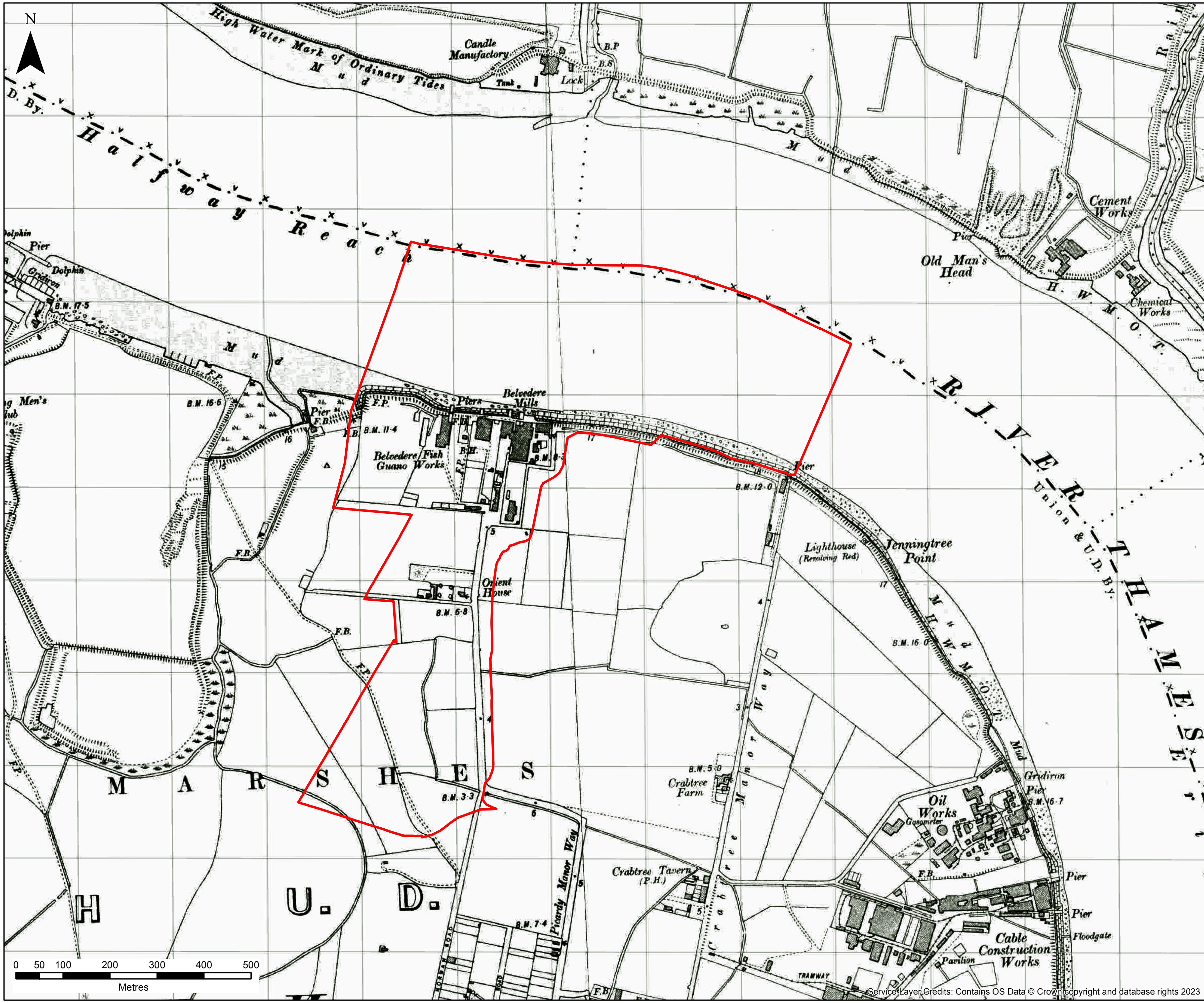

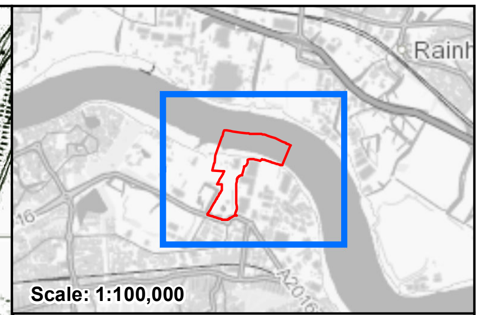

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FIGURE 13
ORDNANCE SURVEY 3RD EDITION 6": MILE MAP OF 1907 (NOT TO SCALE)

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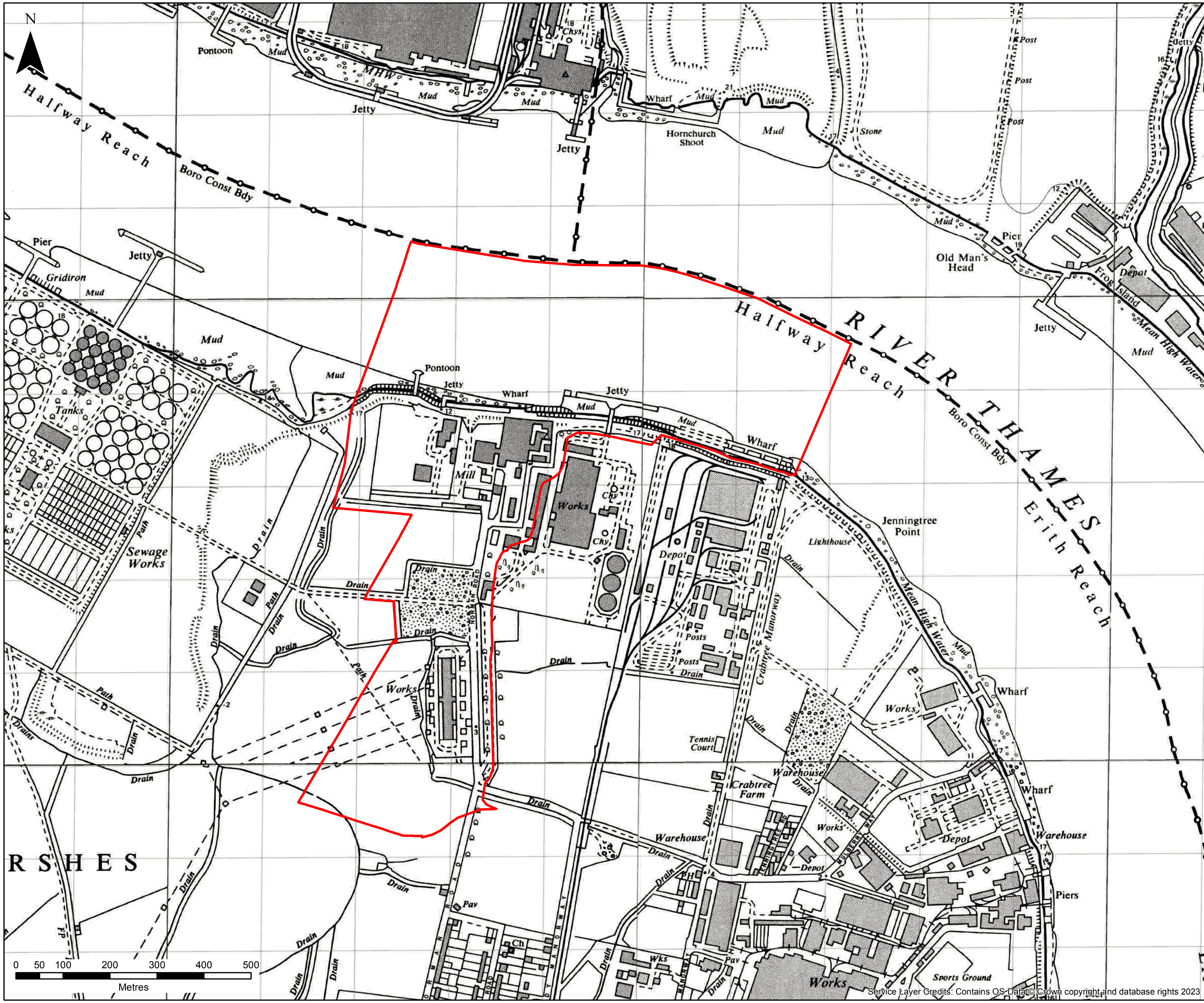

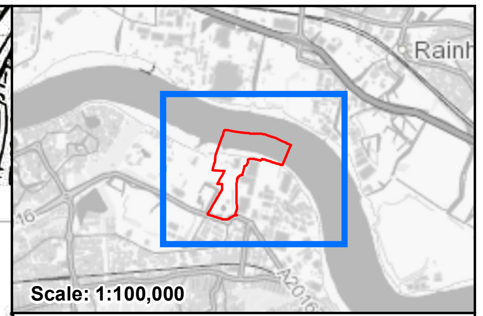

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FIGURE 14
ORDNANCE SURVEY 1: 10,000 SCALE
MAP OF 1966-69 (NOT TO SCALE)

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Figure 15

Figure 16

Figure 15
North-west facing view showing the North Borax Laydown Area within the Site Boundary (WSP 2023)

Figure 16
North-west facing view showing the South Borax Laydown Area within the Site Boundary (WSP 2023)

Figure 17

Figure 18

Figure 17
South-west facing view showing a ditch on the southern boundary of the South Borax Laydown Area within the Site Boundary (WSP 2023)

Figure 18
West facing view from Norman Road showing ground remediation work taking place in the Creekside area within the Site Boundary (WSP 2023)

Figure 19

Figure 20

Figure 19
West facing view from Norman Road showing the Munster Joinery warehouse within the Site Boundary (WSP 2023)

Figure 20
West facing view from Norman Road showing the area of hardstanding to the south of Munster Joinery within the Site Boundary (WSP 2023)