Lower Thames Crossing

6.3 Environmental Statement Appendices Appendix 10.6 – Preliminary Risk Assessment Report

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Lower Thames Crossing

Appendix 10.6 – Preliminary Risk Assessment Report

List of contents

Page number

List of plates

Page number

List of tables

Page number

List of figures

1 Executive summary

1.1.1 This Preliminary Risk Assessment Report summarises potential land quality issues around the proposed A122 Lower Thames Crossing (Project) route, based on available desk-study information.

1.1.2 The purpose of the assessment is to identify potential geo-environmental constraints that may affect, or be affected by, the Project, and allow information gaps to be identified. Information sources were systematically reviewed within the area of the Order Limits and to a 250m buffer zone outside this area. This is referred to as the study area.

1.1.3 The report summarises information on potential contamination sources previously reported elsewhere (Section 3) and presents additional recently obtained information from desk-study sources. Information on historical and current land uses, transport infrastructure, waste management sites and industrial sites is included.

1.1.4 The report sets out the preliminary Conceptual Site Model (CSM) for contamination risks for the Project. Potential contamination sources, pathways and receptors are described in this report and summarised in Annex C (Part 1).

1.1.5 All the desk-based and walkover survey information sources listed in Section 3 were reviewed for land uses, events, sites and features with the potential to cause contamination. A phased approach was undertaken to identify the potential contamination features that may credibly affect or be affected by the construction and operational phases of the Project, i.e. could plausibly form part of a pollutant linkage. Over 200 such features were designated as credible sources of contamination and are described in detail in this report. They comprise historical and permitted landfills, industrial sites such as brick and concrete works, a power station, a former airfield, and railway and road infrastructure, amongst others. In some cases, natural ground conditions – such as generation of ground gas – can also pose a risk; these are discussed in Section 6.

1.1.6 A number of potential receptors have been identified, including human health, controlled waters, drinking water supplies, ecological and built environment receptors. Potential exposure pathways linking these receptors to the sources identified have been outlined in Section 8 and Annex C (Part 1).

1.1.7 Information from ground investigations is used to further refine the conceptual model in the form of Generic Quantitative Risk Assessments and support the development of appropriate engineering solutions to address or mitigate the identified contamination risks within the appropriate legislative regimes.

2 Introduction

2.1 Background

2.1.1 National Highways (the Applicant) has submitted an application under section 37 of the Planning Act 2008 for a Development Consent Order (DCO) for the A122 Lower Thames Crossing (the Project).

2.1.2 This Preliminary Risk Assessment Report presents potential land quality and contamination issues around the proposed Project route. The Project would provide a connection between the A2 and M2 in Kent, east of Gravesend, crossing under the River Thames through two bored tunnels, before joining the M25 south of junction 29.

2.1.3 This report develops a conceptual site model (CSM) that sets out potential pollutant linkages along the Project route. The report identifies where there may be adverse effects arising from existing soil or water contamination on the permanent or temporary works, or adverse effects to human health or the environment.

2.2 Objectives

2.2.1 The purpose of the assessment is to identify potential geo-environmental constraints and related ground abnormals that may affect, or be affected by, the Project. It will also allow information gaps to be identified. The assessment aligns with the tiered approach for risk assessment set out in Land Contamination: Risk Management (LCRM) (Environment Agency, 2021).

2.2.2 The findings of this report are used to assist in the design of required ground investigation works; it forms the basis of the geo-environmental interpretation for Project design and supports other reports in the Development Consent Order (DCO) application, such as the Environmental Statement (Application Documents 6.1 to 6.3). The information in this report will be used by the Contractors to complete further ground investigations prior to construction to inform the detailed design of the Project and where supplementary investigation is required to assess residual contamination risks. The commitment is secured in the Register of Environmental Actions and Commitments (REAC) (Items GS001, GS027 (if required) and GS028).

2.2.3 The report sets out the preliminary CSM for geo-environmental risks for the Project route and assigns preliminary risk ratings (high, medium or low risk) to each potential source of contamination using desk-based information. A secondary stage of review is then undertaken to evaluate the identified sources in the context of the proposed design works. Based upon this secondary review the risk ratings are refined to identify the main sources which could be impacted by or impact upon the Project. Once refined by detailed ground investigation and further risk assessment, including the generic quantitative risk assessment described in Appendix 10.9: Generic Quantitative Risk Assessment (GQRA) Report for the Phase 2 Investigation (Annex A–D), the CSM will be used to feed into the detailed design of the Project route, including structural, drainage and civil engineering design aspects.

2.3 Report scope and structure

2.3.1 The report is based upon the DCO Order Limits. It incorporates a 250m buffer zone outside the Order Limits, referred to herein as the study area.

2.3.2 Potentially contaminative features were identified for each section of the Project route, and potential contaminants of concern (COC) have been identified based on generic assumptions and professional judgment.

2.3.3 For the purposes of this assessment, features within the study area (a buffer zone of 250m around the Order Limits) have been taken into account, as shown on Figure 1.

2.3.4 The 250m buffer is based on professional experience and aligns with the Guidance for the Safe Development of Housing on Land Affected by Contamination Research & Development 66 (National House-Building Council (NHBC) and Environment Agency, 2008), which states that off-site features within an area up to 250m from the site boundary should typically be considered within the hazard identification stage. Features at greater distance should only be described if they are particularly large or have the potential to affect the land quality at the site or the wider environmental quality. On review, no such features were considered to adversely impact the Project.

2.3.5 The structure of the report is as follows.

a. Section 3 outlines the available information used to compile this report and undertake the preliminary qualitative risk assessment.

b. Section 4 describes the structure and development of the CSM and the approach taken to identify credible contaminant sources.

c. Section 5 identifies potentially contaminative land uses and historical activities, and contaminants likely to be associated with them.

d. Section 6 provides an assessment of the potential for ground conditions giving rise to contamination from non-anthropogenic sources, e.g. ground gas.

e. Section 7 identifies sensitive land uses and other receptors that may be affected by contamination along the Project route.

f. Section 8 identifies potentially complete exposure pathways between the potential contaminant sources and receptors in the CSM.

g. Section 9 presents the CSM for the Project route. A preliminary risk rating is given for each potential pollutant linkage.

h. Section 10 summarises the risk of unexploded ordnance (UXO) along the Project route.

i. Section 11 summarises the potential significant risks identified at this stage.

2.4 Site description and route alignment

2.4.1 The A122 Lower Thames Crossing (the Project) would provide a connection between the A2 and M2 in Kent, south-east of Gravesend, crossing under the River Thames through a tunnel, before joining the M25 south of junction 29.

2.4.2 The A122 would be approximately 23km long, 4.25km of which would be in tunnel. On the south side of the River Thames, the Project route would link the tunnel to the A2 and M2. On the north side, it would link to the A13, M25 junction 29 and the M25 south of junction 29. The tunnel entrances would be located to the east of the village of Chalk on the south of the River Thames and to the west of East Tilbury on the north side.

2.4.3 Junctions are proposed at the following locations:

a. New junction with the A2 to the south-east of Gravesend

b. Modified junction with the A13/A1089 in Thurrock

c. New junction with the M25 between junctions 29 and 30

2.4.4 To align with the National Policy Statement for National Networks (NPSNN) policy and to help the Project meet the Scheme Objectives, it is proposed that road user charges would be levied in line with the Dartford Crossing. Vehicles would be charged for using the new tunnel.

2.4.5 The Project route would be three lanes in both directions, except for:

a. link roads

b. stretches of the carriageway through junctions

c. the southbound carriageway from the M25 to the junction with the A13/A1089, which would be two lanes

2.4.6 In common with most A-roads, the A122 would operate with no hard shoulder but would feature a 1m hard strip on either side of the carriageway. It would also feature technology including stopped vehicle and incident detection, lane control, variable speed limits and electronic signage and signalling. The A122 design outside of the tunnel would include emergency areas. The tunnel would include a range of enhanced systems and response measures instead of emergency areas.

2.4.7 The A122 would be classified as an ‘all-purpose trunk road’ with green signs. For safety reasons, walkers, cyclists, horse-riders and slow-moving vehicles would be prohibited from using it.

2.4.8 The Project would include adjustment to a number of local roads. There would also be changes to a number of public rights of way, used by walkers, cyclists and horse riders. Construction of the Project would also require the installation and diversion of a number of utilities, including gas mains, overhead electricity powerlines and underground electricity cables, as well as water supplies and telecommunications assets and associated infrastructure.

2.4.9 The Project has been developed to avoid or minimise significant effects on the environment. Some of the measures adopted include landscaping, noise mitigation, green bridges, floodplain compensation, new areas of ecological habitat and two new parks.

2.4.10 This report considers the following:

a. The 'Order Limits', which refers to the outermost extent of the Project within which works would be carried out.

b. A 250m buffer zone outside this Order Limits, referred to as the study area. An extended area is considered in relation to potential sources of contaminants to river sediment, as detailed in section 5.4.

c. The 'route alignment' refers to the proposed highway and embankment design presented within the DCO application.

2.4.11 The Order Limits, route alignment and study area are presented on Figure 1.

2.5 Nitrogen deposition compensation sites

2.5.1 Changes to traffic flows arising from the operation of the Project have the potential to result in the deposition of nitrogen on nearby habitats, including sites designated for ecological conservation.

2.5.2 Mitigation measures have been identified to reduce the amount of nitrogen emitted from the Project, where necessary and practicable, including the installation of speed enforcement cameras on the M2 between junctions 3 and 4 to encourage motorists to obey existing speed limits.

2.5.3 Where it has not been feasible to identify appropriate mitigation measures to reduce potential significant effects from nitrogen deposition, compensation measures have instead been identified. These compensation measures have been designed to offset significant effects of nitrogen deposition once the Project is operational, by planting new compensatory habitats and enhancing existing ones.

2.5.4 As set out in Section 2.3 of ES Chapter 2 and identified on Figure 2.4: Environmental Masterplan (Application Document 6.2), eight sites have been identified for the provision of compensatory habitat planting for the Project, equating to approximately 240ha in total. These sites are referred to as follows:

a. Bluebell Hill

b. Burham

c. Henhurst Hill

d. Court Wood (Shorne Woods)

e. Fenn Wood (Shorne Woods)

f. Hoford Road

g. Buckingham Hill

h. Hole Farm East

2.5.5 A standalone desk study and preliminary risk assessment has been completed for each of the proposed nitrogen deposition compensation sites. This is presented in Annex D.

3 Sources of information

3.1 Reports relevant to the Project

3.1.1 The following reports are relevant to the land quality/contaminated land aspects of the Project. This report has utilised those listed below in developing the CSM.

Preliminary Sources Study Report (PSSR)

3.1.2 Halcrow Hyder JV (2016) gives an overview of the ground conditions for the shortlisted routes A and C at the options appraisal stage. It describes the engineering parameters for the various geological formations that would be encountered and geotechnical hazards that might have significant impact on route options such as landfills, soft ground and potential ground risks. Information specific to land quality, including aspects of geology, geomorphology, hydrogeology and hydrology is presented in Section 5 and Appendix 4 of the PSSR.

Scoping Report

3.1.3 As part of the Environmental Impact Assessment the scoping report (Highways England, 2017) gives an overview of all environmental topics associated with the Project including land contamination. Details are given in Chapter 10 Geology and Soils. Preliminary identification of potential receptors and pathways is given as well as potential contaminant sources, such as landfills, along the route.

Preliminary Environmental Information Report

3.1.4 Preliminary Environmental Information Report Chapter 11 Geology and Soils presents the preliminary environmental information for the assessment of potential effects on geology and soils related to the construction and operation of the Project. It outlines the sources of information available at the time of writing and describes the understanding of the potential environmental effects of the Project (Highways England, 2018b).

Addendum PSSR

3.1.5 The Secretary of State announced the preferred route for the Project on 12 April 2017. An Addendum to the 2016 PSSR was subsequently prepared (Highways England, 2018c).

3.2 Desk-based information sources

3.2.1 Desk-study information was gathered from several sources. The principal information sources utilised are summarised in Table 3.1.

Table 3.1 Principal information sources

Information source	Description
Historical OS maps	Historical OS mapping from 1862 to 1995 at 1:1,250, 1:2,500, 1:10,560 and 1:10,000 scales was provided as Geographical Information System (GIS) raster data from Groundsure Ltd. Not all years are available as mapping was dependent on when the topographical mapping surveys were carried out. Published dates are given, however, these may not correspond to survey dates. Coverage within a year was not complete for the entire Project and was sparse for some dates. Some areas of the study area were already developed at the time of the earliest historical maps, and therefore potentially contaminative land uses prior to this date may not have been identified.
Environmental datasets	Environmental datasets were obtained as GIS vector data from Landmark in 2019 (Landmark, 2019). Landmark are a provider of digital mapping and site-specific environmental risk information, containing current and historical information. The datasets obtained cover the following topics: • Environmental permitting records • Pollution incident records • Landfill records (historical and authorised sites) • Contemporary trade directory entries • Mineral extraction records • Licensed waste management records • Fuel station entries • Industrial safety registers such as Control of Major Accident Hazards (COMAH) sites (Health and Safety Executive, 2020) The data were compiled by Landmark from various local authority records, statutory undertakers and government agencies. Proprietary datasets titled HLUD (Historical Land Use Data) and HTEF (Historical Tanks and Energy Facilities) were also provided by Landmark. These were created by Landmark in collaboration with Ordnance Survey via a computerised analysis of available historical maps. A complete list of datasets with descriptions and originating organisations is given in Annex B.
Online planning records	Publicly available online planning records were reviewed. Where available, the review focused on those areas identified as being potentially contaminative. Land contamination is a material consideration under the National Planning Policy Framework (Ministry of Housing, Communities and Local Government, 2021), and therefore it is assumed that any contamination issues would be raised during a planning application.

Information source	Description
Historical aerial images	Historical aerial photographs were reviewed from the Historic England Aerial Photo Explorer (Historic England, 2022). The review focused on those areas identified as being potentially contaminative. A historical aerial photo interpretation exercise was carried out by Ebor Geoscience on behalf of the Applicant utilising stereoscopic analysis of archive historical aerial photographs. Geomorphological features, such as slope instability and karst features, areas of excavation and infilling, and industrial areas, were identified from the photos and from supplementary maps and Light Detection and Ranging (LiDAR) data (Lee, Mills and Brunsden, 2018).
Preliminary geomorphological assessment	A preliminary geomorphological assessment was undertaken by CH2M on behalf of the Applicant in February 2018. This comprised a high-level review of desk-based information sources such as historical aerial photographs, LiDAR data and soil/geology/landform maps to identify potential geohazards and adverse ground conditions. These included areas of landfill (CH2M, 2018).
Consultation with local authorities	In response to stakeholder consultation, Thurrock Council, Kent County Council and the London Borough of Havering provided information on landfills and other environmental features within their unitary boundaries. Gravesham Borough Council responded during Statutory Consultation but did not provide any further environmental information.

3.2.2 Several other third-party sources of information have been utilised for this report and information obtained and produced by other Project workstreams (e.g. geotechnical, land and property, stakeholder engagement) is included as appropriate.

3.3 Site walkover surveys

3.3.1 Site walkover surveys were conducted between July 2017 and October 2017, September 2018, August 2020 and May 2022. The objective of these surveys was to gather information on existing site conditions within the study area. It was not the objective of the site walkovers to visit the entire study area, but to focus on areas of potential interest in relation to geology, soils and potentially contaminated land.

3.3.2 Appendix 10.3: Site Walkover Factual Report (Application Document 6.3) provides a full description of the observations including identification of potential contaminative sources recorded during the site walkover surveys, along with photographs. The locations are presented on Figure 10.1 of the Environmental Statement (Application Document 6.2).

3.3.3 Access to conduct the surveys was limited to Public Rights of Way and areas where access had been agreed with third-party landowners. At the request of the landowners, access to and observations of farmland with crops were generally made from the site boundary or existing farm tracks, where feasible.

4 Development of the Conceptual Site Model

4.1 Scope of Conceptual Site Model

4.1.1 A geo-environmental Conceptual Site Model (CSM) is defined as:

'…*a description and/or representation of the site, incorporating what is known about the ground and groundwater conditions; the actual and potential contamination; the physical conditions and environmental setting; the receptors; and potential pathway*[s]… *between contamination sources and receptors*.' (British Standards Institution, 2017).

4.1.2 The aim of the preliminary CSM is to identify potential risks to human health, controlled waters, ecology and the environment arising from the construction and operation of the Project, with regards to current or historical contaminative land uses.

4.1.3 The assessment is based on identification of 'pollutant linkages', i.e. contaminant-pathway-receptor relationships following the approach described in Land Contamination: Risk Management (LCRM) (Environment Agency, 2020).

4.1.4 For a pollutant linkage to be present, three elements must exist in combination:

a. A **source** (of contamination): Normally an anthropogenic feature such as a landfill, industrial site or pollution incident. Existing contamination in soil or water from historical activities can act as a secondary source of contamination.

   A contaminant is a substance in, on or under the land that has the potential to cause harm to a receptor(s). This can be a single chemical or a mixture and associated with one or more physical phases (solid, liquid or gas).

b. A **pathway**: A route for contamination to travel from the source and be brought into contact with a receptor, this includes physical processes such as leaching from soil and migration via groundwater, and exposure mechanisms such as dermal contact, inhalation or ingestion by humans. Pathways are specific to the receptor type.

c. A **receptor**: Relevant receptors may be humans (e.g. future road users, neighbouring residents) or environmental (e.g. aquifers used for public water supplies or surface waters and associated ecosystems). Built structures can also be affected by contaminants (e.g. corrosion to subsurface structures and utilities).

4.1.5 A source of contamination and a pathway to receptors must be present for there to be a pollutant linkage. If one of the above elements is not present, then a pollutant linkage is not present and there is no risk, even if a contaminant is present.

4.1.6 Physical hazards such as slope instability, subsidence (natural and mining induced), soil compressibility and shrink-swell, seismicity and flooding have not been included in the CSM. These hazards have been considered as part of the geotechnical investigation and are addressed within the design through the application of the Design Manual for Roads and Bridges (DMRB) Standard, CD 622 Managing Geotechnical Risk (Highways England 2020a).

4.1.7 Natural 'chemical' hazards, including naturally elevated contaminants in soils and waters, and ground gas from non-anthropogenic sources, have been included in the CSM.

4.2 Approach and assumptions

4.2.1 The CSM for the Project has been developed in accordance with relevant guidance including:

a. Land Contamination: Risk Management (LCRM) (Environment Agency, 2020) (formerly Contaminated Land Report 11: Model Procedures for the Management of Land Contamination (Environment Agency, 2004)

b. BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice (British Standards Institution, 2017)

c. Contaminated Land Risk Assessment: A guide to good practice (C552) (Construction Industry Research and Information Association (CIRIA), 2001)

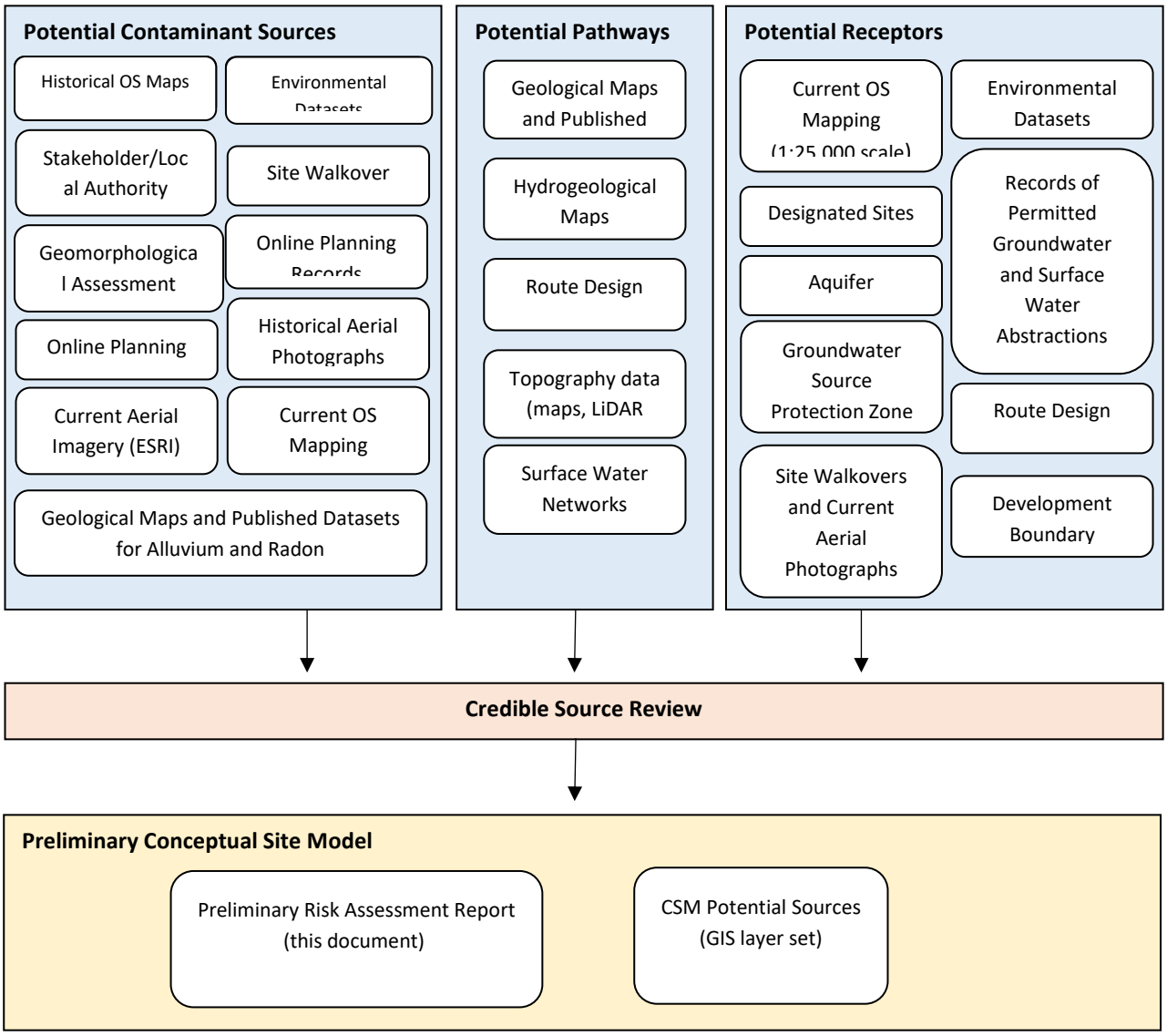
d. Assessing risks posed by hazardous ground gases to buildings (C665) (CIRIA, 2007)

e. BS 8485:2015+A1:2019: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (British Standards Institution, 2019)

f. British Standard Institution (2020). BS EN ISO 21365:2020: Soil quality — Conceptual site models for potentially contaminated sites. London: British Standards Institution.

4.2.2 The principal information sources used and general approach is shown in Plate 4.1.

Plate 4.1 Development of the Conceptual Site Model



4.2.3 Historical mapping was integrated using GIS, and features that were considered relevant to the CSM were digitised. These were grouped into four categories:

a. Category 1, Terrain: mapped pits, quarries and mines, changes in slope symbols or contour lines

b. Category 2, Landfill: mapped slag and spoil heaps, disappearance of ditches, ponds or pits, changes in slope symbols or contour lines, and movement of high-tide limits

c. Category 3, Water: surface water bodies and wells

d. Category 4, Industrial: potentially contaminative anthropogenic land use, including factories and 'works', military land, transport sites, aggregate sites, electrical facilities, etc.

4.2.4 Each feature was given a unique refence (e.g. HLU1234) to aid in identification. Four date fields were used to capture the range of dates for which a feature was shown:

a. ‘Preceding date’: latest available map before a feature is first shown

b. ‘Date first shown’: earliest available map a feature is shown on

c. ‘Date last shown’: latest available map a feature is shown on

d. ‘Following date’: first available map which does not show a feature which was previously shown

4.2.5 As the range of dates covered by the historical mapping is limited, only a date range for the appearance and disappearance of features can be given, in the absence of corroborating information. For example, clay pit 2 in Table 4.1 can only be presumed to be infilled sometime between 1984 and 1992.

Table 4.1 Example of historical mapping review dates for potentially infilled and non-infilled pits

Description	Type	Preceding date	Date first shown	Date last shown	Following date
Clay pit 1 *Pit not filled/ still exists*	Terrain	1938 *Pit not shown*	1945 *Pit first shown*	1995 *Pit last shown*	<NULL> *Pit is still shown on most recent available historical map (1995)*
Clay pit 2 *Pit infilled*	Landfill	1938 *Pit not shown*	1945 *Pit first shown*	1984 *Pit last shown*	1992 *Pit not shown (presumed infilled)*
Infilled Pond *Pond infilled*	Landfill	<NULL> *Feature is shown on earliest available historical map (1865)*	1865 *Pond first shown*	1960 *Pond last shown*	1965 *Pond not shown (presumed infilled)*

4.2.6 To produce a list of potential contaminant sources to include in the CSM and assist in developing the scope of ground investigation, the features from the historical map review together with the features in the environmental dataset from Landmark and other sources listed in Section 3, were assessed to determine whether they could plausibly form part of a pollutant linkage, i.e. using conservative assumptions, could a source, pathway and receptor be present for one or more COC. The following factors were incorporated in this assessment:

a. Age, size, type and location of the potential contaminant source

b. Likely type and mobility of COC
c. Location within the study area
d. Alignment at that location (e.g. tunnel, cutting, embankment) or proposed land use (e.g. construction compound, ecological compensation)
e. Generalised geology and hydrogeology at that location (likely mobility of contaminants)
f. Distance and sensitivity of potential receptors (identified in Section 7)

4.2.7 Superficial and bedrock geology in the study area (as mapped by the British Geological Survey (BGS)) is shown in Figure 2 and Figure 3.

4.2.8 This assessment ('credible source review' in Plate 4.1) was carried out by the Project geo-environmental team using the information presented in this report and professional judgement. This was based on the high-level knowledge of potential contaminant pathways, receptors and the route alignment as presented in the DCO application Documents. Representation of a potential contaminant source in Section 5 or the GIS layer does not imply a particular level of risk to any receptor.

4.2.9 The resulting list of potentially contaminative features are termed credible contamination sources. This list was reassessed as necessary as the route alignment evolved. All potential sources of contamination within the CSM are given a Historical Land Use (HLU) number and are described in Section 5.

4.2.10 Various assumptions have been adopted in the development of the CSM as follows:

a. Existing electricity substations have been included as credible contamination sources where a potential pollutant linkage may be present subject to the factors listed above. Where the evidence indicated that the installation may have been present prior to 1981 polychlorinated biphenyls (PCBs) have been assumed to have been present as this predated the regulations banning PCBs in new installations.

b. Existing highways may be associated with release of contaminants through point sources such as individual pollution incidents, and diffuse pollution via runoff and aerial deposition. These are not considered as potential contaminant sources in the CSM as it is beyond the current scope to investigate diffuse sources, and point sources are assumed to be controlled through pollution control points and drainage systems.

c. Electricity pylons (and access roads) are not considered potentially contaminative in the context of the Project. Where design information indicates that part of the study area is for restringing or realignment of overhead electricity lines, it was not reviewed for potentially contaminant sources due to the limited ground disturbance associated with this type of work.

d. Agricultural sites such as farmyards may be associated with contamination arising from agricultural activities such as vehicle and plant maintenance, storage of fuels and agrichemicals, and historical waste disposal practices such as onsite burial and burning. Many agricultural pollutants, in particular nutrients such as nitrogen and phosphorous compounds, are diffuse and not considered significant in the context of the Project. Any potential risk, however, would be addressed via the measures implemented through the second iteration of the environmental management plan (as set out within the Code of Construction Practice (Application Document 6.3). Historical and recent mapping and aerial photographs were reviewed as described in Section 3, and potential point sources of agricultural contamination such as farmyards were identified. Sites considered credible contaminant sources for the Project were included in the CSM based on factors a) to f) and consideration of the scale and type of activity based on the features visible on aerial photographs.

e. Potential point sources, associated with individual residential properties and small localised rural industries, have only been considered where information is available.

f. Many sites along the route have been subsequently redeveloped following historical potentially contaminative uses. Land contamination is a material consideration under the National Planning Policy Framework (Ministry of Housing, Communities and Local Government, 2019) and prior planning regulations. The planning regime requires the site to be ‘suitable for use’, and therefore existing contamination should have been investigated and remediated if necessary, at the time of the redevelopment. During the review of publicly available online planning records, available documents and associated planning conditions (where made) were considered as part of the review to determine credible sources.

4.2.11 The likely significance of the overall level of risk for each potential contamination source is assigned in Annex D (Part 1) based on available information. The risk would depend on the particular environmental setting of each individual pollutant linkage, the significance of the source contaminant concentration(s) and the sensitivity of receptors present. Further information on the risk levels is given in Section 11.

5 Potential sources of contamination

5.1 Introduction

5.1.1 Features identified as potential contaminant sources during the review of desk-study information were considered, and an assessment was made as to whether they could form a credible pollutant linkage that may affect the Project.

5.1.2 Possible impacts considered as part of this assessment included the source having the following:

a. Potential to contaminate soil or groundwater

b. Potential to form a pollutant linkage with the receptors identified in Section 7 that an element of the Project could come into contact with (e.g. highway cuttings, tunnel portals)

c. Potential to form a pollutant linkage with a third-party receptor where the Project may alter the nature of the source or pathway, through temporary or permanent works, mitigation measures or related development (e.g. mineral safeguarding, ecological habitat creation or subsurface utility diversion)

5.1.3 Credible sources within the study area were considered. Sources more distant than 250m are considered unlikely to impact the development unless they are large, potentially contaminating land uses. Based on a qualitative review of the historical OS maps, no additional sites likely to adversely impact the development were identified outside the 250m buffer. As such, the potential sources of contamination reviewed are located, at least in part, within 250m of the Order Limits.

5.1.4 The nature of the potentially contaminative feature, such as age, size, likely COC, and distance from the Project, together with the environmental setting, including the topography, generalised geology and hydrogeology, and potential for the presence of a preferential pathway, was reviewed at this stage, to discount any feature that was highly unlikely to be relevant to the Project.

5.1.5 Contaminants likely to be associated with the site or activity are listed for each potential source based on published information and professional judgement. Additional contaminants may be present depending on the site history and any undocumented land uses. All contaminants associated with each potential source are given in this section, regardless of the likelihood of them forming part of a pollutant linkage in the context of the Project, for example consideration of their low mobility in the environment. This likelihood is further assessed in Section 9 and Annex C (Part 1).

5.1.6 Dates given are generally sourced from historical mapping and therefore should be treated as approximate unless stated otherwise.

5.1.7 The Project would cross several major utility routes, including high-pressure gas and oil pipelines, and high-voltage electrical cables. These are not considered likely to pose a significant contamination risk as they are assumed to be managed infrastructure; however, they may be considered built receptors, or

may create a preferential pathway (for example enabling migration of ground gases).

5.1.8 The detailed locations of the potential contaminant sources are shown in Figure 4. A detailed summary of the identified potentially contaminative land uses is provided in the following sections. The review has been split into six areas along the Project route:

a. A2/M2 junction to South Portal

b. South Portal to River Thames

c. River Thames

d. River Thames to North Portal

e. North Portal to A13

f. A13 to M25 junction

5.2 A2/M2 junction to South Portal

General area description

5.2.1 Several industrial land uses have been identified around the proposed A2/Lower Thames Crossing junction. An existing petrol filling station (PFS) and a former PFS are located in the area of the proposed junction. The A2 follows the line of the Watling Street Roman Road. The High Speed 1 (HS1) railway runs to the south of the A2.

5.2.2 Electrical overhead lines and pylons are located along and across the route between Thong and Riverview Park. These are not anticipated to pose significant contamination risks to the Project.

5.2.3 The A2 was realigned around 2008 near the current junction at Singlewell. The road was moved to the south, allowing a widening from three to four lanes in each direction. The former route of the A2 was then turned into a parkland area.

5.2.4 The ground elevation along the A2 is approximately 70m Above Ordnance Datum (AOD) at the M2 and Singlewell junctions in the east and west, rising to 115m AOD south of Shorne Woods. The ground then descends steeply to approximately 35m AOD at the South Portal.

Proposed route alignment

5.2.5 Currently the A2 carriageway is in cutting south of Brewers Wood and Shorne Woods Country Park, with significant earthworks and embankments at the Singlewell junction and M2 junction 1. New cuttings and embankments are proposed to form the A2 junction with the Lower Thames Crossing, and the highway continues in a gradually deepening cutting to the South Portal.

Geology and hydrogeology

5.2.6 A summary of the mapped geology from BGS Sheet 271, Dartford (BGS, 1998) is given here. The ground model for this section has been further developed following the results of the ground investigation as detailed in the Preliminary

Ground Investigation Report (Phase 2) A2/M2 Connections (Document Number: HE540039-CJV-VGT-SSZREP-GEO-00001).

5.2.7 The existing M2 junction 1 in the east of the site is located on chalk (Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated)) with some areas of the Thanet Formation. The chalk includes marl seams and flints. The Thanet Formation is described as glauconite-coated, nodular flint at base, overlain by pale yellow-brown, fine-grained sand that can be clayey and glauconitic (BGS, 2020).

5.2.8 In the area around Shorne Ridgeway – south of Shorne Woods, the chalk and Thanet Formation are overlain by the Lambeth Group (sand, silt and clay) with the overlying Harwich Formation (sand and gravel) and London Clay Formation (clay and silt) forming the high ground.

5.2.9 Bedrock at the proposed A2 junction and the Singlewell junction is the Thanet Formation with the underlying Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) exposed in the centre where a dry valley runs approximately north–south.

5.2.10 Superficial Deposits are sparse, with isolated linear elongated Head Deposits (clay, silt, sand and gravel) located west of the M2 junction and at the A2 junction following the line of the dry valleys. Head Deposits are sedimentary deposits formed by reworking of weathered parent material by periglacial slope processes and are generally classed as a Secondary Undifferentiated aquifer. Small areas of peat are indicated near Fenn Wood and south of Brewers Wood, partly underneath the existing A2 carriageway, associated with a small area of Head Deposits.

5.2.11 The chalk in this area is designated by the Environment Agency as a Principal aquifer. Groundwater within the Chalk aquifer at the site is believed to be at significant depth below the A2, approximately 50m below ground level (bgl) (Arcadis, 2010). The Thanet Formation is classed as a Secondary A aquifer. The bedrock forming the topographic high ground at Shorne Woods (Lambeth Group and Harwich Formation) are classed as Secondary A aquifers, although the overlying London Clay Formation is not expected to support significant groundwater. Several surface water ponds are located in this area, and two artificially constructed attenuation/balancing ponds are located either side of the A2. Several other small ponds and lakes are present in this section but are not expected to be in hydraulic continuity with the Chalk aquifer.

5.2.12 Two groundwater Source Protection Zones (SPZ) are located within 250m of the Order Limits – one covers the area to the west of the junction and is associated with an abstraction near Northfleet Green, and one covers land to the east associated with abstractions at Three Crutches.

5.2.13 From the A2 junction, the route follows the descending chalk slope northwards to the South Portal. The chalk is shown on the map as Seaford and Newhaven Chalk Formations (undifferentiated). Further branched dry valleys with associated Head Deposits are present, generally orientated north to south. Natural dissolution processes associated with the Chalk formations may have created dissolution features, such as pipes and swallow holes, and increased rate and depth of weathering is associated with the dry valleys (CIRIA, 2002).

Migration of any contamination in soil and water may be affected by these features.

Overview of potential sources of contamination

5.2.14 Sites associated with industrial land uses have been identified along this section of the Project route. PFSs, electricity substations and the HS1 transformer station have been identified in the areas surrounding the A2 junction. Former nurseries and quarries have been identified from historical mapping along the route and several chalk pits have also been noted. The former Gravesend Airport is positioned around Thong Lane to the west of the Project.

5.2.15 Details for each HLU including potential contaminants associated with the potential source are given below. The likely significance of the overall level of risk for each potential contamination source is assigned in Annex C (Part 1) based on available information.

Cole Wood Chalk Pit (HLU0120)

5.2.16 A small chalk pit with an approximate area of 850m^2 is visible on the earliest available historical map of A2/M2 junction area, dated 1907. The chalk pit was still present on the 1910 map but absent on the 1931 map, indicating it may have been infilled. Prior to the construction of the nearby road, trenching was carried out. This revealed a chalk mound which was excavated to a depth of 2m bgl. The material was interpreted as backfill of an approximate 3m diameter shaft, suggesting the site was a denehole (Kent County Council, 2019).

5.2.17 The pit is recorded in BGS mineral records (Landmark, 2019) as a ‘ceased’ opencast pit within the undifferentiated chalk strata, comprising the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation.

5.2.18 As the former pit is located within the current A2 junction, it is possible that previous infill may have been replaced with other material as part of the junction redevelopment works in the 1990s.

5.2.19 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, polycyclic aromatic hydrocarbons, inorganics, metals, asbestos and hazardous gases.

Infilled Pond (HLU0114)

5.2.20 A pond, approximately 720m^2 in area, was shown on historical maps up to the 1907 version. Mapping from 1931 indicates that it may have been infilled by this time. The nature of the fill material is unknown and may have included contaminated material, although any degradable material or organic contaminants are likely to have substantially degraded since filling occurred. The current alignment of the A2 passes adjacent to the north of this feature.

5.2.21 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAH), inorganics, metals, asbestos and hazardous gases.

Road Haulier Depot (HLU0125)

5.2.22 A road haulier depot (Harlex Haulage Services and Crane Hire) is identified in contemporary trade directory information, located on Park Pale Lane immediately north of the current A2 alignment. This is listed as an 'office', but industrial and storage units associated with the yard are shown in aerial images of the site. Harlex's website indicates that the site is also used for vehicle maintenance (Harlex, 2018).

5.2.23 Historical mapping indicates that the depot buildings were constructed in the 1960s on the site of Park Pale Farm.

5.2.24 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, volatile organic compounds (VOC), semi volatile organic compounds (SVOC) and asbestos.

Brickyard and Kilns (HLU0119)

5.2.25 A brickyard and associated kilns were shown south of Brewers Wood on historical maps from 1867 to 1907. Clay workings were shown at this location on the 1869 historical OS map. The brickyard is located on the Thanet Sand Formation, described by the BGS as sand, silt and clay (BGS, 2019). The brickyard was not shown on historical maps from 1931 onwards, and the A2 was widened to mostly cover the site from approximately 1968.

5.2.26 Brickyards during this period were generally fuelled with wood or coal, although other fuels, including waste materials, were also used. Generally, limited or no pollution control measures were in use, and waste fuel ash was often disposed of locally, often in the nearby excavated clay pits.

5.2.27 The current A2 alignment passes over the former brick pit, and therefore some infill materials must be present, but their composition is currently unknown.

5.2.28 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, asbestos and hazardous gases.

Former Poultry Yard (HLU0118)

5.2.29 A poultry yard was shown on historical mapping from 1867. The poultry yard is labelled as such to 1966; however, the structure continues to be mapped to 1993 (last available map). The feature is located approximately 20m south of the current A2 alignment.

5.2.30 As well as common agricultural contaminants from fuel storage and building materials, such as petroleum hydrocarbons and asbestos, significant levels of nutrients are generated by livestock husbandry, including soluble ammoniacal nitrogen and nitrates. Arsenic was historically used in poultry feed and can be associated with disposal of poultry waste (Jackson and Bertsch, 2001). Depending on waste disposal practices, elevated contaminant concentrations in soil and groundwater may be present in this area, although degradable contaminants such as pathogens are likely to be reduced due to the age of the contaminant source.

5.2.31 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination and hazardous gases.

Former Road Haulage Site (HLU0136)

5.2.32 A former road haulage site was identified from the Landmark trade directories, south of the Project at the A2 junction on Halfpence Lane in Cobham. The road haulage site record is dated 1978. From historical maps, the site was unoccupied between 1867 and 1907. A building was present on the site in 1931 but was not labelled.

5.2.33 Recent aerial images show the building to still be present, but it now appears to be a residential property (Earthstar Geographics | Lower Thames Crossing, 2022).

5.2.34 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.

Cobham Farm (HLU0137)

5.2.35 A farm is shown south of the Project at the A2 junction on Cobhambury Road. From historical maps, the farm was present from 1867 with an adjacent orchard to the south. The farm is still shown in the last available historical map dated 1977.

5.2.36 Recent aerial images show the farm is still present (Earthstar Geographics, 2022). The farm, now called Cobhambury Farm, is owned by T Jackson and Sons and is noted as being a livestock and arable farm.

5.2.37 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Sheep Wash (HLU0207)

5.2.38 A sheep wash is shown south of the Project at the A2 junction on historical maps from 1864 to 1963. It was shown as a pond on historical maps dated from 1967 onwards. Chemicals used in these facilities have the potential to cause localised soil contamination and pollute groundwater over a wider area. Compounds used can contain metals, such as arsenic, and various pesticides including organochlorides (banned in 1994), organophosphorus and synthetic pyrethroid pesticides.

5.2.39 Potential contaminants associated with this HLU are considered to include metals and pesticides.

Electricity Substation, Valley Drive (HLU0231)

5.2.40 An electricity substation is located at the junction of Valley Drive and Franklin Road, in Gravesend. The substation was shown on historical OS maps dated 1972 and is currently housed in a metal shed. The substation is believed to be maintained by UK Power Networks.

5.2.41 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PCBs.

Electricity Substation (HLU0206)

5.2.42 An electricity substation (HLU0206) located immediately north of the A2 and west of Shorne Woods Country Park was identified on historical maps from 1967 (although an outline of the location is mapped from 1963). A planning application (reference 19520163) dated 1952 is recorded in this location for the erection of a switching station (Gravesham Borough Council, 2019a).

5.2.43 As this site pre-dates the phase out of PCBs, historical spillages of liquids containing PCBs may have occurred.

5.2.44 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PCBs.

Esso A2 Westbound Petrol Filling Station (HLU0215)

5.2.45 A PFS is located to the south of the westbound A2, in the area of the proposed A2/Lower Thames Crossing junction. It is first shown on historical mapping from 1972 and is still in use (Esso Cobham London Road). The site was described as a 'garage' on historical maps and vehicle repair facilities may have been present. The PFS currently includes several pump islands, a single retail building and parking for cars and lorries. The Local Authority Pollution Prevention and Control (LAPPC) PG1/14 (petrol filling station) permit reference, dated 1998, for this site is PP1/98/041 (Landmark, 2019).

Review of existing reports

5.2.46 The most recent information reviewed relating to the PFS provides details of drainage works in 2017. Surface water is indicated to be drained from the westbound PFS via two petrol interceptors to the west and north of the site (Toureen Group Drawing dated 13/10/2017) (Toureen Group, 2017).

5.2.47 Former tank details for the westbound PFS have been ascertained from Esso Drawing 201241-1963-052/A (Esso, n.d.) as two storage tanks for diesel totalling 92,100 litres, two tanks for unleaded petrol totalling 63,000 litres and a 4,500 litre AD-Blue (diesel exhaust fluid) tank. These have been removed and replaced with double-skinned underground storage tanks (USTs) (Arcadis, 2013).

5.2.48 Details of previous ground investigation and environmental assessments dated from 2009 to 2011 for the westbound PFS were provided to the Applicant by Esso. These have been summarised below.

5.2.49 The environmental works initially undertaken in 2009 comprised a desk-based study followed by intrusive geo-environmental investigation. The investigation comprised the advancement of five boreholes to a depth of 15m bgl. Measured concentrations of petroleum hydrocarbons were identified in soil. Groundwater was not encountered but was expected to rest at 50m below the site based on historical sources (Arcadis, 2013).

5.2.50 The site was subject to planning for redevelopment, with a number of environmental planning conditions in place. The redevelopment included removal of 10 USTs with their associated pipe network and an existing interceptor and superceptor. Three new double skinned USTs were then installed, which are assumed to be the current ones. Soils were sampled from

around the tank and line excavations as well as from trial pits across the site (Arcadis, 2013).

5.2.51 Measured soil concentrations of Total Petroleum Hydrocarbons (TPH) in excess of the Site-Specific Assessment Criteria for human health were recorded in a limited number of samples in the area of a former superceptor. However, further assessment indicated that the risk to commercial workers was low. The risk to the principal Chalk aquifer via vertical leaching was also reported to be low, based on the results of a Detailed Quantitative Risk Assessment (Arcadis, 2010).

5.2.52 Following the redevelopment and environmental assessment works, environmental planning conditions were successfully discharged for the site.

5.2.53 A pond is visible on aerial imagery to the east and west of the PFS, possibly balancing ponds for highway runoff. Landmark have identified potential filled ground to the west of the PFS based on historical maps from 1982 (Landmark, 2019), which may be a source of ground gas.

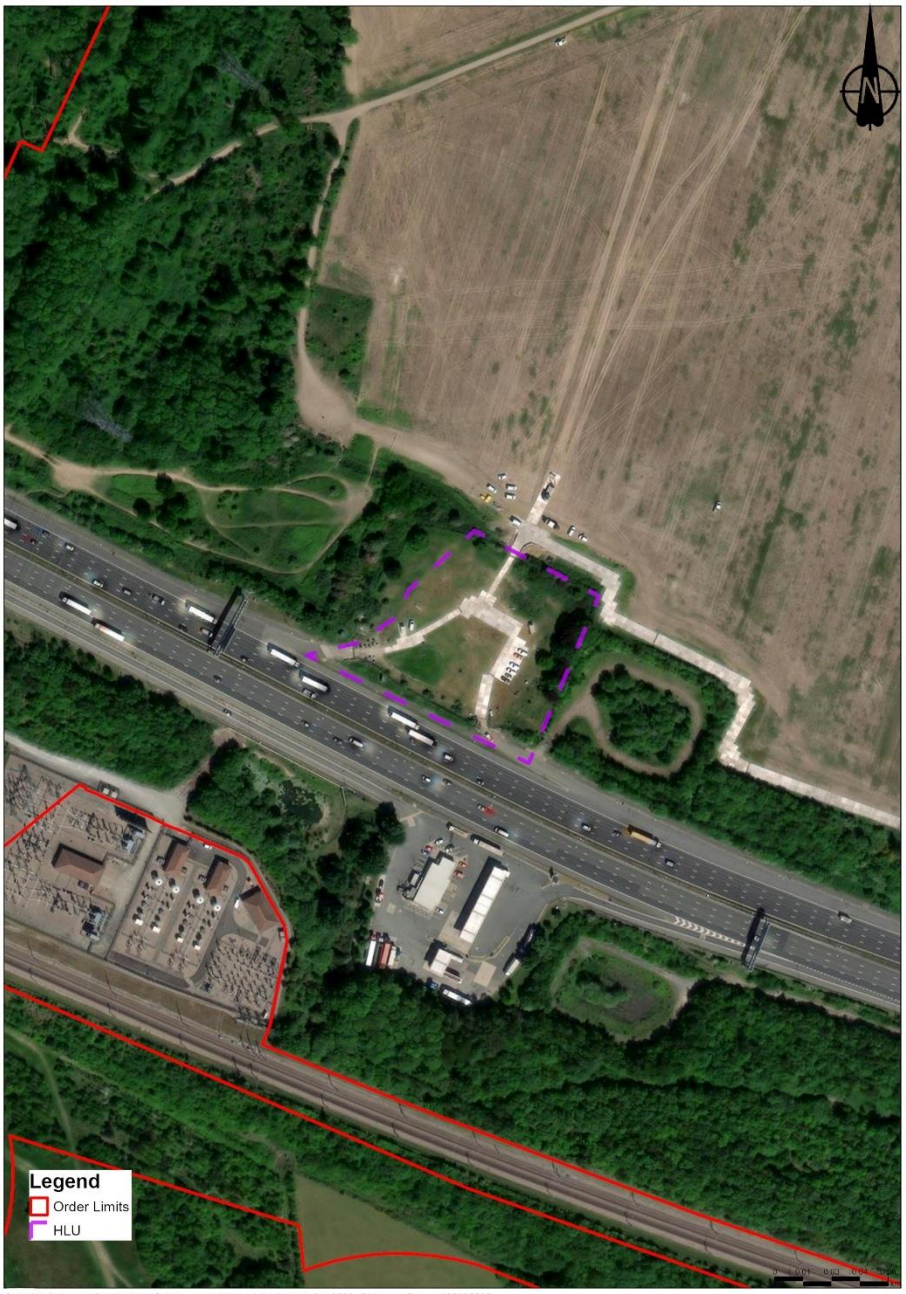
5.2.54 A 2016 planning application (reference 20160142) was approved for the installation of three above-ground Liquefied Petroleum Gas storage tanks and single Liquefied Petroleum Gas dispensing pump (Gravesham Borough Council, 2019b).

5.2.55 Potential contaminants associated with this HLU are considered to include Petroleum hydrocarbons, PAH, Methyl Tert-Butyl Ether (MTBE), metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Former A2 Eastbound Petrol Filing Station (HLU0214)

5.2.56 The former (eastbound) PFS north of the A2 (east of Claylane Wood) (Plate 5.1) was also constructed by 1972.

Plate 5.1 A2 Eastbound Petrol Filling Station HLU0214



5.2.57 A planning application (reference 19760502) was approved in 1976 for the installation of a 6,000 gallon diesel UST (Gravesham Borough Council, 2019c). The LAPPC reference, dated 1998, for this site is PP1/98/038. No pollution incidents are recorded in the area (Landmark, 2019).

5.2.58 A pond is visible to the east of the northern PFS, possibly a balancing pond for highway runoff.

5.2.59 Information received by the Applicant indicates that some contamination remediation works have been carried out following the demolition of the PFS. A WSP drawing dated August 2012 indicates the location of historical USTs and a superceptor (WSP, 2012). It is understood that remediation works were carried out following the demolition of the site between 2008 and 2011. The

remediation of the former PFS has been approved by the Environment Agency. Elements of the Project's temporary and permanent works are proposed to cross the location of the former PFS. Therefore, a commitment to consult with the Environment Agency On works occurring within the boundary of the PFS prior to the works commencing is secured within the Register of Environmental Actions and Commitments (GS030). This commitment would ensure that the proposed works would not compromise the remedial action that has taken place within the former PFS site. A balance pond is indicated to the east of the former petrol station which is assumed to be for highway runoff.

5.2.60 Potential contaminants associated with this HLU are considered to include Petroleum hydrocarbons, PAH, Methyl Tert-Butyl Ether (MTBE), metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

High Speed 1 (HLU0126) and Related Infrastructure (HLU0222 and HLU0221)

5.2.61 HS1 runs south of the A2 within the study area. The line section was constructed in 2002 (Highways England, 2017) and opened in 2003. The line is electrified, and a large substation is present immediately south of the proposed A2 junction. The line is in cutting between the M2 junction and Shorne Woods and mostly at grade from Shorne Woods to the Singlewell Junction. Locations of drainage outfalls for the cuttings (if present) are unknown.

5.2.62 The Singlewell Infrastructure Maintenance Depot (HLU0222) is also present immediately to the south of the A2 Singlewell junction. Constructed in 2007, it comprises berthing sidings, fuelling facilities, rolling stock repair workshops, plant storage and offices (Glasspool, n.d.-a). A walkover survey in October 2017 did not have access onto this site, which was instead viewed from the public footway. It was noted that the site was used for the maintenance of trains. Materials and waste storage (including large cable reels, skips full of strap metal, scaffolding poles, railway sleepers and plastic piping), electricity transformers and large blue structures (possibly tanks) were observed. Fly tipped waste was present by the footpath, comprising construction waste, insulation, plastic, foam and polystyrene.

5.2.63 A large electricity substation facility (HLU0221) associated with the railway is present south of the proposed A2 junction.

5.2.64 The Department of the Environment's (1995a) Industry Profiles: Railway land lists contaminants associated with running lines, stations, sidings and engineering workshops which may be relevant to the infrastructure adjacent to the Project. However, several contaminants are associated with older coal or diesel fuelled rolling stock and therefore not relevant to HS1. Similarly, electrical transformers containing PCBs and oil-filled cables are unlikely to be present due to the construction date of the facility.

5.2.65 The made ground forming the railway embankments should have been placed under the environmental and waste legislation pertaining at the time of construction (approximately 2003), and therefore should not contain significant contaminant concentrations.

5.2.66 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics and metals, phenols, VOC and SVOC.

Henhurst Road Contractors Depot (HLU0220)

5.2.67 A civil engineering contractor's depot is located adjacent to the south of the A2 and within the proposed footprint of the A2 junction. The site appears to be used for vehicle and plant storage, and bulk material stockpiling and processing (Earthstar Geographics, 2022). Materials stored on site may include railway ballast and other construction materials such as metal rails, electrical equipment, chemicals and fuels.

5.2.68 Historical maps indicate that, up until at least 1993, this site was part residential and agricultural. The A2 was formerly further to the north but now is re-aligned and immediately adjacent.

5.2.69 A planning application (reference 20120288) was granted in 2014 for the use of the land for ground works and a civil engineering contracting yard (materials storage, aggregate processing, parking and repairs of vehicles, plant and machinery) (Gravesham Borough Council, 2017b). A contemporary trade directory entry for Sonic Rail Services Ltd. is located at the site (Landmark, 2019).

5.2.70 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, inorganics, phenols, VOC, SVOC, hazardous gases and asbestos.

Church and Graveyard (HLU0257)

5.2.71 St Margaret's church and graveyard is shown on historical maps from 1865 south of the Project at the A2 on Church Road. Both the church and graveyard are still present on the site.

5.2.72 According to the National Churches Trust website (2020), the church is listed as a Grade II building with Saxon origins (the first vicar was noted in 1227). The church was altered in 1596 and had major restoration works in both 1796 and 1838.

5.2.73 Potential contaminants associated with this HLU are considered to include metals (particularly lead), formaldehyde and ammoniacal nitrogen.

Chalk Pit (HLU0208)

5.2.74 A chalk pit is shown as an excavation on the 1863 mapping. The chalk pit was still present on the 1938 map but absent on the 1954 map, indicating it may have been infilled. The location of the chalk pit is now within agricultural fields.

5.2.75 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos and hazardous gases.

Petrol Filling Station (HLU0265)

5.2.76 Turnpike service station is shown on historical maps from 1969, west of the Project, on the A2. The site included both a PFS and a restaurant. As part of the A2 widening scheme, the service station, restaurant and tanks were demolished in approximately 2007.

5.2.77 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Singlewell Service Station (HLU0224)

5.2.78 Environmental database records for a fuel station, contemporary trade directory entry and historical tank are located off Hever Court Road in Singlewell. Currently the site is a car repair, MOT and vehicle sales garage (Singlewell Service Centre).

5.2.79 Historical mapping indicates that a garage has been present on this site from approximately 1961, although a building outline in the same location was shown on mapping from approximately 1938.

5.2.80 Contamination from historical fuel or oil spills, and vehicle maintenance activities may be present in soils, and may have impacted groundwater. No pollution incidents have been recorded near to the service centre. An LAPPC permit dated 25/03/2010 is also recorded in this location for a waste oil burner.

5.2.81 To the south of Singlewell Service Station, a further site resembling the layout of a PFS has been identified on historical mapping from 1961 to 1982. No further information has been identified with regard to this site. The location of this potential historical petrol station lies between the existing A2 and pre-2007 route of the A2. If present, it may therefore have been decommissioned as part of the associated re-alignment earthworks, although no information regarding this has been identified.

5.2.82 As such, although the extent of HLU0224 is aligned with Singlewell Service Station, a HLU0224 PFS related source could extend further south. This uncertainty in potential risk, however, would be dealt with adequately via the measures detailed within Chapter 10: Geology and Soils (Application Document 6.1) and within the Register of Environmental Actions and Commitments (Appendix 2.2, Application Document 6.3). The measures, described below, would be implemented during construction through the second iteration environmental management plan.

5.2.83 The Contractors would complete further ground investigations prior to construction to inform the detailed design of the Project and where supplementary investigation is required to assess residual contamination risks. The commitment is secured in the REAC (GS001, GS027 (if required) and GS028).

5.2.84 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, phenols, VOC, SVOC, asbestos and hazardous gases.

Electricity Substation (HLU0226)

5.2.85 An electricity substation is located east of Thong Lane. It is shown on historical mapping from 1972.

5.2.86 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PCBs.

Poultry Farm, Thong Lane (HLU0218)

5.2.87 A poultry farm (Ideal Poultry Farm) is shown on historical maps at Westwood Farm, Thong, from 1962 to 1993. Potential sources of contamination associated with poultry rearing include storage and spillages of heating fuels, animal waste products, buried carcasses and other informal burial of waste. The buildings associated with the poultry farm on the historical maps were located to the east of Thong Lane, but other agricultural buildings on the west of Thong Lane are included as part of this potential source and may still be used for poultry or other agricultural uses.

5.2.88 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination and hazardous gases.

Gravesend Airport (HLU0321) and associated features (HLU0322, HLU0213, HLU0313)

History – pre-WWII

5.2.89 The site of Gravesend airfield was selected in 1932 for use as an emergency landing ground for commercial airlines flying to Croydon Airport and London (Kent Past, 2012). The site was used for aircraft construction and demonstrations from 1936 (Discover Gravesham, n.d.-d). Buildings on the site at this time appear to comprise a combined control tower and clubhouse, two hangers and fuel and oil stores (Britain From Above, n.d.). The airport is not shown on the OS 1938 1:10,560 map, possibly due to wartime censorship.

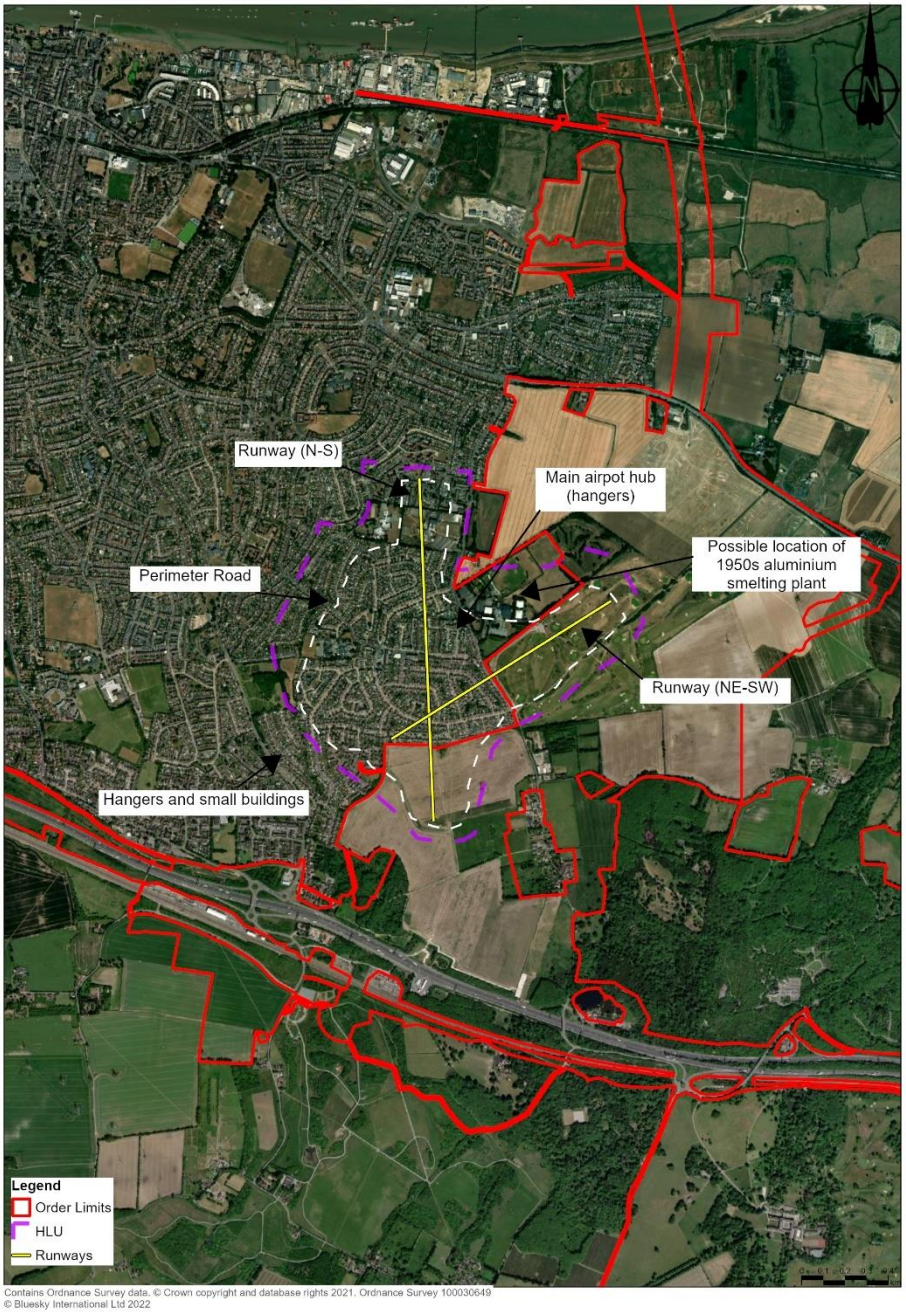
History – WWII

5.2.90 The site became a satellite fighter station for Biggin Hill in 1939 (Kent Past, 2012). Although the main landing surfaces remained grass, by 1944 it had 30 hard standings, eight ‘blister’ aircraft hangers, and one type T1 aircraft hangar (Historic England, 2015). During this time, two runways and various hangers and workshops were reported to be present.

5.2.91 From 1942, a variety of RAF units and aircraft were heavily involved in operations across mainland Europe (Kent Past, 2012), In 1943, an extension to the runways was finished (Trueman, 2015). ‘Summerfield track’ lightweight wire mesh ground reinforcement and runway lighting was installed (Discover Gravesham, n.d.-d).

5.2.92 Features of the layout of the airport are described in the Archaeological Desk-Based Assessment of 20th century Military Archaeology (Appendix 6.3, Application Document 6.3). Key features are shown on Plate 5.2 whilst detailed records are presented on Figure 13 of the Archaeological Desk-Based Assessment of 20th century Military Archaeology (Appendix 6.3, Application Document 6.3).

Plate 5.2 Aerial photograph of Gravesend Airport (HLU0321) approximately 1940 with route alignment



5.2.93 A deep-water tank existed on site and was reported to be backfilled (Kent History Forum, n.d.). Other areas are also likely to contain deep made ground.

5.2.94 Buildings thought to be present at the main airport hub included:

a. brick-built three-storey control tower

b. single-storey brick guardroom building with a flat concrete roof

c. double smaller hanger and fuel pumps (Essex Aero factory)

d. large 1930s wooden hanger (dismantled approximately 1961 and moved to Northfleet industrial estate)

e. second wooden Essex Aero workshop (deep water tank in front) (Kent History Forum, 2017)

5.2.95 Aircraft were stored over a wide area around the perimeter road to avoid presenting a concentrated target for attack, shown by the multiple 'frying pan' hardstandings on the 1946 historical mapping. Blast pens were often constructed from earth, sandbags or concrete to protect other aircraft and personnel in the event of an aircraft explosion during an attack. Other structures on the site at this time probably included equipment and ordnance stores, fuel tanks, air-raid shelters, pillboxes and anti-aircraft gun emplacements.

5.2.96 Following D-Day in June 1944, the airport was subsequently used as a command station for barrage balloons. The airport was known to be a base for both mounted barrage balloons and lorry-transported gas refill cylinders in the latter part of WWII (Smalley, 2017).

History – Post-WWII

5.2.97 Throughout the war, Essex Aero had used Gravesend Airport as a manufacturing base of self-sealing petrol tanks, constructed from rubber compounds (Discover Gravesham, n.d.-d). The company continued operations at Gravesend in the 1950s. Possible activities included aircraft recycling and manufacture of other products in magnesium alloys. There is a possibility that aircraft dismantled on site contained radioactive materials (e.g. radium dials). The 1955 OS 1:10,560 scale map shows the factory building at the main airport hub and indicates some of the hangers in the south-west and hardstanding in the north have been removed.

5.2.98 Internet research indicates that Essex Aero operated an aluminium smelting plant in the 1950s for the recycling of aircraft frames into other products such as milk crates (Smalley, 2017), possibly where the current sports centre is located (Kent History Forum, n.d.).

5.2.99 Gravesend Airport formally closed in June 1956 when Essex Aero went into liquidation (Discover Gravesham, n.d.-d). From 1958, the Riverview Park housing estate was built on the area of the airport (Trueman, 2015).

5.2.100 Between 1960 and 1980, two schools, the Cascades Leisure Centre and playing fields were constructed on the site. The deep water tank was reported to have been backfilled around this time (Kent History Forum, n.d.). By 2003, the Southern Valley Golf Course had been constructed on the south-eastern section of the perimeter road. It is possible that the hardstanding in this area was removed at this time. The perimeter road in the south-west corner is still evident in the field south of Riverview Estate.

5.2.101 Table 5.1 summarises the potential contaminative sources and contaminants associated with the former Gravesend Airport.

5.2.102 Further assessment of the hazards relating to UXO are given in the Zetica report (Zetica, 2022).

Table 5.1 Potential contaminative sources and contaminants associated with the former Gravesend Airport

Activity and date	Possible location within Gravesend Airport	Contaminants of concern
Aircraft maintenance (1932–1956)	Main airport hub and blister hangers around perimeter road	Petroleum hydrocarbons, metals, Volatile Organic Compounds (VOC), Semi-Volatile Organic Compounds (SVOC), PAH, asbestos
Aircraft manufacture and dismantling	Main airport hub	Petroleum hydrocarbons, metals (principally iron, aluminium and magnesium), PAH, asbestos Radium (luminescent dials)
Manufacture of self-sealing fuel tanks (1940s–1950s)	Main airport hub	Petroleum hydrocarbons, metals, sulphides, phenols, asbestos
Aircraft frame recycling/aluminium smelting	North of perimeter road (current area of leisure centre)	Metals (primarily aluminium) petroleum hydrocarbons, asbestos
Storage of fuel oil, lubricating oil, paints, VOCs and SVOCs and explosives	Main airport hub, stores and armouries identified by Zetica (2022)	Petroleum hydrocarbons, VOC, SVOC, phenols, explosives, PAH, asbestos
Demolition of airport structures, hangers, buildings, etc.	Main airport hub, smaller hangers in south-west and north-west	Asbestos, metals
Infilling of bomb craters, natural hollows and deneholes, redundant excavations, deep water tank, etc. (made ground)	Entire airport site	Metals, asbestos, petroleum hydrocarbons, hazardous gases

5.2.103 Fluorinated compounds such as Per- and Poly-Fluoroalkyl Substances (PFAS) are potential contaminants at airports due to their use in fire-fighting foams. However, they are not identified as potential COC for Gravesend, as they were not used until the 1960s, which is after the decommissioning of the airport.

5.2.104 The Project route runs along the eastern edge of the proposed airfield, adjacent to the former perimeter road. The majority of the former airfield is located in the current Riverview Park area, to the north-west of the route.

5.2.105 Records indicate that pipe mines were buried at the airport during WWII, as a precaution against invasion (Think Defence, 2015). These would likely have been buried about 10 feet below ground (British Broadcasting Corporation (BBC), 2016) along the runways. During ‘Operation Crabstick’ (17–23 April 1990), 33 Regiment Royal Engineers removed the pipe mines laid around RAF Gravesend (Gravesend Airport History Project, n.d.). The local residents of Riverview Park were sent on daily outings, for their safety (Discover Gravesham, n.d.-d). No evidence is available to show that all the pipe mines

have been removed. The risk of UXO would be managed in line with the requirements set out in the Code of Construction Practice (Appendix 2.2, Application Document 6.3) and the recommendations of the UXO Desk Study Report (Appendix 10.10, Application Document 6.3).

Nursery, Thong Lane (HLU0330)

5.2.106 A plant nursery is located east of Thong Lane and south of Southern Valley Golf Course. Historical maps indicate that this area was in use as an orchard in 1946 and buildings in the south of the site are first shown in 1955. Aerial images indicate materials and waste storage on a large part of the site (Earthstar Geographics, 2022).

5.2.107 A discharge consent is recorded for Hartshill Nursery in 1992. This was issued for final/treated effluent discharge into land and classed as a '…*crop and animal rearing/plant nursery*' (Landmark, 2019).

5.2.108 Information from the walkover survey in October 2017 at Hartshill Nursery noted the following:

a. The site comprised a lawn and turf company and nursery. The northern part of the site (which the Project would bisect) comprised a soil and waste storage area.

b. A large stockpile of soil (with concrete, brick, plastic mixed in), waste plastic, wooden pallets, old machinery, gas canisters, bricks, sand, ceramics and empty drums.

c. The southern part of the site comprised the office. A site contact stated that the former quarry (HLU0310) was beneath the office and was infilled after WWII. During piling for the foundations, the edges of the quarry could not be found.

d. The far southern part of the site comprises vehicle storage, a workshop for vehicle and equipment maintenance (no hardstanding), two (5,400 and 1,500 litre) diesel tanks (red diesel and white diesel) sited on hardstanding but not in bund. A stained metal oil can was noted adjacent to the tank (possibly used for topping up vehicles) with evidence of oil staining on hardstanding floor.

e. Waste skips were noted for general waste and recyclables. Scattered waste noted outside the skips (artificial turf and plastic).

5.2.109 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, herbicides, pesticides, asbestos.

Infilled chalk pits between Thong Lane and the A226 (HLU0308, HLU0309, HLU0310 and HLU0312)

5.2.110 There are several chalks pits around the A226 shown on historical OS maps that appear to have been backfilled. These include three chalk pits: HLU0308,

located on the junction of the A226 and Church Lane; and HLU0309 and HLU0310 located west and east of Thong Lane respectively.

5.2.111 HLU0308 is shown as an excavation on the 1897 and 1909 mapping, and no longer shown by 1933. HLU0309 is shown as an excavation on the 1864 mapping and labelled as an old chalk pit by 1888. HLU0310 is shown as a chalk pit on the 1864 mapping and no longer shown by 1962.

5.2.112 The land use at these locations is now agricultural fields, hedgerow or roadside verges. A walkover survey in October 2017 did not encounter any visible evidence of the infilled pits.

5.2.113 A local historical account (Smalley, 2017) provides further information on infilled chalk pits, believed to be HLU0309 to the west and HLU0310 to the east of Thong Lane. The western pit HLU0309 is described as being approximately 15m across, and the eastern pit, HLU0310, now located beneath the Bayliss Landscape Contractors Ltd. site on the corner of Thong Lane and Shorne Ifield Road, as smaller but 15m deep. They were reportedly dug with shallow sloping sides to allow access for horse and cart which is consistent with the irregular shape of HLU0310 on historical mapping.

5.2.114 During WWII, three Nissen huts were reportedly constructed in the eastern pit (HLU0310). Three 10 feet (3m) high ‘caves’ were excavated into the side of the western pit (HLU0309), used as WWII air raid shelters.

5.2.115 According to this source, the cave nearest the road was not infilled, and trees were felled directly into the pit. Compressible ground and subsurface voids may therefore still be present. Anecdotal evidence is presented of collapse holes appearing in the adjacent field, west of Thong Lane, following the backfilling of the pit. Rubbish, including pipe bombs from Gravesend Airport (HLU0321), was reported to have been deposited before the pit was infilled by the local council, and therefore contaminative materials may be present.

5.2.116 The area of the eastern pit (HLU0310) is now used as a nursery. Anecdotal sources indicated that some of the buildings on this site are piled.

5.2.117 Another potentially backfilled pit of unknown use (HLU0312) is located to the west of Southern Valley Golf Course (within the site of the former Gravesend Airport). It was excavated before 1909 and apparently filled by 1938. The nature of the fill material is not known. This feature is now partly under residential housing along Thong Lane.

5.2.118 Potential contaminants associated with these HLUs are considered to include petroleum hydrocarbons, PAH, metals, inorganics, herbicides, pesticides, asbestos, explosives (HLU0309) and hazardous gases.

Southern Valley Golf Course (HLU0324)

5.2.119 Construction of the Southern Valley Golf Course started in January 1998 (The Southern Valley Golf Club, 2019) and is located east of Thong Lane, on the north-east of the former Gravesend Airport. The course comprises approximately 60 hectares, including 18 holes, a clubhouse, greenkeeping yard and car parks. A compound with waste storage and a gas storage tank is located to the north-west of the clubhouse. The natural topography slopes down towards the north and north-east. The presence of a groundwater abstraction

borehole was recorded during the site walkover in 2018. Anecdotal evidence from a site walkover survey in October 2017 indicates that material from Bluewater shopping centre (former quarry) was imported for landscaping fill. No documentary evidence for this is available and other material of unknown quality may also have been imported.

5.2.120 A trade discharge consent was issued to Southern Valley Golf Course in 1999 and reissued in 2012 for discharge of '*process water*' into land.

5.2.121 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, asbestos, herbicides and pesticides.

Crown Garage (HLU0341)

5.2.122 The site, located east of the Project on the A226, was originally shown as Crown Inn on historical maps between 1865 and 1907. From 1907, a building was shown on site but not labelled.

5.2.123 Seven contemporary trade directory entries for Crown Garage are listed for the site relating to car dealers, motor garage services and a printers. Of the seven, three are listed as active (Fairways (Rover), RJP Auto Services and S&G Motors) with the rest listed as inactive (Landmark, 2019).

5.2.124 According to the S&G Motors website, the garage has been running since 1969 (S&G Motors, n.d.). Both RJP Auto Services and Fairways Rover appear to still be active and present on the site.

5.2.125 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Court Lodge Farm (HLU0340)

5.2.126 Court Lodge Farm is shown in historical maps from 1888, east of the Project on the A226. The farm was no longer shown on historical maps by 1966. Recent aerial images show that residential properties now occupy the site (Earthstar Geographics, 2022).

5.2.127 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Former Greenway Petrol Filling Station (HLU0343)

5.2.128 A building is shown on historical maps from 1966 on the site of the former Court Lodge Farm (HLU0340), east of the Project on the A226.

5.2.129 LAPPC records for Greenway Petroleum are dated 1999 (PG1/14 petrol filling station), and a historic tanks point is recorded in the landmark environmental database (Landmark, 2019).

5.2.130 Recent aerial images show that residential properties now appear to occupy the site (Earthstar Geographics, 2022).

5.2.131 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Fair Folly Garage (HLU0342)

5.2.132 Two contemporary trade directory entries are listed at the site: Fair Folly Garage is listed as inactive and Bodyworx is listed as being active. Recent aerial images show the site still appears to be occupied by such land use (Earthstar Geographics, 2022).

5.2.133 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

5.3 South Portal to River Thames

Area description

5.3.1 The South Portal is located south of Rochester Road (A226) and the route continues northwards in a bored tunnel beneath Filborough Marshes and the River Thames.

Proposed route alignment

5.3.2 The South Portal excavation forms a cutting down the north-facing slope of the chalk, above the river floodplain. The proposed tunnel is a twin-bore tunnel beneath the River Thames.

5.3.3 The potential contaminative features presented in this section are within the tunnelled section of the Project route. Therefore, no above ground highways works are anticipated, but significant excavation around the South Portal area is required and groundwater control is also anticipated.

5.3.4 Additional above ground works in this area include drainage works, ecological set aside areas and construction compounds.

Geology and hydrogeology

5.3.5 The cutting for the South Portal is formed within the cretaceous White Chalk Subgroup, mapped as the Lewes Nodular, Seaford Chalk Newhaven Chalk Formations (undifferentiated). Dry valleys have been identified in the chalk, generally trending north–south and some dissolution weathering features were identified during the aerial photo interpretation (Lee, Mills and Brunsden, 2018). Head Deposits (clay, silt, sand and gravel) are shown within the dry valleys. Small remnant outliers of the Thanet Sand Formation (glauconitic, fine-grained sands) are mapped to the north of the A226.

5.3.6 Superficial deposits within the floodplain of the Thames comprise River Terrace Deposits, principally the Taplow Gravel and Lynch Hill Gravel Members, underlying several metres of Alluvium (clay, silt, sand and peat).

5.3.7 The chalk is classed as a Principal aquifer, the River Terrace Deposits are classed as a Secondary A aquifer and the Alluvium is classed as a Secondary Undifferentiated aquifer. There is one groundwater Source Protection Zone (SPZ) within 250m of the Order Limits. The SPZ3 falls within the Order Limits at the A226, east of the Project route and is associated with both the Southern Water Services Ltd. groundwater abstraction (ref: 9/40/01/0511/G) and an abstraction at Higham.

5.3.8 The main surface water features located within this section of the Project route include the Thames and Medway Canal located to the north of Lower Higham

Road and a series of drainage ditches and ponds located around the Eastcourt and Filborough Marshes Ramsar protected wetlands area. As the route alignment would be in a bored tunnel prior to crossing these areas, it is unlikely that the works would significantly impact these features. The hydrogeological impact of tunnelling on the protected wetlands has been explored in the Hydrogeological Risk Assessment Chapter 14.5 Annex 5.

Overview of potential sources of contamination

5.3.9 The main site of potential contamination located within this section of the Project route is the Milton Rifle Range, located immediately south of the River Thames. The section also includes a historical landfill located at Filborough Farm, a maritime training centre and a large electricity substation. The Thames and Medway Canal and North Kent Railway cross over the Project route, running in a north-west to south-east direction, south of the Milton Rifle Range.

5.3.10 Details for each HLU including potential contaminants associated with the potential source are given below. The likely significance of the overall level of risk for each potential contamination source is assigned in Annex C (Part 1) based on available information.

St Mary's Cemetery (HLU0311)

5.3.11 St Mary's church and cemetery are located off Church Lane. It is shown on the 1863 map and is still present today. The church dates from the 11th to 13th century (Discover Gravesham, n.d.-b).

5.3.12 Potential contaminants associated with this HLU are considered to include metals (particularly lead), formaldehyde and ammoniacal nitrogen.

Former Piggery (HLU0320)

5.3.13 Piggeries are shown around St Mary's Church between 1938 and 1993 (last available historical map). Livestock units can be a source of various contaminants, principally organic wastes. The stocking intensity is not likely to be as high compared to modern units.

5.3.14 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination and hazardous gases.

Viewpoint Place (HLU0329)

5.3.15 Viewpoint Place is a rural residential property located on the A226 Gravesend Road to the south-east of Chalk village. This site is mostly shown as wooded or agricultural on historical maps from the 1860s to the 1990s. A number of vehicles, trailers or caravans are shown on the most recent aerial imagery (Earthstar Geographics, 2022). Two large warehouse-type buildings are also visible adjacent to the east. Spillages of fuels, oils or other liquids and informal burial or burning of waste may have occurred in the past.

5.3.16 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen and hazardous gases.

Filborough Farm Historical Landfill (HLU0413 and HLU0422)

5.3.17 Filborough Farm Landfill is a landfill on Lower Higham Road. A quarry (gravel pit) is first shown on maps dated 1888, and the southern part (adjacent to Lower Higham Road) was landfilled according to Environment Agency records (Landmark, 2019). Other small pits are shown approximately 150m to the south-east on the 1899 map. These gravel pits probably worked the Taplow Gravel Member, estimated to be approximately 5m thick (Lee, Mills and Brunsden, 2018), and the Filborough Farm Landfill may be of similar depth.

5.3.18 The recorded historical landfill area is approximately 150m^2 and underlies and is immediately adjacent to the current farm buildings and residential properties. The licence was issued in 1976 and the last waste received was recorded as December 1991, although based on historical mapping, filling may have commenced before this. The local authority landfill reference is GR17. The licence holder name is given as ‘local builder’ and the deposited waste as including inert and commercial waste (Landmark, 2019).

5.3.19 The remainder and majority of the former gravel pit is not designated by the Environment Agency as landfill, but topographic information indicates that it is at least partially filled, with some areas now being ponds.

5.3.20 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, inorganics, PAH, VOC, SVOC, PFAS, ammoniacal nitrogen and hazardous gases.

5.3.21 A smaller gravel extraction pit (HLU0422) of irregular shape and approximately 500m^2 was shown on the 1907 historical map approximately 15m west of Filborough Farm Landfill. The pit was shown on the 1955 historical map but not the 1961 map, indicating it may have been infilled prior to the main landfilling period at the adjacent Filborough Farm Landfill.

5.3.22 A foam concrete manufacturer is based at Filborough Farm, and a sewage discharge consent for final treated effluent is also recorded at this location.

5.3.23 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, inorganics, PAH and hazardous gases.

Thames and Medway Canal (disused) (HLU0414)

5.3.24 The Thames and Medway Canal crosses the tunnelled section of the Project route. Constructed between 1804 and 1824, the canal joined the River Thames at Gravesend to the River Medway at Strood (Discover Gravesham, n.d.-e).

5.3.25 The canal was officially abandoned in 1934 (Thames and Medway Canal Association, n.d.), and during and after WWII the canal was progressively infilled. Evidence from historical and contemporary mapping suggests that the majority of the infill to the east of the Project route was complete by 1960, but filling may have occurred later.

5.3.26 Potential contamination issues associated with the canal are the bottom sediment and infill material. The infill material may include WWII bomb rubble (Thames and Medway Canal Association, n.d.).

5.3.27 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

North Kent Railway Line (HLU0411) and Milton Range Halt (HLU0415)

5.3.28 The Project route crosses the North Kent Railway line (HLU0411) between Gravesend Station to the west and Hoo Junction to the east. The railway was constructed in 1846 (Highways England, 2017) and is currently heavily used by passenger and freight services. The line was electrified (750V direct current third rail) by the mid-20th century.

5.3.29 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals and asbestos.

5.3.30 The Milton Range Halt railway station (HLU0415), located at the eastern end of the rifle range (HLU0417), was in use between July 1906 and September 1932, although sporadic use may have continued until 1956. It was built primarily to serve the rifle range and used mostly for railway maintenance rather than passengers. An engineer's siding existed behind one of the platforms, the remains of which reportedly survived until 2009 (Glasspool, n.d.-b).

5.3.31 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos, PCB, VOC and SVOC.

Milton Rifle Range (HLU0417) and clay pits (HLU0418 and HLU0419)

5.3.32 The Milton Range was constructed as a military rifle range in 1862 (Zetica, 2022). It was first shown on mapping in 1864. The site is now used as a firing range by the Metropolitan Police (Discover Gravesham, n.d.-c). The range is bordered to the north by the southern bank of the River Thames and to the south by the disused canal.

5.3.33 The range consists of five embankments forming the target butts, and several low earthen mound firing points. The embankment materials are not known. The targets were mounted on metal frames equipped with pulleys to raise and lower them into the steel-lined marker's gallery in front. A railway track for removal of targets for repair (at a former workshop which has now been removed) was also present (Lee, Mills and Brunsden, 2018) but has since been covered by a concrete path. Several small shelters and buildings are present as well as a larger building (use unknown) in the south-east of the firing range. The land is low lying and drained by a network of ditches (Subterranea Britannica, 2011). The route is in tunnel at the location of the range.

5.3.34 The Milton Ranges Bylaws 1963 (Statutory Instrument No.1555) authorise the firing of '*all rifles, machine guns, revolvers and pistols*'. No indication that the site was used for artillery firing, testing of mines or other explosives, or manufacturing has been found, although a 'workshop' is identified in the byelaws document near the canal, south of the target butts (The Milton Ranges Byelaws, 1963) (Plate 5.3).

5.3.35 The relevant planning documents for the site available online have been reviewed. An application for the construction of a berthing and loading jetty was submitted in 1976 (Gravesham Borough Council, 2017a).

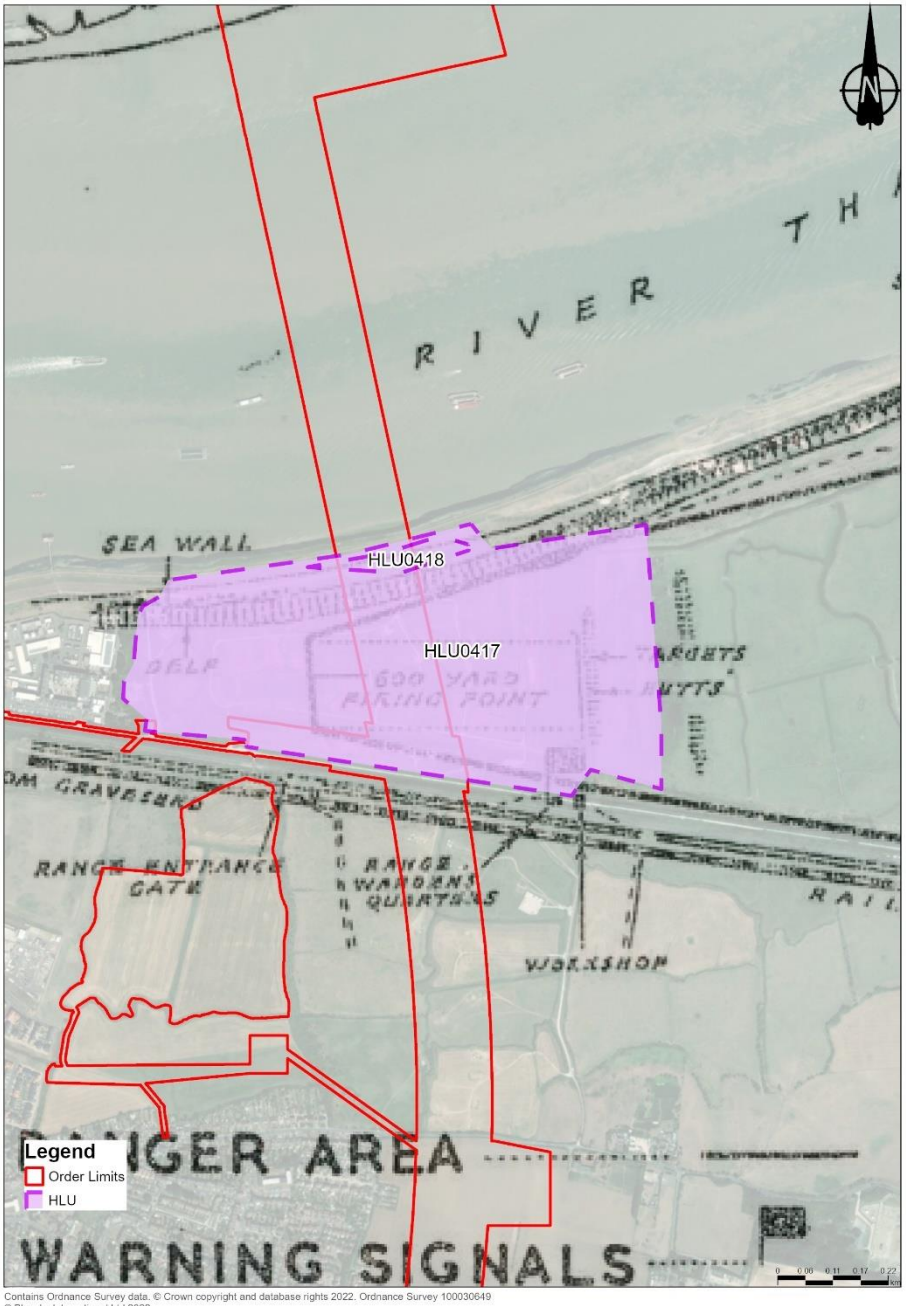
5.3.36 WWII records indicate a small amount of mustard gas was stored on the site, used for decontamination training. This was subsequently removed, and no spillages are recorded (Zetica, 2022).

5.3.37 Potential contaminants associated with this HLU are considered to include metals (particularly antimony, lead and zinc), asbestos, petroleum hydrocarbons and PAH.

5.3.38 Clay pits and various small ponds are visible north and west of the range on historical maps from approximately 1932. The clay pit to the north (HLU0418) appears from historical mapping to be infilled from approximately 1981. The former clay pit to the west (HLU0419) is currently mapped as a pond and therefore is not believed to be infilled and as such not considered a potential contaminant source.

5.3.39 Potential contaminants associated with these HLUs are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.

Plate 5.3 Layout of Milton Rifle Range (HLU0417) from the 1963 Bylaws with Area of Former Clay Pits (HLU0418 and HLU0419)



Eastcourt Marshes Electricity Substation (HLU0420)

5.3.40 A large electricity substation/distribution facility is located to the west of Milton Rifle Range. The substation is first shown on historical maps dated 1973 and connects a cable running under the River Thames to overhead electricity lines running south-east to the Thames and Medway Canal over the Project route and then eastwards towards Higham. The electricity cable under the River Thames is shown on a Port of London Authority (2016) drawing to run underground at 40m below ordnance datum from Tilbury B power station. A record of a surface water discharge consent, for '*discharge of other matter-surface water*' to freshwater river, is associated with the 400kV line cable tunnel, dated 1967 and revoked under the Environmental Permitting Regulations (EPR) 2010.

5.3.41 Potential contaminants associated with this HLU are considered to include PCBs and petroleum hydrocarbons.

Training Centre (HLU0428)

5.3.42 A large building labelled as 'National Sea Training College' was first shown on historical maps dated 1973. This was built over marshland and drainage channels that connected to the main channel to the east and the River Thames. According to internet sources, the main building was probably built around 1967 and reportedly demolished in 1975 (Discover Gravesham, n.d.-a), although it appears to be present on the 1981 historical map.

5.3.43 The site remained in use and in 2003, owing to a reduction in the size of the Merchant Navy, became a training facility for the Metropolitan Police. The presence of storage tanks is also recorded in the Landmark environmental database in the centre of the police training facility, but the materials stored are unknown (Landmark, 2019). Anecdotal evidence gathered during the walkover survey in October 2017 indicates there is a diesel pump and petrol-bomb making facility on site.

5.3.44 Contemporary mapping indicates that buildings in the south west of the HLU are occupied by the National Sea Training Centre (Esri, Maxar, Earthstar Geographics, and the GIS User Community, 2022), used to provide fire training facilities (North Kent College, 2019). The older National Sea Training College may have also carried out firefighting exercises. A trade discharge consent dated 1997 is associated with this part of the site.

5.3.45 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, PFAS and asbestos.

J Clubb Aggregate Yard (HLU0448)

5.3.46 The aggregate yard located between the Thames and Medway Canal and the River Thames, was shown on historical maps as unoccupied until 1973 when a works was established. Several further buildings were established on site by 1981, which is the last available map. The site, now owned by J Clubb, is used as an aggregate yard (Landmark, 2019).

5.3.47 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics and asbestos.

Denton Wharf (HLU0447)

5.3.48 Denton Wharf is shown on historical maps from 1865. In 1865, small buildings were present at the site with a jetty along the northern edge. The Port of London Sanitary Hospital was established on the eastern portion of the site in 1895. Between 1923 and 1938, the causeways were remodelled, and the hospital was labelled as an isolation hospital. Several buildings appeared on historical maps by 1973 and were still present in the last available map dated 1981. The hospital building was labelled as a quarantine station in 1981.

5.3.49 Several contemporary trade directories are now recorded at the site comprising distribution services, plastic specialists, freight forwarding services and electrical industry facilities (Landmark, 2019).

5.3.50 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos and PCBs.

Wharf Road Industrial Estate – north (HLU0435)

5.3.51 Wharf road industrial estate north is shown on historical maps in 1955, before which the estate was shown as being unoccupied. The estate was later expanded in 1973 and is still present (Earthstar Geographics, 2022).).

5.3.52 Several active contemporary trade directory entries are listed in the Landmark environmental databases (Landmark, 2019). The businesses include lifting gear suppliers, a car repair garage, used tyre logistics centre, waste transfer station and general engineers.

5.3.53 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Wharf Road Industrial Estate – south (HLU0446)

5.3.54 Wharf road industrial estate south is shown as unoccupied on historical maps until 1973 when several buildings were established on the site. A timber yard was labelled as being present on site in 1981.

5.3.55 Current aerial imagery show containers, a large warehouse and heavy goods vehicles (Earthstar Geographics, 2022).

5.3.56 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Enterprise House Industrial Units (HLU0445)

5.3.57 Enterprise House Industrial Units is located south of Wharf Road. A canal basin (Thames & Medway Canal) is shown at the location of the industrial units on available historical maps dated between 1885 and 1971 (National Library of Scotland, 2022). Current aerial imagery (Earthstar Geographics, 2022) shows much of the canal basin to have been infilled and developed as part of the wider industrial area. The site is occupied with industrial buildings and heavy goods vehicles are also shown.

5.3.58 Several contemporary trade directory entries are recorded in Landmark environmental databases which include road haulage, scaffolding, roofing and container suppliers (Landmark, 2019).

5.3.59 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Norfolk Road Industrial Estate (HLU0433)

5.3.60 Norfolk Road Industrial Estate is shown on historical maps by 1973, when several buildings are shown which are labelled as ‘works’. No changes were shown by the last available historical map dated 1981. Industrial buildings are still present as shown on recent aerial imagery (Earthstar Geographics, 2022). Several businesses are active on site including a roofing business and motor garage/repair shop. An electrical substation is shown in Landmark environmental databases, but it is not clear whether this is still present on the estate (Landmark, 2019).

5.3.61 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos and PCBs.

Road Haulage Yard (HLU0444)

5.3.62 The road haulage yard is located between the Thames and Medway Canal (HLU0414) and the East Kent Railway (HLU0411).Historical maps show two buildings by 1966. The buildings were no longer present in the last available historical map dated 1973. Recent aerial imagery shows an industrial building and heavy goods vehicles on hardstaning (Earthstar Geographics, 2022).

5.3.63 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Hospital (HLU0438)

5.3.64 A hospital is shown on historical maps between Mark Lane and Norfolk Road, south of the River Thames in 1932. The hospital remained until 1955. The building was still shown on historical maps dated 1966 to 1981, but was no longer labelled as a hospital.

5.3.65 Recent aerial imagery and mapping show the location is now Waterton Park, a public open space including a playground (Earthstar Geographics, 2022).

5.3.66 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, asbestos and microbial contamination.

Comma Oil and Chemicals (HLU0434)

5.3.67 Comma oil and chemicals factory is shown on historical maps south of the East Kent Railway (HLU0411) in 1966. The factory was still shown on the last available historical map dated 1981.

5.3.68 Recent aerial imagery and mapping show the factory is still present on site. (Earthstar Geographics, 2022). Comma is a manufacturer of automotive lubricants and chemicals for passenger and commercial vehicles (Moove Lubricants Limited, 2022).

5.3.69 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC and asbestos.

Denton-Comma Oil Landfill (HLU0443)

5.3.70 Denton-Comma Oil Landfill was located south of the East Kent Railway (HLU0411) adjacent to the Comma Oil and Chemicals factory (HLU0434). Historical maps show the site to have been unoccupied.

5.3.71 Landmark environmental databases recorded the site as a historical inert waste landfill operated by J Clubb Limited (Landmark, 2019) (Environment Agency ref: EAHLD19292). Filling dates are not available for the landfill.

5.3.72 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and, SVOCs.

Sewage Works (HLU0437)

5.3.73 A sewage treatment works is shown on historical maps south of the East Kent Railway (HLU0411) in 1932. The works was expanded in both 1955 and 1973 and recent aerial imagery show it to still be present (Earthstar Geographics, 2022).

5.3.74 Potential contaminants associated with this HLU are considered to include metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases and PFAS.

5.4 River Thames

River Thames sediment

5.4.1 This section considers potential sources of contamination to the sediment within the River Thames around the location of the tunnel crossing. Only major individual contaminant sources are identified, as contamination within the river environment may potentially have originated in a wide area upstream or downstream of the Project.

5.4.2 The bored tunnel would run under the Gravesend Reach of the tidal River Thames, close to the Thames Estuary. Much of Greater London is therefore included in the catchment upstream of the Project. Historically, the River Thames has been polluted by a variety of urban land uses. Notwithstanding recent improvements in water quality, the sediment has the potential to act as a store of historical contamination. The River Thames is a well-mixed estuary, which means that the river flow is much less than the tidal volume. The water mass, and accompanying sediment transport, moves up and down the river with the flood and ebb tides (Port of London Authority, 2014). Potential contaminant sources downstream of the study area have therefore also been considered.

5.4.3 Potential contamination in river sediment can originate from:

a. Shipping (fuel and oil spills and ballast discharges, anti-fouling compounds, loss of cargo)

b. Surface runoff into the river (organic and inorganic compounds, nutrients) (diffuse source)

c. Direct discharges from industrial and other land uses adjacent to the river (point source discharge – permitted and unpermitted)

d. Indirect discharges from drainage systems (combined sewer overflows), water treatment plant outlets)

e. Contamination from natural and artificial tributaries (dissolved and suspended load)

f. Air deposition (e.g. from industrial and transport emissions)

Major land-based sources near the Project

5.4.4 Table 5.2 provides a list of the major land-based sources which are indicative of potential contamination. Other sources further away may also have an impact on the contaminant composition and levels within the sediment.

5.4.5 As the number of historical and current potential contaminative land uses which may have impacted the River Thames is very large, only point sources of significant size and proximity (within 3km) are summarised herein. This should not be considered an exhaustive list of contaminant sources but will likely cover the main contaminant groups and those most likely to influence sediment quality at the crossing location.

5.4.6 All distances are approximate and given from the Order Limits.

Table 5.2 Major land-based potential sources of contaminants to river sediment

Direction	North bank	South bank
Upstream	Goshems Farm historical landfill (also known as East Tilbury landfill) and current land raising by Ingrebourne Valley Ltd (adjacent) (HLU0526). Tilbury Power Station (HLU0630) and associated outfalls (500m to 1km). Cable tunnel from south bank emerges here. Tilbury Sewage Works (1.8km). Port of Tilbury (3.5km).	Electricity substation and cable tunnel (250m). Industrial sites along Wharf Road including fire training centre, logistics centres, aggregate facility, and vehicle repair centres (400m to 1.2km).
Downstream	East Tilbury Marshes Hazardous Waste Landfill (adjacent) (HLU0523).	None identified.

Discharge consents

5.4.7 The following surface water discharge consents, directly or indirectly discharging to the River Thames, have been identified within 2km of the Project (distances are given from the route alignment at the crossing). This information

was obtained from environmental data supplied by Landmark (Landmark, 2019).

a. 320m downstream north bank: Outfall (Bowers Sluice) identified on historical maps dated 1960 to present. This is believed to take surface water drainage from Tilbury Marshes to the north and may be impacted by the adjacent East Tilbury Marshes (hazardous waste) landfill.

b. 440m upstream south bank: Fire Fighting Training Centre (trade) (via stream at Eastcourt Marshes).

c. 840m upstream south bank: Gravesend Training Complex (trade) (via stream at Wharf Road) (HLU0428).

d. 750m upstream south bank / 1,000m upstream north bank: 400kV Line Cable Tunnel, Denton (sub-station/electricity/gas/air conditioning supply) (revoked). Substation is located 200m upstream.

e. 830m upstream south bank: Gravesend Sewage Treatment Works, Southern Water Services Ltd.

f. 950m upstream south bank: Clubbs Washed Gravel Company (trade discharge - mineral workings, revoked).

g. 1,380m upstream south bank: Southern Water Services Ltd. (Public Sewage: Storm Sewage Overflow).

h. 1,350m upstream north bank: Tilbury Power Station, Fort Road (trade: cooling water and substation).

i. 1,380m upstream south bank: Empress Road Chamber, Gravesend, Southern Water Services Ltd. (sewerage – water company).

j. 1,890m upstream north bank: Tilbury Water Recycling Centre, Anglian Water Services Ltd. (sewage discharges – final/treated effluent – water company).

5.4.8 No detailed information on discharge volumes or composition is available.

Pollution incidents

5.4.9 The following pollution incident, within the River Thames or near to tributaries within 2km of the Project crossing, have been identified. Only pollution incidents recorded as affecting the water environment (rather than soil or air) have been included. This information was obtained from environmental data supplied by Landmark Information Group (Landmark, 2019).

a. 1,000m upstream, south bank: Dering Way, Denton, Category 2 – significant incident to water, dated 07/05/2004, no information on contaminants available.

Potential contaminants and existing sediment quality data

5.4.10 Potential contaminant groups associated with the above sources and commonly associated with urban river sediment include:

a. inorganic substances, such as metals, nutrients and sulphides

b. organic substances, such as petroleum hydrocarbons, organo-metals, herbicides, pesticides, pharmaceuticals

c. Persistent Organic Pollutants, including PCB and PFAS

5.5 River Thames to North Portal

Area description

5.5.1 The route alignment from the north bank of the River Thames to the North Portal is located in the East Tilbury Marshes and has historically been subject to significant land raise and waste disposal activities (Plate 5.4). Mudflats, shingle and a sea wall are present along the riverbank together with several former and current jetties. A network of former salt marsh creeks and drainage ditches is present, likely to be within or on the land raise material.

5.5.2 Land raising activities are currently ongoing along this section of the Project route. Several areas of historical and permitted landfill are designated by the Environment Agency in this area. These are shown on Plate 5.5 and Plate 5.6.

5.5.3 There are two significant proposed elements of the route alignment from the River Thames to the North Portal, which include:

a. twin-bored tunnel

b. North Portal excavation

Geology and hydrogeology

5.5.4 The underlying geology is anticipated to be several metres of tidal river deposits and Alluvium overlying the White Chalk Subgroup. Peat is noted at significant depths (4–13m bgl) in borehole logs for the area (RWE, 2004). Groundwater will be at shallow depths and tidally influenced near the river.

5.5.5 A series of gravel terraces, formed of several River Terrace Deposits members, are present north of the Thames, separated by low scarp slopes (Lee, Mills and Brunsden, 2018). Several historical gravel pits have been identified, some of which have been infilled.

5.5.6 The White Chalk Subgroup is classified as a Principal aquifer. The River Terrace Deposits are classified as a Secondary A aquifer and the Alluvium is classified as a Secondary Undifferentiated aquifer. No groundwater abstractions or SPZs have been identified in this area.

5.5.7 The bored tunnel is anticipated to be principally within the White Chalk Subgroup beneath the River Thames. The North Portal structure is subject to design and may be within the White Chalk Subgroup, River Terrace Deposits and Alluvium and would require removal or regrading of the made ground/landfill deposits.

5.5.8 The Alluvium is described as '*clay, silt, sand and peat*' (BGS, 2019) and may present a range of hazardous ground conditions including compressible soils, perched water and generation of ground gases, principally methane.

Hydrology

5.5.9 The land north of the Thames is generally flat and low-lying. The area approximately 240m inland of the current high-water mark was reclaimed from tidal mudflats in the mid-20th century (former sea wall shown on historical OS maps to 1948, HLU0526).

5.5.10 The Tilbury Marshes area is drained by a network of shallow ditches, many of which have likely been modified during the land reclamation and landfilling phases in the area, e.g. Bowater Drain around East Tilbury Landfill. The water level in the ditches is reported to be tidally influenced (RWE Npower, 2004).

5.5.11 Structures, such as Bowater Sluice are present at the outfall to the River Thames.

Overview of potential sources of contamination

5.5.12 This section of the Project route includes several sites identified as being potentially major sources of contamination. Significant landfilling and land raising has taken place in the areas immediately north of the River Thames around Tilbury and East Tilbury. The sites of Tilbury Sewage Treatment Works and the former Tilbury Power Station also fall within the west of the study area. Significant historical military land has also been identified around Coalhouse Fort and East Tilbury Battery in the east of the study area.

5.5.13 Details for each HLU including potential contaminants associated with the potential source are given below. The likely significance of the overall level of risk for each potential contamination source is assigned in Annex C (Part 1) based on available information.

Plate 5.4 Overview of landfill areas near the North Portal

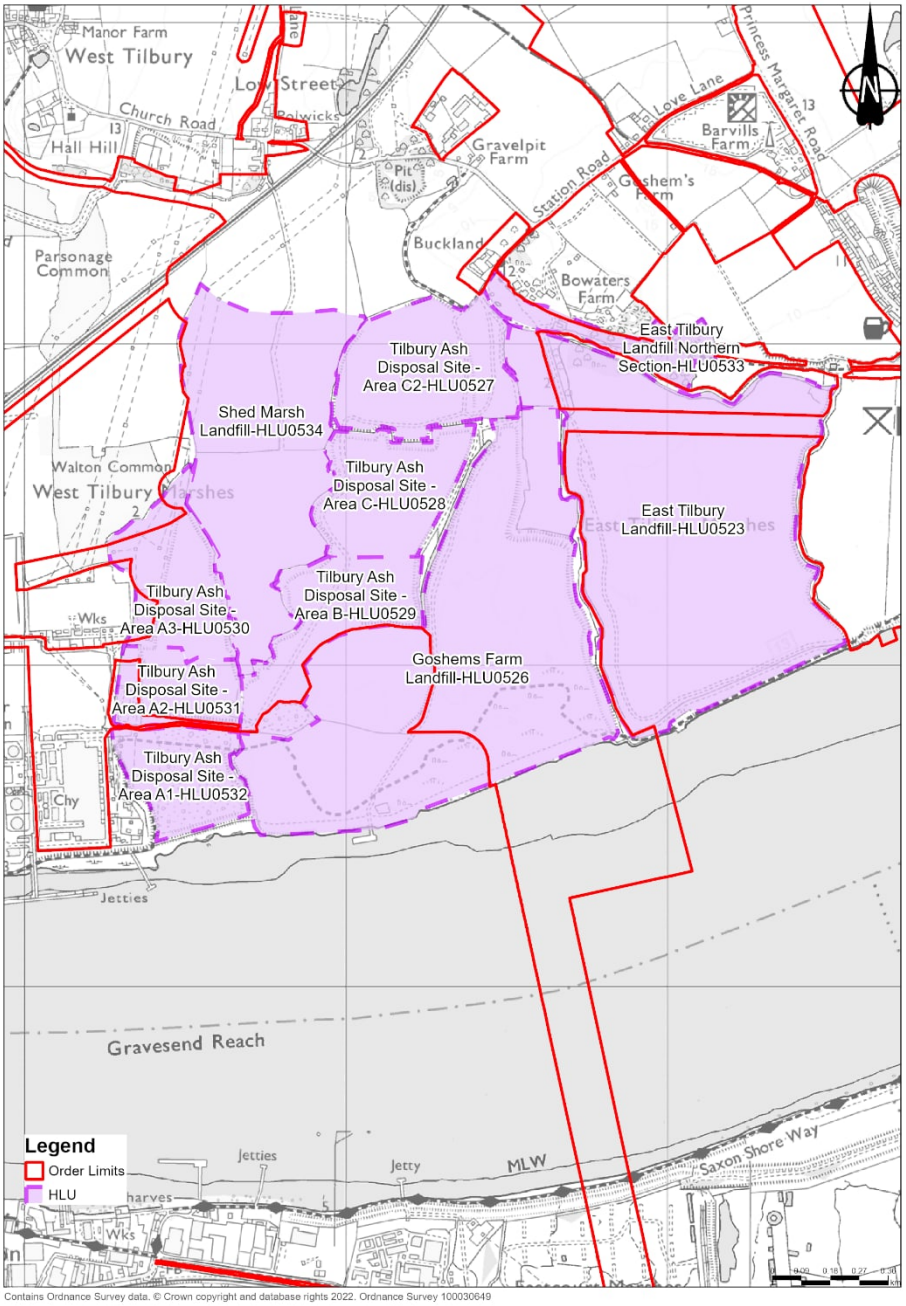


Plate 5.5 Environment Agency records of historical landfill areas near the North Portal

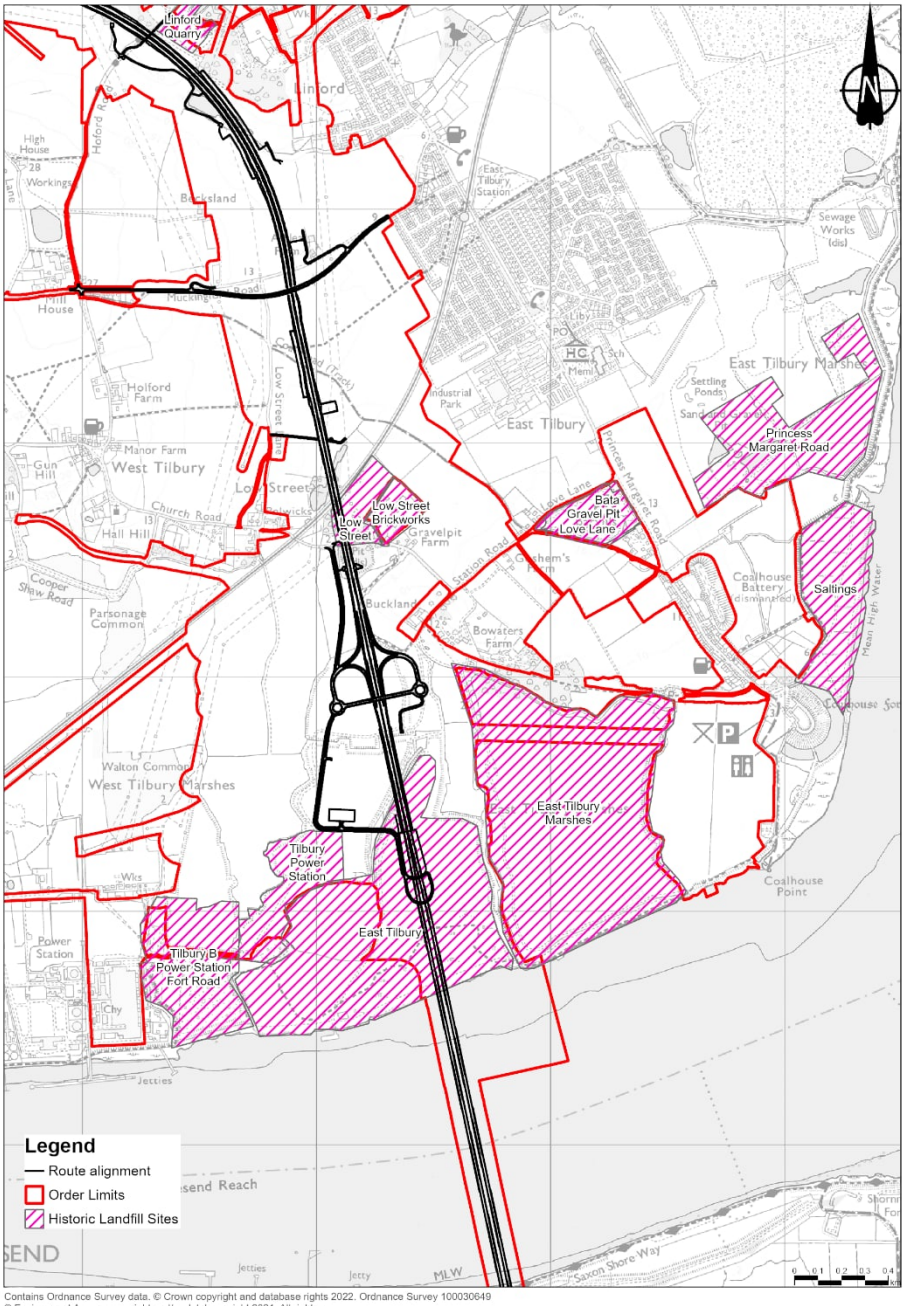
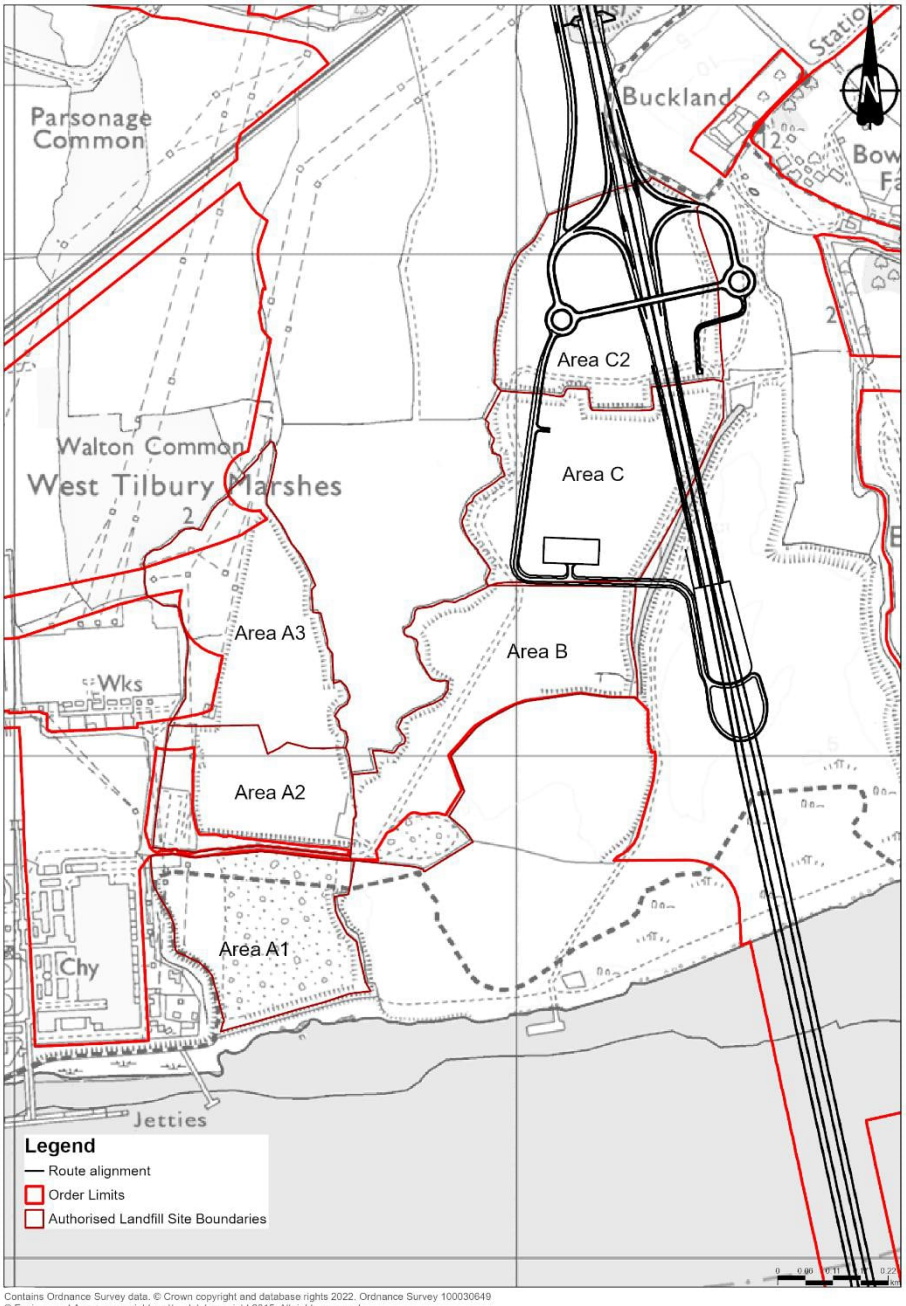


Plate 5.6 Environment Agency records of authorised landfill areas near the North Portal



Goshems Farm Landfill (HLU0526)

5.5.14 Goshems Farm (Plate 5.7) a historical landfill of approximately 78 hectares. There have been several phases of landfilling at this site, starting in the late 19th and early 20th century, with fill reported to be a mixture of mainly ash and bottles (SLR, 2011). It has the Thurrock Council ID THU048 and Environment Agency reference EAHLD00566. Previous licence numbers were Waste Management Licence (WML) 102617 and ING024 (Landmark, 2019).

5.5.15 Historical maps show that a sea wall ran through the southern section until 1948. The sea wall was no longer present on maps in 1955 suggesting it was

removed as part of land reclamation works (Landmark, 2019). Therefore, any deposition works in this section must have occurred post 1948.

5.5.16 The Environment Agency records indicate Goshems Farm was operated until 1958 by the Tilbury Contracting and Dredging Company Limited, indicating it may have been used for dredged sediment from the Thames. The waste type is recorded by the Environment Agency as including household waste (Landmark, 2019). Thurrock Council records the landfill as closed and the waste type as household and refuse ash; the closure date is again given as 31/12/1958 (Landmark, 2019). Ingrebourne Valley Ltd. stated that the land was historically filled with a mixture of 'ash and bottles' (Ingrebourne Valley Ltd., 2014a). The permitted waste types are inert, from mineral extraction, construction wastes, thermal processes and soil and stones.

5.5.17 The Environment Agency has also recorded two planning consents to extend the original tipping area. The first planning consent dated 4 July 1968 (reference THU/580/68) related to an extension of the permitted tipping area by 8.5 hectares along the northern boundary to blend the tip contours with the surroundings. This consent specified that this area was to be used for deposition of inert material and decomposed refuse only (Callear and Bewers, 1993).

5.5.18 The second planning consent dated 1968 (reference THU/587/68) extended the tipping area by 2.9 hectares into the north-west corner, for deposition of household refuse only (Callear and Bewers, 1993). An application in 1983 for the deposition of household, commercial and inert wastes was refused, but another application for the '*restoration…with dry household, commercial and inert wastes*' together with a new jetty was granted in 1990 (Table 5.3).

5.5.19 Planning permission was granted by Thurrock Council in September 1998 to Ingrebourne Valley Ltd. for the restoration of the former waste disposal site by spreading spoil from civil engineering works transported to site via the River Thames. Proposed restoration levels were between 4 and 8m AOD.

5.5.20 A report on the East Tilbury Landfill (HLU0523) referred to a lagoon, (known as the Esso lagoon) that was a suspected source of contamination to local surface waters (Callear and Bewers, 1993). The purpose and contents of this lagoon were not known but the outfall was indicated to be in the north of the Goshems Farm Landfill site (approximate National Grid Reference (NGR) 567460, 176660).

5.5.21 A pollution incident (Landmark ID 2151243) is recorded by the Environment Agency in the south-west of Goshems Farm Landfill (NGR 567000, 175800), dated June 1992. This was recorded as a Category 3 (minor) incident involving '*oils – unknown*'. No further details are available such as the cause, or whether soil and/or water was impacted. Another pollution incident was recorded in 1993 at Bowater Sluice adjacent to the east of Goshems Farm; no further details are available for this incident.

Recent Restoration Works (Ingrebourne Valley Ltd.)

5.5.22 Environmental Permit No. EPR/WP3094EP/A001 (type A25: deposit of waste to land as a recovery operation) dated 2011 permits importation of 1.8 million

tonnes of inert waste to a maximum depth of 2m (SLR report estimated 830,000 tonnes (SLR, 2011)) for restoration purposes.

5.5.23 Planning permission (application number 11/50352/TTGCND) was granted to Ingrebourne Valley Ltd. by Thurrock Thames Gateway Development Corporation dated 04 November 2011. It sets conditions for the restoration work (Thurrock Council, 2019). These include:

a. '*The site shall be restored to a condition suitable for a grazing agricultural after use…*

b. Importation of material and landfilling shall be completed by 31 October 2017 and all restoration works completed by 31 October 2018. Only suitable clean, non-putrescible waste materials (comprising topsoil, subsoil, brickwork, concrete, stone, pulverised fuel ash (PFA) clays and silts, plaster and sand or mixtures of these materials) shall be deposited at the site. In particular, no man-made materials shall be deposited at the site.'

5.5.24 Inert material has been sourced from various projects including the London Underground Northern Line Extension and the Thames Tideway Project (Ferrovial, 2015). Material is delivered by road and river and segregated at the Thames jetty. It is understood that additional Thames Tideway material is planned to be deposited at this site.

5.5.25 A summary of the landfilling phases at Goshems Farm is given in Table 5.3.

Table 5.3 History of landfilling and planning applications at Goshems Farm Landfill

Approximate date(s)	Operator(s)	Waste materials/application details
Late 19th century to 1958	Not known. Tilbury Contracting and Dredging Company Limited.	Pre-1950s domestic waste (may include coal ash, glass bottles, ceramics, etc.) (Landmark, 2019). River dredgings (sand, silt, clay).
1968 Planning Application (granted) reference number: THU/580/68 Planning Application (granted) reference number: THU/587/68	Not known.	Extension of the permitted tipping area by 8.5 hectares along the northern boundary to blend the tip contours with the surroundings. Extension of the permitted tipping area by 2.9 hectares into the north-west corner.
1983 Planning Application (refused) reference number: 83/00124/MIN	Not known.	Restoration of land by controlled infilling with dry household, commercial and inert wastes and the construction of jetty to serve the development (Thurrock Council, 2019).
1990 Planning Application (permitted) reference number: 90/00972/MIN	Not known.	Restoration of former tip site of agriculture with related woodland by means of infilling with predominantly inert, commercial and industrial waste (no documentation available) (Thurrock Council, 2019).

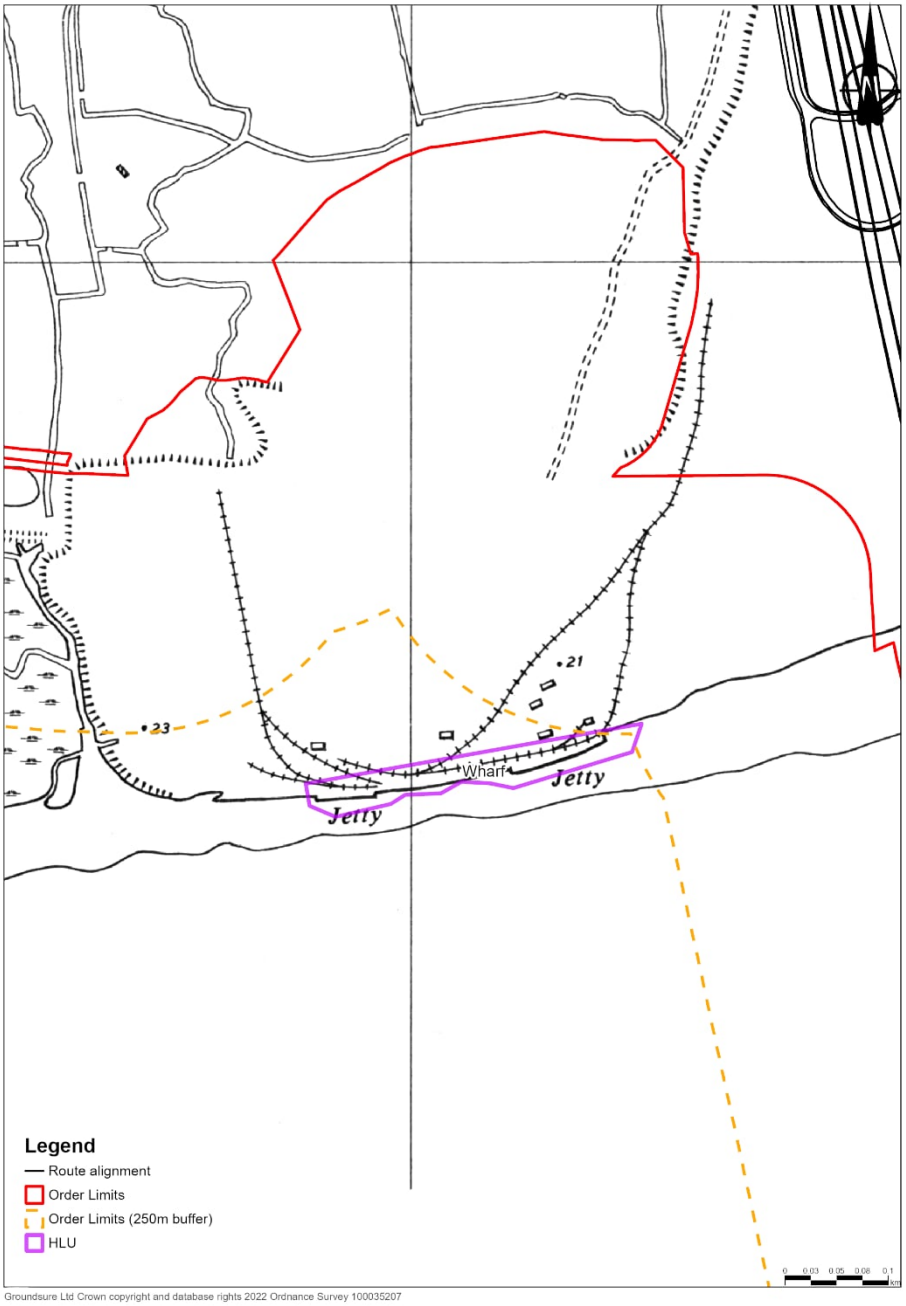
Approximate date(s)	Operator(s)	Waste materials/application details
1998 Planning Application (permitted) reference number: 98/00773/MIN 2011 and 2015 (modification of conditions)	Ingrebourne Valley Ltd.	Restoration of former waste disposal site by spreading spoil from civil engineering works transported to site via the River Thames. 2015 variation to increase quantity of imported material to 1,101,000m^3 (Thurrock Council, 2019).
2013 Planning Application (advice given) reference number: 13/00531/SCR	Ingrebourne Valley Ltd.	Screening Opinion for a Temporary Jetty at Goshems Farm, East Tilbury (Thurrock Council, 2019). See HLU0521.
2021 Application in determination. Application reference EA/EPR/WP3094EP/V003	Ingrebourne Valley Ltd.	Received by Environment Agency for a change in final restoration contours, waste types and quantities for restoring the landfill.

5.5.26 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, tributyltin (TBT), SVOC, VOC and hazardous gases.

Wharves South of Goshems Farm Landfill (HLU0521)

5.5.27 Several historical wharves and modern jetties are present on the north bank of the River Thames, to the east of Goshems Farm Landfill and Tilbury Power Station. Historical mapping from 1955 indicates two wharves present along the river bank which are served by two railway lines from the north-east (approximately 400m long) and north-west (approximately 300m) shown in Plate 5.7.

Plate 5.7 Extract from historical map showing wharves south of Goshems Farm (1:10:560 scale, 1955 edition) (HLU0521)



5.5.28 The wharves were still shown in the 1967 1:10,560 and 1991 1:10,000 scale historical maps, but the railway lines were no longer present. The wharves were still present on the 1991 historical map but were labelled as ‘disused’. Recent aerial imagery suggest the wharves are still present at the site but now appear to be grassed over and disused (Earthstar Geographics, 2022).

5.5.29 More recent importing of soil started in approximately 2013. A jetty was constructed between the wharves and was used for importing soils from various construction projects, including the Northern Line Extension, to raise the ground level at Goshems Farm (Greater London Authority, 2017).

5.5.30 A second jetty was constructed by Tideway FLO (Ferrovial Agroman UK Ltd. and Laing O'Rourke Construction as a joint venture) in 2018 for the same purpose, to enable deeper water barges to serve the site (The Impartial Reporter, 2019).

5.5.31 Potentially contaminating activities that may have been carried out include fuel and lubricant storage, railway maintenance and uncontrolled deposition of waste materials.

5.5.32 Potential contaminants associated with this HLU are considered to include metals, asbestos, inorganics, petroleum hydrocarbons and PAH.

Poultry Farm, Buckland (HLU0518)

5.5.33 A poultry farm was shown on historical mapping from 1961 to 1992 (Landmark, 2019). Several buildings are apparent at the site and are likely to have included sheds, waste tanks, fuel storage and other agricultural units.

5.5.34 Recent aerial imagery show the farm buildings are still present at the site, suggesting the farm may still be in operation (Earthstar Geographics, 2022).

5.5.35 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, pesticides, asbestos, ammoniacal nitrogen, microbial contamination and hazardous gases.

Tilbury Ash Disposal Site (PFA Landfill) (HLU0532, HLU0531, HLU0530, HLU0529, HLU0528, HLU0527) and Shed Marsh (HLU0534)

5.5.36 Tilbury Ash Disposal Site is a pulverised fly ash (PFA) landfill currently operated by RWE Npower. It was used for disposal of PFA, a waste product of coal combustion at Tilbury Power Station, which is now closed. The ash disposal site is split up into several areas in the Environment Agency records (A1, A2, A3, B, C and C2) as shown in Plate 5.4. Filling records provided by Landmark (2019) are summarised in Table 5.4. The ash disposal site also encompasses drainage ditches which discharge to the River Thames at 567900E, 175800N.

5.5.37 Natural geological material is not believed to have been excavated, with all landfill operations instead taking place on top of existing surfaces. A report prepared by RWE (RWE Npower, 2004) stated that disposal operations involve shallow land raise to a maximum of 6m AOD. It states that significant settlement is not anticipated, and the land is to be topsoiled and returned to agricultural use.

5.5.38 A 'slag heap' was shown across the majority of Area B on historical mapping dated 1991 but was absent on the previous map dated 1973.

5.5.39 The area known as 'Shed Marsh' (HLU0534) does not appear to be part of the area currently occupied by RWE, nor is there an Environment Agency record specifically for the area. However, it is shown in local authority records and therefore is considered to be a credible source, albeit this is the only line of evidence for this source.

5.5.40 Observations were made of PFA extraction from Areas A2 and A3 for reuse in manufacturing construction materials (walkover survey October 2017).

Table 5.4 Tilbury Ash Disposal Sites records

Landfill	HLU reference	Approximate area (hectares)	Historical landfill references (Landmark dataset key 189)	Authorised landfill references (Landmark dataset key 73)
Tilbury Ash Disposal Site Area A1 (authorised and historical landfill)	HLU0532	10.6	Tilbury B Power Station Fort Road (historical landfill comprising Areas A1 and A2). Reference EAHLD01275. Other reference 193/91 First waste input: 1978. Last waste input: date not given. Deposited waste included inert waste.	Licence number: NAT001 WML ref.: 70298 Issue date: 27/08/1991 EPR Licence: EAEPR\Environment Agency/EPR/LP3999NS/A001 Status: transferred 19/05/2017 Waste landfilling: >10 tonnes per day with capacity >25,000 tonnes excluding inert waste
Tilbury Ash Disposal Site Area A2 (authorised and historical landfill)	HLU0531	8.6		
Area A3 (authorised landfill)	HLU0530	13.7	N/A	Licence number: INT004 WML ref.: 71186 Issue date: 22/06/2001 EPR Licence: EAEPR\Environment Agency/EPR/DP3498NX/A001
Area B (historical and authorised landfill)	HLU0529	15.3	Also known as Tilbury Power Station. Reference EAHLD31052. BGS reference 1948. Thurrock Council Reference THU011. First waste input: 15/02/1968. Last waste input: date not given.	Licence number: NAT002 WML Licence ref.: 70262 Issue date: 20/01/1978 EPR Licence: EAEPR\Environment Agency/EPR/BP3399NM/A001
Area C (authorised landfill)	HLU0528	14.9	Thurrock Council Reference THU081.	Licence number: NAT001 WML ref.: 70298 Issue date: 27/08/1991 EPR Licence: EAEPR\Environment Agency/EPR/LP3999NS/A001

Landfill	HLU reference	Approximate area (hectares)	Historical landfill references (Landmark dataset key 189)	Authorised landfill references (Landmark dataset key 73)
Area C2 (authorised landfill)	HLU0527	19.3	N/A	Licence number: INN002 WML ref.: 71185 Issue date: 22/06/2001 EPR Licence: EAEPR\Environment Agency/EPR/DP3898NN/T001 (HLU0527 includes additional area to the north-east of Area C2)
Shed Marsh Landfill	HLU0534	40.5	Forms part of Thurrock Council reference THU011 (HLU0529). Waste type: PFA.	N/A

5.5.41 The latest Environmental Permit for the Tilbury Ash Disposal Site is variation application number EPR/GP3733DZ/V005 (dated 13 August 2020). The variation approves a derogation from the inert landfill waste acceptance criteria required by the Landfill Directive in respect of London Clay arising from various infrastructure and tunnelling projects.

5.5.42 Planning permission for the disposal of PFA was granted in 1963. A further grant is recorded in May 2013 for disposal at Areas A2, A3 and B (Thurrock Council, 2019). The operator named on the expired permits for all the 'Area' landfills is RWE Npower Plc.

5.5.43 An 'engineering report' dated 2010 was quoted in data provided to the Applicant by Thurrock Council as stating planning permission was granted to extend the height of the PFA disposal sites on Areas A1, A2, A3 and B to 9m AOD, with the remainder at 6m AOD.

5.5.44 A permit transfer in 2017 to Ingrebourne Valley Ltd. is recorded with respect to 'Tilbury Ash Disposal Site'. This area covers the former Areas A1, A2, A3, B, C and C2, with an additional area to the east of area C2. The permit allows deposition of >10 tonnes per day (Table 5.5) (Landmark, 2019).

5.5.45 Areas A1, A2 and C are grouped together in the Environment Agency licence records. Authorised landfill Areas A1 and A2 cover approximately the same extent as the (historical) Tilbury B Power Station Fort Road landfill. The operator for this landfill is shown as National Power Plc., a successor of the Central Electricity Generating Board which was operating between 1990 and 2001.

5.5.46 Environment Agency registered landfill site records from 2001 indicate Area A3 and C2 were receiving/licensed for inputs equal to or greater than 250,000 tonnes per year. All licences are recorded as type A07: Industrial waste landfill (factory curtilage).

5.5.47 The Environment Agency website also records a historical landfill in Area B. No dates are shown, and the operators are recorded as Esso Petroleum Company and Central Electricity Generating Board. Waste types are given as inert, industrial and liquid wastes, which may indicate that other types of power station waste are deposited in this area.

5.5.48 A pollution incident (Landmark ID 2151172) dated July 1992 is located near Bowaters Sluice to the west of East Tilbury. It is categorised as a Category 3 – minor incident to freshwater but no other details are given (Landmark, 2019).

5.5.49 PFA poses low risks to the environment compared to other forms of landfill. It has a low gas generation potential and becomes less permeable over time, thereby reducing leaching rates. However, the potential remains for unrecorded disposal of other wastes within the PFA, such as asbestos, and further investigation is required.

5.5.50 Potential contaminants associated with these HLUs are considered to include metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC and hazardous gases.

Tilbury Power Station (HLU0630), Power Station Works (HLU0629) and Railway Branch Lines (HLU0606 and HLU0607)

5.5.51 Tilbury A in the south-west corner of the site was a coal-fired, later oil-fired power station constructed from 1951 and operational between 1956 and 1981 (Essex County Council, 2010). Coal was previously stored in the northern section of the site during operation. ‘Works’ including tanks and hoppers (HLU0629) were shown on the 1973 historical map to the north of the power station, south of the railway. This area is believed to have been a former coal storage area (walkover survey, October 2017). This area also incorporated former branch lines that ran between the main railway line and the power station which may have brought coal to the power station. The railway lines appear to have been removed on recent aerial imagery (Earthstar Geographics, 2022). Tilbury A was demolished in 1999 (Essex County Council, 2010).

5.5.52 Tilbury B, in the south-east corner of the site, was a coal-fired power station operational between 1969 and 2011. Occasionally, heavy fuel oil was also used at Tilbury B to power up the generators (RPS, 2017). In 2011, construction began to convert Tilbury B power station to burn biomass, although the plans were mothballed in 2013 (RWE, n.d.). The power station has been demolished; this was completed in 2018 (RWE Npower, 2016). The demolition works should have been carried out in accordance with relevant environmental legislation to ensure that pollution or spread of hazardous materials (e.g. asbestos) was controlled. The walkover survey in October 2017 (viewed from land with public right of way) noted separated piles of metal, concrete and cables.

5.5.53 Several ground investigations have been carried out at the site between 2004 and 2017. The main findings of these investigations are summarised in the Land Contamination Review and Gap Analysis Report prepared by RPS (RPS, 2017). The investigations noted evidence of heavy metals, asbestos fibres, free phase hydrocarbons, TPH and PAH within the soil and shallow perched groundwater.

5.5.54 Made ground at the site has been recorded as 0.4m to 3.3m thick with bands of concrete also found at depth (0.55 to 3.2m bgl) (RPS, 2017).

5.5.55 Three main pollution incidents are believed to have occurred on site (RPS, 2017). The first relates to a Heavy Fuel Oil spillage within the bund area surrounding an oil tank. The incident is recorded as moderate/major and may have impacted surface waters via a surface water drain system within the bund area. The second incident relates to asbestos wastes identified along the western boundary of the coal stockyard during lighting tower installations at the site in 1997 and 2006.

5.5.56 The last incident relates to a release of transformer oil during a fire in the 1960s. This incident was subsequently followed by an investigation and light non-aqueous phase liquid (LNAPL) remediation, completed in October 2014. Later site walkovers carried out by RPS in 2015 suggested that some LNAPL may still be present (RPS, 2017).

5.5.57 Two phases of remedial works have been carried out at the site by Vertase FLI, in 2014 and 2017 (RPS, 2017). The first phase took place in the location of the former Tilbury A and comprised excavation of contaminated soil, pump and treat of groundwater including free product recovery, ex situ bioremediation of hydrocarbon impacted soil, reinstatement, decommissioning of boreholes and verification of remedial work.

5.5.58 The second phase was carried out to remediate contamination in five locations around the former Heavy Fuel Oil tank farm and contractor's laydown area. The areas were identified within the RPS Environmental Permitting Strategy (RPS, 2017). This phase comprised a combination of ex situ bioremediation of soils, pump and treat of perched groundwater, including the remediation of groundwater impacted by free phase hydrocarbons.

5.5.59 The 2017 RPS report concludes that a number of pollutant linkages may remain active at the site related to the presence of petroleum hydrocarbons, PAH, asbestos and ground gas.

5.5.60 Anti-glider ditches were constructed during WWII to the north and north-east of the power station (Essex County Council, 2010). These may have been subsequently infilled and may be within the Order Limits.

5.5.61 A permitted surface water discharge for the power station cooling water to the River Thames is recorded on the Environment Agency website at NGR TQ664753. Cooling water is sometimes treated with biocides to prevent biofilm growth.

5.5.62 In February 2012, there was a major fire involving 4,000–6,000 tonnes of wood pellets in two storage cells (BBC, 2012).

5.5.63 Six discharge consents (for cooling and/or treated water) and numerous Integrated Pollution Control (IPC) records are shown within the Tilbury Power Station site (Landmark, 2019). Tanks, lighting towers, chimneys and conveyors are shown on historical mapping.

5.5.64 No evidence of oil or chemical spillage was identified on the aerial photographs (limited dates) covering the Tilbury area (Lee, Mills and Brunsden, 2018).

5.5.65 According to the available historical OS mapping, railway branch lines (HLU0606 and HLU0607) were present between approximately 1950 and 1987 connecting the main line to the former Tilbury Power Station. The tracks were still present in 1991 but may have been disused.

5.5.66 Potential contaminants associated with Tilbury Power Station (HLU0630) are considered to include metals, coal constituents (PAH, sulphur), nitrogen oxides, petroleum hydrocarbons, VOC, SVOC, PCB, PFAS and asbestos.

5.5.67 Potential contaminants associated with the Power Station works (tanks and hopper) (HLU0629) are considered to include metals, coal constituents (PAH, sulphur) petroleum hydrocarbons, VOC, SVOC and asbestos.

5.5.68 Potential contaminants associated with the railway branch lines (HLU0606 and HLU0607) are considered to include metals, inorganics, petroleum hydrocarbons, PAH and asbestos.

Tilbury Sewage Works (HLU0626) and Associated Features (HLU0623, HLU0624 and HLU0627)

5.5.69 Tilbury Sewage Works (HLU0626) was constructed in approximately 1940 and is still present at the site. An extension was added in the northern section of the site in 1990 (HLU0627). Sewage treatment tanks were constructed by 1950 in the northern section of the site and were still present on historical mapping in 1992 (HLU0623). The use of these tanks is not known. Aerial imagery shows that these tanks are no longer present at the site (Earthstar Geographics, 2022).

5.5.70 Potential contaminants associated with these HLUs are considered to include metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases and PFAS.

5.5.71 An aqueduct and water tanks were constructed to the north of the sewage works in approximately 1950 and the tanks were still present on historical maps in 1992 (HLU0624).

5.5.72 Recent aerial imagery now shows the aqueduct and water tanks and the aforementioned sewage treatment tanks to have been replaced by an area of hardstanding which may potentially be used for storage. Heavy goods vehicles are also visible, as well as piles of material stored on the hardstanding (Earthstar Geographics, 2022). It is unclear what the material is, but it could be non-biodegradable waste separated from the sewage waiting to be moved to landfill or waste disposal.

5.5.73 Potential contaminants associated with this HLU are considered to include metals, inorganics, sewage-related organics, ammoniacal nitrogen, asbestos, micro-organisms and hazardous gases.

5.5.74 An IPC record (Rtal Ltd.) dated 2000 was located here for ‘5.1 A © Incineration within the Waste Disposal Industry’ (Landmark, 2019), possibly associated with an energy recovery process from waste solids. A more recent (2017) Integrated Pollution Prevention and Control (IPPC) application for a biomass processing plant for Stobart Biomass Products Limited is also recorded.

Electricity substation Facility (HLU0622)

5.5.75 An electricity substation is shown east of Fort Road and north of Tilbury Sewage Treatment Works (HLU0626) on historical maps from 1950. Recent aerial imagery show that the substation is still present at the site(Earthstar Geographics, 2022).

5.5.76 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PCBs.

East Tilbury Landfill (HLU0523 and HLU0533)

5.5.77 The East Tilbury Landfill (Thurrock Council ID THU017), also known as East Tilbury Marshes Landfill, is a former hazardous waste landfill located adjacent to the east of the Order Limits (Plate 5.4). It covers an approximate area of 84 hectares including the additional area to the north (HLU0533). Environment Agency records (reference EAHLD00554) list the operator as Cory Environmental Limited (Landmark, 2019) and filling dates are given as 1932 to 1990. The recorded waste types are industrial, commercial and household wastes and liquids/sludge wastes. The permit holder is listed as William Cory and Son Limited.

5.5.78 A ‘Status Report’ prepared in 1993 for the predecessor to the Environment Agency, the National Rivers Authority (Callear and Bewers, 1993), provides some records of waste inputs, indicating domestic, commercial and industrial waste, including hazardous materials and liquid wastes. These waste types are consistent with those given in local authority records (Landmark, 2019). The estimated total waste capacity of the landfill is in the order of 1,000,000m3 (Callear and Bewers, 1993).

5.5.79 It is understood that the landfill is underlain by Alluvium (predominantly clays and silts with peat bands), concealing the River Terrace Deposits and the Chalk. The Alluvium contains clayey layers that may have provided a low permeability barrier between contaminated landfill and the underlaying River Terrace Deposits and Chalk aquifer (Callear and Bewers, 1993).

5.5.80 According to the Status Report, at the onset of the landfill operations at the site, no engineered pollution control measures were in place. In 1978, dual drainage ditches were constructed around the perimeter of the waste to prevent leachate arising from the landfill spreading into the immediate surroundings. Leachate was collected in the inner drainage ditch and pumped back over the waste as a form of recirculation. It is not reported when leachate collection ceased. Excess leachate not collected from the inner drainage ditch continued to be discharged to the River Thames via Bowater Sluice, located on the south-western corner of the landfill. The number of pollution incidents reportedly declined after the perimeter ditches were installed (Callear and Bewers, 1993). Contamination from historical or current leachate inputs to surface waters may build up in sediments within local ditches and the River Thames.

5.5.81 Given the nature of the materials disposed at the site, it is very likely the landfill has been, and still is, generating landfill gases, although at the time of writing, no records have been made available to the Project about this aspect.

5.5.82 Potential contaminants associated with these HLUs are considered to include metals, inorganics, petroleum hydrocarbons, PAH, SVOC, VOC, chlorinated

hydrocarbons, PCBs, ammoniacal nitrogen, PFAS, asbestos and hazardous gases.

Historical Jetty South of East Tilbury Landfill (HLU0520)

5.5.83 A jetty was shown on historical OS mapping south of the area of East Tilbury Landfill between approximately 1948 and 1991 (labelled as disused by this date). The purpose of this jetty is uncertain. A report on East Tilbury Landfill states that 'early in the [landfill's] history… waste was brought down river from London by barge' (Callear and Bewers, 1993). Therefore, this jetty may have been used for waste transfer.

5.5.84 Recent aerial imagery (Earthstar Geographics, 2022), shows that the jetty is largely demolished.

5.5.85 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, SVOC, VOC, chlorinated hydrocarbons, PCBs, ammoniacal nitrogen, PFAS and asbestos.

Coalhouse Point Coal Wharf (HLU0709) and Tramway (HLU0707)

5.5.86 The coal wharf at Coalhouse Point was first shown on the 1777 Chapman and Andre historical map as two small structures (Essex County Council, 2018). The coal wharf was shown in more detail on historical maps from 1838 (Brown and Pattison, 2003). The wharf replaced an earlier ferry pier and was used for unloading coal which was taken to the village of East Tilbury (Fautley and Garon, 2001).

5.5.87 The wharf remained in use until WWII when a radar tower (labelled as a 'water tower' on historical maps) was constructed adjacent. The tower was no longer labelled on the 1951 historical maps and currently survives in a dilapidated state. Archaeological pits excavated at the wharf recorded a 'considerable depth' of made ground including coal and ceramics (Brown and Pattison, 2003). Aerial images of the area taken in 2000 show some lines of possible timbers are visible within the inter-tidal area (Essex County Council, 2018).

5.5.88 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

5.5.89 The tramway (HLU0707) was built in the 1860s to deliver guns and stores to the adjoining Coalhouse Fort. In 1897, it was extended onto a jetty at the wharf (Brown and Pattison, 2003). The tramway was shown on the 1948 historical map but not on the 1955 edition.

5.5.90 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH and asbestos.

Sewage Works at Coalhouse Fort (HLU0704 and HLU0705)

5.5.91 A sewage works, including tanks (HLU0704) and a pumping station (HLU0705), is shown on historical mapping. The sewage tanks were first shown on mapping in 1921 and were possibly constructed in a former pond, the nature of the infill material of which is not known. The pumping station was first shown in 1990.

5.5.92 Potential sources of contamination in this area include leaks and spillage of untreated sewage, and fuels for any pumping machinery. A pollution incident

(Landmark ID 2151247) is recorded from 1996 in the area of the sewage tank. The record indicates that the contaminants were alkali chemicals, leaking from drums, and it was classed as a Category 3 – minor incident (Landmark, 2019). Alkaline substances such as quicklime are sometimes used to treat sewage sludge for use as a fertiliser.

5.5.93 Potential contaminants associated with these HLUs are considered to include metals, petroleum hydrocarbons, PAH, PFAS, asbestos, microbial contamination, inorganics and hazardous gases.

East Tilbury Battery (HLU0721)

5.5.94 The East Tilbury Battery, located to the east of Princess Margaret Road in East Tilbury, was constructed in approximately 1889/1890 to support the Coalhouse Fort with long-range guns mounted on concealed carriages (Historic England, 2020). The battery was decommissioned prior to the First World War, during which time the guns were also removed (Historic England, 2020). The battery remains present at the site and has been largely preserved.

5.5.95 As the battery was used for military purposes, shrapnel, waste metal and explosives may be present at the site along with chemicals associated with fuel storage and waste fire pits.

5.5.96 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, explosives and sulphates.

Saltings Landfill (HLU0728)

5.5.97 Saltings Landfill (Thurrock Council reference THU042) is a large (19.5 hectares) former landfill to the east of Princess Margaret Road along the banks of the River Thames. Historical maps show the site was originally marshland/mudflats which were labelled as Common Saltings in 1865.

5.5.98 A landfill licence was issued in 1988 to Holland Dredging Company (UK) Ltd for the deposition of river dredgings, inert waste and liquid sludge (Landmark, 2019). The last input date is recorded as 1993, after which time the landfill is presumed to have been disused. Filling dates are not available.

5.5.99 The landfill is now a designated wildlife site (Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Special Area of Conservation (SAC)) and Local Nature Reserve (LNR) which is part of the Coalhouse Fort estate. During the walkover survey in 2018, the site manager stated that the landfill bund was constructed from sacks of mud and silt and that the landfill used to receive dredging waste from the River Thames but has long since dried up and re-vegetated into rough grassland and scrub.

5.5.100 A mineral workings trade discharge consent was also issued to Holland Dredging Company Ltd in 1983. The consent was revoked in 1993 (Landmark, 2019). The site is also recorded as being part of the military land associated with the nearby East Tilbury Battery and Coalhouse Fort between 1898 and 1938.

5.5.101 Recent aerial imagery show the site is disused and covered by shrubland (Earthstar Geographics, 2022).

5.5.102 Potential contaminants associated with this HLU are considered to include metals, inorganics, TBT and hazardous gases.

Goshems Farm (HLU0538)

5.5.103 Goshems Farm is located on Station Road, west of East Tilbury village. The farm buildings and the area to the south-east are approximately 3.1 hectares in area. Historical aerial images indicate that trailers and hay or silage are stored on the site.

5.5.104 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.5.105 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, pesticides, asbestos, ammoniacal nitrogen, microbial contamination and hazardous gases.

5.6 North Portal to A13

Area description

5.6.1 The route alignment covering the area from the North Portal to the A13 includes a section of the Tilbury and Southend Railway crossing west of the hamlet of Low Street. The railway also cuts across countryside around the settlements of West Tilbury, Mill Ho, Becksland and Linford. Chadwell St Mary is to the west. High-voltage electricity transmission overhead lines run from Tilbury Power Station in the south northwards to the M25.

5.6.2 The land generally rises northwards along the route from 5m AOD at the North Portal to 29m AOD in the area of Stanford Road south of the A13 junction.

5.6.3 There are significant earthworks planned around the A13 junction involving both cuttings and the construction of embankments. A viaduct is also proposed to cross over the Tilbury Loop railway line.

Geology and hydrogeology

5.6.4 The underlying bedrock is anticipated to be Chalk around the North Portal. However, moving northwards, Thanet Formation is anticipated to underlie the majority of the route alignment in this section. Patches of Lambeth Group are expected around the Orsett golf course area to the east of the route alignment amongst the Thanet Formation. The A13 junction is underlain by the Lambeth Group and, in the northern portion of the junction, London Clay and Harwich Formation.

5.6.5 The superficial deposits in this section are expected to comprise Alluvium, Head Deposits and the Taplow Gravel Member. The Boyn Hill Gravel Member is also shown between Brentwood Road and the A13 junction. According to BGS datasets, Head Deposits underlie the eastern portion of the A13 junction, with the Black Park Gravel Member underlying the area south of Stanford Road and the A13/A128 junction.

5.6.6 The superficial deposits in this area are classified as Secondary A and Secondary Undifferentiated aquifers. The Boyn Hill and Taplow Gravel Members are classed as Secondary A aquifers. The solid geology including the Chalk, Thanet Formation, Lambeth Group and Harwich Formation have been classified as Principal and Secondary aquifers, and the London Clay has been classified as Unproductive Strata. There is one groundwater Source Protection Zone (SPZ) which is associated with the Linford Pumping Station and covers the majority of the North Portal area.

5.6.7 Several ponds have been identified across this section of the Project route between Low Street to Heath Place and the A13 junction. A stream and spring are also present in Linford.

Overview of potential sources of contamination

5.6.8 This section of the Project route includes several sites with an extensive history of industrial land use, including Princess Margaret Road Landfill, East Tilbury Quarry, Low Street Brickworks and Linford Quarry. This section also includes several farms and PFSs. The London, Tilbury and Southend Railway crosses over the Project route in the south.

5.6.9 Details for each HLU including potential contaminants associated with the potential source are given below. The likely significance of the overall level of risk for each potential contamination source is assigned in Annex C (Part 1) based on available information.

Gasworks, gasometer and retort (HLU0608)

5.6.10 Gasworks, gasometer and retort are shown on the 1863 map only. A gasholder was marked as disused within the site area on the 1892-1914 map (National Library of Scotland (2022) Map Images. Accessed July 2022. https://maps.nls.uk/).

5.6.11 Potential contaminants associated with this HLU are considered to include metals, inorganics, aromatic hydrocarbons, PAH, phenols, asbestos and hazardous gases. There is also potential for coal dust, spent oxide foul lime, coal tar and ammoniacal liquor contamination to be associated with this HLU.

Tilbury Junction railway, engine shed and sidings (HLU0609)

5.6.12 Tilbury junction railway and associated sidings are shown on the 1863 historical map. An engine shed associated with the railway is shown on the 1944-1971 map towards the northern end of the site area with coal sidings labelled to the eastern side of the site area (National Library of Scotland (2022) Map Images. Accessed July 2022. https://maps.nls.uk/).

5.6.13 Potential contaminants associated with this HLU are considered to include asbestos, metals, inorganics and organics (including fuel oils, lubricating oils, greases, chlorinated and non-chlorinated solvents, phenols, PAH and PCB) and hazardous gas.

Depot (HLU0612)

5.6.14 An industrial depot is first present in 1992 located to the east of the current Ferry Road and south of the current A1089 alignment (Landmark, 2019). The depot is not shown on mapping preceding 1992 (National Library of Scotland

(2022) Map Images. Accessed July 2022. https://maps.nls.uk/). Recent aerial imagery shows the depot has been replaced with hardstanding parking area and large warehouse (Earthstar Geographics, 2022) understood to be used for trailer storage and repair (RTJ Trailers Ltd (2022). Accessed July 2022. http://www.rtjtrailers.com/).

5.6.15 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, phenols, VOC, SVOC and asbestos.

Tilbury East Railway Sidings (HLU0625)

5.6.16 Railway sidings were shown on historical maps from 1959 up until 1966 and were no longer shown on the 1973 historical map (Landmark, 2019). The sidings occupied the length of Tilbury East Junction to approximately 75m north of the River Thames. Recent aerial imagery show the majority of the site footprint is now occupied by an area of hardstanding used for vehicle storage (Earthstar Geographics, 2022).

5.6.17 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, asbestos, inorganics, PAH, VOC and SVOC.

Infilled Pond North of Station Road (HLU0514)

5.6.18 A pond approximately 96m^2 in area was shown on historical maps from 1865, within the boundary of Gravelpit Farm, located adjacent to the north of Station Road, south-east of Readmans Industrial Estate (HLU0512). The pond was absent on the 1939 historical map, indicating it had been infilled.

5.6.19 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.

Former Low Street Brickworks (HLU0524) and Associated Features (HLU0802, HLU0803, HLU0804, HLU0805, HLU0828 and HLU0830)

5.6.20 Several features are shown on historical mapping in and around the Low Street Brickworks site. These include:

a. Railway cisterns, wells and an engine house (pre-1865 to approximately 1967, not shown on 1973 mapping) (HLU0828)

b. Brickworks (clay and brick tiles manufacturer) with associated kilns (HLU0524) shown mapping from 1921 to 1955, not shown by 1961

c. Railway sidings, first shown on 1921 mapping, last shown in 1955, not shown by 1961 (HLU0830)

d. Four electricity substations (from approximately 1961) (HLU0802 to HLU0805)

e. ‘Works’ at Gravelpit Farm (1991)

5.6.21 The railway cisterns, wells and engine house were no longer present on historical maps by 1973. It is unlikely that the demolition works were carried out

to modern standards such as the removal of potentially hazardous materials, including asbestos. Therefore, residual soil contamination from such works may be present at the site.

5.6.22 Railway sidings were shown on historical maps up until 1967 and were no longer shown on the 1973 historical map. Gravel pits are also indicated in this area.

5.6.23 These features predate Low Street Landfill (HLU0535) and Low Street Brickworks Landfill (HLU0536).

5.6.24 Site walkovers carried out in October 2017 observed that electricity substations were still present at the site and are thought to be associated with the adjacent railway or pumping station.

5.6.25 Potential contaminants associated with HLU0524 are considered to include metals, inorganics, phenols, asbestos and PAH.

5.6.26 Potential contaminants associated with HLU0828 are considered to include metals, PAH, petroleum hydrocarbons, PCB, inorganics, phenols and asbestos.

5.6.27 Potential contaminants associated with HLU0830 are considered to include metals, petroleum hydrocarbons, asbestos, inorganics, PAH, VOC and SVOC.

5.6.28 Potential contaminants associated with HLU0802, HLU0803, HLU0804 and HLU0805 are considered to include PCBs and petroleum hydrocarbons.

Low Street Landfill (HLU0535), Low Street Brickworks Landfill (HLU0536) and Disused Pit to South of Station Road (HLU0515)

5.6.29 There are two records of historical landfills associated with the former Low Street Brickworks site: the Low Street Landfill and the Low Street Brickworks Landfill. They are adjacent, located south of the East Tilbury railway and north of Station Road (Plate 5.8).

Low Street Landfill (HLU0535)

5.6.30 The former pits north of Station Road are registered as historical landfills. The Low Street Landfill (adjacent to the railway) has the Thurrock Council ID THU061 and Environment Agency reference EAHLD00579. Filling dates are recorded as 1969 to 1976, and the waste type is documented as industrial and commercial wastes in Environment Agency records; and non-hazardous, industrial, commercial in local authority records. Quarry and brickworks materials may also be present at the site.

5.6.31 The pits are thought to have been infilled between 1955 and 1961 (Landmark, 2019). The infill material is listed as industrial waste. It is, however, possible that unrecorded materials have also been deposited within the pits.

5.6.32 Low Street Landfill covers an area of approximately six hectares, previously occupied by railway sidings. The north-east portion of the historical landfill extends over the area currently occupied by electricity substations. BGS records indicate the south-west portion of the site was occupied by a mineral site which is now recorded as '*ceased*' (Landmark, 2019). Clay and shale from the Taplow Gravel Member and sand from the Thanet Formation were extracted during operation. The Thanet Formation in this location is recorded as being 20m to 30m thick (BGS, 2017).

5.6.33 The southern portion of the site was occupied by a separate mineral site which is also recorded as '*ceased*' according to the BGS records (Landmark, 2019). During operation, sand and gravel from the Taplow Gravel Member were extracted.

5.6.34 The walkover survey in October 2017 confirmed that landfilling activities had ceased and recorded that the site was used for temporary lorry and skip storage. A large burnt area and several large soil mounds were observed around the site containing visible evidence of metal, ceramics, concrete and brick. Site personnel stated that the mounds were used as earth bunds. Two small brick structures were also observed at the site. It was stated that the structures were boreholes used for the supply of water to Tilbury Power Station. It was also stated that there are large below-ground water pipes and electricity cables beneath the site. There was a small brick building on the north-western edge of the site which appeared to be a substation or a pumping station.

5.6.35 Potential contaminants associated with HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

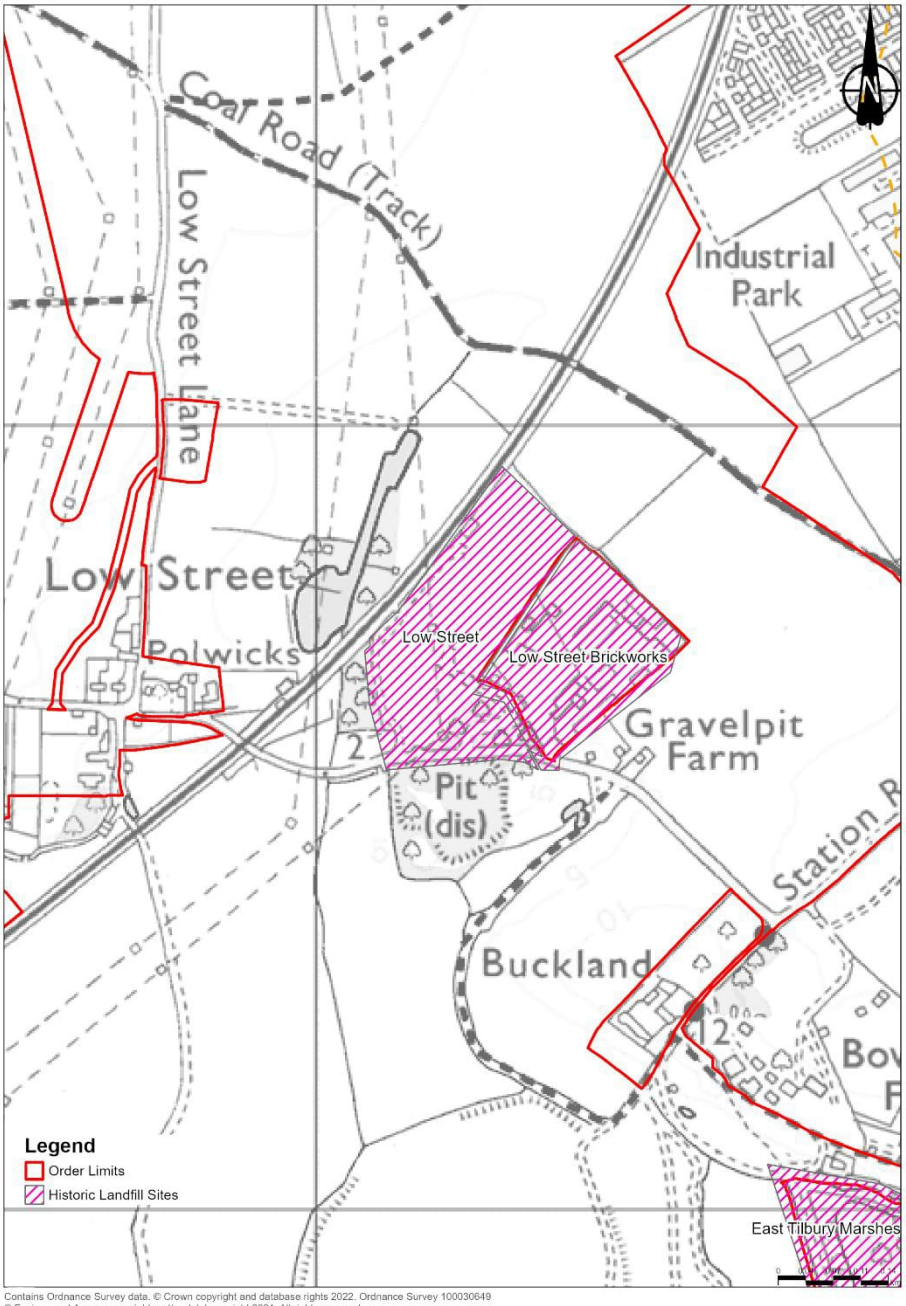
Low Street Brickworks Landfill (HLU0536)

5.6.36 The Low Street Brickworks Landfill (located beneath the current metal recycling facility) has the Thurrock Council ID THU062 and Environment Agency reference EAHLD01270. Filling dates are given as 1956 to 1977 and the waste type is given as industrial waste (Landmark, 2019).

5.6.37 Low Street Brickworks Landfill covers an area of approximately four hectares, previously occupied by a brickworks with associated kilns and gravel pits (approximately 1921–1955). The site is now occupied by a metal recycling facility and industrial estate (HLU0512). A mineral site was recorded at the site but is now recorded as '*ceased*'. During operation, Taplow Gravel Member sand and gravel and Thanet Formation sand was extracted from the site.

5.6.38 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Plate 5.8 Low Street Landfill (HLU0535) and Low Street Brickworks Landfill (HLU0536)



5.6.39 The Environment Agency website indicates the site operator for both landfills was Leeman and Readman (Environment Agency, 2017). The fill thickness is not known but the original pit depth is 3–4m, based on the known thicknesses of the extracted gravel deposits (Lee, Mills and Brunsden, 2018).

Disused Pit to South of Station Road (HLU0515 and HLU0537)

5.6.40 The gravel pit to the south of Station Road (HLU0515) is shown on mapping from 1868 and marked as disused on the most recently available historical OS map dated 1991. Aerial imagery show it is mainly woodland (Esri, Maxar, Earthstar Geographics, and the GIS User Community, 2022). The filled ground

has also been identified within Landmark data and is recorded as 'Unknown filled ground' (HLU0537).

5.6.41 A mineral site (HLU0515) was recorded south of Station Road at the gravel pit site which is now '*ceased*'. During operation, Taplow Gravel Member sand and gravel and Thanet Formation sand was extracted at the site and the site was recorded as disused in 1973 (Landmark, 2019).

5.6.42 Potential contaminants associated with HLU0515 and HLU0537 are considered to include metals, inorganics, PAH, petroleum hydrocarbons, asbestos and hazardous gases.

Scrap Metal Facility (HLU0512) and Infilled Ponds (HLU0513 and HLU0525)

5.6.43 This site is currently a metal recycling facility and industrial estate which processes and recycles scrap metal from local activities such as the dismantling of Tilbury Power Station (European Metal Recycling (EMR), 2020). The earliest available mapping showed 'works' on the site from 1961, prior to which the site was shown as agricultural land (approximately 1865–1895) (Landmark, 2019). A gravel pit and brickworks appeared on the site between approximately 1895 and 1921 (HLU0524). The brickworks may have been disused by 1923 and demolished between approximately 1955 and 1961.

5.6.44 Records indicate the site is a licensed waste management facility, and licence records show licence 71134 (75,000–250,000 tonnes/year) was issued in 1998 to JS Trucks Ltd and transferred in 2004 to Lester Reclaim Spares Ltd. (licence 71395). A metal recycling sites (mixed) licence (<10,000 tonnes/year) was issued in 1994 to Mayer Parry Recycling Ltd. (modified in 2009).

5.6.45 Several active and inactive contemporary trade directory entries have also been noted at the site (Landmark, 2019) including hydraulic engineer manufacturers (inactive); engineering services (including metal fabrication) (inactive); scrap metal merchants (active); car breakers/dismantlers (inactive); garage services (active); vehicle dealers and car body repairs (inactive); and car painters and sprayers (inactive).

5.6.46 A discharge consent registered to Mayer Parry Recycling Ltd is located near to the site, dated 2011, for discharge of trade discharge into land (soakaway).

5.6.47 Metal recycling operations cover a wide range of activities, including dismantling, sorting and storage. The time period and types of activities that have been historically undertaken at the site, and any pollution control measures used, are not known. Potential releases of various contaminants may have occurred to soil associated with vehicle fluids, burning of non-metal materials, removal of asbestos-containing components and cleaning of metals using solvents. Before modern pollution control measures were implemented, metal recycling sites may have disposed of liquid or solids wastes by burying on site (Department of the Environment, 1995b).

5.6.48 Potential contaminants associated with HLU0512 are considered to include metals, inorganics, petroleum hydrocarbons, PAH, VOC, SVOC, phenols, chlorinated hydrocarbons, PCBs and asbestos.

5.6.49 Two former ponds (HLU0513 and HLU0525) were shown on historical mapping at the location of the metal recycling facility between 1961 and 1973. They were

no longer shown on historical maps in 1991, suggesting they may have been infilled. The fill material is unknown.

5.6.50 Potential contaminants associated with HLU0513 and HLU0525 are considered to include metals, inorganics, PAH, petroleum hydrocarbons, asbestos and hazardous gases.

Electricity substations at EMR Scrapyard (HLU0504, HLU0505 and HLU0506)

5.6.51 Three electricity substations are shown on historical maps from 1961 to the most recent OS map dated 1992 around the EMR scrapyard at Readmans Industrial Estate. Recent aerial images suggest the substations are still present at the site (Earthstar Geographics, 2022).

5.6.52 Potential contaminants associated with these HLUs are considered to include PCBs and petroleum hydrocarbons.

Love Lane Pit Landfill (HLU0727)

5.6.53 A landfill and mineral site is located at Love Lane/Princess Margaret Road in East Tilbury. The site has previously been noted as ‘Bata gravel pit’ and could have been related to the former Bata shoe factory located to the north-west of the landfill.

5.6.54 Historical mapping indicates excavation at Love Lane Pit (approximately 7.2 hectares) would have started between 1898 and 1921, and the pit was shown on historical maps up to 1973. A historical landfill licence was held by Aylett Gravel for the site between approximately 1934 and 1988 for the disposal of inert, industrial and commercial waste. The pit was no longer shown on historical maps in 1990, suggesting it may have been infilled.

5.6.55 Aerial imagery (Earthstar Geographics, 2022) and the 2018 walkover survey have revealed that the site is now occupied by a solar farm.

5.6.56 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, PFAS, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen and hazardous gases.

Former Bata Shoe Factory and Thames Industrial Park (HLU0827)

5.6.57 Bata shoe factory was located south of Muckingford Road and was first shown on historical maps dated 1938. Various features such as factories, garages and tanks are shown on the site on historical maps from 1967 to 1988. The factory was operational for around 70 years and closed in 2005 (Burrows, 2016).

5.6.58 A wide range of chemicals can be involved in the shoe manufacturing processes, and as such, there is a potential for residual contamination to be present within the soil at the site. Recent aerial imagery suggest the factory building has been restored and is still present at the site as the Bata Heritage Centre (Earthstar Geographics, 2022).

5.6.59 The site also held a planning consent for the storage of flammable substances, namely liquefied petroleum gas. LAPPC records at the site are dated 1998 (PG6/28 rubber processes) and 1994 (PG6/23 coating of metal and plastic). No records of tanning processes are available, but an earlier tannery was shown on historical maps dated 1938 on a smaller site on the other side of Princess

Margaret Road. The site was also registered under the Notification of Installations Handling Hazardous Substances Regulations 1982 (revoked in 2013) (Landmark, 2019). No details of which hazardous substances were held are recorded.

5.6.60 The site is now occupied by Thames Industrial Park. Records of manufacturing businesses at the site include manufacturers of air and water filtration equipment, canvas goods, rubber, silicones and plastics, packaging, pumps and compressors, cooling and refrigeration, and concrete products. Building supplies and metal fabrication companies are also listed (Landmark, 2019).

5.6.61 Potential contaminants associated with this HLU are considered to include VOC, SVOC, metals, petroleum hydrocarbons and phenols.

Princess Margaret Road Landfill (HLU0724)

5.6.62 Historical maps show extensive gravel pits (approximately 41.7 hectares) covering the southern portions of the area since approximately 1973, but mineral extraction and related activities are reported to have occurred on the site since the 1950s (PDE Consulting Limited, 2008). BGS Mineral Records show Kempton Park Gravel Member sands and gravels and Thanet Formation sands were extracted across the site (Landmark, 2019).

5.6.63 A landfill licence was issued to S Walsh & Sons in 1980, and the current status is recorded as unknown. The licence is classed as A6: landfill taking other waste (construction, demolition and dredgings). An inactive landfill licence for non-hazardous commercial and industrial waste is also registered for Aylett Gravel Ltd.

5.6.64 A review of planning applications submitted to Thurrock Council and aerial imagery suggest the site is still operational as both a landfill and extraction site. A planning application (reference: 08/00958/TTGMIN) was submitted by S Walsh & Sons in 2008 for the continued use of the site for sand and gravel extraction and deposition of inert waste. The application also included plans for phased restoration works across the site. According to the Thames Thurrock Gateway Development Corporation planning committee report attached to the planning application (Thurrock Thames Gateway Development Corporation (2010) Planning Committee 1 November 2010 Agenda Item No 7, ‘parts of the site have been in-filled with inert, commercial and industrial waste since the 1980’s and works of restoration undertaken’.

5.6.65 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, PFAS, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases and TBT.

East Tilbury Quarry Landfill (HLU0725)

5.6.66 The East Tilbury Quarry Landfill is shown to the east of Princess Margaret Road. The site is shown on available historical maps as a gravel pit from 1991 but was registered as a licensed waste facility in 1985 when a landfill licence was issued to S Walsh & Son Ltd. The landfill was classed as A6: landfill taking other wastes (construction, demolition and dredgings). Environment Agency records show a prosecution relating to authorised processes at the site, but the location may not be precise and could potentially affect the proposed ecological mitigation land (Landmark, 2019). This relates to a case recorded in 2013

where the waste carrier for the site was found guilty for illegally dumping asbestos waste at the site.

5.6.67 The current licence status of the site is unclear but aerial imagery (Earthstar Geographics, 2022) suggest that the quarry is now part of the active Princess Margaret Road landfills and is therefore assumed to be included under the landfill licence held by S Walsh & Son Ltd.

5.6.68 A BGS mineral site is recorded on the site for the extraction of Thanet Formation sands and Taplow Gravel Member gravel and sand. The mineral site is recorded as '*ceased*'.

5.6.69 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases and TBT.

Low Street Railway (Tilbury Loop) (HLU0605) and Former Low Street Railway Station (HLU0510)

5.6.70 The railway line crosses the Project route at Low Street and is part of the Tilbury Loop railway line on the London, Tilbury and Southend railway line.

5.6.71 Low Street Station was present approximately 170m west of the route from 1861 to 1967 (Smith, 2008). The railway was electrified in the 1960s (Smith, 2015).

5.6.72 Potential contaminants associated with these HLUs are considered to include metals, inorganics, petroleum hydrocarbons, PAH and asbestos.

Condovers Farm (HLU0539) and Sheep Wash (HLU0503)

5.6.73 Condovers Farm is located on Church Road, north of the London, Tilbury and Southend railway line (HLU0605).

5.6.74 The farm buildings are shown on the earliest available historical mapping dated 1865. Later maps indicate that additional buildings were constructed on site and existing buildings may have been demolished.

5.6.75 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.76 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and microbial contamination.

5.6.77 A sheep wash (HLU0503) is shown on historical maps from 1939 to 1973. Recent aerial imagery suggest the site is not now used for livestock; however, the continued existence of the sheep dip has not been ruled out (Earthstar Geographics, 2022). Compounds used can contain metals such as arsenic, organochlorides (banned in 1994) and various pesticides including organophosphorus and synthetic pyrethroid pesticides.

5.6.78 Potential contaminants associated with this HLU are considered to include metals and pesticides.

Railway Yard (HLU0540)

5.6.79 A small industrial area is present at 'Railway Yard', north of the London, Tilbury and Southend railway line, off Station Road. Contemporary trade directory records show an active plant hire and sales workshop (Apollo plant hire and sales) and an inactive gas suppliers on this site (Landmark, 2019). Aerial images suggest that buildings existed at this site prior to 2004 (use unknown), and the site was redeveloped in approximately 2006. Recent imagery appear to show heavy goods vehicle storage, temporary cabins and various materials stored on site (Earthstar Geographics, 2022).

5.6.80 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH phenols, asbestos, SVOC and VOCs.

Infilled Gravel Pits (HLU0516, HLU0819, HLU0821)

5.6.81 Two former gravel pits, HLU0516 (985m^2) and HLU0821 (31,000m^2) are located north of London Tilbury and Southend Railway, to the south of Church Road. The pits are adjacent, and the larger gravel pit was first shown at the site in approximately 1865.

5.6.82 Slope symbols were shown on all sides of the HLU0821 pit in 1865 but from 1898 were only shown on the north, east and west sides, indicating that it may have been only excavated to a shallow depth, cut into the south-facing slope. Therefore, significant filling may not have occurred, but the presence of some made ground cannot be ruled out. The pit was shown as a sports ground from 1955 and is now the site of Condovers Scout Activity Centre. A building labelled 'works' was shown in the south-east of pit HLU0821 (at Condovers Farm) from 1958 to 1991 (last available historical map), but no information on the activities carried out is available.

5.6.83 A smaller gravel pit (HLU0516) was shown to the east of the larger gravel pit between approximately 1921 and 1991. It is not shown on current OS maps so may have been infilled.

5.6.84 During operation, both pits were likely used for the extraction of Taplow Gravel Member sand and gravel (Landmark, 2019).

5.6.85 Another gravel pit (HLU0819, 0.4 hectares) was located to the east of Courtney Road south of the A13 junction and was excavated from approximately 1960. It was potentially infilled between 1973 and 1991 based on historical map evidence. Aerial imagery now shows the site is now agricultural land (Earthstar Geographics, 2022).

5.6.86 Potential contaminants associated with these HLUs are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.

St James' Church and Graveyard (HLU0839)

5.6.87 St James' Church and Graveyard is shown on historical maps at West Tilbury from 1865. The church building is still present but appears to be a residence.

5.6.88 The original church is thought to have been present on the site since Norman times and constructed towards the end of the 12th century. The original church

was destroyed several times through storms, wars and invasions but has been rebuilt (St James Trust, n.d.). According to the church website, the church itself is now a private residence but the graveyard is still present on the site (St James Trust, n.d.).

5.6.89 Potential contaminants associated with this HLU are considered to include metals (particularly lead), formaldehyde and ammoniacal nitrogen.

Wellhouse Farm (HLU0840)

5.6.90 Wellhouse Farm first appeared on historical maps in 1865. Although the farm buildings were still present until the last available maps, dated 1991, it was no longer labelled as Wellhouse Farm from 1895.

5.6.91 Recent aerial imagery suggests the farm is still present. Several small warehouse-type buildings can be seen, and waste appears to be stored in the west (Earthstar Geographics, 2022).

5.6.92 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Gunhill Farm (HLU0842)

5.6.93 Gunhill Farm, located outside of West Tilbury village, was first shown on historical maps in 1865. The farm was still present on the last available map dated 1991.

5.6.94 Recent aerial imagery shows several outhouses, including a relatively large building with a corrugated roof on site. A residential property can also be seen (Earthstar Geographics, 2022).

5.6.95 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Mill House Farm (HLU0863)

5.6.96 Mill House Farm is located between Holford Road and High House Lane. The farm was first shown on historical maps in 1865 when Tilbury Flour Mills occupied were present. By 1895, a gravel pit was labelled on the western edge. Mill house was labelled in 1923. Mill house was expanded in 1973 and again in the last available map dated 1991.

5.6.97 Recent aerial images show the site is still occupied by an arable farm (Earthstar Geographics, 2022).

5.6.98 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Shroves Hill Wood Landfill (HLU0859)

5.6.99 Shroves Hill Wood Landfill was first shown on historical maps on Linford Road in 1898. In 1898, gravel pits were shown, which expanded in 1923 and were no longer present by 1967. In 1967, a works was shown with several buildings. Further buildings were added in 1973. A poultry farm, tank and a depot were shown in the last available map dated 1991.

5.6.100 Shroves Hill Wood Landfill is labelled on local authority records as a landfill accepting household, non-hazardous industrial and commercial waste (THU063). According to the Environment Agency database, the first input date is recorded as 1951 and the last input is 1973 (Ref: EAHLD01271).

5.6.101 Recent aerial imagery shows that the landfill is now largely infilled and appears to be used for storage of materials, lorries and possible extraction activities in the south-west corner. Several caravans are also present (Earthstar Geographics, 2022).

5.6.102 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOCs.

Bennetts Industrial Estate (HLU0860)

5.6.103 The industrial estate is shown on historical maps on Linford Road in 1923, with a gravel pit also present adjacent. More buildings were present by 1967. No significant changes are apparent between 1967 and the last available map dated 1991.

5.6.104 Historical aerial images show the estate was occupied by several buildings and appeared to have been used for storage of cars or motor-related businesses in 1999. Recent aerial imagery shows the industrial estate is still present (Earthstar Geographics, 2022).

5.6.105 Several trade directory entries are associated with the estate relating to a used car dealership, garage, asbestos waste transfer (issued on 17 July 2014 to Asbestos Waste Transfer Ltd), waste treatment to produce soils (<75,000 tonnes per year, issued to Henderson and Taylor Public Works Ltd) and a waste wood treatment licence (issued to Rekola Recycling Ltd) (Landmark, 2019).

5.6.106 Potential contaminants associated with this HLU are considered to include Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Chadwell Hall Pit Landfill (HLU0861)

5.6.107 Chadwell Hall Pit Landfill is a former landfill, recorded on the local authority landfill database as THU010. No details are available relating to the filling dates or waste type (Landmark, 2019).

5.6.108 The landfill is not shown on the available historical maps, but recent aerial images show the site appears to be a grassed public open space within a residential area (Earthstar Geographics, 2022).

5.6.109 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOCs.

Linford Road Landfill (HLU0862)

5.6.110 Linford Road Landfill is shown on historical maps south of Linford Road, from 1966 when a gravel pit and works is noted. Both the gravel pit and the works were expanded in 1973. The pit was labelled as disused in the last available map dated 1991, but the warehouses were still present. No details are available relating to the filling dates or waste type accepted.

5.6.111 Recent aerial imagery and mapping shows the landfill to have been developed to residential housing (Earthstar Geographics, 2022), with the Coward Trading Estate on the southern boundary.

5.6.112 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Buckingham Hill Landfill (HLU0864)

5.6.113 Buckingham Hill Landfill is on Buckingham Hill Road (Plate 5.10). The historic landfill is a former sand and gravel pit which was excavated between approximately 1949 and 1962 according to historical maps. The gravel pit was infilled with household waste from approximately 1967 to 1991 (Landmark, 2019). The landfill base is presumed to be unlined within Thanet Formation. The maximum waste depth is reported as 15m (Thurrock Council, 2020).

5.6.114 The following reports were provided by Thurrock Council to the Applicant. These reports provide both desk-based information and the results and assessment of gas monitoring relating to areas of crop growth impacted by landfill gas. The areas of crop impact vary depending on the time of reporting, however are shown along the western boundary with Buckingham Hill landfill:

a. Methane Gas Monitoring Collingwood Farm Chadwell St Mary Essex (ADAS, 1995)

b. ADAS (1995) undertook investigation of the fields associated with Colingwood Farm adjacent to the west of Buckingham Hill landfill. High levels of methane gas along the eastern boundary of the field adjacent to the landfill were recorded. It was concluded that there was a good correlation between measured methane levels and severity of crop damage.

c. Phase 1 Land Quality and Ground Gas Assessment Collingwood Farm, Essex (Waterman Environmental, 2008)

d. Waterman Environmental (2008) undertook a desk based review of information and concluded that the principal sources of contamination were likely to be associated with ground gas / leachate from Buckingham Hill landfill, or the high pressure gas main present on the eastern boundary of Collingwood Farm. Further investigation was recommended.

e. Collingwood Farm: Alleged Crop Damage Phase 2 Site Investigation (SKM Enviros, 2010)

f. SKM Enviros (2010) undertook the drilling and installation of boreholes within the landfill, along the boundary of the landfill and the adjacent Collingwood Farm field, and within the field.

g. At the landfill, all boreholes encountered a clay cap to between 1m and 2m thickness, underlain by waste of various composition, but including sand and silt, construction waste, wood, plastics, textiles, paper, wire and ceramics. Strong landfill odours were also noted. The boreholes were drilled to a maximum depth of 13m and did not penetrate the full thickness of the landfill. No evidence of waste was recorded in the exploratory holes on the landfill boundary or within the field, with the recorded natural soils comprising sands, gravels, silts and clays.

h. The results of the landfill boreholes recorded concentrations of methane up to 73% volume by volume in air (v/v) and carbon dioxide to 32.3% v/v, with associated depletion in oxygen concentrations. A positive correlation between atmospheric pressure and gas concentration was evident. Elevated methane and carbon dioxide was also recorded at the field boreholes, with highest concentrations recorded in the centre part of the field boundary, correlating with zones of crop impact.

i. Reduction in oxygen levels as a result of migration of landfill gas was concluded to be the cause of retardation of crop growth and ultimately die-back. Passive gas control by means of a vent trench was recommended to prevent future gas migration and therefore mitigate the adverse impact on crop growth. No further information has been provided to the Project as to any work post this 2010 report. Subsequent correspondence from Thurrock Council to the Project (email dated 2 August 2022) states that there appears to be no record suggesting that a gas venting trench was installed.

5.6.115 A further report was provided by Thurrock Council:

a. Buckingham Hill Road Report on Gas Risk Assessment (Applied Environmental Research Centre Limited, 2006)

b. This report presents the results of investigation of risk of landfill gas to adjacent residents and general public from Buckingham Hill landfill. Monitoring of two on-site boreholes located between the perimeter of the landfill and the nearest residential properties was undertaken, in the north west corner of the landfill.

c. Borehole records were not provided with the report. Gas monitoring was undertaken on five occasions between April 2005 and January 2006. Methane was not detected. Carbon dioxide was recorded up to 6.4% v/v with associated depleted oxygen.

5.6.116 Recent aerial imagery show that the former landfill is now an area of scrubland, with Linford Civic Amenity waste collection site operational to the east, which is a household waste and recycling centre (Earthstar Geographics, 2022).

5.6.117 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

5.6.118 This site is also a proposed nitrogen deposition compensation site, and is discussed in Annex D.

Collingwood Farm Landfill (HLU0865)

5.6.119 Collingwood Farm Landfill is located to the south of the A13 (Plate 5.10). The site was unoccupied until 1986 when it was shown on historical maps as a gravel pit.

5.6.120 Landmark environmental databases show the site is a local authority recorded landfill (THU033) which accepted soil and inert builder's waste. Collingwood Farm Landfill is also recorded as a 9.6ha historic landfill on the Environment Agency database (ref: EADLD01627) and received inert, industrial, commercial and household waste.

5.6.121 A planning application report (06/00352/TTGOUT) issued to Thurrock Council in 2006 states that the site is a former quarry, parts of which were also a former landfill. Part of the site is noted as still undergoing backfilling, but the majority was completed at the time of the application. The site is also noted as having an uneven land surface. Recent aerial imagery suggest the land surface has since been levelled, and part of it is used as a storage facility, with multiple containers visible (Earthstar Geographics, 2022).

5.6.122 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Brentwood Road Petrol Filling Station (HLU0866)

5.6.123 Brentwood Road PFS is shown on historical maps on Brentwood Road between 1865 and 1923 when a small building was present. By 1938, a larger building was constructed which then expanded in 1966. In 1973, a large building was present. No changes were made between 1973 and the last available map dated 1991.

5.6.124 Current aerial imagery shows a petrol filling station now present (Earthstar Geographics, 2022).

5.6.125 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Chadwell St Mary Cemetery (HLU0867)

5.6.126 The cemetery and chapel are shown on historical maps on Brentwood Road between 1921 and 1938.

5.6.127 According to the Thurrock Council website, the cemetery opened in 1925 (Thurrock Council, n.d.). Recent aerial imagery show the cemetery and crematorium are still present (Earthstar Geographics, 2022).

5.6.128 Potential contaminants associated with this HLU are considered to include metals (particularly lead), formaldehyde and ammoniacal nitrogen.

Chadwell St Mary Landfill (HLU0868)

5.6.129 Chadwell St Mary Landfill is a local authority recorded landfill located at the A13, on the A1089 Dock Approach Road. The landfill (THU052) is recorded as having received inert, industrial and commercial waste between 1961 and 1965 (Landmark, 2019).

5.6.130 The landfill was not shown on historical maps, but a technical college was present on historical maps by 1973. Recent aerial imagery shows the area to be vegetated with the college still present (Earthstar Geographics, 2022).

5.6.131 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Woodview and Sandy Lane Landfills (HLU0869)

5.6.132 Woodview and Sandy Lane landfills are shown on historical maps at the A13, on the A1089 Dock Approach Road. The area was originally occupied by Heath Farm in 1865. In 1923, a gravel pit was shown. The pit was expanded by 1947 and appeared to no longer be present in 1955. A works and a recreational ground were labelled in 1966. Between 1973 and 1982, a road was constructed through the area.

5.6.133 The landfills are recorded on the local authority databases as receiving industrial commercial and household waste. The filling dates were given as 1961 to 1967 for Woodview landfill (THU050) and 1961 to 1980 for Sandy Lane landfill (THU021).

5.6.134 Recent aerial images show the area is now with residential development adjacent (Earthstar Geographics, 2022).

5.6.135 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Barvills Farm (HLU0729)

5.6.136 Barvills Farm is located on Princess Margaret Road, north of East Tilbury village.

5.6.137 The farm buildings are first shown and labelled as a farm on historical mapping from 1967, and previous maps indicate that some gravel extraction has taken place, related to the gravel pit at Love Lane Landfill adjacent to the north (HLU0727). LiDAR data indicate that the farm may be within the former pit, but some filling cannot be ruled out and so made ground can be assumed to be present.

5.6.138 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels,

agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.139 Potential contaminants associated with this HLU are considered to include ammoniacal nitrogen, petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, microbial contamination and hazardous gases.

Ashlea Farm (HLU0834)

5.6.140 Ashlea Farm is located on Muckingford Road west of Linford village. The residential building in the south of the site is first shown on historical mapping from 1955; however, the larger barns and silos to the north are only shown on mapping from 1988. The surrounding farmland appears primarily arable rather than livestock production (Earthstar Geographics, 2022).

5.6.141 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.142 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Linford Quarry Landfill (HLU0816), Gravel pit mounds (HLU0817), Rainbow Shaw Quarry Landfill (HLU0825) and Precast Concrete Works (HLU0818)

Linford Quarry Landfill (HLU0816)

5.6.143 Linford Quarry Landfill is located to the south of Holford Road (Plate 5.9). The area included in this source covers various pits identified in this area and areas covered by the local authority landfill records. HLU0816 is therefore larger than the Environment Agency recorded landfill area for Linford Quarry Landfill.

5.6.144 Several mounds (HLU0817) were shown in the south of the landfill on historical OS maps between 1958 and 1987 (Landmark, 2019). The mounds were no longer present on the historical maps in 1991, and LiDAR data do not indicate clearly whether or not they are still present. The most likely source of the material is waste from the gravel extraction activities, but other contaminative materials may also be present.

5.6.145 There are five former gravel pits recorded at the Linford Quarry site which cover an area of approximately 40 hectares. The gravel pit located in the southern portion of the site is recorded as being used for the extraction of Thanet Formation sands and is now '*ceased*'. The gravel pits located in the central, western and north-western portions of the site are recorded as being used for the extraction of Black Park Gravel Member sands and gravels and are now '*ceased*' (Landmark, 2019). The pits are estimated to have been between 5m and 13m in depth. The gravel pit located in the north-eastern portion of the site is recorded as being used for the extraction of Thames Valley Formation and Black Park Gravel Member sands and gravels and is also '*ceased*'. According to data received from Thurrock Council, the extraction activities at the site took place from 1984 and stopped in 1993 (Halcrow Hyder JV, 2016).

5.6.146 There are two landfill licence records associated with the gravel pit in the site of the western gravel pit. The first was issued in 1993 to Tarmac Ltd. for a landfill classed as A7: Industrial landfill (factory curtilage) and is now recorded as being expired. The second is active and was issued to Tarmac Building Products Ltd in 2006. The licence is for a landfill classed as L05: Inert landfill (Landmark, 2019). A walkover carried out in 2018 revealed the landfill is used for the disposal of rejected or broken aircrete blocks manufactured at the factory on site.

5.6.147 An approved planning application was submitted to Thurrock Council by Durox in 2014 to revise the restoration scheme and extend the time for tipping of on-site generated inert waste to April 2024 (reference: 14/00323/FUL).

5.6.148 Potential contaminants associated with HLU0816 are considered to include inorganics, metals, asbestos, hazardous gases.

5.6.149 Potential contaminants associated with HLU0817 are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos and hazardous gases.

Rainbow Shaw Quarry Landfill (HLU0825)

5.6.150 Rainbow Shaw Quarry is shown to the north-west of Linford, to the north of Holford Road (Plate 5.9). The gravel pit was shown on mapping as disused from approximately 1973; however, recent aerial images indicate that works may be ongoing at the site (Earthstar Geographics, 2022).

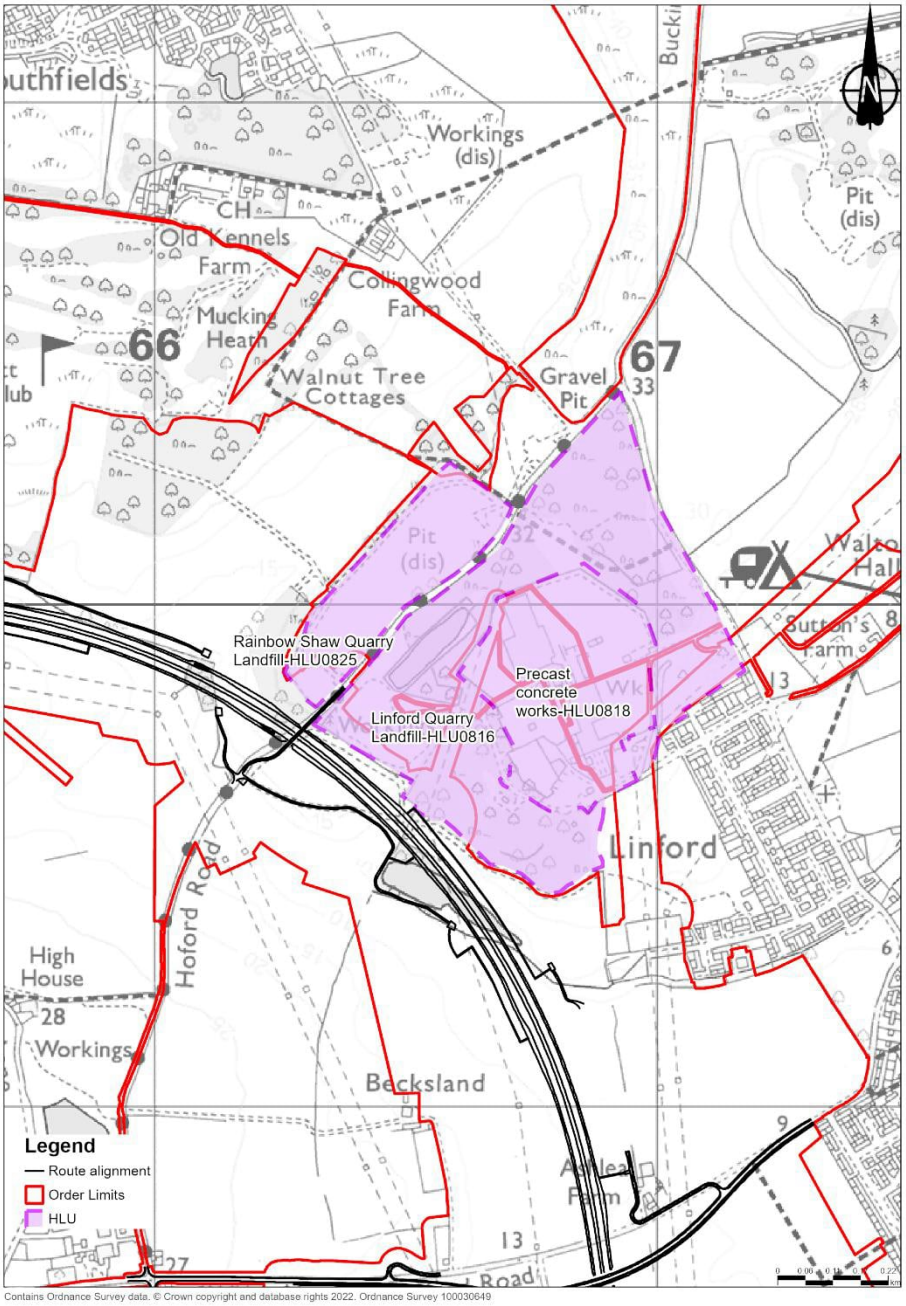
5.6.151 BGS records indicate the gravel pits at the site were used for the extraction of Black Park Gravel Member and Thanet Formation sands and gravels. The pit is recorded as being '*ceased*' (Landmark, 2019).

5.6.152 The site was registered as a licensed waste management facility in 2006. The licence was issued to Clearserve Ltd and classed as L05: Inert Landfill. The licence appears to still be active. Environment Agency records state the site was first permitted as a landfill in 1999 and operations began in 2000. The site also holds a licence for physical treatment facilities which was issued to Clearserve Ltd in 1997. The licence appears to still be active, but no further details are available (Landmark, 2019).

5.6.153 Information from Thurrock Council reported borehole monitoring at the site (Halcrow Hyder JV, 2016). During the monitoring, it was revealed that groundwater levels within the chalk were between -3m and 3m AOD. In the Thanet Formation, groundwater was between -5m and 4m AOD. The site is also recorded as having no requirement for a basal lining system (Halcrow Hyder JV, 2016).

5.6.154 Potential contaminants associated with this HLU are considered to include inorganics, metals, asbestos and hazardous gases.

Plate 5.9 Linford Quarry Landfill (HLU0816), Rainbow Shaw Quarry Landfill (HLU0825) and Precast Concrete Works (HLU0818)



Precast Concrete Works (HLU0818)

5.6.155 A ‘works’ (with several tanks) is shown on OS mapping from approximately 1971 to the present day and is now registered as a precast concrete works operated by Tarmac Building Products Limited. Durox aircrete blocks are manufactured at the site from PFA, sand, cement, aluminium powder, lime and water. Aerial imagery ((Earthstar Geographics, 2022) suggest the gravel pit has been partially infilled in the north-east but may still be operational in the north-west.

5.6.156 Several trade directory entries have been recorded at the site. Durox Building Services and the concrete and mortar readymix company, RMC Readymix, are both recorded as inactive. Tarmac Building Services Limited was issued a landfill licence in 2006 and is still present and active at the site. The landfill is classed as A05: inert landfill (Landmark, 2019).

5.6.157 LAPPC records for the site indicate that '*blending, packing, loading and use of bulk cement*' (PG3/1) and '*sand drying and cooling*' (PG3/9) was permitted from 1992. A discharge consent dated 1988 was recorded (Aerated Concrete Ltd) for discharge into land (Landmark, 2019). Trade directory entries for road haulage services (Canute Group Ltd), ready-mix concrete and mortar manufacturing (Cemex, Tarmac and RMC Readymix), and building block manufacturers and distributors (Tarmac) are shown within the concrete plant (Landmark, 2019).

5.6.158 Two pollution incidents are recorded at the concrete works. A spillage of '*chemicals – alkali*' (Landmark ID 2151178) is given a Category 3 – minor impact rating, located at a '*ditch adjacent to Durox plant*'. A release of diesel (Landmark ID 2151257) is also given as a minor (potential groundwater) impact. During the walkover survey, several silos and hoppers containing cement, sand and lime sand were noted, along with bunded tanks of 'stabilisation oil'. An electricity substation and high-voltage electricity transformer, a 156,000 litre gas oil (reserve boiler fuel) tank, a salt and brine plant, slurry tanks, and aluminium powder storage areas were also observed (Highways England, 2018bc).

5.6.159 Potential contaminants associated with this HLU are considered to include alkalis, petroleum hydrocarbons, VOC, SVOC and PCB.

Brook Farm (HLU0835)

5.6.160 Brook Farm is located off High House Lane. The farm was shown on the earliest available historical maps dated 1864. The current buildings are to the east of High House Lane, however in the past mapping shows that buildings have also been located to the west and south of the current arrangement, and which have included glasshouses.

5.6.161 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.162 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Infilled Ponds at Brook Farm (HLU0814 and HLU0815)

5.6.163 Two ponds were shown on historical mapping from 1864 north of Brook Farm, either side of High House Lane. Both ponds were no longer shown after the 1973 map, indicating it may have then been infilled. The infill material is not known but may include agricultural wastes.

5.6.164 Potential contaminants associated with these HLUs are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases, herbicides and pesticides.

Orsett Golf Club (HLU0858)

5.6.165 Orsett Golf Club is first shown on historical maps at Brentwood Road, south of the A13 in 1915. The golf club is still present.

5.6.166 Although the golf club was not shown on historical maps until 1915, it has been present since approximately 1899 (Thurrock Local History Society, 2020). A wooden clubhouse was erected in 1901 but was later replaced by an asbestos-sheet panel building in approximately 1919 (Thurrock Local History Society, 2020). Recent aerial imagery shows that the golf club is still present (Earthstar Geographics, 2022).

5.6.167 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, asbestos, herbicides and pesticides.

Seaborough Hall (demolished) (HLU0822)

5.6.168 Seaborough Hall was a residential property located to the west of Brentwood Road, shown on historical mapping dated from 1865 to 1973. It was not shown on the 1986 historical map. The site may have included fuel stores such as coal or oil for domestic heating. Thurrock Local History Society record that only a stone wall and rubble remains at the site (Thurrock Local History Society, 2019). Recent aerial imagery indicate that the site has mostly been incorporated into the adjacent arable field (Earthstar Geographics, 2022).

5.6.169 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals and asbestos.

Infilled Pond West of Brentwood Road (HLU0807)

5.6.170 A pond was present at the former Seaborough Hall site west of Brentwood Road between approximately 1865 and 1954. It was no longer shown on historical maps in 1963, suggesting it may have been infilled. The fill material is unknown.

5.6.171 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, inorganics, asbestos and hazardous gases.

Infilled Gravel Pits East of Brentwood Road (HLU0823 and HLU0824)

5.6.172 Two gravel pits were shown on available historical mapping located east of Brentwood Road from 1915 and infilled between approximately 1938 to 1954.They were labelled as old gravel pits from 1954. The pits were no longer shown on historical maps from 1963.

5.6.173 Potential contaminants associated with these HLUs are considered to include metals, asbestos, petroleum hydrocarbons, hazardous gases, PAH and inorganics.

Heath Place (HLU0966)

5.6.174 Heath Place is located off Hornsby Lane approximately 0.8km north of Chadwell St Mary. The farm was shown on the earliest available historical maps dated 1865. The building layout alters from the 1955 historical map, and by 1965 the building layout appears to be the current one. No information on the current use (agricultural or industrial) of the site is available.

5.6.175 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.176 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, asbestos, pesticides, ammoniacal nitrogen and hazardous gases.

Former Nevilles Farm (HLU0967) and Infilled Pond (HLU0933)

5.6.177 Nevilles Farm was shown on all available historical maps, dated between 1865 and 1993. Limited details are given by the maps, but the farmyard was shown in 1960 to comprise several large buildings and a glasshouse.Aerial imagery (Earthstar Geographics, 2022) shows the buildings to have been demolished and the area now scrubland.

5.6.178 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.179 A pond (approximately 0.04 hectares, as measured from historical OS maps dated 1865) was present at the former Nevilles Farm site south of Baker Street from approximately 1865. The pond was potentially infilled prior to 1965.

5.6.180 Potential contaminants associated with HLU0967 are considered to include petroleum hydrocarbons, PAH, metals, inorganics, asbestos, pesticides, ammoniacal nitrogen and hazardous gases.

5.6.181 Potential contaminants associated with HLU0933 are considered to include metals, asbestos, PAH, inorganics, petroleum hydrocarbons, PAH and hazardous gases.

Dansand Quarry, Stanford Road (HLU0963)

5.6.182 The Dansand Quarry is located west of Brentwood Road and shown as an active quarry on the Essex Mineral Resources Map (British Geological Survey, 2002). The site was operated by Metropolitan Waste Management Orsett Limited for extraction of Black Park Gravel Member and Thanet Formation sand and gravel until April 2012 (ENVIROS, 2009).

5.6.183 Several businesses, including aggregate recyclers, ‘Recycled in Orsett’ and other building material processing, lorry hire firms, etc., are located at the quarry (RIO Soils Ltd, 2019). A waste management facility licence (reference 102042) was issued in 2011 to ‘Recycled in Orsett’ for the ‘treatment of waste to produce soil <75,000 tonnes per year’ and appears to still be active. Recent aerial imagery show significant earthworks are present on the site (Earthstar Geographics, 2022).The site walkover surveys in October 2017 and 2022 noted that the quarry was an active sand and gravel extraction pit and used for stockpiling, processing and recycling of aggregates. The materials recycled included soils, concrete, rock, ceramics and asphalt which were processed and recycled into aggregates or blended into topsoil. On the northern side of the

site, there were portacabin offices, weighbridge and aggregate bays, and large stockpiles of imported soils, asphalt, concrete, etc. were present across the site. The site could potentially have received soils or fill from construction sites.

5.6.184 A pollution incident (Landmark ID 119341209) dated 2014 is recorded in the study area. The severity to land is Category 2 – significant, but the contaminant type is not given (Landmark, 2019). Another pollution incident (Landmark ID 2151969) is recorded within the quarry site. This is dated 1997 and refers to overflowing sewage (Category 3 – minor incident). Its location is given as Tripp Hill pumping station, so it may not actually be located within the quarry (data accuracy given as 100m).

5.6.185 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics and asbestos.

Southfields Quarry Landfill (HLU0946)

5.6.186 Southfields Quarry Landfill (also known as Orsett Depot Quarry) (Plate 5.10) is located south of the A13 and east of Stanford Road and covers approximately 3.1 hectares. Historical maps show a gravel pit from 1965 and the pit was labelled as disused by approximately 1973. The Environment Agency database indicates it has a current permit, but the landfill is in a closed state (filling has ceased) (Landmark, 2019). It is classed as A05: landfill taking non-biodegradable wastes (WML 70402, EPR/FP3099NS) (Landmark, 2019). The operator is shown as Southfields Gravel Company Ltd. Filling dates are not provided.

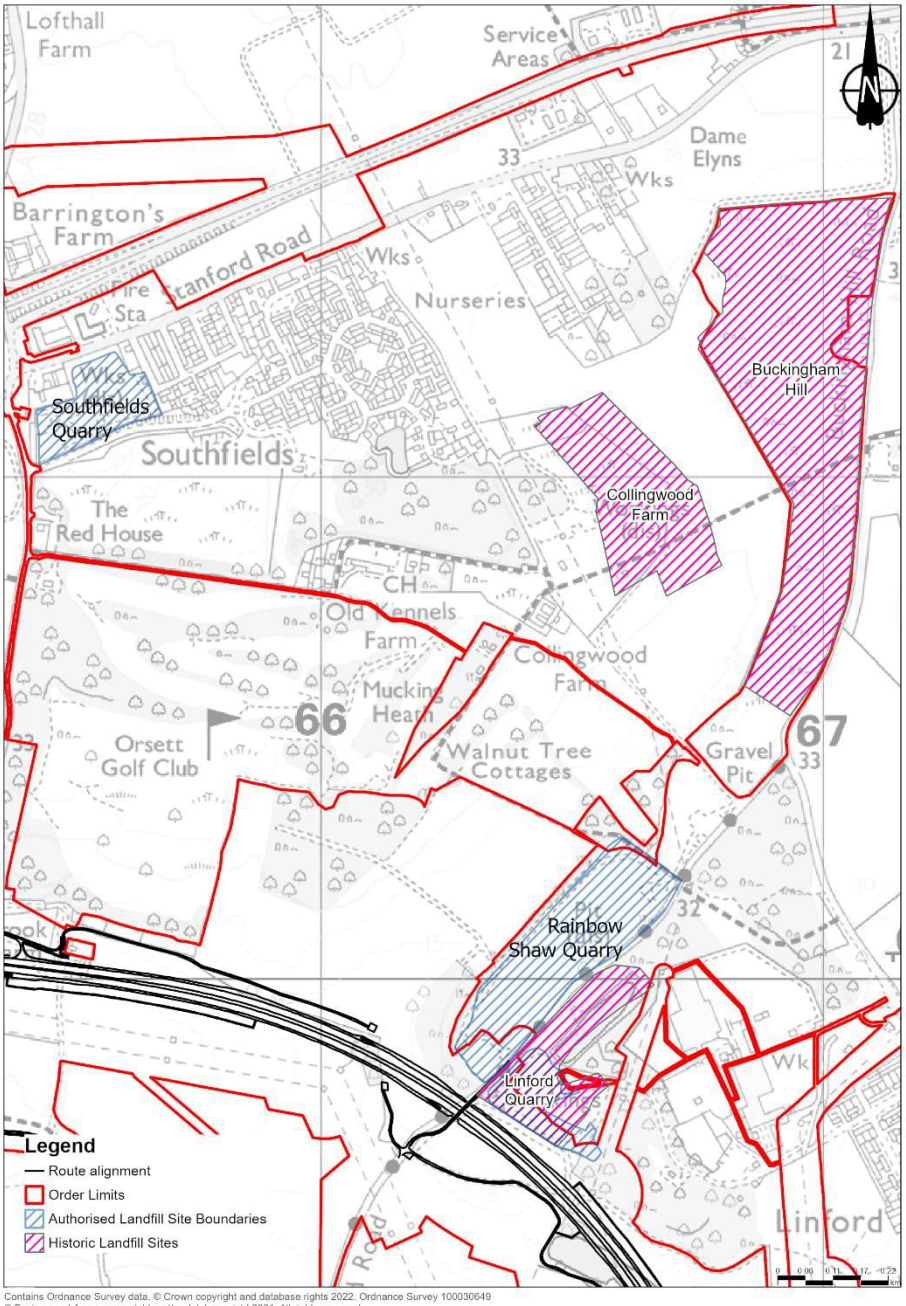
5.6.187 Two trade directory entries have been recorded at the site. One is for recycling services and is registered to Mega Recycling Ltd who are recorded as suppliers, dealers, merchants and processors in scrap metal, waste building products, stones, fuels and building contractor services. The second entry is registered to the Unique Separation Company Ltd. who are recorded as builders' tools and equipment manufacturers. Both entries are recorded as being inactive.

5.6.188 Mucking Heath gravel pit is shown on historical maps on land to the north of Orsett Golf Course and Mucking Heath, east of Brentwood Road. It is recorded as active on the 1973 map (northern part only) and disused in 1987 (Landmark, 2019).

5.6.189 The Mucking Heath gravel pit area was occupied prior to 1965 by Orsett Camp (military camp). Depots and works were shown to the north of the Mucking Heath gravel pit from 1965 to 1988. However, this area has now been developed as the current Welling Road residential housing (Landmark, 2019), and therefore these are not considered potential contaminant sources.

5.6.190 Potential contaminants associated with this HLU are considered to include metals, inorganics, PAH, petroleum hydrocarbons, asbestos, VOC, SVOC, ammoniacal nitrogen and hazardous gases.

Plate 5.10 Buckingham Hill Landfill (HLU0864), Collingwood Farm Landfill (HLU0865) and Southfields Quarry Landfill (HLU0946)



Vehicle Repair and Maintenance Garage at A13/A128 Junction (HLU0949)

5.6.191 A vehicle repair and maintenance garage with an on-site petrol filing station is located to the east of the A13/A128 Southfields Junction, with historical mapping showing a building outline in this location from approximately 1865. The garage is labelled as such from the 1954 map. There are two trade directory entries attached to the site which are registered to Kent Elms Car Centre Ltd. and Kent Elms Citroen. Both entries are recorded as being inactive.

5.6.192 Aerial imagery (Earthstar Geographics, 2022) shows that the facility is still present. Fuel storage tank(s) likely remain at the site.

5.6.193 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, metals, inorganics, asbestos, VOC, SVOC, MBTE and hazardous gases.

Garage (HLU0975)

5.6.194 A garage is shown on historical maps south of the A13 on Stanford Road between 1954 and 1963. Red Lion service station garage is recorded as active on the site in the contemporary trade directory entries (Landmark, 2019).

5.6.195 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Works (unspecified) (HLU0977)

5.6.196 A works was shown on historical maps south of the A13 on Stanford Road in 1973. Prior to 1973, several small buildings occupied the site in 1938, and a larger building was constructed by 1954 which was then labelled as a works in 1973.

5.6.197 Several trade directories are recorded at the site including an active plastic injection-moulding, and inactive carpet and rug manufacturers, furniture manufacturers, and truck and trailer painting businesses (Landmark, 2019).

5.6.198 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC and inorganics.

Orsett Industrial Park (HLU0978)

5.6.199 Orsett Industrial Park is shown south of the A13 on Stanford Road. Several small buildings occupied the site in 1938. A larger building was constructed by 1954 which was labelled as a works in 1973. Several other buildings were also constructed by the last available map dated 1986.

5.6.200 Recent aerial images show the site is occupied by an industrial estate comprising several businesses including the Garage (HLU0975) and the timber company in the former works site (HLU0977).

5.6.201 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC and asbestos.

Orsett Cock South Petrol Filling Station (HLU0979)

5.6.202 The PFS is located between the A13 and Stanford Road. The PFS was not present on historical maps by the last available map dated 1986, however the site use remains as such in aerial imagery (Earthstar Geographics, 2022).

5.6.203 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Orsett Cock North Petrol Filling Station (HLU0980)

5.6.204 The PFS is located to the north of the A13. The PFS was not present on historical maps by the last available map dated 1986, however the site use remains as such in aerial imagery (Earthstar Geographics, 2022).

5.6.205 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos and hazardous gases.

Barrington's Farm (HLU0965)

5.6.206 Barrington's Farm is located to the north-east of the Orsett Cock roundabout on the A13.

5.6.207 The farm was shown on the earliest available historical maps dated 1865 with a layout similar to the current building arrangement, although it is likely that buildings have been demolished and replaced in this time.

5.6.208 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.6.209 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Welcome Villa Petrol Filling Station (HLU0960)

5.6.210 Third-party environmental data do not contain any record of a garage or other similar business at the site (Landmark, 2019). Online planning records show that an application for a PFS was first granted in 1955, with an extension to the site and redevelopment of the forecourt permitted in 1961 and 1966 respectively. An application for a conversion to a self-service filling station and a new 6,000-gallon UST was also granted in 1969. An application (82/00783/FUL) for the erection of a vehicle showroom and workshop was refused in 1982 (Thurrock Council, 2019).

5.6.211 The site is now a residential property (Earthstar Geographics, 2022). A desk-based review was carried out by a Chartered Mineral Surveyor from the Valuation Office Agency who indicated the presence of a former PFS at Welcome Villa, Stanford Road, Orsett. The information provided was taken from email correspondence provided to the Project by National Highways (Chirico and Long, 2018). The surveyor stated that the '*tank(s) probably remain* [at the site] *and there may well be or have been an historic contamination plume*'*.*

5.6.212 No PFS or similar garage site is specifically labelled on available historical maps, but the site layout between approximately 1960 to 1995 appears consistent with a PFS use. A canopy may have also been present in 1969. Prior to 1950, an older building was shown at the site, and a well was labelled at the residential property (Prattocks) adjacent to the west (Plate 5.11).

5.6.213 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, MBTE, BTEX (benzene, toluene, ethylbenzene, xylene), metals, inorganics, asbestos, VOC, SVOC and hazardous gases.

Plate 5.11 Historical Mapping (1:2,500) of Welcome Villa (HLU0960) Site Dated 1897, 1960 and 1969

Plate a (1897)

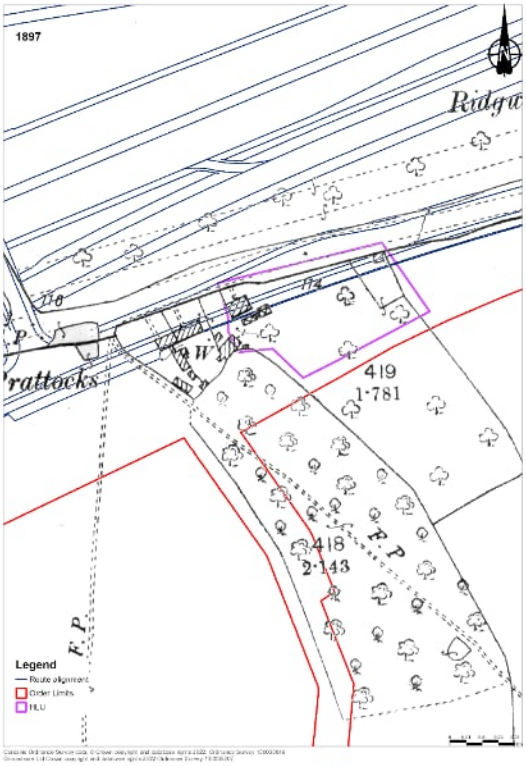


Plate b (1960)

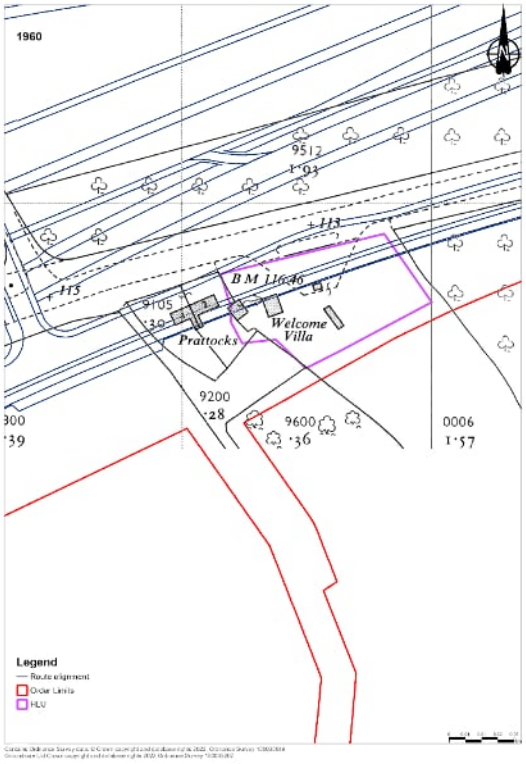
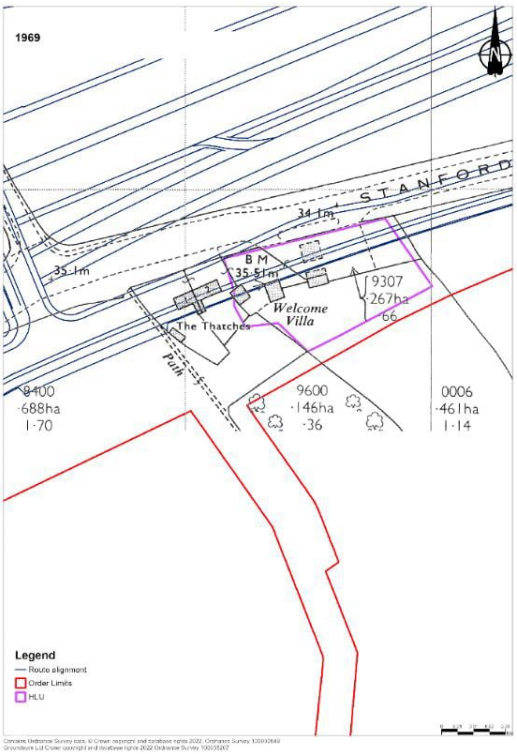


Plate c (1969)



Orsett Heath Recreation Ground Landfill (HLU0962), Infilled Gravel Pit (HLU0958) and Works (HLU0954)

5.6.214 Local authority records show the Orsett Heath Recreation Ground landfill to have been occupied by a domestic refuse landfill site of approximately 6.2 hectares (HLU0962) (Landmark, 2019).

5.6.215 Potential contaminants associated with HLU0962 are considered to include metals, asbestos, VOC, SVOC, ammoniacal nitrogen, PAH, inorganics, petroleum hydrocarbons and hazardous gases.

5.6.216 A gravel pit (HLU0958) was shown on historical maps between 1939 and 1947. It was not shown on the 1955 map, and the current A1089 Dock Approach Road runs over it, indicating it has also been infilled. This area is not identified in landfill records and the fill material is unknown.

5.6.217 Potential contaminants associated HLU0958 are considered to include metals, asbestos, PAH, inorganics, petroleum hydrocarbons, inorganics and hazardous gases.

5.6.218 A ‘works’ (HLU0954) appears on mapping between approximately 1955 and 1966. The works were no longer present at the site and it was labelled as a recreation ground by 1973.

5.6.219 Potential contaminants associated with HLU0954 are considered to include metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC and inorganics.

Sewage Pumping Station (HLU0956)

5.6.220 A sewage pumping station is located south of the A13 along Heath Road. The pumping station was constructed approximately 1973 to 1975.).

5.6.221 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, asbestos, microbial contamination, PFAS, inorganics and hazardous gases.

Infilled Gravel Pit, South of Stanford Road (HLU0940)

5.6.222 A gravel pit (approximately one hectare) was shown south of Stanford Road and just north of Treetops School from the 1895 historical map. A BGS recorded mineral site is located here for ‘*Little Thurrock Gravel Pit*’, extracting Palaeocene sand and gravel (Landmark, 2019), likely to be the Boyn Hill Gravel member. Historical mapping is unclear after the 1960 edition, and therefore the pit is presumed to have been filled after this date. The A1013 is shown to have been widened to cover the northern end of the pit. The pit is not shown on the historical landfill database for the Environment Agency (Environment Agency, 2020) as a landfill but appears to be infilled and grassed on recent aerial imagery (Earthstar Geographics, 2022).

5.6.223 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.

5.7 A13 to M25 junction 29

Area description

5.7.1 The Project joins the existing M25 at North Ockendon.

5.7.2 The area between the A13 and M25 is generally sparsely populated and dominated by low-lying land in Orsett Fen, which is drained to the River Thames to the south-west by the Mardyke. This section includes the Romford and Grays railway line which crosses the route alignment to the south of M25 junction 29 and the London, Tilbury and Southend railway line which passes the route alignment to the west at North Ockendon. The area has also been widely exploited for sand, gravel and clay and several former pits are now infilled or water filled.

5.7.3 The ground generally falls to the north between the A13 and Orsett Fen from approximately 35m AOD to 2m AOD. The ground rises again to 31m AOD westwards from Orsett Fen to North Road.

Proposed route alignment

5.7.4 The Project joins the M25 at North Ockendon. There are numerous cuttings and embankments at the A13 and M25 junctions.

Geology and hydrogeology

5.7.5 The underlying geology is predominantly Alluvium and Head Deposits in Orsett Fen with a ridge of Boyn Hill and Lynch Hill Gravel Members between North and South Ockendon and at the A13 junction. Bagshot Formation and Claygate Member deposits are also present north of M25 junction 29. The entire area is underlain by London Clay, except the A13 area which is underlain by the Lambeth Group.

5.7.6 The superficial deposits in this section have all been designated as Secondary A or Secondary Undifferentiated aquifers. The Bagshot Formation, Claygate Member and London Clay are classified as Unproductive Strata.

5.7.7 There is one groundwater Source Protection Zone (SPZ) which covers most of the route in this section. It is classified as an SPZ3 and is likely to be associated with the abstraction at Stifford.

5.7.8 A series of moats, ponds, lakes and streams have been identified across this section of the Project route.

Overview of potential sources of contamination

5.7.9 This section of the Project includes several sites associated with landfilling. There are several farms along this stretch of the Project route and a number of infilled ponds which are thought to be associated with former mineral extraction activities which have taken place in the area. Industrial units have also been identified in the areas around the A13 junction and north of the M25.

5.7.10 Details for each HLU including potential contaminants associated with the potential source are given below. The likely significance of the overall level of risk for each potential contamination source is assigned in Annex C (Part 1) based on available information.

Millers Sand and Gravel Pits Landfill (HLU0943) and Infilled Gravel Pit (HLU0941)

5.7.11 Millers Sand and Gravel Pits are shown as historical landfill by the Environment Agency, located to the east of Baker Street and north of the A13 (Plate 5.12). The filling dates are given as 1948 to 1965 and the waste type is commercial and household waste (Landmark, 2019). Historical maps agree with the filling dates given by the Environment Agency and the land appears to have been in agricultural use since. The landfill covers approximately 15 hectares.

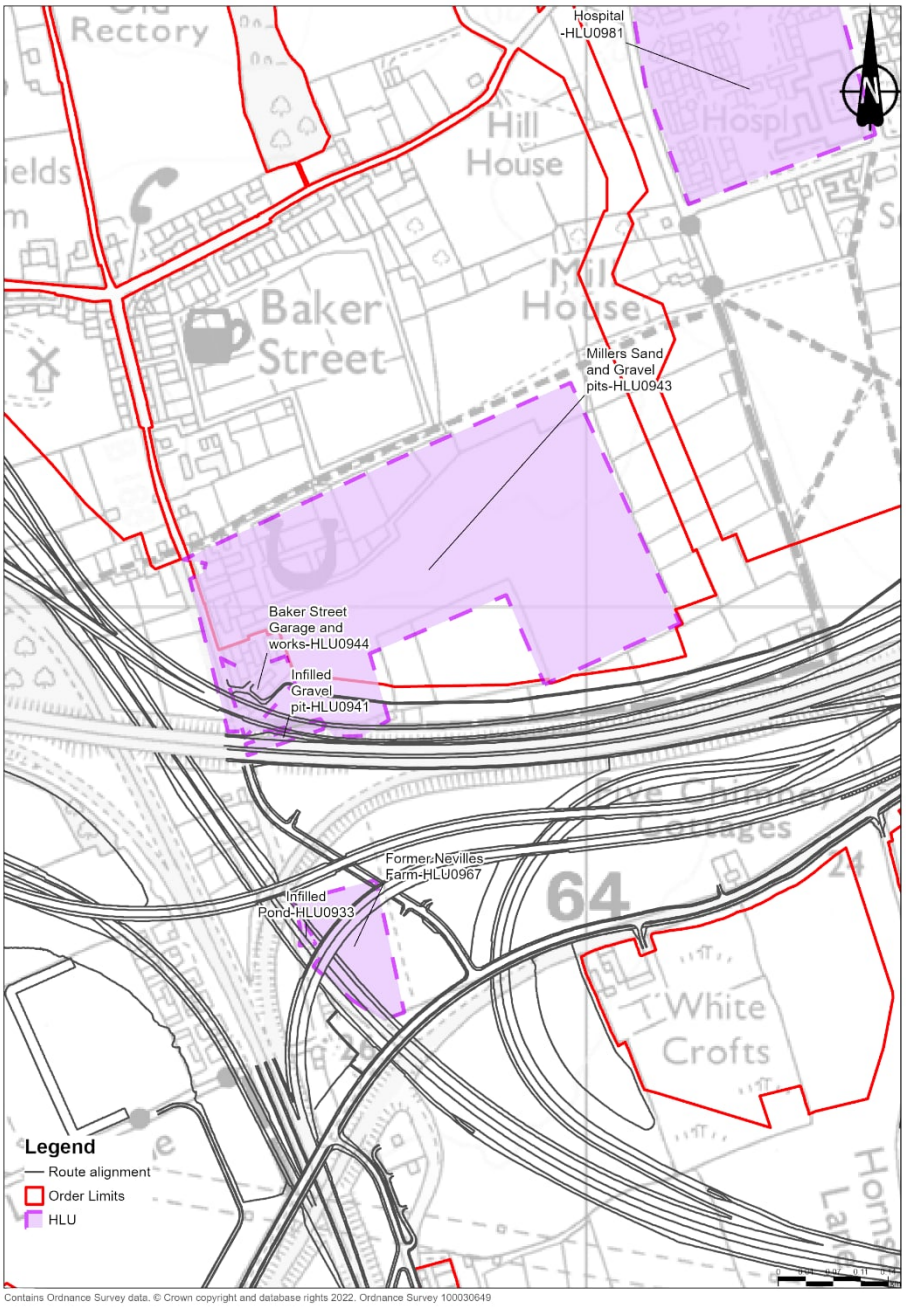
5.7.12 The BGS records the gravel pit as working Boyn Hill Gravel Member sands and gravels (Landmark, 2019). The gravel pit was not shown on maps in 1938, suggesting excavation started between 1938 and 1948.

5.7.13 Potential contaminants associated with HLU0943 are considered to include metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, VOC, SVOC and hazardous gases.

5.7.14 Another gravel pit (HLU0941) was shown on historical mapping to the south of the Millers Sand and Gravel Pits from 1915 and 1955 and was also used for the extraction of Boyn Hill Gravel Member sands and gravels. The pit was no longer mapped by 1965, indicating it had been infilled.

5.7.15 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos and hazardous gases.

Plate 5.12 Millers Sand and Gravel Pits (HLU0943)



Former Works and Garage, Baker Street (HLU0944)

5.7.16 'Works' were shown on the most recent historical OS map dated 1993 on Baker Street immediately north of the A13 junction (Plate 5.12). These are understood to have been redeveloped into semi-detached housing. Records of vehicle recovery and breakdown services are shown nearby (Landmark, 2019).

5.7.17 The 1985 historical map shows 'works' and a garage in this location. Planning records from the 1960s to 1980s indicate the garage consisted of petrol pumps, repair workshops and a spray booth (Thurrock Council, 2017a). The works were redeveloped with planning approval, and current land use along Baker Street now appears to be a mix of residential, private gardens, equestrian and

agricultural uses (Earthstar Geographics, 2022). As the site was recently redeveloped, it is likely to be suitable for use, but some contaminants may still remain.

5.7.18 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, asbestos, VOC, SVOC and hazardous gases.

Mobbs Farm (HLU0972)

5.7.19 Mobbs Farm is located to the north of the A13. The farm was shown on the earliest available historical maps dated 1865. In the past mapping shows that buildings have been located to the north of the current arrangement. The farm building, although not labelled, is shown on historical mapping up until 1965 but is not present on the 1975 map.

5.7.20 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.7.21 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Clay Pit (HLU0935)

5.7.22 A clay pit is shown as an excavation on 1865 mapping with kiln located to the immediate south of the pit. The clay pit was still present on the 1938 map but absent on the 1955 map, indicating it may have been infilled (Landmark, 2019). The location of the clay pit is now within agricultural fields with Stifford Clays Road to the north and west, and the A13 to the south.

5.7.23 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.

Hospital (HLU0981)

5.7.24 Orsett Hospital in Orsett was first shown between 1865 and 1895 when it was originally labelled as Orsett union workhouse. The building was boarded to the south by allotment gardens at this time. In 1915, the building was labelled as an institution infirmary. A smithy is also identified to the north of the site.

5.7.25 The site was labelled as a public assistance institution in 1938 when the building was expanded. By 1955, the site was labelled as Tilbury and Riverside hospital. The hospital was expanded in 1965 and renamed to Orsett Hospital. The hospital expanded again in 1975 and most of the open space surrounding the building was replaced by buildings. The site remained like this in the last available map dated 1985.

5.7.26 Recent aerial imagery shows the hospital is still present but is surrounded by residential housing (Earthstar Geographics, 2022).

5.7.27 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH and microbial contamination.

Tank at Green Lane, Orsett (HLU1005)

5.7.28 A ‘tank’ was marked on historical OS maps dated 1915 to 1921, within Hobletts Farm Nursery, to the north of Green Lane in Orsett. It was not shown on the 1938 map. The tank use is not known; it may have been a water tank but is conservatively assumed to have been used to store fuels. This area was shown as agricultural on the historical maps, and recent aerial images appear to suggest it is now used for horse riding and stables. Glasshouses and a chimney may also have been present at the nursery.

5.7.29 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PAH.

Small Infilled Ponds in Orsett Fen (HLU1030, HLU1031, HLU1032, HLU1038, HLU1039, HLU1040, HLU1056, HLU1059)

5.7.30 Several ponds have been shown on historical maps around the Orsett Fen area. The majority of these ponds are present on maps between 1865 and 1965 and no longer present by 1975, suggesting they were infilled during the period between 1965 and 1975. Pond HLU1056 (195m^2) was present between 1866 and 1898 and no longer present by 1921.

5.7.31 These ponds are relatively small in size, but the material used to infill the ponds is not known.

5.7.32 Potential contaminants associated with these HLUs are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Ockendon Grays Areas II and III Landfill (HLU1062)

5.7.33 Ockendon Areas II and III Landfill (including that labelled as ‘Ockendon Grays Area No.3’ on Plate 5.13 is an engineered non-hazardous landfill located approximately 500m to the east of North Ockendon, Essex. Areas II and III are part of the wider Ockendon landfill complex, comprising approximately 230 hectares of former clay pits, of which 139 hectares have been used for landfill (Veolia, 2019). Areas II and III are approximately 73 hectares in total. The other landfills have reportedly been in operation since September 1977 (Cleanaway Ltd., 1996).

Plate 5.13 Ockendon Landfills (HLU1062) and Flint Grit Pond (HLU1055)

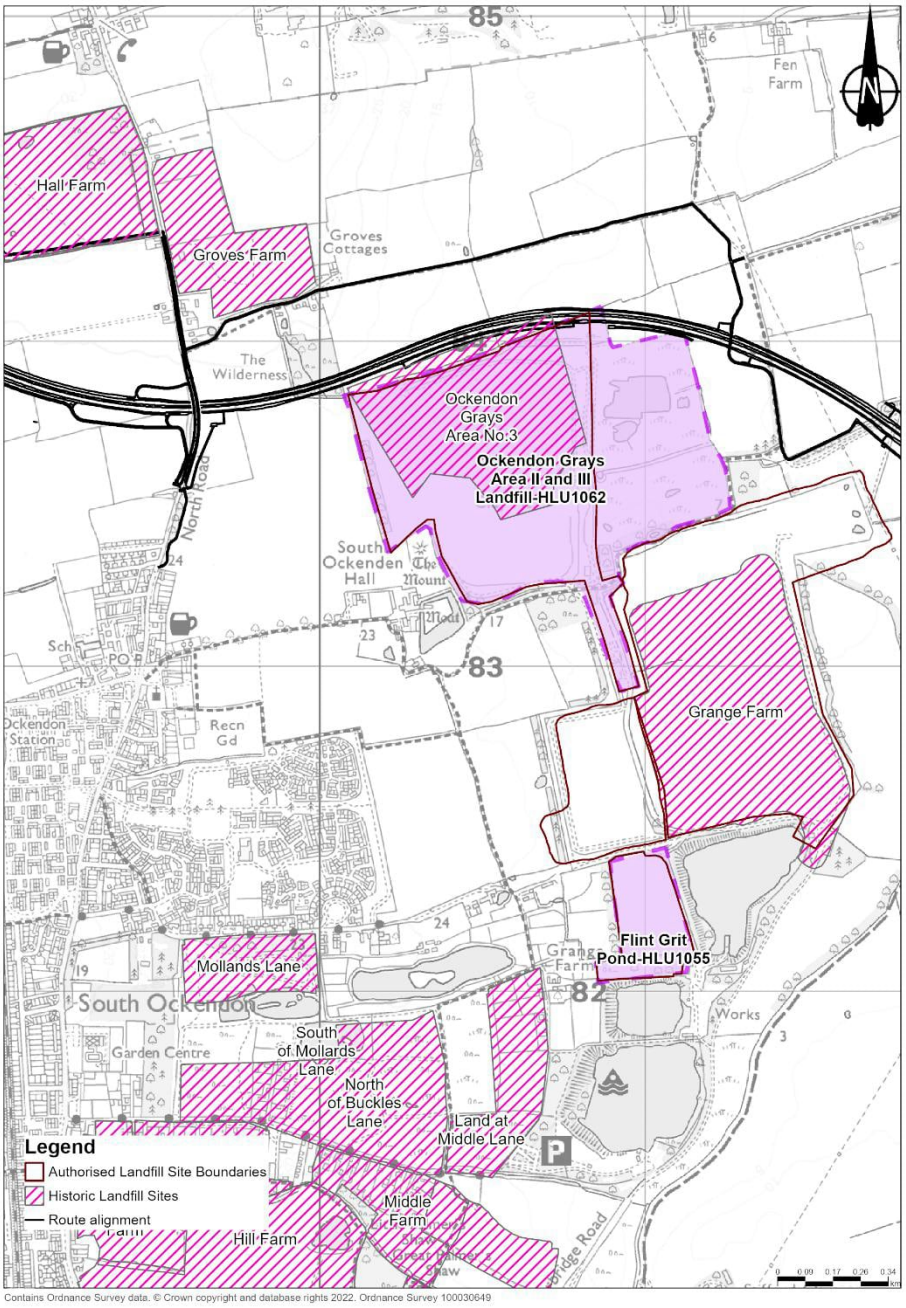
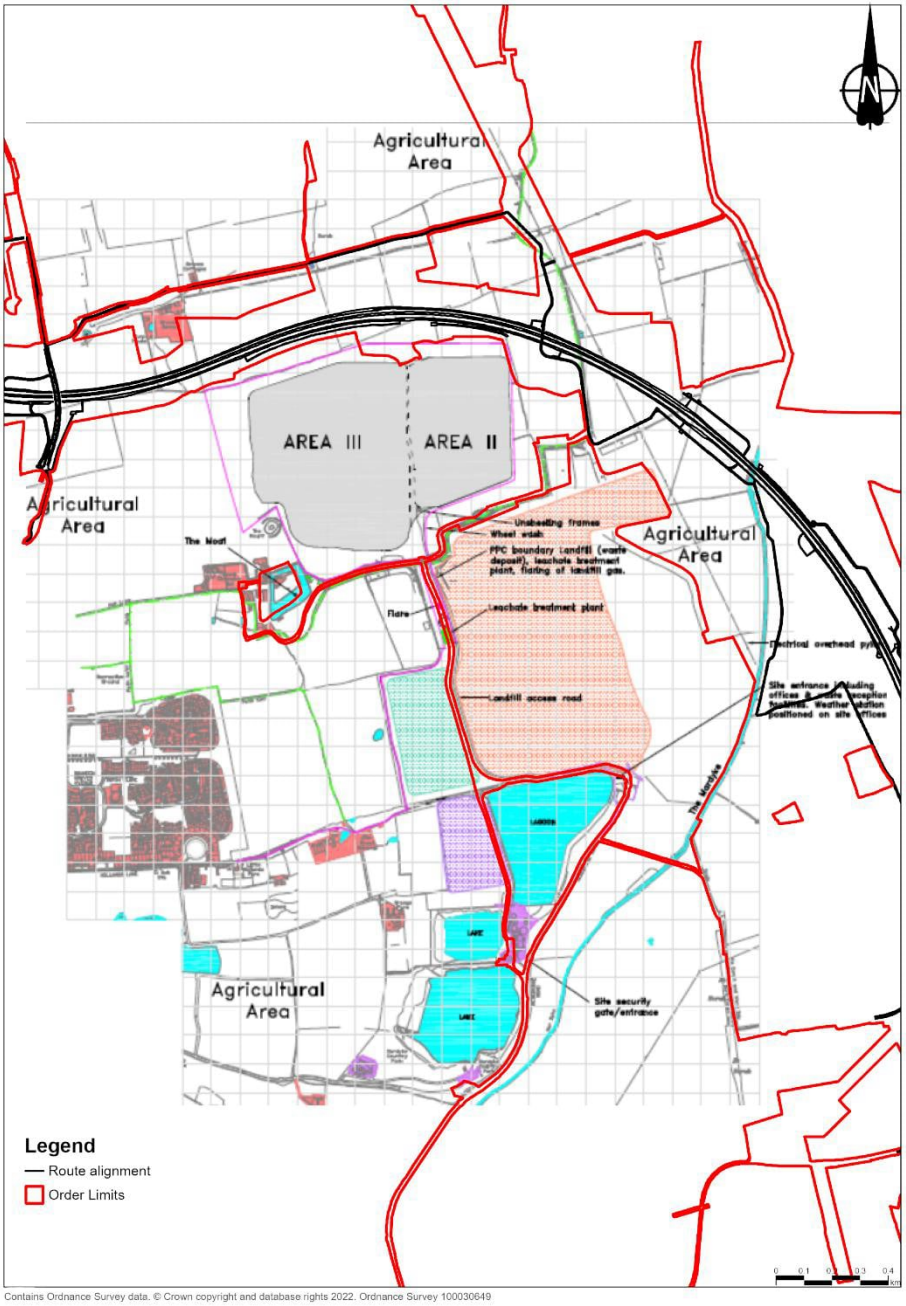


Plate 5.14 Ockendon Area II and III Landfill (HLU1062) and Surrounding Areas (from 2008 Variation) (Environment Agency, 2008)



5.7.34 Planning permission (reference THU/469/82) for an extension of 220 hectares of clay extraction works (including Area II and III) was granted by Essex Council in July 1983 (Cleanaway Ltd., 1996). An application for a waste management licence was submitted and subsequently granted in November 1997 (reference WML379/97). This reportedly permitted waste types including road gully emptying and sweeping waste and cement-bonded asbestos (Environment Agency, 2015).

5.7.35 Aerial photo analysis estimated the depth of working to be approximately 18m (from LiDAR and parallax bar measurements) (Lee, Mills and Brunsden, 2018).

The quarry depth was reported in the original licence application as between 19m and 33m deep (Cleanaway Ltd., 1996).

5.7.36 The site was re-permitted as a non-hazardous waste landfill (reference BW0410IH) in 2005 in accordance with Pollution Prevention and Control and Landfill Directive requirements (Environment Agency, 2015). The permit was extended to Area II in 2008 and transferred to Veolia ES Landfill Ltd., who now operate the site, in 2009. The current permit (reference NP3736GU) allows a wide variety of waste types to be landfilled at the site, including municipal waste (Environment Agency, 2009). The surveyor undertaking the walkover survey at the site in 2018 was advised by the site representative that the landfill mainly receives waste from domestic waste transfer stations.

5.7.37 The landfill was temporarily mothballed from December 2011 (Veolia, 2011) until July 2016 (Landmark, 2019). During this period, it did not accept waste imports except for restoration purposes (Veolia, 2011).

5.7.38 The site is currently permitted to accept 1,250,000 tonnes per year of non-hazardous waste and 250,000 tonnes per year of inert waste (Environment Agency, 2008).

5.7.39 Potential contaminants associated with this HLU are considered to include metals, inorganics, organics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Landfill construction and infrastructure

5.7.40 A 2015 report for the site indicated that landfill gas was extracted and used to generate electricity via an off-site gas plant (Veolia, 2015). According to the Environment Agency, there is no membrane installed at the site. The *in situ* London Clay has been reworked to 1m depth to meet a permeability of $<1x10^{-9}$m/s and subject to construction quality assurance. There is no historical landfill beneath the current engineered area (II and III), but other areas have historical landfill (Environment Agency, 2015).

5.7.41 Landfill gas is extracted from the waste by a network of gas extraction wells. The gas is utilised in a power generation plant operated by a third party, and gas flares are also present on site. Leachate is extracted from the waste by a leachate drainage system and pumped to an on-site treatment plant before being disposed of to foul sewer (Environment Agency, 2008).

5.7.42 More than 200 gas and leachate monitoring wells are installed across the landfill. In addition, two of the southern cells have settlement gauges in place to monitor the long-term settlement of the biodegradable waste. Various records for the landfill, including monitoring results, site plans of monitoring wells and leachate collection and extraction infrastructure, as well as permits for expansion to the east (Area II) are available. Information provided by the Environment Agency details the landfill to be between 19m and 33m deep and has leachate level restrictions in place (4m of head from the base), maintaining an inward piezometric gradient in relation to the surrounding groundwater by pumping, which prevents the leachate permeating into the aquifer.

Grange Farm Landfill (HLU1051)

5.7.43 Grange Farm Landfill (approximately 45 hectares) is located to the south east of Ockendon Grays Areas II and III Landfill (Plate 5.13). Thurrock Council local authority record THU006 states the waste type to be household, asbestos, N.H. Industrial (not defined, likely 'non-hazardous') and commercial. Environment Agency records (EAHLD01644) state the deposited waste included industrial, commercial and household waste, operated by Cleanaway Ltd. First input date is given as 31 December 1974 and last input as 31 July 1990.

5.7.44 A feature likely comprising a pit is indicated in the south of the site on historical maps from 1966 to 1976. Historical mapping from 1987 indicates an area of filling corresponding with the site boundary. Prior to 1966, the site is indicated as undeveloped agricultural land.

5.7.45 Potential contaminants associated with this HLU are considered to include metals, inorganics, organics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Flint Grit Pond Landfill (HLU1055)

5.7.46 Flint Grit Pond landfill is located to the south of Grange Farm landfill (Plate 5.13). Environment Agency reports (CLE001) state that it was a co-disposal landfill site operated by Veolia E S Cleanaway (UK) Ltd and the status of the permit is in closure.

5.7.47 Flint Grit Pond landfill is shown on historical mapping between 1975 and 1985 (Landmark, 2019).

5.7.48 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, inorganics, PAH, PFAS, ammoniacal nitrogen and hazardous gases, VOC and SVOC.

Works (HLU1058)

5.7.49 A works was first shown on historical mapping in 1955. It was last shown in 1985. The works is not shown on the preceding map dated 1938 (Landmark, 2019). Recent aerial imagery shows a small building or structure associated with the works still standing in the original location (Earthstar Geographics, 2022). The appearance of buildings and structures coincides with the adjacent clay pits and are likely associated.

5.7.50 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC and inorganics.

Sewage Pumping Station (HLU1076)

5.7.51 A sewage pumping station is located on Fen Lane. The site was formerly occupied by a works which was shown on historical maps in 1965. Before this, the site was unoccupied. The works was still present on the last available map dated 1985. Recent aerial images suggest it is still present on site (Earthstar Geographics, 2022).

5.7.52 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, asbestos, microbial contamination, PFAS, inorganics and hazardous gases.

Castle's Farm (HLU1066)

5.7.53 Castle's Farm is shown on historical maps at Orsett Fen in 1866. The farm remained on site until 1975 when it was no longer present. In the last available map, dated 1985, the site is shown to be vegetated with a small pond.

5.7.54 Recent aerial images show the site is occupied by vegetation and no buildings appear to be present (Earthstar Geographics, 2022).

5.7.55 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Groves Farm Landfill (HLU1110)

5.7.56 Groves Farm Landfill (approximately 19 hectares) is situated to the east of North Road (B186). Groves Farm landfill comprises a former sand and gravel quarry (Boyn Hill Gravels Member). Excavation commenced after 1938 and was likely completed by 1970 (Lee, Mills and Brunsden, 2018 - Map 3 Grove Farm area). Records indicate it was filled from 1972 to 1978 with inert industrial, commercial and household wastes.

5.7.57 An electricity substation and 'works' (HLU1112) are shown on the 1987 OS map in the area of the pit, suggesting it had been infilled.

5.7.58 A pond (1,160m^2) was shown in the south of the landfill site on historical maps predating the landfill from 1866 to 1938. This is assumed to have been filled at the same time as the landfill.

5.7.59 According to Environment Agency records (Landmark, 2019), the site was filled between 1972 and 1978 with inert, industrial and household waste. The operator was given as 'East Ham, West Ham and Ilford', indicating a local authority–run landfill. The Environment Agency licence number for the site is 022/77. Aerial imagery shows that the site is now scrubland (Earthstar Geographics, 2022).

5.7.60 Potential contaminants associated with HLU1110 is considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC.

Works and Electricity Substation (HLU1112)

5.7.61 A building labelled "works" and an electricity substation adjacent are located at the former Groves Farm Landfill (HLU1110), shown on historical mapping between 1967 and 1987.

5.7.62 Potential contaminants associated with this HLU are considered to include Metals, asbestos, petroleum hydrocarbons and PCB.

Hall Farm Landfill (HLU1140)

5.7.63 Hall Farm Landfill is located west of North Road (B186). The Environment Agency record for Groves Farm Landfill (HLU1110) also encompasses part of the area of Hall Farm Landfill (Landmark, 2019).

5.7.64 Hall Farm landfill comprises a sand and gravel pit (Boyn Hill Gravel Member) of approximately 20 hectares, shown on historical mapping between 1895 and 1967. The gravel pit was no longer shown on historical maps by 1974,

suggesting it had been infilled. Information on the Environment Agency website (Environment Agency, 2017) indicates it was filled between 1959 and 1984 with inert, commercial, and household wastes. No permit number is given, but the Environment Agency website states that active landfill gas control measures are present. A walkover survey in 2018 indicated that the site is mostly scrub and embankments, and large concrete blocks were observed on site.

5.7.65 Four small ponds were shown in the north-west of the landfill site on historical maps between approximately 1895 and 1974. The ponds were no longer shown on historical maps by 1987, suggesting they had been infilled. Recent aerial images show the ponds are no longer present at the site (Earthstar Geographics, 2022). The fill material is not known.

5.7.66 Potential contaminants associated with HLU1140 are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, VOC, SVOC and hazardous gases.

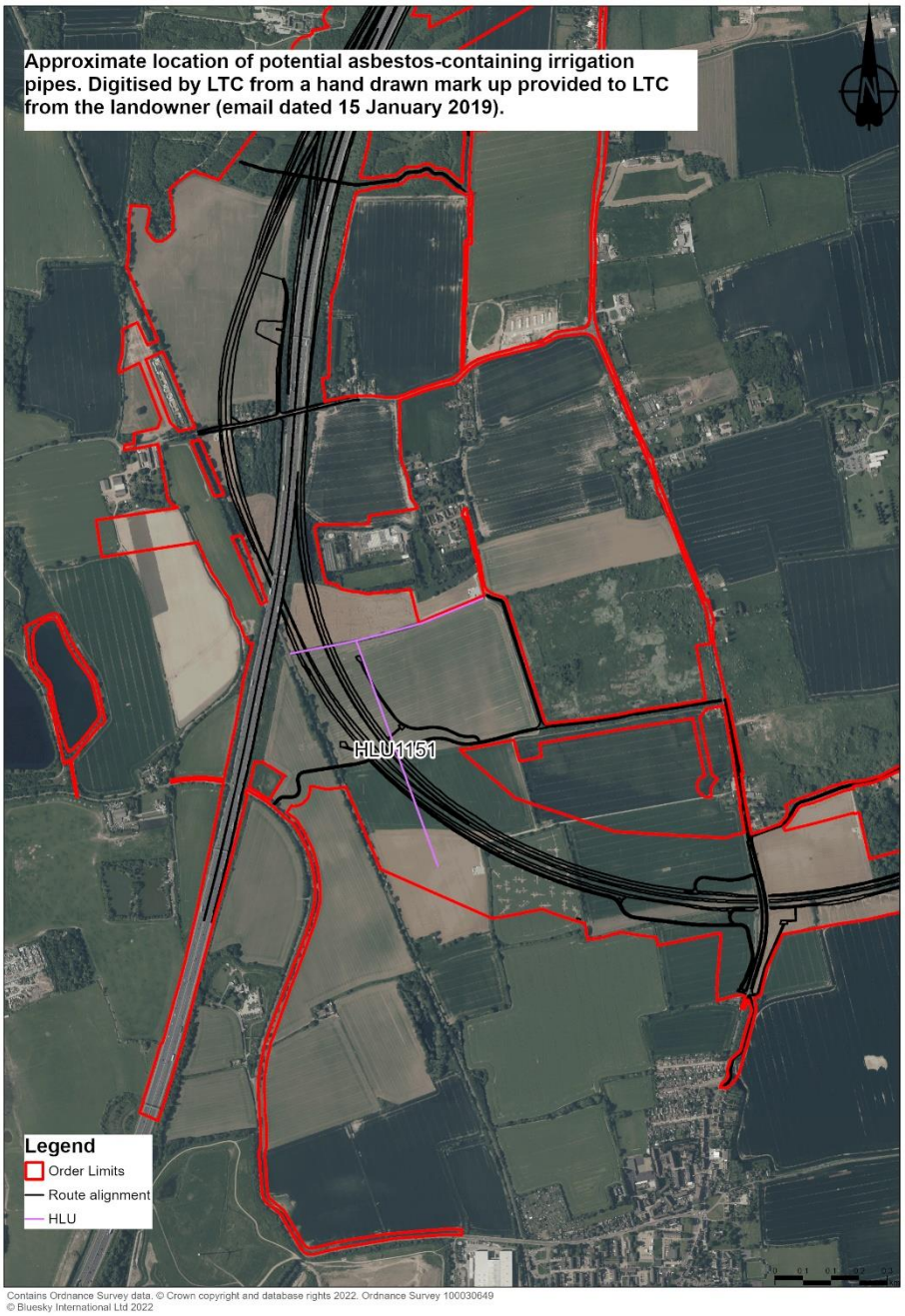
5.7.67 A small gravel pit (HLU1116) of approximately 0.7 hectares was also shown on historical mapping to the south of the site between 1895 and 1954. The pit was no longer present on the 1967 map, suggesting it had been infilled. The fill material is not known.

5.7.68 Potential contaminants associated with HLU1116 are considered to include metals, petroleum hydrocarbons, PAH, inorganics, asbestos and hazardous gases.

5.7.69 Information provided to the Project Land and Property Team (email from the landowner to the Applicant, 15 January 2019) indicates that current subsurface irrigation pipes at Hall Farm, North Ockendon, may contain asbestos (HLU1151). Two main pipes were identified: one running for 250m east–west, and a second, reported to be decommissioned, running 640m north–south (Plate 5.15). The type and percentage of asbestos has not been reported.

5.7.70 The potential contaminants associated with this HLU is asbestos.

Plate 5.15 Potential asbestos-containing irrigation pipes at Hall Farm (HLU1151)



Hall Farm Electricity Substation (HLU1144)

5.7.71 An electricity substation is shown on historical maps to the west of North Ockendon Hall Farm on Church Lane. The substation was first shown on available mapping in 1974 and was still present on the last available map dated 1993. Recent aerial images show that a built structure is still present at the site, assumed to be the substation (Earthstar Geographics, 2022).

5.7.72 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons and PCBs.

Hall Farm Nursery (HLU1152)

5.7.73 Glasshouses have been present at Hall Farm since approximately 1974 (Landmark, 2019), having expanded over the years. Current aerial photographs show a nursery operation, with areas of hardstanding and what appears to be external materials or waste storage areas (Earthstar Geographics, 2022).

5.7.74 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, inorganics, herbicides, pesticides and asbestos.

Romford and Grays Railway Line (HLU1108)

5.7.75 The single-track branch line connecting Grays to Upminster was first shown on historical mapping dated 1895. The Upminster to Grays section underwent electrification in the 1960s, and the railway line is still present and operational.

5.7.76 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals and asbestos.

Infilled Gravel Pit (HLU1139)

5.7.77 A gravel pit is present on historical mapping between 1821 and 1938, and no longer present by 1954, suggesting it had been infilled. The fill material is not known.

5.7.78 Potential contaminants associated with this HLU are considered to include metals, asbestos, petroleum hydrocarbons, inorganics, PAH and hazardous gases.

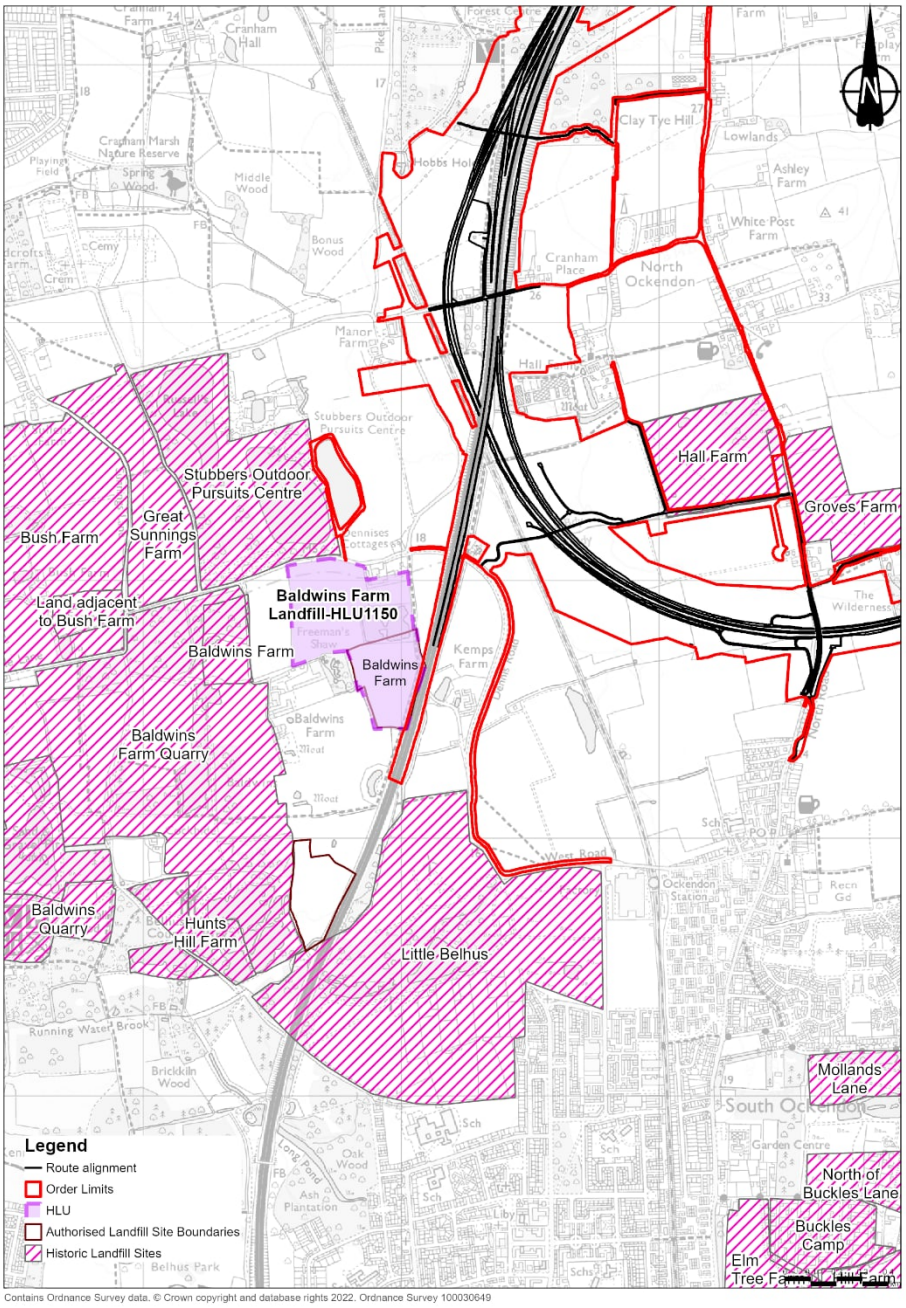
Baldwins Farm Landfill (HLU1150)

5.7.79 Baldwins Farm Landfill (approximately 22 hectares in area) is located west of the M25. The farm is shown as historical landfill in local authority records, and the southern part is shown as an authorised landfill (modified licence) on the Environment Agency website (Environment Agency, 2017) (Plate 5.16). The operator for the authorised landfill is given as Tarmac Aggregates Limited under WML 80438 and permit number EPR/BP3197ND. It is shown as a landfill taking ‘non-biodegradable wastes’. The site name is given as Lafarge Redland Aggregates Ltd and the date of issue is given as 1987 (Landmark, 2019).

5.7.80 An Ingrebourne Valley Ltd. website indicates that the site is a former quarry which was filled with 6m to 7m depth of domestic and commercial waste (Ingrebourne Valley Ltd., 2014b). It implies that filling has ceased, and the site is in the restoration phase. Environment Agency records dated 1990 indicated that the site was closed. Recent aerial imagery (Earthstar Geographics, 2022) support this and show the site to be vegetated, with large ponds in the north. The quarry is not shown on available historical maps but planning records show an application for extension of sand and gravel workings was approved in 1958 (Thurrock Council, 2019).

5.7.81 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, PFAS, VOC, SVOC and hazardous gases.

Plate 5.16 Location of Baldwins Farm Landfill (HLU1150)



Stubbers Outdoor Pursuits Centre Landfill (HLU1159)

5.7.82 Stubbers Outdoor Pursuits Centre is located at the M25 in North Ockendon. The site was unoccupied between 1866 and 1965. Between 1965 and 1975, two large gravel pits were identified on historical maps. In 1985, the pits appeared to have been combined with the western portion of the pit labelled as disused and the remainder appearing to have been infilled.

5.7.83 The landfill is recorded on the landmark environmental databases as a historical landfill which received inert and industrial waste. The filling dates are given as 1979 to 1980 (Landmark, 2019).

5.7.84 Historical aerial images show that two lakes had been constructed at the site by 1999. Recent aerial images show the site is now occupied by an outdoor adventure facility (Stubbers Outdoor Pursuits), with two lakes used for boating and water sports, and a complex of buildings, with the remaining areas all vegetated (Earthstar Geographics, 2022).

5.7.85 The Stubbers Outdoor Pursuits website states that the business has been running since 1996 (Stubbers Adventure Centre, 2020).

5.7.86 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Manor Farm (HLU1154)

5.7.87 Manor Farm is located on Ockendon Road to the west of the M25, approximately 1.2km west of North Ockendon.

5.7.88 The farm was shown on the earliest available historical maps dated 1866. Few significant changes to the site layout can be seen on historical maps up to the present day, although it is possible that the buildings have been demolished and rebuilt during this time.

5.7.89 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.7.90 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics pesticides, herbicides, asbestos, ammoniacal nitrogen and hazardous gases.

Franks Farm Industrial Park (HLU12115)

5.7.91 Available records indicate that a metal fabrication business was based at Franks Farm Industrial Park on St Mary's Lane (Landmark, 2019). The site now appears to be a farm shop.

5.7.92 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, asbestos, VOC and SVOC.

Wyngray Farm (HLU12117)

5.7.93 Wyngray Farm is located off St Marys Lane, approximately 75m east of the M25. The farm was not shown on the historical map dated 1988 but was shown on the 1:2,500 map dated 1989.

5.7.94 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.7.95 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, asbestos, ammoniacal nitrogen, metals, inorganics and hazardous gases.

London, Tilbury and Southend Railway Line (HLU1212)

5.7.96 The existing M25 carriageway crosses the London, Tilbury and Southend railway line north of North Ockendon. The line is regularly used for freight and passenger services out of Fenchurch Street Station.

5.7.97 The section that crosses the route was constructed by 1895 and electrification began in the early 1960s (Thurrock Council, 2017b).

5.7.98 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals and asbestos.

Infilled Pond (HLU1233)

5.7.99 A pond was shown on historical maps between 1866 and 1975 to the south of the London, Tilbury and Southend railway line. It was no longer shown on the 1988 map, by then under a road embankment, indicating it was likely then infilled. It is now partially covered by the eastern part of the M25 carriageway embankment.

5.7.100 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, inorganics, metals, asbestos and hazardous gases.

Little Tabrams Farm (HLU12116)

5.7.101 Little Tabrams Farm is located on Folkes Lane to the north-west of M25 junction 29. The farm was first shown on the 1958 historical map.

5.7.102 Farmyards and other agricultural sites may historically have been subject to informal waste disposal practices such as burning or burying. Storage of fuels, agrichemicals and animal waste products may have occurred, and there could be unrecorded spillages of these substances. Asbestos was commonly used in buildings such as barns and may still be present above or below ground.

5.7.103 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases.

Infilled Ponds at Little Tabrams Farm (HLU12114)

5.7.104 An area to the north of the farm was shown to contain two ponds on historical maps dated 1866 to 1939. Both were no longer mapped and therefore likely filled by approximately 1958. Recent aerial imagery indicates that the site is now largely grassed (Earthstar Geographics, 2022).

5.7.105 Potential contaminants associated with this HLU are considered to include metals, petroleum hydrocarbons, PAH, inorganics, asbestos, hazardous gases, herbicides and pesticides.

Industrial Units at Folkes Farm (HLU12111)

5.7.106 Folkes Farm is located north-west of M25 junction 29. Buildings were shown in this location from the earliest available historical mapping dated 1866. The site appears to have undergone several phases of extension with additional buildings shown on mapping up until the last available, dated 1992. From review of recent aerial images, the site appears to be occupied by several industrial and commercial businesses.

5.7.107 There are several inactive trade directories which have also been registered at the site which are summarised in Table 5.5 (Landmark, 2019).

Table 5.5 Inactive trade directories registered at Folkes Farm (HLU12111)

Company name	Registered trade
Maxrail Ltd	Electrical Engineers
Kingsbeech Trading	Distribution Services
Chunnel Freightways	Freight Forwarders
Pickton Haulage Ltd.	Road Haulage Services
Ammax International	Freight Forwarders
Healthcare Installations Ltd.	Joinery Manufacturers

5.7.108 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals, inorganics, pesticides, phenols, herbicides, asbestos, ammoniacal nitrogen and hazardous gases.

M25 junction 29 Works Yard (HLU12112)

5.7.109 A works yard is shown on historical aerial images dated December 2010 and later. Before this date, the site was shown as arable fields in the south and what appears to be a bulk materials storage or processing area in the north-east. The nature of these materials cannot be ascertained from the images, although a waste management licence is recorded for treatment of waste to produce soil (<75,000 tonnes per year) in this area in September 2012 (Landmark, 2019).

5.7.110 The previous use of the remainder of the site is assumed to be a civil engineering compound. This is consistent with the M25 widening works carried out between junction 28 and 30 between 2010 and 2012 (Road Traffic Technology, n.d.). Potential contaminants may therefore include fuels, lubricants, construction materials (cement, etc.) and metals associated with storage or processing areas and made ground.

5.7.111 A discharge consent (permit number NPSWQD007446) is located in the south-west of the site, dated June 2009. It relates to consented '*sewage and trade combined (unspecified)*' discharge to a stream from '*Site Compound M25 Junction 29*' (Landmark, 2019).

5.7.112 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH inorganics and metals.

Codham Hall Industrial Units (HLU12113)

5.7.113 Codham Hall is an industrial area located north of the A127 and east of the M25. The site appears to be currently used for storing vehicles (including highways maintenance vehicles) and other materials

5.7.114 Two LAPPC permit records for mobile screening and crushing are associated with the site: one dated 2010, and one dated 1994 (now revoked). Manufacturing activities recorded as being present at the site include arable farming, cleaning equipment and supplies, and electronic equipment, but records indicate these are offices or warehouses and are therefore of low pollution potential (Landmark, 2019).

5.7.115 A pollution incident (Category 3 – minor incident) was recorded in 1992 to a freshwater stream, but the pollutant details are not given (Landmark, 2019).

5.7.116 Potential contaminants associated with this HLU are considered to include petroleum hydrocarbons, PAH, metals and inorganics.

Infilled Pond (HLU1216)

5.7.117 A pond was shown on historical maps between 1866 and 1967 to the east of the M25. It was no longer shown on the 1975 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields.

5.7.118 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1219)

5.7.119 A pond was shown on historical maps between 1866 and 1967 to the west of the M25. It was no longer shown on the 1975 map, indicating it was likely then infilled. The infilled pond is now located partly under Folkes Lane, a wooded area and a car park (associated with Folkes Lane woodland).

5.7.120 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1220)

5.7.121 A pond was shown on historical maps between 1866 and 1967. It was no longer shown on the 1975 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields.

5.7.122 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

5.7.123 This site is located within Hole Farm, a proposed nitrogen deposition compensation site, and is discussed in Annex D.

Infilled Pond (HLU1238)

A pond was shown on historical maps between 1865 and 1958. It was no longer shown on the 1963 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields to the south of the London, Tilbury and Southend railway line.

5.7.124 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1250)

5.7.125 A pond was shown on historical maps between 1866 and 1967. It was no longer shown on the 1975 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields.

5.7.126 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1260)

5.7.127 A pond was shown on historical maps between 1895 and 1958. It was no longer shown on the 1960 map, indicating it was likely then infilled. The location of the infilled pond is now within Folkes Lane Woodland.

5.7.128 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1282)

5.7.129 A pond was shown on historical maps between 1865 and 1963. It was no longer shown on the 1967 map, indicating it was likely then infilled. The location of the infilled pond is now within woodland to the east of the M25.

5.7.130 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

Infilled Pond (HLU1286)

5.7.131 A pond was shown on historical maps between 1895 and 1967. It was no longer shown on the 1975 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields to the east of the M25.

5.7.132 Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.

6 Natural ground-related hazards

6.1 Introduction

6.1.1 Natural ground-related hazards also need consideration as potential sources of contamination, in addition to the anthropogenic sources identified in Section 5, as they could adversely affect the Project.

6.1.2 Adverse ground conditions relating to geotechnical suitability (e.g. subsidence) are not included in this report.

6.1.3 Hazards arising from natural ground conditions will be further assessed following appropriate ground investigation.

6.2 Naturally occurring ground gas

6.2.1 In addition to anthropogenic sources of contamination, the following natural ground materials have the potential to pose a risk to human health, specifically via generation of ground gases which may pose an asphyxiation, toxicological or explosion risk if allowed to build up in confined spaces such as tunnels or service ducts:

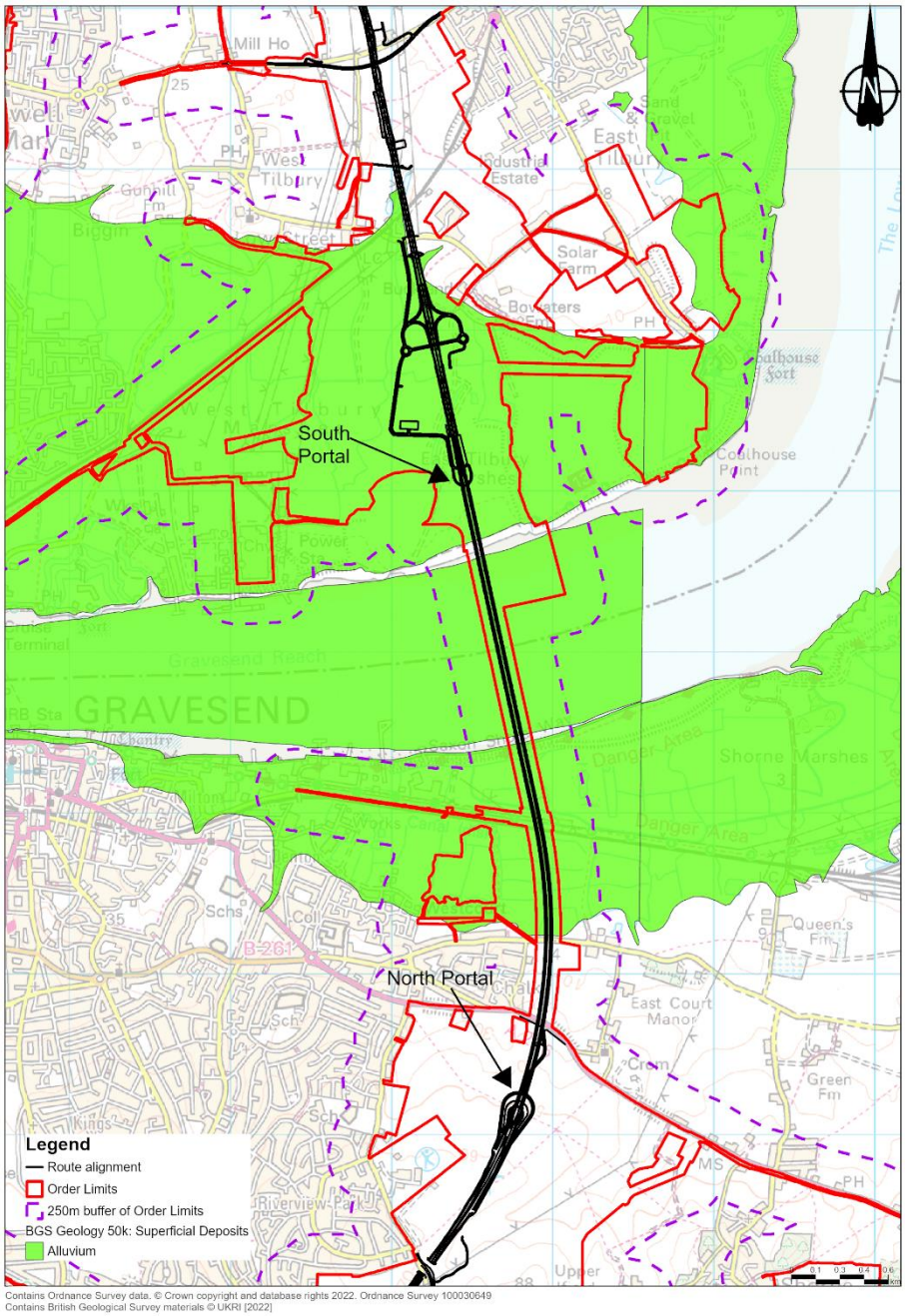
a. Ground gas generation (methane and carbon dioxide) from breakdown of organic matter in Alluvium and peat deposits

b. Naturally elevated carbon dioxide concentrations in Chalk strata due to carbonate dissolution

c. Low-oxygen environments in Lambeth Group and Chalk strata, which can pose a risk to tunnelling operations (Newman, 2013).

6.2.2 Alluvium deposits are present in three main areas: within the floodplain of the River Thames, around the Mardyke area and north of the junction with the M25 (associated with an abandoned early Thames meander) (Lee, Mills and Brunsden, 2018). Ground gas generation within organic material is of highest concern to the north of the River Thames, due to the likely thickness of the Alluvium and the proposed location of the North Portal which could be affected by hazardous ground gas (Plate 6.1).

Plate 6.1 Mapped Alluvium extents in the River Thames floodplain



6.2.3 Approximately five main peat layers are thought to be present near the North Portal, interspersed with layers of sand, gravel and silt/clay (Highways England, 2018a). Boreholes drilled for the Phase 1A ground investigation near to the North Portal encountered up to 16m of soft silty clay with layers of peat and a sulphurous odour (Highways England, 2018a). These boreholes were not designed as gas monitoring installations. Nevertheless, observations on site indicate a substantial reservoir of gas is associated with the peat layers (drilling was suspended on BH2374 to allow gas to vent off). Methane concentration readings up to 83.2% v/v (BH1309A, 21/03/2018) and 67.3% v/v (BH2374 06/03/2018) were subsequently recorded in boreholes screening the Alluvium.

6.2.4 The Alluvium is a heterogenous deposit, and therefore gas emissions, storage and migration within the stratum will be controlled by the vertical and horizontal distribution of peat, fine-grained and coarse-grained material, as well as groundwater saturation and tidal variation.

6.2.5 A potentially significant amount of gas may be dissolved in groundwater within the Alluvium and may come out of solution should pore pressures be modified (e.g. by groundwater pumping for excavations).

6.2.6 The methanogenic degradation of organic material to form the peat has taken place over a long period – the Alluvium was deposited during the Holocene (from 11,600 years ago) – and the current rate of gas generation is probably low. However, the volume of gas stored in the deposits may be significant and may present a hazard during the Project construction and operational phases.

6.2.7 Further ground investigation and detailed assessment of the gas regime around the North Portal will be required to determine the risks to the Project and any mitigation measures that might be needed. This recommendation has been carried forward within the REAC through commitments GS018 and GS025.

6.3 Phosphatic Chalk and radon gas

6.3.1 Phosphatic deposits occur naturally in many Chalk strata and are generally a minor component of the rock. In rare cases, significant thicknesses of phosphatic Chalk have been encountered, most notably at the proposed A303 Stonehenge Tunnel (Mortimore *et al*., 2017). Significant deposits of phosphatic Chalk are not anticipated along the Project route.

6.3.2 The physical and chemical nature of larger phosphatic chalk deposits are different from ‘normal’ chalk and may pose additional constraints to the construction of the Project, in particular the tunnel and portals. Phosphatic Chalks are generally weaker and less well cemented, and this has implications for both tunnel boring and groundwater control in tunnels and excavations. Phosphate is a plant nutrient, and therefore reuse of Chalk spoil or discharge of Chalk-origin groundwater containing high concentrations of phosphate may cause environmental impacts in certain scenarios (Mortimore, 2012).

6.3.3 Phosphatic Chalk is also associated with elevated levels of radon-222, a naturally occurring radioactive gas. Radon is generated by the decay of trace amounts of uranium isotopes naturally present in varying concentrations in most soil and rock types. Inhalation of radon gas and its decay products can present a hazard to human health when it has built up in enclosed and occupied spaces such as buildings. The risk is higher for spaces with a high occupancy period, e.g. residential homes.

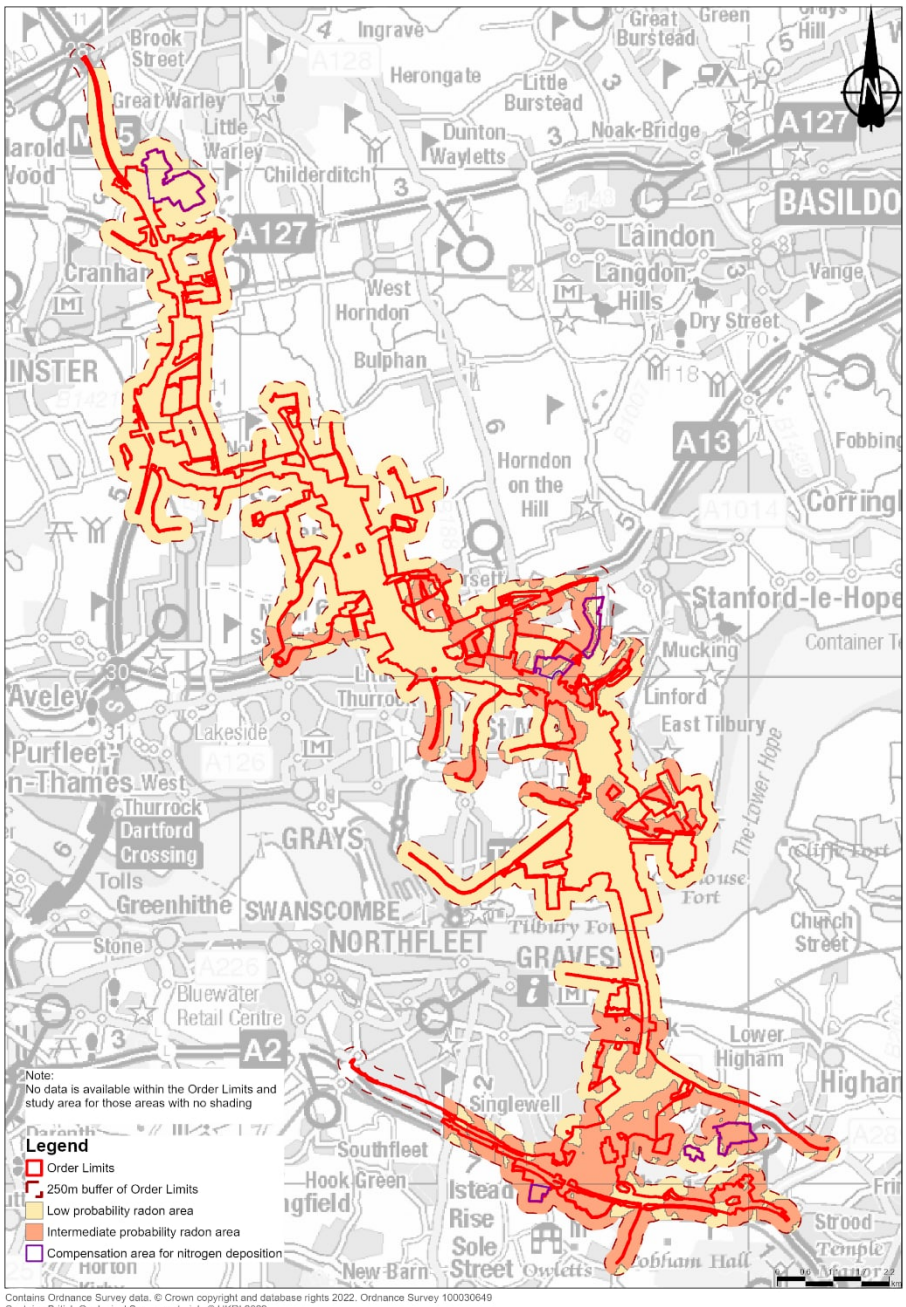
6.3.4 Guidance provided by the BGS and Public Health England classifies areas by the probability that properties will be above the Action Level (200Bq/m^3). New buildings in areas where more than 3% of properties are likely above the Action Level will require basic radon protection (Building Research Establishment, 2015).

6.3.5 These probability classifications are based on radon monitoring and exposure assumptions for above-ground residential buildings and are therefore not directly applicable to below-ground transport infrastructure such as the Project

tunnels. They do however provide some context in which to assess the potential risks to the Project.

6.3.6 The majority of the study area is classified as the lowest risk for radon (i.e. less than 1% of homes are estimated to be at or above the Action Level). Some of the Project route is classified as an intermediate probability area (i.e. 1% to 3% of homes are estimated to be at or above the Action Level). The distribution is shown in Plate 6.2.

Plate 6.2 Distribution of radon classification along the Project route



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6.3.7 The Ionising Radiations Regulations 2017 require protective measures to be put into place where the measured average exposure of employees to radon gas exceeds 300Bq/m^3.

6.3.8 Risks to human health from radon during construction and operation are considered to be low due to the unenclosed nature of the Project, allowing any radon generated to disperse into the atmosphere. Build-up of ground gas, including radon, is more likely within the tunnel and portal structures. However, the short occupancy time and ventilated design of the habitable spaces associated with the tunnels mean that risks to individuals due to radon exposure in these locations are also likely to be low. Additional protective design and operational measures specifically for radon mitigation are unlikely to be required, unless significant amounts of phosphatic Chalk are encountered during the ground investigation. The implications for materials management and Chalk handling and reuse should be considered in this case.

6.4 Background soil chemistry

6.4.1 Some soil and rock types can give rise to naturally elevated concentrations of contaminants, such as metals. The natural geology within the Order Limits is not considered to pose a potential risk to the identified receptors from background soil chemistry, which generally comprises Alluvium, River Terrace Deposits and Chalk.

6.4.2 Background soil chemistry data is published by the BGS. This represents both 'natural' contaminant concentrations and anthropogenic contamination from non-point sources. BGS do not include 'point source' contamination from individual sources. The dataset is derived from two main sources: the G-BASE sampling programme run by the BGS, and the Imperial College Wolfson Atlas. Soil samples in rural areas are collected at a rate of approximately one composite sample, from a $20m^2$ area, every $2km^2$, at depths of 5–20cm bgl and 35–50cm bgl. The soil chemistry for each area and element is grouped into concentration bands (mg/kg).

6.4.3 Maximum soil classification bands for selected metals in rural soil and sediment published by the BGS for the Order Limits (Landmark, 2019) are:

a. arsenic (As): 25–35mg/kg

b. cadmium (Cd): 1.8–2.2mg/kg

c. chromium (Cr): 120–180mg/kg

d. nickel (Ni): 45–60mg/kg

e. lead (Pb): >1,200mg/kg

6.4.4 The maximum results are more likely indicative of anthropogenic sources and aerial deposition. With regards to lead, maximum results (>1,200mg/kg) coincide with an area around the North Portal at Goshems Farm landfill.

6.4.5 The risk to construction workers from lead concentrations, and the potential for wind-blown dusts affecting other human health receptors during construction of the North Portal, may need to be considered further. Elevated lead concentrations in soil may also affect options for material reuse or disposal. Site specific concentrations will be determined during intrusive ground investigations and risk assessment completed as required.

7 Potential receptors

7.1 Introduction

7.1.1 Various receptors that may be affected by contamination have been identified based on the Order Limits. These have been grouped by generic type at this stage of the assessment. Examples have been given for each type and the main locations where these have been identified; however, this is not necessarily an exhaustive list of all receptors.

7.1.2 The main types of receptor s identified can be summarised as follows:

a. Human health (health impacts on humans due to exposure to contaminants)

b. Controlled waters (pollution of groundwater or surface water including marine ecology and marine environment)

c. Terrestrial ecology (direct or indirect adverse effects on natural ecosystems and the component flora and fauna)

d. Construction materials (degradation to on-site structures and other built assets or ground gas and vapour intrusion risks to existing off-site structures and services)

7.1.3 These are detailed in the sections below. For the purposes of this CSM, property (e.g. crops, livestock and heritage) are not included as potential receptors.

7.1.4 Figure 5 identifies the broad land use types present within a 250m buffer of the Order Limits and do not necessarily apply to small individual properties or land uses. These have been categorised and identified at a relatively small scale (approximately 1:10,000) from OS mapping and aerial photography. Therefore, smaller areas of different land use may be present within the areas identified. They represent a broad classification of sensitivity for a human health risk assessment (residential land use being of highest sensitivity to contamination).

Table 7.1 Description of land use categories

Group	Land use type	Examples
Rural	Agricultural	Arable and pastoral fields, field boundaries and hedgerows, farm buildings (including farmhouses), barns, animal husbandry, stables
	Woodland	Woodland
Commercial and industrial	Commercial	Retail, services and similar sites, including fuel retail
	Industrial	Manufacturing, waste, utilities, haulage
	Transport	Major roads, rail, maintenance and shipping sites

Group	Land use type	Examples
	Landfill	Recorded landfill sites
	Other	Milton Rifle Range, Fire Station, training complex.
Residential and other access land	Residential	Residential properties, houses, flats, bungalows, etc.
	Recreational	Public parks; gardens; leisure sites such as golf courses and leisure centres; and heritage sites, such as Coalhouse Battery
	Institutional	Schools/colleges

7.2 Human health receptors

7.2.1 A variety of human health receptors have been identified along the Project route. These have been classified into six receptor categories, RH01 to RH06, with each category representing receptors where similar exposure pathways are likely to be active. Human health exposure pathways may include contact with contaminants via oral, dermal or inhalation exposure.

7.2.2 Each receptor group also relates to broadly comparable levels of sensitivity as the sensitivity of human receptors will vary (for example, an adult commercial worker is considered less sensitive than a child in a residential setting). The sensitivity relates to the duration and amount of exposure. For example, the duration and dust concentration to which road users may be exposed are ordinarily assumed to be relatively low levels. However, during construction human health receptors may be affected by wind-blown dust at higher levels.

7.2.3 A number of the human health receptors identified are only applicable to the construction or operational phases of the Project.

7.2.4 The identified human health receptors, RH01 to RH06, are summarised in Table 7.2.

Table 7.2 Human health receptors

Ref.	Receptor	Phase	Locations
RH01	Construction workers For example: site investigation staff, ground workers, site engineers, supervisors, surveyors, pavement layers, utilities installers and tunnelling operatives.	Ground investigation and construction	Whole route (Order Limits including land required temporarily) Higher levels of exposure would be expected in areas of excavation (tunnel and where the Project route is in cutting)
RH02	Operations staff For example: highway workers, emergency services, tunnel operations, maintenance and utilities engineers	Operation	Whole route (permanent land take) Exposure duration will be greater in permanent places of work
RH03	Road users	Operation	Whole route (highway)

Ref.	Receptor	Phase	Locations
	For example: drivers (e.g. stopped on hard shoulder, using tunnel) and also pedestrians using crossing points and trespassers.		
RH04	Adjacent land users – residents (long term exposure).	Construction and operation	Numerous residential areas within 250m of the Order Limits. See Figure 5.
RH05	On site and adjacent land users of outside open space (e.g. recreational walkers/footpath users and users of recreational sites).	Construction and operation	Public open space and recreational sites within 250m of the Order Limits have been identified. See Figure 5.
RH06	Adjacent land users – industrial, commercial and agricultural workers	Construction and operation	Industrial and commercial and sites within 250m of the Order Limits have been identified in Figure 5. Examples are summarised in Table 7.3.

7.2.5 The identified human health receptors RH01 to RH03 are present along the route alignment and considered to be of equal sensitivity for the purpose of this assessment (although certain receptors, such as tunnelling operatives, may only be present in localised areas). Human health receptor RH04, adjacent residential land users, are present along the Project route. While the composition and sensitivity of individual residential properties may vary, this high-level assessment considers all residential properties to be comparable in terms of sensitivity.

7.2.6 Table 7.3 provides a summary and examples of potential human health receptors RH05 (individual recreational sites and generic public open space) and RH06, which are considered to be the most varied land uses and have a wider range of sensitivity, compared with RH01 to RH04. The locations of the general categories of human health receptors are shown in Figure 5.

Table 7.3 Land uses – RH05 (On site and adjacent land users – public open space and recreational sites) and RH06 (Adjacent land users – industrial, commercial and agricultural workers)

Location	Public open space and recreational sites (RH05)	Industrial and commercial workers (RH06)	Rural (RH06)
A2/M2 junction to South Portal	For example: • Southern Valley Golf course (HLU0324) users • Cascades Leisure Centre users • Pedestrians on public rights of way and other footpaths	For example: • Employees at Park Pale Farm Haulier Depot (HLU0125) • Workers at Henhurst Road contractor's depot (HLU0220) • Workers at Channel Tunnel Rail Link railway sites (HLU0126) • Employees at Esso A2 Westbound PFS (HLU0215)	For example: • Agricultural workers around Thong and Chalk villages
South Portal to North Portal	For example: • Pedestrians on Public Rights of Way and other footpaths • Users of proposed public open spaces e.g. Chalk Park	For example: • Construction workers at the former Tilbury Power Station site (HLU0630) • Milton Rifle Range users (HLU0417)	For example: • Agricultural workers working on areas of ash fields used for arable farming
North Portal to A13	For example: • Golf course users – Orsett Golf Club (HLU0858) • Pedestrians on Public Rights of Way and other footpaths • Recreation ground users • Users of proposed public open spaces e.g. Tilbury Fields	For example: • Workers at EMR Scrap metal facility (HLU0512) • Workers at Dansand Quarry (HLU0963) and Southfields Quarry (HLU0946) • Workers at pre-cast concrete works (HLU0818) • Workers at Thames Industrial Park (former Bata shoe factory) (HLU0827)	For example: • Agricultural workers working farmland between the North Portal and A13
A13 to M25	For example: • Employees and visitors at Thames Chase Forest Centre. • Pedestrians on Public Rights of Way and other footpaths	For example: • Hall Farm Nursery (HLU1152) workers	For example: • Agricultural workers working farmland between the A13 and M25

7.3 Controlled water receptors

7.3.1 Controlled water receptors, including both groundwater (designated aquifers) and surface waters (inland, coastal and estuarine waters), have been identified and have the potential to be impacted by the construction and operational phases.

7.3.2 Controlled waters (as defined by the Water Resources Act 1991) are statutory receptors. As such, any new development must consider the potential impact that it may have on controlled waters and the development plan must ensure that it does not have a detrimental effect on the quality of groundwater and surface water receptors.

7.3.3 In addition to existing pollutant linkages that may be present, there is potential for impact to controlled water receptors to occur during construction works due to the potential for mobilisation of contamination (i.e. creation of pathways). Construction activities leading to the mobilisation of contamination may include movement of contaminated soils to a previously unimpacted area. It may also include activities such as piling works which have the potential to either draw contamination deeper, or to create pathways for migration of contaminated groundwater to previously unconnected receptors.

7.3.4 All of the Order Limits south of the River Thames and most of the Order Limits north of the A13 are located within a Nitrate Vulnerable Zone. These are areas designated as being at risk from agricultural nitrate pollution and where controls must be in place to prevent water pollution from sources of nitrate (typically fertilizers applied on farms). If required, appropriate soil management techniques have been identified to manage soil erosion and avoid impacts to controlled waters. These are secured via GS009, GS010, GS011, GS013 and RDWE006 set out in the REAC.

7.4 Groundwater resources and abstractions

7.4.1 Groundwater resources within bedrock and superficial deposits are classified using the following aquifer designations by the Environment Agency (Environment Agency, 2017):

a. Principal aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

b. Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

c. Secondary B aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of what were formerly designated as non-aquifers.

d. Secondary Undifferentiated aquifers have been assigned in cases where it has not been possible to attribute either category A or B due to the variable characteristics of the rock type.

7.4.2 Strata not designated as one of the above categories are known as unproductive strata. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow (Environment Agency, 2017). Based on this information, impacts on unproductive strata as a receptor have not been assessed.

7.4.3 The actual sensitivity of groundwater bodies will be dependent on several factors including the thickness of any confining strata, the presence of an unsaturated zone above the groundwater surface, the strata permeability and the attenuation properties of those strata.

7.4.4 Mapped strata identified and designated as aquifers are identified in Table 7.4.

Table 7.4 Controlled water receptors – designated aquifers

Ref.	Receptor	Approximate locations*
RW01	Alluvium – Secondary A and Secondary Undifferentiated aquifer	M2 junction 1 to River Thames River Thames Channel River Thames to Low Street Orsett Fen
RW02	Head Deposits – Secondary A and Secondary Undifferentiated aquifer	M2 junction 1 to River Thames Low Street Orsett Fen North Ockendon
RW03	River Terrace Deposits (Boyn Hill, Lynch Hill, Brent Park Black Park and Taplow Gravel Members) – Secondary A aquifer	Lower Higham Road to River Thames East Tilbury, Low Street and A13 Muckingford Road to Brentwood Road North Ockendon
RW04	White Chalk Subgroup (Lewes Nodular Chalk, Seaford Chalk and Newhaven Chalk) – Principal aquifer	M2 junction 1 to River Thames River Thames to Low Street
RW05	Thanet Formation – Secondary A aquifer	Small outliers at the A2 junction, Chalk and Lower Higham Road Low Street to A13 junction
RW06	Lambeth Group – Secondary A aquifer	Shorne Woods Country Park A13 junction
RW06a	Harwich Formation – Secondary A aquifer	Shorne Woods Country Park A13 junction

** Aquifer units: preliminary location as shown on geological mapping; excavation and tunnelling works may encounter strata in a wider area*

7.4.5 Groundwater Source Protection Zones (SPZs) have been designated by the Environment Agency for groundwater abstraction points used for public drinking water supply:

a. SPZ1: Inner Zone (50-day travel time)

b. SPZ2: Outer Zone (400-day travel time)

c. SPZ3: Total catchment (defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source).

7.4.6 The SPZs which may be affected (where the study area are within the boundary of a designated SPZ) are summarised in Table 7.5 and SPZs are also shown in figure HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-50109 - Groundwater Receptors and Resources presented in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3).

Table 7.5 Source Protection Zones

Abstraction	Likely aquifer source	Approx. nearest point from Order Limits		
		SPZ1	SPZ2	SPZ3
Higham – Southern Water Services Ltd ref. 9/40/01/0511/G	Chalk	812m north	504m north	Within Order Limits
Three Crutches – Southern Water Services Ltd ref 9/40/01/0511/G [1]	Chalk	300m east	Within Order Limits	Within Order Limits
Cuxton/Cobham – Southern Water Services Ltd ref. 9/40/01/0511/G [1]	Chalk	1200m south east	Within study area	Within Order Limits
Instead Rise/Northfleet – Southern Water Services Ltd ref. 9/40/01/0511/G [1]	Chalk	1,180m south west	620m south west	Within Order Limits
Northfleet – Southern Water Services Ltd. ref. 9/40/01/0511/G [1]	Chalk	Within study area	Within Order Limits	Within Order Limits
Windmill Hill /Gravesend – Southern Water Services Ltd ref. 9/40/01/0511/G [1]	Chalk	1,280m south west	380m north	Within Order Limits
Stifford/West Thurrock – Northumbrian Water Ltd ref. 8/37/56/*G/0044 [1]	Chalk	900m west	590m south west	Within Order Limits
Linford – Northumbrian Water Ltd. reference 8/37/56/*G/0044 [1]	Thanet Fm/ Chalk	Within Order Limits	Within Order Limits	Within Order Limits
Abstraction not known	Unknown	850m south west	Within study area	Within Order Limits

Note 1: according to the most recent information received from the Environment Agency (June 2021), the licence has been revoked. However, for the purpose of this document, this groundwater abstraction will be considered as an active licence.

7.4.7 The Linford abstraction is understood to not be in use for public water supply but is still operational.

7.4.8 Known groundwater abstractions within the study area are summarised in Table 7.6 and shown in figure HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-50109 - Groundwater Receptors and Resources presented in Application Document 6.3, Appendix 14.5 Hydrogeological Risk Assessment.

Table 7.6 Known groundwater abstractions within 250m of Order Limits

Abstraction name and possible source aquifer	Location	Information source	Comments
Southern Valley Golf Course (White Chalk Subgroup)	Riverview Park	LTC Water Features Survey	Unlicensed abstraction. Ordnance Survey map suggests ground level is approximately 65m AOD.
J Clubb Ltd (River Terrace Deposits)	Gravesend	Environment Agency – licensed abstractions	Mineral washing Licence No. 9/40/01/0498/G Max. annual quantity: 83,969m^3 Max. daily quantity: 336m^3
Southern Water Services Ltd. (Chalk)	Gravesend Sewage Works	Environment Agency – licensed abstractions	General washing/process washing Licence No. 9/40/01/0508/G Max. annual quantity: 55,000m^3 Max. daily quantity: 340m^3
RWE Generation UK PLC (White Chalk Subgroup)	Gravelpit Farm	Environment Agency – licensed abstractions	General use relating to secondary category (medium loss) Licence No. 8/37/56/*G/0073 4No. Boreholes, Low St, East Tilbury Max. annual quantity: 1,100,000m^3 Max. daily quantity: 5,500m^3
CH Cole and Sons (Fluvial Sands/Gravels)	Irrigation reservoir at Low Street	Environment Agency – licensed abstractions	General farming and domestic, Spray Irrigation – Direct Licence No. 8/37/56/*G/0006 Max. annual quantity: 182,000m^3 Max. daily quantity: 1,300m^3
S Walsh & Son Ltd (Fluvial Sands/Gravels)	East Tilbury Marshes, Princess Margaret Road Landfill	Environment Agency – licensed abstractions	Gravel pit at East Tilbury, mineral washing Licence No. 8/37/56/*G/0026 Max. annual quantity: 409,100m^3

Abstraction name and possible source aquifer	Location	Information source	Comments
			Max. daily quantity: 1,909m^3
Northumbrian Water Ltd (White Chalk Subgroup)	Linford	Environment Agency – licensed abstractions	Potable Water Supply – Direct (see Table 7.5) Licence No. 8/37/56/*G/0044 Max. annual quantity: 3,728,000m^3 Max. daily quantity: 18,065m^3
Orsett Golf Club Ltd. (Chalk)	East of Brentwood Road	Environment Agency – licensed abstractions	Spray Irrigation – Direct Licence No. AN/037/0056/012 Max. annual quantity: 24,000m^3 Max. daily quantity: 240m^3
CH Cole and Sons (Fluvial Sands/Gravels)	Three locations: Botney Farm, Castles Farm and Hobletts Farm, Orsett.	Environment Agency – licensed abstractions	General farming and domestic Licence No. 8/37/56/*G/0032 Max. annual quantity: 11,140m^3 Max. daily quantity: 42m^3

7.4.9 The local authorities recorded no private water supplies (as defined by the Private Water Supplies Regulations 2016 (as amended)) within the study area (Chapter 14: Road Drainage and the Water Environment (Application Document 6.1)).

7.5 Surface water resources and abstractions

7.5.1 Surface water bodies include natural watercourses and modified and artificial water bodies. The main watercourse along the Project route is the River Thames which is tidal/brackish at the Gravesend Reach where the route alignment crosses under in a tunnel (Highways England, 2019).

7.5.2 The impact of the route on surface water bodies would depend on the proximity and potentially active pathways (lateral migration of groundwater, direct runoff of water and sediment), the nature of the works (tunnel, cutting or embankment), the existing land quality, and the importance (sensitivity) of the water body both chemically and biologically.

7.5.3 Surface water features surveyed during Phases 1 to 4 of the Water Features Survey are summarised in Table 2-2 of Appendix 14.2, Application Document 6.3 and shown on drawing HE540039-CJV-EGN-SZP_EGNE00000000-DR-LE-50149 within Annex B of the Water Features Survey Factual Report. This includes both surface waterbodies and surface water abstractions. The relevant

local authorities have been contacted, and confirmed that they have no records of any unlicensed abstractions.

7.5.4 Where construction works are proposed within the Thames Estuary, the potential environmental risks associated with contaminated sediment and disturbance and resuspension of sediment should be considered so as to mitigate possible environmental deterioration of the Thames Estuary.

7.5.5 The impact on surface water drainage from the Project during operation is not assessed as a pathway of concern in this report and is considered within Chapter 14 of the Environmental Statement (Application Document 6.1).

7.6 Ecological receptors

7.6.1 Planned development works must consider the potential for impact on ecological receptors, and the Applicant must ensure that the Project does not have a detrimental effect on the overall ecology of the area, which includes all flora and fauna. Some areas are not formally designated but may be identified as priority habitat or other classification schemes. Some areas along the Project route have statutory and non-statutory designations where ecological receptors are of particular importance and sensitivity. The potential for contaminated soil or water to affect these designated areas requires specific consideration to ensure that loss of habitat or species does not occur. Sites include SSSI: Site of Special Scientific Interest (Wildlife and Countryside Act 1981); SPA: Special Protection Area (Birds Directive); pSPA: potential Special Protection Area; LWS: Local Wildlife Site (non-statutory) and LNR: Local Nature Reserve (National Parks and Access to the Countryside Act 1949).

7.6.2 Potential ecological receptors are detailed in ES Chapter 8: Terrestrial Biodiversity (Application Document 6.1) and shown on figure HE540039-CJV-EBD-SZP_EGNE00000000-DR-LE-50039 - 8_1 Designated Sites.

7.6.3 Construction works beneath the Thames Estuary have the potential to disturb contaminated sediment. Depending on the type and concentration of sediment contamination, potential effects on river and estuary biota, including benthic organisms, may also occur as a result of this.

7.6.4 All ecological receptors are referred to as RE01 in Table 7.6.

7.7 Construction materials

7.7.1 Construction materials (including building foundations, underground services and other subsurface construction) may be affected by several types of contaminant. If present, contamination may require specific consideration in construction design and material specification.

7.7.2 Specific design mitigation measures may be required to prevent hydrocarbons, VOCs and SVOCs, and other organic chemicals causing concrete weakening, and penetrating plastic utility pipes. Inorganic compounds including sulphates may cause chemical attack and weakening of concrete and must be considered in concrete specifications. The presence of ground gases requires specific protection measures to be incorporated into building design, so as to prevent build-up of gases in confined spaces which may cause damage if the lower explosive limit is exceeded.

7.7.3 Materials that may be directly affected by contamination during construction and operation include:

a. RB01 (on-site): Highway pavements and associated structures (including bridge foundations, abutments, retaining walls, sheet piles, etc.)

b. RB02 (on-site): Sub-base materials

c. RB03 (on-site): Tunnel lining and portal elements

d. RB04 (on-site): Utilities – new or relocated existing pipes, cables, drainage etc.

e. RB05 (off-site): Existing structures and services (ground gas and vapour intrusion risks only)

7.7.4 In addition, structures and utility runs near to the Project route may be indirectly affected by changes in the ground gas or groundwater regimes caused by the temporary or permanent works. For example, dewatering associated with the Project may enhance the migration of existing dissolved or gaseous contaminants over large distances.

8 Potentially active pathways

8.1.1 This section provides a summary of the potentially active pathways, relevant to the sources and receptors identified in this CSM review in Sections 5, 6 and 7. Only relevant pathways that have the potential to cause a plausible pollutant linkage have been included.

8.1.2 Potential pathways include both human health exposure pathways, and environmental fate and transport pathways.

8.1.3 For a pollutant linkage to exist, a pathway must be present connecting the contaminant source and the receptor. Pathways that have been considered as potentially active are:

a. direct and dermal contact and incidental ingestion of contaminated soil

b. direct and dermal contact and incidental ingestion of contaminated groundwater

c. ingestion of soil or wind-blown dust

d. build-up of vapours or gases in confined spaces

e. inhalation of vapours, gases or wind-blown dust or fibres

f. leaching of contaminants from soil into groundwater

g. migration of contaminated groundwater on or off site

h. groundwater migration to surface waters

i. contaminated runoff (water and sediment) from land to surface waters

8.1.4 Direct and dermal contact by humans with surface waters is not considered a relevant pathway. This is because human contact with surface waters is an unlikely scenario in the context of the Project.

8.1.5 There is potential for the project to cause preferential migration of contaminants through considered pathways d, e, f, g and h via proposed construction such as services, trenches and deep foundations.

8.1.6 Pathways are summarised by their relevance to receptor types in Table 8.1 below. They are introduced into the preliminary CSM by matching with individual sources according to the contaminant type(s) and environmental setting, as set out in Annex C (Part 1).

Table 8.1 Potentially active pathways by receptor type

Receptor		D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW
		Direct/dermal contact and ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff from land to surface waters
RH01	Construction workers For example: site investigation staff, ground workers, site engineers, supervisors, surveyors, pavement layers, utilities installers and tunnelling operatives.	**D-S01**	**D-G01**	**A01**	**V01**	**F01**				
RH02	Operations staff For example: highway workers, emergency services, tunnel operations, maintenance and utilities engineers	**D-S02**	**D-S02**	**A02**	**V02**	**F02**				
RH03	Road users For example: drivers (e.g. stopped on hard shoulder, using tunnel) and also	**D-S03**		**A03**	**V03**	**F03**				

Receptor		D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW
		Direct/dermal contact and ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff from land to surface waters
	pedestrians using crossing points and trespassers.									
RH04	Adjacent land users - residents (long-term exposure)			**A04**	**V04**	**F04**	**S-G04**	**GL-04**		
RH05	On site and adjacent land users – public open space (e.g. recreational walkers/footpath users, and users of recreational sites)	**D-S05**		**A05**	**V05**	**F05**	**S-G05**	**GL-05**		
RH06	Adjacent land users – industrial, commercial and agricultural workers			**A06**	**V06**	**F06**	**S-G06**	**GL-06**		
RW01–RW06	Groundwaters (Principal and Secondary aquifers) and associated SPZ						**S-G07**	**G-L07**		

Receptor		D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW
		Direct/dermal contact and ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff from land to surface waters
RW07–RW53	Surface waters						**S-G08**	**GL-08**	**G-SW08**	**R-SW08**
RB01–RB05	Construction materials (structures and services)	**D-S09**	**D-G09**		**V09**		**S-G09**	**G-L09**		
RE01	Ecological receptors			**A10**		**F10**	**S-G10**	**GL-10**	**G-SW10**	**R-SW10**

9 Preliminary qualitative risk assessment

9.1 Summary of Conceptual Site Model

Description

9.1.1 The preliminary CSM developed for the Project, including the potential source-pathway-receptor linkages identified, is documented in Annex C (Part 1). The annex lists the relevant potentially active pathways for each source identified and details the receptors which may potentially be impacted.

9.1.2 Ecological and built receptors are not included in Annex C (Part 1) as they are applicable for nearly all the contamination sources along the Project route.

Evaluation of pollutant linkages

9.1.3 The tabular description of the CSM in Annex C (Part 1) is based on the identified credible contaminant sources.

9.1.4 Pathways and receptors were assigned to each contaminant source (HLU) based on an assessment of their potential to form part of a source-pathway-receptor linkage, taking account of the types of COC and environmental setting.

9.1.5 As a starting point and to achieve a level of consistency, a deterministic approach was undertaken first utilising GIS and conservative assumptions. This followed the approach set out in Table 9.1.

9.1.6 The source-pathway-receptor linkages were then reviewed, and pathways and receptors were added or removed using professional judgement on the likelihood of specific source-pathway-receptor linkages being present, based on the information available.

Table 9.1 Initial assignment of pollutant pathways and receptors

Pathway/receptor			Active if:	Assumptions and rationale
Potential pathways	D-S	Direct/dermal contact and incidental ingestion of contaminated soil.	Source is on site (within Order Limits).	Construction workers may come into contact with any soil within the Order Limits.
	D-G	Direct/dermal contact and incidental ingestion of contaminated groundwater.	Present if a significant source, such as a large landfill or petrol filling station and if there is the potential for encountering groundwater within excavations.	Direct contact with contaminated groundwater would be rare and is of most concern where excavations are dewatered. Groundwater abstractions are assessed under the controlled water receptor section as designated aquifers.
	A	Ingestion of soil or wind-blown dust.	Source is within the route alignment.	Soil would only be significantly disturbed and exposed to wind when affected by the main intrusive works along the route alignment.
	V	Build-up of vapours or gases in confined spaces.	VOC or hazardous gas is a COC and source is within 50m of the Order Limits.	Gas is unlikely to migrate laterally through the subsurface more than 50m in granular soils (Massmann and Farrier, 1992) (CIRIA, 2007) except in fractured bedrock.
	F	Inhalation of vapours, gases or wind-blown dust or fibres.	Pathways A or V are active.	Inhalation only likely when vapours or gases have built up or when soil has become airborne.
	S-G	Leaching of contaminants from soil into groundwater.	Source is on a designated superficial or bedrock aquifer.	Conservatively ignore potential for overlying low permeability layers and retardation.
	G-L	Migration of contaminated groundwater on or off site.	Source is on a designated superficial or bedrock aquifer.	Conservatively ignore potential for dilution and retardation.
	G-SW	Groundwater migration to surface waters.	Aquifer present and source is within 200m of a surface water feature.	Conservatively ignore groundwater flow direction, dilution and retardation.
	R-SW	Contaminated runoff (water and soil) from land to surface waters	Source is within 10m of a surface water feature.	Surface runoff unlikely to be significant over more than 10m (Environment Agency, 2007) except in exceptional circumstances.

Pathway/receptor			Active if:	Assumptions and rationale
Human health receptors	RH01	Construction workers	Source is on site (within Order Limits	Construction workers may come into contact with any soil within the Order Limits.
	RH02	Operational staff	Source is within 5m of route alignment.	Highway maintenance groundworks would be restricted to close to the highway alignment.
	RH03	Road users	Source is within the route alignment.	Road users (including pedestrians) are restricted to the highway alignment.
	RH04	Adjacent land users – residents	Source is within the Order Limits and is within 100m of a residential area.	Project work is assumed to not have any impact on the condition of off-site sources. Contamination is unlikely to migrate more than 100m in most circumstances. High-level land uses as shown in Figure 5.
	RH05	On site and adjacent land users – public open space	Source is within the Order Limits and is within 100m of public open space area.	
	RH06	Adjacent land users – Industrial, Commercial and Agricultural workers, and users of Recreational sites (ICAR)	Source is within the Order Limits and is within 100m of ICAR area.	
Controlled water receptors	Superficial aquifer		Source is on a designated superficial aquifer.	Conservative approach - ignore potential for overlying low-permeability layers and retardation.
	Bedrock aquifer		Source is on a designated bedrock aquifer.	
	Source Protection Zones (SPZs)		Source is within a designated SPZ (2019 update).	
	Surface Water		Source is within 10m of a surface water feature or G-SW pathway is active.	Conservatively ignore groundwater flow direction, dilution and retardation. Surface runoff unlikely to occur over more than 10m.

9.2 Qualitative risk assessment methodology

9.2.1 Based on the potentially active pollutant linkages identified, Annex C (Part 1) assigns a preliminary risk rating, from low to high, for each of the potential sources. Where multiple linkages are identified, the highest risk is given.

9.2.2 The assessment is based on professional judgement using the information currently available for each potential source as presented in Section 5, the environmental setting and the likely sensitivity of receptors present.

9.2.3 The risk ratings are based on:

a. the likelihood that the pollutant linkage is currently present, based on the mobility of the contaminants potentially present at the source and the potential environmental pathways

b. the severity of the potential effects on the receptor

c. the future potential pollutant linkages based on the impact of the Project development and construction works

9.2.4 The method of applying risk ratings is based on guidance provided in Contaminated land risk assessment: A guide to good practice (C552) (CIRIA, 2001). The risk ratings given have been defined based on the risk to the specific receptors identified, and the impact this would cause to construction of the Project route. A detailed description of the risk ratings is given in Annex C (Part 2).

9.2.5 The risk rating given includes qualitative evaluation of the following:

a. Both Project-related receptors such as structures and road users, and third-party and environmental receptors.

b. Both the construction and operational phases (highest risk is given for each pathway). The construction phase includes associated enabling and temporary works such as construction compounds and access roads.

9.2.6 The risk ratings do not consider the potential scale or cost of mitigation measures that would be required to mitigate the pollutant linkage.

9.2.7 The risk ratings are qualitative and are defined in Table 9.2.

Table 9.2 Definition of risk ratings

Risk Rating	Definition
High	Complete pollutant linkage is **likely** and potential for significant adverse impacts upon human health or the environment. Ground investigation and further assessment essential.
Medium	Complete pollutant linkage is **possible** and potential for adverse impacts upon human health or the environment. Ground investigation and/or further assessment required.
Low	Complete pollutant linkage is of **low likelihood** and potential for limited adverse impacts upon human health or the environment.

Risk Rating	Definition
	Limited ground investigation and/or further assessment may be prudent.

9.3 Qualitative assessment results

9.3.1 The preliminary risk ratings are provided in Annex C (Part 1) and are qualitative estimates based on desk-study information only. They are intended to be used for prioritisation of ground investigation and subsequent further risk assessment based on site-specific ground investigation. Where multiple pathways and receptors are identified, the risk rating is based on the pollutant linkage with the highest risk.

9.3.2 Following the preliminary qualitative risk assessment, the following credible contaminant sources were identified as medium and high risk. This represents an initial evaluation of the significance for each source in accordance with the LCRM process for a Tier 1 Preliminary Assessment.

Table 9.3 Summary of medium and high credible contaminant sources

Medium	HLU0207	Sheep Wash
Medium	HLU0206	Electricity substation
Medium	HLU0215	Esso A2 Westbound Petrol Filling Station
Medium	HLU0220	Henhurst Road Contractors Depot
Medium	HLU0224	Singlewell Service Station
Medium	HLU0321	Former Gravesend Airport
Medium	HLU0322	Gravesend Airport Perimeter Road - Northeast
Medium	HLU0213	Gravesend Airport Perimeter Road - Southeast
Medium	HLU0309	Chalk Pit (west of Thong Lane)
Medium	HLU0324	Southern Valley Golf Course
Medium	HLU0532	Tilbury Ash Disposal Site - Area A1
Medium	HLU0531	Tilbury Ash Disposal Site - Area A2
Medium	HLU0530	Tilbury Ash Disposal Site - Area A3
Medium	HLU0529	Tilbury Ash Disposal Site - Area B
Medium	HLU0528	Tilbury Ash Disposal Site - Area C
Medium	HLU0527	Tilbury Ash Disposal Site - Area C2
Medium	HLU0534	Tilbury Ash Disposal Site - Shed Marsh Landfill
Medium	HLU0630	Tilbury Power Station
Medium	HLU0828	Former railway engine house
Medium	HLU0830	Former railway sidings at brickworks
Medium	HLU0804	Electricity substation
Medium	HLU0515	Suspected quarry fill
Medium	HLU0537	Suspected quarry fill

Medium	HLU0819	Potentially infilled pit
Medium	HLU0823	Infilled gravel pit east of Brentwood Road
Medium	HLU0824	Infilled gravel pit east of Brentwood Road
Medium	HLU0949	Vehicle repair and maintenance garage at A13-A128 junction
Medium	HLU0960	Welcome Villa PFS
Medium	HLU0940	Infilled gravel pit
Medium	HLU0943	Millers Sand and Gravel Pit landfill
Medium	HLU0944	Former works (unspecified) and garage at Baker Street.
Medium	HLU1062	Ockendon Grays Areas II & III Landfill
Medium	HLU1151	Potential asbestos containing irrigation pipes, Hall Farm
High	HLU0526	Goshems Farm Landfill
High	HLU0523	East Tilbury Landfill
High	HLU0533	East Tilbury Landfill - northern extension
High	HLU0535	Low Street Landfill
High	HLU0536	Low Street Brickworks Landfill
High	HLU0512	Metal recycling facility

10 Unexploded ordnance (UXO)

10.1.1 An UXO Desk Study and Risk Assessment has been carried out for the Order Limits by Zetica (Zetica, 2022).

10.1.2 Potential sources of UXO considered in the report include pre-WWI military sites, WWI and WWII bombing and anti-aircraft defences, marine ordnance hazards, training facilities such as Milton Range, and wartime airfields such as Gravesend Airport. The presence of significant industrial and transport bombing targets near the Project route are also examined as well as anecdotal evidence provided to the Project.

10.1.3 The following areas identified in the Order Limits were assigned a moderate UXO hazard level by Zetica:

a. WWII bombing (10 areas)

b. River Thames

c. Milton Range

d. Gravesend Airport (pipe mines)

e. Bomber aircraft crash (Botany Farm, Orsett)

10.1.4 No records of any significant bombing or other sources of UXO hazard have been identified in the remainder of the Order Limits, which is assigned a low UXO hazard level.

10.1.5 Zetica note however that during WWII the Order Limits are in an area that was subjected to heavy bombing due to the proximity to Continental Europe and being on the flightpath to important strategic targets. Numerous Anti-Aircraft (AA) batteries were established to defend against air raids. Further, large parts comprised marshland during WWII and it possible that bomb and shell impacts may have been missed and gone unrecorded in uninhabited areas. As such, the potential for encountering a UXB (Unexploded Bomb) or UXAA (Unexploded Anti-Aircraft) shell cannot be discounted.

10.1.6 Gravesend Airport is known to have been bombed on at least one occasion and mined during the war. The majority of the airport has been redeveloped as the Riverview housing estate. However, the proposed route alignment crosses the east of the former airport site in an area that was not redeveloped for housing. The airfield has since been redeveloped into housing. Records indicate that not all of the pipe mines laid at the airfield were removed during WWII and post-WWII clearances and may remain in situ.

10.1.7 The risk of UXO would be managed in line with the requirements set out in the Code of Construction Practice (Appendix 2.2, Application Document 6.3) and the recommendations of the UXO Desk Study Report (Appendix 10.10, Application Document 6.3).

10.1.8 A number of potential contaminants may be associated with UXO sites, including metals and explosive residues from exploded ordnance, and a range of other contaminants from the destruction of the target, especially PAH from burning materials.

10.1.9 Contaminants associated with incendiary bombs include phosphorus, magnesium, aluminium, ferrous iron, and barium. Other point sources of contamination from UXO are aircraft crash sites, decommissioning sites or burning pits. Contamination impacts from UXO are likely to be highly localised. Therefore, bombing densities and damage along the Project route are probably not sufficient to cause widespread contamination, based on the evidence available.

11 Conclusions

11.1 Summary

11.1.1 This report presents a CSM outlining the geo-environmental constraints, including potential risks from contamination of soil and water, that may be present in the study area. The CSM has been developed based on the sources, pathways and receptors identified.

11.1.2 Potentially contaminative sources have been identified in the study area. The largest of these include historical and permitted landfills, industrial sites such as brick and concrete works, a power station, a former airfield, and railway infrastructure.

11.1.3 Various potential receptors, including human health, controlled waters, drinking water supplies, ecological and construction materials receptors, have been identified based on the route alignment.

11.1.4 Potentially active pathways have been identified and include both human health exposure pathways, and environmental fate and transport pathways.

11.1.5 This CSM forms the basis of the qualitative risk assessment undertaken and presented in Annex C (Part 1). The qualitative risk assessment includes assigning a risk rating (high, medium or low risk) to each of the potential contamination sources identified, based on the information currently available.

11.2 Conclusions

11.2.1 The assessment has identified a number of potential geo-environmental constraints and related ground abnormals that may affect, or be affected by, the Project.

11.2.2 The output of the risk ranking identified a total of six identified potential sources as high-risk sources and a total of 33 sources as medium-risk. The remaining identified potential sources were assigned a low-risk ranking.

11.2.3 The majority of the high risk sources are located around the East Tilbury area, and include landfills and waste facilities. All are located within the Order Limits. The natural Alluvium deposits, located north and south of the Thames, which are a potential source of hazardous gas are located within the path of the proposed route alignment.

11.2.4 Sites ranked as of medium risk are located along and around the route alignment. These include the former Gravesend Airport, a number of landfills located distant to the proposed route alignment but within the Order Limits, PFSs, infrastructure and facilities associated with rail lines, Tilbury Power Station, and a number of smaller features falling close to or within the route alignment such as electricity substations and infilled features.

a. The findings of the UXO risk assessment (Zetica, 2022) identified a moderate potential risk for UXO due to WWII bombing (10 areas); the River Thames; Milton Range; Gravesend Airport (pipe mines); Bomber aircraft crash (Botany Farm, Orsett) and around the former Gravesend Airport in Kent.

11.2.5 This report is considered sufficient to inform the next stages of investigation and design for the Project and provides a robust assessment that aligns with the tiered approach for risk assessment set out in Land Contamination: Risk Management (LCRM) (Environment Agency, 2021). The CSM is refined by subsequent tiers of assessment (generic quantitative risk assessment as presented in Appendix 10.9). Contractors would complete further ground investigations prior to construction to inform the detailed design of the Project and where supplementary investigation is required to assess residual contamination risks. This commitment is set out in the REAC (GS001, GS027 (if required) and GS028).

11.3 Nitrogen deposition compensation sites

11.3.1 Annex D presents available desk-based information for the proposed nitrogen deposition compensation sites. Various online sources of information have been used as well as project purchased data where it is available. The objective of the desk studies was to produce a high-level conceptual site model, identifying potential pollutant linkages and a preliminary risk rating that may need to be taken into consideration in the construction and operation of the proposed nitrogen deposition compensation sites.

11.3.2 Eight sites have been identified for the provision of compensatory habitat planting for the Project, and preliminary risk assessments undertaken. The following preliminary qualitative risk ratings in the context of the proposed nitrogen deposition compensation sites have been allocated.

a. Bluebell Hill – low risk

b. Burham – low risk

c. Henhurst Hill – low risk

d. Court Wood (Shorne Woods) – low to medium risk (localised medium risks)

e. Fenn Wood (Shorne Woods) – low risk

f. Hoford Road – low to medium risk (localised medium risks)

g. Buckingham Hill – medium risk

h. Hole Farm East – low risk

11.3.3 Further detail is presented in Annex D.

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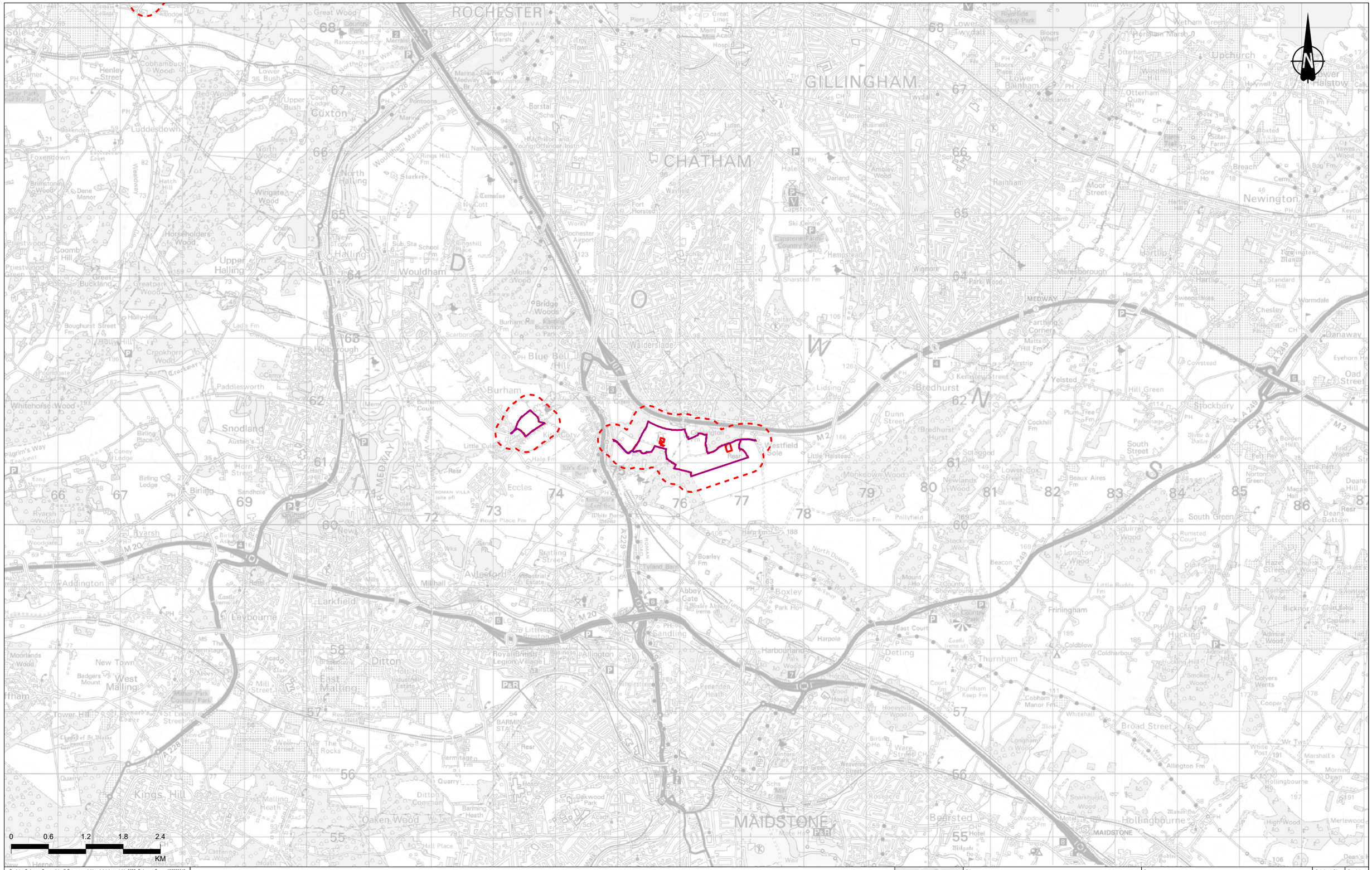
Annexes

Annex A Figures



Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Risk assessment relating to the proposed compensation area for nitrogen deposition is excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW		

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION	Original Size	Revision
Application Document Number	TR010032/APP/6.3	A3	P02
		Scale	1:55,000

Drawing Title

Figure 1 : Conceptual Site Model Study Area

Page 1 of 3

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00004

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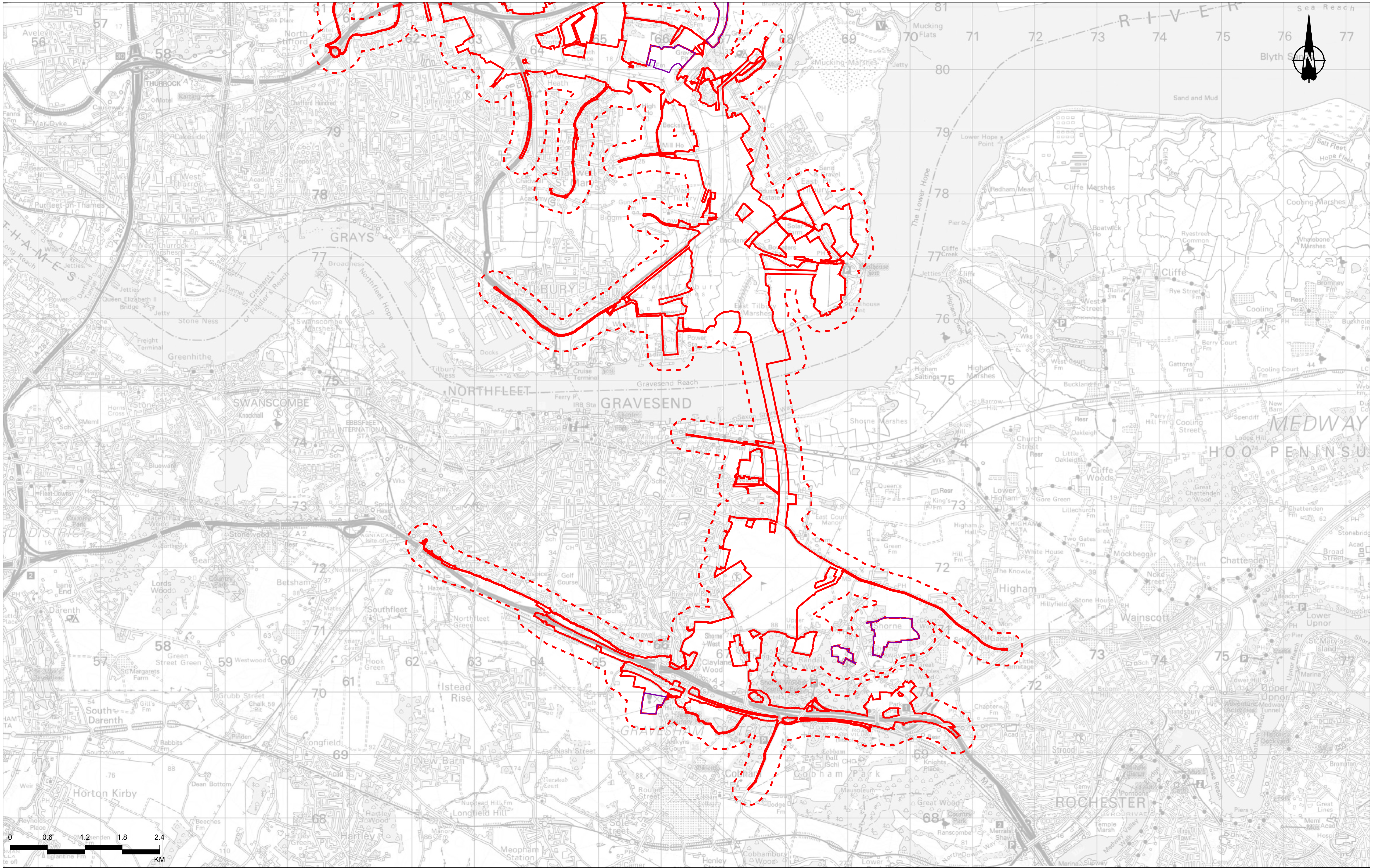

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P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Risk assessment relating to the proposed compensation area for nitrogen deposition is excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Original Size: A3

Revision: P02

Application Document Number: TR010032/APP/6.3

Scale: 1:55,000

Drawing Title: Figure 1 : Conceptual Site Model Study Area

Page 2 of 3

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00004

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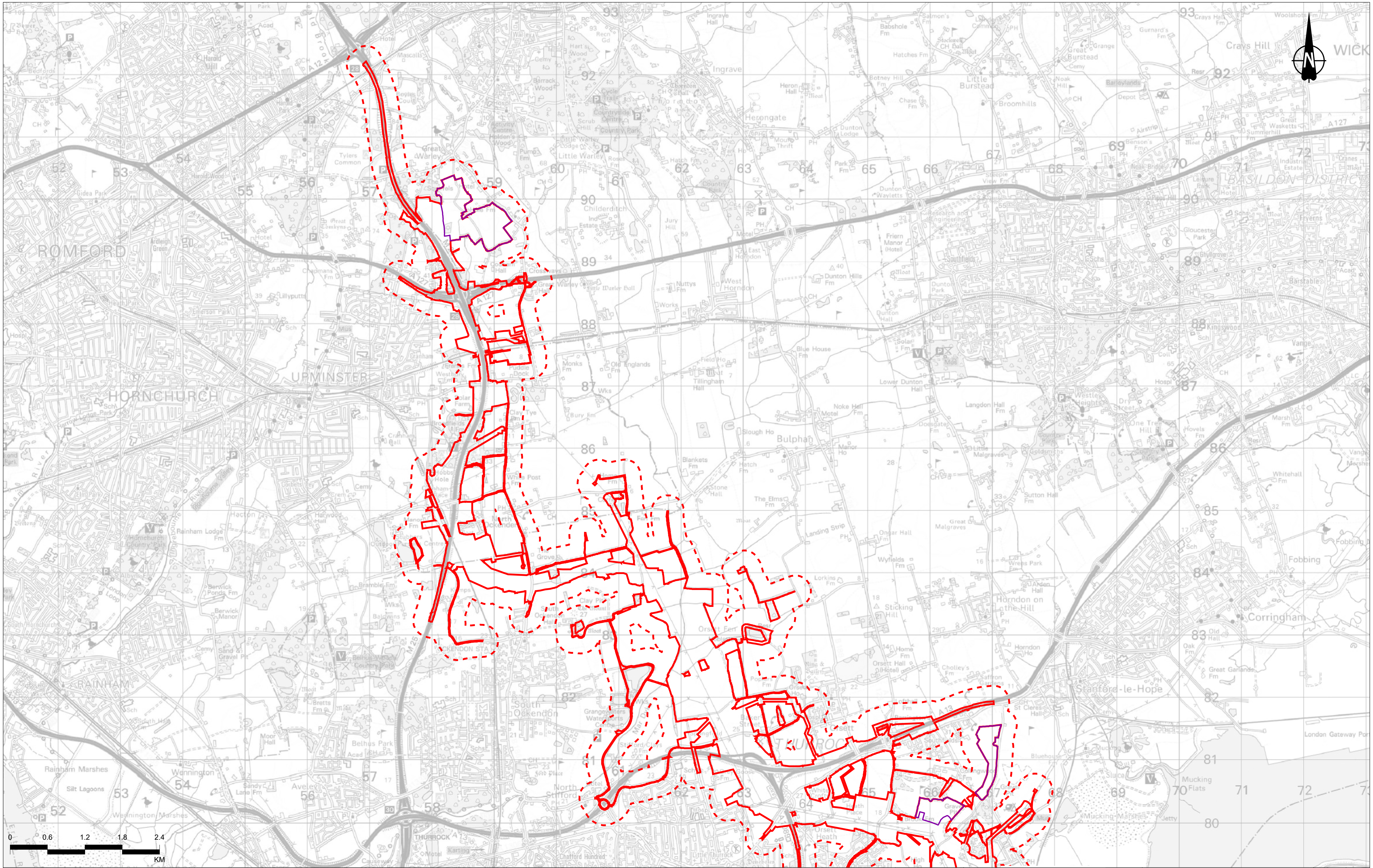

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Risk assessment relating to the proposed compensation area for nitrogen deposition is excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Original Size: A3

Revision: P02

Application Document Number: TR010032/APP/6.3

Scale: 1:55,000

Drawing Title: Figure 1 : Conceptual Site Model Study Area

Page 3 of 3

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00004

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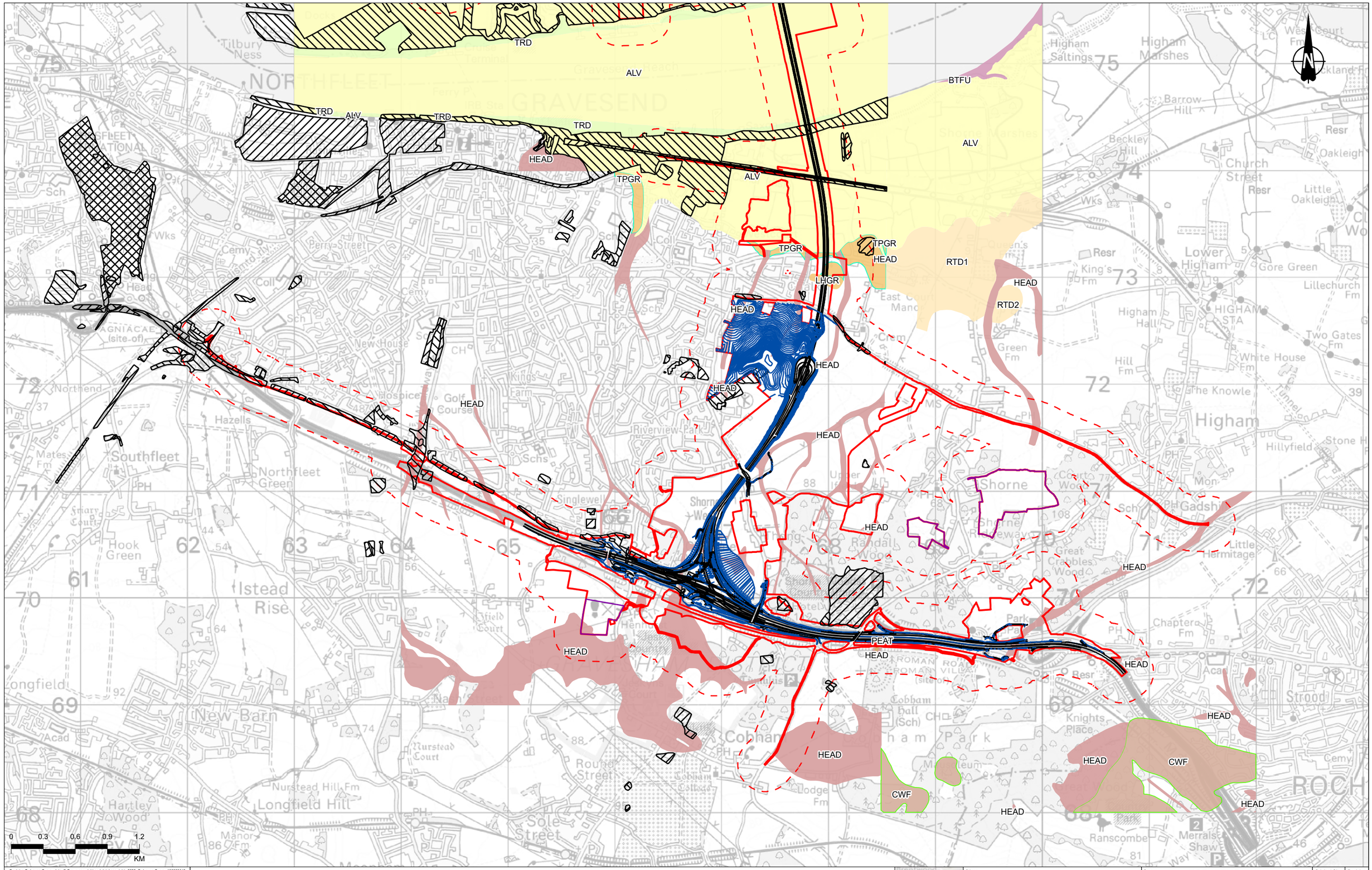

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Earthworks
- Order Limits
- Study area (250m buffer to Order Limits)
- Compensation area for nitrogen deposition

BGS 50k Superficial Deposits

- Alluvium (ALV)
- Beach and Tidal Flat Deposits (Undifferentiated) (BTFU)
- Clay-with-flints Formation (CWF)
- Head (HEAD)
- Lynch Hill Gravel Member (LHGR)
- Peat (PEAT)
- River Terrace Deposits (Undifferentiated); River Terrace Deposits, 1; River Terrace Deposits, 2 (RTD)
- Taplow Gravel Formation (TPGR)
- Tidal River Or Creek Deposits (TRD)
- Made Ground
- Infilled Ground
- Worked Ground

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION | Original Size: A3 | Revision: P02

Application Document Number: TR010032/APP/6.3 | Scale: 1:32,000

Drawing Title: Figure 2: Superficial Geology (MAPPED SUPERFICIAL GEOLOGY AS SUPPLIED BY BGS) Page 1 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00005

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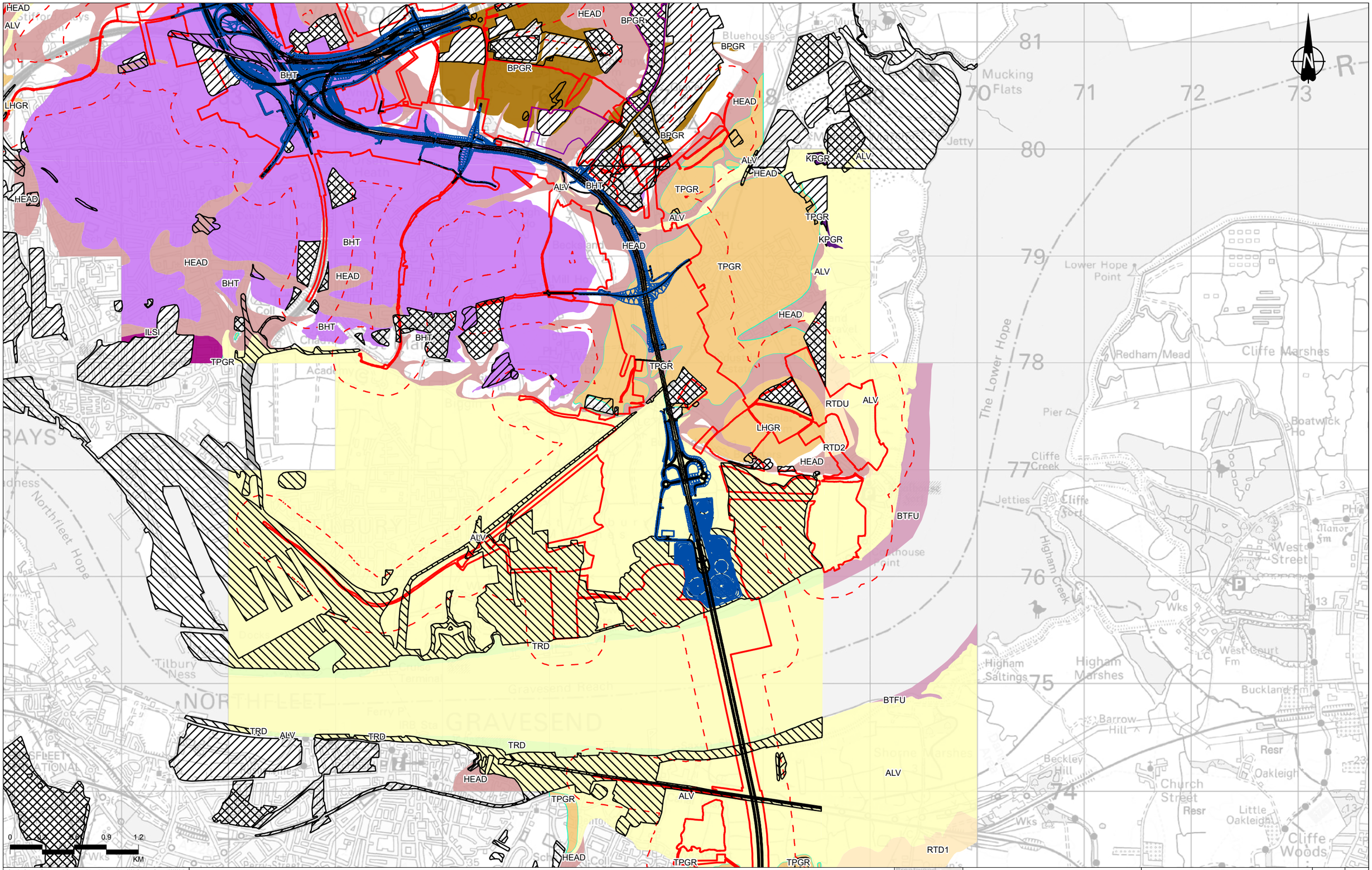

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study area (250m buffer to Order Limits)
- Compensation area for nitrogen deposition

BGS 50k Superficial Deposits

- Alluvium (ALV)
- Beach and Tidal Flat Deposits (Undifferentiated) (BTFU)
- Black Park Gravel Member (BPGR)
- Boyn Hill Gravel Member (BHT)
- Head (HEAD)
- Ilford Silt Member (ILSI)
- Kempton Park Gravel Formation (KPGR)
- Lynch Hill Gravel Member (LHGR)
- River Terrace Deposits (Undifferentiated); River Terrace Deposits, 1; River Terrace Deposits, 2 (RTD)
- Taplow Gravel Formation (TPGR)
- Tidal River Or Creek Deposits (TRD)
- Made Ground
- Infilled Ground
- Worked Ground

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION | Original Size: A3 | Revision: P02

Application Document Number: TR010032/APP/6.3 | Scale: 1:32,000

Drawing Title: Figure 2: Superficial Geology (MAPPED SUPERFICIAL GEOLOGY AS SUPPLIED BY BGS) Page 2 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00005

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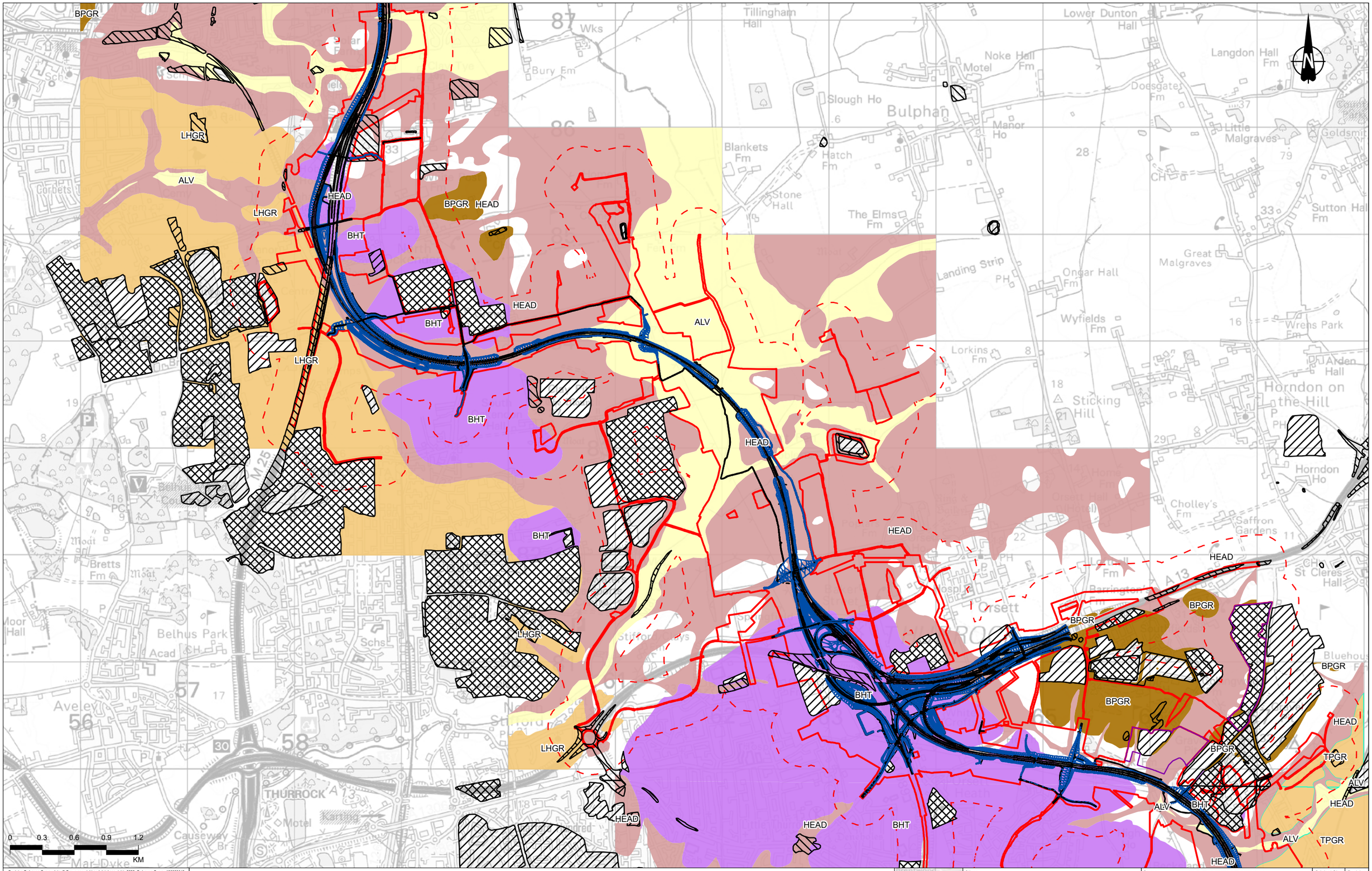

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study area (250m buffer to Order Limits)
- Compensation area for nitrogen deposition

BGS 50k Superficial Deposits

- Alluvium (ALV)
- Black Park Gravel Member (BPGR)
- Boyn Hill Gravel Member (BHT)
- Head (HEAD)
- Lynch Hill Gravel Member (LHGR)
- Taplow Gravel Formation (TPGR)
- Made Ground
- Infilled Ground
- Worked Ground

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION	Original Size	Revision
Application Document Number	TR010032/APP/6.3	A3	P02
		Scale	1:32,000

Drawing Title: Figure 2: Superficial Geology (MAPPED SUPERFICIAL GEOLOGY AS SUPPLIED BY BGS)
Page 3 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00005

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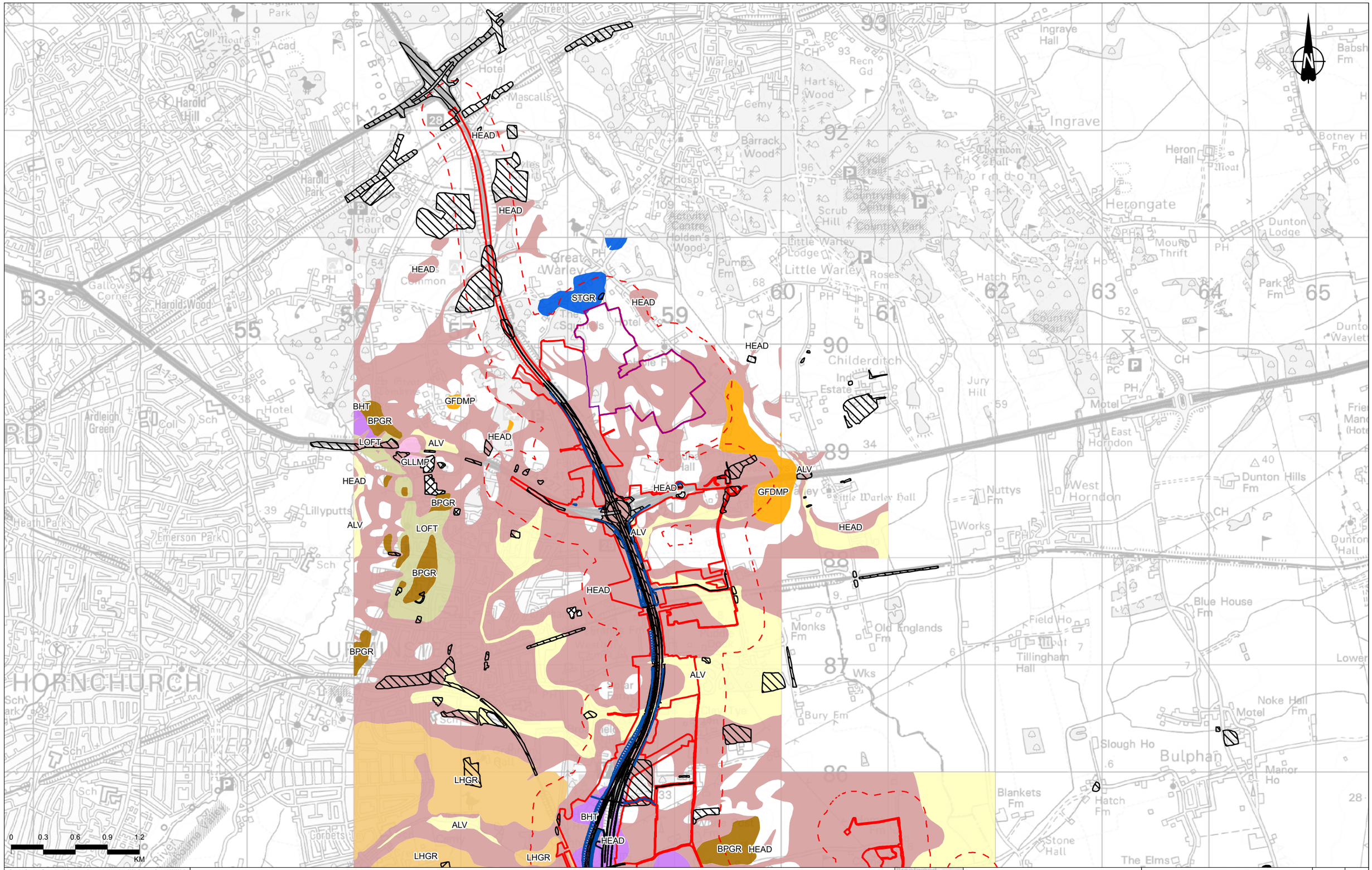

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Order Limits
- Study area (250m buffer to Order Limits)
- Compensation area for nitrogen deposition

BGS 50k Superficial Deposits

- Alluvium (ALV)
- Black Park Gravel Member (BPGR)
- Boyn Hill Gravel Member (BHT)
- Glaciofluvial Deposits, Mid Pleistocene (GFDMP)
- Glaciolacustrine Deposits, Mid Pleistocene (GLLMP)
- Head (HEAD)
- Lowestoft Formation (LOFT)
- Lynch Hill Gravel Member (LHGR)
- Stanmore Gravel Formation (STGR)
- Made Ground
- Infilled Ground
- Worked Ground

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P02
Application Document Number	TR010032/APP/6.3
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Drawing Title: Figure 2: Superficial Geology (MAPPED SUPERFICIAL GEOLOGY AS SUPPLIED BY BGS) Page 4 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00005

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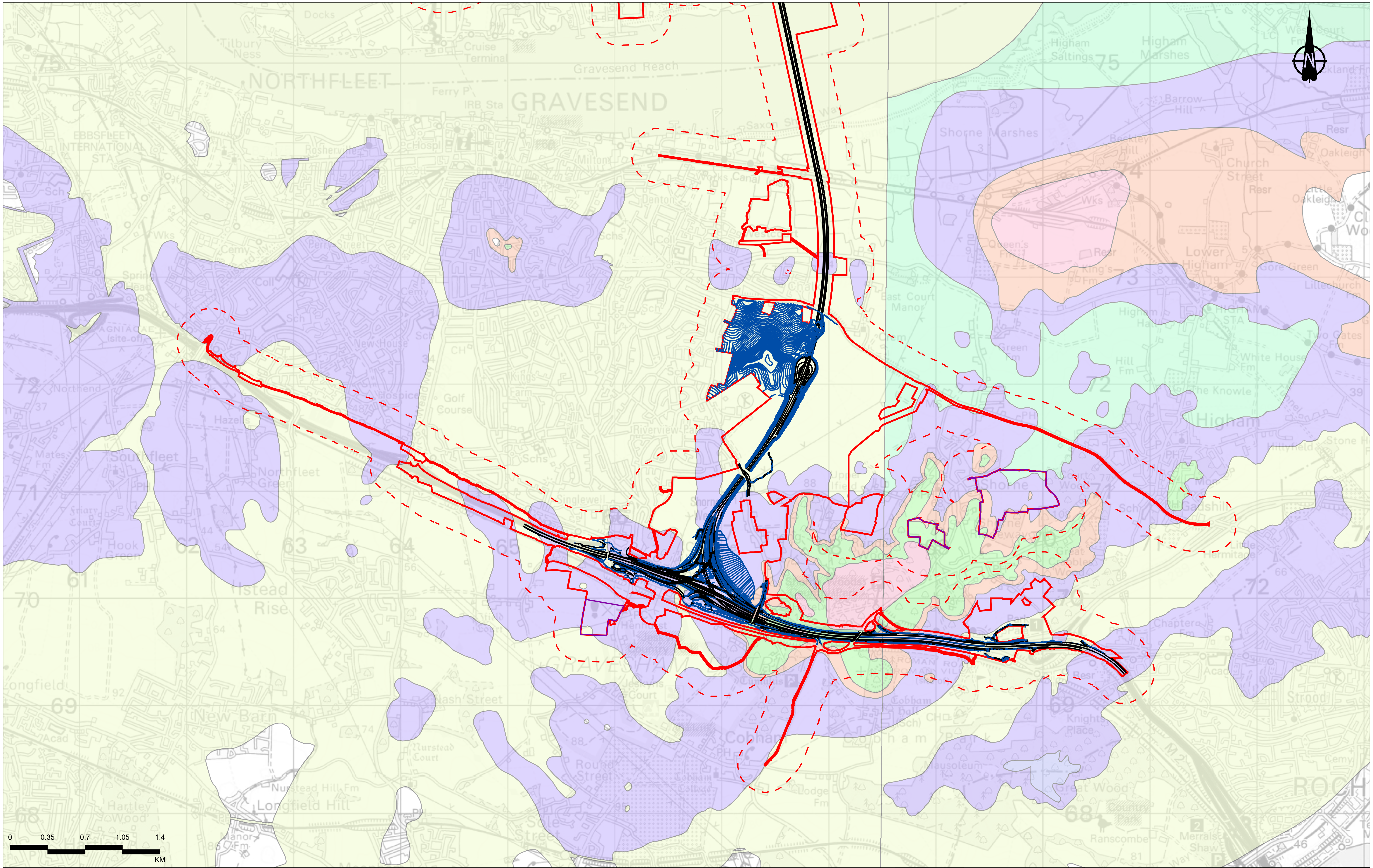

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S2	05/10/2022	DCO Application	CD	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Earthworks
- Order Limits
- Compensation area for nitrogen deposition
- 250m buffer of Order Limits

BGS Geology 50k Bedrock Geology

- HARWICH FORMATION
- LAMBETH GROUP
- LENHAM FORMATION
- LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED)
- LONDON CLAY FORMATION
- SEAFORD CHALK FORMATION
- THANET FORMATION

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Application Document Number: TR010032/APP/6.3

Original Size: A3

Revision: P02

Scale: 1:32,000

Drawing Title: Figure 3: Bedrock Geology (MAPPED BEDROCK GEOLOGY AS SUPPLIED BY BGS) Page 1 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00006

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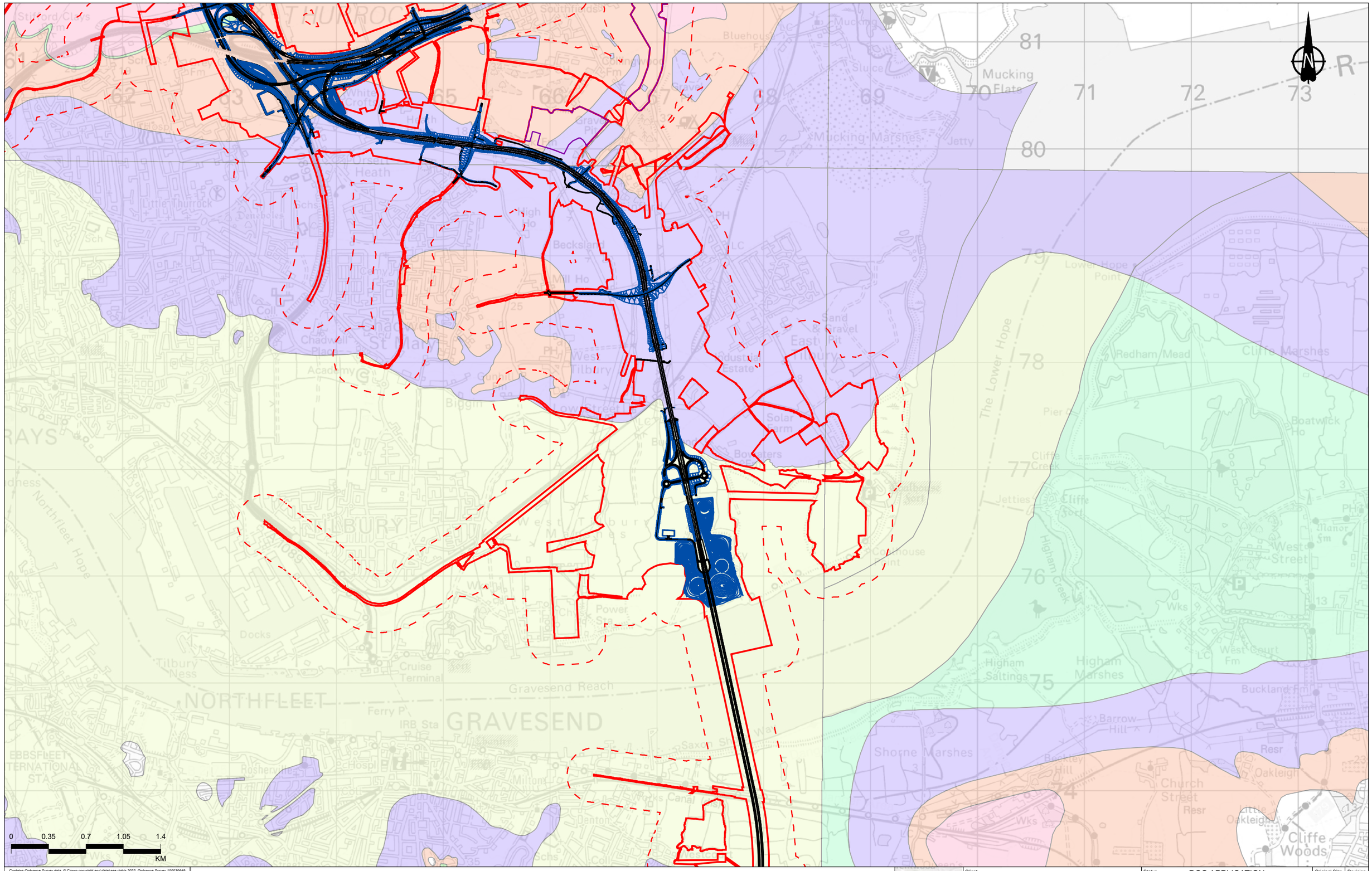

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Earthworks
- Order Limits
- Compensation area for nitrogen deposition
- 250m buffer of Order Limits

BGS Geology 50k Bedrock Geology

- HARWICH FORMATION
- LAMBETH GROUP
- LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED)
- LONDON CLAY FORMATION
- SEAFORD CHALK FORMATION
- THANET FORMATION

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S2	05/10/2022	DCO Application	CD	JR	TW

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P02
Application Document Number	TR010032/APP/6.3
Scale	1:32,000

Drawing Title: Figure 3: Bedrock Geology (MAPPED BEDROCK GEOLOGY AS SUPPLIED BY BGS) Page 2 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00006

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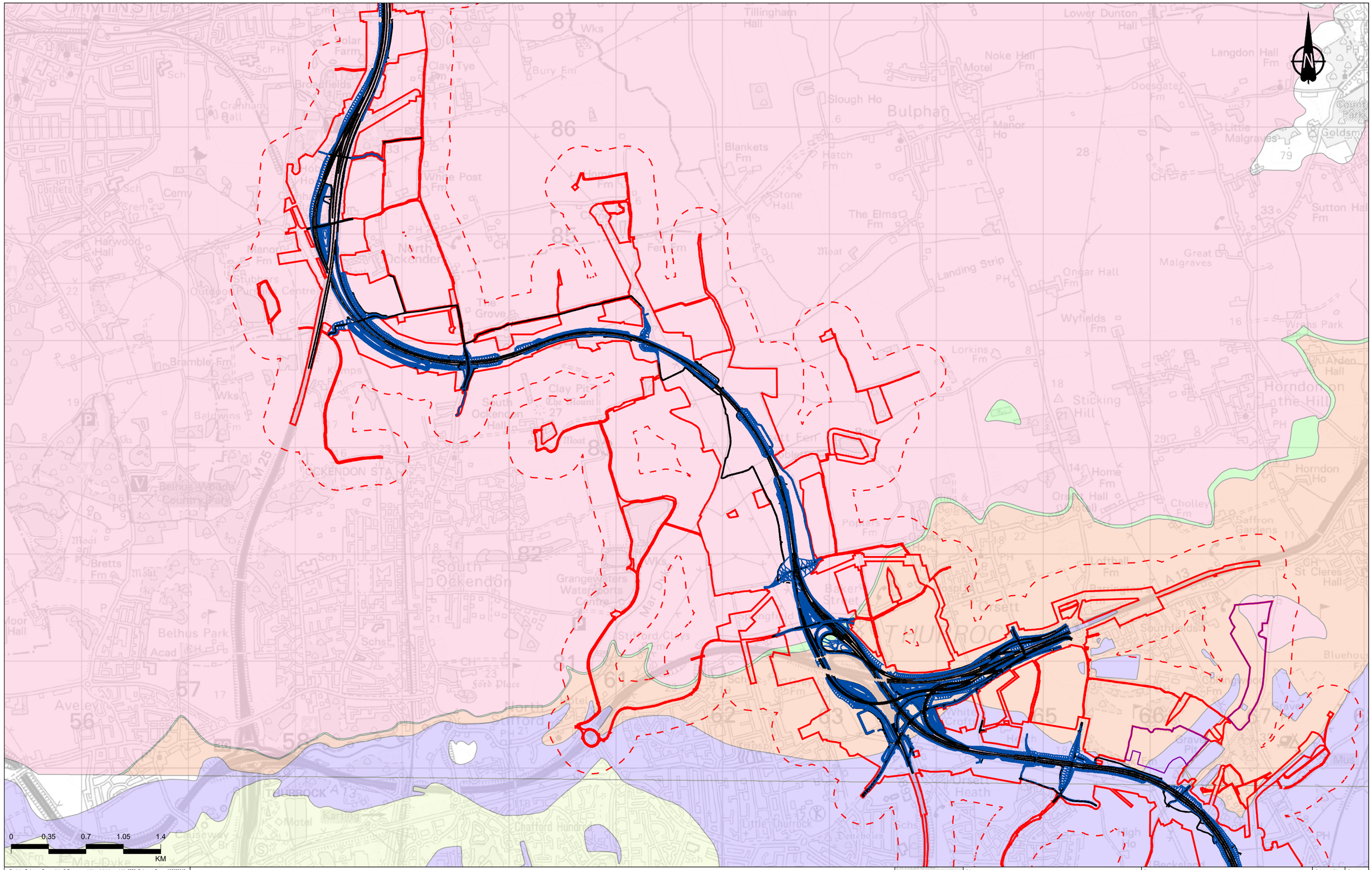

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S2	05/10/2022	DCO Application	CD	JR	TW

Notes:

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2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Earthworks
- Order Limits
- Compensation area for nitrogen deposition
- 250m buffer of Order Limits

BGS Geology 50k Bedrock Geology

- HARWICH FORMATION
- LAMBETH GROUP
- LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED)
- LONDON CLAY FORMATION
- THANET FORMATION

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P02
Application Document Number	TR010032/APP/6.3
Scale	1:32,000

Drawing Title: Figure 3: Bedrock Geology (MAPPED BEDROCK GEOLOGY AS SUPPLIED BY BGS) Page 3 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00006

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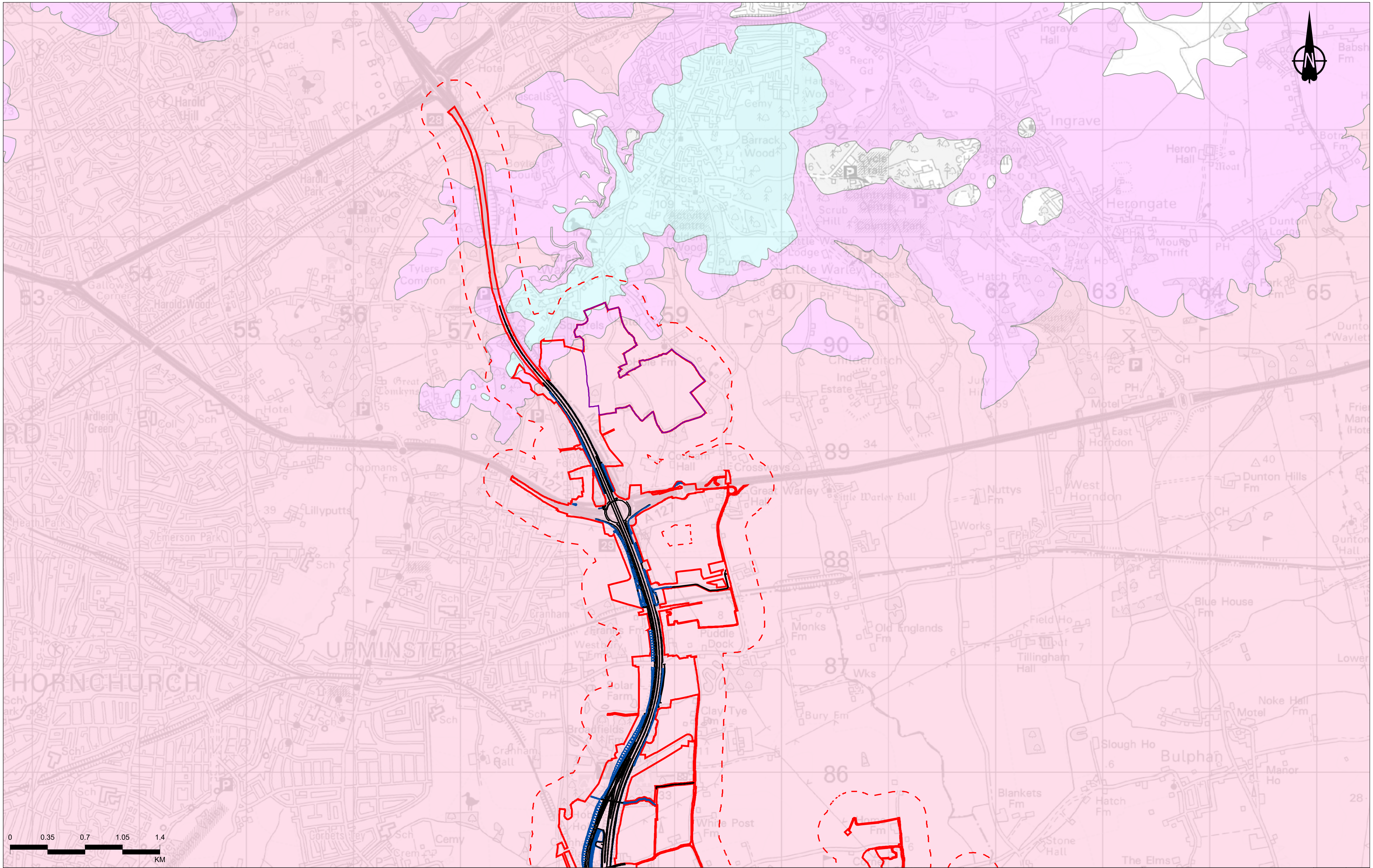

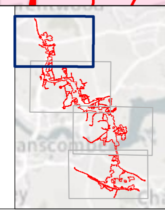

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P02	S2	05/10/2022	DCO Application	CD	JR	TW

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Data relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this data please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Earthworks
- Order Limits
- Compensation area for nitrogen deposition
- 250m buffer of Order Limits

BGS Geology 50k Bedrock Geology

- BAGSHOT FORMATION
- CLAYGATE MEMBER
- LONDON CLAY FORMATION

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Application Document Number: TR010032/APP/6.3

Original Size: A3

Revision: P02

Scale: 1:32,000

Drawing Title: Figure 3: Bedrock Geology (MAPPED BEDROCK GEOLOGY AS SUPPLIED BY BGS) Page 4 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00006

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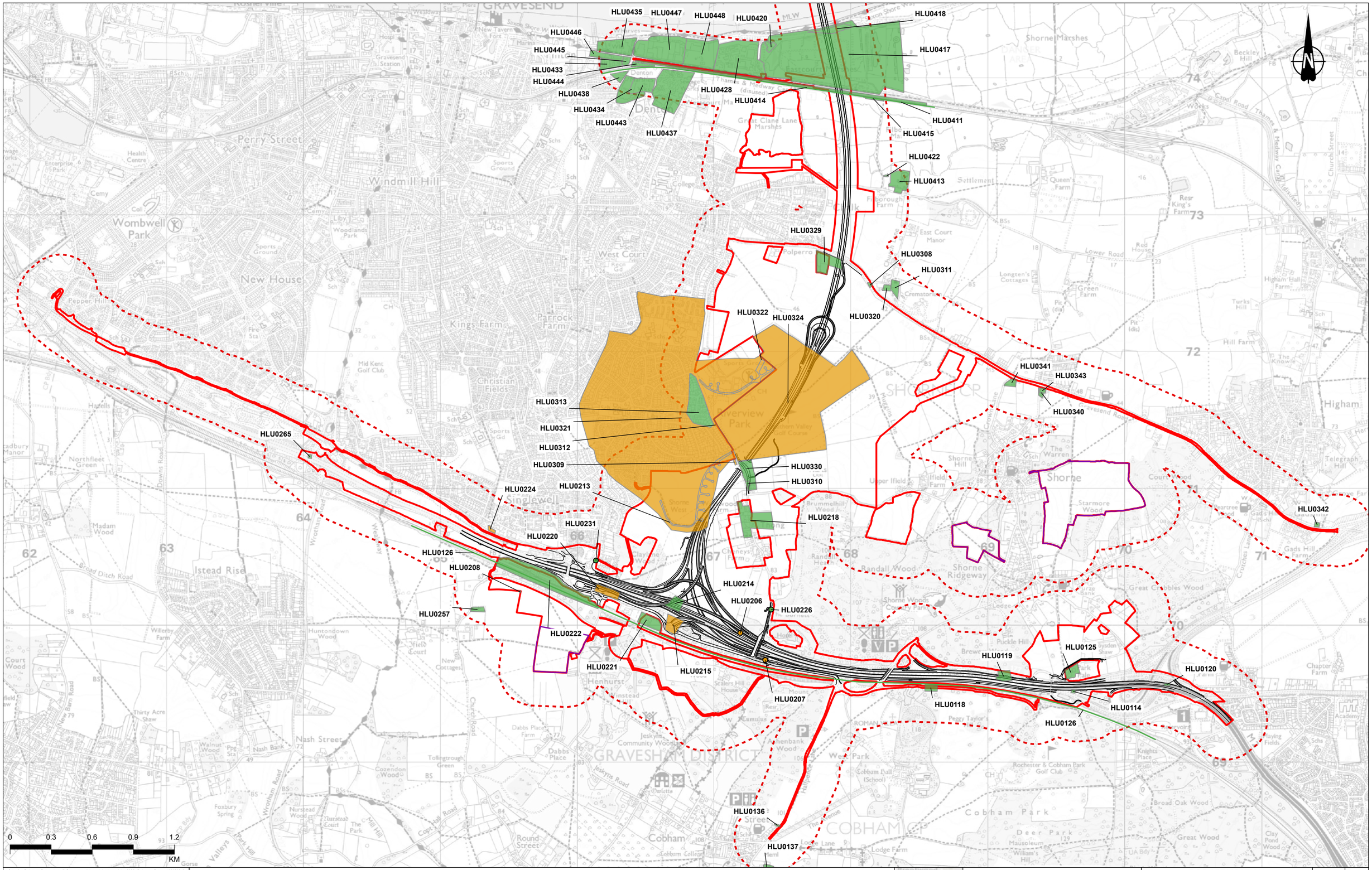

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	05/10/2022	DCO Application	SW	TA	BF

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Risk assessment relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Order Limits
- Compensation area for nitrogen deposition
- Study Area (250m buffer to Order Limits)

Preliminary Qualitative Risk Assessment Rating

- Low
- Medium
- High

Preliminary Qualitative Risk Assessment Rating

- Low

Preliminary Qualitative Risk Assessment Rating

- Medium
- High

Preliminary Qualitative Risk Assessment Rating

- Low
- Medium
- High

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION	Original Size A3	Revision P02
Application Document Number	TR010032/APP/6.3	Scale 1:25,000	

Drawing Title

Figure 4 - Credible Contamination Sources and Preliminary Qualitative Risk Assessment Rating
Page 1 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00007

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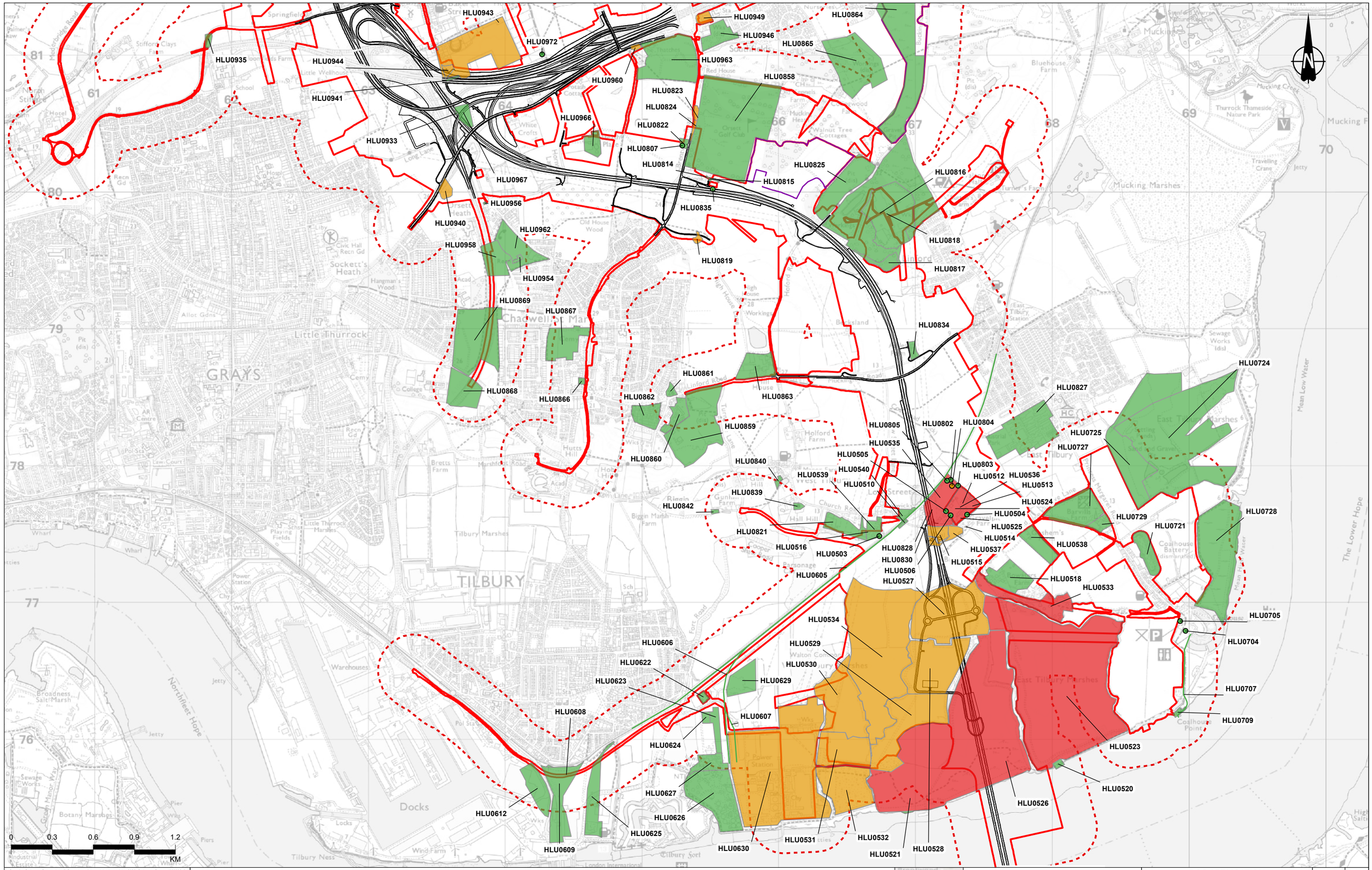

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Appr'd
P02	S8	05/10/2022	DCO Application	SW	TA	BF

Notes:

1. Drawing to be read in conjunction with Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

2. Risk assessment relating to the proposed compensation areas for nitrogen deposition are excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6, Application Document 6.3.

Legend

- Route alignment
- Order Limits
- Compensation area for nitrogen deposition
- Study Area (250m buffer to Order Limits)

Preliminary Qualitative Risk Assessment Rating

- Low
- Medium
- High

Preliminary Qualitative Risk Assessment Rating

- Low
- Medium
- High

Preliminary Qualitative Risk Assessment Rating

- Low
- Medium
- High

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION	Original Size	Revision
Application Document Number	TR010032/APP/6.3	A3	P02
		Scale	1:25,000

Drawing Title

Figure 4 - Credible Contamination Sources and Preliminary Qualitative Risk Assessment Rating
Page 2 of 4

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- Compensation area for nitrogen deposition
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- High

Preliminary Qualitative Risk Assessment Rating
- Low

- Medium
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Preliminary Qualitative Risk Assessment Rating
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- Medium
- High

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION	Original Size	Revision
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		Scale	1:25,000

Drawing Title

Figure 4 - Credible Contamination Sources and Preliminary Qualitative Risk Assessment Rating
Page 3 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00007

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Client: national highways

Project: LOWER THAMES CROSSING

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Drawing Title: Figure 4 - Credible Contamination Sources and Preliminary Qualitative Risk Assessment Rating Page 4 of 4

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Notes:

1. Drawing to be read in conjunction with Application Document 6.3, Appendix 10.6a: CSM Report.

2. Information relating to the proposed compensation areas for nitrogen deposition area excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6 Application Document 6.3.

Legend

- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Land Use Type

- Agricultural
- Wood
- Commercial
- Industrial
- Transport
- Other
- Public access
- Recreational
- Residential

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Application Document Number: TR010032/APP/6.3

Original Size: A3

Revision: P02

Scale: 1:25,000

Drawing Title: Figure 5 - Potential Human Health Receptors and Land Use

Page 1 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00008

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Legend

- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Land Use Type

- Agricultural
- Commercial
- Industrial
- Transport
- Other
- Public access
- Recreational
- Residential
- Institutional

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
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Drawing Title: Figure 5 - Potential Human Health Receptors and Land Use

Page 2 of 4

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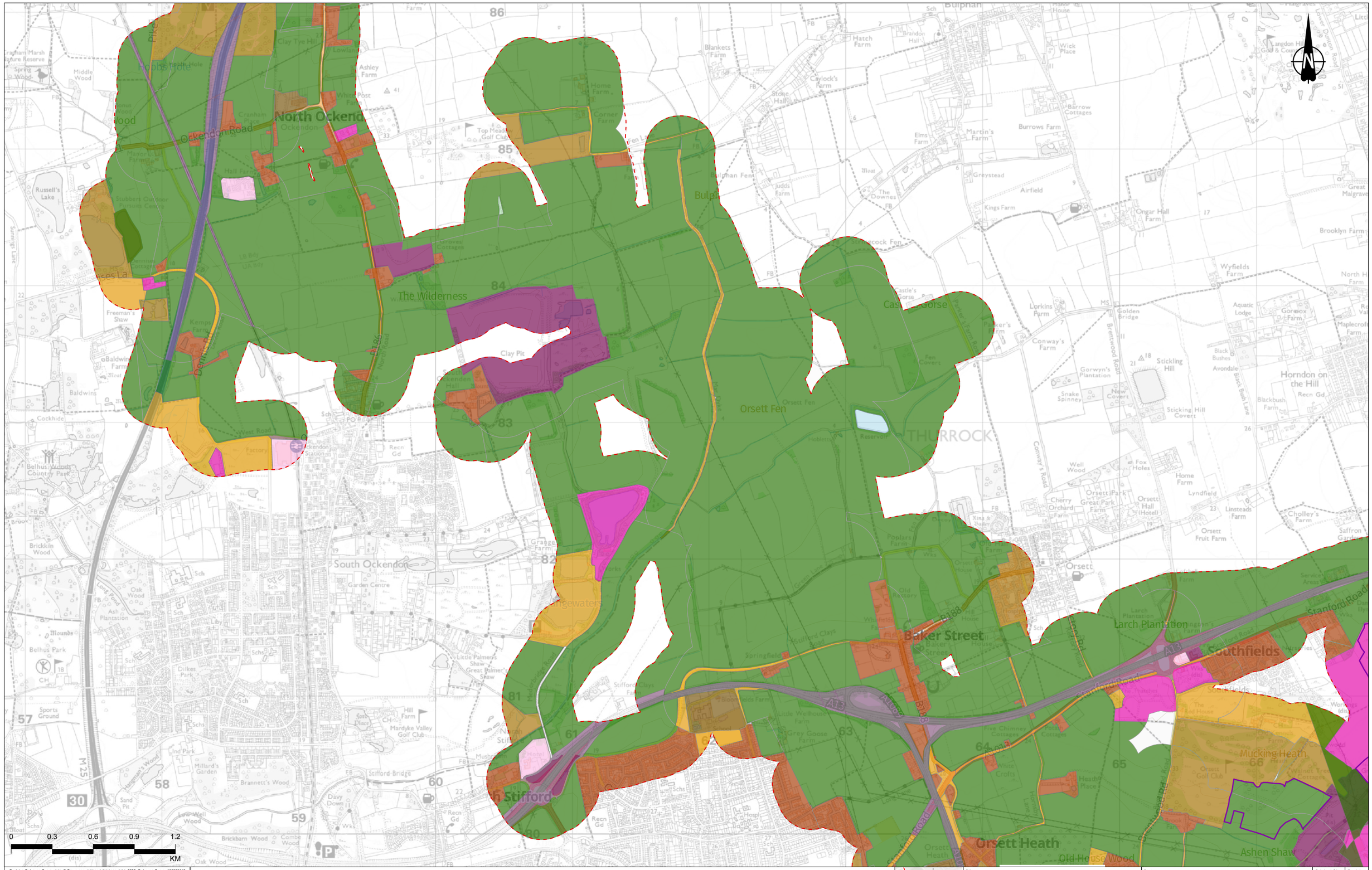

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- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Land Use Type

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- Commercial
- Industrial
- Transport
- Other
- Public access
- Recreational
- Residential
- Institutional

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Original Size: A3

Revision: P02

Application Document Number: TR010032/APP/6.3

Scale: 1:25,000

Drawing Title: Figure 5 - Potential Human Health Receptors and Land Use

Page 3 of 4

Drawing Number: HE540039-CJV-GEN-GEN-DRA-GEO-00008

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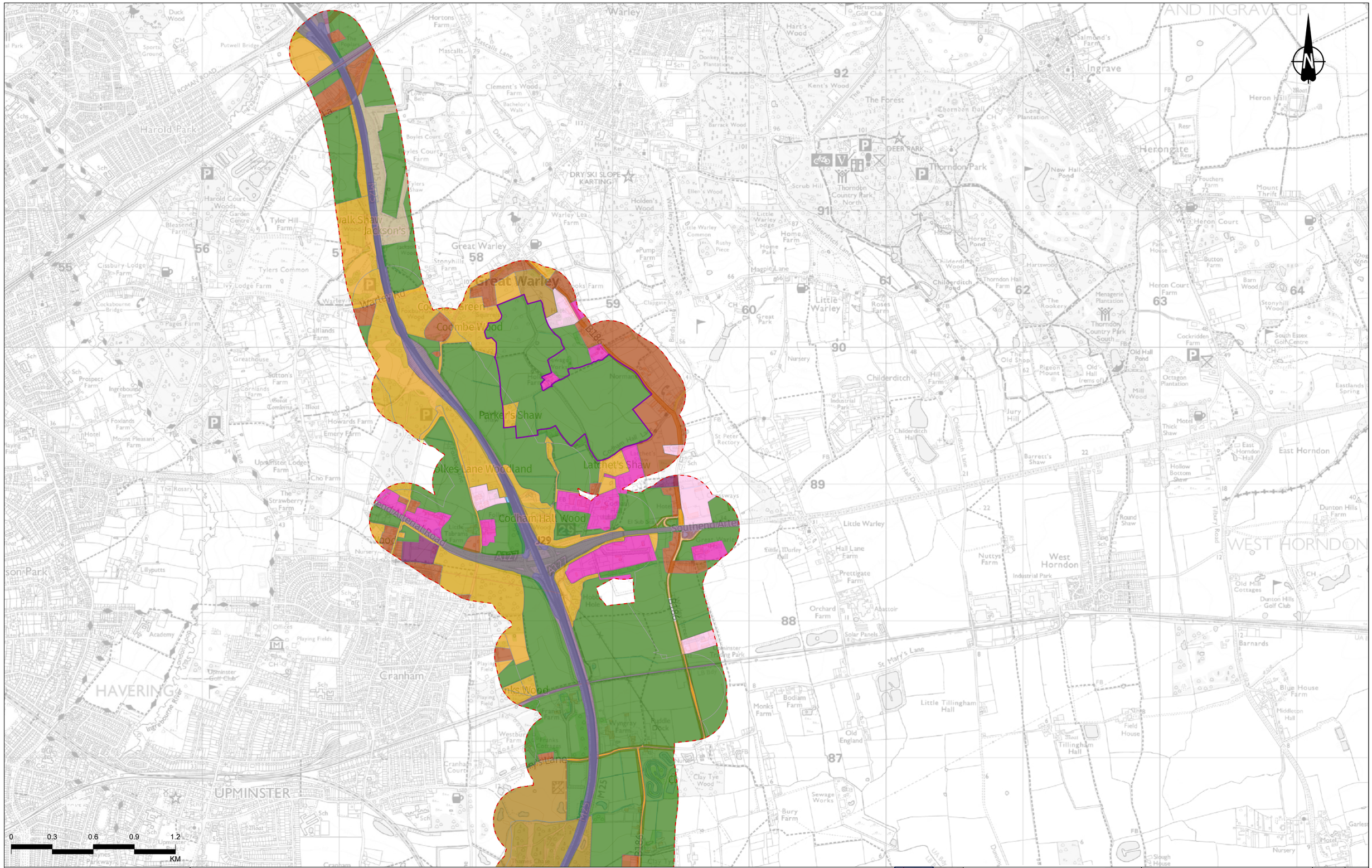

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2. Information relating to the proposed compensation areas for nitrogen deposition area excluded from this figure. For this assessment please refer to Annex D of Preliminary Risk Assessment Report Appendix 10.6 Application Document 6.3.

Legend

- Study Area (250m buffer to Order Limit)
- Compensation area for nitrogen deposition

Land Use Type

- Agricultural
- Wood
- Commercial
- Industrial
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- Other
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- Residential

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Original Size: A3

Revision: P02

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Scale: 1:25,000

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Annex B Acronyms and Glossary

B.1 Acronyms

Term	Explanation
AA	Anti-aircraft
AA	Annual average
ACM	Asbestos Containing Material
AGS	Association of Geotechnical and Geo-Environmental Specialists
BH	Borehole
BOD	Biological Oxygen Demand
BritPits	British Pits
BS	British Standard
BSi	British Standards Institute
BTEX	Benzene, toluene, ethylbenzene and xylenes
C4SL	Category 4 Screening Level
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
COPC	Contaminants of Potential Concern
CEMP	Construction Environmental Management Plan
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research and Information Association
COMAH	Control of Major Accident Hazards
COC	Contaminants of Concern
CS	Characteristic Situation
CSO	Combined sewer overflow
DDT	Dichlorodiphenyltrichloroethane
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
EPR	Environmental Permitting Regulations
EDD	Electronic Data Deliverable
GS	Grab sample
GI	Ground Investigation
Ha	Hectares
HFO	Heavy fuel oil
HLUD	Historical Land Use Data (Landmark dataset)

Term	Explanation
HLU	Historical Land Use (LTC reference number)
HTEF	Historical Tanks and Energy Facilities
IBC	Intermediate bulk container
ICAR	Industrial, Commercial, Agricultural and Recreational (land use)
IPC	Integrated Pollution Control
IPPC	Integrated Pollution Prevention and Control
ISO	International Standards Organisation
LAPPC	Local Authority Pollution Prevention and Control
LCRM	Land Contamination: Risk Management (formerly CLR11 Model Procedures for the Management of Land Contamination)
LGS	Local Geological Sites
LiDAR	Light Detection and Ranging
LOD	Limit of detection
LNAP	Light Non-Aqueous Phase Liquid
LNR	Local Nature Reserve
LPG	Liquified Petroleum Gas
LTM	Long-term monitoring
LQM	Land Quality Management
l/h	Litres per hour
LTC	Lower Thames Crossing
LQM/CIEH S4UL	Land Quality Management/Chartered Institute of Environmental Health Suitable for Use Levels
MAP	Monitoring action plan
mbar	millibar
M-BAT	Metal Bioavailability Assessment Tool
mbdat	Metres below datum
m bgl	Metres below ground level
MDL	Method detection limit
MHCLG	Ministry of Housing, Communities and Local Government
MTBE	Methyl tert-butyl ether
NGR	National Grid Reference (British National Grid)
NIHHS	Notification of Installations Handling Hazardous Substances
NVZ	Nitrate Vulnerable Zone
ODN	Ordnance Datum Newlyn
OH	Open hole
OP	Organo-Phosphorus (pesticide)

Term	Explanation
OS	Ordnance Survey
PAH	Poly Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PEIR	Preliminary Environmental Information Report
PFAS	Per-/Polyfluoroalkyl substances
PFOA	Perfluorooctanoate
PFOS	Perfluoro-octane-sulfonic acid
PFS	Petrol filling station
PHE	Public Health England
PID	Photo ionisation detector
PLA	Port of London Authority
PNEC	Predicted No-Effect Concentrations
POP	Persistent Organic Pollutants
POS	Public open space (land use)
PPC	Pollution Prevention and Control
ppmv	Parts per million by volume
pSPA	proposed Special Protection Area
PSSR	Preliminary Sources Study Report
QRA	Qualitative Risk Assessment
RTD	River Terrace Deposits
SP	Synthetic Pyrethroid (pesticide)
SVOC	Semi Volatile Organic Compounds
SW	Surface Water
SWMP	Surface Water Management Plan
TBT	Tributyltin
TTGDC	Thames Thurrock Gateway Development Corporation
TOC	Total Organic Carbon
TP	Trial Pit
tpa	Tonnes per annum
TPH	Total Petroleum Hydrocarbons
TPH CWG	Total Petroleum Hydrocarbons Criteria Working Group
UKDWS	UK Drinking Water Standards
UKPN	UK Power Networks
UST	Underground storage tank

Term	Explanation
UXAA	Unexploded anti-aircraft
UXB	Unexploded bomb
UXO	Unexploded Ordnance
VOA	Valuation Office Agency
v/v	By volume
WML	Waste management licence
WS	Window Sample
% v/v	volume per volume
% w/w	weight per weight

B.2 Glossary

Term	Abbreviation	Explanation
Above ordnance datum	**AOD**	Above ordnance datum, vertical datum used by an ordnance survey as the basis for delivering altitudes on maps.
AGS data format		Data in AGS format (.ags) is a text file format used to transfer data reliably, between organisations in the site investigation industry, independent of software, hardware or operating system.
Annual Average		Annual average (AA). Concentration or parameter value average over 12 months and based on a minimum of 12 individual sample results.
Anthropogenic		Created by people or caused by human activity.
Area of Outstanding Natural Beauty	**AONB**	Statutory designation intended to conserve and enhance the ecology, natural heritage and landscape value of an area of countryside.
Aquifers – Principal		These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
Aquifers – Secondary A		Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
Aquifers – Secondary B		Mainly lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers.
Aquifers – Secondary undifferentiated		Secondary undifferentiated are aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value.
British Geological Survey	**BGS**	A partly publicly funded body which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shelf by means of systematic surveying, monitoring and research.
BritPits		An abbreviation of British Pits. The database holds information on: • names of mines, quarries, oil wells, gas wells, ash and desulphogypsum plants • geographic location • address • operator • mineral planning authorities • geology • mineral commodities produced • end-uses (where known)
C4SL		Category 4 Screening Levels for assessment of land affected by contamination as published by DEFRA in document SP1010, produced by CL:AIRE.

Term	Abbreviation	Explanation
Conceptual site model	**CSM**	A land contamination CSM refers to the source-pathway-receptor (SPR) linkage approach for identifying pollutant linkages. Development and refinement of the CSM is part of the process defined in LCRM guidance.
Contaminated Land: Applications in Real Environments	**CL:AIRE**	independent not-for-profit organisation established to stimulate the regeneration of contaminated land in the UK.
Controlled Waters		Waters including groundwater, freshwater and saline water as defined in the UK Water Resources Act 1991.
Department for Environment, Food and Rural Affairs	**Defra**	Department for Environment, Food and Rural Affairs: the government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the United Kingdom of Great Britain and Northern Ireland.
Deneholes		An underground structure consisting of a number of small chalk caves entered by a vertical shaft.
Detailed Quantitative Risk Assessment	**DQRA**	Tier 3 of the risk assessment process according to LCRM guidance on the assessment of land contamination. A DQRA uses detailed site-specific information to estimate risk.
Drinking Water Standards	**DWS**	Concentrations of substances or other parameter values and properties define by regulation or guidance, below which water is considered 'wholesome' and fit for potable use. In the UK, DWS are defined by the Water Supply (Water Quality) Regulations 2016
Duplicate sample		A sample taken for quality assurance purposes. A duplicate sample is a sample which is obtained from the same location and depth, at the same time and on the same day, and via the same sampling method as the original or 'parent' sample.
ESdat		Specialist environmental database system; used to validate, import and analyse environmental data.
Environment Agency	**EA**	A non-departmental public body of Defra. The Environment Agency is the leading public body for protecting and improving the environment in England.
Environmental Quality Standards	**EQS**	Concentrations of substances or other parameter values and properties define by regulation or guidance for the protection of the environment.
Field Blank		A blank or 'clean' sample taken for quality assurance purposes and created in the field by the sampler.
Generic Assessment Criteria	**GAC**	Parameter values, such as substance concentrations, defined based on generic assumptions (i.e, non site-specific) for the quantitative assessment of risk. Concentrations below a GAC typically present a low or minimal risk to the receptor(s) which they are defined as protective of. Concentrations above a GAC do not necessarily represent a risk, but may indicate the need for action such as further assessment.
Generic Quantitative Risk Assessment	**GQRA**	Tier 2 of the risk assessment process according to LCRM guidance on the assessment of land contamination. A GQRA uses generic assessment criteria and assumptions to estimate risk.

Term	Abbreviation	Explanation
Geographic information system	**GIS**	An integrated collection of computer software and data used to view and manage information about geographic places, analyse spatial relationships, and model spatial processes.
HoleBASE		Geotechnical data knowledge management system
Interceptor		Part of a wastewater treatment system that collects substances such as silt, grit and soil, as well as traces of oil and fuel prior to discharge or further treatment.
LQM/CIEH Suitable for Use Levels		Human health generic assessment criteria produced by Land Quality Management and the Chartered Institute of Environmental Health.
Local wildlife site	**LWS**	A non-statutory designation for sites with substantive nature conservation value.
Maximum allowable concentration	**MAC**	An EQS for a pollutant may either be an AA or a MAC. MAC are used to assess individual monitoring events from continuous or regular monitoring when the AA of the pollutant is below the AA EQS.
Made ground		Anthropogenic soils placed by man.
National Planning Policy Framework	**NPPF**	Published in March 2012 by the UK's Department of Communities and Local Government, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG) for use in England.
Preliminary Risk Assessment	**PRA**	Tier 1 of the risk assessment process according to LCRM guidance on the assessment of land contamination. A PRA develops a conceptual site model.
Pollutant linkage		A pollutant linkage comprises a source, pathway and receptor. A contaminant source, environmental and/or exposure pathway and sensitive receptor is a pollutant linkage which gives rise to a potential risk to the receptor.
Pulverised Fuel Ash	**PFA**	Also referred to as fly ash, is the ash resulting from the burning of pulverised coal in coal-fired electricity power stations.
Qualitative Risk Assessment		Refinement of the CSM by reviewing qualitative and quantitative information sources.
Ramsar		A wetland of international importance, designated under the Ramsar convention.
Semi-volatile organic compounds	**SVOC**	Organic compounds that tend to have a higher molecular weight and higher boiling point temperature than VOCs.
Special Area of Conservation	**SAC**	Land designated under Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora. SACs protect habitats and species considered to be of European interest.
Special Protection Area	**SPA**	Land classified under Directive 79/409 on the Conservation of Wild Birds. SPAs protect rare and vulnerable birds and regularly occurring migratory species.
Site of Special Scientific Interest	**SSSI**	Land notified as an SSSI under the Wildlife and Countryside Act (1981), as amended. SSSI are the finest sites for wildlife and natural features in England, supporting many characteristic, rare and endangered species, habitats and natural features.

Term	Abbreviation	Explanation
Source-Pathway-Receptor linkage	**SPR linkage**	The approached used to describe pollutant linkages where a source is a known or potential source of contamination and a receptor is an environmental, human or built receptor which may be caused harm. A pathway is the route linking a source and receptor by which exposure or harm occurs.
Source protection zone	**SPZ**	Part of a groundwater catchment used for public water supply. SPZ are designated by the Environment Agency for the protection of public water supply from contamination from potentially polluting activities and accidental releases of pollutants.
Superceptor		A brand model of interceptor. A Superceptor is full retention interceptor, meaning that all flow is treated, and oil or fuel retained. Designed for use in areas where there is the possibility of spillage of pollutants such as petrol filling stations where all of the discharge from the area must be intercepted.
sustainable drainage system	**SuDS**	A sustainable drainage system designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges.
Tentatively Identified Compound	**TIC**	Non-target compound tentatively identified during analysis from a library of potential compounds. Reported concentration maybe semi-quantitative and unaccredited.
Trip blank		A clean sample of a matrix (eg water) is taken from the laboratory to the sampling site and transported back to the lab without having been exposed to the sampling procedure.
Unproductive strata		Rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
Volatile organic compound	**VOC**	Organic compound that is volatile under normal environmental/atmospheric conditions, although it can be found in the ground in the solid, liquid and dissolved phase form as well as in gaseous phase
Water Framework Directive	**WFD**	A European Community Directive (2000/60/EC) of the European Parliament and council designed to integrate the way water bodies are managed across Europe.
% v/v		Volume concentration of a solution, expressed as % v/v, which stands for volume per volume
% w/w		Weight concentration of a solution, expressed as % w/w, which stands for weight per weight

Annex C Part 1 Preliminary Qualitative Risk Assessment Part 2 Likelihood and Severity definitions

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways									Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Cole Wood Chalk Pit	**HLU0120**	Small rural chalk pit potentially infilled approximately 1907 to 1931. Possible reworking for A2/M2 junction in 1990s.	Petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAH), inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x			x	x	x					Principal Aquifer	SPZ III	288	Minor	Low likelihood	Low	Unlikely to be a significant risk due to small size, the age of the fill material and location beneath proposed highway.
	Infilled pond	**HLU0114**	Former pond filled with unknown material between 1907 and 1931.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x		x	x	x			x	x		Principal Aquifer	SPZ III	21	Minor	Low likelihood	Low	Unlikely to be a significant risk due to small size, the age of the fill material and location beneath proposed highway.
	Road Haulier Depot	**HLU0125**	Road haulier depot, haulage services and plant hire from 1960s onwards.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within Order Limits and study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x		x	x				x	x		Principal Aquifer	SPZ II	120	Medium	Low likelihood	Low	Unlikely to be a significant contaminant source due to relatively recent construction of facility.
	Brickyard and kilns	**HLU0119**	19th and early 20th century brickyard and kilns.	Metals, asbestos, hazardous gases, petroleum hydrocarbons, PAH.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand, Silt and Clay); Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x		x	x	x			x	x		Secondary Aquifer - A; Principal Aquifer	SPZ III	34	Minor	Likely	Low	Unlikely to be a significant risk due to small size, age and location beneath proposed highway. Mostly beneath existing A2 alignment.
	Former Poultry Yard	**HLU0118**	Former poultry yard (approximately 1867 to 1993).	Petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination, hazardous gases.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand, Silt and Clay); Lambeth Group (Sand, Silt and Clay)	x		x	x	x	x	x	x		x					x	x		Secondary Aquifer - A	SPZ III	44	Minor	Likely	Low	Unlikely to be a significant risk due to the degradable nature of contaminants and age of feature. May influence local groundwater quality baseline.
	Former road haulage site	**HLU0136**	Former road haulage site (Landmark, 2018). Residential property currently present.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)				x	x	x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	180	Minor	Low likelihood	Low	Aerial photo evidence suggests site was very small scale, and was agricultural field up to circa 1990.
	Cobham Farm	**HLU0137**	Farmyard and farm buildings. Also referred to as Cobhambury Farm	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within 250m study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x											Principal Aquifer	SPZ II	235	Mild	Low likelihood	Low	Farm is outside development boundary but may influence groundwater quality in aquifer.
	Sheep Wash	**HLU0207**	Sheep wash (approximately 1864 to 1963).	Metals, pesticides.	Within Order Limits and study area	No superficial deposits	Harwich Formation (Sand and Gravel); Lambeth Group (Sand, Silt and Clay)	x		x		x	x	x	x		x	x	x		x	x		Secondary Aquifer - A	None	145	Medium	Likely	Medium	Potential soil and groundwater contamination resulting from long-term use of sheep wash facility. Limited information and may no longer exist.
	Electricity substation, Valley Drive	**HLU0231**	Electricity substation, approximately 1972 to present.	Petroleum hydrocarbons, PCB.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x					Secondary Aquifer - A	None	143	Mild	Likely	Low	Small scale electricity substation, no records of any pollution incidents identified. Risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	Electricity substation	**HLU0206**	Electricity substation located north of the A2. Constructed circa 1967	Petroleum hydrocarbons, PCB.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x	x	x	x	x			x	x				x			Secondary Aquifer - A	None	213	Medium	Likely	Medium	Potential for unrecorded releases of PCBs. Possible disturbance during proposed works.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Esso A2 Westbound Petrol Filling Station	**HLU0215**	Vehicle garage and petrol filing station (1972–present). Possible made ground to west.	Petroleum hydrocarbons, PAH, Methyl Tert-Butyl Ether (MTBE), metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x	x		x	x	x		x	x		Secondary Aquifer - A; Principal Aquifer	None	19	Medium	Likely	Medium	Operational PFS. Known (minor) hydrocarbon impacts to soil. Site redeveloped in 2010 and environmental condition reports available.
	Former A2 Eastbound Petrol Filling Station	**HLU0214**	Former vehicle garage and petrol filing station (approximately 1972 to approximately 2008).	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x	x		x	x	x			x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A; Principal Aquifer	None	25	Medium	Low likelihood	Low	The remediation of the former PFS has been approved by the Environment Agency. A commitment to consult with the Environment Agency on works occurring within the boundary of the PFS prior to the works commencing is detailed in the REAC (GS030). This commitment would ensure that the proposed works would not compromise the remedial action that has taken place.
	Railway lines (HS1 / CTRL)	**HLU0126**	Electrified HS1 line opened 2003. Possible made ground in embankments.	Petroleum hydrocarbons, PAH, inorganics, metals.	Within Order Limits and study area	Clay-with-flints Formation (Clay, Silt, Sand and Gravel); Peat (Peat); Head (Clay, Silt, Sand and Gravel)	Lambeth Group (Sand, Silt and Clay); London Clay Formation (Clay and Silt); Harwich Formation (Sand and Gravel); Thanet Formation (Sand, Silt and Clay); Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x		x	x	x	x	x	x	Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer; Secondary Aquifer - A; Unproductive Strata	None	18	Minor	Low likelihood	Low	Unlikely to be a significant risk due to modern nature of development and absence of recorded incidents. Imported fill suitable for rail use likely suitable for road use.
	Chalk Pit	**HLU0208**	Small chalk pit potentially infilled between 1938 and 1954	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x	x	x	x	x			x					x		Secondary Aquifer - A	SPZ III	283	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age of feature and likely materials filled at this time.
	Singlewell Railway Maintenance Depot	**HLU0222**	Singlewell Infrastructure Maintenance Depot (2007 onwards).	Petroleum hydrocarbons, PAH, inorganics, metals, phenols, VOC, SVOC.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x	x		x	x	x		x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	45	Mild	Low likelihood	Low	Unlikely to be a significant risk due to modern nature of development. Potential presence of clay reduces likelihood of impact to controlled waters. Potential for current fuel storage on site increases potential severity.
	HS1 electricity substation facility (Singlewell Feeder Station)	**HLU0221**	Large substation site (from 2003).	Petroleum hydrocarbons.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x	x		x				x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	25	Mild	Likely	Low	Unlikely to be a significant risk due to modern nature of development and absence of recorded incidents. Risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	Henhurst Road Contractors Depot	**HLU0220**	Civil engineering contractor's yard and aggregate processing site (post-1993). Possible made ground.	Metals, petroleum hydrocarbons, PAH, inorganics, phenols, VOC, SVOC, hazardous gases, asbestos.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x	x	x	x		Secondary Aquifer - A	SPZ III	221	Medium	Likely	Medium	Potential for unrecorded pollution to soil or groundwater from storage of materials and bulk material processing. .
	Singlewell Service Station	**HLU0224**	Vehicle maintenance garage approximately 1961 to present.	Petroleum hydrocarbons, PAH, MTBE, metals, phenols, VOC, SVOC, asbestos, hazardous gases.	Within 250m study area	No superficial deposits	Thanet Formation (Sand)				x		x	x										Secondary Aquifer - A	SPZ III	292	Medium	Likely	Medium	Operational vehicle sales and service centre. Severity based on potential for ongoing primary sources and absence of further information. Potential for unrecorded pollution to groundwater and impact to site via lateral migration.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Electricity substation	HLU0226	Electricity substation located north of the A2. Constructed before 1972.	PCB, petroleum hydrocarbons.	Within Order Limits and study area	No superficial deposits	Lambeth Group (Sand, Silt and Clay)				x		x	x										Secondary Aquifer - A	None	129	Minor	Likely	Low	Potential for unrecorded releases of PCBs. Human health receptors not identified and risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	Poultry Farm, Thong Lane	HLU0218	Poultry farm, approximately 1962 to 1993.	Petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination, hazardous gases.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x	x	x		Secondary Aquifer - A	None	182	Minor	Likely	Low	Potential localised impact to soil due to unrecorded releases or burials, and potential wider impact to groundwater quality.
	Former Gravesend Airport	HLU0321	Former civilian and military airfield. Former land uses are known or suspected to include aviation fuel storage and dispensing, firefighting, blast pens, aircraft service/manufacture/breaking, deep Made Ground, and an aluminium smelter.	Petroleum hydrocarbons, PAH, radium, explosives, asbestos, metals, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x	x	x	x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A; Principal Aquifer	SPZ II	548	Medium	Likely	Medium	Wide range of potential pollutants but main buildings are already developed for adjacent residential. Potential impacts to groundwater.
	Gravesend Airport Perimeter Road - Northeast	HLU0322	North-east section of the concrete track forming Gravesend Airport Perimeter Road.	Petroleum hydrocarbons, PAH, radium, asbestos, metals, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x			x	x	x	x		x		Principal Aquifer	None	818	Medium	Likely	Medium	Likely only localised impacts depending on crashes, unrecorded waste pits but no direct evidence of such.
	Gravesend Airport Perimeter Road - Southeast	HLU0213	South-east section of the concrete track forming Gravesend Airport Perimeter Road, partially intact north of Claylane Wood.	Petroleum hydrocarbons, PAH, radium, asbestos, metals, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x	x	x	x		Secondary Aquifer - A; Principal Aquifer	None	586	Medium	Likely	Medium	Likely only localised impacts depending on crashes, unrecorded waste pits but no direct evidence of such.
	Church and Graveyard	HLU0257	St Margaret's church and graveyard. Mapped from 1865, still present.	Metals (particularly lead), formaldehyde, ammoniacal nitrogen	Within 250m study area	No superficial deposits	Thanet Formation (sand)						x	x										Secondary Aquifer - A	SPZ III	600	Minor	Low likelihood	Low	Possible impact to groundwater but very small scale graveyard so pollutant load likely to be small.
	Petrol Filling Station	HLU0265	Petrol filling station. First shown in 1969, last shown 1993. The A2 was realigned over the site in circa 2007.	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	Head Deposits (Clay, silt, sand and gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)	x		x	x	x	x	x	x		x	x	x			x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ II	60	Medium	Low likelihood	Low	No decommissioning or remediation records are available but recent highways works (circa 2007) suggest that gross contamination is unlikely to remain in near-surface soils. Possible deep groundwater impact in chalk.
	Gravesend Airport buildings	HLU0313	Hangers and terminals for the former Gravesend Airport. Now redeveloped as Riverview Park housing estate.	Petroleum hydrocarbons, PAH, VOC, SVOC, radium, asbestos, metals, hazardous gases, explosives.	Within 250m study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)				x		x	x										Secondary Aquifer - A; Principal Aquifer	None	1058	Mild	Likely	Low	Wide range of potential pollutants but main buildings are already developed for residential. Potential impacts to groundwater.
	Nursery	HLU0330	Plant nursery, approximately 1955 to present. Significant waste storage.	Petroleum hydrocarbons, PAH, metals, inorganics, herbicides, pesticides, asbestos.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x		x	x	x			x	x	x	x		x		Secondary Aquifer - A; Principal Aquifer	None	496	Minor	Likely	Low	Potential impact to soil due to unrecorded releases or uncontrolled waste disposal, unlikely significant risk due to likely localised impact.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Chalk Pit	**HLU0308**	Chalk pit, potentially filled between 1909 and 1933.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x		x			x	x	x		Principal Aquifer	None	78	Minor	Likely	Low	Unlikely to be a significant risk due to age of feature and likely materials filled at this time.
	Chalk Pit	**HLU0309**	Chalk pit potentially filled between 1955 and 1962. Potential for voids from excavated tunnels and waste deposits including putrescible material and pipe bombs.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases, explosives.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x			x	x	x	x		x		Principal Aquifer	None	727	Severe	Low likelihood	Medium	Anecdotal evidence of informal dumping of waste indicates moderate levels of contaminants may be present. Degradable contaminants may be reduced. Potential risk from presence of UXO and voids.
	Chalk Pit	**HLU0310**	Chalk pit potentially filled by 1962. Potential for voids from in situ air raid shelters. Now used as a nursery.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x			x		Secondary Aquifer - A; Principal Aquifer	None	524	Mild	Likely	Low	Unlikely to be a significant risk due to age of feature and likely materials filled at this time.
	Unknown Pit	**HLU0312**	Unknown pit, potentially filled between 1909 and 1938.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x			x			x		x		Secondary Aquifer - A; Principal Aquifer	None	1034	Minor	Likely	Low	Unlikely to be a significant risk due to age of feature and likely materials filled at this time.
	Southern Valley Golf Course	**HLU0324**	Golf course (1998 to present).	Metals, petroleum hydrocarbons, PAH, asbestos, herbicides, pesticides.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x		x	x	x			x	x	x	x		x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A; Principal Aquifer	None	484	Medium	Likely	Medium	Potential for deleterious materials in imported fill and bulk storage of fuel and pesticides. Rating increased due to the potential size of affected area.
	Piggery	**HLU0320**	Former piggery located approximately 220m east of the South Portal.	Petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, microbial contamination, hazardous gases.	Within 250m study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x		x	x	x	x								Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to directly impact the route but potential wider impact to groundwater quality near south portal.
	St Mary's cemetery	**HLU0311**	Church and cemetery. First shown in 1863, still present	Metals (particularly lead), formaldehyde, ammoniacal nitrogen.	Within 250m study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)						x	x	x									Principal Aquifer	None	24	Minor	Likely	Low	Unlikely to be a significant risk due to small size and age (first identified on historical maps 1863). May influence local groundwater quality baseline but most contaminants are of low mobility.
	Viewpoint Place	**HLU0329**	Residential site used for materials storage and possible agricultural use. Potential for unrecorded waste disposal or spillages.	Petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	No superficial deposits	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x			x	x	x	x	x	x		Principal Aquifer	None	490	Mild	Likely	Low	Unlikely to be a significant risk due to small size. Any unrecorded contaminative activities are likely to have been small-scale and the impacts localised. Location directly on Principal Aquifer increases potential water resources risk.
	Court Lodge Farm	**HLU0340**	Farmyard and buildings, first shown 1888–1966. Residential properties now present (Earthstar Geographics, 2022).	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases	Within 250m study area	No superficial deposits	Thanet Formation (sand, silt and clay)						x	x									None	Principal Aquifer	SPZ III	335	Mild	Unlikely	Low	Age of former farm suggests degradable contaminants in soil and groundwater will be reduced and non-mobile contaminants are unlikely to travel to the development boundary.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology: Superficial Geology provided by BGS	Generalised Bedrock Geology: Bedrock Geology provided by BGS	Potential Pathways: D-S Direct/dermal contact and incidental ingestion of contaminated soil	D-G Direct/dermal contact and incidental ingestion of contaminated groundwater	A Ingestion of soil or wind-blown dust	V Build-up of vapours or gases in confined spaces	F Inhalation of vapours, gases or wind-blown dust or fibres	S-G Leaching of contaminants from soil into groundwater	G-L Migration of contaminated groundwater on or off site	G-SW Groundwater migration to surface waters	R-SW Contaminated runoff (water and sediment) from land to surface waters	Human Health Receptors: RH01 Construction workers	RH02 Operational staff	RH03 Road users	RH04 Adjacent land users - residents	RH05 On site and adjacent land users — public open space	RH06 Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Controlled Water Receptors: Superficial Aquifer Aquifer(s)	Bedrock Aquifer Aquifer(s)	SPZ SPZ	Surface Water Distance to SW (m)	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Crown Garage	HLU0341	Garage shown since 1960 or earlier. Still in active use as a garage.	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x									None	Principal Aquifer	None	450	Medium	Low likelihood	Low	Possible groundwater impact.
	Fair Folly Garage	HLU0342	Garage present from approximately 2007 to present (Earthstar Geographics, 2022).	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within 250m study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x									None	Principal Aquifer	SPZ III	490	Medium	Low likelihood	Low	Possible groundwater impact.
	Former Greenway Petrol Filling Station	HLU0343	Former PFS, shown between approximately 1960 and 1990. Residential properties now occupy the site (Earthstar Geographics, 2022).	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within 250m study area	No superficial deposits	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x									None	Principal Aquifer	SPZ III	370	Mild	Low likelihood	Low	Former PFS now developed for residential. Gross contamination not expected to remain but may cause residual impact to groundwater.
	Filborough Landfill	HLU0413	Inert and commercial waste landfill (approximately 1970s to 1991) (former gravel pit).	Metals, asbestos, petroleum hydrocarbons, inorganics, PAH, VOC, SVOC, PFAS, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)						x	x	x	x								Secondary Aquifer - A	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk due to small size and location. At this point, the route is in a tunnel at depth greater than this feature. May influence local groundwater quality baseline
	Infilled gravel pit west of Filborough Landfill	HLU0422	Smaller gravel pit – possibly infilled prior to 1961.	Metals, asbestos, petroleum hydrocarbons, inorganics, PAH, hazardous gases.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)						x	x	x									Secondary Aquifer - A	Principal Aquifer	None	31	Minor	Likely	Low	Unlikely to be a significant risk due to small size and location. At this point, the route is in a tunnel at depth greater than this feature. May influence local groundwater quality baseline
	Thames and Medway Canal	HLU0414	Disused, partially infilled canal. Constructed between 1804 and 1824 and abandoned in 1934.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk due to age. At this point, the route is in a tunnel at depth beneath.
	North Kent Railway	HLU0411	Railway line on embankment constructed approximately 1846 and electrified in mid-20th century.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Low likelihood	Low	Unlikely to be a significant risk. Route is in tunnel beneath Alluvium.
	Milton Range Halt - platforms	HLU0415	Disused platforms for former railway halt and engineers siding.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, PCB, VOC, SVOC.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x		x	x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk. Route is in tunnel beneath Alluvium.
	Milton Rifle Range	HLU0417	Former military rifle range currently used for police training. Historical railway track, former workshop and other associated buildings.	Metals (particularly antimony, lead and zinc), asbestos, petroleum hydrocarbons, PAH.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x		x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk. Route is in tunnel beneath Alluvium.
	Clay pits	HLU0418	Clay pit, now infilled (approximately 1981).	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x	x	x	x	x		x		Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk. Route is in tunnel beneath Alluvium.
	Eastcourt Marshes Electricity Substation	HLU0420	Large electricity substation south of River Thames cable tunnel (approximately 197 3 to present).	PCB, petroleum hydrocarbons.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x		x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	None	26	Minor	Likely	Low	Unlikely to be a significant risk to the main tunnel. Minor potential for spillages, including PCBs to impact adjacent drainage outfall. Human health receptors not identified and risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	Training Centre	HLU0428	Training centre, including firefighting training. Formerly National Sea Training College (approximately 1960s or 1970s to 2003), now operated by Met Police for training.	Metals, petroleum hydrocarbons, PAH, PFAS, asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x			x	x	x	x	x				x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk to the main tunnel. Minor potential for spillages to impact adjacent drainage outfall.
	Norfolk Road Industrial Estate	HLU0433	Industrial estate shown 1973 to present. Several active businesses are present on site. An electrical substation may also be present.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos, PCB.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	None	145	Medium	Unlikely	Low	Any groundwater impacts likely to move north away from LTC.
	Comma Oil and Chemicals	HLU0434	Manufacturer of automotive lubricants and chemicals. Factory present 1966 to present.	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	None	15	Medium	Low likelihood	Low	Possible impact to groundwater and disused canal if in hydraulic continuity. No recorded evidence of pollution and distance to development boundary possibly sufficient to attenuate hydrocarbon concentrations.
	Wharf Road Industrial Estate - North	HLU0435	Industrial estate shown 1955 to present. Comprises several active businesses.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	None	15	Medium	Unlikely	Low	Any groundwater impacts likely to move north away from LTC.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	Potential Pathways: D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	Human Health Receptors: RH01	RH02	RH03	RH04	RH05	RH06	Controlled Water Receptors: Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Sewage Works	**HLU0437**	Sewage treatment works shown 1932 to present.	Metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases, PFAS.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)				x	x	x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Mild	Low likelihood	Low	Possible historical soil or groundwater impacts up-gradient of development boundary.
	Hospital	**HLU0438**	Hospital shown 1932 to 1955. A building was shown 1966 to 1981 but was not labelled as a hospital.	Metals, petroleum hydrocarbons, PAH, asbestos, microbial contamination.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	90	Minor	Unlikely	Low	Possible demolition materials or buried waste may remain on site but groundwater impacts likely to move north away from LTC.
	Denton-Comma Oil Landfill	**HLU0443**	Former inert waste landfill operated by J Clubb Limited recorded on Landmark Environmental databases. Filling dates are not available for the landfill - Environment Agency ref: EAHLD19292 .	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	30	Medium	Low likelihood	Low	Possible impact to groundwater and disused canal if in hydraulic continuity. No recorded evidence of pollution.
	Road Haulage Yard	**HLU0444**	Coach and minibus hire depot yard from at least 1966.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)				x	x	x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Mild	Low likelihood	Low	Small scale vehicle yard, no evidence of refueling facilities, may influence surface water quality in adjacent disused canal.
	Enterprise House Industrial Units	**HLU0445**	Industrial estate shown 1885 – 1971 and 1981 to present. Several active businesses present on the site.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	35	Mild	Low likelihood	Low	Any groundwater impacts likely to move north away from LTC.
	Wharf Road Industrial Estate - South	**HLU0446**	Industrial estate shown 1973 to present. Comprises several active businesses.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	90	Mild	Unlikely	Low	Any groundwater impacts likely to move north away from LTC.
	Denton Wharf	**HLU0447**	Industrial estate first shown 1865 to present. Comprises several active businesses. Hospital also shown on the site between 1895 and 1981.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos, PCB.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)				x	x	x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	None	10	Mild	Low likelihood	Low	Any groundwater impacts likely to move north away from LTC.
	J Clubb Aggregate Yard	**HLU0448**	Sand and gravel suppliers present on the site from approximately 1990 to present.	Petroleum hydrocarbons, PAH, metals, inorganics, asbestos.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)						x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	None	10	Mild	Low likelihood	Low	Any groundwater impacts likely to move north away from LTC.
	Metal recycling facility	**HLU0512**	Current waste processing site including end-of-life vehicles and metal processing.	Metals, inorganics, petroleum hydrocarbons, PAH, VOC, SVOC, phenols, chlorinated hydrocarbons, PCB, asbestos.	Within Order Limits and study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	71	Severe	Likely	High	Potential for unrecorded pollution to soil or groundwater from storage of materials and vehicle and metal processing. Main buildings and processes located off site. Location near north portal increases the potential for adverse effect on the route.
	Wharves	**HLU0521**	Wharves and jetties for importing soil and waste materials. Historical railway.	Metals, asbestos, inorganics, petroleum hydrocarbons, PAH.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy); Tidal River Or Creek Deposits (Clay and Silt)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x			x	x	x	x	x					x		Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk but localised impacts to soil and sediment may be present from historical material storage or spillages.
	Poultry Farm, Buckland	**HLU0518**	Poultry farm established approximately 1961 to present	PAH, metals, inorganics, petroleum hydrocarbons, pesticides, asbestos, ammoniacal nitrogen, microbial contamination, hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)						x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	62	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of potential primary sources and the degradable nature of contaminants. May influence local groundwater quality baseline.
	Historical Jetty South of East Tilbury Landfill	**HLU0520**	Former jetty (approximately 1948 to 1991). Potential waste transfer point and infilling related to partial demolition of the jetty.	Metals, inorganics, petroleum hydrocarbons, PAH, SVOC, VOC, chlorinated hydrocarbons, PCBs, ammoniacal nitrogen, PFAS, asbestos	Within 250m study area	Tidal River Or Creek Deposits (Clay and Silt)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)			x	x	x	x	x	x	x							Unproductive Strata	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk but localised impacts to soil and sediment may be present from historical material storage or spillages.
	East Tilbury Landfill	**HLU0523**	Former hazardous waste landfill . Filling dates approximately 1932 to 1990 with recorded industrial, commercial and household wastes and liquids/sludge wastes	Metals, inorganics, petroleum hydrocarbons, PAH, SVOC, VOC, chlorinated hydrocarbons, PCBs, ammoniacal nitrogen, PFAS, asbestos, hazardous gas.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x					x	x	Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer	SPZ III	0	Severe	Likely	High	Potentially significant source of pollution to surface and groundwaters that could impact the route in the vicinity of the north portal. Potentially significant source of landfill gas. Location near north portal increases the potential for adverse effect on the route.
	Goshems Farm Landfill	**HLU0526**	Former late 19th/early 20th century landfill, reportedly mostly ash and bottles, dock and river dredgings. Currently undergoing restoration .	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, tributyltin (TBT), SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x	x	x			x		Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer	SPZ III	0	Severe	Likely	High	Potential for wide range of contaminants to be present in area of north portal excavation. Adjacent to surface water and within SPZIII. Potential for ground gas generation from organic wastes (dredgings) and natural alluvium. Location near north portal increases the potential for adverse effect on the route.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Tilbury Ash Disposal Site - Area C2	**HLU0527**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal.
	Tilbury Ash Disposal Site - Area C	**HLU0528**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x	x	x		x		Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal.
	Tilbury Ash Disposal Site - Area B	**HLU0529**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x						Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal.
	Tilbury Ash Disposal Site - Area A3	**HLU0530**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal. Location near north portal increases the potential for adverse effect on the route.
	Tilbury Ash Disposal Site - Area A2	**HLU0531**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal. Location near north portal increases the potential for adverse effect on the route.
	Tilbury Ash Disposal Site - Area A1	**HLU0532**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x				x	x	Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer	None	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal. Location near north portal increases the potential for adverse effect on the route.
	Sewage Works	**HLU0626**	Sewage treatment works (constructed approximately 1940) with extension to north (approximately 1990).	Metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases, PFAS.	Outside both	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)						x	x	x	x							Secondary Aquifer - Undifferentiated; Unproductive Strata	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk due to site encroaching on an area of the route which will be used temporarily for access and utility rerouting only.
	Sewage Works - Northern Extension	**HLU0627**	Sewage treatment works (constructed approximately 1940) with extension to north (approximately 1990).	Metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases, PFAS.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)						x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant risk.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	Potential Pathways: D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	Human Health Receptors: RH01	RH02	RH03	RH04	RH05	RH06	Controlled Water Receptors: Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Sewage Treatment Tanks	**HLU0623**	Sewage treatment tanks (constructed approximately 1950) disused and removed (by 1992).	Metals, inorganics, sewage-related organics, PAH, ammoniacal nitrogen, microbial contamination, asbestos, hazardous gases.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	22	Minor	Likely	Low	Unlikely to be a significant risk.
	Sewage Works - Aqueduct and water tanks	**HLU0624**	Aqueduct and water tanks constructed approximately 1950 . Last shown 1991; no longer present at site.	Metals, inorganics, sewage-related organics, ammoniacal nitrogen, asbestos, micro-organisms, hazardous gas.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	23	Minor	Likely	Low	Unlikely to be a significant risk.
	Electricity substation	**HLU0622**	Electricity substation facility north of Station Approach, approximately 19 50 to present.	Petroleum hydrocarbons, PCB.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x			x	x	x	x	x			x	x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	3	Mild	Likely	Low	Potential for localised impacts to soil in the case of unrecorded releases of PCBs. Risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	East Tilbury Landfill - northern extension	**HLU0533**	Former hazardous waste landfill . Filling dates approximately 1932 to 1990 with recorded industrial, commercial and household wastes and liquids/sludge wastes	Metals, inorganics, petroleum hydrocarbons, PAH, SVOC, VOC, chlorinated hydrocarbons, PCBs, ammoniacal nitrogen, PFAS, asbestos, hazardous gas.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x	x	x	x	x	x	x	x	x	x				x	x	Secondary Aquifer - A; Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Severe	Likely	High	Potentially significant source of pollution to surface and groundwaters that could impact the route in the vicinity of the north portal. Hazardous materials may be present within landfill. Potentially significant source of landfill gas.
	Tilbury Ash Disposal Site - Shed Marsh Landfill	**HLU0534**	PFA landfill for Tilbury Power Station (and potential for unrecorded disposal of other materials).	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, SVOC, VOC, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x	x	x	x	x	x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for a wide range of contaminants to be present but likely dominated by those associated with PFA. Potential impacts to groundwater and surface waters in the area of the north portal.
	Low Street Landfill	**HLU0535**	Industrial/commercial landfill (1969 to 1976).	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Severe	Likely	High	Potential for wide range of contaminants to be present in the area. Potential for ground gas generation from organic wastes (dredgings) and natural alluvium. Location near north portal increases the potential
	Gasworks, gasometer and retort	**HLU0608**	Gasworks, gasometer and retort are present in 1863. Marked as disused by 1892-1914 map	Metals, inorganics, aromatic hydrocarbons, PAH, phenols, asbestos and hazardous gases. coal dust, spent oxide foul lime, coal tar and ammoniacal liquor.	Within Order Limits and study area	Alluvium	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)	x		x	x	x	x	x	x		x						x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	20	Minor	Low likelihood	Low	Potential for soil and groundwater impacts where gasworks activities were located. Unlikely to be a significant risk as access route is currently in place as a surfaced main road.
	Tilbury Junction railway, engine shed and sidings	**HLU0609**	Railway and sidings mapped from at least 1863. Engine shed shown on maps from 1944 - 1971	Asbestos, metals, inorganics and organics (including fuel oils, lubricating oils, greases, chlorinated and non-chlorinated solvents, phenols, PAH and PCB) and hazardous gas.	Within Order Limits and study area	Alluvium	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)	x		x	x	x	x	x	x		x						x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	10	Minor	Low likelihood	Low	Localised impacts to soil may be present from historical material storage or spillages and potential for encountering historic railway embankment and track ballast of unknown composition. Unlikely to be a significant risk as access route is currently in place as a surfaced main road.

Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
				Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
					Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Low Street Brickworks Landfill	**HLU0536**	Industrial landfill (1956 to 1977).	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	47	Severe	Likely	High	Potential for wide range of contaminants to be present in the area. Potential for ground gas generation from organic wastes (dredgings) and natural alluvium. Location near north portal increases the potential for adverse effect on the tunn
	Depot	**HLU0612**	Industrial depot first recorded on maps in 1992. Later replaced with hardstanding and warehouse new.	Metals, inorganics, petroleum hydrocarbons, PAH, phenols, VOC, SVOC and asbestos	Within Order Limits and study area	Alluvium	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)	x		x	x	x	x	x	x		x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Low likelihood	Low	Potential for soil and groundwater impacts from historical depot material storage or spillages. Site area is currently occupied by a trailer storage company with a surfaced main road to the north.
	Coalhouse Point Coal Wharf/	**HLU0709**	Wharf for coal deliveries constructed prior to 1777, now demolished. Possible timbers remain.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x		x	x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Likely	Low	Unlikely to be a significant contaminant source to route due to distance and age of feature.
	Coal Wharf Tramway	**HLU0707**	Tramway constructed approximately 1860s, removed approximately 1948–1955.	Metals, petroleum hydrocarbons, PAH, asbestos.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x		x	x	x	x								Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant contaminant source to route due to distance and age of feature.
	Sewage Tank	**HLU0704**	Sewage tank near Coalhouse Fort, constructed approximately 1921.	Metals, petroleum hydrocarbons, PAH, PFAS, asbestos, microbial contamination, inorganics, hazardous gases.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	23	Minor	Likely	Low	Unlikely to directly impact the route but may affect local groundwater quality in this area of the development boundary
	Pumping station	**HLU0705**	Sewage pumping station near Coalhouse Fort, constructed approximately 1990 .	Metals, petroleum hydrocarbons, PAH, PFAS, asbestos, microbial contamination, inorganics, hazardous gases.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x									Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	20	Minor	Likely	Low	Unlikely to directly impact the route but may affect local groundwater quality in this area of the development boundary
	East Tilbury Battery	**HLU0721**	Constructed approximately 1889–1890. Decommissioned approximately 1913, but remains are still present at the site.	Metals, petroleum hydrocarbons, PAH, explosives, sulphates.	Within Order Limits and study area	River Terrace Deposits (Undifferentiated) (Clay and Silt)	Thanet Formation (Sand, Silt and Clay)	x			x		x	x	x		x						Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	105	Minor	Likely	Low	Unlikely to be a significant risk. Localised impacts to soil may be present from historical material storage or spillages.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Saltings Landfill	**HLU0728**	Former landfill for river dredging, inert waste and liquid sludge approximately 1988–1993.	Metals, inorganics, TBT, hazardous gases.	Within Order Limits and study area	Beach and Tidal Flat Deposits (Undifferentiated) (Clay, Silt and Sand)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand, Silt and Clay)						x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Potential for range of contaminants to be present. Potential for ground gas generation from organic wastes (dredgings) and natural alluvium. Confined spaces and human health receptors are assumed to be absent. May influence local groundwater quality baseline.
	Goshems Farm	**HLU0538**	Farmyard and farm buildings.	PAH, metals, inorganics, petroleum hydrocarbons, pesticides, asbestos, ammoniacal nitrogen, microbial contamination, hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)			x		x	x	x				x	x					Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	408	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of primary sources. Localised impacts to soil may be present from historical material storage or spillages.
	Infilled pond adjacent and north of Station Road	**HLU0514**	Small pond potentially infilled by 1939.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	47	Minor	Likely	Low	Unlikely to be a significant risk due to size of source and age of the fill material. Mostly beneath existing Station Road.
	Former railway engine house	**HLU0828**	Railway cisterns, wells and engine house. Extant prior to 1865. Removed between 1967 and 1973.	Metals, PAH, petroleum hydrocarbons, PCB, inorganics, phenols, asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Medium	Likely	Medium	Localised impacts to soil may be present from historical material storage or spillages. Location near north portal increases the potential for adverse effect on the route.
	Tilbury East Railway Sidings	**HLU0625**	Railway and sidings mapped from 1959 to 1966. Dismantled by 1973.	metals, petroleum hydrocarbons, asbestos, inorganics, PAH, VOC and SVOC	Within Order Limits and study area	Alluvium	Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated) (Chalk)	x		x	x	x	x	x	x		x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	None	0	Minor	Low likelihood	Low	Localised impacts to soil may be present from historical material storage or spillages and potential for encountering historic railway embankment and track ballast of unknown composition. Unlikely to be disturbed given the access route is currently in place as a surfaced main road.
	Former brickworks at Low Street	**HLU0524**	Brickworks, kiln and gravel pit constructed prior to 1921, and demolished between 1955 and 1961.	Metals, inorganics, phenols, asbestos, PAH.	Within Order Limits and study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x			x	x	x		x			x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	57	Minor	Likely	Low	Unlikely to be a significant risk due to age and pre-dating the current land use. Localised impacts to soil may be present from historical material storage.
	Electricity substation	**HLU0802**	Constructed circa 1961, still present in 2017.	PCB, petroleum hydrocarbons.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x			x	x	x		x					x		Secondary Aquifer - A	SPZ III	147	Mild	Likely	Low	Potential for unrecorded releases of PCBs. Risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	Electricity substation	**HLU0803**	Constructed circa 1961 , still present in 2017.	PCB, petroleum hydrocarbons.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x			x	x			x					x		Secondary Aquifer - A	SPZ III	213	Mild	Likely	Low	Potential for unrecorded releases of PCBs. Risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	Electricity substation	**HLU0804**	Constructed circa 1961, still present in 2017.	PCB, petroleum hydrocarbons.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x		x	x	x	x		x	x	x			x		Secondary Aquifer - A	SPZ III	175	Medium	Likely	Medium	Potential for unrecorded releases of PCBs. Increased severity due to location.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Electricity substation	HLU0805	Constructed circa 1961, still present in 2017.	PCB, petroleum hydrocarbons.	Within Order Limits and study area	No superficial deposits	Thanet Formation (Sand)	x		x			x	x	x		x					x		Secondary Aquifer - A	SPZ III	126	Mild	Likely	Low	Potential for unrecorded releases of PCBs. Risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	Power Station Works (tanks and hopper)	HLU0629	Constructed c.1967–1973.	Metals, coal constituents (PAH, sulphur) petroleum hydrocarbons, VOC, SVOC, asbestos.	Within 250m study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x	x							Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Minor	Likely	Low	Localised impacts to soil may be present from historical material storage or spillages.
	Tilbury Power Station	HLU0630	Former fossil fuel power station 1950s to 2013. Major fire in 2012.	Metals, coal constituents (PAH, sulphur), nitrogen oxides, petroleum hydrocarbons, VOC, SVOC, PCB, PFAS, asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x	x	x	x	x	x	x	x					x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Medium	Likely	Medium	Potential for soil impacts where power station activities have impacted soil within the development boundary. Impacts to soil may be present from historical material storage or spillages. May impact baseline groundwater quality and indirectly affect soil quality through aerial deposition. Location near north portal
	Disused Pit to South of Station Road	HLU0515	Suspected partially backfilled disused gravel pit, south of Station Road.	Metals, inorganics, PAH, petroleum hydrocarbons, asbestos, hazardous gases.	Within Order Limits and study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Medium	Likely	Medium	Site is shown on OS map as a disused pit but localised infilling or dumping may have taken place. Location near north portal increases the potential for adverse effect on the route.
	Suspected quarry fill	HLU0537	Suspected area of fill south of Station Road.	Metals, inorganics, PAH, petroleum hydrocarbons, asbestos, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Medium	Likely	Medium	Site is shown on OS map as a disused pit but localised infilling or dumping may have taken place. Location near north portal increases the potential for adverse effect on the route.
	Princess Margaret Road Landfill	HLU0724	Active landfill taking 'other wastes ' (construction, demolition, dredgings). Historical deposition of inert and non-hazardous commercial and industrial waste since the 1980s.	Petroleum hydrocarbons, PAH, PFAS, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases, TBT.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand, Silt and Clay); Thanet Formation (Sand)				x	x	x	x	x	x							Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Operational landfill. Potential for wide range of contaminants to be present. Potential wider impacts to surrounding soil. May influence baseline groundwater quality.
	Infilled pond at metal recycling facility	HLU0513	Former ponds at metal works, potentially infilled between 1973 and 1991.	Metals, inorganics, PAH, petroleum hydrocarbons, asbestos, hazardous gases.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)				x	x	x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	165	Minor	Likely	Low	Potential for unrecorded pollution to soil or groundwater from infill materials. Potential size of source is relatively small.
	Infilled pond at metal recycling facility	HLU0525	Former ponds at metal works, potentially infilled between 1973 and 1991.	Metals, inorganics, PAH, petroleum hydrocarbons, asbestos, hazardous gases.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)				x	x	x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	87	Minor	Likely	Low	Potential for unrecorded pollution to soil or groundwater from infill materials. Potential size of source is relatively small.
	Electricity substation	HLU0504	Electricity substation, constructed prior to 1961.	PCB, petroleum hydrocarbons.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)				x		x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	134	Minor	Likely	Low	Potential for unrecorded releases of PCBs. Off-site source reduces potential severity. Human health receptors not identified and risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	Electricity substation	HLU0505	Electricity substation, constructed prior to 1961.	PCB, petroleum hydrocarbons.	Within 250m study area	No superficial deposits	Thanet Formation (Sand)				x		x	x	x									Secondary Aquifer - A	SPZ III	153	Minor	Likely	Low	Potential for unrecorded releases of PCBs. Human health receptors not identified and risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Electricity substation	HLU0506	Electricity substation, constructed prior to 1961.	PCB, petroleum hydrocarbons.	Within 250m study area	No superficial deposits	Thanet Formation (Sand)				x		x	x	x									Secondary Aquifer - A	SPZ III	141	Minor	Likely	Low	Potential for unrecorded releases of PCBs. Human health receptors not identified and risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	East Tilbury Quarry	HLU0725	Landfill taking other wastes (construction, demolition, dredgings). Possible illegal dumping of asbestos waste.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases, TBT.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand, Silt and Clay); Thanet Formation (Sand)				x	x	x	x	x	x							Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Operational landfill. Potential for wide range of contaminants to be present. Potential wider impacts to surrounding soil. May influence baseline groundwater quality.
	Love Lane landfill	HLU0727	Landfill operational approximately 1934–1990 for inert, industrial and commercial waste.	Petroleum hydrocarbons, PAH, PFAS, inorganics, metals, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	355	Minor	Likely	Low	Unlikely to significantly impact the route. Assumed no confined spaces or human health receptors. May influence wider groundwater baseline quality.
	Former Bata shoe factory and Thames Industrial park	HLU0827	Shoe factory constructed approximately 1938 and closed 2005.	VOC, SVOC, metals, petroleum hydrocarbons, phenols.	Within 250m study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)						x	x	x	x							Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Localised impacts to soil may be present from historical material storage or spillages
	Former railway sidings at brickworks	HLU0830	Constructed between 1898 and 1921, possibly removed between 1955 and 1961.	Metals, petroleum hydrocarbons, asbestos, inorganics, PAH, VOC, SVOC.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x	x	x		x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	24	Medium	Likely	Medium	Localised impacts to soil may be present from historical material storage or spillages. Location near north portal increases the potential for adverse effect on the route.
	Low Street Railway (Tilbury Loop)	HLU0605	Existing railway line.	Metals, inorganics, petroleum hydrocarbons, PAH asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy); Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand); Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk	x		x		x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Principal Aquifer; Secondary Aquifer - A	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk. Contaminants of low mobility (hydrocarbons likely heavy end), reducing potential for risk to controlled waters.
	Former Low Street Railway Station	HLU0510	Former railway station 1861 to 1967.	Metals, inorganics, petroleum hydrocarbons, PAH asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk); Thanet Formation (Sand)	x		x	x		x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated	Principal Aquifer; Secondary Aquifer - A	SPZ III	71	Minor	Low likelihood	Low	Unlikely to be a significant risk. Contaminants aged and of low mobility (hydrocarbons likely heavy end), reducing potential for risk to controlled waters.
	Power Station railway branch lines	HLU0606	Branch lines to former Tilbury Power Station.	Metals, inorganics, petroleum hydrocarbons, PAH asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x			x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk. Contaminants of low mobility (hydrocarbons likely heavy end), reducing potential for risk to controlled waters.
	Power Station railway branch lines	HLU0607	Branch lines to former Tilbury Power Station.	Metals, inorganics, petroleum hydrocarbons, PAH asbestos.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)	x		x			x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Principal Aquifer	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk. Contaminants of low mobility (hydrocarbons likely heavy end), reducing potential for risk to controlled waters.
	Sheep wash	HLU0503	Sheep wash (approximately 1939 to 1973).	Metals, pesticides.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy [Unlithified Deposits])	Thanet Formation (Sand)				x		x	x	x								Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	18	Minor	Likely	Low	Unlikely to be a significant risk but localised impacts to soil may be present from historical material storage or spillages which have potential to enter groundwater.
	Condovers Farm	HLU0539	Farmyard and farm buildings.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, microbial contamination.	Within Order Limits and study area	Taplow Gravel Member (Sand and Gravel); Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silty, Peaty, Sandy [Unlithified Deposits])	Thanet Formation (Sand)	x		x			x	x	x	x	x				x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to small scale.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	Potential Pathways: D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	Human Health Receptors: RH01	RH02	RH03	RH04	RH05	RH06	Controlled Water Receptors: Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Railway Yard Industrial Area	**HLU0540**	Industrial area, current occupiers may include plant hire workshop andan inactive gas suppliers.	Metals, inorganics, petroleum hydrocarbons, PAH phenols, asbestos, SVOC, VOC.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy); Taplow Gravel Member (Sand and Gravel); Head (Clay, Silt, Sand and Gravel)	Thanet Formation (Sand)	x					x	x	x	x	x			x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Principal Aquifer; Secondary Aquifer - A	SPZ III	8	Minor	Likely	Low	Unlikely to be significant source of contamination due to the relatively small scale of the potentially contaminative activities. Residual risk of unrecorded pollution.
	Potentially infilled gravel pit	**HLU0516**	Small gravel pit, potentially infilled north of London Tilbury and Southend Railway	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	31	Minor	Likely	Low	Unlikely to be a significant risk due to small size, the age of the fill material.
	Potentially infilled pit	**HLU0819**	Large gravel pit east of Courtney Road, excavated from approximately 1960, potentially infilled between 1973 and 1991.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	397	Medium	Likely	Medium	Potential to encounter made ground and impacted soil.
	Potentially infilled gravel pit	**HLU0821**	Large gravel pit north of London Tilbury and Southend Railway, limited evidence for infilling but cannot be discounted.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x			x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	2	Minor	Likely	Low	Unlikely to be a significant risk and limited evidence of filling.
	Barvills Farm	**HLU0729**	Farmyard and farm buildings mapped from 1967. Potential gravel extraction/landfilling	Ammoniacal nitrogen, petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, microbial contamination, hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (Sand and Gravel)	Thanet Formation (sand)				x		x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	310	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of potential primary sources and the degradable nature of contaminants. May influence local groundwater quality baseline.
	Ashlea Farm	**HLU0834**	Farmyard mapped from 1955 and farm buildings including silos mapped from 1988.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Taplow Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x				x	x	x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ II	330	Minor	Likely	Low	Unlikely to be a significant risk due to the age (c.1991) of the agricultural buildings.
	Precast concrete works	**HLU0818**	Precast concrete works constructed prior to 1971 still present at the site. Currently operated by Tarmac Building Products Ltd.	Alkalis, petroleum hydrocarbons, VOC, SVOC, PCB.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand); Thanet Formation (Sand); Lambeth Group (Sand, Silt and Clay)				x	x	x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ II	51	Mild	Likely	Low	Known spillage of chemicals – alkali and a release of diesel. Potential impact to soil and groundwater likely to be localised arising from known spill.
	Linford quarry and landfill	**HLU0816**	Active inert landfill in former sand and gravel pits associated with precast concrete works. Potential for unrecorded waste disposal. Parts of site undergoing restoration works.	Inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand); Lambeth Group (Sand, Silt and Clay); Thanet Formation (Sand)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - A; Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ II	0	Mild	Likely	Low	Unlikely to be a significant risk due to low degradability of materials. May influence local groundwater baseline quality.
	Rainbow Shaw Quarry	**HLU0825**	Gravel pit shown approximately 1895 . Recorded as disused on historical mapping dated 1991. Active inert landfill in former sand and gravel pits associated with precast concrete works.	Inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand); Thanet Formation (Sand); Lambeth Group (Sand, Silt and Clay)	x		x	x	x	x	x	x		x	x	x		x	x	Secondary Aquifer - A; Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	60	Mild	Likely	Low	Unlikely to be a significant risk due likely low degradability of materials. May influence local groundwater baseline quality.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology: Superficial Geology provided by BGS	Generalised Bedrock Geology: Bedrock Geology provided by BGS	Potential Pathways: D-S Direct/dermal contact and incidental ingestion of contaminated soil	D-G Direct/dermal contact and incidental ingestion of contaminated groundwater	A Ingestion of soil or wind-blown dust	V Build-up of vapours or gases in confined spaces	F Inhalation of vapours, gases or wind-blown dust or fibres	S-G Leaching of contaminants from soil into groundwater	G-L Migration of contaminated groundwater on or off site	G-SW Groundwater migration to surface waters	R-SW Contaminated runoff (water and sediment) from land to surface waters	Human Health Receptors: RH01 Construction workers	RH02 Operational staff	RH03 Road users	RH04 Adjacent land users - residents	RH05 On site and adjacent land users — public open space	RH06 Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Controlled Water Receptors: Superficial Aquifer Aquifer(s)	Bedrock Aquifer Aquifer(s)	SPZ SPZ	Surface Water Distance to SW (m)	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Gravel pit mounds	HLU0817	Spoil mounds shown on maps dated approximately 1958 to 1987. Current presence unknown.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x		x		x	x	Secondary Aquifer - A; Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ II	77	Minor	Likely	Low	Unlikely to be a significant risk due to size. Spoil heaps may no longer be present. Most likely origin is gravel extraction waste.
	Infilled pond at Brook Farm	HLU0814	Two former ponds present from 1864, potentially infilled between 1973 to 1999.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases, herbicides, pesticides.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Thanet Formation (Sand)	x		x	x		x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	26	Minor	Low likelihood	Low	Unlikely to be a significant risk due to size. Potential presence of clay reduces likelihood of impact to controlled waters.
	Infilled pond at Brook Farm	HLU0815	Two former ponds present from 1864, potentially infilled between 1973 to 1999.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases, herbicides, pesticides.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Thanet Formation (Sand)	x		x	x		x	x	x	x	x	x		x	x	x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk due to size. Potential presence of clay reduces likelihood of impact to controlled waters.
	Seaborough Hall (demolished)	HLU0822	Former house and grounds, demolished approximately 1973 to 1986.	Petroleum hydrocarbons, PAH, metals, asbestos.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x		x	x	x	x		x	x	x		x	x	Secondary Aquifer - A; Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	161	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of primary sources. Some potential for historical spillages, buried waste and Made Ground.
	Infilled pond west of Brentwood Road	HLU0807	Pond possibly infilled between 1954 to 1963.	Metals, petroleum hydrocarbons, PAH, inorganics, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Lambeth Group (Clay, Silt and Sand)				x	x	x	x	x									Secondary Aquifer - A	SPZ III	179	Minor	Likely	Low	Potential for unrecorded pollution to soil or groundwater from infill materials. Potential size of source is relatively small.
	Infilled gravel pit east of Brentwood Road	HLU0823	Gravel pits excavated approximately 1915. Infilled between approximately 1938 to 1954.	Metals, asbestos, petroleum hydrocarbons, hazardous gases, PAH, inorganics.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x			x	x	x		x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	205	Medium	Likely	Medium	Potential to encounter made ground and contamination. Increased severity due to location.
	Infilled gravel pit east of Brentwood Road	HLU0824	Gravel pits excavated approximately 1915. Infilled between approximately 1938 to 1954.	Metals, asbestos, petroleum hydrocarbons, hazardous gases, PAH, inorganics.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x			x	x	x		x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	205	Medium	Likely	Medium	Potential to encounter made ground and contamination. Increased severity due to location.
	Brook Farm	HLU0835	Farm present on site prior to 1864. Site buildings may have been demolished based on historical mapping	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	Thanet Formation (sand)	x		x			x	x	x		x	x					Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	264	Minor	Low likelihood	Low	Localised impacts to soil may be present from material storage or spillages. Unlikely to be a significant risk due to likely size of primary sources.
	St James' Church and graveyard	HLU0839	Church and graveyard present on historical maps 1865 to present. Thought to have been built towards the end of the 12th century.	Metals (particularly lead), formaldehyde, ammoniacal nitrogen.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Thanet Formation (sand)						x	x	x									Secondary Aquifer - A	SPZ III	70	Minor	Unlikely	Low	Possible impact to groundwatery but very small scale graveyard so pollutant load likely to be small.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Wellhouse Farm	**HLU0840**	Farmyard and buildings shown in 1865. Last mapped as an active farm in 1895.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Thanet Formation (sand)				x	x	x	x	x	x							Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	5	Mild	Unlikely	Low	No evidence of recent agricultural activities, possible influence on local groundwater or surface water quality but LTC works unlikely to encounter groundwater in this location.
	Gunhill Farm	**HLU0842**	Farm shown between 1865 and 1991. Buildings still present on site, possibly still farm.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Alluvium (clay, silt, peat and sand)	Thanet Formation (sand)						x	x	x								Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	25	Mild	Low likelihood	Low	Farmyard is small scale, possible localised groundwater impact.
	Orsett Golf Club	**HLU0858**	Golf club first shown in 1915 and is still present on site with clubhouse.	Metals, petroleum hydrocarbons, PAH, asbestos, herbicides, pesticides.	Within Order Limits and study area	Head Deposits (Clay, silt, sand and gravel) and Black Park Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)	x					x	x	x		x			x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	40	Mild	Low likelihood	Low	No available evidence of imported material for construction of course but cannot be ruled out.
	Shroves Hill Wood Landfill	**HLU0859**	Landfill accepting household, non-hazardous industrial and commercial waste between 1951 and 1973 (EAHLD01271) Site appears to be used for storage and possible extraction activities (Earthstar Geographics 2022)	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	No superficial deposits	Lambeth Group (clay, silt and sand)				x	x	x	x									Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	250	Medium	Low likelihood	Low	Possible impacts to groundwater depending on landfill construction and waste types.
	Bennetts Industrial Estate	**HLU0860**	Industrial Estate comprising active car/motor related businesses including a used car dealer and a garage service. Asbestos waste transfer licence also	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)				x	x	x	x									Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	435	Medium	Low likelihood	Low	Possible groundwater impact but groundwater unlikely to be encountered.
	Chadwell Hall Pit Landfill	**HLU0861**	Local authority recorded landfill (THU010). No details available regarding filling dates or waste type (Landmark, 2018). Site now appears to be vegetated.	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	720	Medium	Low likelihood	Low	Possible groundwater impact but groundwater unlikely to be encountered.
	Linford Road Landfill	**HLU0862**	Historic landfill. No details available regarding filling dates or waste type. Site is now occupied by residential housing.	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Thanet Formation (sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	410	Minor	Low likelihood	Low	Landfill less likely to contain significant degradable material due to residential development above.
	Mill House Farm	**HLU0863**	C H Cole and Sons Farmyard and buildings. Still present and operational.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases	Within Order Limits and study area	Boyn Hill Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)				x	x	x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	340	Medium	Low likelihood	Low	Possible impact on groundwater quality.
	Buckingham Hill Landfill	**HLU0864**	Former sand and gravel pit (excavated approximately 1949 to 1962) infilled with household waste from approximately 1967 to 1991. Landfill base presumed unlined in within Thanet Formation. Maximum waste depth reported as 15m. (Thurrock Council, 2020) Current household waste and recycling centre to east. Still operational.	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	No superficial deposits	Lambeth Group (clay, silt and sand); Thanet Formation (sand)		x		x	x	x	x			x						Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	220	Mild	Likely	Low	Records indicate site was restored with a capping layer but this is not confirmed. Possible groundwater impacts. Desk-based information and the results and assessment of gas monitoring undertaken adjacent to the landfill relating to areas of crop growth impacted by landfill gas
	Collingwood Farm Landfill	**HLU0865**	Local authority recorded landfill (THU033) recorded as open, receiving soil and inert builder's waste. Collingwood Farm historic landfill recorded as a historic landfill (EADLD01627) Receiving inert, industrial, commercial, and	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within 250m study area	No superficial deposits	Lambeth Group (clay, silt and sand)						x	x	x								Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	145	Mild	Low likelihood	Low	Possible groundwater impact.
	Brentwood Road Petrol Filling Station	**HLU0866**	Small PFS mapped between 1865 and 1923. Rebuilt several times by 1938, 1966 and 1973. Current aerial imagery shows a petrol filling station now present (Earthstar Geographics | Lower Thames Crossing, 2022).	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within 250m study area	Boyn Hill Gravel Member (sand and gravel)	Thanet Formation (sand)				x	x	x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	525	Medium	Low likelihood	Low	Possible groundwater impact, but groundwater unlikely to be encountered.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology: Superficial Geology provided by BGS	Generalised Bedrock Geology: Bedrock Geology provided by BGS	Potential Pathways: D-S Direct/dermal contact and incidental ingestion of contaminated soil	D-G Direct/dermal contact and incidental ingestion of contaminated groundwater	A Ingestion of soil or wind-blown dust	V Build-up of vapours or gases in confined spaces	F Inhalation of vapours, gases or wind-blown dust or fibres	S-G Leaching of contaminants from soil into groundwater	G-L Migration of contaminated groundwater on or off site	G-SW Groundwater migration to surface waters	R-SW Contaminated runoff (water and sediment) from land to surface waters	Human Health Receptors: RH01 Construction workers	RH02 Operational staff	RH03 Road users	RH04 Adjacent land users - residents	RH05 On site and adjacent land users — public open space	RH06 Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Controlled Water Receptors: Superficial Aquifer: Aquifer(s)	Bedrock Aquifer: Aquifer(s)	SPZ: SPZ	Surface Water: Distance to SW (m)	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Chadwell St Mary Cemetery	**HLU0867**	Cemetery and crematorium.	Metals (particularly lead), formaldehyde, ammoniacal nitrogen	Within Order Limits and study area	Boyn Hill Gravel Member (sand and gravel)	Thanet Formation (sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	725	Medium	Low likelihood	Low	Possible groundwater impact, but groundwater unlikely to be encountered.
	Chadwell St Mary Landfill	**HLU0868**	Historical landfill (THU052). Deposited waste included inert, industrial and commercial waste. Waste input dates recorded as 1961 to 1965. (Landmark, 2018).	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	Head Deposits (clay, silt, sand and gravel)	Thanet Formation (sand)				x	x	x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	320	Medium	Low likelihood	Low	Possible groundwater impact, but groundwater unlikely to be encountered.
	Woodview and Sandy Lane Landfills	**HLU0869**	Historical landfill (THU050/THU021). Deposited waste included industrial, commercial and household. Filling dates given as 1961 to 1967 and 1980. The area is now with residential development adjacent (Earthstar Geographics, 2022).	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	No superficial deposits	Thanet Formation (sand)				x	x	x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	535	Medium	Low likelihood	Low	Possible groundwater impact, but groundwater unlikely to be encountered.
	Clay pit	**HLU0935**	Clay pit and kiln, mapped from 1938, removed or infilled from 1955 onwards.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics and hazardous gases.	Within Order Limits and study area	No superficial deposits	London Clay	x		x	x	x					x	x				x	None	Unproductive strata	SPZ III	276	Minor	Likely	Low	Unlikely to be a significant risk due to size and age.
	Heath Place	**HLU0966**	Farm or industrial buildings.	Petroleum hydrocarbons, PAH, metals, inorganics, asbestos, pesticides, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)				x		x	x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of potential primary sources. May influence local groundwater quality baseline.
	Former Nevilles Farm	**HLU0967**	Former farm buildings and farmyard present from at least 1865 to 1993. Now scrubland.	Petroleum hydrocarbons, PAH, metals, inorganics, asbestos, pesticides, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x			x		x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	820	Minor	Likely	Low	Localised impacts to soil may be present from historical material storage or spillages. Unlikely to be a significant risk due to likely size of primary sources.
	Infilled pond	**HLU0933**	Infilled pond south of the A13 junction. Potentially infilled prior to 1965	Metals, asbestos, PAH, inorganics, petroleum hydrocarbons, PAH, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to size. Potential to encounter made ground and impacted soil.
	Dansand Quarry	**HLU0963**	Aggregate recyclers and building material processing. Made ground. Two recorded pollution incidents.	Petroleum hydrocarbons, PAH, metals, inorganics, asbestos.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Thanet Formation (Sand); Lambeth Group (Clay, Silt and Sand)	x		x		x	x	x	x		x	x	x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	38	Minor	Likely	Low	Unlikely to be a significant risk. Quarry is located next to the existing A13.
	Southfields Quarry Landfill	**HLU0946**	Landfill (non-biodegradable) no filling dates provided but still marked a disused gravel pit until 1973.	Metals, inorganics, PAH, petroleum hydrocarbons, asbestos, VOC, SVOC, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Black Park Gravel Member (Sand and Gravel)	Thanet Formation (Sand); Lambeth Group (Clay, Silt and Sand)				x		x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	216	Minor	Likely	Low	Unlikely to directly impact. May influence local groundwater quality baseline.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Vehicle repair and maintenance garage at A13-A128 junction	**HLU0949**	Former garage and PFS built approximately 1938–1954, Listed as inactive, however buildings and likely fuel storage still present at the site.	Petroleum hydrocarbons, metals, inorganics, asbestos, VOC, SVOC, MBTE, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)				x	x	x	x	x								Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	189	Medium	Likely	Medium	Storage tanks may still be present. A relatively large PFS compared to others identified, in use until recently. Severity based distance and potential size of primary sources. Potential for impacts to soil from fuel storage leakages and spills. Potential for unrecorded pollution impacts.
	Barrington's Farm	**HLU0965**	Farmyard and farm buildings first present prior to 1865.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)				x		x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	267	Minor	Likely	Low	Unlikely to be a significant risk due to likely size of potential primary sources and distance from site. May influence local groundwater quality baseline.
	Welcome Villa PFS	**HLU0960**	Former PFS (approximately 1960 s onwards), now residential property . Tanks may still be present.	Petroleum hydrocarbons, MBTE, BTEX, metals, inorganics, asbestos, VOC, SVOC, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x	x		x	x	x	x	x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	162	Medium	Likely	Medium	Relatively small compared to other PFS identified. Although tanks may still be present, given age and size, primary sources are unlikely large enough to justify a severe rating although along route alignment. Potential impacts to soils and groundwater from historic material storage and spills. Potential for unrecorded pollution incidents.
	Orsett Heath Recreation Ground Landfill	**HLU0962**	Domestic refuse landfill recorded by local authority. Gravel pit in south shown possibly infilled between approximately 1947 and 1973.	Metals, asbestos, VOC, SVOC, ammoniacal nitrogen, PAH, inorganics, petroleum hydrocarbons, hazardous gases.	Within 250m study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)			x	x		x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	838	Minor	Likely	Low	Unlikely to be a direct source of contamination due to the distance. Potential to impact wider soil and groundwater quality.
	Infilled gravel pit under A1089	**HLU0958**	Infilled gravel pit, potentially infilled between 1947 and 1955 with unknown material.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x	x		x	x	x				Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	1002	Minor	Likely	Low	Unlikely to be a direct source of contamination, located under existing road.
	Works	**HLU0954**	Shown on the site approximately 1955 to 1966. Potentially demolished 1967 to 1968.	Metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC, inorganics.	Within 250m study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	907	Minor	Likely	Low	Unlikely to be a significant risk due to distance and age. Potential for a wide range of potential contaminants to be present due to specific land use at the Works being unknown.
	Sewage Pumping Station at Orsett Heath	**HLU0956**	Possibly for A13 junction, constructed approximately 1973 to 1975. Still present at the site.	Metals, petroleum hydrocarbons, PAH, asbestos, microbial contamination, PFAS, inorganics, hazardous gases.	Within 250m study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)				x		x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	693	Minor	Likely	Low	Unlikely to be a significant risk due to size and distance.
	Infilled gravel pit	**HLU0940**	Gravel pit for the extraction of sand and gravel from approximately 1895. Potentially infilled post 1960.	Metals, asbestos, petroleum hydrocarbons, PAH, inorganics, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Thanet Formation (Sand)	x		x	x	x	x	x			x	x	x		x	x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	484	Medium	Likely	Medium	Potential to encounter contaminated soil May influence soil and groundwater baseline quality.
	Millers Sand and Gravel Pit landfill	**HLU0943**	Gravel pit excavated approximately 1938 to 1948. Used as historical landfill for commercial and household wastes between 1948 to 1965.	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, VOC, SVOC, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x	x	x	x	x	x	x			x	x	x	x		x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	281	Medium	Likely	Medium	Potential to encounter contaminated soil May influence soil and groundwater baseline quality.
	Infilled gravel pit	**HLU0941**	Infilled gravel pit south of Millers Sand and Gravel Pit (partially under current A13), excavated between approximately 1915 and 1955, potentially infilled between approximately 1955–1965.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x			x	x	x	x		x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	229	Mild	Likely	Low	Potential to encounter contaminated soil May influence soil and groundwater baseline quality. Relatively small area of fill reduces potential severity.
	Former works (unspecified) and garage at Baker Street.	**HLU0944**	Former garage with repair, spray painting and refuelling facilities. Mapped from 1955 until approximately 1993	Petroleum hydrocarbons, PAH, metals, inorganics, asbestos, VOC, SVOC, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	Lambeth Group (Clay, Silt and Sand)	x		x	x	x	x	x			x	x	x	x		x	Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	252	Medium	Likely	Medium	Although tanks may still be present, given age and size, primary sources are unlikely large enough to justify a severe rating although along route alignment. Potential impacts to soils and groundwater from historic material storage and spills. Potential for unrecorded pollution incidents. Storage tanks may still be present.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology: Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	Potential Pathways: D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	Human Health Receptors: RH01	RH02	RH03	RH04	RH05	RH06	Controlled Water Receptors: Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Preliminary Qualitative Risk Assessment: Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Mobbs Farm	HLU0972	Former farm buildings and farmyard present from at least 1865 to 1965. Not present by 1975	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen and hazardous gases	Within Order Limits and study area	Head Deposits (clay, silt, sand and gravel) and Alluvium (clay, silt, sand and gravel)	Lambeth Group (Clay, Silt and Sand)	x		x			x	x	x	x	x	x						Secondary Aquifer - Undifferentiated	Secondary Aquifer - A	SPZ III	770	Minor	Low likelihood	Low	Localised impacts to soil may be present from material storage or spillages. Unlikely to be a significant risk due to likely size of primary sources.
	Garage	HLU0975	Garage shown between 1954 and 1963 (Landmark, 2018). Red Lion Service Station is noted as being active in trade directory records on site	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within 250m study area	Black park Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	580	Mild	Low likelihood	Low	Former garage is off-site and age of garage suggests degradable contaminants in soil or groundwater will have reduced.
	Works (unspecified)	HLU0977	Works first shown in 1973. Still present on site. Registered trade directories on site include an active plastic injection-moulding, and inactive carpet and rug manufacturers, furniture manufacturers, and truck and trailer painting businesses.	Metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC, inorganics.	Within 250m study area	Black park Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	520	Mild	Low likelihood	Low	Possible groundwater impacts but source is significant distance from site.
	Orsett Industrial Park	HLU0978	Industrial estate comprising various commercial businesses, including plant and machinery hire, civil engineering and timber merchants.	Petroleum hydrocarbons, PAH, metals, phenols, VOC, SVOC, asbestos.	Within 250m study area	Black park Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)						x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	505	Mild	Low likelihood	Low	Possible groundwater impacts but source is significant distance from site.
	Orsett Cock North Petrol Filling Station	HLU0980	BP service station and PFS. Constructed later than 1986; currently operational	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	No superficial deposits	Lambeth Group (clay, silt and sand)				x	x	x	x									None	Secondary Aquifer - A	SPZ III	480	Medium	Low likelihood	Low	No evidence of any contamination releases.
	Hospital	HLU0981	Orsett Hospital, first shown from 1865 still present and operational.	Metals, petroleum hydrocarbons, PAH, microbial contamination.	Within Order Limits and study area	No superficial deposits	Lambeth Group (clay, silt and sand)						x	x									None	Secondary Aquifer - A	SPZ III	255	Minor	Unlikely	Low	Potential contaminating activities (e.g. incineration) likely to be small scale.
	Orsett Cock South Petrol Filling Station	HLU0979	BP service station and PFS . Constructed later than 1986; currently operational.	Petroleum hydrocarbons, PAH, MTBE, metals, inorganics, VOC, SVOC, asbestos, hazardous gases.	Within Order Limits and study area	Black Park Gravel Member (sand and gravel)	Lambeth Group (clay, silt and sand)				x	x	x	x									Secondary Aquifer - A	Secondary Aquifer - A	SPZ III	580	Medium	Low likelihood	Low	No evidence of any contamination releases.
	Tank	HLU1005	Historical tank (shown on maps dated 1915 to 1921). Assumed fuel storage.	Petroleum hydrocarbons, PAH.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)				x		x	x									Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	203	Minor	Low likelihood	Low	Above ground tank which is consider no longer to be present. Historical use of tank is unknown and potentially agricultural. Unlikely to be a significant risk due to time since removal. Presence of clay reduces likelihood on pathway on site.
	Infilled pond	HLU1030	Small pond (1,070m2), potentially infilled with unknown material between 1965–1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x	x	x	x	x		x	x	x			x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	33	Minor	Likely	Low	Unlikely to be a significant risk due to size. Potential to encounter made ground and impacted soil, but likely that human health risk can be readily managed.
	Infilled pond	HLU1031	Small pond (1,120m2), potentially infilled with unknown material between 1965–1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x		x	x	x		x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	117	Minor	Low likelihood	Low	Unlikely to be a significant risk due to small size, distance. Presence of clay reduces likelihood of significant impact to controlled waters.
	Infilled pond	HLU1032	Small pond (615m2), potentially infilled with unknown material between 1965–1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x			x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to small size. Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.
	Infilled pond	HLU1038	Small pond (790m2), potentially infilled with unknown material between 1965–1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x		x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	12	Minor	Low likelihood	Low	Unlikely to be a significant risk due to small size. Presence of clay reduces likelihood of significant impact to controlled waters.
	Infilled pond	HLU1039	Small pond (560m2), potentially infilled with unknown material between 1965–1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within 250m study area	Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x	x	x					x	Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to small size. Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Infilled pond	HLU1040	Small pond (445m2), potentially infilled with unknown material between 1965-1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x	x	x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to small size. Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.
	Infilled pond	HLU1056	Small pond (195m2), potentially infilled with unknown material between 1898-1921.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x		x	x	x	x	x	x				x	Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to size. . Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.
	Infilled pond	HLU1059	Small pond (295m2), potentially infilled with unknown material between 1965-75.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x	x	x	x			x	x	x			x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	346	Minor	Likely	Low	Unlikely to be a significant risk due to size. Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.
	Grange Farm Landfill	HLU1051	Industrial, commercial, and household waste. Filled 1974 to 1990.	Metals, inorganics, organics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	No superficial deposits	London Clay Formation (Clay, Silt and Sand)				x		x	x	x	x							N/A	Unproductive Strata	None	0	Minor	Low likelihood	Low	Permitted landfill. Situated on low permeability London Clay, and in area of overlying Head deposits. Potential for wider impacts to soil and groundwater. May influence baseline quality data.
	Flint Grit Pond Landfill	HLU1055	Co-disposal landfill shown on mapping between 1975 and 1985.	Metals, asbestos, petroleum hydrocarbons, inorganics, PAH, PFAS, ammoniacal nitrogen and hazardous gases, VOC and SVOC	Within Order Limits and study area	No superficial deposits	London Clay Formation (Clay, Silt and Sand)				x		x	x	x	x						x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	21	Minor	Low likelihood	Low	Closed landfill. Situated on low permeability London Clay, and in area of overlying Head deposits. Potential for wider impacts to soil and groundwater. May influence baseline quality data.
	Works	HLU1058	Unspecified works first shown from 1955 until 1985. Building may still be present on site (Earthstar Geographics 2022).	Metals, asbestos, petroleum hydrocarbons, PAH, VOC, SVOC and inorganics	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x			x						x						Secondary Aquifer - Undifferentiated	Unproductive strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to distance and age. Potential for a wide range of potential contaminants to be present due to specific land use at the Works being unknown.
	Ockendon Grays Areas II & III Landfill	HLU1062	Active Veolia non-hazardous and inert landfill. Filled from approximately 1977 to present.	Metals, inorganics, organics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x	x	x	x	x	x	x		x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Medium	Likely	Medium	Recently operational and permitted landfill. May influence baseline soil and groundwater quality due to size of landfill.
	Castle's Farm	HLU1066	Farmyard and buildings shown 1866 to 1975 (Landmark, 2018).	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Head Deposits (clay, silt, sand and gravel) and Alluvium (clay, silt, sand and gravel)	London Clay Formation (clay, silt and sand)	x			x	x	x	x	x		x						x	Secondary Aquifer - Undifferentiated	Unproductive strata	SPZ III	40	Mild	Unlikely	Low	No evidence of recent agricultural activities, possible influence on local groundwater or surface water quality but unlikely to encounter groundwater in this location.
	Sewage Pumping Station	HLU1076	Sewage pumping station, still present.	Metals, petroleum hydrocarbons, PAH, asbestos, microbial contamination, PFAS, inorganics, hazardous gases.	Within Order Limits and study area	Head Deposits (clay, silt, sand and gravel)	Lambeth Group (clay, silt and sand)				x	x	x	x	x									Secondary Aquifer - Undifferentiated	Unproductive strata	SPZ III	85	Mild	Low likelihood	Low	Small scale pumping station, no evidence of pollution.
	Groves Farm landfill	HLU1110	Historical landfill (filled 1972 to 1978 with inert industrial, commercial and household wastes). Aerial imagery shows that the site is now scrubland (Earthstar Geographics 2022)	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, hazardous gases, VOC, SVOC.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x	x		x			x	x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	14	Mild	Likely	Low	Unlikely to be a significant risk. Potential impact to wider soil and groundwater. May influence baseline soil and groundwater quality.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Works and electricity substation	**HLU1112**	Works shown between 1967 to 1987 in pit with an associated substation.	Metals, asbestos, petroleum hydrocarbons, PCB.	Within 250m study area	Boyn Hill Gravel Member (Sand and Gravel) (removed in this location due to Hall Farm gravel pit)	London Clay Formation (Clay, Silt and Sand)						x	x									Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	86	Minor	Likely	Low	Unlikely to be a significant risk. Likely to have been buried in Groves Farm Landfill but may impact local groundwater quality. Risk to water resources low given limited size of potential impact from hydrocarbons and low mobility of PCBs.
	Infilled Gravel Pit	**HLU1139**	Gravel pit mapped between 1821 and 1938. Likely infilled by 1954. The fill material is not known.	Metals, asbestos, petroleum hydrocarbons, inorganics, PAH and hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (sand and gravel)	London Clay Formation (Clay, Silt and Sand)	x	x		x	x	x	x	x		x					x	Secondary Aquifer - A	Unproductive Strata	SPZ III	162	Minor	Likely	Low	Unlikely to be a significant risk due to size and age.
	Hall Farm Landfill	**HLU1140**	Gravel pit shown 1895 to 1967. Recorded as historical landfill (filled 1959 to 1984 with inert, commercial and household wastes).	Metals, inorganics, petroleum hydrocarbons, PAH, PFAS, ammoniacal nitrogen, asbestos, VOC, SVOC, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x	x	x	x			x	x	x	Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Mild	Likely	Low	Unlikely to be a significant risk. May influence baseline soil and groundwater quality.
	Infilled gravel pit	**HLU1116**	Small gravel pit 1866 to 1954. Potentially infilled 1954–1967.	Metals, petroleum hydrocarbons, PAH, inorganics, asbestos, hazardous gases.	Within Order Limits and study area	Boyn Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)				x	x	x	x	x	x	x			x	x	x	Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to be a significant risk due to size and age.
	Potential asbestos containing irrigation pipes, Hall Farm.	**HLU1151**	Subsurface irrigation pipes may contain asbestos.	Asbestos.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)					x					x	x	x			x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	0	Medium	Likely	Medium	Likely to require removal by specialist contractor due to pipes located beneath route.
	Electricity substation	**HLU1144**	Electricity substation appears on historical maps from 1974.	Petroleum hydrocarbons, PCB.	Within 250m study area	Boyn Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x			x	x	x		x					x	Secondary Aquifer - A	Unproductive Strata	SPZ III	97	Mild	Likely	Low	Potential for unrecorded releases of PCBs. Risk to water resources low given limited size of potential impact from hydrocarbons, aquifer classification and low mobility of PCBs.
	Hall Farm Nursery	**HLU1152**	Commercial glasshouses and landscape business (1974 to present).	Metals, petroleum hydrocarbons, PAH, inorganics, herbicides, pesticides, asbestos.	Within 250m study area	Head (Clay, Silt, Sand and Gravel); Boyn Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x	x	x	x	x	x		x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Operational landscape gardening business. Any impacts present likely localised, resulting from material storage, use and spillages.
	Romford & Grays Railway Line	**HLU1108**	Constructed by 1895. Still present and operational.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Lynch Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x	x	x	x	x	x		x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to significantly impact the route as planned intrusive works unlikely to affect railway line. Relatively low environmental mobility of CoC (hydrocarbons likely heavy end).
	Baldwins Farm Landfill	**HLU1150**	Historical landfill, domestic and commercial waste, filling complete by 1990.	Metals, inorganics, petroleum hydrocarbons, PAH, ammoniacal nitrogen, asbestos, PFAS, VOC, SVOC, hazardous gases.	Within Order Limits and study area	Lynch Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)		x		x	x	x	x	x	x							Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Permitted landfill. Unlikely to be a significant risk due to position next to existing M25 and limited potential for ground disturbance in this area. M25 is on an embankment in this area. Situated on low permeability London Clay. Potential wider impacts to soil and groundwater. May influence baseline quality data.
	Manor Farm	**HLU1154**	Farmyard and farm buildings mapped from 1866.	Petroleum hydrocarbons, PAH, metals, inorganics pesticides, herbicides, asbestos, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Lynch Hill Gravel Member (Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)				x		x	x	x									Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	13	Minor	Likely	Low	Unlikely to be a significant risk due to small size. Localised impacts may be present due to material storage, use and spillages. May influence local groundwater quality baseline.
	Stubbers Outdoor Pursuits Centre Landfill	**HLU1159**	Historical landfill. Deposited waste included inert and industrial. Filling dates 1979 to 1980 (Landmark, 2018). Currently occupied by Stubbers Outdoor Pursuits Centre lakes.	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases	Within 250m study area	Lynch Hill Gravel Member (sand and gravel)	London Clay Formation (clay, silt and sand)		x				x	x	x	x	x							Secondary Aquifer - A	Unproductive strata	SPZ III	0	Medium	Low likelihood	Low	Possible impacts to groundwater and surface water.
	Franks Farm Industrial Park	**HLU12115**	Former metal fabrication business.	Metals, petroleum hydrocarbons, asbestos, VOC, SVOC.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)						x	x	x	x							Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	8	Minor	Unlikely	Low	Unlikely to be a significant risk due to distance from site. Potential presence of clay reduces likelihood of impact to controlled waters.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Wyngray Farm	HLU12117	Farmyard and farm buildings, possible material storage.	Petroleum hydrocarbons, PAH, pesticides, asbestos, ammoniacal nitrogen, metals, inorganics, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)				x		x	x	x	x							Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	1	Minor	Likely	Low	Little information is available on the site use but may include materials storage. Localised impacts may be present due to material storage, use and spillages. Unlikely to be a significant risk due to likely size of potential primary sources and distance from site.
	London, Tilbury and Southend Railway	HLU1212	Railway line constructed by 1895 and electrified from the 1960s.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x		x	x	x	x	x	x	x	x		x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Likely	Low	Unlikely to significantly impact the route as planned intrusive works unlikely to affect railway line. Relatively low mobility CoC (hydrocarbons likely heavy end).
	Infilled Pond	HLU1216	Pond shown on historical maps from 1866 to 1967. Potentially infilled by 1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	Claygate Member (sandy clay)	x		x			x	x			x					x	Secondary Aquifer - Undifferentiated	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	SPZ III	207	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age.
	Infilled Pond	HLU1219	Pond shown on historical maps from 1866 to 1967. Potentially infilled by 1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x	x	x	x	x		x	x				x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	164	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.
	Infilled Pond	HLU1220	Pond shown on historical maps from 1866 to 1967. Potentially infilled by 1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x			x	x	x	x			x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	121	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.
	Infilled Pond	HLU1238	Pond shown on historical maps from 1865 to 1958. Potentially infilled by 1963.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x			x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	108	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.
	Infilled Pond	HLU1250	Pond shown on historical maps from 1866 to 1967. Potentially infilled by 1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	No superficial deposits	Claygate Member (sandy clay)	x		x			x	x			x					x	N/A	Secondary Aquifer - A	SPZ III	233	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age.
	Infilled Pond	HLU1260	Pond shown on historical maps from 1895 to 1958. Potentially infilled by 1960.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x			x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	267	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.
	Infilled Pond	HLU1282	Pond shown on historical maps from 1865 to 1963. Potentially infilled by 1967.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x	x		x					x	Secondary Aquifer - Undifferentiated	Unproductive strata	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.
	Infilled Pond	HLU1286	Pond shown on historical maps from 1895 to 1967. Potentially infilled by 1975.	Metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x	x	x	x	x	x	x	x		x					x	Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	3	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age. Potential underlying clay reduces likelihood of impact to controlled waters.

	Name	Ref. No	Description	Potential Contaminants associated with contaminant source	Location and Geology			Potential Pathways								Human Health Receptors						Controlled Water Receptors				Preliminary Qualitative Risk Assessment			
					Location with respect to Order Limits and Study Area	Generalised Superficial Geology	Generalised Bedrock Geology	D-S	D-G	A	V	F	S-G	G-L	G-SW	R-SW	RH01	RH02	RH03	RH04	RH05	RH06	Superficial Aquifer	Bedrock Aquifer	SPZ	Surface Water	Severity	Likelihood	Preliminary Qualitative Risk Assessment Rating	Potential Significance of Pollutant Linkage(s)
						Superficial Geology provided by BGS	Bedrock Geology provided by BGS	Direct/dermal contact and incidental ingestion of contaminated soil	Direct/dermal contact and incidental ingestion of contaminated groundwater	Ingestion of soil or wind-blown dust	Build-up of vapours or gases in confined spaces	Inhalation of vapours, gases or wind-blown dust or fibres	Leaching of contaminants from soil into groundwater	Migration of contaminated groundwater on or off site	Groundwater migration to surface waters	Contaminated runoff (water and sediment) from land to surface waters	Construction workers	Operational staff	Road users	Adjacent land users - residents	On site and adjacent land users — public open space	Adjacent land users – industrial, commercial and agricultural workers, and users of recreational sites	Aquifer(s)	Aquifer(s)	SPZ	Distance to SW (m)				
1	2	3	4	5		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Infilled Pond	**HLU1233**	Former pond infilled with unknown material between 1975 and 1988. Partially under M25 embankment.	Petroleum hydrocarbons, PAH, inorganics, metals, asbestos, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x	x	x	x	x		x	x	x			x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	140	Minor	Low likelihood	Low	Unlikely to cause significant impact to the route as is located beneath existing embankment. Presence of clay reduces likelihood of significant impact to controlled waters, but feature is adjacent to surface water.
	Little Tabrams Farm	**HLU12116**	Farmyard and farm buildings first mapped from 1985	Petroleum hydrocarbons, PAH, pesticides, herbicides, asbestos, metals, inorganics, ammoniacal nitrogen, hazardous gases.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)						x	x	x								Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	162	Minor	Low likelihood	Low	Unlikely to be a significant risk due to likely size of potential primary sources and distance from site. Potential presence of clay reduces likelihood of impact to controlled waters.
	Infilled ponds	**HLU12114**	Agricultural field with two infilled ponds (filled prior to 1958) and possible recent earthworks (2018).	Metals, petroleum hydrocarbons, PAH, inorganics, asbestos, hazardous gases, herbicides, pesticides.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)						x	x	x								Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	131	Minor	Low likelihood	Low	Unlikely to be a significant risk due to age and distance from the development boundary. Potential underlying clay reduces likelihood of impact to controlled waters.
	Industrial units at Folkes Farm	**HLU12111**	Former farm now occupied by industrial and commercial businesses. First shown approximately 1866.	Petroleum hydrocarbons, PAH, metals, inorganics, pesticides, phenols, herbicides, asbestos, ammoniacal nitrogen, hazardous gases.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x	x		x	x	x								Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	165	Minor	Low likelihood	Low	Unlikely to be a significant risk due to likely size of potential primary sources and distance from site. Potential localised impacts from material storage and spillages. Potential for unrecorded pollution impacts. Potential underlying clay reduces likelihood of impact to controlled waters.
	Junction 29 Works Yard	**HLU12112**	Soil processing facility (pre-2010 to present), and highway contractor's compound (2010 to present).	Petroleum hydrocarbons, PAH inorganics, metals.	Within Order Limits and study area	Head (Clay, Silt, Sand and Gravel); Alluvium (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)	x		x			x	x	x	x	x				x	x	Secondary Aquifer - Undifferentiated; Secondary Aquifer - A	Unproductive Strata	SPZ III	0	Minor	Low likelihood	Low	Unlikely to be a significant risk due to relatively recent nature of land use. Potential underlying clay reduces likelihood of impact to controlled waters.
	Codham Hall Industrial Units	**HLU12113**	Industrial units (possibly warehousing and offices) and vehicle storage.	Petroleum hydrocarbons, PAH, metals, inorganics.	Within 250m study area	Head (Clay, Silt, Sand and Gravel)	London Clay Formation (Clay, Silt and Sand)				x		x	x	x	x							Secondary Aquifer - Undifferentiated	Unproductive Strata	SPZ III	9	Minor	Low likelihood	Low	Unlikely to be a significant risk. Known land use is generally of low pollution potential. Potential underlying clay reduces likelihood of impact to controlled waters.
	Ground Gas within Alluvium and Peat Deposits	**HLU9901**	Ground gas, principally methane, with low oxygen levels, stored within peat layers in Alluvium in soil gas and dissolved phase.	Hazardous gases	Within Order Limits and study area	Alluvium (Clay, Silty, Peaty, Sandy)	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x		x	x	x				N/A	N/A	None	N/A	Severe	Likely	High	Potential for release of stored geological methane within peat deposits during construction. Sufficient methane release may cause catastrophic damage to buildings or infrastructure. Potential for migration and release of dissolved methane during dewatering or similar.
	Ground Gas within chalk	**HLU9902**	Ground gas, principally carbon dioxide, with low oxygen levels, within chalk strata in soil gas and dissolved phase.	Hazardous gases	Within Order Limits and study area	Various	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x	x	x	x		x	x	x				N/A	N/A	None	N/A	Mild	Likely	Low	Potential for encountering high levels of carbon dioxide in confined spaces such as tunnel portals and during dewatering which may require additional controls to be in place.
	Radon gas within phosphatic chalk	**HLU9903**	Radon gas generated by areas of phosphatic chalk (if present).	Hazardous gases, nutrients	Within Order Limits and study area	Various	Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (Chalk)				x	x						x	x	x				N/A	N/A	None	N/A	Mild	Likely	Low	Potential for encountering radon (carcinogenic) if phosphatic chalk encountered. Currently no evidence it is present. May require additional controls to be in place if present.

Annex C Part 2 - Likelihood and severity

C.1 Classification of severity

C.1.1 Severity classification relates to the impact on the route and development works. For example, the classification will be lower for sites that are off-site or more distant from the development boundary, or may be greater where planned development works are more likely to be impacted (e.g. site within areas of extensive earth works such as the north portal. Severity is also lower where a source is smaller in size or contaminants concentrations are likely to have depleted (e.g. due to age and degradability), or where identified receptors are of lower sensitivity.

Table C.1 Classification of Severity.

Classification	Definition
Severe	Acute risk to human health, with the potential to result in significant harm. Significant pollution of controlled water. Catastrophic damage to a building/property constituting significant harm. An acute risk resulting in significant harm to an ecological system.
Medium	Chronic risk to human health with the potential to result in significant harm. Significant harm to controlled waters, such as the deterioration in water quality resulting in the lowering of classification of a water body. Significant harm, such as irreversible change, to an ecological system as defined in the Contaminated Land Statutory Guidance. Significant harm to a building/property resulting from long term effects such as sulphate attack.
Mild	Potential damage to crops, buildings, services and harm to the environmental and human health, which are unlikely to constitute significant harm but are viewed as constituting abnormal development costs. Potential for water quality standards to be exceeded in controlled waters which may constitute pollution, but unlikely to constitute significant pollution.
Minor	Harm, although unlikely to constitute significant harm, which may result in financial loss to the scheme, or expenditure to resolve. Potential risk to human health which may be readily managed by means including, but not limited to dust mitigation and personal protective clothing. Potential to locally affect water quality, but unlikely to cause water quality standards to be exceeded such that effects are permanent or alter the regional resource value of a receptor.

C.1.2 When applied to human health, controlled waters, ecological receptors or property such as buildings, the term ‘significant harm’ relates to the possibility of harm as defined in the Contaminated Land Statutory Guidance (Environment Agency, 2012).

C.2 Classification of likelihood

C.2.1 Likelihood classification relates to the likelihood of a pollutant linkage being present. The likelihood is considered lowered if mitigating circumstances are likely to be present. For example, this may include the presence of underlying clay reducing the potential for lateral migration of groundwater, or overlying hardstanding reducing the potential for infiltration and human health exposure. Likelihood does not relate to the likelihood of pollution being present.

Table C.2 Classification of Likelihood

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place, and is even less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

C.3 Matrix of severity against likelihood to gain risk rating

Table C.3 Risk Matrix

		Severity			
		Severe	**Medium**	**Mild**	**Minor**
Likelihood	**High likelihood**	High	High	Medium	Low
	Likely	High	Medium	Low	Low
	Low likelihood	Medium	Low	Low	Low
	Unlikely	Low	Low	Low	Low

C.3.2 The risk ratings given have been consolidated from the CIRIA C552 risk classifications as follows:

a. High: Analogous to Very High Risk or High Risk

b. Medium: Analogous to Moderate Risk

c. Low: Analogous to Moderate/Low Risk, Low Risk or Very Low Risk

Annex D Nitrogen Deposition Compensation Sites: Preliminary Risk Assessment

national highways

Lower Thames Crossing

Annex D – Nitrogen Deposition Compensation Sites Preliminary Risk Assessment

APFP Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Lower Thames Crossing

Annex D – Nitrogen Deposition Compensation Site Land Quality Desk Study

List of contents

Page number

List of plates

Page number

1 Introduction

1.1 Nitrogen deposition compensation sites

1.1.1 Changes to traffic flows arising from the operation of the Project have the potential to result in the deposition of nitrogen on nearby habitats, including sites designated for ecological conservation.

1.1.2 Mitigation measures have been identified to reduce the amount of nitrogen emitted from the Project, where necessary and practicable. Further details can be found in ES Chapter 2: Project Description (Application Document 6.1).

1.1.3 Where it has not been possible to identify appropriate mitigation measures to reduce potential significant effects from nitrogen deposition, compensation measures have instead been identified. These compensation measures have been designed to offset significant effects of nitrogen deposition once the Project is operational, by planting new compensatory habitats and enhancing existing ones.

1.1.4 As identified on the Environmental Masterplan (Figure 2.4, Application Document 6.2), eight sites have been identified for the provision of compensatory habitat planting for the Project, equating to approximately 240 hectares in total. These sites are referred to as follows, from south to north:

a. Bluebell Hill

b. Burham

c. Henhurst Hill

d. Court Wood (Shorne Woods)

e. Fenn Wood (Shorne Woods)

f. Hoford Road

g. Buckingham Hill

h. Hole Farm East

1.1.5 It is proposed that these compensation sites would have a woodland-dominated mosaic of habitats created through planting and natural regeneration including woodland, grassland and scrub; providing new wildlife-rich habitats, linked to existing habitats and improving biodiversity along new ‘green corridors’. Additional benefits would include opportunities for increasing public access to the countryside and local landscape improvements through planting.

1.1.6 The DCO application documents have not specified the design and future management regime for the habitat creation sites proposed as compensation for the effects of nitrogen deposition. The design and management regimes for these locations will be developed as part of the detailed design, in accordance with the control plan documents including the Outline Landscape Ecology Management Plan (Application Document 6.7), Design Principles (Application

Document 7.5) and the Environmental Masterplan (ES Figure 2.4: Application Document 6.2).

1.2 Methodology

1.2.1 This Annex presents available desk-based information for the proposed nitrogen deposition compensation sites. Various online sources of information have been used as well as LTC purchased data where it is available. The objectives of the desk studies are to produce a high-level conceptual site model, identifying potential pollutant linkages and a preliminary risk rating that may need to be taken into consideration in the construction and operation of the proposed nitrogen deposition compensation sites.

1.2.2 Sources of information used to undertake this baseline are provided in the references section at the end of this Annex.

1.2.3 For the purposes of this assessment, features within the study area (a buffer zone of 250m around the Order Limits) have been taken into account.

1.2.4 The following sites were visited as part of a walkover survey carried out in May 2022:

a. Bluebell Hill

b. Henhurst Hill

c. Court Wood

d. Fenn Wood

e. Hoford Road

f. Hole Farm

g. Buckingham Hill

h. Hole Farm East

1.2.5 The Burham and Buckingham Hill nitrogen deposition compensation sites were not visited during the May 2022 survey due to land access restrictions.

2 Bluebell Hill

Bluebell Hill
Approximate postcode: ME14 3EG

Plate D.1 Location of nitrogen deposition compensation site at Bluebell Hill

Description	The site is situated within a predominantly rural area, with the site comprising ploughed agricultural fields with local roads, including Bell Lane transecting the area. A compound area is located on the southern boundary of the north-western area (not part of proposed nitrogen deposition compensation site) including industrial

Bluebell Hill Approximate postcode: ME14 3EG	
	type buildings and five communication towers (“Bluebell Hill transmitting station”) dated from the 1970s Wikipedia (2022). Bluebell Hill transmitting station. Accessed July 2022. https://en.wikipedia.org/wiki/Bluebell_Hill_transmitting_station. On the northern boundary of the central section (not part of proposed nitrogen deposition compensation site) is Cossington Fields Farm North with associated buildings and a residential building, an area of this also appears to include some vehicle storage. On the northern boundary of the north-eastern section (not part of proposed nitrogen deposition compensation site) is the Westfield Sole Reservoir (covered reservoirs). A small roadway joins Bell Lane leading to an area (approximately 400m wide), which appears to be used for storage of scrap / waste, including numerous discarded vehicles and containers. The entrance to this roadway was gated off during the 2022 walkover with no visible signage. Areas of woodland are immediately to the south-west (the Wouldham to Detling Escarpment SSSI), north-west and north (beyond which is the M2). Further ploughed fields are immediately to the east and south-east. Overall, the site slopes to the south-east.
Site walkover	 Agricultural fields within the eastern part of the nitrogen deposition compensation site to the south of Bell Lane

Bluebell Hill
Approximate postcode: ME14 3EG

Fields in the north-eastern section and small buildings and transformer associated with Westfield Sole Reservoir – signage indicates that the site is managed by Southern Water. Electrical infrastructure and above ground storage tanks were observed.

Gated entrance to scrap /waste storage area north of site (not in the nitrogen deposition compensation site) – no drainage or interceptor was observed.

Bluebell Hill
Approximate postcode: ME14 3EG

Tyres and other waste material along Bell Lane to the north of the nitrogen deposition compensation site

Small cluster of masts (Bluebell Hill Freeview Transmitter) visible from south-east corner of the westernmost field.

Bluebell Hill Approximate postcode: ME14 3EG	
	 Mound of stockpiled earth close to intersection of Bell Lane and driveway to farm in the north of site.
Geology	Clay-with-flints Formation (clay, silt, sand and gravel). The dominant lithology is orange-brown and red-brown sandy clay with abundant nodules and rounded pebbles of flint, underlain by the Lewes Nodular Chalk Formation. British Geological Survey (2022). Geology of Britain viewer. Accessed July 2022. www.bgs.ac.uk/data/mapViewers/home.html. British Geological Survey (2022). BGS maps portal. Accessed July 2022 https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ The Wouldham to Detling Escarpment is a 311 hectare biological and geological Site of Special Scientific Interest (SSSI) within the Kent Downs Area of Outstanding Natural Beauty. This SSSI is located adjacent to the south-western boundary of the area. Overall, the SSSI extends for 10km along the chalk scarp of the North Downs east of the River Medway. The geological interest of this SSSI occurs in the Upper and Lower Culand Pits, which are located approximately 1.3km to the west of the area. The sequence of Chalk in these pits contains rich and diverse collections of fossil fish that are reported as superbly preserved and as such have been the subject of much scientific research. *Source: Natural England (2022) Designated Sites View. Accessed July 2022 https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1001339.pdf via https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1001339&SiteName=wouldham&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=*

Bluebell Hill Approximate postcode: ME14 3EG	
Hydrogeology	The Clay-with-flints Formation is classified as unproductive aquifer. The Lewes Nodular Chalk Formation is a Principal aquifer. The area is within a Zone 3 Total Catchment source protection zone. The closest Zone 1 inner protection zones are located approximately 870m to the south-east and 1km to the south-west. No known Environment Agency licenced groundwater abstractions are recorded within 250m of the nitrogen deposition compensation site. *Source: Natural England (2022) MAGIC https://magic.defra.gov.uk/ accessed July 2022 and LTC Environment Viewer (Landmark, 2019).*
Hydrology	No statutory main rivers are identified within 1km of the proposed area. The Westfield Sole Reservoir (covered reservoirs) are located on the northern boundary of the north-eastern section of the proposed area. A balancing pond is located approximately 115m to the north west of the proposed area. No known Environment Agency licenced surface water abstractions are recorded within 250m of the nitrogen deposition compensation site. *Source: Environment Agency Main River map (Environment Agency 2022). Accessed July 2022 https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386* and *Landmark (2019).*
Historical mapping	1892 – 1908 west is agricultural fields, including Cossington Fields, east is mainly woodland with agricultural fields to the east, including Westfield Wood. Buildings are shown at the location of Cossington Fields Farm North. 1842 – 1952 the overall land use is similar, though Westfield Wood has extended to the east. A series of clay pits are shown approximately 150m to 200m to the west of the area. A series of chalk pits (with kilns) are shown beyond these, the closest is approximately 380m to the west. 1937 – 1961 overall the site land use remains the same. The Bluebell Hill transmitting station is now labelled as WT Station with associated masts. 1949 – 1970 overall the site land use remains the same. The clay pits to the west are no longer shown. Works and depot associated with the chalk pits are labelled. *Source: National Library of Scotland (2022). Map Images. Accessed July 2022. https://maps.nls.uk/*
Environmental datasets	The site check performed via the Multi-agency Geographic Information for the Countryside (MAGIC) site check tool was utilised https://magic.defra.gov.uk/ accessed 16 February 2022 shows the Wouldham to Detling SSSI is located adjacent to the area beyond the south-west boundary. Frith Wood historic landfill is located approximately 250m southwest of the nitrogen deposition compensation site and was licenced for inert waste between November 1992 and surrender in December 2000. Given the fill type, age and

Bluebell Hill Approximate postcode: ME14 3EG	
	distance this is not considered to have a credible risk of impact on the subject site. *Source: Landfill https://groundsure.io/ accessed 16 February 2022 and DEFRA historic landfill sites GIS layer*
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Plate D.2 Bluebell Hill Potential Sources of Contamination** 

	Proposed works a. Fencing / securing site (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing. c. Tree planting d. Grassland sowing e. Utility works unknown **Potential sources of contamination** Whilst considered unlikely and limited, potential localised contaminant sources are considered to include: a. Cossington Fields Farm North (petroleum hydrocarbons, PAH, metals, inorganics, pesticides, asbestos, ammoniacal nitrogen and hazardous gases). b. Area (approximately 400m wide) off Bell Lane to the north used for storage of scrap / waste (metals, petroleum hydrocarbons, PAH, inorganics, phenols, VOC, SVOC, hazardous gases and asbestos) c. Westfield Sole Covered reservoir (localised contaminant source of petroleum hydrocarbons and polychlorinated biphenyls (PCBs). d. Bluebell Hill Transmitting Station (petroleum hydrocarbons, polychlorinated biphenyls (PCBs). **Potential pathways** Potentially active pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been an agricultural field since the earliest available historical mapping and as such on-site contamination is not expected. The identified off-site sources of contamination are considered unlikely to pose a risk of contamination to the site. Should unexpected contamination be encountered, implementation of standard protocols including watching briefs

Bluebell Hill Approximate postcode: ME14 3EG	
	during earthwork activities and (GS028), materials (GS006) and soil (GS009-GS014) management procedures, as secured through the Register of Environmental Actions and Commitments (REAC), would be sufficient to manage potential risks resulting from existing contamination. The site is considered to be a low risk in the context of the proposed nitrogen deposition compensation site.

3 Burham

Burham
Approximate postcode: ME1 3SW

Plate D.3 Location of nitrogen deposition compensation site at Burham

Description	The site comprises agricultural fields and is situated within a semi-rural area to the south-east of Burham Village accessible via a trackway off Rochester Road. Residential properties are located adjacent to the site to the south-west. The proposed nitrogen deposition compensation site is bordered to the northeast by Bluebell Hill Hiking area on the site of Upper Culand chalk Pit and to the south by

Burham Approximate postcode: ME1 3SW	
	the remains of Lower Culand Pit. Overhead lines are visible running across the northeast portion of the site. Overall the site slopes to the south west.
Walkover	Not undertaken.
Geology	The nitrogen deposition compensation site is underlain by the Zig Zag Chalk Formation and West Melbury Marly Chalk Formation (both part of the Grey Chalk subgroup). Superficial head Quaternary head deposits are mapped along several valleys which lie north east/south west throughout the area. Sources: Online BGS Geology of Britain viewer https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/ and BGS maps portal https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ Accessed July 2022. *British Geological Survey (2022). Geology of Britain viewer. Accessed July 2022. www.bgs.ac.uk/data/mapViewers/home.html.* *British Geological Survey (2022). BGS maps portal. Accessed July 2022 https://www.bgs.ac.uk/information-hub/bgs-maps-portal/*
Hydrogeology	The Zig Zag Chalk Formation and West Melbury Marly Chalk Formation are classified as the Principal bedrock aquifer. The areas of superficial drift are designated as a Secondary (undifferentiated) superficial aquifer. The area is not mapped within any Source protection zones and the nearest Environment Agency abstraction points are located at least 1km south-east of the study area. Source: Online https://magic.defra.gov.uk/ accessed July 2022.
Hydrology	The nearest main river is located 800m south west of the study area and there are no statutory main rivers or statutory surface water features mapped within 1km. *Environment Agency Main River map (Environment Agency 2022). Accessed July 2022 https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386*
Historical mapping (online sources)	1864 – the nitrogen deposition compensation site is mapped as part of Kewland farm with several buildings located in the southern edge of the site and the south corner partially planted with trees and a small pond. The land is bordered to the north by a trackway and the surrounding land is fields crossed by marked pathways. 1895 – the farm on site is now labelled as Great Culand and has had minor changes to building layouts. A tunnel with air shafts is marked through the centre of site running northeast/southwest. Two chalk pits have opened the land to the north east and the tunnel is for a tramway connecting the chalk and Burham Brick, lime and cement works to the west. A magazine building is located on the northeast border of the study area. 1907 – expansion of the chalk pits. 1933 – minor changes to building layouts and landscape on site. Land to the north-east of site is now marked as Old Chalk Pit – tram lines have been partially

Burham
Approximate postcode: ME1 3SW

removed and vegetation growth is indicated. An additional chalk pit has been opened on the land across the road to the south of the study area and minor excavation has been done on the land surrounding the tramway to the southwest.

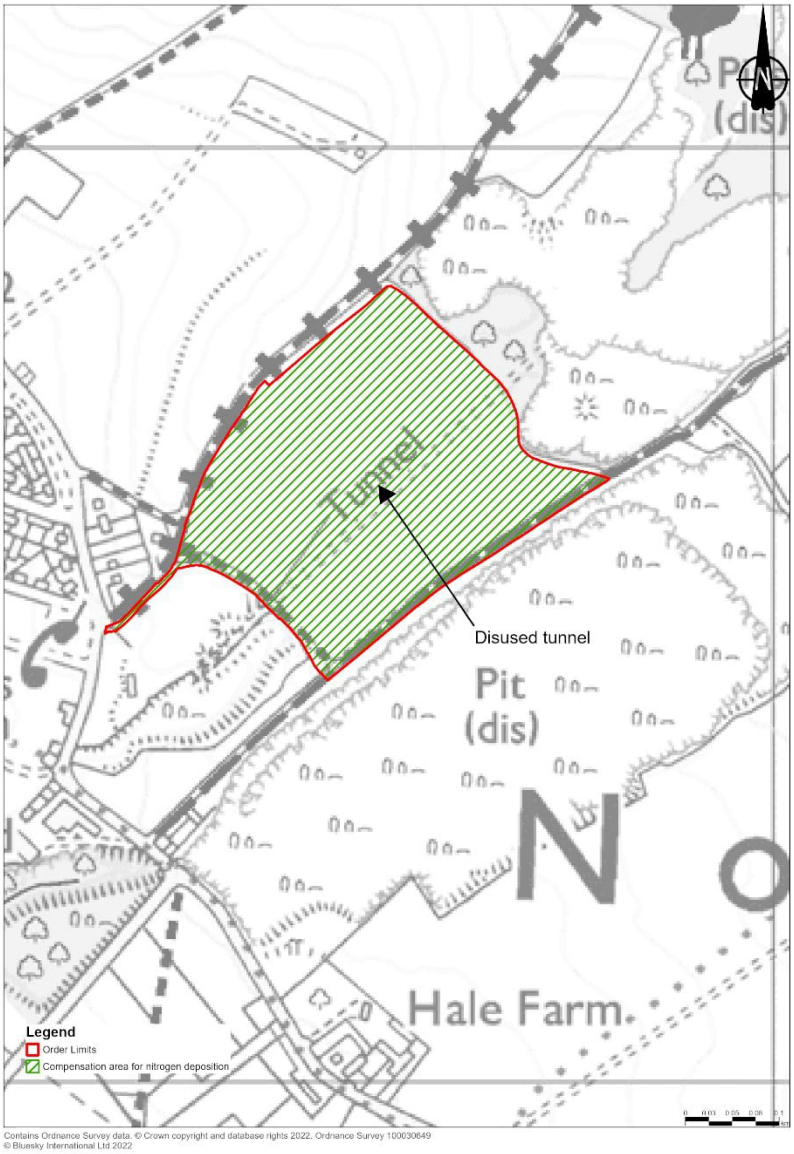
1939 – expansion of the chalk pit to the south of the site, construction of houses on land to the east of site along Rochester Road.

By 1960 – farm on site marked as Great Culand (site of). Both chalk pits are marked as Old Chalk Pit

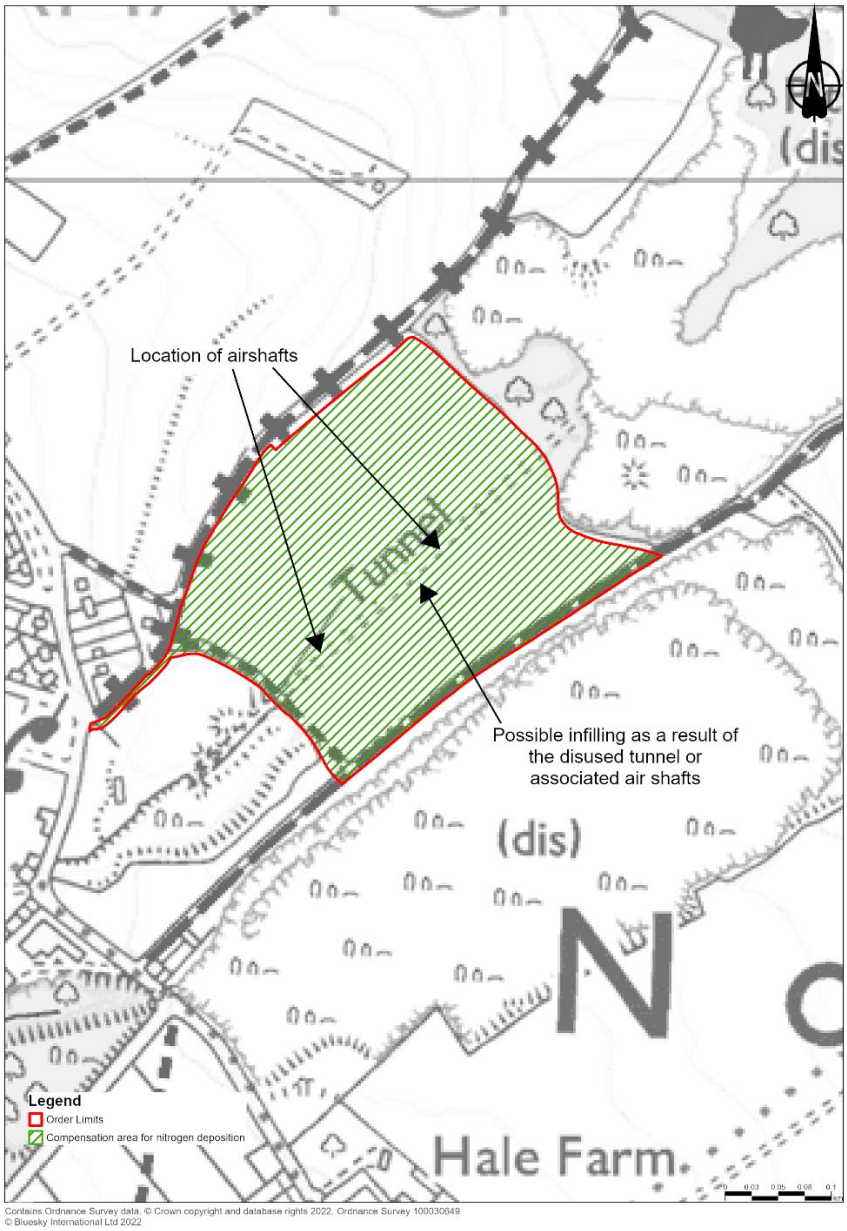
1960 onwards – at some point the pond in the southern corner of site has been infilled and the farm buildings demolished.

The historical and current OS maps indicate an abandoned tramway tunnel running northeast/southwest through the centre of the site, see mapping extract below (Esri, Maxar, Earthstar Geographics, and the GIS User Community, 2022).

Plate D.4 Location of disused tunnel



Burham Approximate postcode: ME1 3SW	
Environmental datasets	The review performed via the MAGIC site check tool was utilised shows Upper Culand Pit adjacent to the northeast boundary and Lower Culand Pit to the south as part of the Wouldham to Detling escarpment (biological) SSSI. The area is also within the Kent Downs Area of Outstanding Natural Beauty. Culand Pit is indicated as the closest licenced historical landfill approximately 460m south. The licence was issued in January 1976 and expired in December 1976. No further details could be found. Source: https://magic.defra.gov.uk/ accessed July 2022 Landfill https://groundsure.io/ accessed July 2022 and DEFRA historic landfill sites GIS layer
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.

Burham Approximate postcode: ME1 3SW	
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Plate D.5 Burham – Attwood's nitrogen deposition compensation site potential sources of contamination**  **Proposed works** a. Fencing / securing site (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing c. Tree planting d. Grassland sowing e. Utility works unknown

Burham Approximate postcode: ME1 3SW	
	Potential sources of contamination Possible infilling may be present as a result of the disused tunnel or associated air shafts where excavations may have been undertaken and backfilled. The nature of the fill material is unknown and may have included contaminated material, although any degradable material or organic contaminants are likely to have substantially degraded since filling occurred precluding it as a gas generating source. **Potential pathways** Potentially active pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** There is the potential for infilled ground related to the tunnel and infrastructure. Whilst unlikely if any localised impacts are present that may be disturbed by proposed ground works or should unexpected contamination be encountered, implementation of standard protocols including watching briefs during earthwork activities and (GS028), materials (GS006) and soil (GS009-GS014) management procedures, as secured through the Register of Environmental Actions and Commitments (REAC), would be sufficient to manage potential risks resulting from existing contamination. The site is considered to be a low risk in the context of the proposed nitrogen deposition compensation site.

4 Henhusrt Hill

Henhurst Hill
Approximate postcode: DA12 3AN

Plate D.6 Location of nitrogen deposition compensation site at Shorne Woods, Henhurst

Description	The site comprises ploughed agricultural fields and is situated within a predominantly rural area surrounded by agricultural fields to the north and west. Henhurst Road is located to the east with a parking area and café building associated with Jeskyns Community Woodland beyond. A cluster of residential

Henhurst Hill Approximate postcode: DA12 3AN	
	properties are located off the south east corner of the nitrogen deposition compensation site, along Henhurst Road. An electricity pylon is located in the south west corner of the nitrogen deposition compensation site, with overhead cables running south west to east across the lower portion of the nitrogen deposition compensation site. Overall the site slopes to the west. Watling Street, the A2 is located approximately 430m to the north, with the town of Singlewell to the north of the A2. High Speed 1 (HS1), or the Channel Tunnel Rail Link (CTRL) runs to the south of the A2 approximately 260m to the north of the nitrogen deposition compensation site. The Singlewell Infrastructure Maintenance Depot is also present immediately to the south of the A2.
Walkover	 View of southwest corner of nitrogen deposition compensation site from Henhurst Road showing location of electrical pylons 

Henhurst Hill Approximate postcode: DA12 3AN	
	Northern boundary of site from corner of Church Rd and Henhurst Road – both roads were observed to be in good condition with kerb border and no visible stains or spills  Singular discarded tyre was the only significant waste observed on the site.
Geology	There are no mapped superficial deposits with the exception of the south west corner, which is underlain by Head (clay, silt, sand and gravel). This is further underlain by the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated). The remainder and majority of the nitrogen deposition compensation site is underlain by the Thanet Formation, silty fine-grained sand, with sandy silt, silt or sandy, silty clay. Source: Online BGS Geology of Britain viewer https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/ and BGS maps portal https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ Accessed 21 February 2022.
Hydrogeology	The Head mapped in the south west corner is classified as a Secondary (undifferentiated) aquifer. The Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation in this portion of the nitrogen deposition compensation site is classified as a Principal aquifer. The Thanet Formation is a Secondary A aquifer. The nitrogen deposition compensation site is within a Zone 3 Total Catchment source protection zone. Source: Online https://magic.defra.gov.uk/ accessed 21 February 2022.
Hydrology	No statutory main rivers are identified within 1km of the proposed nitrogen deposition compensation site. Henhurst Lake is located approximately 460m to the south east of the nitrogen deposition compensation site.

Henhurst Hill Approximate postcode: DA12 3AN	
	The area in the centre of Jeskyns Country Park Car Park approximately 50m east of the proposed area has been indicated as a swamp and location of potential Groundwater Dependent Terrestrial Ecosystems through field-based assessments carried out by the LTC Environment Team. Source: Environment Agency Main River map (Environment Agency 2022). Accessed July 2022 https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386
Historical mapping	The National Library of Scotland was accessed to review available online Ordnance Survey (OS) mapping. 1892 – 1908 the nitrogen deposition compensation site comprises open fields, with Henhurst Road to the east. Building outlines are shown off the south east corner of the nitrogen deposition compensation site. 1841 – 1952 there is no change to the site use, a smithy is labelled at the buildings to the south east corner. 1937 – 1961 there is no change to the site use. The smithy is no longer labelled as such. By 1944, mapping shows it to be part of Henhurst Cottages. 1945 – 1965 there is no change to the site use. 1949 – 1970 there is no change to the site use. Source: National Library of Scotland https://maps.nls.uk/ accessed 28 February 2022
Environmental datasets	The review of the MAGIC site check tool shows no datasets recorded of relevance to the study area. No recorded historic or authorised landfills were identified within 1km of the nitrogen deposition compensation site. Source: https://magic.defra.gov.uk/ accessed 28 February 2022 Landfill https://groundsure.io/ accessed 16 February 2022
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Proposed works** a. Fencing / securing site (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing c. Tree planting d. Grassland sowing e. Utility works unknown **Potential sources of contamination** No likely on-site sources of contamination associated with the nitrogen deposition compensation site's historic or current land use have been identified.

Henhurst Hill Approximate postcode: DA12 3AN	
	Potential pathways Potential pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been an agricultural field since the earliest available historical mapping and as such on-site contamination is not expected. The identified off-site sources of contamination are considered unlikely to pose a risk of contamination to the site. Should unexpected contamination be encountered, implementation of standard protocols including watching briefs during earthwork activities and (GS028), materials (GS006) and soil (GS009-GS014) management procedures, as secured through the Register of Environmental Actions and Commitments (REAC), would be sufficient to manage potential risks resulting from existing contamination. The site is considered to be a low risk in the context of the proposed nitrogen deposition compensation site.

5 Fenn Wood (Shorne woods)

Fenn Wood (Shorne Woods)
Approximate postcode: DA12 3HH

Plate D.7 Location of nitrogen deposition compensation site at Fenn Wood

Description	The nitrogen deposition compensation site is an open parcel of land surrounded by woodland, located off the north east corner of Shorne Woods Country Park. Residential properties off Woodlands Lane are located on the eastern boundary. Overall the site slopes to the north east.

Fenn Wood (Shorne Woods) Approximate postcode: DA12 3HH	
Walkover	 Due to access limitations only the southwest corner of site was visible during the walkovers. It is grass-covered with trees around the perimeter and appears to have been used for grazing animals.  Discarded IBC cage in southeast corner of site

Fenn Wood (Shorne Woods) Approximate postcode: DA12 3HH	
	 Household waste bin storage in access route leading to site from Woodlands Lane
Geology	No superficial deposits are mapped. The Harwich Formation (sand and gravel) is mapped underlying the majority of the site. The Lambeth Group (sand, silt and clay) is mapped on the north and north east boundary of the nitrogen deposition compensation site. Source: British Geological Survey (2022). Geology of Britain viewer. Accessed July 2022. www.bgs.ac.uk/data/mapViewers/home.html. British Geological Survey (2022). BGS maps portal. Accessed July 2022 https://www.bgs.ac.uk/information-hub/bgs-maps-portal/
Hydrogeology	The site is situated on a Secondary A Aquifer. The majority of the site is not mapped within a source protection zone. The south-east corner is mapped to be on the edge of a Zone 3 Total Catchment. Source: Defra (2022) MAGIC. Accessed July 2022. https://magic.defra.gov.uk/
Hydrology	No statutory main rivers are identified within 1km of the proposed area. An watercourse, flowing to the north, is mapped off the east of the nitrogen deposition compensation site. A drain running south-west north-east is also mapped off the north boundary of the nitrogen deposition compensation site. Both are classified as Ordinary Watercourses. A small water feature (pond / lake) is mapped adjacent to the north west corner and another on the northern boundary. There are a number of issues, drains and lakes associated with Shorne Wood Country Park. Source: Environment Agency Main River map (Environment Agency 2022). Accessed July 2022 https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386

Fenn Wood (Shorne Woods) Approximate postcode: DA12 3HH	
Historical mapping	1892 – 1908 the nitrogen deposition compensation site is open fields, with Randall Wood on the south-west boundary and Shorne is to the north east. A smithy (later labelled Overblow House) is approximately 37m to the north east. 1841 – 1952 a gravel pit is located approximately 285m to the north. An old gravel pit is located approximately 230m to the east. 1937 – 1961 the site land use remains the same. 1949 – 1970 overall the site land use remains the same. A gravel pit is mapped approximately 50m to the north. Source: National Library of Scotland (2022). Map Images. Accessed July 2022. https://maps.nls.uk/
Environmental datasets	A review of the online MAGIC site check tool shows the woods to the east, the Shorne and Ashenbank Woods to be a SSSI (biological). Historic landfill datasets show no recorded historic or authorised landfills within 1km. Source: https://magic.defra.gov.uk/ accessed 1 March 2022 https://groundsure.io/ accessed 1 March 2022
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Proposed works** a. Fencing / securing site (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing c. Tree planting d. Grassland sowing e. Utility works unknown **Potential sources of contamination** No likely on-site sources of contamination associated with the nitrogen deposition compensation site's historic or current land use have been identified. **Potential pathways** Potential pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors**

Fenn Wood (Shorne Woods) Approximate postcode: DA12 3HH	
	Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been an agricultural field since the earliest available historical mapping and as such on-site contamination is not expected. The site is considered to be a low risk in the context of the proposed nitrogen deposition compensation site.

6 Court Wood (Shorne Woods)

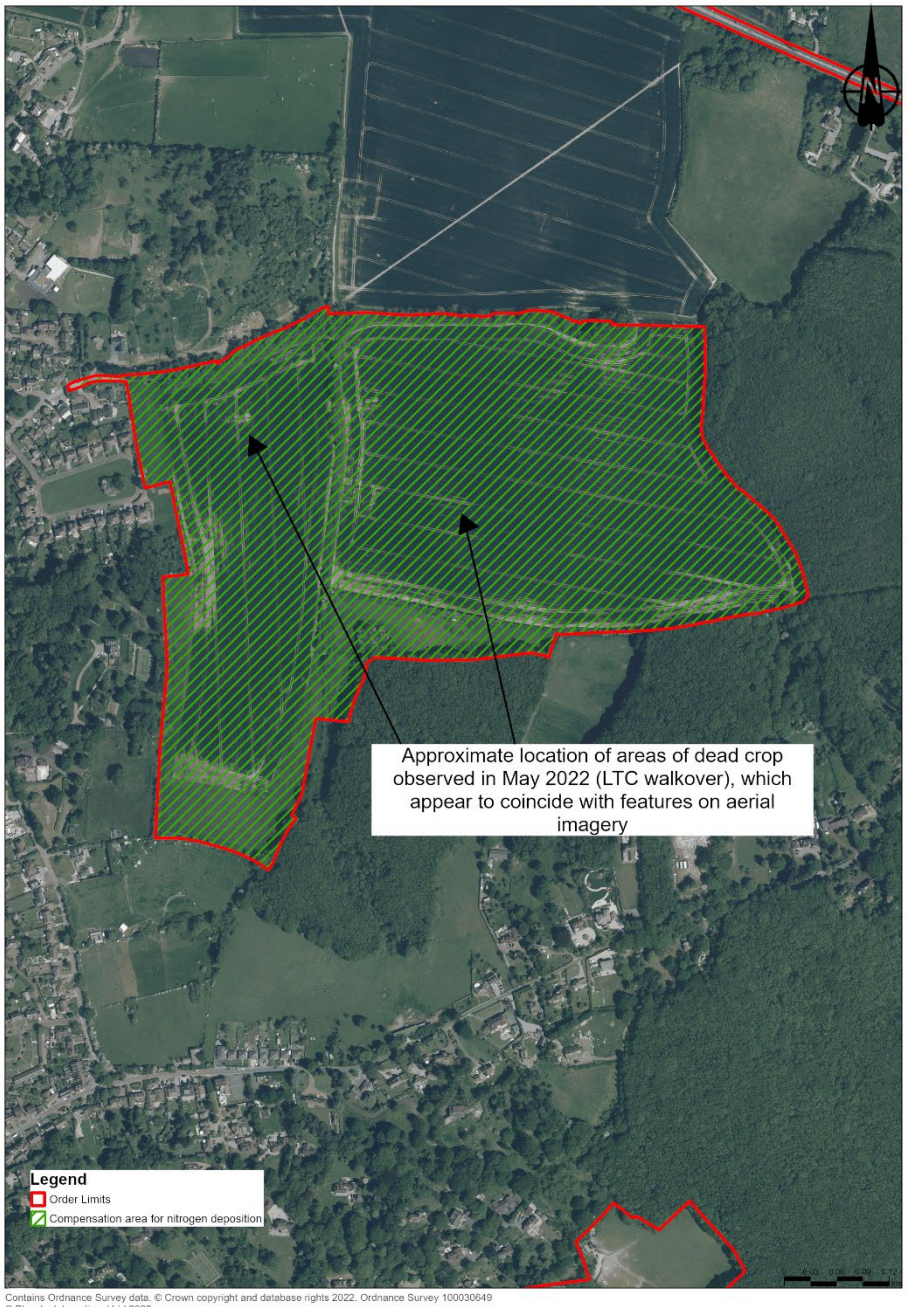
Court Wood (Shorne Woods)
Approximate postcode: DA12 3ED

Plate D.8 Location of nitrogen deposition compensation site at Court Wood

Description	The site comprises ploughed agricultural fields. The village of Shorne is to the west, further fields to the north and woodland to the east and south. Overall the site slopes to the north east. During the site walkover in May 2022, a number of areas of dead crop were noted, the approximate location of these are shown on Plate 9. No obvious explanation for these areas has been established, although the areas are visible on aerial imagery (Earthstar Geographics, 2022).

Court Wood (Shorne Woods)
Approximate postcode: DA12 3ED

Plate D.9 Location of areas of crop impact



Walkover	Walkover:  Western agricultural field crossed by telecoms lines (note area of dead crop adjacent to overhead pylon)  Fallow southern end of western agricultural field crossed by overhead telecommunication lines

Eastern agricultural field from southeast corner.

Some evidence of small-scale historic quarrying activity noted in the forested area to the north eastern corner of the site. Mapping data indicates that the area currently contains a small pond – this was not visible due to mature vegetation.

Court Wood (Shorne Woods) Approximate postcode: DA12 3ED	
	 High water level was noted in the drainage ditch along the northern border of both fields (photo taken at intersection of the western and eastern field)  Offsite to the northern boundary parked plant and waste or stored equipment/furniture/tyres were observed but could not be investigated further due to land access constraints.
Geology	No superficial deposits are mapped. The central portion of the nitrogen deposition compensation site is underlain by the Thanet Formation (sand, silt and clay). The northern portion is underlain by the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated), the south-west portion is underlain by the Lambeth Group (sand, silt and clay) and the furthermost south west corner of the site is mapped as underlain by the Harwich Formation (sand and gravel). Source: Online BGS Geology of Britain viewer https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/ and BGS maps portal https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ Accessed 2 March 2022.

Court Wood (Shorne Woods) Approximate postcode: DA12 3ED	
Hydrogeology	The Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated), and the Thanet Formation are Principal Aquifers. The Lambeth Group and the Harwich Formation are Secondary A Aquifers. The areas is within a Zone 3 Total Catchment source protection zone. Source: Online https://magic.defra.gov.uk/ accessed 16 February 2022 and LTC Env viewer
Hydrology	An ordinary watercourse (stream or ditch) is mapped running alongside the north boundary of the nitrogen deposition compensation site. A small pond is marked on the northern edge of the proposed site.
Historical mapping	National Library of Scotland was reviewed for online Ordnance Survey (OS) mapping. 1892 – 1908 the nitrogen deposition compensation site is open fields, with woodland to the east and south. A smithy (later labelled Overblow House) is mapped on the west boundary. 1842 – 1952 an old gravel pit is located approximately 90m to the west (later occupied by a residential property) and an old brick works on the north boundary. An old chalk pit is mapped approximately 280m to the north east. 1937 – 1961 the site land use remains the same. 1949 – 1970 overall the site land use remains the same. Source: National Library of Scotland https://maps.nls.uk/ accessed 2 March 2022
Historical aerial images	The following is a summary of available historical aerial images from Historic England.org.uk accessed in July 2022 Aerial images dated July 1950 and August 2005 show the site to have been agricultural open land.
Environmental datasets	No recorded historic or authorised landfills are recorded within 1km. Source: https://groundsure.io/ accessed 2 March 2022
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Proposed works** a. Fencing / securing site (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing c. Tree planting d. Grassland sowing e. Utility works unknown

Court Wood (Shorne Woods) Approximate postcode: DA12 3ED	
	Potential sources of contamination No likely on-site sources of contamination associated with the nitrogen deposition compensation site's historic or current land use have been identified. **Potential pathways** Potential pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been an agricultural field since the earliest available historical mapping and as such on-site contamination is not expected. During the site walkover in May 2022, however a number of areas of dead crop were noted, the approximate location of these is shown on Plate 9. No clear rationale for these areas has been established from desk-based work and will therefore be investigated further. The site will be subject to detailed design to determine the most appropriate ecological features for the site, the measures for which are set out in the Outline Landscape and Ecology Management Plan (oLEMP), Application Document 6.7. The site is considered to be a low – medium risk in the context of the proposed nitrogen deposition compensation site. It should be noted that medium risk is associated with localised uncertainties.

7 Hoford Road

Hoford Road
Western site owned by Seventyholds Ltd.
Approximate postcode: RM16 3DT

Plate D.10 Location of nitrogen deposition compensation site at Hoford Road

Description	The majority of the nitrogen deposition compensation site is agricultural fields. A large portion of the western half is open land with clusters of shrub / woodland. The Orsett Golf Course is adjacent to the north and west of the nitrogen deposition compensation site. To the south is further agricultural fields, and a strip of woodland. The Rainbow Shaw Quarry Landfill (HLU0825) is located adjacent to

<table>
<tr><td colspan="2">Hoford Road
Western site owned by Seventyholds Ltd.
Approximate postcode: RM16 3DT</td></tr>
<tr><td></td><td>the east of the nitrogen deposition compensation site. Linford Quarry Landfill (HLU0816) and a precast concrete works operated by Tarmac Building Products Limited (HLU0818) are located approximately 270m to the east beyond Rainbow Shaw Quarry. Overall the site slopes to the south east.</td></tr>
<tr><td>Walkover</td><td>Walkover:
 
View across both agricultural fields of the nitrogen deposition compensation site from the Rainbow Shaw Quarry Landfill (HLU0825) to the southeast.</td></tr>
</table>

Hoford Road Western site owned by Seventyholds Ltd. Approximate postcode: RM16 3DT	
	 Vehicles and tyres associated with Rainbow Shaw Quarry Landfill (HLU0825) visible from Hoford Road
Geology	Superficial deposits include Head (clay, silt, sand and gravel) mapped underlying the eastern half of the nitrogen deposition compensation site, as well as a lens running north-south near the western boundary Limited outcrop of Black Park Gravel Member (sand and gravel) is also mapped, on the western boundary and a lens running north-south in the centre of the nitrogen deposition compensation site. The nitrogen deposition compensation site is further underlain by the Lambeth Group (clay, silt and sand) in the west and the Thanet Formation (sand) in the east. Source: Online BGS Geology of Britain viewer https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/ BGS maps portal https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ Accessed 3 March 2022.

Hoford Road Western site owned by Seventyholds Ltd. Approximate postcode: RM16 3DT	
Hydrogeology	The Head is classified as a Secondary Aquifer – Undifferentiated and the Black Park Gravel Member a Secondary A Aquifer. The Lambeth Group and the Thanet Formation are Secondary A Aquifers. The areas is within a Zone 3 Total Catchment source protection zone. The closest Zone 1 inner protection zone (relating to the Linford abstraction) is located approximately 815m to the south east. A record for an Environment Agency licenced groundwater abstraction for the Orsett Golf Course for spray / irrigation is located approximately 350m to the north of the nitrogen deposition compensation site. An Environment Agency Monitoring borehole in the chalk aquifer is located 300m west, though not licenced for abstraction. Source: LTC Env Viewer and Online https://magic.defra.gov.uk/ accessed July 2022.
Hydrology	An Environment Agency designated main river is approximately 80m to the south, flowing west to east. A large pond (possibly settlement / balancing pond) between the pre-cast concrete works and Linford Quarry is located approximately 215m to the south east. Source: Defra Statutory main rivers map and The Environment Agency Main River map https://www.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386, accessed July 2022.
Historical mapping (online sources)	1892 – 1908 shows the nitrogen deposition compensation site to be open land surrounded by a number of farms. An area of marshland (Mucking Heath) is mapped adjacent to the north-west of the nitrogen deposition compensation site. Woodland, Rainbow Wood, (later labelled as gravel pits) is mapped adjacent to the east. 1842 – 1952 the overall land use is similar, though the Mucking Heath marshes now extends into the north-west portion of the nitrogen deposition compensation site. A gravel pit is now mapped approximately 130m to the east of the nitrogen deposition compensation site. 1937 – 1961 the overall land use is similar, the gravel pit has now expanded, and more extensive sand and gravel pits are mapped to the east and south-east of Rainbow Wood. 1949 – 1970 the overall land use is similar, the portion of marshes in the north-west portion is now mapped as scrub. Orsett Golf Course is now mapped to the north-west and west of the nitrogen deposition compensation site. Source: National Library of Scotland https://maps.nls.uk/ accessed 7 March 2022 to review available online Ordnance Survey (OS) mapping.
Historical aerial images	The following is a summary of available historical aerial images from HistoricEngland.org.uk accessed in July 2022 Aerial images dated July 1951 show the site to have been ploughed agricultural fields and the north-west portion scrub. Orsett Golf Course is to the north-west

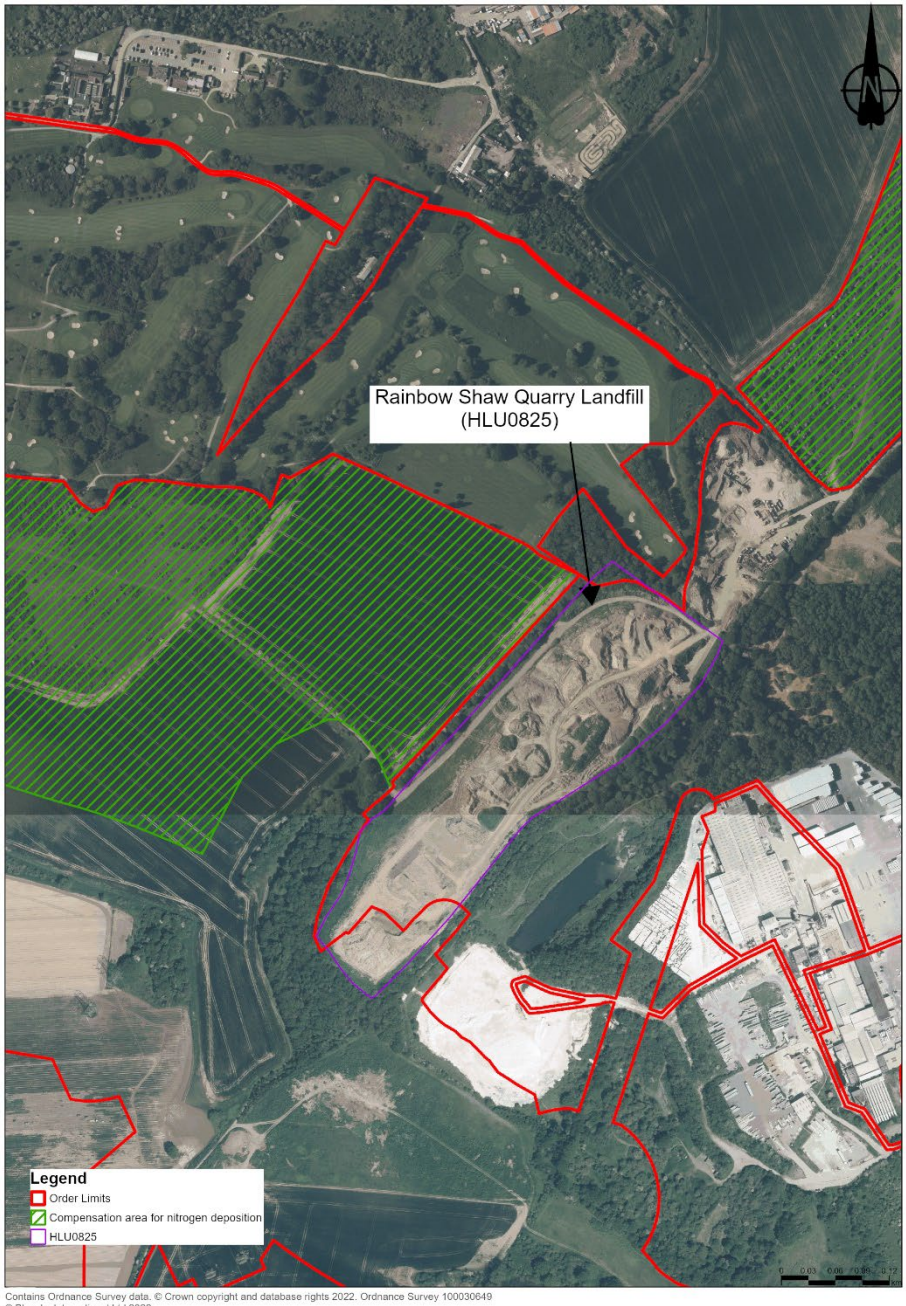
Hoford Road Western site owned by Seventyholds Ltd. Approximate postcode: RM16 3DT	
	and west of the nitrogen deposition compensation site. Rainbow Wood is to the south-east and the land to the east of site is forested or scrubland. Images from August 2005 show the expansion of the Rainbow Shaw Quarry Landfill and the precast concrete works (with several tanks).
Environmental datasets	The Rainbow Shaw Quarry Landfill (HLU0825) is located adjacent to the east of the nitrogen deposition compensation site, registered as a licensed waste management facility in 2006. The licence was issued to Clearserve Ltd and classed as L05: Inert Landfill. The licence appears to still be active and current aerial imagery confirms. Linford Quarry Landfill (HLU0816) and a precast concrete works operated by Tarmac Building Products Limited (HLU0818) are located approximately 270m to the east beyond Rainbow Shaw Quarry. Two landfill licence records are associated with Linford Quarry Landfill – one for a landfill classed as A7: Industrial landfill (factory curtilage) and is now recorded as being expired, the second is active and was issued to Tarmac Building Products Ltd in 2006. The licence is for a landfill classed as L05: Inert landfill. The site also holds a licence for physical treatment facilities which was issued to Clearserve Ltd in 1997. The licence appears to still be active, but no further details are available (Landmark, 2019). The precast concrete works is operated by Tarmac Building Products Limited. Durox aircrete blocks are manufactured at the site from PFA, sand, cement, aluminium powder, lime and water.
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating in the south east rising to a Moderate UXO hazard rating in the north west.

Hoford Road
Western site owned by Seventyholds Ltd.
Approximate postcode: RM16 3DT

Preliminary Risk Assessment

Preliminary Conceptual Site Model

Plate D.11 Hoford Road nitrogen deposition compensation site potential sources of contamination



Proposed works:

a. Fencing / securing site (stock fencing site and metal fence for compounds / building sites) (stock fencing perimeter)
b. Limited groundworks e.g. deep ploughing

Hoford Road Western site owned by Seventyholds Ltd. Approximate postcode: RM16 3DT	
	c. Tree planting d. Grassland sowing e. Utility works unknown **Potential sources of contamination** Whilst considered unlikely and limited, potential contaminant sources are considered to include: a. Rainbow Shaw Quarry Landfill (HLU0825) is located adjacent to the east of the nitrogen deposition compensation site. Potential contaminants associated with this HLU are considered to include inorganics, metals, asbestos and hazardous gases. **Potential pathways** Potentially active pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres d. migration of landfill gas (resulting in low oxygen levels or anaerobic conditions in root zone) Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been open land surrounded by a number of farms, and the majority of the site is now agricultural fields. Mucking Heath marshes extended into the north west portion of the nitrogen deposition compensation site, this portion now appears to be scrub land. The adjacent Rainbow Shaw Quarry may pose a potential source of contamination, with the potential for landfill gas to migrate onto the nitrogen deposition compensation site (which may result in potential impact on crops) and wind blown dust to migrate onto the site (which may result in localised contamination of soils). It is recommended that these uncertainties be investigated further. Review of aerial imagery shows no visible signs of crop issues. Given no enclosed or confined spaces are proposed for the nitrogen deposition

Hoford Road Western site owned by Seventyholds Ltd. Approximate postcode: RM16 3DT	
	compensation site, this is not considered to be a potential risk to human health. Any utility works included may pose a risk to future operations staff (maintenance and utilities engineers) due to gas accumulation via migration. Should unexpected contamination be encountered, implementation of standard protocols including watching briefs during earthwork activities and (GS028), materials (GS006) and soil (GS009-GS014) management procedures, as secured through the Register of Environmental Actions and Commitments (REAC), would be sufficient to manage potential risks resulting from existing contamination. The site is considered to be a low to medium risk (localised medium risk associated with adjacent Rainbow Shaw Quarry Landfill) in the context of the proposed nitrogen deposition compensation site. The site has been assessed with a Moderate UXO hazard rating in the north west. Appropriate mitigation measures would be required in accordance with the Zetica (2022) UXO risk assessment, presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3).

8 Buckingham Hill

Buckingham Hill

Approximate postcode: SS17 0PR

Plate D.12 Location of nitrogen deposition compensation site at Buckingham Hill

Description	The nitrogen deposition compensation site is Buckingham Hill Landfill (HLU0864), an elongated area of open land / scrub, with Buckingham Hill Road along the east boundary. The Linford Civic Amenity Site is located to the north east on the boundary of the nitrogen deposition compensation site. An area that appears to be used for the storage of scrap is also located further north of this, adjacent to the north-east corner of the nitrogen deposition compensation site. Agricultural fields are adjacent to the west and north. Rainbow Shaw Quarry is located to the south-west of the nitrogen deposition compensation site. Further land used for extraction is located to the south-east of the nitrogen deposition compensation site (Orsett Gravel Pit). No access was available in May 2022 to undertake a walkover.
Topography	The site undulates, with two elevated areas, in the north and south.
Geology	The site is a former sand and gravel pit infilled with household waste and as such no superficial deposits are present at the nitrogen deposition compensation site. Head deposits (clay, silt, sand and gravel) are mapped immediately to the west, a thin transect of the Black Park Gravel Member (sand

Buckingham Hill Approximate postcode: SS17 0PR	
	and gravel) is mapped immediately to the north and east, this having been removed beyond it by neighbouring extraction activities. The majority of the nitrogen deposition compensation site is underlain by the Lambeth Group (clay, silt and sand) and a small outcrop of Thanet Formation (sand) is mapped in the south of the nitrogen deposition compensation site. The London Clay Formation is mapped at the north-east corner of the nitrogen deposition compensation site. Source: Online BGS Geology of Britain viewer https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/ and BGS maps portal https://www.bgs.ac.uk/information-hub/bgs-maps-portal/ Accessed 7 March 2022.
Hydrogeology	The surrounding Head deposits are classified as a Secondary undifferentiated aquifer and the Black Gravel Member a Secondary A aquifer. The Lambeth Group and Thanet Formation are classified as Secondary A aquifers. The London Clay is classified as unproductive. The nitrogen deposition compensation site is within a Zone 3 Total Catchment source protection zone. The closest Zone 1 inner protection zone (relating to the Linford abstraction borehole) is located approximately 1.2km to the south-east. Source: Online https://magic.defra.gov.uk/ accessed 7 March 2022.
Hydrology	No surface water features are present at the nitrogen deposition compensation site. The closest appear to be drains and a large pond (balancing / settlement) relating to the gravel extraction works (disused) to the south east of the nitrogen deposition compensation site (Orsett Gravel Pit).
Historical mapping	National Library of Scotland https://maps.nls.uk/ accessed 8 March 2022 to review available online Ordnance Survey (OS) mapping. 1892 – 1908 shows the nitrogen deposition compensation site to be open land surrounded by a number of farms. Buckingham Hill Road runs adjacent to the east of the nitrogen deposition compensation site. 1842 – 1952 the overall land use remains as before. A gravel pit is now mapped approximately 120m to the south west of the nitrogen deposition compensation site. 1937 – 1961 the northern half of the nitrogen deposition compensation site is now mapped as sand and gravel pits. A further sand and gravel pit is mapped to the east of Hoford Road (later Buckingham Hill Road). The gravel pit to the south west of the nitrogen deposition compensation site has expanded in size and further sand and gravel pits are mapped immediately to the south. 1949 – 1970 gravel pits are now mapped across the majority of the nitrogen deposition compensation site. The gravel pits to the east of Hoford Road have also extended, and associated tanks are also mapped.
Environmental datasets	Full detail of this HLU is provided in the main body of the Preliminary Risk Assessment Report (Appendix 10.6, Application Document 6.3). A summary of

Buckingham Hill Approximate postcode: SS17 0PR	
	the information relating to Buckingham Hill Landfill is provided here. The historic landfill is a former sand and gravel pit which was excavated between approximately 1949 and 1962 according to historical maps. The gravel pit was infilled with household waste from approximately 1967 to 1991 (Landmark, 2019). The landfill base is presumed to be unlined within Thanet Formation. The maximum waste depth is reported as 15m (Thurrock Council, 2020). Reports provided to National Highways from Thurrock Council gave both desk-based information and the results and assessment of gas monitoring undertaken at the landfill relating to areas of crop growth located off site to the west of the landfill reported as impacted by landfill gas. It should be noted that this investigation and the impact related to the adjacent field is not located within the nitrogen deposition compensation site site boundary although is related to the off-site migration of landfill gases. The most recent investigation (SKM Enviros, 2010) included the drilling and installation of boreholes within the landfill, along the boundary of the landfill and the adjacent Collingwood Farm field, and within the field. At the landfill, all boreholes encountered a clay cap to between 1m and 2m thickness, underlain by waste of various composition, but including sand and silt, construction waste, wood, plastics, textiles, paper, wire and ceramics. Strong landfill odours were also noted. No evidence of waste was recorded in the exploratory holes on the landfill boundary or within the field, with the recorded natural soils comprising sands, gravels, silts and clays. The results of the landfill boreholes recorded concentrations of methane up to 73% v/v and carbon dioxide to 32.3% v/v, with associated depletion in oxygen concentrations. A positive correlation between atmospheric pressure and gas concentration was evident. Elevated methane and carbon dioxide was also recorded at the field boreholes, with highest concentrations recorded in the centre part of the field boundary, correlating with zones of crop impact. Reduction in oxygen levels as a result of migration of landfill gas was concluded to be the cause of retardation of crop growth and ultimately die-back. Passive gas control by means of a vent trench was recommended to prevent future gas migration and therefore mitigate the adverse impact on crop growth. No further information has been provided to the Applicant as to any work following this 2010 report. Subsequent correspondence from Thurrock Council to the Applicant (email dated 2 August 2022) states that there appears to be no record suggesting that a gas venting trench was installed.
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.
Preliminary Risk Assessment	**Preliminary Conceptual Site Model** **Proposed works:** a. Fencing / securing site (stock fencing site and metal fence for compounds / building sites) (stock fencing perimeter) b. Limited groundworks e.g. deep ploughing c. Tree planting d. Grassland sowing

Buckingham Hill Approximate postcode: SS17 0PR	
	e. Utility works unknown **Potential sources of contamination** The primary source of contamination is the historical use of the site itself as a landfill. Potential contaminants are considered to include metals, inorganics, petroleum hydrocarbons, PAH, PFAS, phenols, ammoniacal nitrogen, asbestos, hazardous gases, VOC and SVOC. Potentially active pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres d. migration of landfill gas (resulting in low oxygen levels or anaerobic conditions in root zone) Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site is an historical landfill, known to have been investigated in terms of the impact of landfill gas on crops. It may also pose a risk to human health receptors from potential direct contact / ingestion of contaminated soil and inhalation of hazardous gases. The site would be subject to detailed design which, in accordance with the requirements set out in the OLEMP (Application Document 6.7), would avoid any adverse effects on the historical landfill. The site is considered to be a medium risk in the context of the proposed nitrogen deposition compensation site.

9 Hole Farm East

Hole Farm East
Approximate postcode: CM13 3JP

Plate D.13 Location of nitrogen deposition compensation site at Hole Farm East

Description	The nitrogen deposition compensation site comprises the agricultural fields surrounding Hole Farm with associated pockets of woodland and the buildings of Hole Farm in the centre of the nitrogen deposition compensation site (though not part of the compensatory proposals). Hole Farm Lane runs north-south through the centre of the site. Residential properties and areas of woodland are present to the north and east; agricultural fields and industrial units are to the south, with a scrap / storage yard to the immediate south. Agricultural fields are to the west, with the M25 beyond. The area adjacent to the south-east corner of the site contains buildings marked as Waterworks House, The Pump Room and Pump House Cottage. A number of industrial parks are located from approximately 180m to the south of the nitrogen deposition compensation site. Overall the site slopes to the south. Esri, Maxar, Earthstar Geographics, and the GIS User Community, 2022

Hole Farm East
Approximate postcode: CM13 3JP

Walkover

View across southernmost field from the southern boundary

Indicative condition of roads between industrial sites to the south of the nitrogen deposition compensation site. Gas pipeline marker and indications of buried services across Codham Hall Lane to the south of site

Hole Farm East
Approximate postcode: CM13 3JP

Cars parked on land just off site of the nitrogen deposition compensation site in the eastern corner - potentially unused or scrap vehicles

View across Hole Farm from the southernmost corner.

Hole Farm East Approximate postcode: CM13 3JP	
	 Warehouse/storage unit off-site to the south looks to be organised with good site housekeeping.
Geology	The majority of the southern two thirds of the nitrogen deposition compensation site is underlain by Head (clay, silt, sand and gravel), there are some pockets where no superficial deposits are mapped, the majority of the northern third has no superficial deposits mapped, with the exception of one lens of Head. The majority of the nitrogen deposition compensation site is further underlain by the London Clay Formation, with the exception of the southernmost portion which is underlain by the Claygate Member (clay, silt and sand). Source: British Geological Survey (2022). Geology of Britain viewer. Accessed July 2022. www.bgs.ac.uk/data/mapViewers/home.html. British Geological Survey (2022). BGS maps portal. Accessed July 2022 https://www.bgs.ac.uk/information-hub/bgs-maps-portal/
Hydrogeology	The Head deposits are classified as a Secondary undifferentiated aquifer and the Black Gravel Member a SecondaryA aquifer. The Claygate Member is classified as a Secondary A aquifer. The London Clay is classified as unproductive. The nitrogen deposition compensation site is within a Zone 3 Total Catchment source protection zone. The closest Zone 1 inner protection zones are located approximately 8.7km to the south. Source: Natural England (2022) MAGIC https://magic.defra.gov.uk/
Hydrology	A ditch is located in the centre of the nitrogen deposition compensation site to the immediate south of the Hole Farm buildings, running initially to the south-west before it orientates southwards to the Mardyke tributary. Another ditch is present to the north of the nitrogen deposition compensation site running initially southwards before it orientates to the south-east to run along the east

Hole Farm East Approximate postcode: CM13 3JP	
	boundary. Five pond-like features are also mapped across the nitrogen deposition compensation site. An Environment Agency designated main river is located approximately 350m to the east of the nitrogen deposition compensation site, flowing to the south east. Barrack Reservoir formed from this river is located approximately 560m to the east of the north east corner of the nitrogen deposition compensation site. Source: Natural England (2022) MAGIC. Accessed July 2022 https://magic.defra.gov.uk/
Historical mapping	1892 – 1908 the nitrogen deposition compensation site comprises agricultural fields surrounding Hole Farm, with a road (Hole Farm Lane) running north-south through the centre. The surrounding area comprises farms and associated land, residential properties and areas of woodland. 1842 – 1952 the nitrogen deposition compensation site remains as before. A pumping station (South Essex Water Works) and associated reservoirs is mapped approximately 50m away from the south-east corner of the nitrogen deposition compensation site. 1937 – 1961 the land use remains the same. 1949 – 1970 the land use remains the same. A cricket ground and pavilion is mapped in the eastern portion of the nitrogen deposition compensation site. Source: National Library of Scotland (2022). Map Images. Accessed July 2022. https://maps.nls.uk/
Historical aerial images	The following is a summary of available historical aerial images from Historic England.org.uk accessed in July 2022 Aerial images dated April 1947 show the nitrogen deposition compensation site to comprise agricultural fields surrounding Hole Farm Road and pockets of woodland. A pumping station and associated reservoirs are present approximately 50m away from the south-east corner of the nitrogen deposition compensation site.
Environmental datasets	Landfill https://groundsure.io/ accessed 16 February 2022 and DEFRA historic landfill sites GIS layer show no recorded historic or authorised landfills within 1km of the nitrogen deposition compensation site. An infilled pond (HLU1220) is present at Hole Farm (see aerial image above), Landmark, 2019. A pond was shown on historical maps between 1866 and 1967. It was no longer shown on the 1975 map, indicating it was likely then infilled. The location of the infilled pond is now within agricultural fields. Potential contaminants associated with this HLU are considered to include metals, inorganics, petroleum hydrocarbons, PAH, asbestos and hazardous gases.
UXO	A UXO risk assessment was undertaken by Zetica (2022), presented as Appendix 10.10 UXO Desk Study & Risk Assessment (Application Document 6.3), with the site assessed with a Low UXO hazard rating.

Hole Farm East
Approximate postcode: CM13 3JP

Preliminary Risk Assessment

Preliminary Conceptual Site Model

Plate D.14 Hole Farm East nitrogen deposition compensation site potential sources of contamination

Proposed works

a. To be carried out by Forestry England according to their planning application.
b. Fencing / securing site (stock fencing perimeter and metal fence for compounds / building sites)
c. Limited groundworks - digging ponds and ditches and deep ploughing
d. Tree planting
e. Grassland sowing
f. Ditch and pond creation
g. Path creation
h. (Visitor centre and access tracks / roads also proposed but not relevant to LTC needs as this is FE proposal)
i. Utility works unknown

Potential sources of contamination

The infilled pond (HLU1220) may be a potential source of contamination. The nature of the fill material is unknown and may have included contaminated material, although any degradable material or organic contaminants are likely to

Hole Farm East Approximate postcode: CM13 3JP	
	have substantially degraded since filling occurred. Given the approximate date of filling (1967-1975) the infilled pond is considered to be past the peak of ground gas generation. No other likely on-site sources of contamination associated with the nitrogen deposition compensation site's historic or current land use have been identified. **Potential pathways** Potentially active pathways are considered to include: a. direct and dermal contact and incidental ingestion of contaminated soil b. ingestion of soil or wind-blown dust c. inhalation of vapours, gases or wind-blown dust or fibres The visitor's centre has not been included in this preliminary risk assessment as it is the subject of a separate planning application. Any utility works carried out within this nitrogen deposition compensation site would have the potential to create preferential pathways within the working area resulting in the migration and accumulation of ground gases. **Potential receptors** Based on the proposed works for the nitrogen deposition compensation site, potential receptors are considered to be: a. Construction workers b. Operations staff c. Ecology (proposed grassland and trees) d. Future visitors (outside environment only) In relation to any utility works, operations staff (maintenance and utilities engineers) and construction materials associated with utilities would be considered a potential receptor. **Preliminary Risk Assessment** The site has been an agricultural field since the earliest available historical mapping and as such, with the exception of potential fill material at HLU1220) on-site contamination is not expected. Whilst unlikely if any localised impacts are present that may be disturbed by proposed ground works or should unexpected contamination be encountered, implementation of standard protocols including watching briefs during earthwork activities and (GS028), materials (GS006) and soil (GS009-GS014) management procedures, as secured through the Register of Environmental Actions and Commitments (REAC), would be sufficient to manage potential risks resulting from existing contamination. The site is considered to be a low risk in the context of the proposed nitrogen deposition compensation site.

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