

The Lake Lothing (Lowestoft) Third Crossing Order 201[*]



Lake Lothing
**THIRD
CROSSING**

Document SCC/LLTC/EX/87: Chapter 12 of the Environmental Statement R1 – Tracked

Planning Act 2008

**The Infrastructure Planning (Applications: Prescribed Forms and Procedure)
Regulations 2009**

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12 Geology, Soils and Contamination

12.1 Scope of the Assessments

Introduction

12.1.1 This chapter describes the assessment of the likely significant effects of the Scheme on geology, soils and contamination during the construction and operational phases. It is supported by Appendices 12A, 12B and 12C and Figures 12.1 to 12.2.

12.1.2 The assessment of this topic area considers potential impacts relating to the following receptors:

- Effects on geology and soils;
- Effects on human health (site users and adjacent site users including construction workers);
- Effects on infrastructure in the operational phase (including new buildings, buried services and foundations); and
- Effects on controlled waters (from the mobilisation of contaminants) is discussed but is specifically dealt with in Chapter 17.

12.1.3 The effects on ecological receptors is specifically dealt with in Chapter 11.

12.1.4 The potential for disturbance of existing contaminated land (including lake-bed sediments) and the potential for construction to establish pathways between contaminants and receptors are also discussed.

Study Area

12.1.5 An initial study area, for which the Desk Study Report (Scoping Report Appendix 6A Annex G) was originally prepared, comprised in most locations a larger area than the Order limits due to the uncertainty at the time (September 2016) as to the amount of land that would be necessary to construct, operate and maintain the Scheme. The decision was taken at that time to assess a wider area in order to all possible constraints and issues in relation to geology, soils and contamination to be identified and assessed.

12.1.6 The initial study area covered an area of approximately 21ha, centred at National Grid Reference 653884, 292755 and this is shown in Appendix 6A (Appendix G).

12.1.7 Following comments from the Environment Agency that were provided along with the Scoping Report (Appendix 6A), the Desk Study Report has been updated and is presented in Appendix 12A.

12.1.8 The study area for the assessment is the Order limits, although a 500m search area for sites of geological interest is used together with a 250m search area for sites such as gasworks, landfills, dye works and bleach works which can be particularly contaminated and from which contamination could have migrated into the Order limits.

Limitations

12.1.9 The ground investigation (see 12.3.4) and the earlier work to support the Desk Study

Report could not access the former timber yard (also known as Jeld Wen) where the New Access Road is to be constructed. No piling is required in this area and highway construction will not extend beyond approximately 1.5m depth in this area therefore it is considered that shallow ground conditions can be assessed at detailed design stage.

12.2 Directives, Regulations, and Relevant Policy

12.2.1 The assessment has been undertaken in accordance with and in reference to legislation specific to geology, hydrogeology and human health as follows.

National Legislation

The Environmental Protection Act 1990

12.2.2 The Environmental Protection Act 1990 defines, within England, Wales and Scotland, the fundamental structure and authority for waste management and control of emissions into the environment. The Act was intended to strengthen pollution controls and support enforcement with heavier penalties.

12.2.3 Part 2A of the Environmental Protection Act 1990 was inserted into that Act by section 57 of the Environment Act 1995 and contains a regulatory regime for the identification and remediation of contaminated land. In addition to the requirements contained in the primary legislation, operation of the regime is subject to regulations and statutory guidance.

12.2.4 The main objective underlying the introduction of the Part 2A contaminated land regime was to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment, assessed in the context of the current use and circumstances of the land.

12.2.5 It provides a means of identifying and remediating land that poses a significant risk to health or environment, where there is no alternative solution. It also works alongside planning rules to help ensure that this land is made suitable for use following development.

12.2.6 Development of land will have to take into account Part 2A because a change in the use of the land may bring the development inside the statutory definition of contaminated land by creating a pollutant linkage.

Water Resources Act 2003

12.2.7 The Water Resources Act 1991 replaced the corresponding sections of the Water Act 1989. The Act sets out the responsibilities of the Environment Agency in relation to water pollution, resource management, flood defence, fisheries, and in some areas, navigation. The Act regulates discharges to controlled waters, namely rivers, estuaries, coastal waters, lakes and groundwaters. To prevent pollution of controlled waters, planning policies and decisions should ensure that new development is appropriate for its location. It requires risks at a construction site to be adequately characterised.

Water Act 2003.

12.2.8 Under the Water Act it is an offence to cause or knowingly permit a discharge of poisonous, noxious or polluting matter into any Controlled Waters without the proper authority.

CDM Regulations

12.2.9 The Construction (Design & Management) Regulations (CDM 2015) are the main set of regulations for managing the health, safety and welfare of construction projects (this includes the risks posed by contamination to construction workers and others who may be affected by the construction activities such as the general public and adjacent site users). CDM applies to all building and construction work and includes new build, demolition, refurbishment, extensions, conversions, repair and maintenance.

National Policy

National Policy Statement for National Networks (January 2015)

12.2.10 The National Policy Statement for National Networks (NNNPS) provides some guidance on assessing geology, soils and contamination in relation to biodiversity and ecological conservation, coastal change, noise and vibration, water quality and resources, land use and sets out how the impacts should be considered.

12.2.11 Paragraph 5.168 of the NNNPS states “For developments on previously developed land, applicants should ensure that they have considered the risk posed by land contamination and how it is proposed to address this.”

National Policy Statement for Ports (2012)

12.2.12 NPS for Ports (PNPS), in Paragraph 5.13.8, likewise advises that developments on “previously developed land.....should ensure that they have considered the risk posed by land contamination”.

National Planning Policy Framework 201

12.2.13 NPPF (paragraphs 120-122) provides guidance on land contamination issues. These include local policies and decisions that ensure development sites are suitable for use, taking account of ground conditions and pollution arising from previous uses, as well as any proposals for land remediation.

12.2.14 Paragraph 120 of the NPPF states that:

“To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.”

12.3 Methods of Assessment

12.3.1 An Environmental Desk Based Study (Appendix 12A) has been prepared, using information from historical Ordnance Survey maps, environmental data reports, previous GI and publicly available remediation reports together with published and internet based information sources.

12.3.2 An understanding of the likely existing environmental setting in terms of geology, soils and contamination has been established with reference to the following sources of information:

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- British Geological Survey, www.bgs.ac.uk;
 - Environment Agency;
<https://www.gov.uk/government/organisations/environment-agency>;
 - Historical Ordnance Survey maps and environmental data reports obtained from GroundSure;
 - Environmental Review and Desk Study Report, reference 13578DS prepared by RSA Geotechnics Ltd dated June 2013;
 - Interpretative Report, Ground Investigation Report Number 13578GI prepared by RSA Geotechnical Ltd dated July 2013;
 - Phase III Remediation Method Statement, reference NG13/015/RMC prepared by JPC Environmental Services dated October 2013; and
 - Phase IV Environmental Remediation and Validation Report, reference NG13/015/RMC/v1.1, prepared by JPC Environmental Services dated April 2015.

12.3.3 The assessment has been based upon the guidance presented in DMRB Volume 11 Section 3 Part 11 Geology and Soils¹ and be supplemented by the assessment procedures contained within BS10175:2011² and CLR11³.

Ground Investigation and Interpretative Reporting

12.3.4 A Ground Investigation (GI) commenced in late July 2017 completing in April 2018 and comprised:

- 28 onshore cable percussion / rotary boreholes;
- 16 machine excavated trial pits;
- 14 window samples;
- Sediment sampling within Lake Lothing for contamination testing;
- Surface water sampling within Lake Lothing for contamination testing (see Appendix 12B);
- Soil and groundwater sampling and chemical testing;
- Gas and groundwater monitoring wells constructed in selected boreholes; and
- Gas and groundwater monitoring.

12.3.5 An Interim Interpretative Environmental Ground Investigation Report has been prepared using the information gathered from the ground investigation and is included in Appendix 12B. This includes human health, controlled waters and ground gas risk

¹ The Highways Agency et al, (1993), Design Manual for Roads and Bridges, Volume 11, Section 3, Part 11, Geology and Soils.

² British Standards Institution (2011). BS 10175:2011 Code of Practice for the Investigation of Contaminated Land.

³ The Environment Agency (2004). Model Procedures for the Management of Land Contamination. Contaminated Land Report 11.

assessments undertaken in accordance with:

- CLR and SR (SC050021 series) (DEFRA) guidance as well as CL:AIRE guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008,
- Environment Agency Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006; and
- Assessing Risked Posed By Hazardous Ground Gases to Buildings (CIRIA) C665, dated 2007.

12.3.6 These human health, controlled waters and ground gas risk assessments have assessed the potential contaminant linkages identified in the Desk Study Report (Appendix 12A) and have allowed the development of an updated conceptual site (CSM) model in Appendix 12B to clarify potential source-pathway-receptor linkages, and assist with the assessment of potential impacts on human health and controlled waters.

12.3.7 A Piling Works Risk Assessment (presented as Appendix 12C) has been prepared to assess the likely impact on controlled waters and underlying geology from the piling works.

Significance criteria

12.3.8 In terms of geological and geomorphological resources as well as contaminated land, DMRB does not provide any specific methods of assessment or scales of measurement for either the value / sensitivity of the receptor or the magnitude of the impact. Assessment has therefore been based on professional judgement, using a phased approach, taking into account the assessment procedures detailed in CLR11 to inform a quantitative risk assessment using the source-pathway-receptor protocol. Determination of significance will be carried out using the criteria detailed in CIRIA C552 and professional judgement.

Consultation

12.3.9 Specific consultation with the Waveney District Council facilities management team and the Environment Protection Officer at Suffolk Coastal and Waveney District Councils was undertaken to ascertain if they were aware of any potentially contaminated sites within the Order limits.

12.3.10 Information from the discussion with Waveney District Council is included within the Desk Study Report (Appendix 12A) and information from the discussion with the Environmental Protection Officer at Suffolk Coastal and Waveney District Councils is detailed in the Interpretative Environmental Ground Investigation Report.

12.4 Baseline Environment

Designated Sites

12.4.1 No geological designated sites exist within 500m of the Order limits although Corton Cliffs SSSI, which is a site designated because of its Pleistocene era geological interest, has been identified during scoping as a site that should be considered for possible inclusion within the assessment. As Corton Cliffs SSSI is approximately

3.5km from the Order limits there is not considered to be a pathway to Corton Cliffs from the Scheme at that distance and it is very unlikely to be impacted upon. Therefore, it has not been included within the scope of the assessment in this chapter.

Desk based studies

Bedrock Geology

12.4.2 As indicated on the British Geological Survey (BGS) website the bedrock geology across the study area comprises the Crag Group. This is a sedimentary green to orange sandstone containing haematite. In the lower deposits, the material predominantly comprises flint gravel.

Superficial Geology

12.4.3 The BGS website indicates that the northern and southern ends of the Order limits are underlain by sand of the Happisburgh Glacigenic Formation while the central parts of the Order limits immediately adjacent to Lake Lothing are underlain by alluvium deposits comprising clay, silt, sand and gravel.

Soils and Sediment

12.4.4 The nature of soils and sediments within the Order limits is undetermined. The Soilscales website⁴ indicates the soils comprise the following: fen peat soils, freely draining slightly acidic sandy soils and freely draining slightly acidic loamy soils. However, due to previous development within the Order limits, naturally occurring soils were only occasionally encountered at the surface during the ground investigation and made ground is more prevalent at the surface.

Potentially Contaminated Sites

12.4.5 The Desk Study presented in Appendix 12A includes a review of information from a GroundSure report. This records that no locations within the study area are determined as contaminated land under Part 2A legislation, but does record a number of historical ground workings, as well as industrial uses; all of which may have introduced contaminated material into the Order limits, including ponds, unspecified pits, lake, unspecified wharf, quay and a refuse heap, rail, ship building and an ice works.

12.4.6 There are records relating to an historic Environment Agency landfill within the south-east corner of the study area as shown on Figure 12.1. GroundSure does not provide any further information on the waste types accepted or licence numbers. The Environmental Protection Officer at Suffolk Coastal and Waveney District Councils provided a brief ground investigation report on this landfill area and this is summarised in the Interpretative Environmental Ground Investigation Report (Appendix 12B).

12.4.7 In addition, two refuse tips (marked on 1963 historic mapping and recorded by GroundSure Local Authority Landfills) are also recorded at this location within the study area but not marked on Figure 12.1 as we cannot delineate the boundaries with any certainty.

⁴ Soilscales. Available from: <http://landis.org.uk>

Previous Ground Investigation / Remediation Information

- 12.4.8** Ground investigation and remediation verification has been undertaken at the Council Offices (see Figure 4.1) by RSA Geotechnics Ltd and JPC Environmental Services. Details are presented in the Desk Study (Appendix 12A). The ground investigation undertaken by RSA Geotechnics Ltd identified the presence of elevated polyaromatic hydrocarbons, total petroleum hydrocarbons (TPH), asbestos and lead within soils which posed a potential risk to human health. It was concluded that there was negligible risk to controlled waters and to the Council office site from ground gas.
- 12.4.9** Remedial works comprising clean cover capping of landscaping areas, removal of all underground fuel storage tanks, and removal of asbestos containing material (ACM) were undertaken.
- 12.4.10** The site currently occupied by the Registry Office on Canning Road (see Figure 4.1), was part of the same site as the Council Offices but was not included in previous ground investigation or remediation works. It is likely that similar contamination will exist within the Order limits in proximity to the Registry Office as was found on the site of the Council offices pre-remediation.
- 12.4.11** A Ground Investigation Report was provided by Suffolk Coastal and Waveney District Council for the small landfill in the south-east corner of the Order limits (see Figure 12.1). No other ground investigation reports have been made available for elsewhere within the Order limits.

2017/2018 Scheme Specific Land Based Ground Investigation

- 12.4.12** A land based GI was undertaken by Geosphere Ltd (contracted to the Applicant) from July 2017 to April 2018 with the dual purpose of informing the design of the Scheme and identifying the extent of any contamination that is present. The scope of works are detailed in the Interim Interpretative Environmental Ground Investigation Report presented as Appendix 12B but broadly comprised: -

- Cable percussion boreholes;
- Machine excavated trial pits;
- Window Samples;
- Hand dug trial pits / inspection pits;
- Installation of gas and groundwater monitoring wells in selected boreholes;
- Soil sampling from the boreholes, trial pits and window samples for the purpose of chemical testing; and
- Gas and groundwater monitoring and groundwater sampling and chemical testing following completion of the intrusive works.

- 12.4.13** Figure 12.2 presents the exploratory hole locations. Engineer's logs and chemical test results are presented in Annex C of the Interim Interpretative Environmental Ground Investigation Report (Appendix 12B).

- 12.4.14** Made ground was recorded at all exploratory hole locations and varied in thickness from 0.75m to at least 3.7m (although this same location recorded possible made

ground in excess of 6.0m depth). The made ground was generally granular and heterogeneous in nature and was composed of detritus including concrete, charcoal, clinker, brick, tile, metal (including reinforcing bar), ash, asphalt, glass, wood, soot, pottery and cast iron. Fragments of potential asbestos containing materials were recorded at two locations (TPC02 and BH102) (see Figure 12.2).

12.4.15 Solid concrete up to at least 0.6m thick and asphalt / flexible surfacing up to 0.2m thick was recorded at a number of locations both at and below the surface. One location recorded concrete to 2.0m thick where it varied from crumbling degraded concrete to solid layers.

12.4.16 A small diameter clay pipe (possibly a redundant land drain) was encountered at one location and was infilled with clay with a hydrocarbon odour.

12.4.17 Other than the man-made detritus recorded within the made ground, visual and olfactory evidence of contamination was recorded at a few locations as hydrocarbon odour within both made ground and natural ground deposits.

12.4.18 The underlying natural deposits were predominantly sand, although layers of silt, clay, gravel and sand and gravel were also recorded.

12.4.19 The Interpretative Environmental Ground Investigation Report (Appendix 12B) includes human health and controlled waters risk assessments, gas risk assessments and waste classification / re-use assessments which have informed the need for mitigation measures.

Ground gas monitoring

12.4.20 Geosphere undertook gas and groundwater monitoring of all installed monitoring wells on ~~six~~ two occasions: 9th to 14th May 2018; and 23rd to 24th May 2018; 11th and 12th June 2018; 25th and 26th June 2018; 10th and 11th July 2018; and 23rd and 24th July 2018.

12.4.21 This comprised measuring the following parameters from each monitoring well: ~~:-~~

- Methane concentration;
- Carbon dioxide concentration;
- Oxygen concentration;
- Volatile Organic Compounds (VOC);
- Atmospheric pressure; and
- Water level.

12.4.22 Methane was recorded up to 0.84% and carbon dioxide up to 43.6%. Volatile organic compounds were recorded up to 23ppm~~4ppm~~. Flow rates varied with initial flows up to 7.950.4 litres per hour reducing but these reduced to less than 1 litre per hour once a maximum steady state flow of 1.2 litres per hour. The higher gas concentrations at the start had been reached and are considered to be ~~elevated as~~ a result of fluctuating water levels rather than generation of gas.

12.4.23 The ground gas risk assessment undertaken in accordance with CIRIA C665 did not record ground gas at concentrations that would require specific gas protection over

and above standard construction techniques.

Human Health Risk Assessment

12.4.24 A human health risk assessment undertaken to identify potential risks to site users and adjacent site users from contamination within the Order limits and has identified the following: -

- Asbestos recorded by the chemical testing laboratory in two samples and also recorded by the GI Contractor at one location during the ground investigation;
- Exceedances of the public open space screening values have been recorded for pH, lead and benzo-a-pyrene;
- Exceedances of the commercial / industrial screening values have been recorded for pH and lead.

Controlled Waters Risk Assessment

12.4.25 Soil leachate chemical testing was undertaken as part of the ground investigation and the results indicate the following minor theoretical risks: -

- Potential risks to Lake Lothing surface water body – metals and speciated polyaromatic hydrocarbons;
- Potential risks to underlying ~~Underlying~~ aquifers - pH, metals and speciated petroleum hydrocarbons.

12.4.26 Groundwater sampling and testing was undertaken on six occasions on completion of the ground investigation and the results indicate the following: -

- Potential risks to Lake Lothing surface water body - metals ;
- ~~Potential risks to underlying aquifers – Exceedances for copper, lead, nickel, hexavalent chromium and zinc indicating groundwater has the potential to impact the surface waters of Lake Lothing. However, the risk of impact is considered low due to the low magnitude of the exceedances.~~
- Minor exceedances for pH, sulphate, metals, speciated petroleum hydrocarbons.

12.4.27 ~~Most exceedances were minor~~ arsenic, chromium and nickel indicating groundwater has been previously impacted although due to the low magnitude of the exceedances, an unacceptable risk is considered unlikely. The chromium exceedances were only identified in the first two monitoring visits and not repeated in subsequent visits indicating a long-term impact is not occurring.

12.4.28 Shallow groundwater exceedances have not been replicated in the deeper groundwater samples and surface sampling of Lake Lothing has not recorded the same determinands as those recorded in either the soil leachate or groundwater samples indicating an impact is not considered to be occurring.

12.4.29 There is some olfactory/ visual evidence of the presence of hydrocarbons in the vicinity of the exploratory holes near the southern bank of Lake Lothing (and in a number of other isolated locations). In addition, there are some associated VOC readings (identified using a PID meter during ground investigation) and minor theoretical hydrocarbon exceedances in soil leachate screening values.

12.4.30 Sampling of groundwater from monitoring well installations within adjacent boreholes do not show any exceedances of groundwater screening values for hydrocarbons. It is therefore concluded that although there is some evidence of hydrocarbon presence in a number of locations on site, particularly near the southern bank of Lake Lothing, the analysis of soil, soil leachate and groundwater samples identify that the concentrations are not significant. It is possible that minor spillages have occurred in the past or that any more significant spillages have dispersed with time due to the generally permeable nature of the sub-strata on site.

Waste Classification and Soil Re-Use Assessment

12.4.31 A waste classification hazardous properties assessment has been carried out in accordance with the WM3 Technical Guidance. The soil chemical test results have been assessed and identified hazardous properties in seven samples. As a **result** ~~results~~, this material cannot be reused in the Scheme and will require offsite disposal as hazardous waste at a suitable permitted facility.

12.4.32 Waste acceptance criteria (WAC) analysis has been carried out on a number of samples in order to assess the acceptability to landfill should offsite disposal be required. Two samples recording hazardous properties were also subjected to WAC testing and the results indicate these materials are suitable for hazardous waste disposal. The other WAC test results indicate that most of the samples meet the criteria for inert waste disposal but four samples fail the inert criteria and will require disposal as non-hazardous waste.

2018 Scheme Specific Marine Sediment and Water Sampling

12.4.33 Marine based sediment and water sampling was carried out by CMS-Geotech Ltd (contracted to WSP) and comprised:

- Surface water sampling at four locations from Lake Lothing waterbody;
- Sampling of sediments from the lake bed at nominal 1m intervals to 4m depth from 12 vibrocore locations; and
- 48 grab samples from the top layer of lake bed sediments.

12.4.34 Engineer's logs and chemical test results are presented in Annex D of the Interim Interpretative Environmental Ground Investigation Report (Appendix 12B).

12.4.35 Some sediment samples recorded contaminant concentrations above the CEFAS Action Level 1 screening values but no samples recorded concentrations above the CEFAS Action Level 2. The assessment has also confirmed that the sediments are also likely to be suitable for disposal at sea and this has been indicatively agreed with the MMO subject to further sampling prior to disposal.

12.5 Predicted Impacts

Construction Impacts

12.5.1 This section builds upon the information from the Desk Study Report and the Interpretative Ground Investigation Report (Appendix 12A and 12B respectively) to assess the potential impacts on the receptors (identified in Appendix 12B) and the underlying and surrounding geology and soils during the construction phase of the

Scheme. Construction work is likely to cause disturbance to the geology and soils and this includes potentially contaminated ground which could then impact upon receptors.

12.5.2 Embedded mitigation and further mitigation are both considered and are identified as such in Section 12.6 below.

Geology and Soils

12.5.3 Some elevated determinands have been identified in both soil, soil leachate and groundwater, as explained in appendix 12B and summarised below.

12.5.4 In addition to potential asbestos recorded on the Draft Engineers logs (see Appendix 12A) at one location, it was also recorded in two made ground soil samples. The potential for more asbestos containing materials to be present within made ground materials cannot be discounted.

12.5.5 Natural ground within the southern site area recorded exceedances of the human health generic assessment criteria (GAC) screening values for both public open space and commercial / industrial end use for alkaline pH at one location and acid pH at two locations.

12.5.6 Natural ground within the northern site area did not record any exceedances of the human health GAC values for either a public open space or commercial / industrial end use.

12.5.7 Made ground within the southern site area recorded exceedances of the human health GAC values for both public open space for benzo-a-pyrene (two locations) and for both a public open space and commercial / industrial end use for alkaline pH (five locations) and lead (one location).

12.5.8 Made ground within the northern site area recorded exceedances of the human health GAC values for a public open space end use for benzo-a-pyrene (one location) and for both a public open space and commercial / industrial end use for alkaline pH (six locations) and lead (one location).

12.5.9 Surface water samples from Lake Lothing have identified minor exceedances of the water quality standard (WQS) screening value for zinc.

12.5.10 Groundwater samples have identified generally low exceedances of the WQS screening values for a number of determinants and risks to controlled waters are therefore considered to be relatively low although there is some evidence of impact to groundwater. Whilst a contaminant linkage is possible, an unacceptable risk to controlled waters is considered unlikely.

12.5.11 There is some olfactory/ visual evidence of the presence of hydrocarbons in the vicinity of the exploratory holes CPTC13, BHC13, BHC101, BHC102, BHC103 and WSC103 near the southern bank of Lake Lothing (and in a number of other isolated locations). In addition, there are some associated VOC readings (identified using a Photo Ionisation Detector during ground investigation) and minor theoretical hydrocarbon exceedances in soil leachate screening values.

12.5.12 Sampling of groundwater from monitoring well installations (adopting best practice of purging) within adjacent boreholes (BHC102, BHC14 and BHC27) do not show any exceedances of groundwater screening values for hydrocarbons.

12.5.13 It is therefore concluded that although there is some evidence of hydrocarbon presence in a number of locations on site, particularly near the southern bank of Lake Lothing, the analysis of soil, soil leachate and groundwater samples identify that the concentrations are unlikely to result in an impact to geology and soils as a result of the construction of the Scheme.

12.5.14 Landfilled materials were not encountered during the GI and ground gas monitoring to date has not identified any emissions that would require gas protection measures above standard floor slab construction, and so it is not considered likely that a pathway could be created from such materials. A further four visits of gas monitoring are programmed to capture a wider range of atmospheric conditions and the results of this monitoring will be presented to the Environment Agency to enable them to fully consider the results of this assessment.

Water Environment

12.5.15 Sediment modelling detailed in Chapter 17 and Appendix 17C has concluded that the change in sediment transport post construction will be negligible and the marine sediment sampling described in appendix 12B has not identified any elevated contamination within the marine sediments.

12.5.16 It is therefore considered that the sediments are unlikely to have an adverse impact from a contamination perspective if they are mobilised during and / or after construction.

12.5.17 Land based ground investigations identified a theoretical risk to controlled waters from soil leachate but the exceedances were of a low magnitude and therefore an unacceptable risk is not considered to exist.

Site Users and Adjacent Site Users including Construction Workers

12.5.18 Asbestos has been identified within made ground that could impact site users, adjacent site users, construction workers and maintenance workers during construction through inhalation of asbestos impacted soils.

12.5.19 Exceedances of human health commercial / industrial screening values have been identified for pH and lead which could impact receptors through direct contact, ingestion and inhalation. However, the concentrations are not considered to be sufficiently elevated to pose an unacceptable risk to site users, adjacent site users and construction workers during construction and can be mitigated with standard construction industry good practice, such as the measures set out below.

Operational Impacts

Geology and Soils

12.5.20 During the operational phase of the Scheme, remediation will have been undertaken where required during the construction phase (pursuant to the DCO) and given the urban environment surrounding the Order limits, geology and soils will not be significantly impacted by the operational highway.

Water Environment

12.5.21 Impacts to the water environment from the operational phase of the Scheme are discussed in detail in Chapter 17.

12.5.22 No unacceptable risks to controlled waters have been identified from the results of the ground investigation (please see Paragraphs 12.5.9 to 12.5.13) and no remedial measures are considered necessary. No further mitigation measures are considered necessary from the perspective of impacts to water from the geology and soils present within the Order limits as part of the operational phase of the Scheme.

Site Users and Adjacent Site Users including Construction Workers

12.5.23 In areas, such as landscaping (reference to Landscaping plan) where humans could interact with the geology and soils, it has been identified that impacts will arise through direct contact, ingestion or inhalation of contaminated soils.

12.5.24 Ground gas monitoring has not identified any ground gas at concentrations that would pose a risk to site users. Gas protection measures in any new buildings associated with the Scheme are not required over and above standard floor slab construction methods.

Infrastructure Within the Order Limits

12.5.25 Infrastructure such as piled foundations could also impact geology and soils through the creation of new pathways for migration of contamination. This is assessed in the Piling Works Risk Assessment in Appendix 12C which has identified no risks to controlled waters or the environment are considered likely during the operational phase and no additional mitigation is required. ~~The assuming the~~ following methods of piled construction are assumed;

- ~~placing steel casing in the upper portions of ground to provide support followed by drilling or augering within the casing to the required pile base level, utilising either a bentonite slurry or polymer to ensure stability of the pile bore and to minimise the risk of contaminants migrating downwards during excavation⁵;~~
- ~~conventional bored piles with temporary casing over the upper 6m to 10m depth (standard practice in the ground conditions identified on site);~~
- appropriate concrete sulphate classification design; and
- appropriate disposal of arisings in accordance with current waste regulations and protocols.

12.6 Mitigation

Construction Impacts

12.6.1 The following embedded mitigation will be undertaken by the Contractor and is relevant to all aspects of Geology and Soils: -:-

- The Scheme will adhere to pollution prevention guidance and best practice during the construction phase which will be incorporated into and managed via the full CoCP. An interim CoCP has been prepared for submission with the ES (see Appendix 5A) which sets the framework for the full CoCP which will be

⁵ The use of polymers or bentonite for pile stability do not change the conclusions presented within the ES as they will both deliver similar levels of environmental performance. Other changes in this paragraph provide more explanation of the proposed technique and provide for the Contractor to adjust piling installations to suit ground conditions by not restricting the depth of temporary casing which does not alter the assessment presented.

prepared by the construction Contractor on the basis of the interim CoCP, as secured as a requirement to the DCO.

12.6.2 The following further mitigation will need to be undertaken by the Contractor as an added safeguard to manage any contamination issues in an efficient and appropriate manner and is relevant to all aspects of geology and soils: -

- The construction Contractor will have a watching brief during the works (excavation and piling in particular) to identify any unforeseen potential contamination. If encountered, works in that area will cease and an appropriate way forward will be agreed with the Environment Agency and / or Local Authority Environment Health Department. This is secured through a DCO requirement.

12.6.3 Table 12-1 summarises mitigation for each of the identified impact receptors, which are also set out in the CoCP.

Table 12-1 – Geology and Soils Construction Mitigation Measures

Impact Receptor	Embedded Mitigation	Further Mitigation
Geology and Soils	Good working practices and housekeeping during construction such as sealing or covering stockpiles of contaminated soils and treating water removed from excavations to the satisfaction of the discharge regulator will be undertaken.	N/A
Water Environment	As indicated in 12.6.1, the Scheme will adhere to pollution prevention guidance and best practice.	N/A
	Water removed from any excavations and discharged directly to controlled waters will be controlled pursuant to the provisions of the DCO. If the Contractor chooses to discharge directly to sewer, this will be controlled by the water company through a consent pursuant to the DCO.	N/A
Site Users and Adjacent Site Users including Construction Workers	Risks to human health from contamination will be managed through the CDM Regulations. The development of method statements and risk assessments for the various construction activities and use of good construction practices are included within the interim CoCP and include; - <ul style="list-style-type: none"> • Use of appropriate PPE for construction workers; • Good hygiene practice including wearing gloves and washing hands before eating, drinking or smoking when working with potentially contaminated soils or water; and • Damping down during periods of dry weather to reduce dust generation. 	N/A
Buried Infrastructure Within the Order	The construction Contractor will assess the ground conditions information at detailed design stage taking into account their chosen design and construction methodology pursuant to the	N/A

Impact Receptor	Embedded Mitigation	Further Mitigation
Limits	CDM Regulations. The operators of relevant services will have controls over the interaction of the Scheme with their assets through the operation of their protective provisions in the DCO.	

Operational Impacts

12.6.4 This section summarises the mitigation for the above predicted operational impacts.

12.6.5 Hard standing is present across much of the Order limits which will limit the amount of precipitation percolation through the made ground in turn reducing the risk of leachate generation. Chemical test results indicate a few soil leachate exceedances indicating a theoretical risk to controlled waters but the magnitude of the exceedances is low therefore no unacceptable risk to the water environment is considered to exist and no mitigation is necessary.

12.6.6 Table 12-2 details mitigation for each of the identified impact receptors.

Table 12-2 – Geology and Soils Operational Mitigation Measures

Impact Receptor	Embedded Mitigation	Further Mitigation
Water Environment	N/A	A suitable drainage system will be incorporated into the Scheme to mitigate to acceptable levels the risk of contamination that could arise from traffic emissions entering the water environment, as secured through the Drainage Strategy (Appendix 18B).
Site Users and Adjacent Site Users including Maintenance Workers	N/A	Due to the presence of asbestos, pH, lead and polyaromatic hydrocarbons, a contaminant linkage is likely to be present. In presenting its full CoCP for approval, the Contractor should set out if its construction methodology requires (or if it does not, why not): <ul style="list-style-type: none"> • further assessment of the locations where asbestos was recorded and if necessary excavation of those areas if they are to be located in landscaping areas, • placement of an inert subsoil and topsoil capping with a geotextile membrane within landscaping areas to break the pathway between the contaminants and the receptors.
Infrastructure Within the Order Limits	N/A	Mitigation and implemented by the Contractor during construction will mitigate any impacts to infrastructure at operation stage.

12.7 Conclusions and Effects

12.7.1 An assessment has been undertaken of the impact of the Scheme on the geology and soils, including potentially contaminated soils and the subsequent impacts on human health, controlled waters and the environment.

12.7.2 Potential risks to construction workers during the construction phase will be managed through the CDM Regulations by the Contractor using developed Method Statements,

Risk Assessments and the use of good construction practices.

- 12.7.3 Potential risks to human health from contamination during the operational phase can be mitigated through placement of an inert soil capping and geotextile membrane in landscaping areas. The exact specification will be confirmed at detailed design.
- 12.7.4 Potential risks to controlled waters are not considered likely to occur.
- 12.7.5 Ground gas has not been recorded in concentrations that require any special gas protection measures in building floor slabs beyond standard floor slab construction.
- 12.7.6 There will be no significant effects upon geology, soils and contamination arising from the Scheme.