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## 11. GROUND CONDITIONS AND HYDROGEOLOGY

### 11.1 Introduction

11.1.1 This chapter of the Preliminary Environmental Information (PEI) Report addresses the potential effects of the proposed Open Cycle Gas Turbine (OCGT) power station (hereafter referred to as the 'Proposed Development') on geotechnical and geo-environmental ground conditions and groundwater.

11.1.2 This Chapter describes the existing geological and hydrogeological conditions at the Site. For this purposes of this assessment, 'the Site' refers to all parts of the Proposed Development Site (defined in Chapter 3: Description of the Site) *excluding* the existing gas pipeline corridor. This Chapter assesses the likely nature and existing sources of contamination which may be present. In addition, an assessment of the likely ground conditions expected at the Site is made, based on a review of previously conducted site investigations. Having established baseline conditions, an assessment has been made of the potential impacts to the existing geological and hydrogeological conditions arising as a result of the Proposed Development and the likely mitigation measures required.

11.1.3 This chapter is supported by Figure 11.1 Geological Cross Section (PEI Report Volume II) and by the following Appendices, provided in PEI Report Volume III:

- Appendix 11A, VPI Energy Park Phase 1 Geo-Environmental Site Assessment, (AECOM, January 2018)
- Appendix 11B, VPI Energy Park, Supplementary Phase 1 Geo-environmental Site Assessment (AECOM, October 2018);
- Appendix 11C, Factual Report on Ground Investigation, Report no. A8015-18, (SOCOTEC, August 2018); and
- Appendix 11D, Phase 2 Geotechnical and Geo-environmental Interpretative Report, VPI Immingham Energy Park (AECOM, August, 2018).

11.1.4 It should be noted that some of the potential impacts and effects relating to the hydrogeology underlying the Proposed Development are also addressed within Chapter 12: Surface Water, Flood Risk and Drainage of this PEI Report.

### 11.2 Legislation and Planning Policy Context

#### Legislative Background: European Legislation

##### ***Water Framework Directive (WFD)***

11.2.1 The European Union (EU) Water Framework Directive (WFD) (2000/60/EC) is one of the key European Directives setting the context for the hydrogeological assessment included within this chapter. The purpose of the WFD is to establish a framework for the protection and improvement of groundwater, and inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters. The

assessment of surface waters is described in Chapter 12: Surface Water, Flood Risk and Drainage.

- 11.2.2 The WFD requires the UK to classify the current condition of key waterbodies (giving a 'Status' or 'Potential') and to set objectives to either maintain the condition, or improve it where a waterbody is failing minimum targets. Any activities or developments that could cause deterioration within a nearby waterbody, or prevent the future ability of a waterbody to reach its target Status, must be mitigated so as to reduce the potential for harm and allow the aims of the WFD to be realised.

#### ***Industrial Emissions Directive (IED)***

- 11.2.3 The Industrial Emissions Directive (IED) (2010/75/EU) was adopted on 24 November 2010 and entered into force in January 2011. The IED is implemented in England and Wales through the Environmental Permitting Regulations (2016). Article 22 of the IED includes a requirement to establish a baseline report for all regulated sites storing and handling hazardous materials. This process is outlined in the European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions (2014/C136/03) (Ref 11-1).
- 11.2.4 This guidance presented a seven-stage approach to generating a 'baseline report' which presents the condition of the land under the site for 'relevant hazardous substances' present at the site. Following completion of a desktop assessment, collation of a targeted set of baseline site condition data for the site may be needed to meet this requirement, including collection of samples of soil and groundwater and their analysis.
- 11.2.5 Article 16 of the IED requires monitoring of groundwater and soil condition to be carried out every 5 and 10 years respectively, with the scale and scope of this monitoring determined based on the findings of the baseline report.

#### ***Groundwater Daughter Directive***

- 11.2.6 The Groundwater Daughter Directive (GDD) (2006/118/EC) was adopted in November 2006, and sets out the approach to protect groundwater against pollution and deterioration in response to Article 17 of the Water Framework Directive. The transposition of the GDD into law in England and Wales is achieved through the Environmental Permitting (England and Wales) Regulations 2016

#### ***7th Environment Action Programme (EAP)***

- 11.2.7 The 7th EAP (Decision No. 1386/2013/EU, Ref 11-2) entered into force in January 2014, and is guided by the following long term vision:

*"In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society"*

11.2.8 The 7th EAP is based around three priority areas requiring more action, including:

- Protect nature and strengthen ecological resilience;
- Boost resource-efficient, low-carbon growth; and
- Reduce threats to human health and wellbeing linked to pollution, chemical substances, and the impacts of climate change.

11.2.9 In relation to geology, hydrogeology and ground conditions, the first priority area identifies further action on soil protection and sustainable use of land, while the third area covers challenges to human health including air and water pollution, excessive noise and toxic chemicals.

### National Legislation

11.2.10 There are three key statutes dealing with the risks posed to human health and the environment associated with historic land contamination, namely:

- Part IIA of the Environmental Protection Act, 1990 (the 'Contaminated Land' regime);
- The Water Resources Act 1991; and
- The Town and Country Planning Act, 1990.

11.2.11 In the UK, Part IIA of the Environmental Protection Act, as introduced by Section 57 of the Environment Act 1995, makes provision for identifying 'contaminated land', the circumstances in which remediation is required and who is responsible for that remediation. Under Part IIA, 'contaminated land' in respect of which remediation may be required is;

*"...any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substance in, on or under the land, that -*

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being or is likely to be caused."*

11.2.12 Under the Water Resources Act 1991, 'controlled waters' are defined as including both surface waters and groundwater. Once a site is classified as 'contaminated land' then remediation is required to render significant pollutant linkages (i.e. the source-pathway-receptor relationships that are associated with significant harm and/or pollution of Controlled Waters) insignificant, subject to a test of reasonableness.

11.2.13 A number of specific regulations have been enacted to implement the statutory European and national legislation into UK law. These regulations include:

- The Anti-Pollution Works Regulations 1999;

- The Control of Pollution (Oil Storage) (England) Regulations 2001;
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015; and
- The Environmental Permitting (England and Wales) Regulations 2016.

11.2.14 A review of the national, regional and local planning policy pertaining to local ground conditions and contaminated land follows.

#### **National Planning Policy**

11.2.15 The Overarching National Policy Statement (NPS) for Energy (EN-1) (Ref 11-3) Section 4.10 (Pollution control and other environmental regulatory regimes) details that issues relating to discharges or emissions from a proposed project which may affect air quality, land quality and the marine environment, or which include noise and vibration may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes. Before consenting any potentially polluting developments:

- *“The relevant pollution control authority is satisfied that potential releases can be adequately regulated under the pollution control framework; and*
- *The effects of existing sources of pollution in and around the site are not such that the cumulative effects of pollution when the proposed development is added would make that development unacceptable, particularly in relation to statutory environmental quality limits.”*

11.2.16 Section 5.10 of EN-1 (Land use including open space, green infrastructure & Green Belt) states that;

*“...applicants should also identify any effects and seek to minimise impacts on soil quality taking into account any mitigation measures proposed. For developments on previously developed land, applicants should ensure that they have considered the risk posed by land contamination”*

11.2.17 Section 5.15 of EN-1 (Water Quality and resources) states that;

*“...where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES [Environmental Statement] or equivalent. The ES should in particular describe:*

- *The existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges;*
- *Existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any*

*relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Catchment Abstraction Management Strategies);*

- *Existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics; and*
- *Any impacts of the proposed project on water bodies or protected areas under the Water Framework Directive and source protection zones (SPZs) around potable groundwater abstractions.”*

11.2.18 NPS EN-2 (Ref 11-4) on Fossil Fuel Electricity Generating Infrastructure states that where a project is likely to have; *“effects on water quality or resources the applicant for development consent should undertake an assessment which should particularly demonstrate that appropriate measures will be put in place to avoid or minimise adverse impacts of abstraction and discharge of cooling water. The applicant for development consent should demonstrate measures to minimise adverse impacts on water quality and resources.”*

11.2.19 NPS EN-4 (Ref 11-5) on Gas Supply Infrastructure and Gas and Oil Pipelines, Section 2.22 (Gas and Oil Pipelines Impacts: Water Quality and Resources) notes that the construction of pipelines can create corridors of surface clearance and excavation that can potentially affect watercourses, aquifers, water abstraction and discharge points. Potential pipeline impacts include interference with groundwater flow pathways, mobilisation of contaminants already in the ground, and introduction of new contaminants, and the applicant should provide an assessment of these impacts.

11.2.20 Section 2.23 of NPS EN-4 identifies that underground cavities and unstable ground conditions may present risks to pipeline projects, and that applicants should assess the stability of the ground conditions associated with the pipeline route:

*“Desktop studies, which include known geology and previous borehole data, can form the basis of the applicant’s assessment. The applicant may find it necessary to sink new boreholes along the preferred route to better understand the ground conditions present. The assessment should cover the options considered for installing the pipeline and weigh up the impacts of the means of installation. Where the applicant proposes to use horizontal directional drilling (HDD) as the means of installing a pipeline under a National or European Site and mitigating the impacts, the assessment should cover whether the geological conditions are suitable for HDD.”*

11.2.21 The National Planning Policy Framework (NPPF) (Ref 11-6) was updated in July 2018 and planning practice guidance (PPG) will be updated in due course to reflect policy changes in the recently updated NPPF. The NPPF ensures that land contamination issues must be considered at the planning stage of development and that land must be ‘suitable for use’, stating in paragraph 178 that planning policies and decisions should ensure that:

- *“A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);”*
- *“After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990”; and*
- *“Adequate site investigation information, prepared by a competent person, is available to inform these assessments.”*

11.2.22 Further to this, paragraph 179 places the responsibility for ensuring that no harm from developments on land featuring land contamination issues upon the developer and/or landowner: *“Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.”*

#### **Local Planning Policy**

11.2.23 The North Lincolnshire Council Local Plan (Ref 11-7) was adopted in 2003 and is used to inform planning decisions within the borough.

11.2.24 Local Plan objective DS7 refers to the development of land which may be affected by contamination and states that: *“In the case of proposals for development on land known or strongly suspected as being contaminated, applicants will be required to demonstrate that the level of contamination can be overcome by remedial measures or improvements. Permission will only be granted on contaminated sites where a detailed site survey has been submitted, and a suitable scheme of remedial measures has been agreed to overcome any existing contamination. Conditions will be imposed and/or a planning obligation entered into to secure the implementation of such a scheme at the appropriate time in the development process and to otherwise restrict and control the development.”*

11.2.25 The North Lincolnshire Council Local Development Framework (Ref 11-8) was adopted in 2011. This sits alongside and in some cases, replaces the previously adopted Local Plan. As part of the Development Framework, a Core Strategy was produced which contains a number of strategic aims and requirements for developments within the borough.

11.2.26 CS17: *Biodiversity* lists a number of requirements through which *“The council will promote effective stewardship of North Lincolnshire’s wildlife”*, which includes; *“4. Ensuring development retains, protects and enhances features of biological and geological interest and provides for the appropriate management of these features.”*

11.2.27 CS18: *Sustainable Resource Use and Climate Change* states that *“The council will actively promote development that utilises natural resources as efficiently and sustainably as possible. This will include... 10. Ensuring development and land use helps to protect people and the environment from unsafe, unhealthy and polluted environments, by protecting and improving the quality of the air, land and water.”*

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## Other Relevant Legislation, Policy, Standards and Guidance

### ***The Building Regulations 2010***

- 11.2.28 The Building Act 1984 is supported by the Building Regulations 2010, which contain detailed information regarding the preparation of a site for redevelopment and resistance to contaminants.

### ***GPLC1 – Guiding Principles for Contaminated Land***

- 11.2.29 The Environment Agency (EA) provides general guidance on the management of land contamination in document 'GPLC1 - Guiding Principles for Land Contamination' (Ref 11-9). The EA also acts as a statutory consultee for developments requiring an Environmental Impact Assessment (EIA). The EA's primary concern in the management of contaminated land through the planning regime is in respect of the protection of the water environment.

### ***Model Procedures for the Management of Contaminated Land, Contaminated Land Report 11 (CLR 11)***

- 11.2.30 CLR11 (Ref 11-10) outlines the approach for the evaluation of contamination in line with UK Government legislation, and EA requirements. The procedures recommend the application of a risk based approach with the first tier assessment being a Phase 1 Desk Top Report to identify previous and current site uses, geological setting and historical contamination records. The approach to further investigation is then based on the risk established by virtue of the Phase 1 Report. If a site has no historical or current evidence of contaminative uses, the scope of further investigation can be less than sites with a long standing history of potentially contaminative uses.

## **11.3 Assessment Methodology and Significance Criteria**

### **Methodology for Assessing Baseline Conditions**

- 11.3.1 Baseline information has been obtained in order to assess the likelihood of finding contamination and its potential nature and extent. Baseline conditions have been identified from documentary research of the site history, geology, hydrogeology and hydrology, and review of a commercially available regulatory database. The assessment has involved a review of the Groundsure reports for the Proposed Development and associated land, existing site investigation reports relating to the wider landholding as well as publically available British Geological Survey (BGS) mapping (Ref 11-11) and the data.gov data repository (Ref 11-12). An intrusive ground investigation has also been conducted at the site. A factual description of the investigation is provided in the SOCOTEC Factual Report on Ground Investigation (Appendix 11C) and interpretation of the findings is presented in the AECOM Geotechnical and Geo-environmental Interpretative Report (Appendix 11D). While these reports were not available when chapter was prepared, the initial findings have been considered where appropriate. This information has then been used to formulate a Conceptual Site Model to allow an assessment of potential environmental risks. The above information has been synthesised, in order to characterise the baseline conditions of the Site.

11.3.2 Potential receptors were then identified and their relative sensitivity evaluated as described within Table 11.1 below, based on the Highways Agency Design Manual for Roads and Bridges (Ref 11-13). The criteria used to determine the sensitivity of receptors and the magnitude of impacts has been developed by technical specialists and has been applied to similar land development proposals. Where appropriate, for the purpose of this assessment, risk likelihood has been interpreted as being equal to the impact rating (e.g. low likelihood/ low impact).

**Sensitivity/ Importance of Receptors**

11.3.3 Using information gathered during the desk-based study, the presence and relative sensitivity of receptors at risk from potential land contamination and risks to geological/ geomorphologic features have been evaluated by consideration of the following factors:

- Surrounding land uses, based on mapping and site visits and consideration of the occupants of adjacent sites;
- Proposed end-use, based on the nature of the Proposed Development;
- Type of construction operations that will be necessary as part of the Proposed Development;
- Surrounding sites of nature conservation importance;
- Underlying groundwater;
- Surrounding sites and/or areas of geological/geomorphological importance; and
- Geology, hydrogeology and hydrology of the Proposed Development and its surrounding area.

11.3.4 The sensitivity of receptors or geological features that could be affected by the Proposed Development is described qualitatively according to the categories presented in Table 11.1.

**Table 11.1: Summary of Receptor Sensitivity**

Qualitative description	Receptor sensitivity		
	Low	Medium	High
End users (operational workers/visitors)	“Hard” end use (e.g. industrial, car parking)	Landscaping or open space	Residential, allotments and play areas
Surrounding land uses	Industrial area	Open space or commercial area	Residential area
Construction workers	Minimal disturbance of ground	Limited earthworks	Extensive earthworks and demolition of buildings

Qualitative description	Receptor sensitivity		
	Low	Medium	High
Ecological sites	No sites of significant ecological value close by	Locally designated ecological sites	Nationally or internationally designated ecological sites, including Sites of Special Scientific Interest (SSSIs), Local and National Nature Reserves, Special Protection Areas etc.
Built environment	Not applicable	Buildings, including services and foundations	Nationally or internationally designated sites of historic value or other sensitivity
Geology / geomorphology	Areas of superficial geology or geomorphologic features with no special significance	Other areas of potential mineral resources Exposed geological features of local importance or educational value	Nationally or internationally designated geological sites Local Geological Sites SSSIs Mineral reserve allocated on Local Minerals Plan
Groundwater	Non aquifer Low quality resource No abstractions within 1 km	Secondary Aquifer Abstraction point within 1 km Source Protection Zone (SPZ) within 1 km of the Site	Principal Aquifer High quality resource Abstraction point within 250 m SPZ on-site

11.3.5 The Site was then considered in detail with respect to the proposed construction, operational and decommissioning phases, and any ground contamination or soil quality related impact considered likely to result are described herein and, where possible, quantified.

**Prediction of Potential Impacts**

11.3.6 The potential impacts (or risks) associated with contaminated land have generally been assessed by means of a hazard-pathway-receptor model (the Pollutant Linkage), where the following definitions apply:

- Hazard = source of contamination;
- Receptor = the entity that is vulnerable to harm from the hazard; and
- Pathway = the means by which the hazard can come into contact with the receptor.

11.3.7 This assessment considers the potential for the Proposed Development to impact on land quality and receptors on and adjacent to the Site. The assessment also

considers the potential for the Proposed Development to impact upon any geological/ geomorphologic features.

**Contamination Sources (Hazards)**

11.3.8 Land contamination sources can be described qualitatively according to the categories shown in Table 11.2. This is a qualitative judgement, but has been developed in line with accepted methodology for Phase 1 desk studies and Part IIA contamination studies.

**Table 11.2: Descriptive Scale for Different Sources of Land Contamination**

Qualitative Description of Source (Hazard)	Previous Land Use
Low	Greenfield site, or previous or on-going activities with low potential to cause contamination (e.g. residential, retail or offices) OR site investigation data indicating no significant contamination
Medium	Previous or on-going activities with some potential to cause moderate contamination (e.g. railways, collieries, scrap yards) OR site investigation data indicating limited contamination
High	Previous or on-going activity on or near to site with high potential to cause land contamination (e.g. gasworks, chemical works, landfills) OR site investigation data including widespread or severe contamination

11.3.9 If a hazard has been identified and potentially sensitive receptors are present, then the potential impacts associated with the Proposed Development can be predicted by considering the pathways by which the hazard may affect the receptors. Table 11.3 below indicates the most likely potential impacts that may occur in relation to the Proposed Development for different categories of receptor.

**Table 11.3: Summary of the Most Likely Potential Pathways / Impacts that May Affect Potentially Sensitive Receptors**

End users (operational workers / residents / visitors)	Surrounding land uses (including offsite residential areas)	Construction workers	Water resources	Ecological sites	Built environment
Direct or indirect ingestion of contaminated soil (operation).	Inhalation or deposition of wind-borne dust (construction)	Direct or indirect ingestion of contaminated soil (construction)	Existing and/or new pollutant pathways (construction and/or operation)	Phytotoxic impacts on plants (operation)	Chemical attack of buried concrete structures (operation)

End users (operational workers / residents / visitors)	Surrounding land uses (including offsite residential areas)	Construction workers	Water resources	Ecological sites	Built environment
Concentration of flammable or asphyxiating in-ground gases in enclosed spaces (operation).	Migration of contamination in sub-surface strata (including gases) (construction and/or operation)	Concentration of flammable or asphyxiating gases in confined spaces (construction)	Generation of liquid and/or mobile contaminants (operation)	Toxic impacts on fauna (operation and/or construction)	Concentration of flammable/explosive gases in confined spaces. (operation)
Inhalation of harmful in-ground vapours / dusts indoors and outdoors (operation).	N/A	Inhalation of asbestos during building demolition (construction)	N/A	Indirect impacts via contamination of water resources (operation and/or construction)	Permeation of water supply pipelines. (operation)

11.3.10 The potential impacts are assessed based on the existing use and predicted construction and operational stages of the Proposed Development.

11.3.11 The magnitude of a potential impact is described wherever possible by using the terms defined in Table 11.4 below.

**Table 11.4: Descriptive Scale for the Impacts of Geology and Land Contamination**

Magnitude of impact	Examples of typical impacts
High	Loss of exposed designated geological feature Very high risk of exposure of a potentially sensitive receptor to potentially harmful levels of contamination via a confirmed pathway
Medium	Quarrying of rock for imported fill, or substantial changes due to cuttings Proven source – pathway – receptor pollutant linkage identified with elevated level of contamination recorded/ or potential to be present
Low	Superficial disturbance to geology; changes in geomorphology Identified source – pathway – receptor pollutant linkage identified but contamination likely to be low risk
Very low	Changes to made ground deposits No source – pathway – receptor pollutant linkage identified

### Significance of Effects

11.3.12 For each of the potential impacts identified, an assessment has been made of the likely significance of effects.

11.3.13 Where geological receptors are present, then their importance (sensitivity) has been determined and the potential impact of the Proposed Development qualitatively predicted.

11.3.14 Effects are classified based on the identified sensitivity/ importance of the receptor and the predicted magnitude of the impact, using the standard assessment matrix set out in Table 11.5 below, in conjunction with professional judgement of site-specific factors that may be of relevance.

**Table 11.5: Matrix to Determine the Significance of an Effect (Prior to Mitigation)**

Magnitude of impact	Sensitivity/ importance of receptor			
	High	Medium	Low	Very Low
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Very low	Minor	Negligible	Negligible	Negligible

11.3.15 This Chapter considers that major or moderate effects are significant for the purposes of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the ‘EIA Regulations’), in accordance with standard EIA practice.

11.3.16 If potentially significant effects are identified, measures are proposed to mitigate the risks identified. However, industry best practices will be applied whether there is the potential for significant effects or not. The assessment is undertaken on the assumption that best practice will be implemented during construction and operation. The generic categories of mitigation are outlined in Table 11.6 below.

**Table 11.6: Generic categories of mitigation**

Category of mitigation	Description of mitigation measures
Remedial works	Remedial work may be required to allow the development to proceed. The scope and nature of any remedial work is likely to be highly dependent on the results of investigations and subsequent risk assessments.
Design changes	Significant effects can be reduced by changes in design e.g. protective measures to prevent build-up of flammable gases, or modification of layouts to ensure that more sensitive end uses (e.g. residential housing, guardhouses) are sited away from likely areas of contamination. Relocation of built features away from geologically important features. Consideration of the construction method proposed for underground structures to minimise potential impacts on groundwater.

Category of mitigation	Description of mitigation measures
Protective measures during construction	Many of the potentially significant effects on the construction workforce can be mitigated by the use of appropriate protective equipment, such as gloves and respiratory protection, and effective dust suppression techniques.
Environmental management	Environmental management may be required to prevent construction work and future operations from giving rise to land contamination.

### Extent of Study Area

- 11.3.17 The Site encompasses the land required for the construction and operation of the Proposed Development, construction laydown area and associated connections including electricity connection and the new gas pipeline route. The Site is located in the vicinity of the existing VPI CHP plant and east of the existing Lindsey Oil Refinery (LOR) in North Killingholme, Lincolnshire.
- 11.3.18 The study area encompasses the Site and a 2 km buffer around the Site; no ground condition or geological effects are anticipated beyond this distance.

### Information Sources

#### ***Desk Study***

- 11.3.19 Separate Phase 1 Geotechnical and Geo-Environmental Site Assessment reports have been prepared for the proposed OCGT Site (Appendix 11A in PEI Report Volume III) and the land intended for construction laydown and gas pipeline connection corridors associated with this Proposed Development (Appendix 11B in PEI Report Volume III). These reports were prepared to determine the baseline ground conditions and to identify any pre-existing land contamination. As part of this assessment, GroundSure® Reports (commissioned from GroundSure Limited) were obtained for the Main OCGT Power Station Site and Proposed Construction Laydown Area and Proposed Gas Pipeline route, as defined in Chapter 3.
- 11.3.20 The GroundSure® Reports summarise the environmental information available in the public domain from a variety of sources, including information on:
- Sites holding relevant authorisations and permits, including Environmental Permits, discharge consents, water abstractions and Control of Major Accident Hazards (COMAH) registered sites;
  - Environmental quality and sensitivity information including information on ground and surface water, and sites of ecological interest;
  - The presence of potentially contaminating activities including waste management and disposal facilities, consented trade effluent discharges, and
  - Other potential risk factors such as radon risk, mining and natural subsidence risk.

***Intrusive Ground Investigation***

11.3.21 An intrusive ground investigation was conducted on an area of land including the proposed OCGT Power Station Site in April 2018. The ground investigation comprised the advancement of six boreholes, eight window samples and the excavation of thirteen machine and hand-dug trial pits and trenches. A total of 26 soil samples were taken and analysed for a range of parameters including metals, Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), Total Petroleum Hydrocarbons (TPH) and asbestos. Fourteen dual-purpose groundwater/ground gas wells were installed, from which a total of seven groundwater samples were obtained on subsequent monitoring visits, and in situ monitoring of ground gas was also undertaken. The findings of the investigation are presented in SOCOTEC' Factual Report in Appendix 11C (PEI Report Volume III), and AECOM's Phase 2 Geotechnical and Geo-environmental Interpretative Report in Appendix 11D (PEI Report Volume III)

**11.4 Consultation**

11.4.1 The consultation undertaken with statutory consultees to inform this chapter, including a summary of comments raised via the formal Scoping Opinion (Appendix 1B PEI Report Volume III) and in response to the informal Stage 1 consultation is summarised in Table 11.7 below.

Table 11.7: Initial Consultation Summary Table

Consultee	Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
Secretary of State	July 2018 (Scoping Opinion)	<p><u>Baseline</u></p> <ul style="list-style-type: none"> <li>The Scoping Report states that a Phase 1 desk study and a Phase 2 intrusive ground investigation have been completed. The results of these studies and the soil analysis should form the basis of the ground conditions and hydrogeology baseline within the ES.</li> <li>Full details of how the baseline assessments were undertaken including the depth and location of the boreholes, window samples, trial pits, and trial trenches should be included within the ES.</li> <li>The Inspectorate notes that the baseline information omits reference to ground gas and the water table. These matters should be included within the baseline in the ES.</li> </ul> <p><u>Underlying Geology</u></p> <ul style="list-style-type: none"> <li>The geology, superficial deposits and soil characteristics for the proposed underground pipeline routes should be described within the ES</li> <li>For greater clarity, the ES should include a figure that presents the underlying geology and superficial deposits.</li> </ul>	<p>These reports have been used to inform the baseline as described within and appended to this Chapter.</p> <p>Full details are included in Appendix IIA &amp; 11B (PEI Report Volume III)</p> <p>Ground gas and hydrogeology have been assessed and are included as part of the baseline presented in this Chapter.</p> <p>The underlying geology at the site is discussed in the Phase 1 and Phase 2 reports and is presented in this Chapter. A conceptual geological cross section is provided as Figure 11.1 (PEI Report Volume II).</p>

Consultee	Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
Secretary of State	July 2018 (Scoping Opinion)	<p><u>Receptors</u></p> <ul style="list-style-type: none"> <li>The Scoping Report has not defined the term 'sensitive receptor'. Sensitive receptors the methodology and criteria used to determine them should be included within the ES. The ES should include a figure(s) depicting the locations of the sensitive receptors.</li> <li>The Scoping Report makes no reference to ecological receptors. The ES should confirm whether any ecological receptors are in hydrological connectivity to the Proposed Development. If any are in hydrological connectivity to the site, any likely significant effects should be described in full in the ES.</li> </ul> <p><u>Mitigation</u></p> <ul style="list-style-type: none"> <li>The Applicant should make effort to agree the proposed mitigation measures with relevant consultation bodies. The assessment in the ES should include a full description of the measures and describe whether they are effective or not.</li> </ul> <p><u>Study Area</u></p> <ul style="list-style-type: none"> <li>The Scoping Report does not provide a study area for the assessment of ground conditions and hydrogeology. A clearly defined and justified study area that adheres to the relevant guidance should be included within the ES.</li> </ul>	<p>Receptor sensitivity and the methodology used to determine that sensitivity is discussed in section 11.3 of this chapter. The risks to ecological receptors are discussed in the Phase 1 and Phase 2 reports and based on the ground conditions identified at the site. The site is not considered to be in hydrological connectivity with the River Humber, and consequently the risk to ecological receptors has been assessed as low.</p> <p>No mitigation is proposed as no significant effects have been identified. Embedded mitigation and pollution prevention measures will be included in the environmental permit required for the operation of the gas-fired power station. The study area comprises a 2km radius from the boundary of the site, as presented in this PEI Report. This is regarded as a highly conservative distance from the site in terms of effects on potential receptors in any pollutant linkages that may be identified. The extent of the study area is outlined in the Phase 1 Desk Studies, which can be found in Appendices 11A and 11B (PEI Report Volume III)</p>

Consultee	Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
Secretary of State	July 2018 (Scoping Opinion)	<p><u>Methodology &amp; Potential Impacts</u></p> <ul style="list-style-type: none"> <li>The Scoping Report does not explain the assessment methodology that will be used in the ES. A full description of the assessment methodology should be included within the ES.</li> <li>The ES should assess impacts from the construction, operation or decommissioning phase of the Proposed Development where significant effects are likely to occur. The assessment should take into account and impacts to human health from ground contamination and/or the migration of material off-site.</li> </ul> <p><u>Underground Gas Pipeline</u></p> <ul style="list-style-type: none"> <li>The Scoping Report does not address the extent to which the construction of the proposed underground gas pipeline may result in significant effects. The ES should establish the ground conditions and hydrogeological baseline for the new underground gas pipeline route(s). This information should be used to undertake full assessment of the anticipated environmental effects that may arise from the construction of the underground gas pipeline(s) within the ES.</li> <li>If a preferred gas pipeline route has not been determined prior to submission of the ES, the ES should include an assessment of the potential environmental effects that may arise from both underground gas pipeline routes.</li> </ul>	<p>The assessment methodology is included as part of this Chapter.</p> <p>Assessed as part of this Chapter.</p> <p>The gas pipeline has been considered as part of the Supplementary Phase 1 document (Appendix 11B in PEI Report Volume III) and has been assessed as part of this chapter.</p> <p>The potential environmental effects of the use of either gas pipeline corridor have been assessed in this chapter</p>

Consultee	Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
Secretary of State	July 2018 (Scoping Opinion)	<p><u>Piling</u></p> <p>The Scoping Report has not included information regarding piling. If piling is necessary, the location of the piling and any associated likely significant environmental effects should be assessed within the ES.</p>	Risks associated with piled foundations have been considered in the Phase 2 Interpretative report presented in Appendix 11D.

Consultee	Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
The Environment Agency	July 2018 (Scoping Opinion)	<ul style="list-style-type: none"> <li>• In producing the Phase 1 and Phase 2 reports (which were not available at the time of the consultation), the developer should;               <ol style="list-style-type: none"> <li>1. Follow the risk management framework provided in CLR11, Model Procedures for the Management of Land Contamination, when dealing with land affected by contamination.</li> <li>2. Refer to the Environment Agency Guiding principles for land contamination for the type of information that we required in order to assess risks to controlled waters from the site. The Local Authority can advise on risk to other receptors, such as human health.</li> <li>3. Consider using the National Quality Mark Scheme for Land Contamination Management which involves the use of competent persons to ensure that land contamination risks are appropriately managed.</li> </ol> </li> <li>• Investigation boreholes that penetrate the full depth of the lower permeability superficial clay deposits may potentially result in risks to the underlying aquifer from the potential mobilisation of contaminants and/or the creation of preferential pathways for contaminant migration. Appropriate risk assessments and best practice should be adopted during intrusive investigations to ensure the integrity of the Principal Chalk aquifer at depth is not compromised.</li> </ul>	<p>The Phase 1 &amp; Phase 2 reports have been prepared in line with available guidance documents.</p> <ol style="list-style-type: none"> <li>1. Both the Phase 1 and Phase 2 documents have been prepared in accordance with the guidance in CLR11. CLR11 is referenced in both the Phase 1 and Phase 2 reports, as well as in this chapter.</li> <li>2. The Environment Agency document 'Guiding principles for land contamination' was considered in producing both Phase 1 and Phase 2 reports and has been referenced in those documents, as well as this chapter.</li> <li>3. Use of the NQMS is considered unnecessary at this stage and no further work is proposed with regards to contamination. Both Phase 1 Desk Study reports and the Phase 2 Ground Investigation have been checked.</li> </ol> <p>The Ground Investigation design took account of the possible presence of aquitards and low permeability strata within the ground and care was taken to ensure that no pathways were created from shallow groundwater to the principal aquifer at depth. Further details on the well installations are provided in the Phase 2 Factual Report (Appendix 11C).</p>

Consultee		Date (method of consultation)	Summary of consultee comments	Summary of response/ how comments have been addressed
North Lincolnshire Council		July 2018 (Scoping Opinion)	<ul style="list-style-type: none"> <li>The proposals to further assess land contamination are acceptable; this department therefore has no further comments to make.</li> </ul>	None Required

## 11.5 Baseline Conditions

### Existing Baseline

11.5.1 This section describes the Site in its current state (without the Proposed Development) and the sensitivity of the receiving environment to change.

### Designated Sites

11.5.2 The Humber Estuary, approximately 1.4km to the north east is designated as a Site of Special Scientific Interest (SSSI), a Special Area of Conservation (SAC), a Special Protection Area (SPA) and a Ramsar Site. North Killingholme Haven Pits, approximately 1.9km to the North, is designated as a SSSI.

11.5.3 The site is located within a Nitrate Vulnerable Zone.

### Existing and Previous Land Uses

11.5.4 Table 11.8 below details the history of the areas of the Site within the proposed OCGT Power Station Site, as based on available OS historical mapping.

**Table 11.8: Summary of Site History (Proposed OCGT Site)**

Date	Onsite Land Use	Offsite Land Use
1886-1887	<ul style="list-style-type: none"> <li>• Marsh land;</li> <li>• Rosper Road present;</li> <li>• East Middle Mere Road present.</li> </ul>	<ul style="list-style-type: none"> <li>• Cawber Farm – north east (450m);</li> <li>• Marsh Farm – south east (750m).</li> </ul>
1906-1910	No significant change.	No significant change.
1930-1947	No significant change.	<ul style="list-style-type: none"> <li>• Goxhill and Immingham Line/Killingholme Station present – east (850m);</li> <li>• School present – south (650m);</li> <li>• Ulceby-Immingham railway line present (100m south west).</li> </ul>
1951	<ul style="list-style-type: none"> <li>• Drainage system in place.</li> </ul>	<ul style="list-style-type: none"> <li>• Municipal buildings present – south east (500m);</li> <li>• Railway depot present – east (850m).</li> </ul>
1968	No significant change.	No significant change.
1974	<ul style="list-style-type: none"> <li>• Railway sidings present (west).</li> </ul>	<ul style="list-style-type: none"> <li>• Vast industrial expansion including an oil refinery west and east of site.</li> </ul>
1983	No significant change.	No significant change.
2002	<ul style="list-style-type: none"> <li>• Pipe line on southern border of site.</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of road system to south (A180/A160/A1173) (750m).</li> </ul>

Date	Onsite Land Use	Offsite Land Use
2010	No significant change.	<ul style="list-style-type: none"> <li>Immingham West Fire Station approximately 750m south of site (date built is unknown).</li> </ul>
2014	<ul style="list-style-type: none"> <li>Car park now present.</li> </ul>	<ul style="list-style-type: none"> <li>New road system throughout oil refinery, directly west of site.</li> </ul>

11.5.5 Prior to its proposed use, this part of the Site has been used originally as agricultural land and latterly as a construction laydown and car parking area for the adjacent refinery. A pipeline was constructed along the southern boundary of the Site between 1983 and 2002. A limited number of other potential sources of contamination were identified from historical maps including a railway, oil refineries and a former sludge land farm.

11.5.6 Table 11.9 below details the history of the areas of the Site associated with the proposed gas pipeline routes, as based on available OS historical mapping.

**Table 11.9: Summary of Site History (Proposed Construction Laydown Areas and Proposed Pipeline Routes)**

Date	Onsite Land Use	Offsite Land Use
1886-1887	<ul style="list-style-type: none"> <li>Marsh/ Agricultural land;</li> <li>Rosper Road present;</li> </ul>	<ul style="list-style-type: none"> <li>Humber road – South (350m);</li> <li>Cawber Farm – north west (550m);</li> <li>East middle mere road - north (650m);</li> <li>Marsh Farm – north east (700m);</li> </ul>
1905-1910	No significant change;	No significant change;
1929-1930	No significant change;	<ul style="list-style-type: none"> <li>Ulceby-Immingham railway line present south (adjacent);</li> <li>School present – south east (350m);</li> </ul>
1947	No significant change;	No significant change;
1951	No significant change;	No significant change;
1968	No significant change;	No significant change;
1974	No significant change;	<ul style="list-style-type: none"> <li>Oil refineries and associated buildings and tanks had been constructed and extended beyond 750m away from the site to the west/ north west and south;</li> <li>Railway line had been constructed running adjacent to the south west of the site;</li> <li>Cawber farm was no longer present;</li> </ul>

Date	Onsite Land Use	Offsite Land Use
1983	No significant change;	No significant change;
2002	<ul style="list-style-type: none"> <li>A pipeline now runs through the middle of the site and one borders the north western boundary of the site;</li> </ul>	No significant change;
2010	<ul style="list-style-type: none"> <li>Buildings constructed on site most likely associated with the VPI facility, with the pipeline being redirected around the facility;</li> </ul>	<ul style="list-style-type: none"> <li>Immingham West Fire Station – south east (400m);</li> </ul>
2014	<ul style="list-style-type: none"> <li>Roads associated with the VPI facility are now shown on the map.</li> </ul>	No significant change.

11.5.7 Prior to the development of a Combined Heat and Power plant, the wider Site had a primarily agricultural use, though it was lost to active farming use prior to its redevelopment in 2004.

#### ***Surrounding Land Use***

11.5.8 The land surrounding the Site was primarily agricultural land until the Humber Refinery and the Lindsey Refinery to west and northwest of the site respectively, were opened in the late 1960s.

#### ***Hydrology***

11.5.9 The largest and most proximal surface water course is the River Humber, located c.1.3km directly to the east of the site. A number of other drains and tributaries of the River Humber are also present in close proximity to the Site. Further information on hydrology and flood risk can be found in Chapter 12: Surface Water, Flood Risk & Drainage.

#### ***Geology & Hydrogeology***

##### Made Ground

11.5.10 Made Ground was encountered during the Phase 2 Ground Investigation (Appendix 11C, Volume III of this PEI Report) in most of the exploratory boreholes over a range of depths (approximately 0.2m to 1.7m below ground level (bgl)) across the site. Made Ground is predominately described as a mix of slightly sandy, slightly gravelly, clay and sandy, clayey, gravel in a few boreholes. It contains a mixture of angular to sub-angular gravel of chalk, flint and sandstone. Cobbles are described as sub-rounded to sub-angular of concrete and chalk.

Superficial Geology

- 11.5.11 Superficial materials were found to be Glacial Deposits, comprising Glacial Till and Glacial Sands and Gravels. Natural superficial deposits were present at the surface in some locations.
- 11.5.12 Glacial Till is found consistently in all of the boreholes with approximately 17.0m to 21.0m thickness. It has been described mainly as firm, becoming stiff to very stiff below 6.0m bgl brown, mottled grey, slightly sandy, slightly gravelly, clay.
- 11.5.13 Layers of Glacial Sands and Gravels were encountered in a number of boreholes, but were absent in boreholes BH2, BH4 and BH5, being replaced by a clay till deposit. Where encountered, the deposits were described as medium dense, brown, slightly sandy, slightly clayey sand and slightly gravelly, slightly clayey, gravel. A layer of sand up to approximately 1.0m thick was encountered in 11 of the 27 exploratory locations, between 4.5m and 6.5 m bgl. A further layer of several metres thickness, varying from 2.3m to 2.7m thick was recorded in 3 of 6 boreholes (BH1, BH3 and BH6) at between 12.9m bgl and 16.0m bgl.

Bedrock Geology

- 11.5.14 The boreholes encountered chalk bedrock of the Burnham Chalk Formation. This confirms what can be seen in the BGS maps of the site. The top the weathered bedrock is found approximately at 21.5m to 27.5m bgl. The upper levels of the chalk are frequently described as extremely weak to very weak with clusters of sub-horizontal and sub-vertical fractures. Chalk was mostly recovered as sandy, gravelly, clay. This indicates the upper part of the chalk is highly weathered.
- 11.5.15 Less weathered chalk was recorded between the depths of 26.1m and 30.9m bgl and described as weak to medium strong, cream/white chalk.

Hydrogeology

- 11.5.16 The EA aquifer classifications for the identified superficial deposit and bedrock underlying the site is summarised in Table 11.10 below:

**Table 11.10: Summary of EA aquifer classifications**

Formation	EA aquifer classification	Aquifer definition
<b>Superficial deposits</b>		
Glacial Deposits	Secondary (undifferentiated) Aquifer	Defined by the EA either as; <i>“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”</i> , or <i>“lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, tin permeable</i>

Formation	EA aquifer classification	Aquifer definition
		<i>horizons and weathering”.</i>
<b>Bedrock</b>		
Burnham Chalk Formation	Principal Aquifer	Defined by the EA as; <i>“highly permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes.”</i>

11.5.17 Groundwater strikes were recorded at a range of depths (1m to 28.6m bgl) throughout the site during the ground investigation. The majority of the strikes occurred in the Glacial Till with a few strikes recorded in the Glacial Sands and Gravels and in the Chalk. In many cases, the groundwater was under sub-artesian pressures and semi-confined by less permeable clay layers. Upon release of these pressures, the recorded water strike level rose quite rapidly.

11.5.18 Following the ground investigation, several visits to site were made to monitor groundwater levels. Recorded groundwater levels ranged from 0.96m bgl to 3.97m bgl.

***Radon***

11.5.19 The Site is not located in a Radon Affected Area and no radon protective measures are necessary in construction of new buildings.

***Previous Investigations of the Site***

11.5.20 Soil Mechanics were commissioned to undertake a ground investigation in 2006 on land including the northern strip of the proposed OCGT Power Station Site formerly used as a sludge land farm. Of the area assessed during this investigation, a number of intrusive locations were observed as being close to Site (TP1, BH5 and CBR7 &10).

11.5.21 From the investigation, made ground was encountered to around 1m bgl, with underlying glacial deposits (comprising stiff clays) extending to at least 16 m bgl (the greatest depth to which any boreholes were advanced). No environmental sampling was conducted as part of this investigation.

11.5.22 Also in 2006, a ground investigation was conducted to support the surrender of the waste management licence which covered activities associated with the disposal/treatment of refinery derived sludge. The sludge land farm operated on the northern part of the proposed OCGT Power Station Site and extended approximately 100m to the north of the site.

11.5.23 Three soil sampling locations, two surface water sampling locations and a groundwater sampling location are relevant for the Site. The results of the chemical analysis indicated that significantly elevated concentrations of hydrocarbons were present in the surface layers of the soil, but that low permeability clays had restricted downwards migration through the soil profile. As such, it was concluded that no risk to groundwater existed at the site. Figure 2 within Appendix B shows where the sampling locations are located in relation to the proposed site.

***Summary of Ground Conditions Encountered – Proposed OCGT Power Station Site***

11.5.24 The ground conditions encountered during the Phase 2 Ground Investigation (April 2018) have been summarised in Table 11.11 below.

**Table 11.11: Summary of Ground Conditions Encountered**

<b>Material</b>	<b>Typical Description</b>	<b>Top of Strata, m bgl</b>	<b>Base of Strata, m bgl</b>	<b>Top of Strata, m OD</b>	<b>Base of Strata, m OD</b>
Made Ground	Sandy gravelly clay	0.0	0.2 to 1.7	6.5 to 4.0	6.3 to 3.2
Glacial Till	Firm to stiff sandy gravelly clay	0.0 to 1.7	21.5 to 27.5	6.0 to 3.5	-16.8 to -21.5
Glacial Sands and Gravels (present in 3 of 6 BH)	Medium dense clayey sand and gravel	12.9 to 13.0	15.2 to 16.0	-6.6 to 8.2	-9.3 to -10.6
Weathered Chalk	Extremely weak to very weak chalk	21.5 to 27.5	26.1 to 30.9	-17.0 to 21.5	-22.5 to -26.6
Unweathered Chalk	Medium strong to strong chalk	26.1 to 30.9	Unproven	-22.5 to 26.5	Unproven

***Potential Pollutant Linkages***

11.5.25 In order for an area of potential contamination (a hazard) identified within the confines of the Site to pose a significant level of risk, a potential source and sensitive target or receptor has to be identified, together with a plausible and effective pathway by which the receptor may be exposed to any given hazard.

11.5.26 Based upon the available information, potential sources of contamination within the Site include:

- Made ground/hard standing present in the car park;

- Stockpiles and mounds (unknown material); and
- Historic landfill/liquid Sludge Disposal Area.

11.5.27 Based upon the available information, potential sources of contamination outside the Site (typically within 500m, unless otherwise specified) include:

- Adjacent refineries (as a result of potential spills/leaks);
- Historic landfills;
- Sand/clay pits;
- Railway line and railway sidings;
- Crushed demolition material / made ground; and

#### Potential Contaminants of Concern

11.5.28 Potential compounds of concern associated with the identified potential sources of contamination were used in order to schedule soil, groundwater and surface water samples collected during the ground investigation (April 2018). The results of the soil and water sampling conducted during the site investigation were screened against Generic Assessment Criteria (GAC). These represent a level of minimal risk, below which it can be presumed that there is no risk to the receptor in question. Where GAC have been exceeded, it does not automatically mean that a risk to the relevant receptor exists but further interpretation of the results may be required. In some cases, the GAC used may also be an environmental standard.

11.5.29 Contaminants of concern that were identified in the Phase 1 reports included:

- Hydrocarbons e.g. crude oil, motor oils, petrol, diesel, kerosene, lubricants, waxes, bitumen, aviation fuel;
- Other organics e.g. alcohols, Polychlorinated Biphenyls (PCBs), methyl tertiary-butyl ether (MTBE), *tert*-Amyl methyl ether (TAME), solvents, aliphatic and aromatic compounds;
- Mineral acids, alkalis, cyanides, sulphur and sulphide;
- Metals e.g. arsenic, zinc, lead, copper, manganese and cadmium;
- Asbestos; and
- Ground gases including carbon dioxide, methane and hydrogen sulphide.

#### Potential Pathways

11.5.30 Based upon the available information, the following are considered to be potential pathways:

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- Human Health;
  - Direct dermal contact with substances in shallow soil and/or groundwater during potential groundworks;
  - Inhalation of substances from the partitioning of vapours from soil and / or shallow groundwater; and
  - Accidental ingestion and/or inhalation of substances in soil/dust and/or shallow groundwater during potential groundworks;
  
- Controlled Waters;
  - Vertical migration through unsurfaced areas, vegetated areas and hard-standing (where there are joins / cracks) and drains/pipework into the Made Ground/shallow soil;
  - Lateral and vertical migration within the made ground and superficial deposits (Secondary undifferentiated Aquifer), e.g. leaching from made ground vertically into shallow soil layers, including into deeper groundwater;
  - Preferential lateral and vertical migration along routes of underground services, pipelines and associated trenches;
  - Lateral overland flow, including via drains, to nearby surface waters;
  - Preferential lateral and vertical migration along routes of underground services, pipelines and associated trench;
  - Lateral and vertical migration within deeper groundwater in the Chalk bedrock (Principal Aquifer);
  - Lateral migration of groundwater into surface water courses and abstraction points;
  - Direct contact of substances within shallow groundwater;
  
- Property;
  - Migration of ground gases and accumulation in confined spaces (e.g. basements, service ducts); and
  - Direct contact with nearby buildings, including Total Lindsey Oil Refinery and Phillips 66;
  
- Ecology;
  - Uptake by ecosystems associated with SSSI, SPA, SAC and Ramsar area; and
  - Uptake by flora and fauna.

#### Potential Receptors and Sensitivity

11.5.31 Environmental receptors identified in the conceptual site model for the current operation of the Site (i.e. baseline conditions) and their respective sensitivity is summarised in Table 11.12 below.

**Table 11.12: Summary of Baseline Receptors and Sensitivity**

Receptor	Sensitivity	Assumptions
On site construction workers	Medium	Assumes correct use of suitable Personal Protective Equipment (PPE) and compliance with site operating procedures.
Off-site workers e.g. Lindsey Oil refinery	Medium	Assumes correct use of suitable PPE, compliance with procedures minimising exposure.
Nearby residents	Low	Initial high sensitivity reduced to low based on distance from site to neighbouring residents and assuming site operations are conducted according to agreed protocols, guidance and legislation, and no spillages or releases occur.
Surface waters including the River Humber	Medium	Initial high sensitivity reduced to medium due to the distance to the major surface water feature and assuming site operations are conducted according to agreed protocols, guidance and legislation, and no spillages or releases occur.
Abstraction points	Low	The distance to the nearest abstraction and the use of the water for industrial purposes and not potable supply reduces the sensitivity of the receptor to low.
Shallow groundwater within the superficial deposits (Secondary undifferentiated Aquifer)	Low	The receptor is not regarded as being sensitive and assumes site operations are conducted according to agreed protocols, guidance and legislation, and no spillages or releases occur.
Deep groundwater within the chalk bedrock (Principal Aquifer)	Medium	Low-permeability superficial deposits are likely to limit transmission from surface to deeper groundwater, assuming normal site operations with no spills or releases and adherence to site guidance and protocols during operations and assuming appropriate mitigation measures are in place during excavation.
Underground services e.g. buried pipes	Low	Assuming appropriate mitigation measures are in place during excavation.
Confined spaces within buildings e.g. basements, service ducts	Low	Assuming appropriate mitigation measures are in place during excavation.
River Humber SSSI, SPA, SAC and Ramsar	Medium	Assuming normal site operations with no spills or releases and adherence to site guidance and protocols during operations.

Receptor	Sensitivity	Assumptions
Flora and Fauna	Low	Assuming normal site operations with no spills or releases and adherence to site guidance and protocols during operations.

### Future Baseline

11.5.32 In the event that the Proposed Development does not proceed, no significant changes to the existing baseline assumed for the Proposed Development are anticipated.

## **11.6 Development Design and Impact Avoidance**

11.6.1 The following impact avoidance measures would either be incorporated into the design or are standard demolition, construction and operational practices. These measures have therefore been taken into account during the impact assessment. Any need for additional mitigation measures as identified as a result of the impact assessment are described (where necessary) later in this Chapter.

### Possible Foundation Solutions

11.6.2 Depending on structural loading and settlement tolerances, based on the known ground conditions at the Site, foundations may comprise shallow pads/ rafts or piles.

11.6.3 It is likely that some of the heavier or more sensitive structures of the Proposed Development, including the stack and turbine block will require piled foundations.

### Construction

11.6.4 The appointed contractor(s) will (in due course) be required to produce a Construction Environmental Management Plan (CEMP) that will provide details of proposed environmental control measures, including measures related to the protection of land quality. The CEMP will include the impact avoidance measures as outlined in this section. A Framework CEMP will be included in the ES to support the DCO application.

11.6.5 During construction of the Proposed Development the Contractor(s) will be required to minimise adverse land contamination effects on sensitive receptors by implementing good operational practices (e.g. employing suitable surface water drainage control).

11.6.6 Construction workers will be protected from contact with hazardous materials by adopting appropriate health and safety measures including an assessment of appropriate measures under the Control of Substances Hazardous to Health (COSHH) Regulations 2002. Such measures will include suitable personal protective equipment, hygiene facilities and the implementation of dust control where considered necessary.

- 11.6.7 With regards to earthworks, the contractor(s) will ensure that all material is suitable for its proposed use and will not result in an increase in contamination-related risks on identified receptors including any landscaped areas and underlying groundwater. Any material moved onto or off the site will need to comply with a Materials Management Plan to ensure that all materials are suitable for the proposed end use.
- 11.6.8 The main potential source of oils and fuels on site is from plant and machinery. All plant and machinery will be checked regularly and, where possible, the use of drip trays will be employed, should vehicles be parked on unsurfaced areas of the site. An emergency spillage action plan will be produced and provisions made to contain any leak/spill.
- 11.6.9 The contractor(s) will be required to implement pollution control measures to deal with any contaminated land encountered during the construction works. These measures will include, as a minimum, the following:
- The requirement for all workers to wear appropriate PPE;
  - The requirement for the contractor(s) to investigate any potentially contaminated ground, including any isolated 'hotspots' of contamination encountered during construction; and then to assess whether there is a need for containment or disposal of any contaminated material. The contractor(s) will also be required to assess whether any additional health and safety measures are required to protect construction workers, future site users, water resources, structures and services. Any such investigations will be required to be undertaken in consultation with the EA and other relevant consultees. To further minimise the risks of contaminants being mobilised and contaminating other soils or water, construction workers will be briefed as to the possibility of the presence of such materials;
  - The requirement for the contractor(s) to place waste arisings and temporary stockpiles away from watercourses and drainage systems, whilst surface water will be directed away from stockpiles;
  - The requirement to reduce the risk to surface water and groundwater from run-off from any contaminated stockpiles during construction works by implementing measures including sealing stockpiles to prevent rainwater infiltration. Alternatively, bunding and/or temporary drainage systems will be put in place, designed in line with current good practice, following appropriate guidelines and obtaining all relevant licences including discharge consents;
  - The requirement to appropriately discharge any waters removed from excavations by dewatering, subject to the relevant licences being obtained; and
  - The requirement for the Contractor(s) to implement a dust management system in order to control the potential risk from any airborne contamination migrating off-site.

- 11.6.10 Foundations and services will be designed and constructed to prevent the creation of pathways for the migration of contaminants and be constructed of materials that are suitable for the ground conditions and designed use, for example water supply pipes will be designed in accordance with current good practice and applicable guidance to ensure pipes are protected from potential impacts associated with any contamination.
- 11.6.11 Gas protection membranes may be incorporated into the foundation design to account for elevated ground gas levels should these be present, in accordance with British Standard 8485 entitled 'Code of practice for the Design of Protective Measures for Methane, and Carbon Dioxide Ground Gases for New Buildings' (Ref 11-14).
- 11.6.12 Should the foundation design require piling into bedrock, then piling selection and construction works will be completed following preparation of a piling risk assessment, completed in accordance with the EA's 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention' (Ref 11-15). The use of a piling risk assessment will be secured by requirement of the draft DCO.

#### **Operation and Maintenance**

- 11.6.13 Most significant impacts to soil and groundwater can be avoided by adhering to good housekeeping and management practices. Potentially contaminating liquid storage areas and transformer building areas will be appropriately bunded. In the event of any spillage or leak, this will ensure that the materials are safely contained. However, cumulative emissions of oil based materials from road vehicles are more difficult to manage. An oil/water separator will be retained or installed as appropriate and utilised within a new drainage system to reduce the likelihood of oil-based materials impacting on the environment. Preventative maintenance and preventative measures to stop spillages or leaks from reaching the underlying ground or controlled waters will be required in order for the environmental permit to be granted by the EA for the operational power station.
- 11.6.14 Various maintenance activities will take place during the operational life of the Proposed Development. The measures set out above in relation to construction will also, where appropriate, be employed during maintenance activities.

#### **Decommissioning**

- 11.6.15 During decommissioning, the contractor(s) would be required to minimise adverse land contamination effects on sensitive receptors by implementing good operational practices (e.g. the use of PPE and suitable surface water drainage control).
- 11.6.16 During any earthworks operations (for example to reprofile the Site to create a platform for future development), the contractor(s) would ensure that all material is suitable for its proposed use and would not result in an increase in contamination-related risks on identified receptors including any landscaped areas. If necessary, this would be controlled under a Material Management Plan as defined in the Construction Industry Research and Information Association (CIRIA) Definition of Waste.

11.6.17 The contractor(s) would be required to implement pollution control measures similar to those proposed for the construction of the Proposed Development.

## **11.7 Likely Impacts and Effects**

### **Construction**

11.7.1 Potential impacts during the construction phase are anticipated to include the following:

- The discovery of soils exhibiting visual and olfactory evidence of contamination during groundworks and the potential disturbance of any residual soil contamination through construction activities such as the installation of underground pipelines;
- The discovery of impacted groundwater/ surface water recovered during dewatering which may not be suitable for discharge without treatment;
- Foundation methods and construction activities that may open and/ or modify potential pollutant linkages, including the disturbance of sediments from the existing drainage system;
- Re-profiling of the site including the possible introduction of new fill materials and the removal of unsuitable materials;
- Runoff from contaminated material exposed and/ or stockpiled during site construction works;
- Contamination arising from spillages associated with vehicles and construction materials;
- Airborne contamination arising from potentially contaminated dust;
- Presence of gases, vapours and groundwater in the ground affecting construction workers;
- Removal of any waste materials and/ or contaminated soil; and
- Introduction of contaminated materials during infilling activities.

### **Operation and Maintenance**

11.7.2 Potential impacts during the operational phase are anticipated to include the following:

- Leaks, spills and contamination from storage of chemicals, fuels and wastes on site affecting site users and groundwater; and
- Presence of gases, vapours and groundwater in the ground affecting site users and buildings.

### Decommissioning

11.7.3 Potential impacts during the decommissioning phase are anticipated to be similar to those effects identified for the construction phase.

### Impact Assessment

11.7.4 The impact avoidance measures outlined above would be incorporated into the design. Consequently, these measures have been taken into account during the impact assessment (see Table 11.13 below). Any need for additional mitigation measures as identified as a result of the impact assessment are described (where necessary) later in this Chapter.

**Table 11.13: Summary of impacts and effects**

Description of impact	Mitigating factors	Sensitivity of resource/receptor	Magnitude of impact	Classification of effect
<b>Construction</b>				
Impact to construction workers from contaminated soils, sediments and groundwater/ surface water encountered during construction.	The risk assessment undertaken as part of the Phase 2 Geotechnical and Geo-environmental Interpretative Report (Appendix 11D, PEI Report Volume III) concluded that no risk to human health existed from the soils on site. Trace concentrations of asbestos fibres were identified in soils (<0.001%), which were assessed as posing a low risk to the proposed development. The potential for low concentrations of asbestos to be present in soils at the Site should be considered by the contractor when assessing PPE / mitigation measures and prior to undertaking any off-site disposal of soils. Standard PPE and an appropriate Construction Environmental Management Plan (CEMP) will protect construction workers from exposure pathways created by excavations and site profiling.	Medium	Low	Minor adverse (not significant)

Description of impact	Mitigating factors	Sensitivity of resource/receptor	Magnitude of impact	Classification of effect
Impact to groundwater from runoff and/or leachates from stockpiled materials during construction.	An appropriate CEMP will minimise the risk of run-off from site won material. Potentially contaminated site won material will be stockpiled on impermeable ground, i.e. concrete or tarmac.	Medium	Low	Minor adverse (not significant)
Impact to groundwater from leaks and spillages from vehicles and installations present during construction.	An appropriate CEMP and good site practice will minimise the risk of spillages entering the ground. Vehicle routes within the development site will be covered in hardstanding and fuels and maintenance liquids stored in appropriately bunded containers on impermeable ground.	Medium	Low	Minor adverse (not significant)
Impact to groundwater through creation of new or exacerbation of existing pathways during construction.	Low permeability strata in the ground may prevent contaminants in the soil entering deeper groundwater. Additional mitigation (e.g. piling risk assessment) may be required and would further reduce the hazard.	Medium	Low	Minor adverse (not significant)
Impacts to flora, fauna, ecological receptors and agricultural land from contaminated soils encountered during construction.	Contaminated soils are anticipated to be restricted to the Site, away from agricultural land and ecological receptors, i.e. Humber Estuary SSSI	Medium	Low	Minor adverse (not significant)
Impact to workers, off-site residents and land from potentially contaminated dusts generated during construction.	Adoption of suitable mitigation measures to minimise dust generation (e.g. damping down of materials).	Medium	Low	Minor adverse (not significant)
Risks to underlying groundwater potential contamination in imported fill placed at the Site.	Imported fill to be suitable for use, and subject to testing and visual inspection prior to acceptance at the Site.	Medium	Low	Minor adverse (not significant)

Description of impact	Mitigating factors	Sensitivity of resource/receptor	Magnitude of impact	Classification of effect
<b>Operation and maintenance</b>				
Impact to groundwater from spills, leachates and runoff during site operation.	All fuel and chemical storage areas to be bunded. Design of surface water drainage to include oil-water separator and sediment traps.	Medium	Low	Minor adverse (not significant)
Impacts to buildings and site workers from gases, vapours and groundwater during operation.	The Phase 2 Geotechnical and Geo-environmental Interpretative Report (Appendix 11D) assessed the site as characteristic situation 2 (CS2) with regard to ground gas risk based on the methodology in BS8485 (Ref 11-13), which equates to a low hazard potential. Assuming the development comprises large industrial buildings with large volume spaces which are well ventilated, standard structural mitigation should be sufficient to control the risk, but this should be confirmed by the designer. If made ground, i.e. the likely source, is removed as part of the development, the risk is further reduced.	Medium	Low	Minor adverse (not significant)

## 11.8 Mitigation and Enhancement Measures

11.8.1 As no significant effects have been identified, no additional mitigation measures are required in order to further reduce the potential impacts and effects from the ground conditions on the Proposed Development.

## 11.9 Limitations or Difficulties

### Assumptions

11.9.1 The identification of possible future receptors is based on the Proposed Development indicative concept design. Detailed method statements and/ or work plans for the construction activities at the Site are not available as a Contractor has not yet been appointed, however it is considered reasonable to assume that proposed construction activities will follow industry best practice and relevant

guidance and comply with current applicable legislation, and that standard construction techniques will be used.

- 11.9.2 It has been assumed that no extensive ground works will be required within the area occupied by the existing CHP plant.

### **Limitations**

- 11.9.3 Due to the lack of existing information regarding ground conditions within the Site, an intrusive ground investigation was conducted in April 2018 and a Factual report and an Interpretative report were produced in August 2018 (Appendices 11C and 11D respectively, enclosed in PEI Report Volume III). The ground investigation was designed to obtain additional information on ground conditions beneath the Site, both from the perspective of engineering design and assessing environmental risks. While adequate and robust for the purposes of an initial assessment, it should be noted that there may be ground conditions or contamination present in areas of the Site which are not identified in the ground investigation and which cannot be considered in this assessment. Assuming that the mitigation measures outlined in 11.6 are adopted, any additional contamination subsequently encountered during construction should not result in significant effects.

## **11.10 Residual Effects and Conclusions**

- 11.10.1 Based on the information as detailed herein, the construction, operation, maintenance and decommissioning activities proposed at the Site would have the potential to generate a number of land contamination related adverse effects on identified receptors if appropriate impacts avoidance measures as detailed above are not implemented.
- 11.10.2 However, as the impact avoidance measures are to be employed and any further mitigation measures identified following an appropriately designed ground investigation will be implemented, the significance of effects related to potential geological, hydrogeological and contamination related impacts associated with the Proposed Development during the construction, operation, maintenance and decommissioning phases are likely to be negligible or minor adverse, and therefore not significant.

## **11.11 References**

- Ref 11-1 European Commission (2014) *Communication from the Commission, European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions.*
- Ref 11-2 European Commission (2013) *Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to*
- Ref 11-3 Department for Energy and Climate Change (2011) *Overarching National Policy Statement for Energy EN-1.* The Stationary Office, London

- Ref 11-4 Department for Energy and Climate Change (2011) *National Policy Statement for Fossil Fuel Generating Infrastructure: EN-2*. The Stationary Office, London.
- Ref 11-5 Department for Energy and Climate Change (2011) *National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines: EN-4*. The Stationary Office, London.
- Ref 11-6 Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*
- Ref 11-7 North Lincolnshire Council (2018) *North Lincolnshire Local Plan 2003*
- Ref 11-8 North Lincolnshire Council (2011) *North Lincolnshire Council Local Development Framework 2011-2026*
- Ref 11-9 Environment Agency (2010) *GPLC1 – Guiding Principles for Land Contamination*
- Ref 11-10 Department of the Environment, Food and Rural Affairs (DEFRA) (2004) *Model Procedures for the Management of Contaminated Land, Contaminated Land Report 11*
- Ref 11-11 British Geological Survey (2016) available at: [www.bgs.ac.uk](http://www.bgs.ac.uk) [accessed August 2018].
- Ref 11-12 HM UK Government (2017) (<http://data.gov.uk/>) accessed August 2018
- Ref 11-13 Highways Agency (2008) *Design Manual for Roads and Bridges, Volume 11, Section 2 Environmental Impact Assessment, Part 5, Assessment and Management of Environmental Effects*
- Ref 11-14 BSI (2014) *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*
- Ref 11-15 Environment Agency (2001) *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*