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10. Geology, Hydrogeology and Land Contamination

10.1 Introduction

- 10.1.1 This chapter of the Environmental Statement (ES) identifies and addresses the potential impacts and effects of the proposed Post-Combustion Carbon Capture (PCC) developments located at VPI Immingham's Combined Heat and Power (CHP) Plant and Phillips 66 Limited's Humber Refinery (referred to as 'the Proposed Developments') separately as well as cumulatively, on ground conditions and land quality. It should be read with reference to the description of the Proposed Development in Chapter 3.
- 10.1.2 The assessment has been prepared in accordance with the methodology described in Section 10.3 and is based on the information obtained following the completion of the Phase 1 Geo-environmental and Geotechnical Desk Study report (provided in Appendix 10A in ES Volume II).
- 10.1.3 The chapter has been prepared by AECOM Limited.
- 10.1.4 The following receptors have been considered as part of the assessment:
- human health (construction workers and future site users);
 - controlled waters (superficial and bedrock aquifers, surface water features);
 - development infrastructure;
 - agricultural soils; and
 - offsite receptors.
- 10.1.5 This chapter also outlines the proposed design and other measures to help mitigate the potential effects of the Proposed Developments.

10.2 Legislation and Planning Policy Context

- 10.2.1 The European Union (EU) Directives and United Kingdom (UK) Acts considered to be the key legislative drivers for the geology, hydrogeology and land contamination assessment, including risks to human health and the environment from ground conditions, are summarised as follows.

Legislation

EU Legislation

- 10.2.2 The UK left the EU on 31 January 2020 but the legislation discussed in this section has been adopted by the UK and remains applicable to the assessments in this ES.

The Water Framework Directive (2000/60/EC)

- 10.2.3 The Water Framework Directive is the framework for community action in the field of water policy. The principal objective of the Framework is for all groundwater, surface water and coastal water bodies to achieve 'good' status by 2015 and maintain this status. It includes broader ecological objectives as well as aims to prevent deterioration of all water bodies. The Framework aims to develop sustainable water use and reduce and eliminate the presence of hazardous substances within water bodies. It must be considered in any scheme that has the potential to have an impact on any part of the water environment. This is incorporated in The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

Groundwater Daughter Directive (2006/118/EC)

- 10.2.4 The Groundwater Daughter Directive classifies groundwater bodies, establishes pollutant threshold values, and identifies trends and starting points for their reversal. Specific measures to control groundwater pollution are described, including good groundwater chemical status criteria and provisions to control groundwater pollutant inputs. The Directive provides further details on groundwater pollution control that are outlined within the Water Framework Directive (2000/60/EC). This is incorporated in The Groundwater (Water Framework Directive) (England) Direction 2016 and The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

The Environmental Liability Directive (2004/35/EC)

- 10.2.5 The Environmental Liability Directive relates to the prevention and remedying of environmental damage. The Directive refers to environmental damage to habitats and protected species, water damage (chemical and ecological) and land damage caused by land contamination. In this instance, damage is defined as “*a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly*”. It also establishes a framework based on the ‘polluter pays’ principle to prevent and remedy environmental damage. Operators are therefore liable to the cost of prevention measures and remediation strategies. This is incorporated in The Environmental Damage (Prevention and Remediation) (England) (Amendment) Regulations 2019.

Dangerous Substances Directive (2006/11/EC) as amended

- 10.2.6 The Dangerous Substances Directive sets out the measures of pollution caused by certain dangerous substances discharged into the aquatic environment (inland surface water, territorial waters and internal coastal waters). As part of this Directive, List I and List II substances are described, whereby List I substances should be eradicated and List II substances should be reduced. This is incorporated in The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

UK Legislation

The Environmental Protection Act 1990 (EPA) Part 2A - the Contaminated Land Regime

- 10.2.7 Current legislation relating to contaminated land in the UK is contained within Part 2A of the Environmental Protection Act (EPA), which was inserted by Section 57 of the Environment Act 1995 and by Section 86 of the Water Act 2003 (see below) and implemented by the Contaminated Land (England) Regulations 2006 [S.I. 2006/1380] (amended 2012 [S.I. 2012/263]). Under Part 2A, sites are identified as 'contaminated land' if they are (i) causing harm; (ii) if there is a significant possibility of significant harm; or (iii) if the site is causing, or could cause, pollution of controlled waters (i.e. both surface and groundwater).

The Environment Act 1995 (as amended)

- 10.2.8 The Environment Act 1995 makes provision with respect to contaminated land and abandoned mines. Further provisions are provided for National Parks, pollution controls, natural resource conservation and environment conservation/enhancement.

The Environment Act 2021

- 10.2.9 The Environment Act 2021 makes provision with respect to water (surface and groundwater), waste and improvement of the environment. It provides a legal framework for environmental governance and for specific improvement of the environment, including measures on waste and resource efficiency, air quality and environmental recall, water, nature and biodiversity, and nature conservation covenants.

The Water Resources Act 1991 (as amended)

- 10.2.10 The Water Resources Act 1991 provides statutory protection for controlled waters (i.e. streams, rivers, canals, marine environment and groundwater) and makes it an offence to discharge to controlled waters without the permission or consent of the regulators of these areas. The Act gives the Environment Agency powers and duties to prevent or remedy the pollution of controlled waters. Previously under this Act and now under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) it is a criminal offence for a person to cause or knowingly permit pollution of controlled waters. Sections within the Act refer to water resources management, pollution of water resources, flood defences, fishery controls, financial provisions, land and works powers and information provisions.

The Water Act 2003

- 10.2.11 The Water Act 2003 provides measures with regards to holding and issuing licences for water abstractions. The four broad aims of this Act are to ensure sustainable use of water resources, to strengthen the voice of consumers, to increase competition and to promote water conservation. The Act also considers controlled waters pollution and coal mine water discharge and describes provisions for land drainage and flood defence. This Act was issued to amend the 1991 Water Resources Act and Water Industry Act.

The Water Act 2014

- 10.2.12 The aim of the Water Act 2014 was to reform the water industry to make it more innovative and responsive to customers and to increase the resilience of water supplies to natural hazards such as droughts and floods. The Act describes provisions for the following: abstraction water licence modifications, waterworks records, flood insurance for households, internal drainage boards, regulations for the water environment and Regional Flood and Coastal Committees.

Anti-Pollution Works Regulations (as amended) 1999

- 10.2.13 The Anti-Pollution Works Regulations 1999 make provision with respect to anti-pollution works notices and makes specific reference to what a notice should entail, such as a description of the pollution incident and a description of the works or operations that should be carried out. These Regulations empower the Environment Agency to serve a notice to remediate or mitigate on "*any person who has caused or knowingly permitted poisonous, noxious or polluting matter or any solid waste to be present in controlled waters*". The notice will either describe a potential incident and the risk to associated controlled waters, or for a pollution incident that has already occurred, the notice will describe the pollution event. Furthermore, the notice will describe the necessary operations or works which should be carried out.

Environmental Damage (Prevention and Remediation) (England) (Amendment) Regulations 2019

- 10.2.14 The Environmental Damage (Prevention and Remediation) (England) (Amendment) Regulations 2019 make provision for the legal framework regarding minimisation of environmental damage and the remediation of sites with environmental damage. The amendment published in 2019 describes the requirement to report environmental damage to the Secretary of State.

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) and The Environmental Permitting (England and Wales) (Amendment) (EU Exit) Regulations 2019

- 10.2.15 The Environmental Permitting (England and Wales) Regulations 2016 and (EU Exit) Regulations 2019 set out the measures for those carrying out activities that may cause imminent threats of, or actual 'environmental damage', which require a permit. These Regulations also outline the authorities responsible for enforcing the Regulations. Such Regulations cover environmental permits, discharge into regulated facilities, enforcement and offences, public registers and powers/functions of the regulator and authority.

The Contaminated Land (England) (Amendment) Regulations 2012

- 10.2.16 The Contaminated Land (England) (Amendment) Regulations 2012 set out the processes of risk assessment and identification/ evaluation of remediation options.

The Waste (England and Wales) (Amendment) Regulations 2014 (as amended)

- 10.2.17 The Waste (England and Wales) (Amendment) Regulations 2014 set out the measures required for the prevention of, production and management of waste. This describes the purpose of waste prevention programmes with waste prevention measures and makes reference to monitoring by appropriate authorities using qualitative or quantitative benchmarks.

Policy

National Policy

National Planning Policy Framework

- 10.2.18 The National Planning Policy Framework (NPPF) (Ministry of Communities, Housing and Local Government (MCHLG), 2021) sets out the government's planning policies for England and how these are expected to be applied. This Framework contains policies relevant to the geology and soils assessment.
- 10.2.19 Paragraph 120c describes how *“Planning policies and decisions should] give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land”*.
- 10.2.20 Paragraph 174b relates to contributing to and enhancing the local environment through recognising the benefits of natural capital, ecosystem services, agricultural land, trees and woodland.
- 10.2.21 Paragraphs 183 – 188 form part of a section called ‘Ground conditions and pollution’.
- 10.2.22 Paragraph 183 details requirements of planning policies in the context of proposed development on a site including adequate site investigation, suitability in the context of ground conditions, land instability and contamination and proposals for mitigation. This requires that land cannot be classified as contaminated post remediation as defined under the Environmental Protection Act 1990 Part IIA.
- 10.2.23 Paragraph 184 relates to the responsibility of developers and/ or landowners for safe development.
- 10.2.24 Paragraph 185 refers to minimising the effects of pollution and adverse impacts from the proposed development.

Planning Practice Guidance

- 10.2.25 The Planning Practice Guidance (PPG) (Department for Levelling Up, Housing and Communities and MHCLG, 2021) provides an in-depth guidance to sections of the NPPF. Sections that are relevant to the geology, hydrogeology and land contamination assessment include Land Affected by Contamination, Land Stability and Natural Environment.

National Policy Statements

- 10.2.26 A series of Energy National Policy Statements (NPS) were published in 2011 by the Department of Energy and Climate Change to describe the energy infrastructure national policy. Consultation on updated drafts of the Energy NPS were published in 2021 (Department for Business, Energy & Industrial Strategy, 2021a). The NPS were produced for Nationally Significant Infrastructure Projects (NSIPs). Although the Humber Zero project is not

designated as an NSIP, the NPS provides useful and relevant guidance which has been summarised below.

- 10.2.27 The draft update of the Overarching NPS for Energy (EN-1) describes the major energy infrastructure delivery policies (Department for Business, Energy & Industrial Strategy, 2021b). Section 2.2 to 2.4 details the government's position on net zero targets and decarbonisation of the energy sector. Section 4.3 states that human health effects of the proposed project should be identified and mitigated, including from air or water pollution, dust, odour, hazardous waste and substances and exposure to radiation. Section 4.11 (Pollution Control and Other Environmental Regulatory Regimes) (Department for Business, Energy & Industrial Strategy, 2021b) details that issues relating to discharges or emissions from a proposed project which may affect onshore environments, offshore environments 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 it should be confirmed that:

“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”.

- 10.2.28 Section 5.4 of NPS EN-1 (Biodiversity and Geological Conservation) details the importance of geological conservation and mitigation, and states that:

“where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity”

- 10.2.29 Section 5.16 of NPS EN-1 (Water Quality and Resources) describes the potential for infrastructure to affect the water environment, such as groundwater, transitional waters and surface water. The policy encourages the management of surface water in construction and protection measures to mitigate potential groundwater pollution. It 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 or equivalent”.

- 10.2.30 The policy recommends that the ES includes the following:

“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) and also demonstrate how proposals minimise the use of water resources and water consumption in the first instance;

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 protected areas (including shellfish protected areas) under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and source protection zones (SPZs) around potable groundwater abstractions”.

10.2.31 Specific reference is made within the Overarching NPS for Energy (EN-1) and the NPS for Renewable Energy Infrastructure (EN-3) to carbon capture and storage (Department for Business, Energy & Industrial Strategy, 2021b, c).

Local Policy

The North Lincolnshire Local Plan, 2003

10.2.32 A summary of the planning policy within the North Lincolnshire Local Plan (North Lincolnshire Council (NLC), 2003) that is relevant to geology, hydrogeology and land contamination assessment is provided in Table 10.1.

Table 10.1: Relevant Policy within the North Lincolnshire Local Plan (2003)

Policy Reference	Summary
RD1 – Development involving High Quality Land on page 92.	The policy states that developments will be permitted if it does not result in the loss of Grades 1, 2 and 3a unless there is evidence that the land cannot be developed elsewhere such as lower agricultural grades; land that has already been developed; land allocated for development or land in settlement boundaries. It also states lower quality agricultural land is preferred, and for high grade land, there should be an overriding need for that land.
DS1 – General Requirements (v) on page 244	Part of the criteria for developments includes the prevention of pollution to water, air or land that can cause a danger to the environment or result in detrimental conditions.
DS1 – General Requirements (xiii) on page 245	The policy states the importance of the provision of suitable on-site drainage and overcoming issues with off-site drainage problems.
DS7 – Contaminated Land on page 250	The policy refers to the requirement to demonstrate contaminated land can be remediated. Reference is also made towards the need for a suitable site survey and agreement of a remedial measures scheme to grant permission.
DS9 – Development of Land in the Vicinity of Established Hazardous Installations and Pipelines on page 251	The policy states that planning permission will only be granted in cases where the risks are considered acceptable or can be overcome.
DS10 – New Hazardous Installations and Pipelines on page 251	The policy states that permission will only be granted if it is demonstrated that there are no development restrictions in the surrounding area; there will be no risk to residential properties, or risk to other premises nearby.
DS11 – Polluting Activities on page 252	The policy states the requirement to demonstrate that potentially polluting emissions will not cause contaminated land, threaten current and future surface and groundwater, or adverse environmental conditions that may affect nearby areas and developments.
DS13 – Groundwater Protection and Land Drainage on page 253	The policy states that proposals must consider the requirement for effective land drainage and groundwater protection.
DS14 – Foul Sewage and Surface Water Drainage on page 254	The policy states the need for foul and surface water disposal provision.
DS15 – Water Resources on page 254	The policy states that developments which would negatively affect the water resources via pollution or water abstraction would not be permitted.

Source: North Lincolnshire Local Plan 2003 (NLC, 2003)

North Lincolnshire Core Strategy Adopted 2011

- 10.2.33 A summary of key paragraphs within the North Lincolnshire Core Strategy Adopted 2011 (NLC, 2011) is provided in Table 10.2.

Table 10.2: Summary of key policies within the North Lincolnshire Core Strategy Adopted 2011

Policy Reference	Summary
Paragraph 4.27 and 4.28 on page 24 and paragraph 4.36 on page 25	The paragraphs state the measures to minimise pollution, improve soil quality and water quality will be supported.
Point 10 on CS18: Sustainable Resource Use and Climate Change on page 112	This point makes reference to protecting the environment from pollution and improving the quality of land and water with proposed developments.
Paragraph 11.2 on page 106	This paragraph states that there are several aims to become resilient to climate change, including a reduction in pollution levels, promotion of renewable energy and improvements in water quality.
Paragraph 11.41 on page 113	The paragraph states how support should be provided for carbon capture technologies and cleaning up previously contaminated land.

Source: North Lincolnshire Core Strategy Adopted 2011 (NLC, 2011)

10.3 Assessment Methodology and Significance Criteria

Impact Assessment and Significance Criteria

- 10.3.1 To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied. This methodology has been developed using a range of guidance.
- 10.3.2 Assessment of potential contamination within this ES chapter is risk-based using the Conceptual Site Model (CSM) and involving assessment of the contamination sources, receptors and plausible pollutant linkages at the Sites, in accordance with government guidance and the UK framework for the assessment of risk arising from contaminated land. The assessment takes into account principles adopted by the Environment Agency in Land Contamination: Risk Management (Environment Agency, 2021b). The significance of impacts takes into account the principles of assessment identified in CIRIA Report C552, (CIRIA, 2011) and Environment Agency’s guiding principles for land contamination in assessing risks to controlled waters (Environment Agency, 2010).
- 10.3.3 Assessment of receptor value (sensitivity) for the geology, soils and contamination assessment follows the procedure described in Table 3.11 of the Highways England Design Manual for Roads and Bridges (DMRB) Sustainability & Environmental Appraisal, LA 109 Geology and Soils (Highways England, 2019).
- 10.3.4 Assessment of receptor value (importance) for groundwater resources follows the procedure described in Table 3.70 of the Highways England DMRB Sustainability & Environmental Appraisal LA 113, Road drainage and the water environment (Highways England, 2020a).
- 10.3.5 The value (sensitivity or importance) of a resource, ranges from very high to negligible (or low for groundwater) and is dependent on the assessment area or features of importance and

conservation value. The criteria for determining the value of a resource and typical examples for geology, soils, contamination and groundwater are given in Table 10.3 to Table 10.7.

- 10.3.6 Resources assessed to have a value (sensitivity) of medium or higher are assessed in Sections 10.6 and 10.7 of this chapter.

Table 10.3: Sensitivity (value) of geology and soil receptors, and water environment attributes

Example of definitions of sensitivity for different receptors

Level of Sensitivity	Receptors susceptible to land contamination	Soil and geological receptors	Agricultural Soil resources
Very high	<ul style="list-style-type: none"> human health: very high sensitivity land use such as residential or allotments. surface water: Watercourse having a Water Framework Directive (WFD) classification shown in a River Basin Management Plan (RBMP) and $Q95 \geq 1.0 \text{ m}^3/\text{s}$. Site protected/designated under EC or UK legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interest (SSSI), Ramsar site, salmonid water)/Species protected by EC legislation LA 108 [Highways England, 2020c]. groundwater: Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation LA 108 [Highways England, 2020c]. Groundwater locally supports Groundwater Dependant Terrestrial Ecosystems (GWDTE) SPZ1 	<ul style="list-style-type: none"> geology: very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites, UNESCO Global Geoparks, SSSIs and Geological Conservation Review (GCR) where citations indicate features on international importance). Geology meeting international designation citation criteria which is not designated as such. soils directly supporting an EU designated site (e.g. SAC, SPA, Ramsar site). 	<ul style="list-style-type: none"> Agricultural Land Classification (ALC) grade 1 and 2.
High	<ul style="list-style-type: none"> human health: high sensitivity land use such as public open space. surface water: Watercourse having a WFD classification shown in a RBMP and Q95 groundwater: Principal aquifer providing locally important resource or supporting a river ecosystem. The groundwater is within a Source Protection Zone (SPZ) 2 which is defined by the Environment Agency as a “400 day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken”. 	<ul style="list-style-type: none"> geology: rare and of national importance with little potential for replacement (e.g. geological SSSI, ASSI (area of special scientific interest), National Nature Reserves (NNR)). Geology meeting national designation citation criteria which is not designated as such. soils directly supporting a UK designated site (e.g. SSSI). 	<ul style="list-style-type: none"> ALC grade 3a.
Medium	<ul style="list-style-type: none"> human health: medium sensitivity land use such as commercial or industrial. surface water: Watercourses not having a WFD classification shown in a RBMP and $Q95 > 0.001 \text{ m}^3/\text{s}$ 	<ul style="list-style-type: none"> geology: of regional importance with limited potential for replacement e.g. Regionally Important Geological Sites (RIGS). Geology meeting regional 	<ul style="list-style-type: none"> ALC grade 3b.

Example of definitions of sensitivity for different receptors

Level of Sensitivity	Receptors susceptible to land contamination	Soil and geological receptors	Agricultural Soil resources
	<ul style="list-style-type: none"> groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water. This is within a SPZ3 which is defined by the Environment Agency as the “area around a supply source within which all groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point”. 	<p>designation citation criteria which is not designated as such.</p> <ul style="list-style-type: none"> soils supporting non-statutory designated sites (e.g. Local Nature Reserve (LNR), Local Geological Sites (LGSs), Sites of Nature Conservation Importance (SNCIs)). geology: of local importance/ interest with potential replacement (e.g. non designated geological exposures, former quarries/ mining sites. soils supporting non-designated notable or priority habitats. 	
Low	<ul style="list-style-type: none"> human health: low sensitivity land use such as highways and rail. surface water: Watercourses not having a WFD classification shown in a RBMP and Q95 ≤ 0.001 m³/s groundwater: Unproductive strata 	<ul style="list-style-type: none"> geology: of local importance/ interest with potential replacement (e.g. non designated geological exposures, former quarries/ mining sites. soils supporting non-designated notable or priority habitats. 	<ul style="list-style-type: none"> ALC grade 4 and 5.
Negligible	<ul style="list-style-type: none"> human health: undeveloped surplus land/ no sensitive land use proposed. surface water: Receptor is resistant to change and is of little or no environmental value. groundwater: Receptor is resistant to change and is of little or no environmental value. 	<ul style="list-style-type: none"> geology: no geological exposures, little/ no local interest. soils: previously developed land formerly in ‘hard uses’ with little potential to return to agriculture. 	

Source: Adapted from DMRB LA 109 Table 3.11 (Highways England, 2019) and DMRB LA 113 Table 3.70 (Highways England, 2020a)

Magnitude of Impacts

- 10.3.7 The magnitude of potential impact upon geology and soils receptors considers the scale of the predicted change to baseline conditions and where there are potential pathways between an impact source/ hazard and identified receptors. This takes into account the spatial scale of the impact, as well as its duration and reversibility (e.g., the impact magnitude may be moderated if the impacts are temporary rather than permanent; or are reversible rather than irreversible).
- 10.3.8 The magnitude of impact on a receptor (geology, soils and human health) ranges from 'high' to 'negligible'. The criteria for determining the magnitude of impact on a receptor are given in Table 10.4. The significance (effect) of a potential effect on a resource is dependent on its assigned value and the magnitude of impact and is broadly categorised according to the matrix included as Table 10.5.

Table 10-4: Magnitude of adverse impacts - geology and soils (modified from DMRB LA 109 Table 3.12 and Table E/2.1 (Highways England, 2019))

Example of adverse impacts			
Magnitude of impact	Receptors susceptible to land contamination	Soil and geological receptors	Agricultural soils resources*
High	<ul style="list-style-type: none"> human health: significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels - SP1010 (Contaminated Land: Applications in Real Environments (CL:AIRE, 2014)). Potential for significant harm to human health. Contamination heavily restricts future use of land. surface water: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). groundwater: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). 	<ul style="list-style-type: none"> geology: loss of geological feature/ designation and/ or quality and integrity, severe damage to key characteristics, features or elements. soils: physical removal or permanent sealing of soil resource or agricultural land. 	<ul style="list-style-type: none"> Physical removal or permanent sealing of >20 ha of agricultural land.
Medium	<ul style="list-style-type: none"> human health: contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g., category 4 screening levels SP1010). Significant contamination can be present. Control/ remediation measures are required to reduce risks to human health/ make land suitable for intended use. surface water: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). groundwater: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). 	<ul style="list-style-type: none"> geology: partial loss of geological feature/ designation, potentially adversely affecting the integrity; partial loss of/ damage to key characteristics, features or elements. soils: permanent loss/ reduction of one or more soil function(s) and restriction to current or approved future use (e.g., through degradation, compaction, erosion of soil resource.) 	<ul style="list-style-type: none"> Physical removal or permanent sealing of 1ha – 20ha of agricultural land. Permanent loss/ reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
Low	<ul style="list-style-type: none"> human health: contaminant concentrations are below relevant screening criteria (e.g., category 4 screening levels SP1010). Significant contamination is unlikely with a low risk to human health. Best practice measures can be required to minimise risks to human health. 	<ul style="list-style-type: none"> geology: minor measurable change in geological feature/ designation attributes, quality or vulnerability; minor loss of, or alteration to, one (may be more) key characteristics, features or elements. soils: Temporary loss/ reduction of one or more soil function(s) and restriction to current or approved 	

Example of adverse impacts

Magnitude of impact	Receptors susceptible to land contamination	Soil and geological receptors	Agricultural soils resources*
	<ul style="list-style-type: none"> • surface water: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). • groundwater: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). 	future use (e.g., through degradation, compaction, erosion of soil resource).	
Negligible	<ul style="list-style-type: none"> • human health: contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g., category 4 screening levels SP1010). No requirement for control measures to reduce risks to human health/ make land suitable for intended use. • surface water: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). • groundwater: use sensitivity criteria in DMRB LA 113 (Highways England, 2020a). 	<ul style="list-style-type: none"> • geology: very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature/ designation. Overall integrity of resource not affected. • soils: no discernible loss/ reduction of soil function(s) that restrict current or approved future use. 	

* In accordance with DMRB LA 109, the physical removal or permanent sealing of 1ha of agricultural land is not considered to be discernible.

Significance of Effects

10.3.9 Once the value (sensitivity) of each resource and the magnitude of the potential impact upon it are established, the significance (effect) matrix from Table 3.8.1 DMRB Sustainability & Environmental Appraisal, LA 104 Environment Assessment and monitoring (Highways England, 2020b) is used to determine the significance of the potential effect as reported in Table 3.7 of that document. These have been reproduced and are presented as Table 10.5. and Table 10.6, respectively.

Table 10.5: Significance of potential effect

Magnitude of Impact	Sensitivity of Receptor				
	Negligible	Low	Medium	High	Very High
High	Minor	Moderate	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate	Moderate
Negligible	Negligible	Negligible	Negligible	Minor	Minor

Source: Modified from DMRB Table 3.8.1 LA 104 (Highways England, 2020b)

Table 10.6: Significance categories (effects and typical descriptions)

Significance Category	Typical Description
Major	Effects at this level are material in the decision-making process.
Moderate	Effects at this level can be considered to be material decision-making factors.
Minor	Effects at this level are not material in the decision-making process.
Negligible	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Source: Modified from DMRB Table 3.7 LA 104 (Highways England, 2020b).

10.3.10 The methodology described above has been used to assess the significance for the three principal stages of the Proposed Developments, namely:

- construction;
- operation; and
- decommissioning.

10.3.11 Where possible, each effect has been classified both before and after mitigation measures have been applied. Effect remaining after mitigation has been applied are referred to as 'residual effects'.

Study Area

10.3.12 The study area for this assessment is the area over which potential direct and indirect effects of the Proposed Developments are predicted to occur during the construction (and decommissioning) and operational periods.

10.3.13 Direct effects on ground conditions are those that may arise due to those accidental release of contaminants during construction (and decommissioning) and/ or operation.

- 10.3.14 Indirect effects involve disturbing the ground in such a way that contaminant linkages (source-pathway-receptor) are created, for example, introducing a new pathway for the migration of a pollution plume within the Made Ground into aquifers or by allowing potentially contaminated dusts, during construction, to migrate offsite to nearby residential and/ or commercial properties.
- 10.3.15 The study area for the ground conditions including land quality topic is considered to be the entirety of the ground within the Sites' boundaries, along with a buffer extending 250 m around the Sites in order to identify potential off-site sources of contamination and land stability issues to inform the baseline condition within and adjacent to the Sites. This includes the artificial land adjacent to the Sites, geological deposits underlying artificial ground and any natural ground underlying surface water bodies within the area of the Sites. For assessment of effects to controlled waters including groundwater abstractions and groundwater source protection zones a buffer, extending 1 km from the Sites' boundaries, is considered appropriate.
- 10.3.16 These are considered to be appropriate study areas for the assessment of geotechnical and geochemical aspects in accordance with the methodology set out in DMRB LA 109 Geology and Soils (Highways England, 2019). A study zone of 250 m radius for off-site sources of potential contamination and land stability issues are considered appropriate; and a 1 km radius for the assessment to controlled waters, extends a far enough distance from the Sites to be able to consider contamination migration risks, the location of potential contaminants and the location and nature of on-site and offsite potential receptors (as noted in LA 109 Geology and Soils). This is based on professional judgement by competent experts with relevant and appropriate experience of assessing land contamination and contamination dispersion.
- 10.3.17 Factors that affect the extent of the study area will be dependent on the proposed intrusive works including but not limited to excavation, infill and piling. These activities have the potential to disturb the underlying geology and existence of Made Ground. Any localised contamination present has the potential to migrate, and the use of piled foundations has the potential to create new pathways for contaminant migration to underlying aquifers.

Sources of Information/ Data

- 10.3.18 Current baseline conditions have been determined by a desk-based review of available information supplemented by a walkover. A Phase 1 Desk study was prepared by AECOM dated March 2022 and should be read in conjunction with this chapter. The Desk Study is included as Appendix 10A in Volume II of this ES.
- 10.3.19 The main desk-based sources of information that have been reviewed to inform the current baseline description within the vicinity of the Proposed Development Sites include:
- Google Maps website <https://www.google.co.uk/maps> (Google, 2022);
 - British Geological Survey (BGS) GeoIndex Online <http://www.bgs.ac.uk/GeoIndex/> (British Geological Survey, 2022a);
 - The Coal Authority Interactive Map Viewer <http://mapapps2.bgs.ac.uk/coalauthority/home.html> (The Coal Authority, 2022);
 - Cranfield Soil and Agrifood Institute Soilscales <http://www.landis.org.uk/soilscales/> (Cranfield Soil and Agrifood Institute, 2022).
 - MAGIC website <http://magic.defra.gov.uk/> (Department for Environment, Food and Rural Affairs (Defra), 2022);
 - British Geological Survey (BGS) Solid and Drift for Patrington (Sheet 81 (and including parts of Sheet 82 and 90) 1:50,000 (BGS, 1981);
 - BGS Lexicon of Named Rock Units <https://webapps.bgs.ac.uk/lexicon/> (BGS, 2022b); and
 - Zetica UXO Risk Maps <https://zeticauxo.com/downloads-and-resources/risk-maps/> (Zetica, 2022).

Limitations

10.3.20 The assessment has been undertaken based on the following assumptions:

- the assessment undertaken during the ES has been based on the collation and evaluation of available information obtained from the Environment Agency, BGS and Envirocheck Reports;
- the information presented in this chapter is based on the information available at the time of writing the report;
- if, during construction of the Proposed Developments, any previously unidentified contamination is encountered, an appropriate investigation to allow sampling and testing of materials and risk assessment will be undertaken. Any actions resulting from the risk assessment will be agreed with the local planning authority along with any remedial measures in consultation with the Environment Agency, where risks to controlled waters are identified.

Consultation

10.3.21 Responses as part of the Environmental Impact Assessment (EIA) Scoping process have informed the assessment presented in this chapter. These are summarised in Table 10.7.

Table 10.7: Summary of the EIA Scoping responses

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
Environment Agency	AN.2022/1327 39/01-L01. Response to NLC to inform EIA Scoping Opinion. 22 nd February 2022	The Environment Agency stated they do not have concerns related to the controlled waters contamination risk and the Geology, Hydrogeology and Contaminated Land section.	Not applicable.
Natural England	382957. Response to NLC to inform EIA Scoping Opinion. 21 st February 2022	Natural England provided advice on what should be included as part of the ES. This includes an assessment of expected residues and emissions associated with potential water, air and soil pollution due to the Proposed Developments. An assessment of the significant effects of the Proposed Developments on the land, soil and water should also be considered. Natural England have also requested that the extent to which soils and agricultural land would be impacted is included within the ES and mitigation measures are considered. An Agricultural Land Classification survey may need to be completed. Natural England have also identified that the Sites are within or may impact on the Humber Estuary Site of Special Scientific Interest	Inclusion of assessment on agricultural soils. The Humber Estuary SSSI is located over 1 km from the Proposed Development Sites. The study area for controlled waters is up to 1 km therefore, the Humber Estuary SSSI is not considered to be a receptor and is not taken further in this assessment. Impacts on the Humber Estuary SSSI/ Special Protection Area/ Special Area of Conservation/ Ramsar site are assessed in Chapter 6: Air Quality, Chapter 12: Ecology and Nature Conservation, and in the Reports to Inform Habitats Regulations Assessment which accompany each planning application.

Consultee	Reference, Date	Summary of Response	How comments have been addressed in this chapter
		(SSSI) and the North Killingholme Haven Pits SSSI. Therefore, an assessment of the effects and mitigation measures for the SSSI should be considered.	North Killingholme Haven Pits SSSI is located over 2 km from both Sites and is therefore not considered to be a receptor and is not taken further in this assessment. Impacts on North Killingholme Haven Pits SSSI are assessed in ES Chapter 6: Air Quality and Chapter 12: Ecology and Nature Conservation.
NLC Environmental Protection	PA/SCO/2022/ 2. Response to NLC to inform EIA Scoping Opinion. 11 th March 2022.	The Environmental Protection Team support the approach to undertake a Phase 1 desk study and a Phase 2 report if required. NLC and the Environment Agency would like to be involved in the discussion and agree the requirements for an intrusive investigation in advance.	A Phase 1 desk study has been undertaken and is provided as Appendix 10A in Volume II of this ES. A ground investigation has been undertaken at the VPI site by a third party (Worley). A ground investigation will not be undertaken at the pre-planning stage at the Phillips 66 Site, However, it is anticipated that a ground investigation will be undertaken at the Phillips 66 Site prior to construction.

10.4 Baseline Conditions

- 10.4.1 In order to assess the potential impacts and effects of the Proposed Developments, it is necessary to determine the environmental conditions that currently exist at each Site and in the surrounding area, for comparison. These are known as the existing baseline conditions. Baseline conditions are determined using the results of site surveys and investigations or desk-based data searches, or a combination of these, as appropriate.
- 10.4.2 It is also relevant for the EIA to consider future baseline conditions taking account of any planned or likely changes to the existing baseline, for comparison against the future 'With Development' scenarios (Construction, Opening/ Operation and Decommissioning).

Existing Baseline

- 10.4.3 Baseline conditions are set out in the Phase I Geo-environmental and Geotechnical Desk Study Report (AECOM, 2022) which is presented as Appendix 10A in ES Volume II.

Study Area

- 10.4.4 The study area for the geology, hydrogeology and land contamination assessment is the boundary of the Sites and up to 250 m from the Site boundaries. Where necessary, the assessment of impacts will be extended outside the study area to include important off-site features, such as landfills and water features, within the vicinity of the Sites up to 1 km from the Sites' boundaries.
- 10.4.5 Whilst the review of baseline conditions focuses on the geological and hydrogeological setting, it also considers the wider environment in terms of identifying potential receptors that could be impacted upon by any existing or resulting soil and/ or groundwater contamination. Therefore, there is some reference made to hydrological and ecological features in this

chapter. These are also discussed in more detail within Chapter 9: Water Environment and Flood Risk and Chapter 13: Ecology and Nature Conservation of this ES.

Geology

VPI Site

10.4.6 The geology within the area of the VPI Site is summarised in Table 10.8.

Table 10.8: Geology beneath the VPI Site

Stratum	Expected Location	Description (BGS Lexicon of Named Rock Units)
Artificial Made Ground	Although the BGS GeoIndex map for Artificial Ground indicates there is no Made Ground on the VPI Site, it is anticipated that Made Ground will be present beneath the existing VPI Immingham CHP Plant in the north of the VPI Site.	n/a
Superficial Tidal Flat Deposits – Clay and Silt	The southern half of the VPI Site (undeveloped area of the VPI Site), apart from a small area in the south and a small area adjacent to the north-west to south-east trending VPI Site boundary. The deposits are also anticipated in the north-east corner of the VPI Site.	The BGS Lexicon of Named Rock Units describes Tidal Flat deposits as <i>“unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit. Normally a consolidated soft silty clay, with layers of sand, gravel and peat. Characteristically low relief”</i> .
Till, Devensian – Diamicton	The entire VPI Site, underlying the Tidal Flat deposits.	No description given. Likely comprising a mixture of clay, sand, gravel, and boulders.
Bedrock Burnham Chalk Formation	The entire VPI Site, underlying the Devensian Till deposits.	The BGS Lexicon of Named Rock Units describes the Burnham Chalk Formation as <i>“White, thinly-bedded chalk with common tabular and discontinuous flint bands; sporadic marl seams”</i> . The marl seams are of a volcanigenic nature, and often greenish grey in colour.

Source: BGS GeoIndex (British Geological Survey, 2022a) and BGS Lexicon of Named Rock Units (British Geological Survey, 2022b)

10.4.7 There is one historical borehole (TA11NE48) within the VPI Site, which was drilled to a depth of 27.43 m below ground level (bgl). The strata encountered included Soil to a depth of 0.3 m bgl and Warp between 0.3 m bgl and 3.96 m bgl with thicknesses between 0.91 m and 2.44 m. Warp is described on the BGS GeoIndex as *“artificially induced alluvium”* (British Geological Survey, 2022a). Sand and Gravel was encountered between 2.74 m and 3.05 m, and Boulder Clay was observed between 3.96 m bgl and 11.89 m bgl. The historic borehole log noted the presence of Sand between 11.89 m bgl and 12.95 m bgl and the thickness was recorded as between 0.15 m and 0.45 m. Clay, with occasional silt, was encountered between 12.04 m bgl and 18.09 m bgl. The Chalk bedrock was encountered at 18.90 m bgl. However, the base was not proven, and the borehole was terminated within the Chalk at 27.43 m bgl.

Groundwater was encountered at 2.74 m within Warp, 12.80 m within Sand and 18.90 m within Chalk.

10.4.8 There are no faults located within the VPI Site or within the study area.

10.4.9 The VPI Site is not within a Coal Mining Reporting Area. There are no records of historical mineral extraction or non-coal mining activity for the site. Two records for extractive industries or potential excavations are located within the area of Network Rail land for the railway embankment.

Phillips 66 Site

10.4.10 A summary of the geology within the Phillips 66 Site is provided in Table 10.9.

Table 10.9: Geology within the Phillips 66 Site

Stratum		Expected Location	BGS Lexicon Description
Artificial Ground	Made Ground	The BGS GeoIndex Artificial Ground map does not indicate that Made Ground is present on the Phillips 66 Site. However, it is anticipated that Made Ground will be present across the Phillips 66 Site.	n/a
Superficial Deposits	Tidal Flat Deposits – Clay and Silt	A thin strip encroaching on the northern Phillips 66 Site boundary in the east of the Phillips 66 Site underlying the railway lines and sidings, and a small area of vegetated land that overlaps with the VPI Site. A small area of vegetated land that overlaps with the VPI Site and the existing track in the VPI site are also underlain by Tidal Flat Deposits.	The BGS Lexicon of Named Rock Units describes Tidal Flat deposits as “ <i>unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit. Normally a consolidated soft silty clay, with layers of sand, gravel and peat. Characteristically low relief</i> ”.
	Till, Devensian – Diamicton	The entire Phillips 66 Site, underlying the Tidal Flat deposits.	No description given. Likely comprising a mixture of clay, sand, gravel, and boulders.
Bedrock	Bedrock: Burnham Chalk Formation	The entire Phillips 66 Site, underlying the Devensian Till deposits.	The BGS Lexicon of Named Rock Units describes the Burnham Chalk Formation as “ <i>White, thinly-bedded chalk with common tabular and discontinuous flint bands; sporadic marl seams</i> ”. The marl seams are of a volcanigenic nature, and often greenish grey in colour.

Source: BGS GeoIndex (British Geological Survey, 2022a) and BGS Lexicon of Named Rock Units (British Geological Survey, 2022b)

10.4.11 There are nine historic borehole records on the BGS GeoIndex within the wider Phillips 66 Humber Refinery site, of which five borehole log records were accessible: TA11NE111, TA11NE328, TA11NE110, TA11NE108 and TA11NE7. Borehole records indicated that Made Ground was encountered in one borehole, comprising of a red brown clay backfill to 0.25 m bgl. The superficial deposits comprised of Boulder Clay, Clay, Sand, Warp, Gravel, Marl Clay,

Sand and Silt, Sand and Gravel and Silt with depths between ground level and 24.99 m bgl. The thickest strata within the superficial deposits comprised of Boulder Clay between 5.18 m and 14.5 m thick, and Clay between 0.61 m and 14.5 m thick. Chalk was encountered between 18.5 m bgl and 180 m bgl, with thicknesses up to 151.5 m bgl. In borehole TA11NE108, the Chalk was underlain by Limestone between 176 m bgl and 178.5 m bgl, which was underlain by Sandstone between 178.5 m bgl and 185 m bgl. Upper Jurassic Kimmeridge Clay was recorded beneath the Sandstone to 188 m bgl, although the depth to base was not proven. The Chalk in borehole TA11NE111 was also underlain by 5 m of Sandstone and 3 m of Upper Jurassic Kimmeridge Clay, although the base was not proven. Two boreholes recorded a rest level of groundwater at 7.01 m and 9.5 m below the well top within Boulder Clay, and one borehole recorded the rest level of groundwater at 18 m bgl within Sand. There are no boreholes within the area of National Rail Land.

- 10.4.12 There are no faults within the Phillips 66 Site or within the study area. The nearest fault is located approximately 11 km to the west of the Phillips 66 Site.
- 10.4.13 The Phillips 66 Site is not within a Coal Mining Reporting Area. There are no records for historical mineral extraction or non-coal mining activity on the site (Envirocheck Report, 2022).

Soils

VPI Site

- 10.4.14 Information obtained from Soilscales (2022) indicates the soils overlying the Tidal Flat Deposits on the VPI Site are described as *“loamy and clayey soils of coastal flats with naturally high groundwater”* on Soilscales. The texture is anticipated to be loamy and clayey with naturally wet drainage. As a result, the soils and water are described as pollution vulnerable due to the shallow groundwater and presence of ditches. The soils overlying Devensian Till (Diamicton) are anticipated to be *“slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils”*. It is expected that the texture will be loamy and clayey with impeded drainage. Overland water flow is described as the main risk to this soil.
- 10.4.15 Natural England (2019) reports the Agricultural Land Use Classification (ALC) for the majority of the VPI Site is designated as Grade 3. The north-west area of the VPI Site, where the existing VPI Immingham CHP Plant is located, the ALC is designated as Grade Urban. The ALC divides land into Grades 1 to Grades 5, with Grade 3 separated into 3a and 3b. Grades 1-3a are described as the *“best and most versatile land”* (Natural England, 2012). Natural England guidance (2012; 2021) states that Natural England should be consulted if the loss is likely to be 20 ha or more. However, as the area of Grade 3 within the VPI Site is less than 20 ha, an ALC survey is not considered to be necessary.

Phillips 66 Site

- 10.4.16 Information obtained from Soilscales (2022) indicates the soils overlying the Devensian Till (Diamicton) deposits across the entire Phillips 66 Site are described as *“slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils”*. It is anticipated that the texture will be loamy and clayey with impeded drainage. Overland water flow is described as the main risk to this soil. The soils that may be present on the northern Phillips 66 Site boundary, underlain by Tidal Flat Deposits (Clay and Silt) are described as *“loamy and clayey soils of coastal flats with naturally high groundwater”* with a loamy and clayey texture and naturally wet drainage. The soils which overlap into the VPI Site parallel to the railway lines and beneath the existing track are also described as *“loamy and clayey soils of coastal flats with naturally high groundwater”* with a loamy and clayey texture and naturally wet drainage.
- 10.4.17 Natural England (2019) reports the ALC grade for most of the Site to be Grade Urban. A thin strip of land parallel to the railway line in the eastern part of the Phillips 66 Site and across the vegetated land parallel to the railway lines and beneath the existing track (overlapping with the VPI Site) is designated as Grade 3.

Hydrogeology

- 10.4.18 The aquifer designations for the VPI Site and Phillips 66 Site are provided in Table 10.10.

Table 10.10: Aquifer designations within the VPI Site and Phillips 66 Site.

Strata	Relevant Feature	Aquifer Designation
Tidal Flat Deposits (Clay and Silt)	Superficial Aquifer Designation	Unproductive Aquifer
Devensian Till (Diamicton)	Superficial Aquifer Designation	Secondary Undifferentiated Aquifer
Burnham Chalk Formation	Bedrock Aquifer Designation	Principal Aquifer

Source: Envirocheck Report (2021; 2022)

VPI Site

- 10.4.19 The groundwater vulnerability for the VPI Site varies between low and high. The Principal Aquifer in the centre of the southern half of the Site is designated as low vulnerability due to the combination of a productive bedrock aquifer and unproductive superficial aquifer. Areas of the site that are not overlain by Tidal Flat Deposits (Clay and Silt) have a groundwater vulnerability of medium to high due to the combination of a productive bedrock aquifer and a productive superficial aquifer.
- 10.4.20 The entire VPI Site is classified as a Source Protection Zone (SPZ) 3 (Total Catchment) which may be associated with extensive industrial, commercial and public services groundwater abstraction and private water undertaking located between 1.3 km and 1.97 km south-east from the VPI Site.
- 10.4.21 There are no groundwater abstractions within the VPI Site, although there are nineteen groundwater abstractions located between 757 m and 909 m from the VPI Site, for industrial, commercial, public services, general use and petrochemicals processes.

Phillips 66 Site

- 10.4.22 The groundwater vulnerability for the Phillips 66 Site varies between low and medium. The only areas of the Phillips 66 Site that have a low vulnerability are within areas overlain by Tidal Flat Deposits (Clay and Silt), and the remaining areas of the site are classified as medium vulnerability.
- 10.4.23 The entire Phillips 66 Site is classified as a SPZ3 (Total Catchment) and could be associated with an SPZ1 located approximately 1 km south-east and 2.52 km north-west from the Phillips 66 Site.
- 10.4.24 The Envirocheck Report (2022) has thirteen records for groundwater abstractions within the wider Phillips 66 Humber Refinery site, of which four are located within the Phillips 66 Site boundary. No end dates for the abstraction permits were provided. The Humber Refinery Abstraction Licence (AN/029/0009/001/R01) for two boreholes has been confirmed with Phillips 66. The licence was issued on 14th July 2017, with an effective date of 1st April 2018. The abstraction licence will expire on 31st March 2030.

Hydrology

- 10.4.25 The Environment Agency Catchment Data Explorer accessed January 2022, (<https://environment.data.gov.uk/catchment-planning>) indicates both the VPI Site and Phillips 66 Site are located within the North Beck Drain catchment area. The current (2019) data indicates the North Beck Drain has a 'Moderate' ecological status and a chemical status of 'Fail' due to priority hazardous substances Mercury and its compounds and Polybrominated Diphenyl Ethers (PBDE). This is also designated as a heavily modified water body.

VPI Site

- 10.4.26 There are eighteen OS Water Network Lines within the VPI Site boundary, all of which are designated as inland rivers with four located underground and fourteen on the ground surface. These are likely related to the onsite drainage.

- 10.4.27 A further twenty-seven OS Water Network Lines are located within the study area (250 m from the VPI Site), and a further two-hundred and thirty-three are located within 1 km from the VPI Site boundary.
- 10.4.28 The Humber Estuary is located approximately 1.5 km east from the VPI Site.
- 10.4.29 The surface water flooding risk for the VPI Site identified in the Envirocheck Report (285387654_1_1) (2021) indicates there is a Low Risk (1000-year return period) to a High Risk (30-year return period), particularly across the undeveloped area of the VPI Site. The Environment Agency's flood map for planning (<https://flood-map-for-planning.service.gov.uk/> accessed February 2022) indicates that the VPI Site is within Flood Zone 3. These are areas assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. The flood zone does not take into account the presence of flood defences in the area.

Phillips 66 Site

- 10.4.30 There are OS Water Network Lines within the Site boundary near the railway lines, all of which are designated as inland rivers located on the ground surface.
- 10.4.31 The Humber Estuary is located approximately 2.4 km east from the Phillips 66 Site.
- 10.4.32 The surface water flooding risk identified in the Envirocheck Report (2022) indicates there is a Low Risk (1000-year return period) to a High Risk (30-year return period). Areas with a High Risk are mostly located in the south of the Phillips 66 Site and across a small area parallel to the railway lines. The Environment Agency's flood map for planning (<https://flood-map-for-planning.service.gov.uk/> accessed September 2022) indicates that the south-east corner of the Phillips 66 Site, mostly within the area of land which overlaps into the adjacent VPI Site, is within Flood Zones 2 and 3. Flood Zone 2 are areas where there is a 1 in 100 to a 1 in 1,000 annual probability of river flooding (0.1% to 1%) or a 1 in 200 to 1 in 1,000 annual sea flooding probability (0.1% to 0.5%). Flood Zone 3 are areas assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. The remainder of the Site is classified as Flood Zone 1, which has a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). The flood zones do not take into account the presence of flood defences in the area.

Designated and Non-Designated Geology Sites

- 10.4.33 The study area is not within a designated or non-designated geology site.
- 10.4.34 The Natural England Designated Sites View website indicates that the Humber Estuary to the east of the Sites is designated as a Site of Special Scientific Interest (SSSI) of 'mixed' interest which includes geological interest for the Late Pleistocene sediments at South Ferriby Cliff located near Barton-Upon-Humber (Natural England, 2004; 2021).

Site History

VPI Site

- 10.4.35 Historical Ordnance Survey (OS) maps for the VPI Site date from 1887 to 2021.
- 10.4.36 Between 1887 and 1956, the site comprised agricultural fields with footpaths and two buildings located near the eastern site border. The surrounding area of the Site within the study area comprised of further agricultural fields with footpaths, roads, a school 100 m south-east, a well 50 m north-east, a spring located 140 m north, and several springs denoted 600 m and 900 m south-east from the VPI Site. The Ulceby & Immingham L.N.E.R. railway line is depicted on historical maps from 1932 onwards.
- 10.4.37 During the 1960s, drainage was installed within the VPI Site and one of the buildings near the eastern site border was demolished. Further drainage was installed within the study area outside of the VPI Site boundary, and several buildings were constructed adjacent to the eastern VPI Site boundary. The springs were no longer denoted on historical maps during this time.

- 10.4.38 In the 1970s, two pipelines and several tracks were constructed through the VPI Site. The VPI Site then remained mostly unchanged until 1994 when one of the onsite buildings was demolished. During this time, extensive industrial development occurred within the study area, comprising of further railway lines and associated infrastructure within 75 m south-west and 250 m north-west, electrical sub stations within 100 m south-east, warehouses/ depots located 50 m south, and flare stacks, tanks and pipelines within 250 m south-east from the VPI Site (i.e. the Phillips 66 Humber Refinery).
- 10.4.39 Between the 1980s and early 2000s, the surrounding area was developed further with industrial infrastructure associated with an oil refinery (the Lindsey Oil Refinery) located 250 m north-west. Further tanks and silos were constructed within the oil refinery located 250 m south-west from the Site (the Phillips 66 Humber Refinery).
- 10.4.40 Extensive industrial development occurred in 2003 based on the OS historical mapping in the northern half of the VPI Site associated with the VPI Immingham CHP Plant. Drainage through the VPI Site was extended, and chimneys and buildings were constructed. A fire station was constructed 110 m south-east from the VPI Site, and buildings adjacent to the eastern VPI Site boundary, including the school, were demolished. Phillips 66 have confirmed that the development within the VPI Site occurred in 2003.
- 10.4.41 The most recent map (2021) indicates a chimney within the northern half of the VPI Site has been demolished, and cooling towers have been constructed. Drainage through the VPI Site has been reduced, although the drain through the centre of the undeveloped area of the VPI Site is still denoted. The oil refinery located in the north-west (Lindsey Oil Refinery) has been extended, and a mast is denoted adjacent to the southern VPI Site boundary.
- 10.4.42 The Local Plan for North Lincolnshire Inset Map 57 (North Lincolnshire Council, 2003) for the South Humber Bank indicates the area of land within the VPI Site is designated as an area for proposed development.

Phillips 66 Site

- 10.4.43 Historical OS maps for the Phillips 66 Site date between 1887 and 2021.
- 10.4.44 Between 1887 and 1968, the Phillips 66 Site was mostly undeveloped and comprised of open agricultural fields, drains and footpaths. Small buildings were located in the south of the Phillips 66 Site during the 1960s. The Ulceby & Immingham L.N.E.R. railway line, located partly within and immediately north of the Phillips 66 Site, is depicted on historical maps from 1932 onwards. The surrounding 250 m to the Phillips 66 Site were mostly undeveloped during this period, comprising of agricultural fields with minor road networks and the village of South Killingholme located approximately 500 m south-west from the Phillips 66 Site. Several water features are denoted on maps, including a moat 600 north-west, pumps between 500 m and 1 km from the Phillips 66 Site, springs located 495 m north-west, 635 m north-east, and 975 m south-east and wells located 590 m south and 635 m north-east. Several drains and ponds are denoted on the historical maps for the 1960s in the surrounding area to the Phillips 66 Site. Two refuse heaps are denoted 29 m west and 98 m west from the Phillips 66 Site.
- 10.4.45 During the 1970s, extensive industrial development occurred on the Phillips 66 Site associated with the oil refinery (the Phillips 66 Humber Refinery). This comprised of the construction of chimneys, pipelines and railway lines, on the Phillips 66 Site. Industrial development also occurred in the surrounding area during this period as part of the oil refinery site including tanks, lighting towers, flare stacks and electric sub stations. A filling station, garage and a warehouse are shown located within 500 m south-west from the Phillips 66 Site. Tanks were constructed within 520 m south of the Phillips 66 Site and 250 m north of the Phillips 66 Site associated with the two oil refineries (Phillips 66 Humber Refinery and Lindsey Oil Refinery). Warehouses, a factory and works were constructed within 300m south-east and 60m west from the Phillips 66 Site.
- 10.4.46 During the 1980s and 1990s, further industrial infrastructure was constructed on the Phillips 66 Site, comprising chimneys. In the surrounding area, further depots were constructed within 55 m west from the Phillips 66 Site, further tanks were shown within 250 m north of the Phillips 66 Site and the refuse heap is denoted as extending further west.

- 10.4.47 In the 2000s, numerous small buildings were constructed within the Phillips 66 Site. The buildings and garage to the west and south of the Phillips 66 Site respectively were demolished, and further drains are denoted within a 1 km radius from the Phillips 66 Site during this period. The refuse heap does not appear on maps dated post-2006. Further industrial development occurred within 250 m north-east comprising of chimneys and ponds (within the VPI Site). A fire station was constructed 100 m east from the Phillips 66 Site.
- 10.4.48 The 2021 map indicates further small buildings and an additional pipeline have been constructed. Further development is denoted in the surrounding area, particularly within the VPI Site where cooling towers are denoted. The works located within 50 m west from the Phillips 66 Site is now a factory with conveyors, and further pipelines have been constructed within 250 m north of the Phillips 66 Site associated with the Lindsey Oil Refinery.

Potentially Contaminative Land Uses

VPI Site

- 10.4.49 The use of the land in the north of the VPI Site as a CHP Plant is a potentially contaminative land use as there are tanks, electricity substations and pipelines on the VPI Site which requires Hazardous Substance Consent. There are further pipelines in the undeveloped area in the south of the VPI Site.
- 10.4.50 The railway land to the south-west of the VPI Site is a potentially contaminative land use within the study area.
- 10.4.51 The undeveloped area of the VPI Site may have been used as agricultural land in the past, therefore, there is a slight potential for herbicides, insecticides and/ or pesticides within the ground.
- 10.4.52 There are electricity substations located approximately 100 m south-east from the VPI Site.
- 10.4.53 There are unspecified warehouses located approximately 50 m south from the VPI Site.
- 10.4.54 The land use immediately north-west and within 100 m south-west of the VPI Site comprises industrial infrastructure with tanks, pipelines, a fire station and silos associated with the two oil refineries.
- 10.4.55 There are no landfill sites or waste management facilities located on the VPI Site. There is one Historical Landfill located 130 m north-west, which was operated by Lindsey Oil Refinery and accepted liquid sludge waste. The first input date was recorded as 31st December 1986. The last input date has not been supplied. There are two records for Lindsey Oil Refinery Ltd located 250 m north-west for both a Licenced Waste Management Facility and a Registered Waste Treatment or Disposal site for the same location. The records for the Licenced Waste Management Facility indicate the licence was issued on 6th November 1985 and surrendered on 18th October 2008. The records for the Registered Waste Treatment or Disposal site are dated to 6th November 1985 and indicate the status is operational as far as is known.
- 10.4.56 Outside of the study area, there are:
- five Historical Landfill Sites located between 290 m and 795 m from the VPI Site boundary;
 - four Licenced Waste Management Facilities, of which one is also designated as Registered Landfill Site, located between 584 m and 945 m from the VPI Site boundary;
 - three Registered Landfill Sites, of which one is also designated as a Licenced Waste Management Facility, located between 584 m and 685 m from the VPI Site boundary; and
 - one Registered Waste Treatment or Disposal Site located 322 m south-west from the VPI Site boundary.

Phillips 66 Site

- 10.4.57 The current land use for the Phillips 66 Site as an oil refinery is a potentially contaminative land use as there are tanks and pipelines on the Phillips 66 Site. There are Hazardous Substance Consents, Notification of Installations Handling Hazardous Substances (NIHHS) and the designation as a Control of Major Accident Hazards Sites (COMAH) to the south of the Phillips 66 Site boundary, associated with the wider Phillips 66 Humber Refinery site. The Envirocheck Report (2022) indicates that there are two records for Registered Radioactive Substances for the wider Phillips 66 Humber Refinery site. These permits are Bw0819: authorisation under S13 RSA for the disposal of radioactive wastes (was RSA60 S7) and AY8441: authorisation under S7 RSA for the keeping and use of radioactive materials (was RSA60 S1). Phillips 66 have confirmed that these are considered to be previous inactive permits. In addition, Phillips 66 have confirmed the management and use of radioactive materials in the form of sealed sources, in accordance with the Environmental Permit EPR/JB3230DD and the management and use of radioactive materials, and the accumulation and disposal of radioactive waste with the Environmental Permit EPR/VP3890SY.
- 10.4.58 There are railway lines located within the north-east of the Phillips 66 Site and immediately north of the Phillips 66 Site, which could be a potential source of contamination.
- 10.4.59 The undeveloped area of the Phillips 66 Site (where it overlaps with the VPI Site) may have been used as agricultural land in the past, therefore, there is a slight potential for herbicides, insecticides and/ or pesticides within the ground.
- 10.4.60 Electricity sub stations are located 100 m south, 120 m east and 225 m south-east of the Phillips 66 Site which could be a potential source of contamination.
- 10.4.61 The land use within the study area is predominantly for industrial purposes and includes a number of potentially contaminative uses including garages, a filling station, warehouses, works, depots, a fire station and further oil refinery areas to the south and north of the Site.
- 10.4.62 Within the study area, there are Historical Landfills located 22 m north-west and 140 m south, one Licenced Waste Management Facility / Registered Waste Transfer Site located 91 m north-west and one Registered Waste Treatment/ Disposal Site located 135 m south of the Phillips 66 Site. The status of the Registered Waste Transfer site is recorded as "*licence has completion certificate surrendered*". The status of the Registered Waste Treatment / Disposal Site located within the wider Refinery site is recorded as "*site exempt from licence*". However, Phillips 66 have confirmed that the landfill site closed in October 2003.
- 10.4.63 Outside of the study area, there are:
- seven Historical Landfill sites located between 320 m and 846 m from the Phillips 66 Site boundary;
 - six Licenced Waste Management Facilities located between 601 m and 992 m from the Phillips 66 Site boundary;
 - six Registered Landfill Sites located between 314 m and 867 m from the Phillips 66 Site boundary; and
 - three Registered Waste Treatment or Disposal Sites located between 601 m and 705 m from the Phillips 66 Site boundary.

Contemporary Trade Directory Entries

VPI Site

- 10.4.64 There are no active Contemporary Trade Directory Entries listed for the VPI Site.
- 10.4.65 An active Contemporary Trade Use is located 90 m south of the Site for Immingham Transport road haulage services.

10.4.66 Outside of the study area, there are sixteen Contemporary Trade Uses located between 568 m and 960 m from the VPI Site boundary. Of the sixteen Contemporary Trade Uses, five are listed as active between 568 m and 908 m from the VPI Site for the following classifications: Industrial Services (568 m south-east), Mechanical Engineers (573 m south-east), Fuel Dealers and Gas Suppliers (762 m south-east) and Engineering Services (908 m west).

Phillips 66 Site

10.4.67 According to the Envirocheck Report (2022) there are no Contemporary Trade Directory Entries located directly within the Phillips 66 Site boundary. However, there is one active Trade Use within the wider Phillips 66 Humber Refinery associated with engineering services. . Phillips 66 have confirmed that the contract with this engineering services company has not been in place for approximately 10 years. The inactive trade uses in the wider Phillips 66 Humber Refinery Site were associated with chemicals and allied products, engineering (electrical and mechanical) and coating specialists.

Previous Ground Investigations

VPI Site

10.4.68 A ground investigation was undertaken within the undeveloped area of the VPI Site by Geotechnics Limited between 5th and 12th September 2022 (Geotechnics Limited, 2022).

10.4.69 The GI comprised the following:

- twenty inspection pits to 1.2 m bgl in the location of Cone Penetration Test (CPT) locations;
- ten CPT's between 14.58 m bgl and 15.3 m bgl undertaken by Lankelma Limited;
- four cable percussion boreholes (BH01, BH02, BH02A, BH05) to depths between 21.75 m bgl and 23.08 m bgl. However, the presence of a concrete obstruction resulted in the termination of BH02 at 0.9 m bgl. The report notes that an additional two boreholes (BH03 and BH04) will be completed during an additional phase of investigation; and
- groundwater and ground gas monitoring in boreholes BH01 and BH02A between 9 m bgl to 10 m bgl and 18.4 m bgl and 19.4 m bgl respectively.

10.4.70 The following strata was encountered:

- topsoil between ground level and 0.3 m bgl;
- Made Ground between ground level and 1.7 m bgl;
- clay between 0.05 m bgl and 18 m bgl;
- sand between 13 m bgl and 15.4 m bgl;
- gravel between 15 m bgl and 18.2 m bgl; and
- chalk at a minimum depth of 17.5 m bgl.

10.4.71 Groundwater strikes were encountered between 7 m bgl and 13 m bgl within clay. Groundwater strikes were recorded in sand and gravel at 14.9 m bgl and 15 m bgl respectively. One groundwater strike was recorded within chalk bedrock at 18.7 m bgl.

10.4.72 The results of the human health risk assessment indicated that there were no exceedances of the human health GAC within seven soil samples analysed. No asbestos was detected in seven screened samples.

- 10.4.73 The results of the controlled waters risk assessment indicated an EQS exceedances of zinc in BH01 (20 µg/l). EQS and DWS exceedances were also recorded for Aliphatics >C16-C21 (26 ug/l) and >C21-C34 (14 ug/l) and exceedances of EQS and DWS were also recorded for Aromatics >C16-C21 (19ug/l) in BH02A. However, Geotechnics consider this to be a minor exceedance and therefore not an indication of significant hydrocarbon contamination.
- 10.4.74 The results indicated an exceedance of copper was recorded for EQS. However, a m-BAT tool was used resulting in a modified EQS which was greater than the recorded concentration of copper in BH01.
- 10.4.75 The results of the ground gas monitoring undertaken on four visits between 30th September 2022 and 31st October 2022 indicate that there is no significant source of ground gas at depth. Geotechnics note that the ground gas regime is designated as Gas Regime A and there are no ground gas protection measures required.
- 10.4.76 A ground investigation was undertaken on the land adjacent to the northern boundary of the VPI Site by SOCOTEC in 2018.
- 10.4.77 The ground investigation comprised of the following:
- three boreholes were drilled using cable percussion methods between 22.34 m bgl and 28.66 m bgl;
 - three boreholes were drilled using cable percussion and rotary core drilling / open hole drilling between 28.6 m bgl and 34.6 m bgl;
 - three dynamic sampling holes were drilled between 3.75 m bgl and 5.45 m bgl;
 - thirteen trial pits were excavated to depths between 2.5 m bgl and 4.60 m bgl;
 - soil testing comprised of classification tests, consolidated and unconsolidated undrained triaxial tests, recompacted California Bearing Ratio (CBR) tests, consolidation tests, hydraulic cell tests and a soil chemical testing suite;
 - soil and groundwater samples were analysed for chemical suite testing; and
 - three rounds of groundwater and ground monitoring were undertaken between 11th May and 1st June 2018.
- 10.4.78 The general sequence of strata comprised of:
- Made Ground (ground level to 1.7 m bgl);
 - Glacial Till (ground level to 27.5 m bgl);
 - Glacial Sands and Gravels (12.9 m bgl to 16 m bgl);
 - Weathered Chalk (21.5 m bgl to 30.9 m bgl); and
 - Unweathered Chalk (26.1 m bgl to 30.9 m bgl, although the depth to base was not proven).
- 10.4.79 Groundwater strikes were recorded as follows:
- one groundwater strike was recorded in granular Made Ground in TP7 at 0.7 m bgl;
 - groundwater strikes were recorded in Glacial Till between 1 m bgl and 24 m bgl;
 - groundwater strikes were recorded in Glacial Sands and Gravels between 3 m bgl and 13.5 m bgl;
 - groundwater strikes were recorded in Chalk bedrock at 21.5 m bgl and 26.8 m bgl in two boreholes (BH3 and BH6); and
 - the groundwater levels encountered during the groundwater monitoring varied between 0.96 – 0.9 m bgl in WS04 to 3.7 – 3.97 m bgl in BH01.

- 10.4.80 Concrete aggressivity testing was undertaken on five samples of Made Ground and six samples of Glacial Deposits:
- the classification for undisturbed ground in Made Ground was designated as DS-2, AC-2;
 - the classification for disturbed ground in Made Ground was designated as DS-2, AC-2;
 - the classification for undisturbed ground in Glacial Deposits was designated as DS-1, AC-1;
 - the classification for disturbed ground in Glacial Deposits was designated as DS-3, AC-3; and
 - the report notes that a high value of oxidisable sulphides (>0.3%) was present in three out of four samples in Glacial Till which suggested pyritic ground was present.
- 10.4.81 The report notes that visual and olfactory evidence of contamination was recorded (oily smell and black staining) within Made Ground in nine exploratory hole locations.
- 10.4.82 Asbestos was recorded in six out of twenty-five samples in the form of chrysotile fibre bundles at <0.001 w/w% between 0.3 m bgl and 1.25 m bgl.
- 10.4.83 There were no exceedances of the human health GAC in soil and groundwater samples.
- 10.4.84 Exceedances of the GAC criteria for groundwater were recorded as the following:
- exceedance of Drinking Water Standards (DWS) for selenium (maximum concentration of 16 µg/l) in BH03;
 - exceedance of Environmental Quality Standards (EQS) for zinc (maximum concentration of 12 µg/l) in BH01, BH03 and WS05;
 - exceedance of EQS for sulphate (maximum concentration of 983,900 µg/l) in WS03 – WS06; and
 - exceedance of EQS for chloride (maximum concentration of 1,280,000 µg/l) in WS03 – WS05.
- 10.4.85 The results of the ground gas monitoring indicated that the site would be classified as Characteristic Situation CS2. However, if all the Made Ground was removed during the construction works the site would be classified as CS1.
- 10.4.86 The report notes that Made Ground cannot be relied on as a stable founding material due to the variable nature therefore shallow foundations should be placed in natural ground such as the firm to stiff clay in the Glacial Till.
- 10.4.87 The revised CSM and environmental risk assessment indicated the potential residual risk to all receptors is considered Low.
- 10.4.88 The residual risk associated with geotechnical risks is considered Low for variable Made Ground, limited information on the bedrock (Burnham Chalk Formation), unknown services and buried obstructions and high groundwater flow in granular soils and chalk.

Phillips 66 Site

- 10.4.89 Ramboll conducted a groundwater investigation and sampling programme in October 2020 within the wider Phillips 66 Humber Refinery site (Ramboll, 2020a). This investigation includes the area of the Humber Refinery site to the south of the A160 Humber Road, which is not within the Phillips 66 Site boundary.
- 10.4.90 Monitoring was conducted in 32 boreholes, and samples were collected from six boreholes for chemical testing.
- 10.4.91 The rest levels of groundwater were between 0.00 m bgl and 4.91 m bgl.

- 10.4.92 The groundwater flow regime within the wider Phillips 66 Humber Refiner site, as noted by Ramboll, may be from central areas to northern and southern directions and it likely to be discontinuous. Concentrations of the some metals, PAHs and EPHs were higher in 2020 compared to the previous 2017 monitoring reference data.
- 10.4.93
- 10.4.94 The concentrations of determinands were compared to the Generic Assessment Criteria (GAC) for commercial/ industrial end use in the context of human health volatilisation. TCE within BH29 exceeded the GAC.
- 10.4.95 GAC exceedances were recorded for some metals, inorganics, PAHs, EPHs, VOCs and SVOCs the following determinand concentrations in the controlled waters assessment.
- 10.4.96 The conceptual site model indicated the risks to human health and controlled waters were considered to be Low – Low to Moderate.
- 10.4.97 The clay deposits on the Phillips 66 Site, to depths of at least 15 m bgl, provide protection to the Principal Chalk Aquifer due to their low permeability.
- 10.4.98 The majority of GAC exceedances are not considered as a contamination risk because there are not sensitive water resources near the Phillips 66 Site. Although the exceedances of human health GAC are considered not to be affecting current Humber Refinery site users, the report recommends that further intrusive investigation and monitoring is undertaken to assess the risks from TCE.
- 10.4.99 Although the groundwater quality is not considered to be deteriorating, Ramboll recommend that further investigations are undertaken for BH6A (hydrocarbons) and BH29 for increasing EPH and TCE concentrations.

Site Walkover

VPI Site

- 10.4.100 A site walkover was undertaken by two AECOM engineers on 5th May 2022.
- 10.4.101 The northern half of the VPI Site, where the existing VPI Immingham CHP Plant was located could not be accessed at the time of the site walkover. The northern half of the undeveloped land within the VPI site could not be accessed due to fencing and a high density of vegetation across the VPI Site. This area of the VPI Site was therefore observed from a small lay-by area off Rosper Road to the east of the VPI Site. Most of the undeveloped land in the VPI Site comprises dense vegetation, although areas of hardstanding, floodlights and several Intermediate Bulk Containers (IBCs) filled with gravel were located near the eastern VPI Site boundary. Stockpiles of material of an unknown source were located in the northern extent of the undeveloped land in the VPI site. A drain is located immediately adjacent to the eastern VPI Site boundary, which is culverted beneath the lay-by area.
- 10.4.102 A drain (South Killingholme Drain) is located in the centre of the VPI Site, which flows in an easterly direction where it splits into two culverted drains beneath Rosper Road. Areas of thick vegetation and silt deposits were observed within the drain, mostly upstream of the drain. At the western VPI Site boundary, the drain is culverted beneath a hardstanding track. The northern bank of the drain comprises a steep, heavily vegetated slope whilst the southern bank has a lower slope angle and density of vegetation. A hardstanding track, which is partially vegetated, is located parallel to the drain through the centre of the undeveloped land within VPI Site, which leads to a series of interconnected above-ground pipelines, orientated north-west to south-east parallel to the western VPI Site boundary. An overhead pipeline is also located in this area, extending over the railway to the Phillips 66 Humber Refinery. At the time of the site visit, the water within the drain contained a thick material deposit, white to brown in colour, on the surface of the water adjacent to the pipelines. There is a hardstanding footpath adjacent to the area of the drain and pipelines leading to the northern area of the undeveloped land of the VPI Site, however, this could not be accessed due to the vegetation growth. A rusty pipeline was observed parallel to the hardstanding track, although this could not be traced to the western VPI Site boundary due to the vegetation.

- 10.4.103 The remainder of the VPI Site comprised variable extents of vegetation, such as grassland, nettles, and mature shrubs within the centre of the undeveloped land within the VPI Site and parallel to the western VPI Site boundary. In the south and south-east areas of the Site, the vegetation was at approximately 1 m height. This prevented access to the south-east and eastern areas of the VPI Site. At the time of the site visit, it was noted that the ground underfoot in grassland areas within the centre of the undeveloped land within the VPI Site was spongy and uneven. A vertical gas pipeline is located near the southern VPI Site boundary. A gravelled track with gabion retaining structures leads to the railway embankment immediately adjacent to the VPI Site boundary. A tall structure and small building are located within a fenced off area immediately south of the VPI Site.
- 10.4.104 Fly tipped waste was located in the centre of the undeveloped land within the VPI Site, including a rusty refrigerator, rusty metal sheeting, fabric sheeting and a tyre. The land immediately adjacent to the layby area off Rosper Road also contained waste and litter.

Phillips 66 Site

- 10.4.105 A Site walkover of the Phillips 66 Site was undertaken by an AECOM engineer and an employee of Phillips 66 on 23rd November 2022. The following text provides an overview of the Phillips 66 Site using Google Earth imagery dated to June 2021 and a summary of the site from observations during the site walkover.
- 10.4.106 The western boundary of the Phillips 66 Site comprises hardstanding which is currently used as a car park. A thin row of vegetation separates the hardstanding used as a car park from a hardstanding area used for storage purposes. This area of the site was not visited during the site walkover.
- 10.4.107 The western extent of the Site comprises hardstanding construction laydown area that is currently used for storage of construction materials such as pipes and scaffolding. An office and warehouse building are located to the south of the construction laydown area. Several shipping containers, some of which were used as welfare cabins, and lighting towers are located throughout this area. At the time of the site visit, ponding of rainwater was visible throughout the construction laydown area. There is a pipeline in along the northern Phillips 66 Site boundary, through the centre of the hardstanding storage area for various materials including pipes and metal containers. A surfaced road is located to the east of the construction laydown area, which is orientated north to south. The topography throughout this area is relatively flat, however, in the northwest corner of the site, there is an area of flat raised ground which is also used as a construction laydown area. This area is at an elevated height compared to the nearby areas of the Site and is accessed via a metal staircase over the pipeline running through the centre of the construction laydown area. At the time of the site visit, this area of the site had fewer construction materials stored compared to the laydown area further south and comprised hardstanding ground. The elevated laydown area is separated into two areas via mesh fencing in the centre orientated north to south. Multiple oil drum containers aligned in rows orientated north to south were located in the fenced area adjacent to the western site boundary at the time of the visit. Some small areas of litter were observed in this area.
- 10.4.108 The area of the Phillips 66 Site located adjacent to the hardstanding storage area to the east comprises further hardstanding and refinery infrastructure such as multiple ground level and overhead pipelines. The infrastructure is located at height, which is visible from a distance on nearby roads (A160) on the approach to the Phillips 66 Site. The area is separated into blocked structures via surfaced roads and pedestrian footpaths. A large flue-gas stack tower is located within the centre of this area. This area of the site is designated as the fluid catalytic convertor (FCC) processing unit and the crudes processing unit.
- 10.4.109 There is a surfaced road and several small buildings located along the northern boundary of the Phillips 66 Site, parallel to the railway sidings. At the time of the site visit, there was ponding on the northern side of the road. In the west of the site, there are minor vegetated cuttings either side of the railway sidings which separate the railway sidings from the railway line to the north and the Phillips 66 Proposed Development Boundary in the south. Towards the east, the cuttings reduce in gradient and are no longer present resulting in a relatively flat topography. Another pipeline is located along the northern Phillips 66 Site boundary, parallel

to the railway sidings located off-site. This pipeline terminates in the centre of the northern Phillips 66 Site boundary. Shipping container style buildings containing electric sub stations are located adjacent to the surfaced road. Stockpiles of railway ballast were stored within the Phillips 66 Site boundary adjacent to the railway sidings. An area of waste material stockpiles to either be reused on site or disposed off-site are located off-site adjacent to the Phillips 66 Site boundary in the centre of the Site. The waste stockpiles are segregated using a walled concrete structure. At the time of the site visit, the material stockpiles may have contained Made Ground, sand and sandbags. A large walled concrete structure separates the southern site boundary from the surfaced road adjacent to the railway lines. Multiple petroleum coke stockpiles are stored within the confines of the walled structure. The stockpile height extended above the walled structure with a mixture of finer material and larger boulders. There are waste disposal areas located immediately to the south of the Phillips 66 Site boundary which contained separate waste bins for general waste, scrap waste and oil waste.

10.4.110 The triangular area in the eastern half of the Phillips 66 Site comprises of hardstanding, with multiple pipelines orientated east to west along the southern boundary. A railway track is located within the Phillips 66 Site orientated northeast to southwest, leading to a small building. The track crosses the surfaced road and leads towards a building within the wider refinery site. Instrument houses and small buildings are also located within this area of the Phillips 66 Site. The pipelines at the southern boundary extend across the railway sidings and railway lines via a pipeline overbridge towards the VPI Site. A smaller pipeline bridge is located to the west, which extends over the railway sidings to fill railway tank wagons. At the time of the site visit, there were multiple tank wagons on the railway sidings. Vegetation is located either side of the railway lines. There are no cuttings either side of the railway. There is an area of hardstanding between the railway sidings and vegetation which separates the sidings from the railway lines. Holding ponds are located to the south, which are fenced off with concrete walls and metal structures.

10.4.111 The eastern extent of the Phillips 66 Site comprises of vegetated land and a hardstanding track which overlaps with the VPI Site. This area of the Phillips 66 Site was visited as part of the site walkover for the VPI Site. This area of the VPI Site is bounded by a row of mature trees and overgrown vegetation and grassland. Interconnected above ground pipelines were observed parallel to the Phillips 66 Site boundary. A drain (South Killingholme Drain) encroaches onto the Phillips 66 Site application site. In the area of the pipelines, the drain contained a thick material deposit that varied in colour from white to dark brown downstream of the drain. A pipe and sheet of material were stored near to the pipelines. A footpath is located parallel to the pipelines which could not be accessed at the time of the site walkover due to vegetation growth. A vertical gas pipeline was observed on the eastern boundary of the Phillips 66 Site.

10.4.102 Future Baseline

10.4.112 The Phillips 66 Site and VPI Site form part of the existing Phillips 66 Humber Refinery site and the existing VPI CHP Power Station, respectively. Both operational sites are expected to continue operating in the future baseline scenario.

10.5 Development Design and Impact Avoidance

General

10.5.1 This section considers how potential environmental impacts have or will be avoided, prevented, reduced or offset through design and/ or management of the Proposed Developments with respect to ground conditions and contamination.

10.5.2 A ground investigation has been undertaken at the VPI Site and a ground investigation is planned to be undertaken at the Phillips 66 Site, although this will not be undertaken at the pre-planning stage. The ground investigations aim to more accurately quantify potential hazards and a risk assessment carried out to define potential remediation objectives to narrow the degree of uncertainty in the risk rankings. The ground investigations have comprised/ will comprise the following:

- investigation of the nature and extent of the Made Ground across the VPI Site and Phillips 66 Site;
- investigation of the nature of the underlying natural strata, where present, including determination of in-situ soil properties;
- investigation of depths to rockhead;
- chemical testing and geotechnical testing of soil and groundwater samples;
- installation of gas and groundwater monitoring wells and monitoring of ground gas concentrations and groundwater levels; and
- a range of suitable soil, leachate and groundwater chemicals tests, including Building Research Establishment (BRE) sulphate tests.

10.5.3 An interpretive report concluding the findings of the ground investigation at the VPI Site has been produced comprising human health, controlled waters, ground gas and geotechnical risk assessments to fully assess the levels of contamination and geotechnical constraints across the Sites, to identify mitigation measures where required and make recommendations to allow the redevelopment of the Sites.

Construction Phase

Impact on Controlled Waters

10.5.4 To manage the potential impact on controlled waters, a ground investigation has been undertaken at the VPI Site which included installation of groundwater monitoring wells, groundwater monitoring and testing of groundwater. A ground investigation is also planned to be undertaken at the Phillips 66 Site. However, this will not be undertaken at the pre-planning stage. A Generic Quantitative Risk Assessment (GQRA) will be undertaken for the Sites and a Detailed Quantitative Risk Assessment (DQRA) may be required depending on the findings of the GQRA. Where significant risks are identified a remediation strategy will be developed and agreed with NLC.

10.5.5 The surface water runoff will be controlled using appropriate drainage measures and segregating uncontaminated surface water from any potentially polluted waters, as well as impermeable surfacing to minimise infiltration into the ground where necessary. This will minimise the likelihood for potential contaminants to migrate to controlled waters.

10.5.6 If piled foundations are proposed for the Proposed Developments, piling risk assessments will be undertaken in accordance with Environment Agency guidance. These will be used to establish the means of mitigating any risks of causing new pollutant linkages and/ or worsening existing ones with respect to risks to controlled waters at the construction stage of the Proposed Developments.

Impact on Development Infrastructure

10.5.7 Materials used in infrastructure will be designed and specified taking due account of any aggressive ground conditions identified by the ground investigations. The assessment methodology set out in BRE Special Digest 1 (2005) has been adopted to determine the appropriate concrete classification in relation to the protection of buried concrete against sulphate attack.

10.5.8 The previous Interpretive Ground Investigation Reports have identified the Design Sulphate Class and ACEC Class by strata.

10.5.9 The design specification may include the import of engineered fill to improve the bearing capacity of the soil. The specification of materials to be used for the construction of the Proposed Developments will be specific to the ground conditions into which they will be placed.

10.5.10 The ground investigations will be used to determine the suitable founding material which will be required across the Phillips 66 Site and the VPI Site. Any residual risks relating to soft ground will be addressed during the detailed design stage, taking into account the ground

investigation results. The specification design will be determined using data from proposed ground investigation and chemical analysis of soil samples analysing the BRE Sulphate suite.

- 10.5.11 Based on the Proposed Developments' site layout plans at the time of writing, there are no offices or occupied buildings proposed on either Site, therefore ground gas mitigation measures have not been considered further.

Operation Phase

Impact on Controlled Waters

- 10.5.12 There is potential for environmental risks associated with spillages due to road accidents or faulty vehicles. To manage potential impacts on controlled waters during the operational stage of the Proposed Developments, suitable drainage systems (including interceptors) will be employed during construction and maintained during operation to prevent infiltration of surface water or potential contaminants into the ground, surface water drainage systems and water bodies during the operational phase. The operators of the Proposed Developments will comply with the requirements of any permits and/ or will handle and store materials such as chemicals and fuels as recommended by the manufacturer. Spill kits will be available on the Sites and site personnel will also be trained to manage potential accidental spillages on the Proposed Development Sites.

Impact on Development Infrastructure

- 10.5.13 No additional mitigation measures for infrastructure to those detailed for the construction phase will be required during the operational phase.

Decommissioning Phase

Impact on Controlled Waters

- 10.5.14 Mitigation measures similar to those employed for the construction phase of the Proposed Developments will be implemented to minimise the risk of any contaminated surface water runoff from the Sites during the decommissioning phase so that it does not have a detrimental effect on the receiving watercourse and the underlying aquifers. The surface water runoff will be controlled using appropriate drainage measures and segregating uncontaminated surface water from any process effluent streams, as well as impermeable surfacing to minimise infiltration into the ground. This will minimise the possibility for potential contaminants to migrate to controlled waters.

10.6 Likely Impacts and Effects of the Proposed Developments

- 10.6.1 This section identifies the likely impacts and effects resulting from the Proposed Developments. The magnitude of impacts are defined with reference to the relevant baseline conditions, and effects are determined in accordance with the identified methodology. As described earlier, where relevant the effects of the Proposed Developments are described compared to future baselines with and without the Proposed Developments.
- 10.6.2 This technical assessment identifies the environmental impacts of the Proposed Developments at key stages in its construction, operation (including maintenance) and eventual decommissioning without development design and impact avoidance and the potential effects following the implementation of development design and impact avoidance measures (set out in Section 13.5).
- 10.6.3 A ground investigation has been undertaken at the VPI Site and a ground investigation is proposed to be undertaken at the Phillips 66 Site, however, this will not be undertaken at the pre-planning stage. The ground investigation at the VPI Site has been/ specified in accordance with the UK Specification for Ground Investigation (Association of Geotechnical and Geoenvironmental Specialists, 3rd Ed., 2022) and carried out in accordance with British Standard (BS) EN 1997-2:2007 Eurocode 7 (British Standards Institute (BSI), 2007),

BS5930:2015+A1:2020 Code of practice for GIs (BSI, 2020) and BS10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of Practice (BSI, 2017).

Summary of Resource/ Receptor Value

10.6.4 This assessment considers the following resources/ receptors:

- human health (construction workers and future site users);
- controlled waters (superficial and bedrock aquifers, surface water features);
- development infrastructure;
- agricultural soils;
- offsite receptors.

10.6.5 A summary of the sensitivity (value) of the receptors are presented in Table 10.11.

Table 10.11: Summary of sensitivity (value of the receptors).

Resource/ Receptor	Location	Sensitivity/ Value of Receptor	Justification
Human Health			
Workers and Future Site Visitors	VPI Site and Phillips 66 Site	Medium	The on-site workers and visitors will be the most at-risk human health receptors due to their proximity to their potentially contaminated soils/ vapours/ dust and groundwater. However, due to the commercial/ industrial land use at the site, human health is medium sensitivity.
Controlled Waters			
Tidal Flat Deposits (Unproductive Aquifer)	VPI Site and Phillips 66 Site	Low	Unproductive strata
Devensian Till Secondary (Undifferentiated Aquifer)	VPI Site and Phillips 66 Site	Medium	Secondary undifferentiated productive aquifer combined with the underlying productive principal bedrock aquifer give a combined medium sensitivity.
Burnham Chalk Formation (Principal Aquifer)	VPI Site and Phillips 66 Site	High	Principal Aquifer is of high sensitivity. The aquifer is potentially of a lower sensitivity where it is overlain by a thick cover of low permeability unproductive superficial deposits. However, as the superficial deposits are described to contain sand and gravel layers the bedrock aquifer may still be susceptible.
North Beck Drain Catchment	VPI Site and Phillips 66 Site	High	The status of the North Beck Drain was classified as Moderate by the Environment Agency in 2019 (Environment Agency 2021), therefore the sensitivity is high.
Development Infrastructure			
Buildings and services	VPI Site and Phillips 66 Site	Medium	Potential for degradation of foundations if design of concrete does not account for aggressive ground conditions identified at the Sites. Potential for accumulation of ground gases.

Resource/ Receptor	Location	Sensitivity/ Value of Receptor	Justification
Agricultural Soils			
Grade 3 Agricultural Soils	VPI Site and Phillips 66 Site	High	Grade 3 soils present on both Sites, however, the subgrades are unknown. Grade 3a soils are high sensitivity, and Grade 3b soils are medium sensitivity. As a worst case, it is assumed that the soils are Grade 3a.
Offsite Receptors			
Residents (South Killingholme)	West of the Phillips 66 Site	Very high	Very high sensitivity residential land use.
Workers	North of the VPI Site and Phillips 66 Site	Medium	Medium sensitivity industrial land use.

Construction Phase

10.6.6 This section contains an assessment of the potential impacts to ground conditions including land quality receptors as a result of the construction phase of the Proposed Developments.

10.6.7 The following impact pathways have been assessed:

- direct contact with contamination;
- inhalation of dust and/ or soil derived vapours;
- migration of ground gas; and
- lateral and vertical migration (including as a result of piling) of contamination through leachate, groundwater or surface run-off.

VPI Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

10.6.8 Site visitors and on-site workers are considered the main potential human health receptors likely to be affected by the construction phase works. Adverse effects to human health are described in the following paragraphs.

10.6.9 Activities relating to foundation construction, earthworks and excavations and associated movement of ground materials have the potential to cause exposure of on-site workers and/ or site visitors and off-site workers and visitors to potentially contaminated dust.

10.6.10 Disturbances and/ or removal of the ground materials and groundwater which could potentially remove, relocate or mobilise existing potential contaminants (e.g. during foundation construction, earthworks and excavations).

10.6.11 Potential temporary impacts to human health may result from the accidental leak of fuels and oils from vehicular plant or from stored liquids. Other temporary impacts may also result from the use of materials and substances with polluting potential (e.g. concrete, fuel, oils and soil) which have the potential to be mobilised to ground or controlled waters. However, these risks will be mitigated by implementing a site-specific CEMP adopted by the contractor.

10.6.12 Offsite human health receptors at the VPI Site are considered to be offsite workers to the north associated with the Lindsey Oil Refinery and offsite workers to the south associated with the

remainder of the Phillips 66 Humber Refinery that could be at risk of inhalation of dust and/or soil vapours.

- 10.6.13 Development infrastructure may also be at risk from direct contact with aggressive ground conditions. Where adequate mitigation is not incorporated during the design and construction of a development, impacts could be realised during the operational phase.
- 10.6.14 The sensitivity/ receptor value of human health receptors (onsite workers, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/or soil derived vapours is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that the constructions works will be carried out in accordance with a CEMP and environmental good practice on site. A ground investigation has been undertaken at the site to confirm baseline assumptions. A human health risk assessment (HHRA) will be undertaken. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.15 The sensitivity/ receptor value for development infrastructure is considered to be **medium**. The magnitude of impact from direct contact with contaminated soil and leachate is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, a ground investigation has been undertaken at the site to confirm baseline assumptions. The data from the ground investigation will be used to design concrete and service pipes that are appropriate for any aggressive ground conditions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Migration of Ground Gas

- 10.6.16 Ground gas may accumulate within temporary structures erected on the VPI Site during construction. There is the potential for ground gas to be sourced from the Made Ground materials and organic rich soils around and underlying the site. However, it is recommended that entry into excavations or any other enclosed space on a construction site should comply with confined space legislation and be assessed prior to entry.
- 10.6.17 The receptors associated with the accumulation of ground gas are considered to be property and human health.
- 10.6.18 The sensitivity/ value of the development infrastructure (building) is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, ground gas protection measures will be implemented into design and build of permanent and temporary structures if occupied buildings are part of the final design. A ground investigation has also been undertaken to confirm the baseline assumptions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.19 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that workers will comply with confined spaces regulations and will adopt safe working practices under the relevant health and safety legislation. A ground investigation has also been undertaken to confirm the baseline assumptions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off (Including as a Result of Piling)

- 10.6.20 Potential effects to controlled waters could arise from contamination of the Principal Aquifers or Secondary Undifferentiated Aquifer.

- 10.6.21 Excavations and foundations have the potential to disrupt shallow groundwater. Temporary groundwater controls such as dewatering or physical cut-offs may be required to prevent the excavations filling with water, which would likely result in the lowering of groundwater levels in the immediate area of the excavation. Service trenches can also provide preferential flow pathways for groundwater. Dewatering of excavations could result in an adverse risk to groundwater and could also draw contaminated groundwater on site, should any be present.
- 10.6.22 Accidental leaks of fuels and oils from vehicular plant equipment, stored liquids, and other polluting materials have the potential to be mobilised to groundwaters and surface water via vertical and lateral migration or surface run-off. However, these risks will be mitigated by implementing a site-specific CEMP and compliance with relevant environmental permit requirements during operation.
- 10.6.23 Disturbance and/ or removal of ground materials and groundwater could potentially remove, relocate or mobilise potential contaminants, e.g. during foundation construction, earthworks and excavations.
- 10.6.24 There is potential for creation of new Source-Pathway-Receptor linkages (e.g. pile foundation construction through existing Made Ground into underlying natural soils or bedrock) into an aquifer (comprised of coarse or sandy soils (superficial deposits) or chalk (bedrock)).
- 10.6.25 Creation of new potential contaminant linkages or mobilisation of existing contaminants may result from exposure of soils/ increases in rainwater infiltration through changes in ground cover/ in excavations or bulk earthworks.
- 10.6.26 There is also potential for changes to the hydrogeological regime and potential mobilisation of contamination into groundwater during construction and potential effects on groundwater aquifers, e.g. from temporary dewatering activity required as part of construction.
- 10.6.27 The sensitivity/ value of the superficial aquifers (Tidal Flat Deposits/ Devensian Till) is considered to be **low to medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **medium**. Therefore, the effect is considered to be **minor to moderate adverse (not significant to significant)**. However, it is anticipated that piling works would be subject to a foundations works risk assessment. The piling method statements will provide information on the potential to cause pollution and measures to mitigate against the potential pollution. The works on site are anticipated to comply with the CEMP. A ground investigation has also been undertaken to confirm the baseline assumptions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible to minor adverse (not significant)**.
- 10.6.28 The sensitivity/ value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that piling works would be subject to a foundations works risk assessment. The piling method statements will provide information on the potential to cause pollution and measures to mitigate against the potential pollution. The works on site are anticipated to comply with the CEMP. A ground investigation has also been undertaken to confirm the baseline assumptions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.29 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Loss of Agricultural Soils

- 10.6.30 Based upon ALC desk-based data, there is a maximum of 15 ha of Grade 3 agricultural soil at the VPI Site.
- 10.6.31 Assuming a worst-case scenario, the sensitivity (value) of the receptor has been classed as **high** assuming the soils could be sub grade 3a, best and most versatile land. The magnitude of impact from removal of these soils is considered to be **medium** due to the physical removal or permanent sealing of 1 ha – 20 ha of agricultural land. Therefore, the effect is considered to be **moderate adverse (significant)**. However, Natural England guidance (2012; 2021) indicates that consultation with Natural England is only considered necessary where the loss of best and most versatile agricultural land is 20ha or more. As the site is less than 20ha, further consultation with Natural England is not deemed to be necessary.
- 10.6.32 There are no universally applicable measures available to mitigate the direct loss of agricultural land. Regardless of the sub classification, the primary mitigation measures would be set out in a Soil Management Strategy which would include a Soil Resource Plan and Soil Handling Strategy which would confirm the different soil types, the most appropriate re-use for the different soil types; and the proposed methods for handling, storing and replacing soils on site.

Phillips 66 Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

- 10.6.33 Site visitors and on-site workers are considered the main potential human health receptors likely to be affected by the construction phase works. Adverse effects to human health are described in the following paragraphs.
- 10.6.34 Activities relating to foundation construction, earthworks and excavations and associated movement of ground materials have the potential to cause exposure of on-site workers and/ or site visitors and off-site workers and visitors to potentially contaminated dust.
- 10.6.35 Disturbances and/ or removal of the ground materials and groundwater which could potentially remove, relocate or mobilise existing potential contaminants (e.g. during foundation construction, earthworks and excavations).
- 10.6.36 Potential temporary impacts to human health may result from the accidental leak of fuels and oils from vehicular plant or from stored liquids. Other temporary impacts may also result from the use of materials and substances with polluting potential (e.g. concrete, fuel, oils and soil) which have the potential to be mobilised to ground or controlled waters. However, these risks will be mitigated by implementing a site-specific CEMP.
- 10.6.37 Development infrastructure may also be at risk from direct contact with aggressive ground conditions. Where adequate mitigation is not incorporated during the design and construction of a development, impacts could be realised during the operational phase.
- 10.6.38 The sensitivity/ receptor value of human health receptors (onsite workers, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/or soil derived vapours is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that the constructions works will be carried out in accordance with a CEMP and environmental good practice on site. A ground investigation will also be undertaken at the site to confirm baseline assumptions; however, this will not be undertaken at the pre-planning stage. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.39 Additional human health receptors at the Phillips 66 Site are considered to be residents of South Killingholme to the west that could be at risk of inhalation of dust and/ or soil vapours. The sensitivity of this receptor is considered to be **very high**. The magnitude of impact from inhalation of dust and/ or soil derived vapours is considered to be **low**. Therefore, the effect

is considered to be **moderate adverse (significant)**. However, it is anticipated that construction works will be carried out in accordance with a CEMP and environmental good practice on site. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

- 10.6.40 The sensitivity/ receptor value for development infrastructure is considered to be **medium**. The magnitude of impact from direct contact with contaminated soil and leachate is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, a ground investigation will be undertaken at the site to confirm baseline assumptions, however, this will not be undertaken at the pre-planning stage.. The data from the ground investigation will be used to design concrete and service pipes that are appropriate for any aggressive ground conditions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Migration of Ground Gas

- 10.6.41 Ground gas may accumulate within temporary structures erected on site during construction. There is the potential for ground gas to be sourced from the Made Ground materials and organic rich soils around and underlying the site. However, it is recommended that entry into excavations or any other enclosed space on a construction site should comply with confined space legislation and be assessed prior to entry.
- 10.6.42 The receptors associated with the accumulation of ground gas are considered to be property and human health.
- 10.6.43 The sensitivity/ value of the development infrastructure (building) is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, ground gas protection measures will be implemented into design and build of permanent and temporary structures if occupied buildings are part of the final design. A ground investigation will be undertaken to confirm the baseline assumptions; however, this will not be undertaken at the pre-planning stage.. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.44 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that workers will comply with confined spaces regulations and will adopt safe working practices under the relevant health and safety legislation. A ground investigation will be undertaken to confirm the baseline assumption; however, this will not be undertaken at the pre-planning stage. s. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off (Including as a Result of Piling)

- 10.6.45 Potential effects to controlled waters could arise from contamination of the Principal Aquifers or Secondary Undifferentiated Aquifer.
- 10.6.46 Excavations and foundations have the potential to disrupt shallow groundwater. Temporary groundwater controls such as dewatering or physical cut-offs may be required to prevent the excavations filling with water, which would likely result in the lowering of groundwater levels in the immediate area of the excavation. Service trenches can also provide preferential flow pathways for groundwater. Dewatering of excavations could result in an adverse risk to groundwater and could also draw contaminated groundwater on site, should any be present.
- 10.6.47 Accidental leaks of fuels and oils from vehicular plant equipment, stored liquids, and other polluting materials have the potential to be mobilised to groundwaters and surface water via

vertical and lateral migration or surface run-off. However, these risks will be mitigated by implementing a site-specific CEMP and compliance with relevant environmental permit requirements during operation.

- 10.6.48 Disturbance and/ or removal of ground materials and groundwater could potentially remove, relocate or mobilise potential contaminants, e.g. during foundation construction, earthworks and excavations.
- 10.6.49 There is potential for creation of new Source-Pathway-Receptor linkages (e.g. pile foundation construction through existing Made Ground into underlying natural soils or bedrock) into an aquifer (comprised of coarse or sandy soils (superficial deposits) or chalk (bedrock)).
- 10.6.50 Creation of new potential contaminant linkages or mobilisation of existing contaminants may result from exposure of soils/ increases in rainwater infiltration through changes in ground cover/ in excavations or bulk earthworks.
- 10.6.51 There is also potential for changes to the hydrogeological regime and potential mobilisation of contamination into groundwater during construction and potential effects on groundwater aquifers, e.g., from temporary dewatering activity required as part of construction.
- 10.6.52 The sensitivity/ value of the superficial aquifers (Devensian Till) is considered to be **medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that piling works would be subject to a foundations works risk assessment. The piling method statements will provide information on the potential to cause pollution and measures to mitigate against the potential pollution. The works on site are anticipated to comply with the CEMP. A ground investigation will be undertaken to confirm the baseline assumptions; however, this will not be undertaken at the pre-planning stage.. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.53 The sensitivity/ value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that piling works would be subject to a foundations works risk assessment. The piling method statements will provide information on the potential to cause pollution and measures to mitigate against the potential pollution. The works on site are anticipated to comply with the CEMP. A ground investigation will be undertaken to confirm the baseline assumptions; however, this will not be undertaken at the pre-planning stage. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.54 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Loss of Agricultural Soils

- 10.6.55 A small strip of land within the Phillips 66 Site parallel to the railway and an area of land where it overlaps with the VPI Site to the south of the drain and parallel to the railway is designated as Grade 3 agricultural soil.

- 10.6.56 The sensitivity (value) of the receptor has been considered as **high** in a worst-case scenario whereby the soils could be classified as sub grade 3a. Due to the nature of the development (above ground pipeline) within the area of agricultural land, the physical removal or permanent sealing of <1 ha of agricultural land should be reported as not discernible (DMRB, LA109). Therefore, the magnitude of impact is considered to be **negligible**. The effect is considered to be **minor adverse (not significant)**. Natural England guidance (2012; 2021) indicates that consultation with Natural England is only considered necessary where the loss of best and most versatile agricultural land is 20ha or more. As Grade 3 area of the P66 Site is less than 20 ha, further consultation with Natural England is not deemed to be necessary.
- 10.6.57 There are no universally applicable measures available to mitigate the direct loss of agricultural land. Regardless of the sub classification, the primary mitigation measures would be set out in a Soil Management Strategy which would include a Soil Resource Plan and Soil Handling Strategy which would confirm the different soil types, the most appropriate re-use for the different soil types; and the proposed methods for handling, storing and replacing soils on Site.

Operation Phase

- 10.6.58 This section contains an assessment of the potential impacts to ground conditions including land quality receptors as a result of the operation phase of the Proposed Developments.
- 10.6.59 The following impact pathways have been assessed:
- direct contact with contamination;
 - inhalation of dust and/ or soil derived vapours;
 - migration of ground gas; and
 - lateral and vertical migration of contamination through leachate, groundwater or surface run-off.

VPI Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

- 10.6.60 Direct contact with contamination or inhalation of dust and/ or soil derived vapours is unlikely as the Site will be covered in hard standing with the majority of human health receptors will be transient in nature. Receptors may change from assumed baseline conditions and may include site workers, commercial users and visitors.
- 10.6.61 Materials such as concrete, metals and plastic will be employed during the construction of the Proposed VPI Development. These materials could be used underground or above ground level. Development/ building infrastructure can be impacted where materials have been incorrectly specified at the design/ construction stage. Buried concrete could be exposed to chemical attack especially from acidity associated with the presence of sulphate and this could compromise the structural integrity of the underground structures.
- 10.6.62 The sensitivity/ receptor value of human health receptors (onsite workers, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/or soil derived vapours is considered to be **low**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that workers will adopt safe working practices under relevant health and safety legislation. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.63 The sensitivity/ receptor value for development infrastructure is considered to be **high**. The magnitude of impact from direct contact with contaminated soil and leachate is considered to be **medium**. Therefore, the significance of impact is considered to be **moderate adverse (significant)** effect. However, buildings and services will be designed with concrete and service pipes that are appropriate for any aggressive ground conditions. Following the

implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Migration of Ground Gas

- 10.6.64 There is potential for ground gas migration and accumulation within structures built as part of the Proposed VPI Development. The gassing potential of the VPI Site will be assessed within the ground investigation report and appropriate remediation and/or ventilation will be agreed upon and implemented.
- 10.6.65 The sensitivity/ value of the development infrastructure (building) is considered to be **high**. The magnitude of impact from migration and accumulation of ground gas is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, ground gas protection measures will be implemented into the design and build of structures if occupied buildings are part of the final design. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.66 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that workers will adopt safe working practices under the relevant health and safety legislation. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off

- 10.6.67 Impacts on soils, groundwater and surface water could potentially occur during operation as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals and process liquids. Standard industry practices will be adopted to mitigate these potential impacts.
- 10.6.68 The sensitivity/ value of the superficial aquifers (Tidal Flat Deposits/ Devensian Till) is considered to be **low to medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **negligible**. Therefore, the effect is considered to be **negligible adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.69 The sensitivity/ value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **negligible**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.70 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **negligible**. Therefore, the effect is considered to be a **minor adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.

Phillips 66 Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

- 10.6.71 Direct contact with contamination or inhalation of dust and/ or soil derived vapours is unlikely as the Phillips 66 Site will be covered in hard standing with the majority of human health receptors will be transient in nature. Receptors may change from assumed baseline conditions and may include site workers, commercial users and visitors.
- 10.6.72 Materials such as concrete, metals and plastic will be employed during the construction of the Proposed Phillips 66 Development. These materials could be used underground or above ground level. Development/ building infrastructure can be impacted where materials have been incorrectly specified at the design/ construction stage. Buried concrete could be exposed to chemical attack especially from acidity associated with the presence of sulphate and this could compromise the structural integrity of the underground structures.
- 10.6.73 The sensitivity/ receptor value of human health receptors (onsite workers, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/ or soil derived vapours is considered to be **low**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that workers will adopt safe working practices under relevant health and safety legislation. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.74 The sensitivity/ receptor value for development infrastructure is considered to be **medium**. The magnitude of impact from direct contact with contaminated soil and leachate is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, buildings and services will be designed with concrete and service pipes that are appropriate for any aggressive ground conditions. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Migration of Ground Gas

- 10.6.75 There is potential for ground gas migration and accumulation within structures built as part of the Proposed Phillips 66 Development. The gassing potential of the Phillips 66 Site will be assessed within a ground investigation and appropriate remediation and/or ventilation will be implemented as required if occupied structures or buildings form part of the development design.
- 10.6.76 The sensitivity/ value of the development infrastructure (building) is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **medium**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, ground gas protection measures will be implemented into the design and build of structures if occupied buildings are part of the final design. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.
- 10.6.77 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that workers will adopt safe working practices under the relevant health and safety legislation. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off

- 10.6.78 Impacts on soils, groundwater and surface water could potentially occur during operation as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals and process liquids. Standard industry practices will be adopted to mitigate these potential impacts.
- 10.6.79 The following qualitative assessment is subject to the findings of the proposed GI.
- 10.6.80 The sensitivity/ value of the superficial aquifers (Devensian Till) is considered to be **medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **negligible**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.81 The sensitivity/value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **negligible**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.82 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **negligible**. Therefore, the effect is considered to be a **minor adverse (not significant)**. However, it is anticipated that the site will be operated in accordance with Environmental Permits and will have managed surface drainage systems. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.

Decommissioning Phase

VPI Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

- 10.6.83 During the decommissioning phase direct contact with contamination or inhalation of dust and/ or soil derived vapours could be likely when ground is broken. Receptors are considered to be worker (demolition) and visitors to the VPI Site.
- 10.6.84 During the decommissioning phase of the Proposed VPI Development, the use of heavy equipment and activities such as excavation, backfilling and compaction may disturb the soil and mobilise potentially contaminated materials if found to be present.
- 10.6.85 The sensitivity/ receptor value of human health receptors (onsite workers including demolition, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/ or soil derived vapours is considered to be **low**. Therefore, the effect without mitigation measures is considered **minor adverse (not significant)**. Whilst the sensitivity of construction workers has been classed as **medium**, the magnitude of the impact is likely to be **very low** as mandatory PPE will be worn. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.

Migration of Ground Gas

- 10.6.86 There is potential for ground gas migration and accumulation in confined spaces during the decommissioning phase that may pose a risk to workers on the VPI Site.
- 10.6.87 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be carried out in accordance with environmental management plans and environmental good practice on site. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off

- 10.6.88 Impacts on soils, groundwater and surface water could potentially occur during decommissioning as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals and process liquids. Standard industry practices will be adopted to mitigate these potential impacts.
- 10.6.89 Should any dewatering of excavations for the Proposed VPI Development be required during the decommissioning phase, storage and disposal of the water will comply with applicable regulations at that time.
- 10.6.90 The sensitivity/ value of the superficial aquifers (Tidal Flat Deposits/Devensian Till) is considered to be **low to medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **low**. Therefore, the effect is considered to be **negligible to minor adverse (not significant)**. However, it is anticipated that works will be undertaken in accordance with relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.91 The sensitivity/ value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **low**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.92 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **low**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.

Phillips 66 Site

Direct Contact with Contamination and Inhalation of Dust and/ or Soil Derived Vapours

- 10.6.93 During the decommissioning phase direct contact with contamination or inhalation of dust and/ or soil derived vapours could be likely when ground is broken. Receptors are considered to be worker (demolition) and visitors to the Phillips 66 Site.

- 10.6.94 During the decommissioning phase of the Proposed Phillips 66 Development, the use of heavy equipment and activities such as excavation, backfilling and compaction may disturb the soil and mobilise potentially contaminated materials if found to be present.
- 10.6.95 The sensitivity/ receptor value of human health receptors (onsite workers including demolition, site visitors and offsite workers) is considered to be **medium**. The magnitude of impact is from direct contact with contamination and inhalation of dust and/ or soil derived vapours is considered to be **low**. The effect is considered to be **minor adverse (not significant)**. Whilst the sensitivity of decommissioning workers has been classed as medium, the magnitude of the impact is likely to be very low as mandatory PPE will be worn. Therefore, following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.96 Additional human health receptors at the Phillips 66 Site are considered to be residents of South Killingholme to the west that could be at risk of inhalation of dust and/ or soil vapours. The sensitivity of this receptor is considered to be **very high**. The magnitude of impact from inhalation of dust and/ or soil derived vapours is considered to be **low**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that the works would be carried out in accordance with environmental management plans and environmental good practice on site. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Migration of Ground Gas

- 10.6.97 There is potential for ground gas migration and accumulation in confined spaces during the decommissioning phase that may pose a risk to workers on the Phillips 66 Site.
- 10.6.98 The sensitivity/ value of the human health receptors is considered to be **medium**. The magnitude of impact from migration and accumulation of ground gas is considered to be **high**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that workers will comply with confined space regulations and works will be undertaken in accordance with environmental management plans and environmental good practice on site. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

Lateral and Vertical Migration of Contamination Through Leachate, Groundwater or Surface Run-off

- 10.6.99 Impacts on soils, groundwater and surface water could potentially occur during decommissioning as a result of accidental spills from the handling or leakage of fuels, lubricants, stored chemicals and process liquids. Standard industry practices will be adopted to mitigate these potential impacts.
- 10.6.100 Should any dewatering of excavations for the Proposed Phillips 66 Development be required during the decommissioning phase, storage and disposal of the water will comply with applicable regulations at that time.
- 10.6.101 The sensitivity/ value of the superficial aquifers (Devensian Till) is considered to be **medium**. The magnitude of impact from lateral and vertical migration of contamination through leachate, groundwater or surface run-off to the superficial aquifers is considered to be **low**. Therefore, the effect is considered to be **minor adverse (not significant)**. However, it is anticipated that works will be undertaken in accordance with the relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.
- 10.6.102 The sensitivity/ value of the bedrock aquifers (Burnham Chalk Formation) is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through, leachate, groundwater or surface run-off to the bedrock aquifers is considered to be **low**.

Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with the relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **negligible (not significant)**.

10.6.103 The sensitivity/ value of the North Beck Drain Catchment is considered to be **high**. The magnitude of impact from lateral and vertical migration of contamination through groundwater or surface run-off to the North Beck Drain Catchment is considered to be **low**. Therefore, the effect is considered to be **moderate adverse (significant)**. However, it is anticipated that works will be undertaken in accordance with the relevant pollution prevention guidance. Following the implementation of development design measures as detailed in Section 10.5 and mitigation measures as detailed in Section 10.7, the effect is considered to be **minor adverse (not significant)**.

10.7 Mitigation and Enhancement Measures

10.7.1 Development design mitigation measures for geology, hydrogeology and land contamination required for the Proposed Developments are described in Section 12.5 Development Design and Impact Avoidance. Mitigation and enhancement measures, in addition to the measures detailed in Section 10.5, are explained below for the construction, operation and decommissioning phases.

Construction Phase

General

10.7.2 An Outline Construction Environmental Management Plan (CEMP) has been prepared and submitted alongside the planning application (Appendix 4A ES Volume II). This will be developed into detailed CEMPs and implemented by the selected construction contractors for each of the Proposed Developments. The Outline CEMP includes a range of measures associated with mitigating potential impacts associated with land contamination as detailed in this section. Such measures accord with legal compliance and best practice guidance when working with or around contaminated materials.

10.7.3 A Materials Management Plan (MMP) application under the CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice will be made for each of the Proposed Developments. These will set out the procedures and measures that will be taken to classify, track, store, dispose of and possibly re-use all excavated materials that are expected to be encountered during the construction of the Proposed Developments.

10.7.4 Construction phase mitigation measures that will be implemented in relation to the geological and hydrogeological environment are as follows:

- where soil materials are deemed to be surplus to the requirements of the Proposed Developments, such materials will require classification as waste under the Waste Framework Directive (WFD) (2009/98/EC) as either hazardous (17-05-03) or non-hazardous (17-05-04) soils. Classification would be undertaken using a proprietary assessment tool such as “HazWasteOnline™”. Waste deemed to be hazardous, will require sampling and testing of Waste Acceptance Criteria (WAC) analysis suite prior to disposal to landfill;
- stockpiled excavated material (temporary) will be located in a designated area of each of the Sites located away from watercourses to prevent run-off from the stockpile from entering surface water bodies;
- all areas of stockpiled material may be reseeded or otherwise covered temporarily if they are not to be used within three months. All areas of unused and exposed soil within the Sites following construction of the Proposed Developments will be reseeded or otherwise covered as soon as possible. Erosion protection matting may also be used to minimise sediment being entrained by water flow or becoming entrained by the wind if allowed to dry out; and

- washing out of vehicles or equipment will only take place in controlled areas. Suitable locations will be agreed upon through consultation with the Environment Agency and identified within the contractors' CEMPs.

Impact on Human Receptors

10.7.5 The potential impacts specific to construction workers during construction of the Proposed Developments at both the VPI Site and Phillips 66 Site will be managed by adherence to the working practices in accordance with Construction Industry Research and Information Association (CIRIA) C741 Environmental Good Practice on Site 4th Edition (CIRIA, 2015), including:

- measures to minimise dust generation;
- provision of personal protective equipment (PPE), such as gloves, barrier cream, overalls etc. to minimise direct contact with soils;
- provision of adequate hygiene facilities and clean welfare facilities for all construction site workers;
- monitoring of confined spaces for potential ground gas accumulations, restricting access to confined spaces i.e. by suitably trained personnel, and use of specialist PPE, where necessary; and
- preparation and adoption of a site and task specific health and safety plan.

Impact on Controlled Waters

10.7.6 The management measures implemented through the CEMPs will minimise the risk of any contaminated surface water runoff from both the VPI Site and Phillips 66 Site during the site preparation, earthworks and construction phases so there is no detrimental effect on the receiving watercourse and underlying aquifers. Pollution Plans agreed with the Environment Agency and North East Lindsey Internal Drainage Board will be produced and adhered to mitigate against accidental pollution.

10.7.7 If dewatering of either the VPI Site or Phillips 66 Site is required during the construction phase of the Proposed Developments a water discharge activity (WDA) environmental permit from the Environment Agency to discharge to surface water or a trade effluent consent to discharge to foul sewer, agreed with the local sewerage undertaker, will need to be obtained. Arrangements will need to be made to store any waters collected during dewatering to determine that the chemical criteria for the WDA and/ or trade effluent consent can be met before discharging the water. Dewatering of an excavation may be undertaken without a permit subject to complying with conditions set out in the Environment Agency Regulatory Position Statement 'Temporary dewatering from excavations to surface water' (Environment Agency, 2021a).

10.7.8 The prevention of pollution of surface water and/ or groundwater will comply with the requirements set out by the Environment Agency within guidelines published online at www.gov.uk/guidance/pollution-prevention-for-businesses (Defra and the Environment Agency, 2016).

10.7.9 Further mitigation measures for surface waters are outlined in Chapter 9: Water Environment and Flood Risk.

Impact on Soil Resource

10.7.10 There are no universally applicable measures available to mitigate the direct loss of agricultural land. The primary measures to mitigate the impacts on soil resources would be set out in a Soil Management Strategy, to be prepared during the detailed design stage. The Soil Management Strategy would include a Soil Resource Plan and Soil Handling Strategy which would confirm the different soil types (based on the soil surveys to be undertaken); the most appropriate re-use for the different types of soils; and the proposed methods for handling, storing and replacing soils on-site. This is applicable to the land within the VPI Site, which partially overlaps with the site boundary of the Phillips 66 Site.

Operation Phase

General

- 10.7.11 At this stage no additional mitigation measures are considered necessary during the operational stage of the Proposed Developments as the risks identified previously will have been mitigated during the construction stage.
- 10.7.12 Operational impacts are considered to be unlikely as Proposed Developments will be operated in accordance and comply with relevant regulations and legislation.
- 10.7.13 Operations would be limited to the accidental spillage of polluting materials from HGV vehicles and during maintenance works.

Impact on Maintenance Workers

- 10.7.14 For maintenance workers during the operation phase, maintenance works will be carried out in accordance with CIRIA (2015) C741 Environmental Good Practice on Site 4th Edition and a health and safety risk assessment shall be undertaken before works are undertaken. Maintenance workers will be provided with appropriate PPE such as gloves and overalls to minimise direct contact with soils. Entry into excavations or confined spaces will comply with confined space legislation and assessed prior to entry. Should the detailed design of the Proposed Developments incorporate any confined spaces such as ducts, manholes and inspection chambers, a gas monitoring programme and gas risk assessment will be undertaken in accordance with good practice guidance.

Impact on Off Site Receptors and Future Site Users

- 10.7.15 The risk to future site users from direct contact with the underlying soils is considered to be very low. The Proposed Developments will comprise areas of hardstanding across the majority of the Phillips 66 Site and the VPI Site, which will break the potential contaminant linkage and therefore reduce the likelihood of contact further.
- 10.7.16 The risk to future site users from direct contact with contaminated leachate or groundwater is considered to be low. It is considered the probability that future site users will come into contact with contaminated leachate or groundwater at the Sites is unlikely due to the majority of the areas being covered by hardstanding.

Decommissioning Phase

Impacts on Human Receptors

- 10.7.17 The potential impacts specific to demolition workers during the decommissioning phase of the Proposed Developments will be mitigated by adherence to the working practices in accordance with CIRIA (2015) C741 Environmental Good Practice on Site 4th Edition (or the equivalent good practice guidance available at the time of decommissioning), including:
- measures to minimise dust generation;
 - provision of PPE such as gloves, barrier cream, overalls etc. to minimise direct contact with soils;
 - provision of adequate hygiene facilities and clean welfare facilities for all demolition workers;
 - monitoring of confined spaces for potential ground gas accumulations, restricting access to confined spaces i.e. by suitably trained personnel, and use of specialist PPE, where necessary; and
 - preparation and adoption of a site and task specific health and safety plan.

Impact on Controlled Waters

- 10.7.18 If dewatering of the Sites is required during the decommissioning phase of the Proposed Developments this may be discharged to foul sewer under a trade effluent consent or a permit from the Environment Agency to discharge to surface water will need to be obtained, and

arrangements will need to be made to store any waters collected during dewatering to determine whether contamination is present before deciding on where to discharge the waters. Dewatering of an excavation may be undertaken without a permit subject to complying with conditions set out in the Environment Agency Regulatory Position Statement 'Temporary dewatering from excavations to surface water' (2021a).

10.8 Residual Effects and Conclusions

Overview

- 10.8.1 Table 10.12 provides a summary of the residual effects for the construction, operational and decommissioning phases of the Proposed Developments at the VPI Site and Phillips 66 Site. Following the implementation of the design and impact avoidance measures set out in Section 10.5.

Table 10.12: Summary of effects for the Proposed Developments (dependant on results of GI)

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
Construction	Direct contact with contamination and inhalation of dust and/or soil derived vapours – human health (both Proposed Developments)	Moderate adverse (significant)	A ground investigation considering ground conditions and quality has been undertaken at the VPI site and a ground investigation will be undertaken at the Phillips 66 site to confirm baseline assumptions. However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage. Construction works will be carried out in accordance with a CEMP and environmental good practice on site.	Minor adverse (not significant)	Short term, reversible
	Inhalation of dust and /or soil derived vapours – off site residential users human health (Proposed Phillips 66 Development only)	Moderate adverse (significant)	Construction works will be carried out in accordance with a CEMP and environmental good practice on site.	Minor adverse (not significant)	Short term, reversible
	Direct contact with contamination – development infrastructure (both Proposed Developments)	Moderate adverse (significant)	A ground investigation considering groundwater level and quality has been undertaken at the VPI site and a ground investigation is planned to be undertaken at the Phillips 66 Site to confirm baseline assumptions. However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage Buildings and services risks will be mitigated by using concrete and	Minor adverse (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
			service pipes appropriate for any aggressive ground conditions.		
	Migration of ground gas – human health (both Proposed Developments)	Moderate adverse (significant)	<p>A ground investigation considering groundwater level and quality has been undertaken at the VPI site and a ground investigation is planned to be undertaken at the Phillips 66 Site . However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage</p> <p>Workers will adopt safe working practices under relevant health and safety legislation.</p> <p>Workers will comply with confined spaces regulations.</p>	Minor adverse (not significant)	Short term, reversible
	Migration of ground gas – development infrastructure (both Proposed Developments)	Moderate adverse (significant)	<p>A ground investigation considering ground gas quality has been undertaken at the VPI site and a ground investigation is planned to be undertaken at the Phillips 66 Site to confirm baseline assumptions. However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage</p> <p>Ground gas protection measures will be implemented into design and build of permanent and temporary structures if occupied buildings are part of the final design.</p>	Minor adverse (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off (including as a result of piling) – superficial aquifers (both Proposed Developments)	Minor to moderate adverse (not significant to significant)	<p>A ground investigation considering groundwater level and quality has been/ will be undertaken at the VPI site and a ground investigation is planned to be undertaken at the Phillips 66 Site to confirm baseline assumptions. However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage</p> <p>Any piling works would be planned in accordance with best practice guidance (Environment Agency, 2001). Piling operations would be subject to foundation works risk assessment and any potential to cause pollution to the aquifer would be covered by measures to be detailed in piling method statements.</p> <p>Construction works will be carried out in accordance with a CEMP.</p>	Negligible to minor adverse (not significant)	Short term, reversible
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off (including as a result of piling) – bedrock aquifers (both Proposed Developments)	Moderate adverse (significant)	<p>A ground investigation considering groundwater level and quality has been/ will be undertaken at the VPI site and a ground investigation is planned to be undertaken at the Phillips 66 Site to confirm baseline assumptions. However, the ground investigation at the Phillips 66 Site will not be undertaken at the pre-planning stage</p> <p>Any piling works would be planned in accordance with best practice</p>	Minor adverse (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
			<p>guidance (Environment Agency, 2001). Piling operations would be subject to foundation works risk assessment and any potential to cause pollution to the aquifer would be covered by measures to be detailed in piling method statements.</p> <p>Construction works will be carried out in accordance with a CEMP.</p>		
	<p>Lateral and vertical migration of contamination through leachate, groundwater or surface run-off (including as a result of piling) – North Beck Drain catchment (both Proposed Developments)</p>	<p>Moderate adverse (significant)</p>	<p>All development will be undertaken in accordance with relevant pollution prevention guidance.</p>	<p>Minor adverse (not significant)</p>	<p>Short term, reversible</p>
	<p>Loss of agricultural soils (VPI Site only)</p>	<p>Moderate adverse (significant)</p>	<p>The primary measures to mitigate the impacts on soil resources would be set out in a Soil Management Strategy, to be prepared during the detailed design stage. The Soil Management Strategy would include a Soil Resource Plan and Soil Handling Strategy which would confirm the different soil types (based on the soil surveys to be undertaken); the most appropriate re-use for the different types of soils; and the proposed methods for handling, storing and replacing soils onsite.</p>	<p>Moderate adverse (significant)</p>	<p>Long term, irreversible</p>

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
Operation	Direct contact with contamination, inhalation of dust and soil vapours – human health (both Proposed Developments)	Minor adverse (not significant)	Workers will adopt safe working practises under relevant health and safety legislation.	Negligible (not significant)	Short term, reversible
	Direct contact with contamination – development infrastructure (both Proposed Developments)	Moderate adverse (significant)	Buildings and services risks will be mitigated by using concrete and service pipes appropriate for any aggressive ground conditions.	Minor adverse (not significant)	Short term, reversible
	Migration of ground gas – development infrastructure (both Proposed Developments)	Moderate adverse (significant)	Ground gas protection measures will be implemented into design and build of structures if occupied buildings are part of the final design.	Minor adverse (not significant)	Short term, reversible
	Migration of ground gas – human health (both Proposed Developments)	Moderate adverse (significant)	Workers will adopt safe working practices under relevant health and safety legislation.	Minor adverse (not significant)	Short term, reversible
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – superficial aquifers (both Proposed Developments)	Negligible (not significant)	The Proposed Developments will be operated in accordance with Environmental Permits and will have managed surface drainage systems.	Negligible (not significant)	Short term, reversible
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – bedrock	Minor adverse (not significant)	The Proposed Developments will be operated in accordance with Environmental Permits and will have managed surface drainage systems.	Negligible (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
	aquifers (both Proposed Developments)				
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – North Beck Drain catchment (both Proposed Developments)	Minor adverse (not significant)	The Proposed Developments will be operated in accordance with Environmental Permits and will have managed surface drainage systems.	Negligible (not significant)	Short term, reversible
Decommissioning	Direct contact with contamination and inhalation of dust and/or soil derived vapours – human health (both Proposed Developments)	Moderate adverse (significant)	Works will be carried out in accordance with environmental management plans and environmental good practice on site.	Minor adverse (not significant)	Short term, reversible
	Inhalation of dust and/or soil derived vapours – off site residential users human health (Proposed Phillips 66 Development only)	Moderate (significant)	Works will be carried out in accordance with environmental management plans and environmental good practice on site.	Minor adverse (not significant)	Short term, reversible
	Migration of ground gas – Human health (both Proposed Developments)	Moderate adverse (significant)	Works will be carried out in accordance with environmental management plans and environmental good practice on site. Workers will comply with confined spaces regulations.	Minor adverse (not significant)	Short term, reversible
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – superficial	Minor adverse (not significant)	Works will be undertaken in accordance with relevant pollution prevention guidance.	Negligible (not significant)	Short term, reversible

Phase	Description of Effect	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
	aquifers (both Proposed Developments)				
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – bedrock aquifers (both Proposed Developments)	Moderate adverse (significant)	Works will be undertaken in accordance with relevant pollution prevention guidance.	Negligible (not significant)	Short term, reversible
	Lateral and vertical migration of contamination through leachate, groundwater or surface run-off – North Beck Drain catchment (both Proposed Developments)	Moderate adverse (not significant)	Works will be undertaken in accordance with relevant pollution prevention guidance.	Negligible (not significant)	Short term, reversible

Conclusion

- 10.8.2 The potential significance of effect during the construction, operation and decommissioning phases has been assessed for the following receptors: human health, off-site human health (for the Phillips 66 site only), development infrastructure, agricultural soils and controlled waters.
- 10.8.3 The potential effect, after mitigation measures are applied, is considered to be minor adverse (not significant) for human health, off-site human health, development infrastructure and controlled waters receptors in the construction phase. The potential effect for agricultural soils at the VPI site is considered to be **moderate adverse (significant)**. The potential effect for agricultural soils at the P66 Site is considered to be **minor adverse (not significant)**.
- 10.8.4 The potential effect, after mitigation measures are applied, human health is considered to be negligible (not significant) for the direct contact with contamination and inhalation of dust and/or soil derived vapours pathway during the operational phase. The potential effect, after mitigation measures are applied, to controlled waters is considered to be **negligible (not significant)** during the operational phase. The assessment for development infrastructure receptors indicates the potential effect is **minor adverse (not significant)** for migration of ground gas and direct contact pathways. The potential effect (after mitigation measures are applied) to human health associated with migration of ground gas during the operational phase is considered to be **minor adverse (not significant)**.
- 10.8.5 The potential effects (after mitigation measures are applied) during the decommissioning phase for human health, off-site human health (Phillips 66 site only) and development infrastructure is considered to be **minor adverse (not significant)**. The potential effects to controlled waters is considered to be **negligible (not significant)** following the implementation of mitigation measures.
- 10.8.6 Therefore, the potential impacts associated with the Humber Zero project from a geology, hydrogeology and land contamination perspective are considered to be **not significant** for the construction, operation and decommissioning phases.

10.9 References

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