VikingLink

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UK Onshore Scheme

Environmental Statement

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Chapter 07

Geology & Hydrogeology (Proposed Underground DC Cable)

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Environmental Statement Volume 2			
ES Reference	**Chapter**	**Chapter Title**	
ES-2-A.01	Ch01	Introduction	
ES-2-A.02	Ch02	Development of the UK Onshore Scheme	
ES-2-A.03	Ch03	The UK Onshore Scheme	
ES-2-A.04	Ch04	Environmental Impact Assessment Methods	
ES-2-B.01	Ch05	The Proposed Underground DC Cable	
ES-2-B.02	Ch06	Intertidal Zone	
ES-2-B.03	**Ch07**	**Geology & Hydrogeology**	
ES-2-B.04	Ch08	Water Resources & Hydrology	
ES-2-B.05	Ch09	Agriculture & Soils	
ES-2-B.06	Ch10	Ecology	
ES-2-B.07	Ch11	Landscape & Visual Amenity	
ES-2-B.08	Ch12	Archaeology & Cultural Heritage	
ES-2-B.09	Ch13	Socio-economics & Tourism	
ES-2-B.10	Ch14	Traffic & Transport	
ES-2-B.11	Ch15	Noise & Vibration	
ES-2-B.12	Ch16	Register of Mitigation	
ES-2-C.01	Ch17	The Proposed Converter Station	
ES-2-C.02	Ch18	Geology & Hydrogeology	
ES-2-C.03	Ch19	Water Resources & Hydrology	
ES-2-C.04	Ch20	Agriculture & Soils	
ES-2-C.05	Ch21	Ecology	
ES-2-C.06	Ch22	Landscape & Visual Amenity	
ES-2-C.07	Ch23	Archaeology & Cultural Heritage	
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Glossary & Abbreviations

Glossary of Terms	
Term	**Meaning**
base scheme design	The design of the UK Onshore Scheme for the purposes of the planning application.
cone penetration test	Probe method used to determine the geotechnical engineering properties of soils and delineating soil stratigraphy
connection point	The existing Bicker Fen 400 kV Substation; the point on the National Electricity Transmission System (NETS) where Viking Link connects.
the Contractor	Party or parties responsible for the detailed design and construction UK Onshore Scheme.
converter station	Facility containing specialist equipment (some indoors and some potentially outdoors) for the purposes of converting electricity from AC to DC or DC to AC.
converter station site	The proposed site occupying approx. 30 ha containing the converter station and associated landscaping, drainage as well as land required for construction.
Cretaceous	Defined as the period between 145.5 and 65.5 million years ago.
DC cable route	The proposed DC cable route comprising DC and fibre optic cables from the landfall to the converter station.
Devensian	Denoting the most recent Pleistocene glaciation in Britain.
Ferruginous	Containing iron oxides.
Generic Assessment Criteria	Screening criteria derived using generic assumptions about the characteristics and behaviour of contaminant sources, pathways and receptors. These assumptions will be protective in a range of defined conditions.
Generic Quantitative Risk Assessment	Risk assessment carried out using generic assumptions to estimate risk or to develop generic assessment criteria.
Jurassic	Denoting the second period of the Mesozoic lasting for 55 million years between Triassic and Cretaceous periods.
Limits of Deviation	These define the maximum extents of the corridor for which planning permission is sought and within which proposed DC and AC cable routes may be installed.
Local Geological Site	Non-statutory sites that have been identified by local geo-conservation groups as being of importance.
Mineral Safeguard Area	An area designated by Minerals Planning Authorities which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development.
Ooid	A small calcium carbonate or iron coated grain formed in marine environment.

Glossary of Terms	
Term	**Meaning**
Palaeochannels	Remnant of an inactive river or stream channel that has been either filled or buried by younger sediment
Principal Aquifers	These are layers of rock or drift deposits that have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
Quaternary	Denoting the period following the Tertiary period and comprising the Pleistocene and Holocene epochs, the Holocene being most recent
Secondary Aquifers	These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types: Secondary A which are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers and Secondary B which are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
Secondary Undifferentiated	An aquifer classification assigned in cases where it has not been possible to attribute either category A or B to a rock type.
Site of Special Scientific Interest	A site designated by Natural England under the Wildlife and Countryside Act 1981 as an area of special interest by reason of any of its flora, fauna, geological or physiographical features (plants, animals and natural features relating to the Earth's structure).
Source Protection Zone	The Environment Agency identifies Source Protection Zones to protect groundwater (especially public water supply). These zones show the risk of contamination from any activities that might cause pollution. There are three main zones (inner, outer and total catchment) and a fourth zone of special interest, which the Environment Agency occasionally apply, to a groundwater source .
Stoplines	Defensive lines identified during war times that would prevent enemy advances e.g. rivers, ridges, linear obstacles. Often targeted by bombing campaigns hence an unexploded ordnance potential may exist associated with such features.
target priority location	Term adopted during DC cable route ground investigation undertaken in January to March 2017 to denote specific assets and infrastructure targeted for ground investigation.
Temporary Construction Compound	Compound used by the Contractor for siting of offices, welfare facilities, storage and laydown.
Temporary Works Area	Larger working area located on or adjacent to the working width used where construction activities requires a larger area for example at trenchless crossings.

Glossary of Terms	
Term	**Meaning**
Unexploded Ordnance	Explosive ordnance that has been either primed, fused, armed or prepared for use and has been subsequently fired, dropped, launched, projected or placed in such a manner as to present a hazard to operations, persons or objects and remains unexploded either by malfunction or design.
Stoplines	Defensive lines identified during war times that would prevent enemy advances e.g. rivers, ridges, linear obstacles. Often targeted by bombing campaigns hence an unexploded ordnance potential may exist associated with such features.
Unproductive Strata	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
working width	The 30 m wide working corridor required for the installation of underground DC cables.

List of Abbreviation	
Abbreviation	**Meaning**
BBC	Boston Borough Council
BGS	British Geological Survey
BRE	Building Research Establishment
BS	British Standard
CDM	Construction Design Management
CEMP	Construction Environmental Management Plan
CIEH	Chartered Institute of Environmental Health
CLEA	Contaminated Land Exposure Assessment
COSHH	Control of Substances Hazardous to Health
CPP	Construction Phase Plan
DC	Direct Current
DMRB	Design Manuel for Roads and Bridges
DWS	Drinking Water Standard
EA	Environment Agency
EIA	Environmental Impact Assessment
ELDC	East Lindsey District Council
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ERP	Environmental Response Plan
ES	Environmental Statement

List of Abbreviation	
Abbreviation	**Meaning**
EQS	Environmental Quality Standard
GAC	Generic Assessment Criteria
GEL	Geotechnical Engineering Limited
GQRA	Generic Quantitative Risk assessment
H&SP	Health and Safety Plan
HDD	Horizontal Directional Drilling
IDB	Internal Drainage Board
IPPC	Integrated Pollution and Prevention Control
Km	Kilometre
kV	Kilovolt
LGS	Local Geological Sites
LoD	Limit of Deviation
m	Metre
m bgl	Meters Below Ground Level
MCA	Mineral Consultation Areas
MSA	Mineral Safeguarding Areas
NGVL	National Grid Viking Link Limited
NHBC	National House Building Council
NKDC	North Kesteven District Council
NPPF	National Planning Policy Framework
NVZ	Nitrate Vulnerable Zone
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbon
PCPT	Piezo Cone Penetration Test
PPE	Personal Protective Equipment
RNR	Roadside Natural Resource
SHDC	South Holland District Council
SPZ	Source Protection Zone
SSSI	Sites of Special Scientific Interest
SVOC	Semi Volatile Organic Compound
SWMP	Site Waste Management Plan

List of Abbreviation	
Abbreviation	**Meaning**
TCA	Temporary Construction Areas
TCC	Temporary Construction Compounds
TPL	Target Priority Location
UK	United Kingdom
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WAC	Waste Acceptance Criteria

1 Introduction

1.1 Introduction

1.1.1 This chapter has been prepared by AECOM. It reports the results of baseline studies and the assessment of the potential impacts of the proposed Direct Current (DC) cable route on Geology and Hydrogeology. Table 7.1 below sets out the structure of the Environmental Statement (ES) with respect to Geology and Hydrogeology. Reference should be made to other documents which form part of the ES as appropriate.

1.1.2 Impacts on Geology and Hydrogeology are interrelated with impacts on Water Resources and Hydrology (*ES-2-B.04, Volume 2, Chapter 08*), Agriculture and Soils (*ES-2-B.05, Volume 2, Chapter 09*) and Ecology (*ES-2-B.06, Volume 2, Chapter 10)*. Further details of other schemes within the surrounding area that could result in cumulative effects are described in Cumulative Effects (*ES-2-D.01, Volume 2, Chapter 28).*

Table 7.1 Environmental Statement: Geology and Hydrogeology

ES reference	ES volume	ES chapter	Content
ES-2-B.03	**2**	**07**	**Main Report: Proposed Underground DC Cable**
ES-2-C.02	2	18	Main Report: Proposed Converter Station
ES-3-B.01	3	07	Figures: Proposed Underground DC Cable
ES-3-C.01	3	18	Figures: Proposed Converter Station
ES-4-B.03	4	07	Technical Appendices: Proposed Underground DC Cable
ES-4-C.02	4	18	Technical Appendices: Proposed Converter Station

1.2 Chapter Structure

1.2.1 The remainder of this chapter is structured as follows:

- Section 2. Approach to Assessment. Sets out the discipline specific approach to the assessment in accordance with relevant guidance.
- Section 3. Basis of Assessment. Sets out the key assumptions which have been made in undertaking the impact assessment.
- Section 4. Planning Policy and Legislative Considerations. Provides a summary of the key points of planning policy and legislation which have been considered as part of the assessment.
- Section 5. Baseline Conditions. Reports the results of desktop and field studies undertaken to establish existing conditions.

- Section 6. Potential Impacts. Identifies the potential impacts on geology and hydrogeology which may occur as result of construction and operation.
- Section 7. Mitigation. Identifies the mitigation which is proposed including measures which are incorporated into the siting, design and construction of the underground cable.
- Section 8. Residual Effects. Reports the residual effects which remain taking into account proposed mitigation and identifies whether these are significant or not.
- Section 9. Monitoring. Identifies any proposed short, medium or long term monitoring which is proposed to be undertaken during construction and/or operation.
- Section 10. Cumulative Effects. Identifies the inter-project cumulative effects which may occur in combination with other developments.
- Section 11. Summary of Assessment. Provides a summary of the key findings of the impact assessment.

1.2.2 The baseline conditions detailed in Section 5 have been established utilising the sources of information listed in Section 12 of this chapter.

2 Approach to Assessment

2.1 Introduction

2.1.1 This section describes the approach to the identification and assessment of impacts resulting from the construction and operation of the UK Onshore Scheme on Geology and Hydrogeology.

2.2 Summary of Consultation

Scoping Opinion Review

2.2.1 Table 7.2 summarises the issues raised in the scoping opinion in relation to Geology and Hydrogeology and outlines how this has been addressed.

Table 7.2 Scoping opinion (Geology and Hydrogeology)

Consultee	Summary of comment	How and where addressed
Boston Borough Council (BBC)	Requested that the ES should positively acknowledge potential environmental effects on land drainage regimes.	Whilst there is overlap with hydrogeology, the effects on land drainage regimes will be considered and assessed within *ES-2-B.03, Volume 2, Chapter 08: Water Resources and Hydrology.*
Environment Agency (EA)	The EA requested that private groundwater abstractions be considered in the assessment as well as licensed groundwater abstractions.	Groundwater abstraction records identified within a defined zone of influence will be reported on within the baseline conditions against which potential positive or negative environmental effects will be assessed using the Geology and Hydrogeology methodology that is presented in this section.

Additional Consultation

2.2.2 Table 7.3 summarises additional consultation undertaken with relevant statutory and non-statutory consultees in relation to Geology and Hydrogeology and outlines how and where this has been addressed.

Table 7.3 Additional consultation (Geology and Hydrogeology)		
Consultee	**Nature of additional consultation**	**How and where addressed**
BBC	Request made for information on private groundwater abstraction licenses made in September 2016. BBC advised that no records held in September 2016.	Baseline groundwater abstraction information is reported in Section 5.
EA	The EA were contacted in December 2015 and again in January 2016 to request data on consented discharges to controlled waters and groundwater levels for the area around the converter station site at the southern end of the proposed underground cable route. A response was received on 16th February 2016 (reference CCN/2015/560) and 23rd March 2016 (reference CCN/2015/1609).	Baseline groundwater abstraction information is reported in Section 5.
EA	The EA were contacted in October 2016 to request data on private and commercial groundwater abstractions for the area proposed underground cable route and surrounding area. A response was received on the 23rd November 2016 (reference CCN/2016/25333) and 30th January 2017 (reference CCN/2017/34554).	Baseline groundwater abstraction information is reported in Section 5.
East Lindsey District Council (ELDC)	ELDC were contacted for information on private groundwater abstraction licenses in September 2016. Data was provided in December 2016.	Baseline groundwater abstraction information is reported in Section 5.
Greater Lincolnshire Nature Partnership Geodiversity Group	A request was made for information on Local Geological Sites in February 2016 and records were provided back within the same month.	Baseline information on geological sites is reported in Section 5.
North Kesteven District Council (NKDC)	NKDC were contacted for information on private groundwater abstraction licenses in September 2016. NKDC advised in October 2016 that they did not hold any records for private groundwater abstractions.	Baseline groundwater abstraction information reported in Section 5.

Table 7.3 Additional consultation (Geology and Hydrogeology)		
Consultee	**Nature of additional consultation**	**How and where addressed**
South Holland District Council (SHDC)	SHDC were contacted for information on private groundwater abstraction licenses in September 2016. Data was provided in November 2016.	Baseline groundwater abstraction information is reported in Section 5

2.3 Scope of Assessment

Aspects to be assessed

2.3.1 The following specific topic areas have been assessed.

- Geology;
- Hydrogeology;
- Mineral Resources;
- Geological Designated Sites; and
- Soil and Groundwater Contamination.

Spatial Scope

2.3.2 The assessment has considered potential direct and indirect impacts associated with the Limits of Deviation. The Zone of Influence is based on the application boundary for the UK Onshore Scheme plus a 250 m buffer. For groundwater abstractions a 500 m buffer has been adopted. Further information on the definition of the Zone of Influence adopted is provided in Section 5.

2.3.3 The Zone of Influence for Geology and Hydrogeology is illustrated in Figure 7.1 which is presented in *ES-3-B.03, Volume 3, Chapter 07: Geology and Hydrogeology*.

Temporal Scope

2.3.4 In assessing the effects, the likely duration of effect has been considered as either:

- Temporary impacts – during the construction phase comprising the groundworks for the underground cable installation; and
- Longer term, operational and permanent impacts – covers the operational phase and beyond.

2.3.5 The majority of impacts on Geology and Hydrogeology are likely to arise during the construction phase and are anticipated to be temporary and localised, with notable exceptions being where mineral resources are lost or sterilised and where impacts may be more permanent.

2.3.6 The routine operation of the proposed underground DC cable is not likely to have any significant effects on the underlying geology and groundwater under normal operating conditions. Any contamination encountered during construction would be expected to be removed, treated and/or mitigated as part of the construction.

2.4 Identification of Baseline Conditions

Desk Studies

2.4.1 A number of desktop sources of information have been used to establish the baseline conditions of the Zone of Influence. In particular the sources referred to, which are presented in Section 12, have been and referenced to establish the geological and hydrogeological setting, the potential for significant soil or groundwater contamination, the extent of mineral resources and the presence of geologically designated sites.

Field Studies

2.4.2 Intrusive ground investigation has also been undertaken to inform the design of the UK Onshore Scheme and further information on this, in terms of establishing the baseline conditions, is provided in Section 5.

2.5 Assessment Guidance

Impact Assessment

2.5.1 The assessment of the significance of the potential effects on geology is based on guidance provided in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 11 (Ref: 7-01). The potential effects on groundwater have been assessed in a qualitative manner. The assessment of importance, magnitude and significance of predicted effects is based on DMRB HD45/09, Part 10 (Ref: 7-02). There is no specific guidance in relation to assessing the impact of interconnectors on Geology and Hydrogeology, therefore DMRB has been used as it is considered to be the most appropriate methodology because it is designed for assessing the effects of linear schemes. It is also a well-established and tested methodology, familiar to statutory consultees.

Contaminated Land Risk Assessment

2.5.2 The potential effects upon the UK Onshore Scheme from contaminated soils, groundwater and ground gas have been identified. The impacts associated with contaminated land are generally assessed by means of a source/hazard-pathway-receptor methodology in accordance with EA (2004), ‘Contaminated Land Report (CLR11) Model Procedures for the Management of Land Contamination' (Ref: 7-03) and British Standard BS10175, (2011+A1 2013) 'Investigation of Potentially Contaminated Sites - Code of Practice' (Ref: 7-04), where the following definitions apply:

- Source/hazard: a hazardous substance that has the potential to cause adverse impacts to a receptor;
- Receptor: a target that may be affected by contamination; examples include human occupants/users of the site, water resources or structures; and

- Pathway: a route whereby a hazardous substance may come into contact with the receptor: examples include ingestion of contaminated soil and leaching of contaminants from soil into water resources.

2.5.3 For contamination to result in a significant potential impact, it must be demonstrated that there is an identifiable source of contamination (be it an on-site or off-site source), potential sensitive receptors and potential pathways through which the former may affect the latter. The assessment has considered both the impacts of existing contamination on the Scheme, and the potential for the proposed Direct Current (DC) cable to impact upon land quality.

2.5.4 Receptor sensitivity to potential contaminated land has been defined in Table 7.4. This is a qualitative measure that is considered relevant as a means of defining the types and sensitivities of different receptors that may be impacted upon during construction and operation, where in the presence of known or potential contaminated soil or groundwater.

2.6 Impact Assessment Criteria

Sensitivity of Receptors

2.6.1 The sensitivity of a receptor reflects the quality of the receptor and its ability to absorb an impact without perceptible change. Sensitivity is defined in Table 7.4.

Table 7.4 Sensitivity criteria (Geology and Hydrogeology)

Sensitivity	Description	Examples
Very High	Attribute has a high quality and rarity on a regional or national scale.	Principal aquifer providing a regionally important resource Groundwater supporting a site protected under European and UK habitat legislation. Groundwater source protection zone (SPZ) 1. Presence of significant mineral reserves and within a Mineral Consultation Area (MCA) or Mineral Safeguarding Area (MSA). Internationally or nationally important geological/ geomorphological features.
	Other Sensitive receptors susceptible to soil or groundwater contamination.	Residential areas, schools, play areas directly adjacent to construction works. Construction and maintenance workers. Internationally and nationally designated ecological sites directly adjacent to construction works. Surface water features deemed to be of very high quality/value.

Table 7.4 Sensitivity criteria (Geology and Hydrogeology)		
Sensitivity	**Description**	**Examples**
High	Attribute has a high quality and rarity on a local scale.	Principal Aquifer. Secondary A aquifer providing locally important resource or supporting river ecosystem. Groundwater SPZ 2 or 3. Within a MCA or MSA. Regionally important geological/ geomorphological features.
	Other Sensitive receptors susceptible to soil or groundwater contamination.	Residential areas, schools or play areas within 250 m of construction works. Allotments, arable farmland, livestock, market gardens. Regionally important ecological sites. Surface water features deemed to be of high quality/value.
Medium	Attribute has a medium quality and rarity on a local scale.	Secondary A and B Aquifers. Secondary A aquifer providing source of water for agricultural or industrial use with limited connectivity with surface water features. Some mineral potential but not within a MCA or MSA. Locally important geological/geomorphological features.
	Other Sensitive receptors susceptible to soil or groundwater contamination.	Commercial land use or open space (excluding school playing fields and play areas) adjacent to construction works. Surface water feature deemed to be of medium quality/value. Locally important ecological sites.
Low	Attribute has a low quality or rarity on a local scale.	Secondary B Aquifers. Secondary B aquifer providing source of water for agricultural or industrial use with limited connectivity with surface water features. Geology or geomorphology of less than local importance. Limited potential for mineral reserves and site not within a MCA or MSA.
	Other Sensitive receptors susceptible to soil or groundwater contamination.	Commercial land use or open space (excluding school playing fields and play areas) within 250 m of construction works. Residential areas, schools or play areas present > 250 m from construction works. Surface water feature deemed to be of low quality/ value.

Table 7.4 Sensitivity criteria (Geology and Hydrogeology)		
Sensitivity	**Description**	**Examples**
Negligible	Attribute has a negligible quality or rarity on a local scale.	Unproductive groundwater strata. No mineral extraction potential. No geological or geomorphological features of interest.
	Other Sensitive receptors susceptible to soil or groundwater contamination.	No developed land uses other than transport infrastructure within 250 m. Surface water feature deemed to be of negligible quality/value.

Magnitude of Impacts

2.6.2 The magnitude of a potential impact considers the scale of the predicted change to the baseline condition taking into account its duration (i.e. the magnitude may be moderated by the effects being temporary rather than permanent, short term rather than long term). Definitions for effect magnitude are described in Table 7.5. It is unlikely that any effects on geology and soils would be beneficial, so the examples of magnitude all relate to adverse effects.

Table 7.5 Impact magnitude criteria (Geology & Hydrogeology)		
Magnitude	**Description**	**Examples**
High	Total loss or major alteration to key features of the baseline conditions such that post development character/composition of baseline condition will be fundamentally changed.	Pollution of potable sources of water abstraction. Loss of, or extensive change to, an aquifer or groundwater supported designated wetland. Loss of, or extensive change to, nationally important geological/ geomorphological features.
Medium	Loss or alteration to one or more key features of the baseline conditions such that post development character/composition of baseline condition will be materially changed.	Partial loss or change to an aquifer. Partial loss of the integrity of groundwater supported designated wetlands. Permanent loss of regionally important geological features or substantial changes to nationally important geological /geomorphological features.
Low	Results in some measurable change in attributes quality or vulnerability compared to baseline conditions. Changes arising from the alteration will be detectable but	Measurable effect on aquifer but of limited size or proportion, which does not lead to a reduction in the aquifer status. Minor effects on groundwater supported wetlands.

Table 7.5 Impact magnitude criteria (Geology & Hydrogeology)		
Magnitude	**Description**	**Examples**
	not material; the underlying character/composition of baseline condition will be similar to the pre-development situation.	Minor changes to regionally important geological/ geomorphological features or small changes to nationally important geological/ geomorphological features.
Negligible	Very little change from baseline conditions. Change is barely distinguishable, approximating to a "no change" situation.	No measurable effect upon groundwater, or geology/geomorphology.

Assessing the Significance of Effects

2.6.3 The significance of a potential effect is derived from both the sensitivity of the feature and the magnitude of the effect, and can be then determined using the matrix presented in Table 7.6. Effects can be beneficial, adverse or negligible and their significance major, moderate, minor or negligible. Any effect predicted to be minor is considered to be 'Not Significant'. Effects assessed as moderate or major are considered to be 'Significant'.

Table 7.6 Assessment of significance (Geology and Hydrogeology)					
Magnitude of impact	**Sensitivity of receptor**				
	Very High	**High**	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

2.7 Contaminated Land Risk Assessment

2.7.1 The effects of contamination have been identified by a qualitative assessment using the aforementioned source-pathway-receptor approach to determine the potential risks posed to construction workers, buildings/infrastructure, adjacent properties, people and maintenance workers. This will consider the likelihood of a source posing a risk to any given receptor (Table 7.8).

2.7.2 The potential significance of these effects has been assessed using Tables 7.7 and 7.8 which are taken from the National House Building Council (NHBC), EA and Chartered Institute of Environmental Health (CIEH) 'Guidance for the Safe Development of Housing on Land Affected by Contamination' R&D Publication 66' (Ref: 7-05). These classifications can apply to a broad range of scenarios. It should be noted that the categories of pollution incident have no relation to the categories of significant possibility of significant harm to human health or significant possibility

of significant pollution of controlled waters in respect of the Part 2A Statutory Guidance (Ref: 7-06).

Table 7.7 Consequence classification (contaminated land assessment)	
Consequence	**Description**
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the Environmental Protection Act (EPA) (1990), Part 2A (Ref: 7-06), if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A (Ref: 7-06) if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structure and services.

Table 7.8 Probability classification (contaminated land assessment)	
Probability	**Description**
High Likelihood	There is a pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm

Table 7.8 Probability classification (contaminated land assessment)	
Probability	**Description**
	or pollution.
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.
Low Likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. It is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.

2.7.3 A consideration of the magnitude of consequence in relation to contaminated land, and probability will define the level of risk as shown in the table below (Table 7.9) (reproduced from Ref: 7-05).

Table 7.9 Classification of risk from soil and groundwater contamination				
Probability	**Consequence**			
	Severe	**Medium**	**Mild**	**Minor**
High likelihood	Very high risk	High risk	Moderate risk	Low risk
Likely	High risk	Moderate risk	Moderate/ low risk	Low risk
Low likelihood	Moderate risk	Moderate/ low risk	Low risk	Very low risk
Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

2.7.4 The Environmental Impact Assessment Regulations 2017 require the likely significant effects to be identified. The classification of significance is explained in Table 7.10, however, in simple terms effects predicted to be 'major' or 'moderate' are considered to be 'significant' whilst effects predicted to be 'minor' or 'neutral' are considered to be 'not significant'. Likely significant effects on Geology and Hydrogeology are assessed in Section 6 of this chapter.

Table 7.10 Explanation of significance classifications		
Classification	**General description**	**Significant?**
Major (adverse or beneficial)	A large and/or detrimental change to a valuable/sensitive receptor; likely or apparent exceeding of accepted (often legal) threshold or a major departure from national targets. A large and beneficial change, resulting in improvements to baseline conditions whereby previously poor conditions are replaced by compliance with accepted (often legal) thresholds or a major contribution is made to national targets. These are effects which may represent key factors in the decision making process. Potentially associated with sites and features of national importance or likely to be important considerations at a regional or district scale. Major effects may relate to impacts on resources or features which are rare and cannot be relocated, or if lost, cannot be replaced.	Yes
Moderate (adverse or beneficial)	A medium scale change which, although not beyond an accepted (often legal) threshold, is still considered to be generally unacceptable, unless balanced out by other significant positive benefits of the development. Likely to relate to departure from relevant planning policy, rather than legal compliance. A positive moderate effect is a medium scale change that is significant in that the baseline conditions are improved to the extent that guideline targets are contributed to. These effects, if adverse, are likely to be important at a local or district scale and on their own could have a material influence on decision making.	Yes
Minor (adverse or beneficial)	A small change that, whilst adverse, does not exceed accepted thresholds, legal or guideline standards. Unlikely to be a departure from planning policy. A small positive change, but not one that is likely to be a key factor in the overall balance of issues. These effects may be raised as local issues but are typically unlikely to be critical in the decision making process.	No
Negligible	A very small change that is so small and unimportant that it is considered acceptable to disregard. Effects which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error, these effects are unlikely to influence decision making, irrespective of other effects.	No

3 Basis of Assessment

3.1 The Proposed Underground DC Cable

3.1.1 A full description of the construction and operation of the proposed DC cable route from the proposed landfall site in East Lindsey, to the proposed converter station site at North Ing Drove in South Holland, is discussed within *ES-2-B.01, Volume 2, Chapter 5: The Proposed Underground DC Cable*. The following points are considered to be of particular relevance to the Geology and Hydrogeology assessment:

- The proposed DC cable route will typically have a maximum 30 m temporary construction working width, except where Temporary Works Areas (TWA) are defined, and will comprise of the following:
  - Trench in which the DC cables are installed and then backfilled;
  - Temporary drainage/water management measures;
  - Access track including laybys for offloading cable drums;
  - Areas for temporary topsoil and sub-soil storage; and
  - Joint bays where adjacent sections of cable are joined together.
- The DC cable route trench will be typically 1.5 m deep and 1.5 m wide and contain two high voltage DC cables either directly or within cable ducts located in the single trench as well as two fibre optic cables (one for each DC cable);
- Open cut trenching techniques will be used for the proposed DC cable installation wherever possible, although trenchless installation will be adopted where the DC cable route crosses existing infrastructure and assets, such as major roads, railway lines and larger watercourses;
- The trench will be backfilled as much as practicable with excavated material except for 75 mm of cement bound sand which will form the base of the trench, onto which either the cables or cable ducts are laid, and it will also form the surround and cover for the cables;
- As part of the DC cable installation there is also a requirement for temporary construction facilities to be established including:
  - Temporary Construction Compounds (TCC) for the storage of plant and material as well as site offices and welfare facilities for staff; and
  - TWA where the proposed DC cable working width may need to be extended beyond 30 m, for example at crossings where trenchless methods are to be used.
- There will be no permanent above ground infrastructure with the exception of marker posts at locations along the DC cable route. It is proposed to restore, as far as practicable, land and features that have been affected by the trenching works to a condition suitable for its original use/function.

3.2 Any other assumptions

3.2.1 The Geology and Hydrogeology impact assessment has been based upon details of the UK Onshore Scheme, provided by the National Grid Viking Link Limited (NGVL) appointed design team at the time of assessment. Some reliance is placed on third party data and reports within the assessment. It has been assumed that third party data is accurate and a true reflection of what it is indicating. Unless stated otherwise, AECOM has not independently verified the data presented within other consultants' reports.

3.2.2 The Baseline Conditions section of this chapter (Section 5) includes an interpretation of ground conditions encountered during a preliminary ground investigation at selected targeted locations along the proposed DC cable route. The scope of the ground investigation was determined based on desk study information for each location which revealed that at these locations very little by way of development had occurred historically with agriculture being the dominant land use. The potential for heterogeneity in ground conditions between exploratory locations at the targeted features should be acknowledged.

3.2.3 For any decommissioning impacts, these are assumed to be similar to the construction impacts defined in the assessment and are therefore not considered separately.

4 Planning Policy and Legislative Considerations

4.1 National Legislation

4.1.1 The following EU Directives and UK Acts are considered to be the key legislative drivers for the Geology and Hydrogeology topic including dealing with risks to human health and the environment from ground conditions:

- The Water Framework Directive (2000/60/EC) (Ref: 7-07);
- The Groundwater Directive (2006/118/EC) (Ref: 7-08);
- The Environmental Quality Standards (EQS) Directive (2008/105/EC) (Ref: 7-09);
- The Environmental Liability Directive (2004/35/EC) (Ref: 7-10);
- The Environment Act 1995 (Ref: 7-11)
- The Environmental Protection Act 1990 (EPA) and Part 2A (the Contaminated Land Regime) (Ref: 7-6);
- The Water Resources Act 1991 (Ref: 7-12);
- The Water Act 2003 (Ref: 7-13);
- The Building Act 1984 (Ref: 7-14); and
- The Town and Country Planning Act 1990 (Ref: 7-15).

4.1.2 Current legislation relating to contaminated land in the UK is contained within Part 2A of the EPA (Ref: 7-6), which was inserted by Section 57 of the Environment Act 1995 (Ref: 7-11) and by Section 86 of the Water Act 2003 (Ref: 7-13), and elaborated upon within the Contaminated Land (England) Regulations 2006 [S.I. 2006/1380] (amended 2012 [S.I. 2012/263]) (Ref: 7-16). Under Part 2A, sites are identified as 'contaminated land' if they are: causing harm, if there is a significant possibility of significant harm, or if the site is causing, or could cause, pollution of controlled waters (i.e. both surface and groundwater).

4.1.3 The Water Act 2003 (Ref: 7-13) introduced a revision to the wording of the EPA, which requires that if a site is causing or could cause significant pollution of controlled waters it may be determined as contaminated land. Once a site is determined to be 'contaminated land' then remediation is required to render significant pollutant linkages insignificant (i.e. the source-pathway-receptor relationships that are associated with significant harm to human health and/or significant pollution of controlled waters), subject to a test of reasonableness. The Water Resources Act 1991 (Ref: 7-12) 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.

4.1.4 The Building Act 1984 (Ref: 7-14) and in particular the associated the Building Regulations & c (Amendment) Regulations 2015 (Ref: 7-17) are key when considering structural and design

aspects of a development in terms of the geotechnical properties of the ground. The Building Act 1984 (Ref: 7-14) requires that buildings are constructed so that ground movement caused by swelling, shrinkage, freezing, landslip or subsidence of the sub-soils will not impair the stability of any part of the building.

4.2 National Planning Policy

National Planning Policy Framework (2012)

4.2.1 National planning policy is established within the National Planning Policy Framework (NPPF) (Ref: 7-18). Paragraph 109 of the NPPF states that: "The planning system should contribute to and enhance the natural and local environment by:

- Preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability; and
- Remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."

4.2.2 Paragraph 110 requires that plans should aim to minimise pollution and other adverse effects on the local and natural environment.

4.2.3 Paragraph 111 states that planning policies and decisions should encourage:

- "the effective use of land by re-using land that has been previously developed (brownfield land), provided that it is not of high environmental value."

4.2.4 Paragraph 120 advises that where a site is affected by contamination or stability issues, it is the responsibility of the developer or landowner to secure a safe development. Further to this, paragraph 121 advises that planning policies and decisions should ensure that:

- "the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;
- after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and
- adequate site investigation information, prepared by a competent person is presented."

4.3 Regional Planning Policy

Lincolnshire County Council 'Core Strategy and Development Management Policies Lincolnshire Minerals and Waste Local Plan (Adopted 1st June 2016)

4.3.1 The Core Strategy and Development Management Policies (Ref: 7-19) document replaces the Lincolnshire Minerals Local Plan (1991) and most of the policies in the Lincolnshire Waste Local Plan (2006) (Ref: 7-20) with the exception of Policies WLP2 Household Waste Recycling Centres, WLP6 Materials Recovery Facilities and WLP12 Energy from Waste of that document.

The document includes the vision, objectives, spatial strategy and development management policies for minerals and waste development in Lincolnshire over the period to the end of 2031. Whilst the proposed underground DC cable route does not relate to either of these types of development, the following policy is considered relevant to geology and hydrogeology:

- Policy M11 Safeguarding of Mineral Resources states that: "Applications for non-minerals development in a minerals safeguarding area must be accompanied by a Minerals Assessment. Planning permission will be granted for development within a Minerals Safeguarding Area provided that it would not sterilise mineral resources within the Mineral Safeguarding Areas or prevent future minerals extraction on neighbouring land."
- Policy M12 Safeguarding of Existing Mineral Sites and Associated Minerals Infrastructure states that "Mineral sites (excluding dormant sites) and associated infrastructure that supports the supply of minerals in the county will be safeguarded against development that would unnecessarily sterilise sites and infrastructure or prejudice or jeopardise their use by creating incompatible land uses nearby".

4.4 Local Planning Policy

Boston Borough Council Local Plan (Adopted April 1999, saved policies)

4.4.1 The BBC Local Plan (1999) (Ref: 7-21) is the development plan for the borough. The Local Plan consists of a series of documents which set out the spatial vision for BBC, the strategy for delivery of this vision and detailed policies and guidance for managing development in the borough and development sites where change are anticipated.

4.4.2 There are two policies with particular reference to geology and hydrogeology:

- Policy G4 Safeguarding the Water Environment states that: "Planning permission will not be granted for developments which will have an adverse effect on the water environment, or the quality of surface or groundwater."
- Policy G8 Air and Soil Resources states that: "Planning permission will not be granted for developments which will have an adverse effect on the quality of air or soil such as to lead to:

  1) harm to local living or working conditions or the operation of nearby land uses;

  2) harm to the natural flora and fauna of interest in the locality; or

  3) added constraints on future developments in the area."

South Holland District Council Local Plan (Adopted July 2006, saved policies)

4.4.3 The SHDC Local Plan (Ref: 7-22) published in July 2006, provides a comprehensive statement of the Council's planning policies for the development and use of land in the District until 2021. There are two policies of relevance to geology and hydrogeology:

- Policy SG4 Development in the Countryside states that: "Planning permission will only be granted for development in the open countryside which is essential in the proposed location and cannot reasonably be accommodated within defined settlement limits. Development

proposals that would result in an unacceptable impact upon the landscape character of an area, either individually or cumulatively, will only be permitted where:

1) the need for the development in that location outweighs its impact; and

2) no other site or solution exists to accommodate the proposed development."

- Policy SG13 Pollution and Contamination states that: "Planning permission will only be granted for development proposals which:

  1) do not cause unacceptable levels of pollution of surrounding land by noise, light, toxic or offensive odour, airborne pollutants or by the release of waste products; and

  2) provide, as necessary, appropriate treatment of land to clean up pollution and contamination."

Saved policies of the adopted East Lindsey District Local Plan 2007

4.4.4 ELDC adopted the East Lindsey Local Plan in 1995 and the policies and text were updated in 1999 via a formal amendment. As a result, some of the policies were saved and some deleted in 2007. The saved policies (Ref: 7-23) comprise the current development plan for the area and there are two policies of relevance to Geology and Hydrogeology:

- Policy ENV19 Local Sites of Nature Conservation Importance states that: "Development which could adversely affect a site of local nature conservation importance will not be permitted unless it can be clearly demonstrated that there are reasons for the proposal which outweigh the need to safeguard the site or feature … Similarly, sites which are regionally important for their geological or geomorphological, educational or research value have been identified as RIGS under a scheme launched nationally by English Nature in 1991. New designations of SNCIs and RIGS will be reported to the Council and shall then fall within the terms of Policy ENV19".
- Policy ENV21 River Corridors states that: "Development will be permitted where it can be shown that it will not harm the open character, nature conservation importance or recreational importance of the river corridors of the Rivers Witham, Steeping, Bain, Lud, Waring and Lymn and of the Louth Navigation Canal, Great Eau and Wold Grift Drains".

Emerging East Lindsey Local Plan

4.4.5 ELDC are in the process of preparing a new Local Plan which will guide growth and development in East Lindsey up to 2028. The Local Plan will be made up of a Core Strategy and Settlement Proposals and, once adopted, will comprise the statutory development plan for ELDC, replacing the 2007 Local Plan. The emerging Core Strategy (Ref: 7-24) has progressed to draft stage and as such, can only be given limited weight as a material consideration due to its early stage of preparation.

4.4.6 There are two policies with particular reference to geology and hydrogeology:

- Strategic Policy 10 (SP10) – Design states that: "The Council will support well-designed sustainable development, which maintains and enhances the character of the District's towns, villages and countryside by:

  … 7. Development around water sources will only be supported if it contains adequate protection preventing pollution from entering into the water source".

- Strategic Policy 24 (SP24) - Biodiversity and Geodiversity states that: "… 2. The Council will protect sites designated internationally, nationally or locally for their biodiversity and geodiversity importance, species populations and habitats identified in the Lincolnshire Biodiversity Action Plan and the Natural Environment and Rural Communities (NERC) Act 2006. Development, which could adversely affect such a site, will only be permitted in exceptional circumstances."

Central Lincolnshire Local Plan - Adopted April 2017

4.4.7 The Central Lincolnshire Local Plan (Ref: 7-25) was adopted by the Central Lincolnshire Joint Strategic Planning Committee on 24th April 2017 and it now replaces the Local Plans of the City of Lincoln, West Lindsey and North Kesteven District Councils. It contains planning policies and allocations for the growth and regeneration of Central Lincolnshire up to 2036. There are three policies with particular reference to Geology and Hydrogeology:

- Policy LP14 Managing Water Resources and Flood Risk states that: "Development proposals should demonstrate: …

  i. that development with the potential to pose a risk to groundwater resources is not located in sensitive locations to meet the requirements of the Water Framework Directive; …

  l. that relevant site investigations, risk assessments and necessary mitigation measures for source protection zones around boreholes, wells, springs and water courses have been agreed with the relevant bodies (e.g. the Environment Agency and relevant water companies); …

  r. that adequate provision is made to safeguard the future maintenance of water bodies to which surface water is discharged, preferably by an appropriate authority (e.g. Environment Agency, Internal Drainage Board, Water Company, the Canal and River Trust or local council)."

- Policy LP16 Development on Land Affected by Contamination states that: "Development proposals must take into account the potential environmental impacts on people, biodiversity, buildings, land, air and water arising from the development itself and any former use of the site, including, in particular, adverse effects arising from pollution."

- Policy LP21 Biodiversity and Geodiversity states: "All development should:
  - protect, manage and enhance the network of habitats, species and sites of international, national and local importance (statutory and non-statutory), including sites that meet the criteria for selection as a Local Site;
  - minimise impacts on biodiversity and geodiversity; and
  - seek to deliver a net gain in biodiversity and geodiversity."

5 Baseline Conditions

5.1 Study Area

5.1.1 The proposed DC cable route connects the proposed landfall site in East Lindsey (centred on Ordnance Survey (OS) grid reference 553560E, 379926N) to the proposed convertor station (centred on OS grid reference 518645E, 337338N) at North Ing Drove in South Holland. The proposed DC cable route corridor is illustrated in Figure 7.1 which is presented in *ES-3-B.03, Volume 3, Chapter 7: Geology and Hydrogeology*.

5.1.2 The corridor is approximately 67.16 km in length with the majority of the corridor routed through ELDC. Sections of the corridor also pass through the administrative areas of BBC, NKDC and SHDC.

5.1.3 For the purposes of the Environmental Impact Assessment (EIA) the proposed DC cable route has been split into four sections and is described from the proposed landfall to the proposed converter station site (i.e. from east to west):

- Route Section 1: Proposed Landfall to Well High Lane (approximately 13.04 km, entirely within ELDC);
- Route Section 2: Well High Lane to the A16/Keal Road (approximately 16.85 km, entirely within ELDC);
- Route Section 3: the A16/Keal Road to the River Witham (approximately 22.06 km, within ELDC and BBC); and
- Route Section 4: the River Witham to the proposed converter station (approximately 15.21 km, within BBC, NKDC and SHDC).

5.1.4 The proposed DC cable route baseline conditions are subsequently described for each route section. The proposed DC cable route and TWA include Limits of Deviation (LoD). The LoD have undergone a process of iterative design that originally considered an extended area, typically 50 metres either side of the working width for the DC cable route and TWA. During subsequent design development the LoD have reduced in width to generally 50 m either side of a central alignment within which a 30 m working width has typically been allowed; although in some places the LoD have increased, for example at trenchless crossing locations.

5.1.5 The Zone of Influence for this assessment comprises the proposed DC cable working width, the LoD as well as a 250 m buffer extending out from the LoD. For groundwater abstractions and discharges to groundwater, the assessment considers an extended 500 m buffer from the LoD.

5.1.6 Whilst the baseline conditions are focussed 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. There is therefore some reference made to hydrological and ecological features in this section which are discussed in

more detail within *ES-2-B.04, Volume 2, Chapter 08: Water Resources & Hydrology, ES-2-B.06, Volume 2, Chapter 10: Ecology*, and *ES-2-D.01, Volume 2, Chapter 28: Cumulative Effects*.

5.1.7 In accordance with the assessment methodology outlined in Section 2, potential impacts on the geological and hydrogeological features and resources (receptors) are assessed through impact assessment to determine significant effects. Potential significant effects associated with existing, and potential future, soil and groundwater contamination have been determined through the application of a risk-based assessment approach. The baseline conditions section has been structured into five main headings for each route section. These comprise the geological setting and sensitivity, the hydrogeological setting and sensitivity, underground structures, unexploded ordnance and then a section on potential soil and groundwater contamination. Where applicable this heading structure has continued into Section 6, so that it is clear where the two assessment approaches have been applied.

5.1.8 The geological baseline setting has been established by making reference to published British Geological Survey (BGS) mapping (Ref: 7-26, 7-27, 7-28 and 7-29), the AECOM Geology and Hydrogeology Desk Study report (October 2016) (Ref: 7-30) selected publically available BGS historical borehole records (Ref: 7-31), ground investigation completed at selected locations along the proposed DC cable route and proposed landfall (Ref: 7-32 and Ref: 7-33) and selected publications. The AECOM Geology and Hydrogeology Desk Study report (Ref: 7-30) is presented as Appendix 7.1 in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology*.

5.1.9 The geology throughout the proposed DC cable route crosses three distinctive areas; an eroded Chalk shelf overlain by superficial glacial deposits and with overlying Salt Marsh and Tidal Creek deposits present nearer to the coast, the Lincolnshire Wolds where Upper Cretaceous Chalk and Lower Cretaceous formations outcrop to form the characteristic features of the Lincolnshire Wolds, and then the northern Fenlands which are characterised by marine and estuarine deposits, the Barroway Drove Beds, overlying glacial deposits with known palaeochannels.

5.1.10 The preliminary ground investigation undertaken for the proposed DC cable route (Ref: 7-33), which is referred to in the following sections, targeted the emerging DC cable route alignment under consideration at the time of the assessment which in places varies slightly from the current proposed cable route alignment.

5.2 Route Section 1 Proposed Landfall to Well High Lane

Geological Setting and Sensitivity

Published Geology

5.2.1 The superficial geology throughout Route Section 1, from the Proposed Landfall to Well High Lane, is characterised by Quaternary deposits of glacial, marine and alluvial origin overlying Upper Cretaceous Chalk. Quaternary period erosional processes created a reduced shelf which extends up to a buried cliff line, known as the Ipswichian Cliff, which is located approximately within the last 350 m of the route section. This feature marks a transition across the eastern limits of the Lincolnshire Wolds, and is a former coastline that extended from the north west to the

south east of the region (Ref: 7-34). Above the Chalk, and to the east of the Lincolnshire Wolds, the superficial geology is characterised by Devensian Till (Boulder Clay), which is also referred to as 'Marsh Till' within the literature (Ref: 7-34 and 7-35), also with areas of glacial and fluvial sand and gravel deposits which in some places occur towards the basal extents of the Till (Boulder Clay) (Ref: 7-34). Within the eastern part of the Zone of Influence, Till (Boulder Clay), known as the 'Wragby Till', deposited during earlier pre-Devensian glacial periods is reported to have been largely eroded during subsequent interglacial periods (Ref: 7-34).

5.2.2 From the coast and moving inland the Till (Boulder Clay) is overlain by Salt Marsh and Tidal Creek Deposits which accumulated during late Quaternary marine environments and which extend inland to an approximate area north east of Asserby within the proposed DC cable route LoD (Ref: 7-26 and 7-31). Along the coastal fringes of Route Section 1, Blown Sand and Storm Beach deposits overlie the Salt Marsh and Tidal Creek Deposits. The BGS mapping suggest the Till (Boulder Clay) ends approximately 350 m before the end of this route section, although historical BGS borehole records reviewed from the wider area, beyond the Zone of Influence to provide more contextual understanding, suggest they may extend further west just beyond the western extent of this route section.

5.2.3 The solid geology beneath the Till (Boulder Clay) comprises the Chalk Group and a sequence of easterly dipping Upper Cretaceous formations that include the Burnham Chalk Formation at the coast, the Welton Chalk Formation across central areas and then the Ferriby Chalk Formation, at the eastern limits of the route section. According to the BGS, the Burnham Chalk formation is characteristically hard and thinly bedded, with tabular flint bands and discontinuous flint layers. The Welton Chalk Formation is described as being typically softer than the Burnham Chalk, with a few nodular flint bands and the underlying Ferriby Chalk is described as being generally a soft marly chalk and free of flint (Ref: 7-34). The Chalk is confined by the overlying superficial geology in this route section and weathering of the Chalk in the upper parts is reported. Cycles of freezing and thawing conditions has created what is referred to in the literature as "chalk bearings", which are described as fragmented angular blocks of structureless Chalk in a weathered Chalk matrix (Ref: 7-34) that can be up to 5 m in thickness.

5.2.4 Within the Route Section 1 Zone of Influence there are twenty five relevant publically available historical BGS borehole records (Ref: 7-31). These are tabulated and summarised in *ES-4-B.03 Volume 4, Chapter 07 Geology and Hydrogeology* as Appendix 7.2. The records indicate Till (Boulder Clay) to be generally between 17 m and 22 m thickness. Near to the coast the Salt Marsh and Tidal Creek deposits are indicated to be up to 11 m in thickness overlying the Till (Boulder Clay). The thickness of these deposits reduces moving inland. The beach at the landfall is subject to an annual programme of re-profiling and the recharging of sand as part of the Lincshore beach re-nourishment scheme.

Ground Investigation – the Proposed Landfall

5.2.5 A preliminary ground investigation was undertaken in July and September 2016 at the proposed landfall site by Geotechnical Engineering Limited (GEL) on behalf of NGVL (Ref: 7-36). The ground investigation was designed and managed by AECOM and the findings are presented in a Preliminary Ground Investigation Report that was prepared by AECOM in November 2016 and issued formally in January 2017 (Ref: 7-32). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.3.

5.2.6 In total two exploratory boreholes and two piezo cone penetration test (PCPT) locations were completed to a maximum depth of 28.15 metres below ground level (m bgl). The exploratory locations are indicated in Figure 7.2 which is presented in *ES-3-B.03, Volume 3, Chapter 7: Geology and Hydrogeology*.

5.2.7 The sequence of strata encountered generally supports the published geology of Blown Sand and Storm Beach Deposits overlying Salt Marsh and Tidal Creek Deposits; which in turn overlie Till (Boulder Clay) and then the Chalk solid bedrock. Table 7.11 presents a summary of the ground conditions encountered at the proposed landfall site.

Table 7.11 Route Section 1: summary of ground conditions encountered at proposed landfall site

Strata	Name	Description/presence[3]	Depth range to top (m bgl)	Proven thickness (m)
Made Ground	-	Present at BH01 (Alpha)[1] and PCPT01 (Alpha) as brown slightly sandy, slightly gravelly, silty clay with brick content and also fine and medium sand. Frequent rootlets in BH01 (Alpha) and PCPT01 (Alpha).	0.00	0.2 to 2.00
Natural Superficial Deposits	Blown Sand and Storm Beach Deposits	Present at BH02 (Alpha) and inferred at PCPT02 (Alpha) as yellow or brown locally gravelly sands.	0.00	5.60 to 8.79
	Salt Marsh and Tidal Creek Deposits	Present at BH01 (Alpha), BH02 (Alpha) and inferred at PCPT01 (Alpha). Absent in PCPT02. Variety of sandy silty clays, silty sands and clayey silts with rare pockets of organic material.	0.20 to 5.60	6.10 to 8.87
	Till (Boulder Clay)	Present at all locations stiff to very stiff slightly sandy, slightly gravelly silty clays.	8.10 to 12.50	11.03[2] to 14.97
Solid Geology	White Chalk[2]	Present at BH01 (Alpha) and BH02 (Alpha) as gravels, sands and clays	22.50 to 24.04	1.30[2] to 5.65[2]

Table 7.11 Route Section 1: summary of ground conditions encountered at proposed landfall site				
Strata	Name	Description/presence[3]	Depth range to top (m bgl)	Proven thickness (m)
		overlying structureless White Chalk with flint gravels and cobbles.		

1 - "Alpha" was the nomenclature adopted at the time of the ground investigation to distinguish between different landfall site options under assessment;

2 - Not Fully Penetrated; and

3 - The ground conditions identified for the PCPT locations have been inferred by reviewing the CPT profile and correlating the data to information recovered from nearby boreholes and geophysical investigations (Ref: 7-37 and Ref: 7-38).

5.2.8 Seismic refraction surveys were undertaken by Fugro in July 2016 along the proposed landfall alignment at the time of the ground investigation. The full findings of this survey are presented in Fugro's 'Geophysical Survey Field Results A1 Alpha' report reference J35045-R-RESA1.1(01) and dated July 2016 (Ref: 7-37). The technique was used as a stratigraphic profiling tool that measured spatial variations in the seismic velocity of subsurface materials. A review of the findings of the survey has been undertaken within the context of the ground investigation and this is discussed in Section 5.5 of the Preliminary Ground investigation Report (Ref: 7-32) presented in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.3.

Ground Investigation – the Proposed DC Cable Route

5.2.9 A preliminary ground investigation was undertaken between January and March 2017 at selected locations along the proposed DC cable route by GEL on behalf of NGVL (Ref: 7-37). The ground investigation was designed and managed by AECOM and the findings are presented in a Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4.

5.2.10 The following features, defined in the ground investigation report (Ref: 7-33) as Target Priority Locations (TPL), were investigated in Route Section 1:

- TPL 1: A52 Huttoft Road;
- TPL 2: A1111 Sutton Road; and
- TPL 3: A1104 Road.

5.2.11 The sequence of strata encountered generally supports the published geology of Salt Marsh and Tidal Creek Deposits present towards more coastal areas; which in turn overlies Till (Boulder Clay). Moving inland the Salt Marsh and Tidal Creek Deposits gradually disappear and Till (Boulder Clay) is encountered near to the surface. Table 7.12 presents a summary of the ground

conditions encountered at the TPL. More detail on the ground conditions can be found by referring to *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* Appendix 7.4 and the TPL specific technical appendix contained in Appendix A of the Preliminary Ground Investigation report (Ref: 7-33).

Table 7.12 Route Section 1: summary of ground conditions encountered at TPL

Strata	Name [2]	Route section	TPL encountered	Depth range to top (m bgl)	Proven thickness (m)
Made Ground [1]	-	1	TPL 1	0.00	0.4
Natural Superficial Deposits	Salt Marsh and Tidal Creek Deposits (Tidal Flats) [2, 3]	1	TPL 1	0.40	8.60
	Till (Boulder Clay) [3, 4]	1	TPL 1, 2 & 3	0.00 to 9.00	1.75 [5] to 10.45 [5]

TPL 1 included borehole BH003 (Alpha);

TPL 2 included borehole BH027;

TPL 3 included borehole BH026;

1 - Made Ground is defined as material that contained anthropogenic material or where it is underlain by material that contained anthropogenic material;

2 - Interpretation based on published geological information and the recorded field observations;

3 - Based on the lithology recorded it is possible that the upper parts of these deposits may be more alluvial in origin;

4 - Where no Made Ground is encountered at the surface, it is acknowledged that the upper most section of the natural superficial deposits will have been subjected to potential reworking/soil structure improvements including the addition of nutrients and other elements as part of general agricultural practices; and

Geotechnical Hazards

5.2.12 Table 7.13 summarises the potential geotechnical hazards identified within the Route Section 1 Zone of Influence, which has been obtained from the Landmark Envirocheck® Report (Ref: 7-39).

Table 7.13 Route Section 1: potential geotechnical hazards

Hazard type	Receptor hazard potential range (where applicable)
Non coal mining areas	No hazard

Table 7.13 Route Section 1: potential geotechnical hazards	
Hazard type	**Receptor hazard potential range (where applicable)**
Potential for collapsible ground stability hazards	No hazard to very low
Compressible ground stability	No hazard to moderate
Ground dissolution stability	No hazard
Landslide ground stability	Very low
Running sand ground stability	No hazard to moderate
Shrinking or swelling clay ground stability	No hazard to low
Radon affected areas	Less than 1% of homes are above action level to between 1 and 3 % of homes are above action level

Geological Designations

5.2.13 There are no Local Geological Sites (LGS) or geologically designated Sites of Special Scientific Interest (SSSI) present within Route Section 1 (Ref: 7-40).

Mineral Sites and Designations

5.2.14 There are no former/current mineral extraction sites MSA or MCA at, or within close proximity, of the Zone of Influence (Ref: 7-19, 7-30, and 7-40).

Hydrogeological Setting and Sensitivity

Aquifer Designations

5.2.15 The Burnham, Welton and Ferriby Chalk Formations are designated Principal Aquifers by the EA (Ref: 7-41). The superficial aquifer designations as defined by the EA are presented in Table 7.14.

Table 7.14 Route Section 1: superficial geology aquifer classification	
Name	**Aquifer designation**
Salt Marsh and Tidal Creek Deposits	Unproductive strata
Till (Boulder Clay)	Secondary Undifferentiated
Glaciofluvial Deposits (Sand and Gravel)	Secondary A
Alluvium	Secondary A

Groundwater Levels

5.2.16 The EA were contacted in March and November 2016 to request data on groundwater levels within the proposed DC cable route Zone of Influence. Of the data provided by the EA; none was found to fall within the Zone of Influence (Ref: 7-42 and 7-43).

5.2.17 A review of BGS historical borehole records (Ref: 7-31) has been undertaken and observations on groundwater strike and resting levels have been recorded. These are documented in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.2. Where recorded on the historical borehole records, and at the locations located within the coastal areas, groundwater was struck typically at depths of between 4.6 m bgl and 5.79 m bgl, which correspond to levels that are generally within the Salt Marsh and Tidal Creek Deposits. Resting groundwater levels recorded in monitoring installations were recorded to be generally between 0.61 m and 5.64 m bgl in these areas. Around Saleby one groundwater strike level was recorded at 6.4 m bgl with two separate resting level readings in the area ranging between 5.3 m bgl to 5.6 m bgl. The corresponding geology here is variable and indicated to be clays and with localised areas of Glaciofluvial Deposits (sands and gravels) overlying Till (Boulder Clay).

5.2.18 Within Route Section 1, groundwater is present as two distinct units separated by a significant mantle of Till (Boulder Clay) which provides confinement to deeper groundwater contained within the Chalk. Near surface groundwater is indicated to reside largely on the Till (Boulder Clay) with levels within the Salt Marsh and Tidal Creek Deposits towards the coast, and within near surface weathered Till (Boulder Clay), sands and gravels and alluvium moving in land. The Chalk aquifer present at depth beneath the superficial cover appears to be the primary source of groundwater for the majority of the abstractions identified within the Zone of Influence (presented in Table 7.16). It is not considered likely that the proposed DC cable route will interact with the Chalk aquifer due to its depth.

Ground Investigation – Proposed Landfall

5.2.19 The borehole logs from the preliminary ground investigation undertaken at the proposed landfall site (Ref: 7-36) indicate that groundwater was not struck prior to the addition of water drill flush which was required to assist with the rotary core drilling method. The ground investigation report (Ref: 7-32) acknowledged that groundwater encountered once drilling flush was added will have been difficult to identify unless the strike was significant. Drilling records of groundwater levels within cored sections are therefore not considered to be reliable. Table 7.15 presents the observations that were recorded by GEL on their drilling records completed during the field work programme.

Table 7.15 Route Section 1: summary of groundwater encountered during drilling at the proposed landfall			
Borehole	**Groundwater levels m bgl (m AOD)**	**Date and time**	**strata**
BH01 (Alpha) [1]	1.20 (1.35)	19/07/2016 18:00	Made Ground
	1.20 (1.35)	20/07/2016 09:00	Made Ground
	3.85 (-1.30)	20/07/2016 18:00	Salt Marsh and Tidal Creek Deposits
	4.00 (-1.45)	21/07/2016 08:00	Salt Marsh and Tidal Creek Deposits
	4.25 (-1.80)	21/07/2016 18:00	Salt Marsh and Tidal Creek Deposits
BH02 (Alpha) [1]	Dry	20/07/2016 16:10	N/A
	0.40 (4.72)	21/07/2016 11:00	Blown Sand/Storm Beach Deposits
	0.46 (4.66)	21/07/2016 17:45	Blown Sand/Storm Beach Deposits
	2.47 (2.65)	22/07/2016 09:45	Blown Sand/Storm Beach Deposits
	3.64 (1.48)	22/07/2016 14:30	Blown Sand/Storm Beach Deposits
	0.62 (4.50)	25/07/2016 13:00	Blown Sand/Storm Beach Deposits
	3.62 (1.50)	25/07/2016 18:00	Blown Sand/Storm Beach Deposits

1 – "Alpha" was the nomenclature adopted at the time of the ground investigation to distinguish between different landfall site options under assessment.

Ground Investigation – Proposed DC Cable Route

5.2.20 Groundwater strikes encountered during the drilling of the boreholes as part of the preliminary ground investigation undertaken at the TPL in Route Section 1 are recorded on the borehole log records included within the preliminary ground investigation report for the underground DC cable route (Ref: 7-37). The records showed that groundwater strikes were encountered within the Salt Marsh and Tidal Creek Deposits (Tidal Flats) (2.60 m bgl rising to 1.90 m bgl within (BH003 (Alpha)) and within the Till (Boulder Clay) (1.20 m bgl rising to 1.00 m bgl (BH027) and 1.65 m bgl rising to 1.40 m bgl (BH026)).

5.2.21 Based on the first route-wide groundwater monitoring event (undertaken between 8th May 2017 and 12th May 2017) of a one year long groundwater monitoring and sampling programme, a groundwater level within BH001 (Alpha) was recorded at 1.24 m bgl within the Made Ground situated above the Salt Marsh and Tidal Creek Deposits (Tidal Flats). The remaining boreholes from the preliminary ground investigation undertaken at the TPL along the proposed DC cable route in Route Section 1 were not installed with groundwater monitoring installations.

Groundwater Abstractions

5.2.22 Route Section 1 is partially within the Total Catchment (Zone 3) of a groundwater SPZ between an area north east of Ailby to the end of the route section at Well High Lane (Ref:7-41). This is

defined as the area around a source of groundwater within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, as is the case in this location, the source catchment may be displaced some distance from the source. The Zone 1 abstraction point (the source) associated with this SPZ is located approximately 3.85 km north east of the LoD at its closest point. There are also isolated SPZ Zone 1 abstractions, i.e. not indicated to be within the Zone 3 catchment that the proposed DC cable route crosses, located approximately 1.25 km from the LoD to the south west centred on a location just south west of Rigsby.

5.2.23 The EA was contacted in October 2016 and responded in November 2016 regarding a data request for private and commercial groundwater abstractions within Route Section 1 (Ref: 7-43). In addition, a request was made for information on private groundwater abstraction licenses to ELDC in September 2016 and a response was provided in December 2016 (Ref 7-44). The information provided by the EA and ELDC, together with data on licenced groundwater abstractions presented within the Envirocheck® Report (Ref: 7-39), are summarised in Table 7.16.

Table 7.16 Route Section 1: summary of groundwater abstractions

Licence no.	Well name/ location	Abstraction strata	Abstraction description	Distance/direction
4/29/15/*G/0086	Sandilands Golf Club Bore 1	Lincolnshire Chalk	Spray irrigation - direct	325 m north of centre line 245 m north of LoD
4/29/15/*G/0086	Sandilands Golf Club Bore 4	Lincolnshire Chalk	Spray irrigation - direct	100 m north of centre line 20 m north of LoD
4/29/15/*G/0086	Sandilands Golf Club Bore 7	Lincolnshire Chalk	Spray irrigation - direct	150 m south of centre line 50 m south of LoD
4/29/15/*G/0086	Sandilands Golf Club Bore 2	Lincolnshire Chalk	Spray irrigation – direct	380 m south of centre line 275 m south of LoD
4/29/15/*G/0086	Sandilands Golf Club Bore 5	Lincolnshire Chalk	Spray irrigation – direct	600 m south of centre line 500 m south of LoD
4/29/15/*G/0033	Chapman Bore 3, Huttoft	Lincolnshire Chalk	General farming and domestic	415 m south of centre line 390 m south of LoD
4/29/15/*G/0033	Chapman Bore 7, Huttoft	Lincolnshire Chalk	General farming and domestic	395 m south of centre line 345 m south of LoD
4/29/15/*G/0033	Chapman Bore 2, Asserby	Lincolnshire Chalk	General farming and domestic	275 m south of centre line 225 m south of LoD
4/29/15/*G/0028	White Well Bilsby (Asserby)	Estuarine & Marine Deposits	General farming and domestic	60 m north of centre line Adjacent to LoD
4/29/15*G/0036	Brown & Sons	Glacial Sand	General farming	265 m south of centre line

Table 7.16 Route Section 1: summary of groundwater abstractions				
Licence no.	Well name/ location	Abstraction strata	Abstraction description	Distance/direction
	Well, Ailby	and Gravel	and domestic	215 m south of LoD

Groundwater Flooding

5.2.24 The BGS Groundwater Flooding Susceptibility map provided in the Landmark Envirocheck® Report (Ref: 7-39) shows that there is limited potential for groundwater flooding to occur at the eastern extent of Route Section 1 (the proposed landfall). Moving west between the proposed landfall and Crawcroft Lane, south of the village of Hannah, no risk of groundwater flooding is mapped.

5.2.25 The central and western areas of Route Section 1 (between Hannah and Ailby) are generally mapped as having the potential for groundwater flooding to occur at the surface with localised potential for groundwater flooding of property situated below ground level. The western extent of Route Section 1 (near to the village of Haugh) is generally shown to have a limited potential for groundwater flooding to occur.

5.2.26 The ELDC Strategic Flood Risk Assessment dated 2017 (Ref: 7-45) makes no specific reference to the District being at risk from groundwater flooding.

5.2.27 The Water Resources and Hydrology assessment presented in *ES-2-B.04, Volume 2, Chapter 8* concludes that there is a medium potential for groundwater flooding within this route section.

Groundwater Sensitivity

5.2.28 According to Ref: 7-34, the Lincolnshire Chalk aquifer system is a valuable resource which has been used for potable and industrial use for around 200 years. It can store and transmit large quantities of water and is therefore very important for public water supply. The aquifer is subject to active groundwater management and control to manage over abstraction as the aquifer is over committed (Ref: 7-34). A large proportion of the proposed DC cable route crosses Zone 3 of a groundwater SPZ, where the source is located approximately 3.85 km to the north east at its closest point.

5.2.29 Groundwater sensitivity is considered based on the aquifer designation and its resource value as defined by the criteria in Table 7.4. The near surface groundwater unit within the superficial geology within Route Section 1 is considered to be of **medium** sensitivity. Whilst the aquifer designation is Unproductive and Secondary Undifferentiated, areas of Secondary A aquifer designations exist in the wider area. There is a general absence of groundwater abstractions from the superficial aquifer except for two (White Well, licence reference 4/29/15/*G/0028, adjacent to the LoD and Brown and Sons Well, licence reference 4/29/15*G/0036 located in excess of 215 m from the LoD). The deeper groundwater unit contained within the Chalk, and the primary source of groundwater for the majority of the local groundwater abstractions identified,

and the reason for the groundwater SPZ designations, is considered to be a **high** sensitivity receptor.

Underground Structures

5.2.30 Based on a review of underground assets information provided in the Atkins utility search report (Ref: 7-46) and the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1, a summary of the relevant assets identified is provided in Table 7.17.

Table 7.17 Route Section 1: summary of underground assets

Asset type	No. of utilities within LoD	No. utilities within 250 m of LoD
Western Power Distribution cable	2	1
Openreach British Telecommunications cable	6	0
Anglian Water pipe	6	0
Cadent Gas	2	0

5.2.31 In addition to the stated underground utilities, the potential also exists for a network of agricultural land drains relating to the agricultural fields, crossing and running adjacent to the proposed DC cable.

5.2.32 At the Proposed Landfall the Fugro geophysics investigation (Ref: 7-37) concluded that there was no evidence of underground structures along the centreline of the proposed cable route alignment in this area.

Unexploded Ordnance Potential

5.2.33 Zetica Limited was commissioned by AECOM, on behalf of NGVL, to undertake an unexploded ordnance (UXO) desk study, which included the Zone of Influence (Ref: 7-47). Zetica were then requested to undertake a UXO risk assessment (Ref: 7-48). The desk study report and subsequent risk assessment report are included as Appendix 7.5 in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology*. The assessment identified that there is no significant UXO potential within Route Section 1. It was however noted that there was a small arms range within the Zone of Influence between Ailby and Haugh (Rigsby Wood).

Soil and Groundwater Contamination Potential

Historical Land Use

5.2.34 A review of 1:10,000 and 1:2,500 historical mapping (Ref: 7-39) for the Route Section 1 Zone of Influence has been undertaken. The purpose of this review was to highlight the general

development history, together with any potential land uses that may have resulted in potentially significant soil and/or groundwater contamination; which may in turn impact upon construction of the proposed underground DC route.

5.2.35 The main historical land use within the Route Section 1 Zone of Influence has been agriculture. Other land uses of note have included the Great North Railway (present on mapping between 1889 and 1971) which crossed the proposed DC cable route 1.7 km to the west of Boygrift and a former rifle range (present on mapping between 1888 and 1951) present on the proposed DC cable route, south-west of Ailby. A clay, sand and gravel pit was indicated 140 m to the south of the proposed DC cable route alignment (north of Ailby). It is recorded as being active in 1946 but no date is subsequently provided for the cessation of activities.

Current Land Uses

5.2.36 Current OS mapping and aerial imagery (Ref: 7-49) have been reviewed together with site inspections in order to identify the present land use within Route Section 1.

5.2.37 The proposed DC cable route primarily crosses agricultural fields. It crosses three main roads (Sutton Road at two locations and East Street) and one main surface water feature (Wold Grift Drain). A large drain (the Boy Grift Drain) runs parallel to the eastern parts of Route Section 1 for approximately 3 km. An area of ancient woodland (Rigsby Wood) is located approximately 100 m north of the western extent of the Route Section 1, within the Zone of Influence.

5.2.38 The settlements of Markby, Saleby, Thoresthorpe and Ailby are located on the margins of the Route Section 1 Zone of Influence. A small number of individual residential properties (closest approximately 60 m south of the central alignment, adjacent to the LoD, to the south of the route off Sutton Road) and farm buildings (closest approximately 20 m south of the LoD, south of Crawcroft Lane) are present. In addition, Sandilands Golf Course is located adjacent to the eastern extent of Route Section 1 and a caravan park is located approximately 225 m north of the central alignment at the eastern part of the route section (off Huttoft Road).

Regulated Activities and Data

5.2.39 The Landmark Envirocheck® Report (Ref: 7-39) has identified two discharge consents within the Route Section 1 Zone of Influence (both 90 m north of the proposed DC cable route LoD). Both are listed as unknown discharges onto land.

5.2.40 The Landmark Envirocheck® Report (Ref: 7-39) records the following two pollution incidents to controlled waters within Route Section 1:

- 70 m north of the proposed DC cable route LoD (north-west of Ailby): Category 2 (Significant Incident), land runoff of diesel oils (agriculture) into Wold Grift Drain; and
- 175 m north of the proposed cable DC route LoD (near Huttoft Road), Category 3 (Minor Incident), a release of miscellaneous pollutants into an unnamed dyke.

5.2.41 There are no Integrated Pollution Prevention Control (IPPC) processes, hazardous substance consents or fuel station entries located within Route Section 1 (Ref: 7-39).

5.2.42 The EA published landfill mapping does not identify any historic or current landfill sites on, or within the Route Section 1 Zone of Influence (Ref: 7-41).

5.2.43 According to the Envirocheck® Report (Ref: 7-39) there are no licensed waste management facilities within Route Section 1. In addition, there are no current or preferred waste management sites identified in the Lincolnshire County Council *'Core Strategy and Development Management Policies Lincolnshire Minerals and Waste Local Plan*' (Ref: 7-19).

5.2.44 There are no areas within or adjacent to the Route Section 1 Zone of Influence that are classified as 'Contaminated Land' under Part 2a of the Environmental Protection Act 1990 (Ref: 7-06).

Ground Investigation – Soil and Groundwater Chemical Analysis

5.2.45 The findings of the preliminary ground investigations for both the proposed landfall and proposed DC cable route are included within *ES-4-B.03 Volume 4, Chapter 07 Geology and Hydrogeology* Appendix 7.3 and Appendix 7.4. To provide some context to the measured concentrations within the soils and groundwater sampled as part of the proposed landfall ground investigation and soils sampled as part of the proposed DC cable route ground investigation, a contamination assessment in the form of a generic quantitative risk assessment (GQRA) was undertaken by AECOM (Ref: 7-32 and Ref: 7-33).

5.2.46 A summary of the sampling completed to date for Route Section 1 is as follows:

- A total of 11 soil samples (5 from the proposed landfall preliminary ground investigation and two samples each from TPL1, TPL 2 and TPL 3) were obtained from soils located within route section 1. Samples were taken from depths ranging from ground level to 7.2 m bgl and were analysed for a range of determinands including metals, inorganic compounds, speciated polycyclic aromatic hydrocarbons (PAH), speciated total hydrocarbons, total phenols, volatile organic compounds (VOC), semi volatile organic compounds (SVOC) and pesticides and herbicides.
- Six soil samples from between 0.1 m bgl and 7.2 m bgl were submitted for soil leachate testing for a range of determinands including metals, inorganics and PAH. Due to the soil leachate preparation methods hydrocarbons, total phenols, SVOC and VOC were not analysed.
- Groundwater samples were collected from BH001 (Alpha) on one occasion during the proposed landfall ground investigation (Ref: 7-32) and subsequently analysed for a range of determinands including metals, inorganic compounds, PAH, total hydrocarbons, total phenols, VOC and SVOC, organochlorine and organophosphorus pesticides and herbicides.

5.2.47 Groundwater from borehole locations associated with the proposed DC cable route and landfall is currently being monitored (including for the recovery of groundwater samples on two occasions) as part of a year-long groundwater level monitoring programme. An interim monitoring report will be produced in November 2017, with a final report in May 2018. This programme of groundwater

quality monitoring will further serve to establish pre-construction baseline conditions against which future construction and post construction monitoring can be compared against.

5.2.48 The assessment of soil samples recovered from the ground investigations has been based on screening maximum reported concentrations for a range of determinands against soil Generic Assessment Criteria (GAC). The GAC adopted are designed to be protective of a residential with plant uptake end use. In isolated cases reference was made to other default land uses and their GAC (e.g. parks or commercial) to further place into context any exceedances against the residential GAC. This approach was considered to be conservative given that post construction, the land will be returned to its current use (Ref 7-32, Ref: 7-33). The soil leachate and groundwater results were screened against EQS and drinking water standards (DWS) to be both protective of the environment and also drinking water supplies.

5.2.49 Based on the results of the human health assessment, AECOM concluded that as all of the determinands tested were found to be below the adopted screening criteria there was no appreciable significant risk from the soil samples tested within Route Section 1 to human health (Ref 7-32 and Ref: 7-33).

5.2.50 Based on the controlled waters assessment completed it was concluded that the existing soil conditions were broadly consistent with natural background concentrations. Some leachable metal and inorganic determinand concentrations, whilst elevated against their adopted GAC for risk to controlled waters, were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area. There was not considered to be a significant risk posed to surface water quality, the nearest groundwater abstraction or the confined Chalk aquifer currently, during or post construction of the proposed DC cable route from the soils sampled.

Conceptual Site Model

5.2.51 The topography, geology, hydrogeology and hydrology of the site are the main factors that influence the way in which potential contaminants in the soil or groundwater can be transported on or off site, and the ways in which contamination can affect different receptors. Potential receptors are first summarised in this section, and where applicable references are made to other relevant chapters within the ES. Potential sources and pathways linking any sources to the defined receptors are then identified.

Receptors to Soil and Groundwater Contamination - Groundwater

5.2.52 The superficial geology underlying Route Section 1 is generally classified as either Unproductive strata (Salt Marsh and Tidal Creek Deposits) or Secondary Undifferentiated (Till (Boulder Clay)). Localised areas of Glaciofluvial Deposits are present in the area around Asserby and Alluvium is mapped east of Ailby (both classified as Secondary A Aquifers). The superficial Secondary A Aquifers are not mapped to underlie the proposed DC cable route LoD. However, the sensitivity

has conservatively been assessed as **medium** as two groundwater abstractions have been identified within the Zone of Influence that abstract from the superficial aquifers.

5.2.53 The solid geology (Chalk) is classified as a Principal Aquifer and whilst this has been identified as a **high** sensitivity receptor, it is present at depth beneath a substantial superficial cover that will afford the aquifer a degree of protection from any vertical and/or lateral contaminant migration.

5.2.54 A total of ten groundwater abstractions have been identified within the Route Section 1 Zone of Influence, all of which relate to general farming and domestic use or spray irrigation. The closest abstraction is located approximately 60 m from the proposed DC cable route central alignment and is recorded to abstract groundwater from the superficial marine and estuarine deposits (Salt Marsh and Tidal Creek Deposits) (Unproductive strata). Of the remaining abstractions eight are from the Chalk (Principal Aquifer), with the closest located 95 m from the LoD, with the remaining abstraction from glacial sand and gravel and located approximately 200 m from the LoD.

Receptors to Soil and Groundwater Contamination - Water Resources and Hydrology

5.2.55 A summary of potential hydrological receptors identified within Route Section 1 is presented in Table 7.18 and based on data provided in the Envirocheck® Report (Ref: 7-39) and data provided by the EA (Ref: 7-42) Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1.Further details are presented in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology*.

Table 7.18 Route Section 1: summary of watercourse crossings

Watercourse type	Notable crossings	Approximate no. of crossings
Main River	Wold Grift Drain	2
Internal Drainage Board (IDB) maintained watercourse	Where identified: Boy Grift Drain, Crawcroft Lane Drain, Huttoft Main Drain, Bilsby Tank Trap Drain	4
Minor field drains	Unnamed	22

5.2.56 A large drain (Boy Grift Drain) also runs parallel to the eastern part of Route Section 1 between the proposed landfall and Crawcroft Lane (north within the LoD at its closest point).

Receptors to Soil and Groundwater Contamination - Sensitive Sites

5.2.57 A summary of designated environmentally sensitive receptors identified within the proposed DC cable route (Route Section 1) Zone of Influence is provided below and further details are presented in *ES-2-B.06, Volume 2, Chapter 10: Ecology*:

- Sea Bank Clay Pits Site of Special Scientific Interest: A composite site comprising a series of isolated flooded clay workings of varying size, depth and topography which are important for

birds, aquatic invertebrate fauna and aquatic plants. Located approximately 324 m south and 295 m north of the proposed landfall; and

- 5 No. non-statutory designated sites within the Zone of Influence including Firsby to Louth Dismantled Railway Site of Nature Conservation Interest (SNCI), Rigsby Road Verges Local Wildlife Site (LWS), Rigsby Roadside Natural Resource (RNR), Sandilands Golf Course Dunes LWS, Sandilands Pit Local Wildlife Trust reserve.

Receptors to Soil and Groundwater Contamination - Human Receptors

5.2.58 Potential human receptors identified within the Route Section 1 Zone of Influence are summarised as follows:

- Residential properties, with the closest located approximately at the southern LoD, south of Sutton Road;
- Farm buildings, with the closest located approximately 20 m south of the proposed LoD, south of Crawcroft Lane;
- Potential farm workers associated with the agricultural fields adjacent to the proposed DC cable route; and
- Users of the Sandilands Golf Course located adjacent to the eastern extent of the proposed DC cable route.

Receptors to Soil and Groundwater Contamination Buildings and Infrastructure

5.2.59 The closest buildings are the residential properties at the southern LoD, south of Sutton Road.

Potential Receptors Summary

5.2.60 The site-specific receptors were identified based on the proposed land-use as well as the environmental setting within Route Section 1. Table 7.19 presents the identified potentially sensitive receptors that will be considered within the geology and hydrogeology contamination assessment.

Table 7.19 Route Section 1: summary of potentially sensitive receptors

Identified receptor	Receptor sensitivity
Human health – contractors carrying out construction works	Very High
Human health – Agricultural and employment activity within 250 m of proposed construction works.	Low
Human health – Neighbouring residential properties	High
Groundwater - designated Unproductive strata (Salt Marsh and Tidal Creek Deposits Tidal Flats) and Secondary Undifferentiated (Till (Boulder Clay)) superficial aquifers, but providing a local source of groundwater for agricultural	Medium

Table 7.19 Route Section 1: summary of potentially sensitive receptors	
Identified receptor	**Receptor sensitivity**
/domestic use at one property locally (White Well, licence 4/29/15/*G/0028).	
Groundwater – designated confined Principal Aquifer and Zone 2 groundwater SPZ within Chalk aquifer.	High
Surface water features – Wold Grift Drain	Very High
Surface water features – Boy Grift Drain, Crawcroft Lane Drain, Huttoft Main Drain, Bilsby Tank Trap Drain and other unnamed drains crossed or adjacent to the proposed DC cable route.	High

Potential Sources of Contamination

5.2.61 Based on the historical and current land uses in Route Section 1, no significant sources of soil or groundwater contamination have been identified. No current or historical landfill sites have been identified. No evidence of elevated UXO potential has been found within Route Section 1.

Potential Pathways

5.2.62 The human health exposure pathways that are considered viable based on the proposed land use and UK guidance are listed below:

- Dermal contact with soil, dust and groundwater;
- Ingestion of soil, dust and groundwater;
- Inhalation of dust;
- Inhalation of vapours (from soils and groundwater); and
- Inhalation of ground-gas in confined spaces.

5.2.63 The controlled waters pathways considered viable are as follows:

- Vertical and lateral migration of leachate through the unsaturated soils to groundwater;
- Vertical and lateral groundwater migration; and
- Surface water run-off.

Conceptual Site Model Summary

5.2.64 In the absence of any significant sources of soil and/or groundwater contamination, there are not perceived to be any soil or groundwater contamination risks associated with the baseline conditions that might significantly impact upon future development.

5.3 Route Section 2 Well High Lane to A16 (Keal Road)

Geological Setting and Sensitivity

Published Geology

5.3.1 The geology from Well High Lane moving south west is a continuation initially of the superficial Till (Boulder Clay) overlying the Ferriby Chalk that has been described in Route Section 1. From the buried cliff line at the limits of Route Section 1, the Till (Boulder Clay) becomes increasingly absent leaving the Welton Chalk Formation exposed over the majority of the Lincolnshire Wolds, except for occasional superficial sand and gravel and alluvial depositions. Further to the west the underlying Ferriby Chalk Formation and then the subordinate Hunstanton Formation outcrop, which together with the Welton Chalk Formation form a significant proportion of the western scarp face of the Lincolnshire Wolds. The solid geology present beneath the Chalk which becomes exposed in the western area of the Lincolnshire Wolds comprise an easterly dipping sequence of Lower Cretaceous formations including the Carstone Formation, the Tealby Formation, the Roach Formation and the Claxby Ironstone Formation. These overlie the Spilsby Sandstone Formation. The Hunstanton Formation, formerly referred to as the Red Chalk, is characteristic of sandy argillaceous Chalk (Ref: 7-34) that contains rounded quartz grains (Ref: 7-35). The underlying Carstone is described as fine grained sandstone towards its lower sections, becoming coarser in upper sections (Ref: 7-35). The Tealby Formation is described as a pale grey mudstone with ferruginous ooids including in upper sections, a hard "shaley" thinly bedded limestone separately referred to as the Tealby Limestone Member (Ref: 7-34). The Roach Formation is a ferruginous mudstone which is expected to overlie the Sutterby Clay Formation in the area (Ref: 7-34). The Claxby Ironstone Formation is described as a brown to purple oolitic ironstone (Ref: 7-35).

5.3.2 The Spilsby Sandstone which was formed across the Cretaceous and Jurassic boundary is described as a medium to coarse grained weekly cemented pebbly sandstone (Ref: 7-34), and this outcrops within the proposed DC cable route as it passes west and south of Sausthorpe, and again north and east of Raithby. Between Sausthorpe and Raithby the Splisby Sandstone is absent exposing the Kimmeridge Clay Formation of Jurassic age, which has a localised cover of Alluvium mapped. The alluvium is considered to be associated with deposition arising from the course of the River Lymn. To the south of Raithby the sandstone is concealed by a sequence of the Tealby Formation, Claxby Ironstone Formation and Hundleby Clay. The Hundleby Clay is described as a mudstone unit (Ref: 7-34). The Spilsby Sandstone is then again exposed up until another brief subcrop of the Tealby Formation, Claxby Formation and Hundleby Clay to the north of East Keal and West Keal.

5.3.3 Within the Route Section 2 Zone of Influence there are nine relevant publically available historical BGS borehole records (Ref: 7-31). These are summarised in tabular form in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.2. The records are variable which reflects the changing succession of geology throughout the section but they have been found to generally support the published geology.

Ground Investigation – the Proposed DC Cable Route

5.3.4 The aforementioned preliminary ground investigation that was undertaken between January and March 2017 at selected locations along the proposed DC cable route included two TPL within Route Section 2; TPL 4 (A16 Bluestone Heath Road) and TPL15 (A16 Keal Hill and Main Road). It should be noted that TPL 15 is located within both Route Section 2 and Route Section 3. The A16 and Keal Hill is located within Route Section 2 and hence is discussed in this section. The A16 Main Road is located within Route Section 3. The Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33) is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4. More detail on the ground conditions can be found by referring to the TPL specific technical appendix contained in Appendix A of the Preliminary Ground Investigation Report (Ref: 7-33).

5.3.5 The sequence of strata encountered, which is summarised in Table 7.20, generally supports the published geology except where Till (Boulder Clay) is identified at TPL 4. Geological mapping does not show the Till (Boulder Clay) extending as far west as TPL 4. With regards to the solid geology, the presence of the White Chalk near surface at TPL 4 and the absence of the White Chalk within TPL 15, is consistent with the BGS mapped geology, highlighting the shallow nature of the White Chalk over large areas of the Lincolnshire Wolds.

Table 7.20 Route Section 2: summary of ground conditions encountered at TPL

Strata	Name [1]	Route section	TPL encountered	Depth range to top (m bgl)	Proven thickness (m)
Natural Superficial Deposits	Till (Boulder Clay) [2, 3, 4]	2	TPL 4	0.00	1.20
Solid Geology	White Chalk (structureless to 2.6 m bgl)	2	TPL 4	1.20	8.80 [7]
	Possible Spilsby Sandstone [2,, 5]	2	TPL 15 [6]	0.00	2.45
	Kimmeridge Clay Formation (Ancholme Group)	2	TPL 15 [6]	2.45	7.50 [7]

TPL 4 included borehole BH025;

TPL 15 included borehole BH013;

1 - AECOM's interpretation based on published geological information and recorded field observations;

2 - Where no Made Ground is encountered at the surface, it is acknowledged that the upper most section of the natural superficial or solid geology will have been subjected to potential

reworking/soil structure improvements including the addition of nutrients and other elements as part of general agricultural practice;

3 - Based on the lithology recorded it is possible that the upper parts of these deposits may be more alluvial in origin;

4 - The identification of Till (Boulder Clay) at TPL 4 (BH025) is not in line with the published BGS geological mapping. The BGS mapping does not show the Till (Boulder Clay) extending as far west as BH025;

5 - For the purposes of the ground model, the possible Spilsby Sandstone has been assumed to be present from ground level at BH013;

6 - Only BH013 is present within Route Section 2; and

7 - Not fully penetrated.

Geotechnical Hazards

5.3.6 Table 7.21 summarises the potential geotechnical hazards identified within Route Section 2, which has been obtained from the Landmark Envirocheck® Report (Ref: 7-39).

Table 7.21 Route Section 2: potential geotechnical hazards

Hazard type	Receptor hazard potential range (where applicable)
Non coal mining areas	No hazard
Potential for collapsible ground stability hazards	No hazard to very low
Compressible ground stability	No hazard to moderate
Ground dissolution stability	No hazard to very low
Landslide ground stability	No hazard to low
Running sand ground stability	No hazard to low
Shrinking or swelling clay ground stability	No hazard to low
Radon affected areas	Less than 1% of homes above action level to between 1 and 3 % of homes are above action level

Geological Designations

5.3.7 There are no geologically designated SSSI present within the Route Section 2 Zone of Influence (Ref: 7-30).

5.3.8 The following LGS have been identified within the Route Section 2 Zone of Influence:

- Dalby Hill Chalk Quarry (National Grid reference TF405706); a disused Chalk quarry.

5.3.9 The boundary of this quarry is located approximately at the southern LoD for the proposed DC cable route. The proposed DC cable installation is not expected to impact upon the quarry given it is just beyond the extent of the LoD and siting would look to avoid such a feature due to both

engineering and environmental reasons. The location of this site is presented on Figure 7.4 which is presented in *ES-3-B.03, Volume 3, Chapter 7: Geology and Hydrogeology*.

5.3.10 Whilst not designated specifically for their geological significance, the River Lymn which crosses the proposed DC cable route in two locations, is classified as a Chalk Stream by the EA (Ref: 7-30). Chalk streams associate closely with the local hydrogeological conditions. These are presented on Figure 7.4 which is presented in *ES-3-B.03, Volume 3, Chapter 7: Geology and Hydrogeology.*

5.3.11 Considering the sensitivity criteria for geological designations set out within the methodology, a **low** sensitivity has been assigned to the stated geological designation.

Mineral Sites and Designations

5.3.12 There are no former/current mineral extraction sites or MSA at, or within close proximity, to the Route Section 2 (Ref: 7-19, 7-30 and 7-40).

Hydrogeological Setting and Sensitivity

Aquifer Designations

5.3.13 The aquifer classifications identified for the solid geological formations and superficial deposits described are presented in Table 7.22 and 7.23 (Ref: 7-41).

Table 7.22 Route Section 2: solid geology aquifer classification

Formation name	Aquifer designation
Welton Chalk Formation	Principal Aquifer
Ferriby Chalk and Hunstanton Formation	Principal Aquifer
Carstone Formation	Principal Aquifer
Roach Formation, Tealby Formation, Claxby Ironstone	Secondary A and B
Spilsby Sandstone	Principal Aquifer
Kimmeridge Clay Formation	Unproductive strata

Table 7.23 Route Section 2: superficial geology aquifer classification

Name	Aquifer designation
Alluvium	Secondary A

Groundwater Levels

5.3.14 The EA were contacted in March and November 2016 to request data on groundwater levels within the proposed DC cable route Zone of Influence. Of the data provided by the EA; no data was found to fall within the Zone of Influence (Ref: 7-42 and 7-43).

5.3.15 A review of BGS historical borehole records has been undertaken and observations on groundwater strike and resting levels have been recorded. These are documented in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* Appendix 7.2. There is very limited information on groundwater levels within the historical borehole records reviewed. Only one borehole location within an old sand pit at Langton (grid reference 539800, 371100) refers to a groundwater level of 6.7 m corresponding to a level within the Sutterby Marl.

5.3.16 Within Route Section 2, groundwater is present within a number of formations that are designated Principal Aquifers. The Chalk and Spilsby Sandstone Formations represent significant aquifers that the proposed DC cable route will interact with given the extent to which they subcrop within Route Section 2. Within the Chalk, nearly all of the permeability is reported to be provided through its fracturing, which is enhanced through solution weathering (Ref: 7-34). Solution weathering results from naturally formed carbonic acid which dissolves the Chalk to create preferential flow pathways. The underlying Lower Cretaceous formations are in continuity but there may be localised interruptions from marls and less permeable intervening formations. The majority of groundwater flow occurs in the upper parts of the formation where fractures tend to be more developed (Ref: 7-34). The Chalk aquifer within this route section is likely to be recharged by rainfall given the absence of confining superficial cover to limit infiltration across a large part of the route section. A number of springs also exist within the area and those identified within the Zone of Influence from the BGS records are summarised in in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.2. Within the BGS report (Ref: 7-34) a median transmissivity of 2000 m^2/day is cited from a study of 45 pumping test sites across the Chalk aquifer of Lincolnshire.

5.3.17 The BGS reports that groundwater flow within the Spilsby Sandstone aquifer is primarily through intergranular flow with a high porosity. Within the BGS report (Ref: 7-34) a transmissivity range of 6 to 1000 m^2/day for the Spilsby Sandstone is cited from a recent study.

5.3.18 Groundwater strikes encountered during the drilling of the boreholes as part of the preliminary ground investigation undertaken at the TPLs in Route Section 2 are recorded on the borehole log records included within the preliminary ground investigation report for the underground DC cable route (Ref: 7-33) . The records showed that groundwater was not recorded in TPL 4 prior to water flush being used (prior to 3 m bgl) but was encountered at TPL 15 (BH013) within the possible Spilsby Sandstone. It was encountered at 1.20 m bgl rising to 1.00 m bgl.

5.3.19 Neither BH025 (TPL 4) nor BH013 (TPL 15) were installed with groundwater monitoring standpipes as part of the proposed DC underground cable route preliminary ground investigation (Ref: 7-33). Therefore, no further groundwater level data is available at this location.

Groundwater Abstractions

5.3.20 The eastern limits of Route Section 2 up to Sutterby lies within a Zone 3 (Total Catchment) SPZ (Ref: 7-41). The Zone 1 abstraction point (the source) associated with this SPZ catchment is located approximately 7.7 km north east of the eastern limits of the route section. There are also

isolated SPZ Zone 1 abstractions that are not indicated to be associated within the Zone 3 catchment that the proposed DC cable route crosses. These are located approximately 1.3 km from the LoD to the east centred on Fordington and one 1.6 km to 2.5 km from the LoD to the northwest and west respectively centred on Driby. The SPZ highlighted are expected to be partially confined at the eastern limits of the route section.

5.3.21 The EA was contacted in October 2016 and responded in November 2016 regarding a data request for private and commercial groundwater abstractions within Route Section 2 (Ref: 7-43). In addition, a request was made for information on private groundwater abstraction licenses to ELDC in September 2016 and a response was provided in December 2016 (Ref 7-44). The information provided by the EA and ELDC together with data on licenced groundwater abstractions presented within the Envirocheck® Report (Ref: 7-39) are summarised in Table 7.24.

Table 7.24 Route Section 2: summary of groundwater abstractions

Licence no.	Well name / location	Abstraction strata	Abstraction description	Distance/direction
4/30/14/*g/127	Hawkes & Wardle (Farms) Ltd, Sausthorpe	Not stated but based on location assumed to be Spilsby Sandstone	Agricultural (General)	320 m north of centre line 270 m north of LoD
4/30/14/*G/0077	Edus Ltd. Catchpit Raithby	Not stated	Household Water Supply: Drinking; Cooking; Sanitary; Washing; (Small Garden)	430 m east of centre line 375 m east of LoD
4/30/14/*G/0062	Dexthorpe House Well Dalby	Lincolnshire Chalk	General Farming and Domestic	560 m north east of centre line 515 m north east of LoD

Groundwater Flooding

5.3.22 The BGS Groundwater Flooding Susceptibility map provided in the Landmark Envirocheck® Report (Ref: 7-39) generally shows that for Route Section 2 there is limited potential for groundwater flooding to occur. A localised area in the vicinity of the River Lymn (central area of Route Section 2, southwest of Sausthorpe) is mapped as having the potential for groundwater flooding to occur at the surface. The ELDC Strategic Flood Risk Assessment dated 2017 (Ref: 7-45) makes no specific reference to the District being at risk from groundwater flooding.

5.3.23 The Water Resources and Hydrology assessment presented in ES-2-B.03, Volume 2, Chapter 8 concludes that there is a medium potential for groundwater flooding within this route section.

Groundwater Sensitivity

5.3.24 According to the BGS (Ref: 7-34), the Lincolnshire Chalk aquifer system and the Spilsby Sandstone Formation provide a valuable groundwater resource which is used for potable, agricultural and industrial use. Both units store and transmit large quantities of water and are therefore very important for public water supply. The Chalk aquifer is understood to be subject to active groundwater management and control to manage over abstraction as the aquifer is over committed.

5.3.25 Groundwater sensitivity is considered based on the aquifer designation and its resource value as defined by the methodology. The groundwater within the Route Section 2 Zone of Influence is considered to be of **high** sensitivity.

Underground Structures

5.3.26 Based on a review of underground assets information provided in the Atkins utility search report (Ref: 7-46), no underground cables or pipelines associated with supplying utilities such as water, electricity, gas and telecommunications have been identified within the LoD, or within 250 m. However, based on a review of the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1, utilities were identified to cross the proposed underground DC cable route. A summary of the relevant assets identified is provided in Table 7.25

Table 7.25 Route Section 2: summary of underground assets

Asset type	No. of utilities within LoD
Western Power Distribution cable	2
Openreach British Telecommunications cable	9
Anglian Water pipe	19
Cadent Gas	2

5.3.27 The potential exists for the presence of a network of agricultural land drains relating to the agricultural fields, crossing and adjacent to the proposed DC cable route.

Unexploded Ordnance Potential

5.3.28 The Zetica UXO desk study assessment (Ref: 7-47) and risk assessment (Ref: 7-48) identified that there is no evidence of significant UXO potential within Route Section 2. A World War II aircraft crash site is noted at grid reference TF 403736 but not considered to be a significant UXO

constraint. This desk study report and risk assessment report are included as Appendix 7.5 in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology*.

Soil and Groundwater Contamination Potential

Historical Land Use

5.3.29 Historical OS maps supplied as part of the Landmark Envirocheck® Report (Ref: 7-39) have been reviewed in order to identify potentially contaminative historical land uses.

5.3.30 Several former quarries are present within the Route Section 2 Zone of Influence. The larger identified pits are:

- Silver Pits (chalk pit) located 10 m to the east of the LoD, 600 m to the west of Ulceby Cross and indicated on maps from 1906 to the present day;
- Stone Pit located approximately adjacent to the east of the LoD and the A16, and approximately 250 m to the northwest of Dalby. Present on historical mapping from 1888 to 1976; after which it was no longer identified and is assumed to have been filled;
- Old Stone Pit located 73 m south and 275 m west of LoD, adjacent to Langton Hill, marked as disused by 1983;
- Enderby Sand Holes located 235 m to the west of the LoD, approximately 1 km south of Mavis Enderby. Present on mapping from 1887 to the present day;
- Old Marl Pit located approximately 200 m to the west of the LoD, on the eastern limits of West Keal. Present on mapping between1887 and 1978. Labelled on mapping as "Pit (disused)" from 1978; and
- Sand Pit located to the southeast of the aforementioned old Marl Pit at West Keal, 50 m from the LoD. Present on mapping between 1887 and 1978. Labelled as “Pit (disused)” from 1978.

5.3.31 A former brickyard/brick and tile works was present 35 m to the east of the proposed DC cable route LoD, and 400 m north west of East Keal between the 1887 and 1956 mapping. A marl pit was indicated immediately to the south of the brickyard (15 m to the east of the LoD) and was shown to be present between the 1887 to 1978 mapping. The remainder of Section 2 has been historically dominated by agricultural land use.

Current Land Uses

5.3.32 Current OS mapping and aerial imagery (Ref: 7-49) have been reviewed in order to identify the present land use within Route Section 2.

5.3.33 The eastern and central parts of the route section (between the villages of Haugh and Sausthorpe) passes through the Lincolnshire Wolds (Area of Outstanding Natural Beauty). The area is characterised by open agricultural fields. The proposed DC cable route crosses four main roads (Bluestone Heath Road, Partney Road, Raithby Hill and Keal Hill) as well as a main river (the River Lymn) in two locations near Sausthorpe. An area of ancient woodland (Callow Carr) is located adjacent to the western area of the LoD.

5.3.34 The small settlements of Dalby, Raithby, East Keal and West Keal are located on the margins of the Zone of Influence, although no buildings are located within the LoD. A limited number of residential properties (closest 20 m east of LoD, off Keal Hill) and farm buildings (closest 60 m east of LoD west of the A16 and east of Sutterby and 100 m north of the LoD, off Partney Road) are present.

Regulated Activities and Data

5.3.35 The Landmark Envirocheck® Report (Ref: 7-39) has identified five discharge consents within the Zone of Influence located between 40 m and 185 m of the LoD. Theses discharges are recorded as relating to agricultural trade discharge, treated sewage effluent and unknown discharges onto land and one record for treated sewage into a tributary of the River Lymn.

5.3.36 The Landmark Envirocheck® Report (Ref: 7-39) records one pollution incident to controlled water within Route Section 2. This relates to the release of miscellaneous pollutants into an unnamed ditch 235 m west of the LoD, north of West Keal. The EA classified the incident as Category 3 (Minor Incident).

5.3.37 The Envirocheck® Report (Ref: 7-39) records show there are three IPPC processes operating which relate to farm buildings operated by Hawkes Limited. The farm buildings are located approximately 100 m and 160 m and 175 from the proposed LoD, to the south and southeast of Sausthorpe. There are no hazardous substance consents or fuel station entries located within the Zone of Influence.

5.3.38 The EA published landfill mapping identifies one historic landfill site within Route Section 2 (Ref: 7-41). This landfill is small and listed as Harrington Lane landfill, reference EAHLD00062, and is reported to have received household waste. The landfill footprint is relatively small (0.2 hectare) and is located 20 m from the proposed DC cable route centre line, adjacent to the working width and within the LoD of the proposed DC cable route (at its closest point). It is located to the west of Ulceby Cross. There are no current landfills recorded within Route Section 2.

5.3.39 According to the Envirocheck® Report there are no licensed waste management facilities within Route Section 2. In addition, there are no current or preferred waste management sites identified in the '*Lincolnshire County Council Minerals and Waste Local Plan'* (Ref: 7-19) within the Zone of Influence.

5.3.40 There are no areas within or adjacent to the Zone of Influence that are classified as 'Contaminated Land' under Part 2a of the Environmental Protection Act 1990 (Ref: 7-06).

Ground Investigation – Soil and Groundwater Chemical Analysis

5.3.41 The findings of the preliminary ground investigation undertaken along the proposed DC cable route are included within *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* Appendix 7.3. To provide some context to the measured concentrations within the soils sampled as part of the proposed DC cable route ground investigation, a contamination assessment in the form of a GQRA was undertaken by AECOM (Ref: 7-33).

5.3.42 A summary of the sampling completed to date for Route Section 2 is as follows:

- A total of 4 soil samples (two samples each from TPL 4 and TPL 15) were obtained from soils located within Route Section 2. Samples were taken from a depth range of 0.30 m bgl to 4.8 m bgl and were analysed for a similar range of determinands to those described in Route Section 1; and
- Two soil samples from between 0.30 m bgl and 0.50 m bgl were submitted for soil leachate testing and were analysed for a similar range of determinands to those described in Route Section 1.

5.3.43 The assessment of soil samples recovered from the ground investigations has been based on screening maximum reported concentrations for a range of determinands against soil GAC. The GAC adopted are designed to be protective of a residential with plant uptake end use. In isolated cases reference was made to other default land uses and their GAC (e.g. parks or commercial) to further place into context any exceedances against the residential GAC. This approach was considered to be conservative given that post construction, the land will be returned to its current use (Ref: 7-33). The soil leachate results were screened against EQS and DWS to be both protective of the environment and also drinking water supplies.

5.3.44 Based on the results of the human health assessment, AECOM concluded that as all of the determinands tested were found to be below the adopted screening criteria there was no appreciable significant risk from the soil samples tested within Route Section 1 to human health (Ref: 7-33).

5.3.45 Based on the controlled waters assessment it was concluded that the existing soil conditions were broadly consistent with natural background concentrations. Some leachable metal and inorganic determinand concentrations, whilst elevated against their adopted GAC for risk to controlled waters, were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area. There was not considered to be an appreciable significant risk from soil contamination to groundwater including the Principal Chalk aquifer and the associated SPZ 3 (TPL 4). Although groundwater flow through the Secondary A and/or Principal aquifer can act as a pathway to any soil leachate migration into groundwater, given the concentrations recorded there is not considered to be a significant risk posed to surface water quality or the nearest groundwater abstraction currently, during or post construction of the proposed DC cable route from the soils sampled. However, it should be noted that construction of the proposed DC cable route is likely to interact with the Chalk, Carstone and Spilsby Sandstone aquifer given the shallow depth of these formations. In the absence of mitigation there is a potential for construction to introduce contamination or impacts to groundwater in these areas.

5.3.46 Neither BH025 (TPL 4) nor BH013 (TPL 15) were installed with groundwater monitoring standpipes as part of the proposed DC underground cable route preliminary ground investigation (Ref: 7-33).

Conceptual Site Model

Receptors to Soil and Groundwater Contamination - Groundwater

5.3.47 Superficial geology is generally absent across Route Section 2 except for localised alluvial deposits in the vicinity of the River Lymn which are classified as a Secondary A Aquifer by the EA. The solid geology is shown to comprise the Chalk Group, Carstone Formation and Spilsby Sandstone (Principal Aquifers); Roach Formation, Tealby Formation, Claxby Ironstone (Secondary A and B Aquifers); and the Kimmeridge Clay Formation (Unproductive strata).

5.3.48 A total of three groundwater abstraction boreholes have been identified within the Route Section 2 Zone of Influence, the closest of which is located approximately 270 m from the LoD and this abstracts groundwater for general agricultural use. The published geological mapping indicates that this borehole is likely to abstract groundwater from the Spilsby Sandstone (a Principal Aquifer).

Receptors to Soil and Groundwater Contamination - Water Resources and Hydrology

5.3.49 A summary of potential hydrological receptors identified within Route Section 2 is presented in Table 7.26 below based on data provided in the Envirocheck® Report (Ref: 7-38) and the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1. Further details are presented in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology*.

Table 7.26 Route Section 2: summary of watercourse crossings

Watercourse type	Notable crossings	No. of crossings
Main River	River Lymn	2
Other watercourse	Unnamed	4

5.3.50 The proposed DC cable route crosses the River Lymn (classified as a Chalk River by the EA) in two locations east and west of the village of Sausthorpe. An unnamed drain which flows into the River Lymn is also crossed by the proposed DC cable route.

Receptors to Soil and Groundwater Contamination - Sensitive Sites

5.3.51 A summary of designated environmentally sensitive receptors identified within the proposed DC cable route (Route Section 2) Zone of Influence is provided below and further details a presented in *ES-2-B.06, Volume 2, Chapter 10: Ecology*.

- Mavis Enderby SSSI: steep valley sides that support species-rich unimproved grassland, while the poorly drained valley floor has developed marsh. Valuable for a variety of fauna including breeding birds. Located 99 m west of LoD; and

- 7 No. Statutory non-designated sites: including Bluestone Heath Copse SNCI, Callow Carr LWS and ancient woodland, East Keal Clay Pit LWS, Hocker Holt LWS, Manor Farm at Mavis Enderby LWS, Silver Pits at Ulceby SNCI, and Wheelabout Wood SNCI.

Receptors to Soil and Groundwater Contamination - Human Receptors

5.3.52 Potential human receptors identified within the Route Section 2 Zone of Influence are summarised as follows:

- Residential properties, with the closest located approximately 20 m east of the LoD, off Keal Hill and 75 m east of the LoD concerning a residential property north of Dalby;
- Farm buildings, with the closest located approximately 60 m east of the LoD (west of the A16 and east of Sutterby and 100 m north of the LoD, off Partney Road; and
- Potential farm workers associated with the agricultural fields adjacent to the proposed DC cable route.

Receptors to Soil and Groundwater Contamination - Buildings and Infrastructure

5.3.53 The closest building to the Route Section 2 proposed DC cable route is approximately 20 m east of the LoD. Depending on the ground conditions and location of the trench within the LoD, there may be a requirement to provide temporary support for the trench sides or excavations.

Potential Receptors Summary

5.3.54 The site-specific receptors were identified based on the proposed land-use as well as the environmental setting of the Route Section 2 Zone of Influence. Table 7.27 presents the identified potentially sensitive receptors that will be considered within the geology and hydrogeology assessment.

Table 7.27 Route Section 2: summary of potentially sensitive receptors

Identified receptor	Receptor sensitivity
Human health - contractors carrying out construction works	Very High
Human health - Agricultural and employment activity within 250 m of proposed construction works.	Low
Human health - Neighbouring residential properties	Very High
Groundwater - Principal Aquifer (Chalk, Carstone, Spilsby Sandstone), (groundwater SPZ (Zone 3))	High
Groundwater - Secondary A (Alluvium), Secondary A/B (Roach Formation, Tealby Formation, Claxby Ironstone)	Medium
Groundwater – Secondary Undifferentiated Till (Boulder Clay), Unproductive (Kimmeridge Clay)	Negligible

Table 7.27 Route Section 2: summary of potentially sensitive receptors	
Identified receptor	**Receptor sensitivity**
Surface water features - River Lymn	Very High

Potential Sources of Contamination

5.3.55 Based on the historical and current land uses within the Route Section 2 Zone of Influence, no significant sources of soil contamination have been identified. The closest historic landfill is located within the LoD and is relatively small in size. No significant evidence of elevated UXO potential has been found within Route Section 2.

Potential Pathways

5.3.56 The human health exposure pathways that are considered viable based on the proposed land use and UK guidance are listed below:

- Dermal contact with soil, dust and groundwater;
- Ingestion of soil, dust and groundwater;
- Inhalation of dust;
- Inhalation of vapours (from soils and groundwater); and
- Inhalation of ground-gas in confined spaces.

5.3.57 The controlled waters pathways considered viable are as follows:

- Vertical and lateral migration of leachate through the unsaturated soils to groundwater;
- Vertical and lateral groundwater migration; and
- Surface water run-off.

Conceptual Site Model Summary

5.3.58 In the absence of any significant sources of soil and/or groundwater contamination, there are not perceived to be any significant soil or groundwater contamination risks associated with the baseline conditions that might significantly impact upon future development.

5.4 Route Section 3 A16 (Keal Road) to River Witham

Geological Setting and Sensitivity

Published Geology

5.4.1 The solid geology throughout this route section comprises Jurassic age easterly dipping mudstones, sandstones and siltstones of the Ancholme Group that increase in age moving west and south west. The succession includes the Kimmeridge Clay Formation in the north east and the Ampthill Clay Formation in the south west.

5.4.2 Overlying superficial Till (Boulder Clay) is present to the south of East Keal and West Keal. This represents the approximate western extents inland of the Devensian Till (Boulder Clay), which extends from around the south of the Lincolnshire Wolds (Ref: 7-35). To the west of Stickford, a small area of superficial sands and gravels is crossed which overlies older Till (Boulder Clay), the Wragby Till, which was deposited during earlier, pre-Devensian periods of glacial activity. The discontinuous cover of sands and gravels bear more prominence to the north and west of the wider area and results from deposition from glacial meltwaters and former river courses including the River Trent (Ref. 7-35). Around New Bolingbroke the superficial geology becomes dominated by the Barroway Drove Beds which are marine and estuarine deposits that prevail across the remainder of the route section and which were formed by periods of sea level rise and regression. These are frequently organic with peat layers (Ref: 07-50). Across the Fens, palaeochannels have been recorded which represent part of former estuarine creek systems (Ref: 07-51). Within these areas localised increased depths of deposited silt, sand and gravels exist, cut into the underlying Till (Boulder Clay).

5.4.3 Within the Route Section 3 area there are only two publically available historical BGS borehole records (Ref: 7-31). These are tabulated and summarised in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.2. These records are located in the south west of the route section and confirm the presence marine and estuarine Barroway Drove Beds to between 2.5 m and 4.8 m thickness (including a 1.0 m thick layer of Peat) overlying Till (Boulder Clay) to approximately 16 m depth. The solid geology of the Ampthill Formation was only proven in one of the locations.

Proposed DC Cable Route Preliminary Ground Investigation

5.4.4 The aforementioned preliminary ground investigation that was undertaken between January and March 2017 at selected locations along the proposed DC cable route included the following TPL within Route Section 3:

- TPL 15: A16 Keal Hill and Main Road (Main Road only);
- TPL 16: West Fen Catchment Drain;
- TPL 17: West Fen Catchment Drain and Westville Road;
- TPL 18: MSA, Leagate Road; Leagate Road Drain and Newham Main Drain; and
- TPL 19: River Witham (north bank).

5.4.5 The Preliminary Ground Investigation Report (Ref: 7-33) is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4. More detail on the ground conditions can be found by referring to the TPL specific technical appendix contained in Appendix A of the Preliminary Ground Investigation Report (Ref: 7-33). The sequence of strata encountered, which is summarised on Table 7.28, generally supports the published geology. However, within the area of TPL 15 it is possible that Head Deposits which are mapped by the BGS to be north of BH012 (Ref: 7-33) may encroach slightly further south to be situated within TPL 15. Sands and gravels associated with deposition from glacial meltwaters and former river courses including the

River Trent (Ref. 7-33) were encountered within TPL 15 and TPL 19. The solid geology of the Kimmeridge Clay Formation was located at relatively shallow depth (less than 6 m bgl) in the northeast section of Route Section 2 (TPL 15 and TPL 16), increasing to a depth below 18 m bgl moving westwards toward the River Witham.

Table 7.28 Route Section 3: summary of ground conditions encountered at TPL

Strata	Name [2]	Route section	TPL encountered	Depth range to top (m bgl)	Proven thickness (m)
Made Ground [1]	-	3	TPL 18	0.0	0.3
Natural Superficial Deposits	Possible Head Deposits/Possible Till (Boulder Clay) [3]	3	TPL 15	0.0	4.0
	Possible Glaciofluvial Deposits	3	TPL 15	4.0	1.9
	Possible Marine and Estuarine Deposits (Tidal Flats) [3, 4]	3	TPL 16	0.0	2.3
	Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits) [3, 4]	3	TPL 17, 18 & 19	0.0 to 0.3	0.6 to 5.1
	Till (Boulder Clay)	3	TPL 17, 18	1.6 to 5.1	1.4 [6] to 13.25
Natural Superficial Deposits	River Terrace Deposits [5]	3	TPL 19	0.6	18.2 [6]
Solid Geology	Kimmeridge Clay Formation (Ancholme Group)	3	TPL 15, 16 & 17	2.3 to 18.35	1.15 [6] to 17.7[6]

TPL 15 included borehole BH012;

TPL 16 included borehole BH011;

TPL 17 included borehole BH010;

TPL 18 included borehole BH009, TP001, TP002;

TPL 19 included borehole BH008;

1 - Made Ground is defined as material that contained anthropogenic material or where it is underlain by material that contained anthropogenic material;

2 - Interpretation based on published geology and the recorded field observations;

3 - Where no Made Ground is encountered at the surface, it is acknowledged that the upper most section of the natural deposits will have been subjected to potential reworking/soil structure improvements, including the addition of nutrients and other elements as part of general agricultural practice;

4 - Based on the lithology recorded it is possible that the upper parts of these deposits may be more alluvial in origin;

5 - River Terrace Deposits potentially from former river courses, together with more recent deposits associated with the River Witham; and

6 - Not fully penetrated.

Geotechnical Hazards

5.4.6 Table 7.29 summarises the potential geotechnical hazards identified within Route Section 3 from the Landmark Envirocheck® Report (Ref: 7-39).

Table 7.29 Route Section 3: potential geotechnical hazards

Hazard type	Receptor hazard potential range (where applicable)
Non coal mining areas	No hazard
Potential for collapsible ground stability hazards	No hazard to very low
Compressible ground stability	No hazard to moderate
Ground dissolution stability	No hazard
Landslide ground stability	Very low to low
Running sand ground stability	No hazard to moderate
Shrinking or swelling clay ground stability	No hazard to low
Radon affected areas	Less than 1% of homes above the action level to between 1 and 3% of homes above the action level

Geological Designations

5.4.7 There are no LGS or geologically designated SSSI present within the Route Section 3 Zone of Influence (Ref: 7-30).

Mineral Sites and Designations

5.4.8 There is one sand and gravel MSA whose southern limits extend to within 15 m from the northern LoD (Ref: 7-19, 7-30 and 7-40). The MSA is located between Scrub Hill and Gipsey Bridge. Ground investigation undertaken at the margins of the denoted MSA, which comprised two trial pits and one borehole, did not record extensive reserves of sands or gravels. A gravelly fine to coarse sand was located in borehole BH009 (TPL 18) between 2.8 and 3.8 m overlying Till (Boulder Clay). Above this the geology was interpreted to be part of the Barroway Drove Beds (Marine Deposits/Tidal Flat Deposits). Of the two trial pits, trial pit TP001 recorded a 0.75 m thick layer of sand and gravel between 0.85 m and 1.6 m depth. No sands or gravels were identified in TP002. The encountered sequences appear to confirm that the proposed LoD is not crossing

extensive mineral reserves which presumably exist further north within the designated area. The MSA is afforded a **high** receptor sensitivity.

Hydrogeological Setting and Sensitivity

Aquifer Designations

5.4.9 The aquifer classifications identified for the formations described above are presented in Table 7.30 and 7.31 (Ref: 7-41).

Table 7.30 Route Section 3: solid geology aquifer classification

Formation name	Aquifer designation
Kimmeridge Clay Formation, Ampthill Clay Formation	Unproductive strata

Table 7.31 Route Section 3: superficial geology aquifer classification

Name	Aquifer designation
Till (Boulder Clay)	Secondary Undifferentiated
River and Glaciofluvial Deposits (Sand and Gravel)	Secondary A
Marine and Estuarine Deposits (including Barroway Drove Beds)	Unproductive strata
Peat	Unproductive strata

5.4.10 A former infilled channel was encountered at TPL19 around the River Witham. Here recent alluvium was found to overlie sands and gravelly sands that have been deposited in a channel cut into the Till (Boulder Clay) to at least 18.8 m depth. The groundwater level observed during drilling was less than 1.5 m bgl suggesting that these deposits are water bearing.

Groundwater Levels

5.4.11 The EA were contacted in March and November 2016 to request data on groundwater levels within the proposed DC cable route Zone of Influence. Of the data provided by the EA; none was found to fall within the Zone of Influence (Ref: 7-42 and 7-43).

5.4.12 A review of BGS historical borehole records has been undertaken and of the records available within the Zone of Influence, no observations on groundwater strike and resting levels have been recorded.

5.4.13 Groundwater strikes encountered during the drilling of the boreholes as part of the preliminary ground investigation undertaken at the TPLs in Route Section 3 are recorded on the borehole log records which are included within the preliminary ground investigation report for the underground DC cable route (Ref: 7-33) . The records show that groundwater was generally struck between 0.40 m bgl to 1.30 m bgl located within the Possible Head Deposits/Possible Till (Boulder Clay)

(TPL 15), the Possible Marine and Estuarine Deposits (Tidal Flats) (TPL 16), the Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits) (TPL 17, TPL 18) and the River Terrace Deposits (TPL 19).

5.4.14 Based on the first groundwater monitoring event (undertaken between 8th May 2017 and 23rd May 2017) of a one year long groundwater monitoring and sampling programme, the groundwater level within borehole monitoring wells at TPL 16 to TPL 18 and TPL 19 (north bank) was found to be resting between 0.90 m bgl (BH011, TPL 16) and 1.45 m bgl (BH10 (TPL17). Adjacent to the northern bank of the River Witham groundwater level was resting at 1.14 m bgl.

Groundwater Abstractions

5.4.15 The Route Section 3 Zone of Influence is not located within a groundwater SPZ (Ref: 7-41).

5.4.16 The EA was contacted in October 2016 and responded in November 2016 regarding a data request for private and commercial groundwater abstractions within the Route Section 3 Zone of Influence (Ref: 7-43). In addition, a request was made for information on private groundwater abstraction licenses to ELDC and BBC in September 2016 and a response was provided in December 2016 and September (Ref: 7-44). The information provided by the EA and ELDC together with data on licenced groundwater abstractions presented within the Envirocheck® Report (Ref: 7-39) are summarised in Table 7.32.

Table 7.32 Route Section 3: groundwater abstraction summary

Licence No.	Well name/ location	Abstraction strata	Abstraction description	Distance/direction
4/30/13/*G/0132	A E Lenton (Farms) Ltd, Friskney	Not stated	Spray irrigation – direct	270 m west of centre line 220 m west of LoD

5.4.17 Based on the mapped geology it is likely that this licenced abstraction is abstracting from a shallow well within river or Glaciofluvial Deposits which are indicated across the area of the abstraction.

Groundwater Flooding

5.4.18 The BGS Groundwater Flooding Susceptibility map provided in the Landmark Envirocheck® Report (Ref: 7-39) shows that in the eastern part of Route Section 3 (between East Keal and south of East Kirkby) the potential exists for groundwater flooding to occur. The map also shows a localised potential for groundwater flooding of properties situated below ground level in this area. Moving west through the remainder of Route Section 3, no risk from groundwater flooding is mapped.

5.4.19 The ELDC Strategic Flood Risk Assessment dated 2017 (Ref: 7-45) makes no specific reference to the District being at risk from groundwater flooding. The BBC Strategic Flood Risk Assessment dated 2010 also states that flooding from groundwater is of no relevance in the Boston area (AECOM, 2010) (Ref: 7-52).

5.4.20 The Water Resources and Hydrology assessment presented in *ES-2-B.04, Volume 2, Chapter 8* concludes that there is a medium potential for groundwater flooding within this route section.

Groundwater Sensitivity

5.4.21 Groundwater sensitivity is considered based on the aquifer designation and its resource value as defined by the methodology. The groundwater within Route Section 3 is considered to be of **negligible** sensitivity for the majority of the proposed DC cable route and **medium** sensitivity in the area of the Secondary A Aquifer (approximately 1 km off the route) located north west of New Bolingbroke. In addition, groundwater within the sands and gravels associated with the MSA and the River Terrace Deposits within the vicinity of the River Witham is also considered to be of **medium** sensitivity.

Underground Structures

5.4.22 Based on a review of underground assets information provided in the Atkins utility search report (Ref: 7-46) and the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1, a summary of the relevant assets identified within the Zone of Influence is provided in Table 7.33.

Table 7.33 Route Section 3: summary of underground assets

Asset type	No. of utilities within LoD	No. utilities within 250 m of LoD
Western Power Distribution cable	3	14
Bluefield Services cable	1	-
Openreach British Telecommunications cable	9	7
Anglian Water pipe	13	5

5.4.23 In addition to the stated underground utilities, the potential also exists for a network of agricultural land drains relating to the agricultural fields, crossing and adjacent to the proposed DC cable route.

Unexploded Ordnance Potential

5.4.24 The Zetica UXO desk study assessment identified that there is a high risk of UXO potential in the eastern extent of Route Section 3 associated with a former military airfield (RAF East Kirkby)

(Ref: 7-47). The River Witham is deemed as low risk UXO potential based on its designation as a "Stopline" in World War II). A subsequent UXO risk assessment carried out by Zetica (Ref: 40-48) revealed that there was no evidence of heavy bombing raids having occurred at RAF East Kirkby and the site was not considered to be a significant source of UXO hazard. The assessment did note that in 1945 an aircraft crashed into the bomb stores resulting in several high explosive bombs being detonated. The potential for small arms ammunition associated with the airfield site is highlighted. This desk study report and the subsequent risk assessment report are included as Appendix 7.5 in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology*.

Soil and Groundwater Contamination Potential

Historical Land Use

5.4.25 Historical OS maps supplied as part of the Landmark Envirocheck® Report (Ref: 7-39) have been reviewed in order to identify potentially contaminative historical land uses.

5.4.26 Agricultural land has dominated within this route section. A large airfield at East Kirkby was first indicated on mapping from 1956. However, the UXO desk study report (Ref: 7-47) identifies this as the former RAF East Kirkby and states that it was commissioned in 1941 and opened in August 1943 during World War II. It was jointly used by the RAF and the United States Air Force until 1958 when the ownership of the base returned to the RAF and it was then subsequently closed. The airfield is now an aviation museum. The eastern extent of the airfield encroaches to within the LoD and proposed DC cable route alignment in four approximate areas; presented from north to south:

- Eastings: 536010 and Northings: 361965;
- Eastings: 535713 and Northings: 361883 to Eastings: 535133 and Northings: 361539;
- Eastings: 534835 and Northings: 361134 to Eastings: 534554 and Northings: 360654; and
- Eastings: 534131 and Northings: 360342.

5.4.27 There are two former railway lines which crossed Route Section 3. The first was located between New Bollingbrook and Stickney and was a railway between 1951 and 1980. After this date is was labelled as dismantled. The second "dismantled railway" is located parallel and adjacent (north) to the River Witham.

5.4.28 Within the Zone of Influence there was a "Smithy" (metal works or forge) located at the corner of Carrington Road (B1183) and Northlands (road) until 1979.

Current Land Uses

5.4.29 Current OS mapping and aerial imagery (Ref: 7-49) have been reviewed in order to identify the present land use within the Route Section 3 Zone of Influence.

5.4.30 The route currently comprises agricultural land. The route crosses four main roads (Main Road, Carrington Road, Westville Road and Ferry Road) as well as three main rivers as defined by the

EA/Landmark Envirocheck® Report (Ref: 7-39) (Hagnaby Beck, West Fen Catchwater (both drains) and the River Witham).

5.4.31 The small settlements of East Keal, West Keal and Hagnaby Lock are located on the margins of the Route Section 3 Zone of Influence although no buildings are located within the proposed DC cable LoD. A limited number of isolated residential properties (closest 30 m south of the central alignment, off Leagate Road) and farm buildings (closest 65 m west of the central alignment, off Hagnaby Road, to the south of the Lincolnshire Aviation Heritage Centre (to the east of East Kirkby) are present adjacent to the LoD. In addition, a single concrete runway associated with the Lincolnshire Aviation Heritage Centre (to the east of East Kirkby) is situated approximately 295 m north of the central alignment at its closest point. One associated taxi-ways is located approximately 70 m north of the LoD.

Regulated Activities and Data

5.4.32 The Landmark Envirocheck® Report (Ref: 7-39) identifies five discharge consents within the Route Section 3 Zone of Influence (including one 25 m from the LoD (70 m west from the central alignment), and one 15 m south from the LoD, 45 m from the central alignment). These discharges are recorded as relating to treated sewage effluent and unknown discharges onto land and into freshwater streams (two discharges relating to treated sewage).

5.4.33 The Landmark Envirocheck® Report records the following two pollution incidents to controlled waters within the Route Section 3:

- 40 m north of the proposed cable route LoD (near Folly Lane): Category 3 (Minor Incident), agricultural (slurry/animal waste) pollutants released into a tributary of the Medlam Drain; and
- 60 m north of the proposed cable route LoD (near Folly Lane): Category 3 (Minor Incident), agricultural (slurry/animal waste) pollutant spill/leak into a tributary of the Medlam Drain.

5.4.34 According to the Envirocheck® Report there is one IPPC process within the Route Section 3 Zone of Influence. This relates to a farm building operated by F and H Panton Bros located south of Hagnaby Lane, East Kirkby, approximately at the LoD west of the proposed DC cable route central alignment (at its closest point). There are no hazardous substance consents or fuel station entries located within the Route Section 3 Zone of Influence (Ref: 7-39).

5.4.35 The EA published landfill mapping does not identify any historic or current landfill sites on, or within, the Route Section 3 Zone of Influence (Ref: 7-41).

5.4.36 According to the Envirocheck® Report there are no licensed waste management facilities within the Route Section 3 Zone of Influence. In addition, there are no current or preferred waste management sites identified in the '*Lincolnshire County Minerals and Waste Local Plan*' (Ref: 7-19) within the Route Section 3 Zone of Influence.

5.4.37 There are no areas within or adjacent to the Route Section 3 Zone of Influence that are classified as 'Contaminated Land' under Part 2a of the Environmental Protection Act 1990 (Ref: 7-06).

Ground Investigation – Soil and Groundwater Chemical Analysis

5.4.38 The findings of the preliminary ground investigation undertaken along the proposed DC cable route are included within *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* Appendix 7.2. To provide some context to the measured concentrations within the soils sampled as part of the proposed DC cable route ground investigation, a contamination assessment in the form of a GQRA was undertaken by AECOM (Ref: 7-33).

5.4.39 A summary of the sampling completed to date for Route Section 3 is as follows:

- A total of 12 soil samples (two samples each from TPL 15, 16, 17, 19 and four samples from TPL 18) were obtained from within Route Section 3. Samples were taken from a depth range of 0.10 m bgl to 3.0 m bgl and were analysed for a similar range of determinands to those described in Route Section 1 and 2;
- Five soil samples from between 0.30 m bgl and 0.50 m bgl were submitted for soil leachate testing for a similar range of determinands to those described in Route Section 1 and 2;

5.4.40 Groundwater from borehole locations associated with the proposed DC cable route and landfall is currently being monitored (including for the recovery of groundwater samples on two occasions) as part of a year-long groundwater level monitoring programme. An interim monitoring report will be produced in November 2017, with a final report in May 2018. This programme of groundwater quality monitoring will further serve to establish pre-construction baseline conditions against which future construction and post construction monitoring can be compared against.

5.4.41 The assessment of soil samples recovered from the ground investigations has been based on screening maximum reported concentrations for a range of determinands against soil GAC. The GAC adopted are designed to be protective of a residential with plant uptake end use. In isolated cases reference was made to other default land uses and their GAC (e.g. parks or commercial) to further place into context any exceedances against the residential GAC. This approach was considered to be conservative given that post construction, the land will be returned to its current use (Ref: 7-33). The soil leachate results were screened against EQS and DWS to be both protective of the environment and also drinking water supplies.

5.4.42 Based on the results of the human health assessment, AECOM concluded that as all of the determinands tested were found to be below the adopted screening criteria there was no appreciable significant risk from the soil samples tested within Route Section 3 (TPL 15 to TPL 19) to human health (Ref: 7-33).

5.4.43 Based on the controlled waters assessment it was concluded that the existing soil conditions were broadly consistent with natural background concentrations. Some leachable metal and inorganic determinand concentrations, whilst elevated against their adopted GAC for risk to controlled waters, were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area. Although groundwater flow through the Secondary A aquifers can act as a pathway to any soil leachate migration into groundwater, given the concentrations recorded there is not considered to be a

significant risk to surface water quality or the nearest groundwater abstractions currently, during or post construction of the proposed DC cable route from the existing soils sampled.

Conceptual Site Model

Receptors to Soil and Groundwater Contamination - Groundwater

5.4.44 The majority of the Route Section 3 is underlain by superficial geology classified as Secondary Undifferentiated (Till (Boulder Clay)) and Unproductive strata (Barroway Drove Beds). A localised area in the eastern part of the proposed DC cable route (east of Stickford and north west of New Bolingbroke) and approximately 1 km in length, is mapped to be underlain by River and Glaciofluvial Deposits which are classified as a Secondary A Aquifer. Sands and gravels are also present associated with the MSA and the area surrounding the River Witham and these deposits are likely to have similar hydrogeological characteristics. The only abstraction, identified approximately 220 m west of the LoD, is believed to be abstracting from the Secondary A aquifer. The solid geology is classified as Unproductive strata throughout the Zone of Influence.

Receptors to Soil and Groundwater Contamination - Water Resources and Hydrology

5.4.45 A summary of potential hydrological receptors identified within the Route Section 3 Zone of Influence is presented in Table 7.34 below based on data provided in the Envirocheck® Report (Ref: 7-38), data provided by the EA (Ref: 7-42) and the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The Proposed Underground DC Cable* as Appendix 5.1. Further details are presented in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology.*

Table 7.34 Route Section 3: Summary of watercourse crossings

Watercourse type	Notable crossings	No. of crossings
Main River	Hagnaby Beck, West Fen Catchwater Drain and River Witham	3
IDB Maintained watercourse	Twenty Foot Drain, Mavis Enderby, Twelve Foot Drain, Hornbuckels, West Fen Drain, Medlam Drain, Newham Drain, Castle Dyke Drain, Cut Dyke Drain and Black Dyke, Carrington Road Drain, Legate Road Drain	13
Minor Field Drains	Unnamed	30

5.4.46 The Route Section 3 proposed DC cable route crosses three main rivers; the Hagnaby Beck, West Fen Catchwater, Twenty Foot Drain, West Fen Drain and the River Witham. In addition, the proposed DC cable route crosses fourteen maintained drains and thirty smaller drains dividing agricultural field boundaries.

Receptors to Soil and Groundwater Contamination - Sensitive Sites

5.4.47 A summary of designated environmentally sensitive receptors identified within the proposed DC cable route (Route Section 3) Zone of Influence is provided below and further details a presented in *ES-2-B.06, Volume 2, Chapter 10: Ecology*:

- 2 No. Statutory non-designated sites: Braygate SNCI and Hagnaby Lock Nature Reserve.

Receptors to Soil and Groundwater Contamination - Human Receptors

5.4.48 Potential human receptors identified within the Route Section 3 Zone of Influence are summarised as follows:

- Residential properties, closest located adjacent to the LoD approximately 30 m south of the proposed DC cable route central alignment, off Leagate Road;
- Farm buildings, with the closest located approximately 65 m west of the proposed DC cable route central alignment, off Hagnaby Road; and
- Potential farm workers associated with the agricultural fields adjacent to the proposed DC cable route.

Receptors to Soil and Groundwater Contamination - Buildings and Infrastructure

5.4.49 The closest building to the Route Section 3 proposed DC cable route is approximately 30 m south of the central alignment. Depending on the ground conditions and route alignment adopted there may be a requirement to provide temporary support for the trench sides.

Potential Receptors Summary

5.4.50 The site-specific receptors were identified based on the proposed land-use as well as the environmental setting of the Route Section 3 Zone of Influence. Table 7.35 presents the identified potentially sensitive receptors that will be considered within the geology and hydrogeology assessment.

Table 7.35 Route Section 3: summary of potentially sensitive receptors

Identified receptor	Receptor sensitivity
Human health - Contractors carrying out construction works.	Very High
Human health - Agricultural and employment activity within 250 m of proposed construction works.	Low
Human health - Neighbouring residential properties.	Very High
Groundwater - Unproductive Strata (Marine and Estuarine Deposits including the Barroway Drove Beds and Kimmeridge Clay) and Secondary Undifferentiated (Till(Boulder Clay)).	Negligible
Groundwater - Secondary A Aquifer (River and Glaciofluvial Deposits) and	Medium

Table 7.35 Route Section 3: summary of potentially sensitive receptors	
Identified receptor	**Receptor sensitivity**
abstraction identified 220 m west of LoD.	
Surface water features - Hagnaby Beck, West Fen Catchwater Drain and River Witham.	Very High
Surface water features - Twenty Foot Drain, West Fen Drain, Medlam Drain, Newham Drain, Castle Dyke Drain, Cut Dyke Drain and Black Dyke, Mavis Enderby, Twelve Foot Drain, Hornbuckels, Carrington Road Drain, Legate Road Drain and other unnamed drains crossed or adjacent to the proposed DC cable route.	High

Potential Sources of Contamination

5.4.51 Based on the historical and current land uses within Route Section 3, no significant potential sources of soil contamination have been identified. The potential to encounter contaminated ground within the former RAF East Kirkby military airfield from operations conducted here historically are considered to be generally low since the former runway and taxiways and hangers are some distance from the LoD. It has also been considered that any impacted ground e.g. fuel spillages to ground in the area of the airport would likely have restricted mobility in the ground due to the presence of low permeability Till (Boulder Clay) in the area of the former airfield. The potential for localised impacts to have occurred throughout the airfield, for example, from airfield accidents, cannot be entirely ruled out though. A low risk of UXO potential has been identified by Zetica (Ref: 7-48).

Potential Pathways

5.4.52 The human health exposure pathways that are considered viable based on the proposed land use and UK guidance are listed below:

- Dermal contact with soil, dust and groundwater;
- Ingestion of soil, dust and groundwater;
- Inhalation of dust;
- Inhalation of vapours (from soils and groundwater); and
- Inhalation of ground-gas in confined spaces.

5.4.53 The controlled waters pathways considered viable are as follows:

- Vertical and lateral migration of leachate through the unsaturated soils to groundwater;
- Vertical and lateral groundwater migration; and
- Surface water run-off.

Conceptual Site Model Summary

5.4.54 In the absence of any significant sources of soil and/or groundwater contamination, there are not perceived to be any significant soil or groundwater contamination risks associated with the baseline conditions that might significantly impact upon future development.

5.5 Route Section 4 River Witham to the Proposed Converter Station

Geological Setting and Sensitivity

Published Geology

5.5.1 The solid geology throughout this section comprises Jurassic age easterly dipping mudstones, sandstones and siltstones of the Ancholme Group that increase in age moving west and south west. The succession includes the Ampthill Clay Formation in the north east, the West Walton Formation from an area south of the South Forty Drain, and the Oxford Clay Formation at the south western limits of the route section.

5.5.2 The superficial geology is dominated by a continuation of the Barroway Drove Beds (Marine Deposits/Tidal Flat Deposits) overlying Till (Boulder Clay) throughout the full extent of the route section. Palaeochannels have been recorded in the literature around the River Witham representing part of former estuarine creek systems (Ref: 7-51). Within these areas localised increased depths of deposited silt, sands and gravels exist cut into the underlying Till (Boulder Clay).

5.5.3 Within the Route Section 4 Zone of Influence there are only two publically available historical BGS borehole records. These are tabulated and summarised in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.2. The BGS records support the published geology indicating up to a 4.7 m thickness of marine and estuarine deposits overlying Till (Boulder Clay) that was proven to at least 12 m depth.

Ground Investigation– the Proposed DC Cable Route

5.5.4 The aforementioned preliminary ground investigation that was undertaken between January and March 2017 at selected locations along the proposed DC cable route included the following TPL within Route Section 4:

- TPL 19: River Witham (south bank);
- TPL 20: Clay Dike and Clay Dike Bank Road;
- TPL 21: Skerth Drain, West Skerth Soak Dike, and East Skerth DIke;
- TPL 24: Gas pipeline, railway line (Grantham to Skegness line) and Great Hale Eau; and
- TPL 25: South Forty Foot Drain.

5.5.5 The Preliminary Ground Investigation Report (Ref: 7-33) is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.3. More detail on the ground conditions can be found by referring to the TPL specific technical appendix contained in Appendix A of the Preliminary Ground Investigation Report (Ref: 7-33).

5.5.6 The sequence of strata encountered, which is summarised on Table 7.36, generally supports the published geology. The Barroway Drove Beds (Marine Deposits/Tidal Flat Deposits) were encountered within each of the TPL within Route Section 4. Similarly, Till (Boulder Clay) was encountered except at TPL 19 (River Witham – south bank) where River Terrace Deposits (from former river courses and the current River Witham) appear to have cut a channel into the Till (Boulder Clay) and underlying bedrock geology. River Terrace Deposits associated with palaeochannels were also encountered at TPL 21. The solid geology of the Ancholme Group was encountered at each TPL within Route Section 4.

Table 7.36 Route Section 4: summary of ground conditions encountered at TPL

Strata	Name [2]	Route section	TPL encountered	Depth range to top (m bgl)	Proven thickness (m)
Made Ground [1]	-	4	TPL 21	0.0	1.0
Natural Superficial Deposits	Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits) [3, 4]	4	TPL 19, 20, 21, 24, 25	0.0 to 1.0	0.9 to 3.9
	River Terrace Deposits [5, 6]	4	TPL 19, 21	1.25 to 1.9	7.45 to 17.85
	Till (Boulder Clay)	4	TPL 20, 21, 24, 25	2.6 to 9.35	5.7 to 11.5
Solid Geology	Ampthill Clay Formation (Ancholme Group)	4	TPL 19, 20, 21	15.05 to 19.1	1.25 [7] to 4.55 [7]
	West Walton Formation (Ancholme Group)	4	TPL 24	13.4	6.84 [7]
	Oxford Clay Formation (Ancholme Group)	4	TPL 25	11.9 to 14.1	6.16 [7] to 8.32 [7]

TPL 19 included borehole BH007;

TPL 20 included borehole BH006;

TPL 21 included borehole BH005;

TPL 24 included borehole BH003;

TPL 25 included borehole BH002 and BH001;

1 - Made Ground is defined as material that contained anthropogenic material or where it is underlain by material that contained anthropogenic material;

2 - Interpretation based on published geology and the recorded field observations;

3 - Where no Made Ground is encountered at the surface it is acknowledged that the upper most section of the natural deposits will have been subject to potential reworking/soil structure improvements including the addition of nutrients as part of general agricultural practice;

4 - Based on the lithology recorded it is possible that the upper parts of these deposits may be more alluvial in origin;

5 - River Terrace Deposits potentially from former river courses, together with more recent deposits associated with the River Witham;

6 - Suspected palaeochannel formed from former estuarine creek systems (TPL 21); and

7 - Not fully penetrated.

Geotechnical Hazards

5.5.7 Table 7.37 summarises the potential geotechnical hazards identified within the Route Section 4 Zone of Influence from the Landmark Envirocheck® Report (Ref: 7-39).

Table 7.37 Route Section 4: potential geotechnical hazards

Hazard type	Receptor hazard potential range (where applicable)
Non coal mining areas	No hazard
Potential for collapsible ground stability hazards	No hazard
Compressible ground stability	Moderate
Ground dissolution stability	No hazard
Landslide ground stability	Very low
Running sand ground stability	Moderate
Shrinking or swelling clay ground stability	Low
Radon affected areas	No, as less than 1% of homes are above action level

Geological Designations

5.5.8 There are no LGS or geologically designated SSSI present within the Route Section 4 Zone of Influence (Ref: 7-30).

Mineral Sites and Designations

5.5.9 There are no former/current mineral extraction sites, MCA or MSA at, or within close proximity, to the Section 4 Zone of Influence (Ref: 7-19, 7-30 and 7-40).

Hydrogeological Setting and Sensitivity

Aquifer Designations

5.5.10 The aquifer classifications identified for the formations described above are presented in Table 7.38 and 7.39 (Ref: 7-41).

Table 7.38 Route Section 4: solid geology aquifer classification

Formation name	Aquifer designation
Ampthill Clay Formation, West Walton Formation, and Oxford Clay Formation	Unproductive strata

Table 7.39 Route Section 4: superficial geology aquifer classification

Name	Aquifer designation
Till (Boulder Clay)	Secondary Undifferentiated
Marine and Estuarine Deposits (including Barroway Drove Beds)	Unproductive strata
River and Glaciofluvial Deposits (Sand and Gravel)[1]	Secondary A

1 – Not mapped to be present but based on ground conditions encountered.

Groundwater Levels

5.5.11 The EA were contacted in March and November 2016 to request data on groundwater levels within the proposed DC cable route Zone of Influence. Of the data provided by the EA; none was found to fall within the Zone of Influence (Ref: 7-42 and 7-43).

5.5.12 A review of BGS historical borehole records has been undertaken and of the records available within the Zone of Influence, groundwater levels appear to reside predominantly within the Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits) at the transition with the Till (Boulder Clay) between 1.52 m bgl and 3.96 m bgl.

5.5.13 Groundwater strikes encountered during drilling of the boreholes for the preliminary ground investigation undertaken at the TPL in Route Section 4 are recorded on the borehole log records included within the preliminary ground investigation report for the underground DC cable route (Ref: 7-33). The records show that groundwater was generally struck between 1.2 m bgl to 2.0 m bgl (rising to between 1.1 m bgl and 1.95 m bgl), where encountered. At TPL 20 and TPL 21 groundwater was not struck prior to use of drilling flush during the drilling of BH006 and BH005 respectively. With exception to the groundwater strike recorded from BH007 (TPL 19) the groundwater strikes were all recorded to be at a level within the Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits). At TPL 19, the groundwater strike was within the River Terrace Deposits.

5.5.14 Based on the first groundwater monitoring event (undertaken between 8th May 2017 and 12th May 2017) of a one year long groundwater monitoring and sampling programme, the

groundwater level within borehole monitoring wells at TPL 19 (south bank), TPL 20, TPL 21, TPL 24 and TPL 25 was found to be resting between 1.13 m (BH006, TPL 20) and 1.98 m bgl (BH003, TPL24). Adjacent to the River Witham's southern bank, the groundwater level was recorded to be resting at 1.95 m bgl.

Groundwater Abstractions

5.5.15 The Route Section 4 Zone of Influence is not located within a groundwater SPZ (Ref: 7-41).

5.5.16 The EA was contacted in October 2016 and responded in November 2016 regarding a data request for private and commercial groundwater abstractions within the Route Section 4 Zone of Influence (Ref: 7-43). In addition, a request was made for information on private groundwater abstraction licenses to BBC, NKDC and SHDC in September 2016 and a response was provided in September 2016 from BBC and NKDC (Ref: 7-44) and October 2016 (Ref 7-44). The information provided by the EA and the Local Authorities, together with data on licenced groundwater abstractions within the Envirocheck® Report (Ref: 7-39) showed that there are currently no private or commercial groundwater abstraction licences within the Route Section 4 Zone of Influence.

Groundwater Flooding

5.5.17 The BGS Groundwater Flooding Susceptibility map provided in the Landmark Envirocheck® Report shows that the Zone of Influence is not in an area at risk from groundwater flooding (Ref: 7-39). In addition, Section 8.3 of the SHDC Strategic Flood Risk Assessment dated 2010 states that "There are no reports of groundwater flooding occurring in the District. This issue is therefore taken as having no strategic significance in relation to flood risk" (Ref: 7-53). The BBC Strategic Flood Risk Assessment dated 2010 (Ref: 7-52) also states that flooding from groundwater is of no relevance in the Boston area. The NKDC Strategic Flood Risk Assessment dated 2008 also confirms that groundwater flooding is not a significant concern for the district (Ref: 7-54).

5.5.18 The Water Resources and Hydrology assessment presented in ES-2-B.04, Volume 2, Chapter 8 concludes that there is a medium potential for groundwater flooding within this route section.

Groundwater Sensitivity

5.5.19 Groundwater sensitivity is considered based on the aquifer designation and its resource value as defined by the methodology. The groundwater within Route Section 4 is considered to be of **negligible** sensitivity. No groundwater abstractions have been identified.

Underground Structures

5.5.20 Based on a review of underground assets information provided in the Atkins utility search report (Ref: 7-46) and the Crossing Schedule presented in *ES-2-B.01 Volume 4, Chapter 5 The*

Proposed Underground DC Cable as Appendix 5.1, a summary of the underground assets identified within 250 m of the Route Section 4 LoD are summarised in Table 7.40.

Table 7.40 Route Section 4: underground assets summary

Asset type	No. of utilities within LoD	No. utilities within 250 m of LoD
Western Power Distribution cable	1	1
Openreach British Telecommunications cable	9	4
Anglian Water pipe	11	2
National Grid Gas	1	0

5.5.21 In addition to the stated underground utilities, the potential also exists for a network of agricultural land drains relating to the agricultural fields, crossing and adjacent to the proposed DC cable route.

Unexploded Ordnance Potential

5.5.22 The Zetica UXO desk study assessment (Ref: 7-47) and subsequent risk assessment (Ref: 7-48) identified that there is no evidence of significant UXO potential within the Route Section 4 Zone of Influence. The desk study report and the risk assessment report are included as Appendix 7.5 in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology*.

Soil and Groundwater Contamination Potential

Historical Land Use

5.5.23 Historical OS maps supplied as part of the Landmark Envirocheck® Report (Ref: 7-39) have been reviewed in order to identify potentially contaminative historical land uses.

5.5.24 Within the Route Section 4 Zone of Influence, a small sewage works is shown approximately 5 m to the south of the proposed DC cable route LoD and 150 m north of Amber Hill/Old Amber Hill from the 1980 historical mapping to the present day.

5.5.25 Other notable land uses include a “smithy” (forge/metal works) which is indicated 55 m west of the LoD, 1 km north west of Swineshead Bridge and a railway (shown as the “Great North Railway” and the current Grantham to Skegness line). The railway is situated approximately 1.9 km to the south-west of Swineshead Bridge at which point the proposed DC cable route crosses it. The railway has been indicated to be present since 1888 to the present day. The dominant land use within Section 4, historically and currently, has been agriculture.

Current Land Uses

5.5.26 Current OS mapping and aerial imagery (Ref: 7-49) have been reviewed, together with site inspections, in order to identify the present land use within the Route Section 4 Zone of Influence.

5.5.27 The route section predominantly crosses agricultural land. The route crosses one main road (Station Road), a railway track (Grantham to Skegness line), as well as two main rivers (as defined by the EA/Landmark Envirocheck® (Holland Dike and the South Forty Foot Drain). The South Forty Foot Drain runs parallel to the western part of Route Section 4 for approximately 3.5 km (55 m east at its closest point to the LoD).

5.5.28 The closest settlement is Amber Hill located approximately 165 m south of the eastern part of the LoD. A limited number of isolated residential properties are present, with the closest located residential building approximately 150 m from the proposed DC cable route central alignment, and located on the North Forty Foot Bank (road). Farm buildings are also present with the closest located adjacent to the LoD, 40 m west of the proposed DC cable route central alignment, north of the A17 between East Heckington and Swineshead Bridge. A residential property is also associated with this plot, with the building located 165 m to the west of the cable route centre alignment. A small domestic sewage works (possible pumping station) is also present 5 m south of the LoD positioned at the end of a track running north from Amber Hill. This was also shown on historical mapping from 1980.

Regulated Activities and Data

5.5.29 The Landmark Envirocheck® Report (Ref: 7-39) has identified nine discharge consents within the Route Section 4 Zone of Influence (from 30 m of the central alignment within the LoD up to 230 m from the LoD). These discharges are recorded as relating to treated sewage effluent and unknown discharges onto land and into freshwater streams (four discharges relate to treated sewage).

5.5.30 The Landmark Envirocheck® Report records no pollution incidents to controlled water within the Route Section 4 Zone of Influence.

5.5.31 There are no IPPC processes, hazardous substance consents or fuel station entries located within the Route Section 4 Zone of Influence (Ref: 7-39).

5.5.32 The EA published landfill mapping does not identify any historic or current landfill sites on, or within the Route Section 4 Zone of Influence (Ref: 7-41).

5.5.33 According to the Envirocheck® Report there are no licensed waste management facilities within the Route Section 4 Zone of Influence. In addition, there are no current or preferred waste management sites identified in the Lincolnshire County Council Minerals and Waste Local Plan (Ref: 7-19) within the Route Section 4 Zone of Influence.

5.5.34 There are no areas within or adjacent to the Route Section 4 Zone of Influence that are classified as ‘Contaminated Land’ under Part 2a of the Environmental Protection Act 1990 (Ref: 7-06).

Ground Investigation – Soil Chemical Analysis

5.5.35 The findings of the preliminary ground investigation undertaken along the proposed DC cable route are included within *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* Appendix 7.2. To provide some context to the measured concentrations within the soils sampled as part of the proposed DC cable route ground investigation, a contamination assessment in the form of a GQRA was undertaken by AECOM (Ref: 7-33).

5.5.36 A summary of the sampling completed to date for Route Section 4 is as follows:

- A total of 10 soil samples (two samples each from TPL 20, 21, 24, one sample from TPL 19 and three samples from TPL 25) were obtained from soils located within Route Section 4. Samples were taken from a depth range of 0.10 m bgl to 3.1 m bgl and were analysed for a similar range of determinands to those described within Route Sections 1, 2 and 3; and
- Three soil samples from between 0.10 m bgl and 0.50 m bgl were submitted for soil leachate testing for a similar range of determinands to those described within Route Section 1, 2 and 3.

5.5.37 Groundwater from borehole locations associated with the proposed DC cable route and landfall is currently being monitored (including for the recovery of groundwater samples on two occasions) as part of a year-long groundwater level monitoring programme. An interim monitoring report will be produced in November 2017, with a final report in May 2018. This programme of groundwater quality monitoring will further serve to establish pre-construction baseline conditions against which future construction and post construction monitoring can be compared against.

5.5.38 The assessment of soil samples recovered from the ground investigations has been based on screening maximum reported concentrations for a range of determinands against soil GAC. The GAC adopted are designed to be protective of a residential with plant uptake end use. In isolated cases reference was made to other default land uses and their GAC (e.g. parks or commercial) to further place into context any exceedances against the residential GAC. This approach was considered to be conservative given that post construction, the land will be returned to its current use (Ref: 7-33). The soil leachate results were screened against EQS and DWS to be both protective of the environment and also drinking water supplies.

5.5.39 Based on the results of the human health assessment, AECOM concluded that as all of the determinands tested were found to be below the adopted screening criteria there was no appreciable significant risk from the soil samples tested within Route Section 3 (TPL 19 to TPL 21 and TPL 24 to TPL 25) to human health (Ref: 7-33).

5.5.40 Based on the controlled waters assessment it was concluded that the existing soil conditions were broadly consistent with natural background concentrations. Some leachable metal and inorganic determinand concentrations, whilst elevated against their adopted GAC for risk to controlled waters, were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area. Although groundwater flow through the Secondary A aquifers can act as a pathway to any soil leachate migration into groundwater, given the concentrations recorded there is not considered to be a

significant risk to surface water quality or the nearest groundwater abstractions currently, during or post construction of the proposed DC cable route from the existing soils sampled.

Conceptual Site Model

Receptors to Soil and Groundwater Contamination - Groundwater

5.5.41 The superficial geology underlying the Route Section 4 Zone of Influence is classified as Unproductive (Barroway Drove Beds (Marine Deposits/Tidal Creek Deposits)) and Secondary Undifferentiated (Till (Boulder Clay)) by the EA. The solid geology is classified as Unproductive (Ampthill Clay Formation, West Walton Formation, and Oxford Clay Formation). There are currently no private or commercial groundwater abstraction licences within the Zone of Influence. Localised areas of deep granular deposits around the River Witham (TPL 19) and TPL 21 have been identified which are considered to be palaeochannels. These strata are likely to be water bearing and in the wider area are Secondary A designated aquifers.

Receptors to Soil and Groundwater Contamination - Water Resources and Hydrology

5.5.42 A summary of potential hydrological receptors identified within the Route Section 4 Zone of Influence is presented in Table 7.41 below based on data provided in the Envirocheck® Report (Ref: 7-39) and data provided by the EA (Ref: 7-41). Further details are presented in *ES-2-B.03, Volume 2, Chapter 8: Water Resources & Hydrology.*

Table 7.41 Route Section 4: summary of watercourse crossings

Watercourse type	Notable crossings	No. of crossings
Main River	South Forty Foot Drain, Skerth Drain	2
IDB Maintained Watercourse	North Forty Foot , Gill Syke, Ten Foot Drain, Clay Dike, East and West Skerth Soak Dikes, Labour In Vain Drain, Great Hale Eau, Mill Drain	11
Minor Field Drains	Unnamed	22

5.5.43 The proposed DC cable route crosses two main rivers as defined by the EA/Landmark Envirocheck®; the South Forty Foot Drain and the Skerth Drain. In addition, the proposed DC cable route crosses eleven IDB maintained drains and twenty-two smaller drains dividing agricultural field boundaries. The South Forty Foot Drain runs parallel to the southern part of proposed cable route (70 m east of the LoD at its closest point). In the central area, a tributary of the Holland Dike and an IDB Drain which flows into the West Skerth Dike runs parallel to the proposed DC cable route (approximately 100 m to 130 m west and 25 m to 70 m east from the cable central alignment respectively).

Receptors to Soil and Groundwater Contamination - Sensitive Sites

5.5.44 A summary of designated environmentally sensitive receptors identified within the proposed DC cable route (Route Section 4) Zone of Influence is provided below and further details a presented in *ES-2-B.06, Volume 2, Chapter 10: Ecology*.

- 3 No. Statutory non-designated sites: including Great Hale Eau LWS, Old Forty Foot Drain to South Forty Foot Drain LWS, and South Forty Foot Drain LWS.

Receptors to Soil and Groundwater Contamination - Human Receptors

5.5.45 Potential human receptors identified within the Route Section 4 Zone of Influence are summarised as follows:

- Residential properties; with the closest two located to the north west and adjacent east of the proposed DC cable route LoD, on the North Forty Foot Bank (road) and north of the A17 respectively;
- Farm buildings; with the closest located adjacent to the LoD, 40 m west of the proposed DC cable route central alignment, north of the A17; and
- Potential farm workers associated with the agricultural fields adjacent to the proposed DC cable route.

Receptors to Soil and Groundwater Contamination - Buildings and Infrastructure

5.5.46 The closest building to the Route Section 4 proposed DC cable route is approximately 40 m west of the central alignment and adjacent to the LoD. Depending on the ground conditions and final alignment taken there may be a requirement to provide temporary support for the trench sides.

Potential Receptors Summary

5.5.47 The site-specific receptors were identified based on the proposed land-use as well as the environmental setting of Route Section 4. Table 7.42 presents the identified potentially sensitive receptors that will be considered within the geology and hydrogeology assessment.

Table 7.42 Route Section 4: summary of potentially sensitive receptors

Identified receptor	Receptor sensitivity
Human health – contractors carrying out construction works	Very High
Human health – Agricultural and employment activity within 250 m of proposed construction works.	Low
Human health – Neighbouring residential properties	High
Groundwater - Unproductive Strata (Ampthill Clay Formation, West Walton Formation, Oxford Clay Formation, Marine and Estuarine Deposits (including the Barroway Drove Beds)) and Secondary Undifferentiated (Till(Boulder Clay))	Negligible

Table 7.42 Route Section 4: summary of potentially sensitive receptors	
Identified receptor	**Receptor sensitivity**
Groundwater – Secondary A (River Terrace Deposits)	Medium
Surface water features – South Forty Foot Drain, Holland Dike	Very High
Surface water features - North Forty Foot , Gill Syke, Ten Foot Drain, Clay Dike, East and West Skerth Soak Dikes, Labour In Vain Drain, Great Hale Eau, Mill Drain and other unnamed drains crossed or adjacent to the proposed DC cable route.	High

Potential Sources of Contamination

5.5.48 Based on the historical and current land uses within the Route Section 4 Zone of Influence, no significant sources of soil or groundwater contamination have been identified. Risks associated with the small domestic sewage works are considered to be low given its scale and location beyond the LoD. No evidence of elevated UXO potential has been found within the Route Section 4 Zone of Influence.

Potential Pathways

5.5.49 The human health exposure pathways that are considered viable based on the proposed land use and UK guidance are listed below:

- Dermal contact with soil, dust and groundwater;
- Ingestion of soil, dust and groundwater;
- Inhalation of dust;
- Inhalation of vapours (from soils and groundwater); and
- Inhalation of ground-gas in confined spaces.

5.5.50 The controlled waters pathways considered viable are as follows:

- Vertical and lateral migration of leachate through the unsaturated soils to groundwater;
- Vertical and lateral groundwater migration; and
- Surface water run-off.

Conceptual Site Model Summary

5.5.51 In the absence of any significant sources of soil and/or groundwater contamination, there are not perceived to be any soil or groundwater contamination risks associated with the baseline conditions that might significantly impact upon future development.

5.6 Overall Summary of Receptor Sensitivity

5.6.1 Table 7.43 presents an overall summary of receptor sensitivity including receptors susceptible to impact from contamination, and receptors susceptible to potential physical impact from construction by way of derogation of a resource supply, or damage to a designated site.

Table 7.43 Overall summary of potentially sensitive receptors

Geological designated sites and groundwater resources					
Identified receptor		Route Section 1	Route Section 2	Route Section 3	Route Section 4
		Receptor sensitivity			
Ground Stability		Low	Low	Low	Low
Geological Designations		-	Low[2]	-	-
Mineral Sites and Designations		-	-	High	-
Groundwater Resources - abstractions from superficial aquifers	Unproductive	Medium[1]	-	-	-
	Secondary A	-	-	Medium[3]	-
Groundwater resources - abstractions from bedrock aquifers (including SPZ designations)	Unproductive	-	-	-	-
	Secondary A/B	-	-	-	-
	Principal	High[4]	High[5]	-	-
Receptors susceptible to/from soil and/or groundwater contamination					
Human health – contractors carrying out construction works (potential soil and groundwater contamination)		Very High	Very High	Very High	Very High
Human health – contractors carrying out construction works (where UXO risk potential identified)		-	-	Very High	-
Human health – agricultural and employment activity within 250 m of proposed construction works (potential soil and groundwater contamination)		Low	Low	Low	Low
Human health – Neighbouring residential properties (potential soil and groundwater contamination)		High	Very High	Very High	High
Human health – neighbouring residential and commercial properties		-	-	High	-

Table 7.43 Overall summary of potentially sensitive receptors					
Geological designated sites and groundwater resources					
Identified receptor		**Route Section 1**	**Route Section 2**	**Route Section 3**	**Route Section 4**
		Receptor sensitivity			
(where UXO risk potential identified)					
Groundwater sensitivity - superficial geology designations	Unproductive	Medium[7]	-	Negligible	Negligible
	Secondary Undifferentiated		Negligible		
	Secondary A	-	Medium	Medium[3]	Medium
Groundwater - bedrock geology designations (including SPZ)	Secondary A/B	-	Medium	-	-
	Principal	High[4]	High[5]	-	-
	Unproductive	-	Negligible	Negligible	Negligible
Surface water features – Main Rivers		Very High	Very High	Very High	Very High
Surface water features – IDB maintained and other unnamed drains crossed or adjacent to the proposed DC cable route.		High	-	High	High

1 - Providing a local source of groundwater for agricultural /domestic use at one property within LoD of Route Section 1 indicated to be from marine and estuarine deposits (Salt Marsh and Tidal Creek Deposits) (White Well, licence 4/29/15/*G/0028);

2 – Dalby Hill Chalk Quarry LGS at the LoD;

3 – Providing a local source of groundwater for agricultural use at one property 220 m west of LoD in Route Section 3 from a Secondary A superficial river and glaciofluvial aquifer, that does not extend under the LoD (Licence 4/30/13/*G/0132);

4 - Chalk aquifer confined and considered to be afforded a degree of protection by overlying superficial geology; and

5 – Providing a local source of groundwater for spray irrigation at one property 270 m west of LoD in Route Section 2 and inferred to be abstracting from Spilsby Sandstone for agricultural use (Licence 4/30/14/*g/127).

6 Potential Impacts

6.1 Overview of Potential Impacts

Temporary Impacts

6.1.1 A number of activities will occur at the site during the construction phase that have the potential to interact with the underlying Geology and Hydrogeology. These have been identified as:

- Topsoil and subsoil stripping;
- Excavations for proposed DC cable route using trenching and trenchless cable installation techniques;
- Dewatering of excavations;
- Installation of pre and post construction drainage;
- Excavated materials management and soil storage;
- Imported material for backfill of excavations; and
- Establishment of temporary construction compounds and the storage of hazardous materials within them for use in construction, e.g. fuels and oils.

Geological Setting

Materials Management

6.1.2 The construction of the proposed DC cable route, where in open cut, will require a single trench accommodating two DC cables as well as two fibre optic cables (one for each DC cable). Open cut installation will be adopted wherever feasible, but it is envisaged that the application of trenchless installation techniques (e.g. horizontal directional drilling (HDD), auger boring or micro boring) will be required in some locations, particularly where the proposed DC cable route crosses main rivers, rail and road infrastructure and IDB maintained drains.

6.1.3 There is expected to be a surplus of excavated materials following cable installation due to the use of cement bound sand as the founding bed, and surrounds, to the cables when laid in open cut, or from the generation of spoil from the installation of the cables using trenchless techniques. These materials will either need to be managed on site, managed off site or disposed of off-site.

Ground Stability

6.1.4 Earthworks including excavations for open cut trenches and launch/reception pits for trenchless installations, together with dewatering, could adversely affect ground stability and, subsequently impact upon any proposed joint bay platforms or existing surrounding structures through uncontrolled settlement.

Geological Designations

6.1.5 Impacts on geologically designated sites like LGS, may occur where construction activities interact directly within the designated site and in doing so removes or disturbs any aspect of the geological feature affording it the designated status. There is only one LGS that interacts with the limits of the LoD which is Dalby Hill Chalk Quarry in Route Section 2.

Mineral Sites and Designations

6.1.6 Impacts on mineral resources occur where construction over the mineral reserves may sterilise the potential for future mineral abstraction. Severance of mineral areas can also occur when constructing linear development across such areas. Only one sand and gravel MSA has been identified whose limits extend to just beyond the northern LoD in Route Section 3.

Hydrogeological Setting

Dewatering and Drainage

6.1.7 Dewatering of excavations is expected to be required which will generate a quantity of groundwater that will need to be managed and discharged appropriately from the site. An abstraction licence from the EA is required when extracting more than twenty cubic metres/day. Where discharges from site are uncontrolled this could result in pollution of the receiving waters, which may impact on surface water quality. If too much water is discharged, or the discharge rate is too high in the absence of sufficient controls, the capacity of the receiving surface water environment could be exceeded which may cause flooding off site in the wider area. The discharge of groundwater will require an environmental permit from the EA as well as consent from the IDB where discharging to an IDB maintained water course or drain.

6.1.8 Dewatering may also impact on nearby groundwater abstractions by lowering the groundwater table and potentially reducing the supply of groundwater to the abstraction well. However, the extent of any impact would depend on a number of factors summarised below. These will need to be assessed during design development and once the final alignment of the proposed DC cable route is established:

- The amount of drawdown needed to install the cables in the trench/excavation;
- The length of time that dewatering would be needed;
- The distance of the trench or excavation from the well supply;
- The depth of water in the abstraction well relative to the water level at the trench/excavation;
- The rest water level and pumping water level in the well;
- The transmissivity of the aquifer between the dewatering location and the abstraction well; and
- Whether the well abstraction is achieved from a surface-mounted or submersible pump. This would be dependent on the groundwater source that the abstraction is targeting, rate of dewatering abstraction.

6.1.9 The impact of dewatering has been considered qualitatively at this stage using the sensitivity and magnitude criteria presented in Table 7.4 and 7.5 respectively. The assessment has considered the sensitivity of the abstraction, the distance of the abstraction to the LoD, the type of construction that could be undertaken close to the abstraction, the depth of the abstraction well, the rate of abstraction (where known), the geology that the abstraction is drawing groundwater from, as well as the intervening geology between the LoD and the abstraction well. Further quantitative assessment is expected as part of the detailed design.

6.1.10 It is anticipated that land drains will be present in agricultural land within the Zone of Influence and the potential exists for these to be temporarily severed as a result of open cut trench excavations for the proposed DC cable route. This could impact on local near surface ground conditions by reduced drainage and increased water retention if not re-instated during construction. Agricultural land drainage is further assessed in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology* and *ES-2-B.05, Volume 2, Chapter 9: Agriculture & Soils*.

Soil and Groundwater Contamination

6.1.11 Current guidance and best practice for the assessment of soil and groundwater contamination is based on risk assessment rather than impact assessment as discussed in Section 2. A qualitative risk assessment for soil and groundwater contamination has been undertaken for the construction and operational phase. The risk assessment is pre-mitigation and where a significant risk remains, mitigation measures are then recommended in Section 7.

6.1.12 Two stages of preliminary ground investigation have been completed at the proposed landfall and at targeted locations along the proposed DC cable route. Based on the results of the human health GQRA, AECOM concluded that as all of the determinands tested were found to be below the adopted screening criteria there was no appreciable significant risk from the soil samples tested to human health.

6.1.13 Based on the controlled waters assessments completed it was concluded that the existing soil conditions were broadly consistent with natural background concentrations. Some leachable metal and inorganic determinand concentrations, whilst elevated against their adopted GAC for risk to controlled waters, were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area. There was not considered to be a significant risk posed to surface water quality, the nearest groundwater abstraction or the confined Chalk aquifer currently, during or post construction of the proposed DC cable route from the soils sampled.

6.1.14 The potential effects associated with soil and groundwater contamination have been defined based on the likely sources and levels of contamination encountered along the proposed DC cable route; the sensitivity of the receptors and the consequence of the effect resulting from an interaction between the source and the receptor, via a pathway. In addition, consideration has also been given to how construction activities could have the potential to cause soil and groundwater contamination through the use of hazardous materials, and the approach to

excavated materials management. The assessment methodology adopted for these aspects is defined in Tables 7.7, 7.8 and 7.9 in Chapter 2.

6.1.15 The baseline conditions compiled for the Zone of Influence do not suggest a significant potential for soil or groundwater contamination within the proposed DC cable route by virtue of the installation of the DC cable which suggests that there is a low potential for chemically unacceptable soils or groundwater to be encountered during the construction phase; with only one notable area being the former East Kirkby military airfield in Route Section 3 where a slightly higher potential may exist. However, the location of the proposed DC cable route in relation to the main airfield avoids the main former operational areas of the airfield.

6.1.16 In the absence of significant existing sources of soil or groundwater contamination having been defined, there are not considered to be significant source-pathway-receptor linkages based on current conditions, and considering that upon completion, construction of the proposed DC cable route will be fully re-instated to its current form. Further discussion on measures to deal with unexpected contamination that might be found during construction is provided in Section 6. Therefore, the main potential sources of contamination considered in the assessment of impacts are considered to be the limited quantities of fuels and oils that will be brought to site associated with construction plant (e.g. for refuelling excavators, hydraulic oils or generators) and that may be introduced during the construction of the proposed DC cable route. There is also a limited potential for ground-gas to emanate from the known organic deposits present within the Barroway Drove Beds (Marine Deposits/Tidal Flat Deposits) and localised Alluvial deposits, which may preferentially accumulate in excavations or poorly ventilated confined spaces, where construction workers could be required to work.

Construction Workers – Human Health

6.1.17 The handling of excavated soils, construction materials and the use of construction machinery all include the potential to introduce hazardous materials and potential impacts to construction workers. Construction workers have the potential to come into contact with fuels and other chemicals during construction activities, posing a potential risk to human health through dermal contact, ingestion and inhalation.

6.1.18 Prior to construction activities taking place it is contingent on the Project that risk assessments will be undertaken in full accordance with the Health and Safety at Work Act (Ref: 7-55) to restrict and manage any potential exposure to harmful substances. Potential impacts specific to construction workers are expected to be mitigated through the appropriate specification and use of Personal Protective Equipment (PPE), and the implementation of site controls and procedures in accordance with the Principal Contractor's Construction Phase Plan, as required under the Construction Design and Management (CDM) Regulations 2015 (Ref: 7-56).

Neighbouring Site Users, Occupiers and the General Public – Human Health

6.1.19 Neighbouring site users, occupiers and the general public immediately adjacent to, or in proximity to the proposed construction activities could be impacted upon by construction activities. Contaminated soils encountered during earthworks including the creation of stockpiled materials, potentially may be exposed to wind and rain which may increase dispersal through the spread of soil dust in air and/or soil in uncontrolled run off, in the absence of mitigation.

6.1.20 The absence of a significant potential for existing soil contamination suggests that it is unlikely that significant impacts on neighbouring human health would occur from any uncontrolled releases of soil-derived dusts or run off. However, it is possible that construction works could introduce contaminants into the environment through accidental release or unexpected contamination may also be uncovered. In the event that soil derived dusts and/or run-off do migrate to affect neighbouring properties and their occupants, this would be a short-term impact.

Groundwater and Surface Water

6.1.21 The increased use of water during construction works, e.g. for dust suppression, wheel washing or dewatering may lead to increased potential for contaminated water to be generated and increased surface water run-off. This poses a risk to the underlying aquifers and to nearby surface water features that may interact with groundwater.

6.1.22 Where trenchless techniques are undertaken, potential impacts may arise through the inaccurate design depth, whereby excavations or drilling may create pathways for drilling fluids, or other fluids used during construction, to reach groundwater receptors. Where crossing water courses or drains, and where using HDD, drilling too shallow could create a contamination pathway to sensitive surface water receptors, should a break out of drilling fluids, or other fluids used during construction, occur through the bed of the overlying watercourse. This is of particular relevance when working within loose granular deposits.

Longer Term, Operational and Permanent Impacts

Geological Setting

6.1.23 There are not expected to be any longer term operational or permanent impacts on geology resulting from the operation of the proposed DC cable route. On completion, there will be no permanent above ground infrastructure with the exception of marker posts at locations along the route and it is planned to restore the land and features that have been affected by the construction works to a condition suitable for its original use/function.

Hydrogeological Setting

6.1.24 Along the proposed DC cable route, post construction drainage will be installed to ensure that any new drainage installed along the proposed DC cable easement is incorporated into the

existing drainage system and the long-term integrity of the wider land drainage system is maintained.

6.1.25 In view of the proposed drainage solutions, no potential operational effects on hydrogeological conditions associated within the proposed DC cable route have been identified.

Soil and Groundwater Contamination

6.1.26 There are not expected to be any operational risks from contaminated soil and groundwater either to, or from, the proposed DC cable route.

Decommissioning Impacts

6.1.27 Decommissioning effects are assumed to be similar to, but no worse than, the temporary effects.

6.2 Route Section 1 Proposed Landfall to Well High Lane

Temporary Impacts

Geological Setting

Ground Stability

6.2.1 With reference to the methodology outlined in Section 2, it is considered that any settlement of land would represent a **low** magnitude of change to land stability, which is of **low** sensitivity given the general absence of development that might be affected. Therefore, it is assessed that the construction activities would result in an effect of **negligible significance** on land stability, although this assumes typical construction practices; for example shoring, benching, retention or struts, will be adopted and suffice to ensure excavation stability, where it is required. Further information on excavation stability is provided in the Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4.

Geological Site Designations

6.2.2 There are no geologically designated sites identified within the Route Section 1 Zone of Influence.

Mineral Site Designations

6.2.3 There are no designated minerals sites, MSA or MCA within the Route Section 1 Zone of Influence, and hence no potential for severance or sterilisation of local, regional or nationally significant mineral reserves.

Hydrogeological Setting

Dewatering and Drainage

6.2.4 A total of ten groundwater abstractions have been identified within the Route Section 1 Zone of Influence and these are associated with the supply of groundwater for general farming, domestic and spray irrigation uses. Seven of the abstraction wells are located in excess of 200 m from the LoD, six of which concern abstraction from the Chalk aquifer and one concerns abstraction from superficial glacial sand and gravels. There are two abstraction wells located within 50 m of the LoD that abstract groundwater from the Chalk aquifer at depth below the superficial cover. One abstraction well is located adjacent to the LoD, approximately 60 m from the central alignment. This closest abstraction takes groundwater from marine and estuarine deposits, according to the public records reviewed for this licence.

6.2.5 The eight abstractions that target the Chalk, whilst high sensitivity receptors, are unlikely to be affected by construction and dewatering activities given the largely cohesive cover of Till (Boulder Clay) that has been proven by ground investigation and that is widely reported in the literature (Ref: 7-34 and 7-35) to be confining the aquifer. Even where trenchless techniques are required in this route section, these are unlikely to be required at depths that would interact with the Chalk. A **negligible** magnitude is therefore assigned which results in a **minor adverse** impact.

6.2.6 One abstraction well has been identified approximately 60 m north of the proposed central alignment adjacent to the LoD located to the north of Asserby (White Well, licence 4/29/15/*G/0028). This is indicated to abstract from the superficial Marine and Estuarine Deposits (Unproductive strata). The depth of this well is not known, but it is assumed to be no deeper than 15 m depth given that it is targeting the superficial aquifer; any deeper and it would likely penetrate into the Chalk. The available BGS borehole records in the surrounding area indicate the marine and estuarine deposits (Salt Marsh and Tidal Creek Deposits) to be up to around 10 m thickness, overlying Till (Boulder Clay). There appear to be some gravel towards the base of the marine and estuarine deposits noted in the wider area that is around 2 m thickness. Given the proximity of this abstraction well to the proposed trench excavation works and its abstraction from the superficial deposits, the potential exists for dewatering activities to affect the water supply in this well.

6.2.7 The main factors which require consideration during design development are outlined in paragraph 6.1.9.

6.2.8 Assuming the groundwater level is shallow at approximately 1 m bgl, which is reasonably cautious, and the abstraction well is 15 m deep, there would be expected to be adequate water available in the well to withstand short-term dewatering in any trench excavation. Whilst the water level in the well is likely to be impacted by drawdown from dewatering given its proximity to the trench, the impact is not expected to result in derogation of the water supply. However, further detailed assessment would be required prior to construction.

6.2.9 The preferred cable installation method in Route Section 1 is open cut trenching which will typically extend to 1.5 m depth and therefore the amount of potential dewatering required is likely

to be low. Where trenchless techniques are required, HDD is likely to be the adopted solution and launch and reception compounds/pits are likely to be required, which may require dewatering. Auger boring or micro boring are also options that may be considered. For these methods launch and reception pits would be required, but typically deeper than any HDD excavations. The launch pits, where micro boring or auger boring is adopted, will include a temporary concrete floor (to create a clean working area) and a concrete "thrust" wall on the back section to provide resistance for the hydraulic jack. Depending on the ground conditions these excavations may need to be sheet piled to provide both stability and to limit ingress of groundwater. These measures would be expected to reduce the amount of dewatering required if micro boring or auger boring techniques are adopted. It is also noted that the duration of dewatering would be relatively short in this scenario.

6.2.10 A **medium** sensitivity and **low** magnitude has been identified in accordance with the methodology. This results in an overall pre-mitigation effect upon the local groundwater resource that is of **minor adverse** significance. The potential impact associated with dewatering activities on surface waters is considered further in in *ES-2-B.03, Volume 2, Chapter 8: Water Resources & Hydrology*.

Soil and Groundwater Contamination

Construction Workers – Human Health

6.2.11 Construction workers are considered to have a **very high** sensitivity due to the potential for exposure to hazardous materials which if not controlled may occur through dermal contact, inadvertent ingestion or inhalation. The probability of significant harm occurring to human health is defined as **low** taking into consideration the adoption of standard PPE and site controls which are a prerequisite to construction. The potential consequence classification is considered **mild**. The potential effects upon construction workers would be limited for the duration of the construction phase activities. As such, the overall pre-mitigation classification of risk upon health of construction workers during the construction phase is considered to be **low**.

Neighbouring Site Users, Occupiers and the General Public – Human Health

6.2.12 Neighbouring residential and commercial human receptors identified within the baseline Zone of Influence are assigned a **high** and **low** sensitivity, respectively. This considers relative exposure duration between a resident (continuous) and an employee (working hours), together with the proximity of each type of receptor from the construction works. The consequence of effects on human health resulting from exposure to soil dusts and/or uncontrolled run off is defined as **minor** with a probability of it occurring being **low**. As such, provided good construction practices are adopted, the overall pre-mitigation risk from the uncontrolled release of potentially contaminated soil-derived dust or run off upon the health of neighbouring site users, occupiers and the general public during the construction phase is considered to **very low**.

Groundwater and Surface Water

6.2.13 The potential consequence of the potential impacts described in Section 6.1 to the underlying Unproductive and Secondary Undifferentiated aquifers which are assessed as receptors of **negligible** sensitivity generally, although increased locally to **medium** around the area close to the groundwater abstraction (White Well, licence number 4/29/15/*G/0028). The potential consequence to adjacent surface water features (classified as **very high** and **high** sensitivity receptors) that may receive impacted groundwater or run off caused during construction is also considered to be **medium**. The probability of an event occurring, assuming good construction practices are adopted, is **low**. The overall pre-mitigation risk is therefore assessed to be **moderate** to **low** for these receptors.

6.2.14 The potential consequence of the potential impacts described in Section 6.1 to the underlying confined Principal aquifer is assessed as **medium**, with a probability of event occurring to be **unlikely**, which reflects the significant cover of superficial geology above the Principal Aquifer in Route Section 1. The overall pre-mitigation risk is therefore assessed to be **low** for these receptors.

Longer Term, Operational and Permanent Impacts

6.2.15 There are not considered to be any longer term, operational or permanent impacts on geology and hydrogeology.

Decommissioning Impacts

6.2.16 Decommissioning effects are assumed to be similar to, but no worse than, the temporary construction effects described earlier in this section.

6.3 Route Section 2 Well High Lane to A16 (Keal Road)

Temporary Impacts

Geological Setting

Ground Stability

6.3.1 With reference to the methodology, it is considered that any settlement of land would represent a low magnitude of change to land stability, which is of **low** sensitivity given the general absence of development that might be affected. Therefore, it is assessed that the construction activities would result in an effect of **negligible** significance on land stability although this assumes typical construction practices; for example shoring, benching, retention or struts, will be adopted and will suffice to ensure excavation stability, where it is required. Further information on excavation stability is provided in the Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4.

Geological Site Designations

6.3.2 There are no geologically designated SSSI present within the Zone of Influence however an LGS has been identified at the boundary of the LoD. This relates to Dalby Hill Chalk Quarry, a disused quarry in the Lower Chalk. The proposed construction works are not expected to impact on the quarry given that the route alignment and working width would actively seek to avoid this feature for both environmental and engineering reasons. A **low** sensitivity and negligible magnitude of impact has therefore been identified. This results in an overall pre-mitigation effect upon designated geological sites during the construction phase that is considered to be of **negligible** significance.

Mineral Site Designations

6.3.3 There are no designated minerals sites, MSA or MCA within the Route Section 2 Zone of Influence, and hence no potential for severance or sterilisation of local, regional or nationally significant mineral reserves.

Hydrogeological Setting

Dewatering and Drainage

6.3.4 The baseline review has identified three groundwater abstraction boreholes within the Route Section 2 Zone of Influence, the closest of which is located approximately 320 m from the central alignment, and 270 m from the LoD. This is stated to be for general agricultural use. The published geological mapping indicates that this borehole is likely to be abstracting groundwater from the Spilsby Sandstone (a Principal Aquifer).

6.3.5 The two other abstractions are located in excess of 350 m away from the LoD. One is listed as abstracting groundwater from the Chalk for domestic and farming use. The other abstraction does not define the strata from which it is abstracting from but states that the water is used for domestic potable and general supply.

6.3.6 The main factors with regards to impact on abstractions which require consideration during design development are outlined in paragraph 6.1.9. Further detailed assessment would be required as part of design development.

6.3.7 The preferred cable installation method in Route Section 2 is open cut trenching which will typically extend to 1.5 m depth and therefore the amount of potential dewatering required is likely to be low. Where trenchless techniques are required, for example at the two crossings of the River Lymn chalk stream, HDD is likely to be the adopted solution and launch and reception compounds/pits are likely to be required, which may require dewatering. Auger boring or micro boring are also options that may be considered. For these methods launch and reception pits would be required, but typically deeper than any HDD excavations. The launch pits, where micro boring or auger boring is adopted, will include a temporary concrete floor (to create a clean working area) and a concrete “thrust” wall on the back section to provide resistance for the hydraulic jack. Depending on the ground conditions these excavations may need to be sheet

piled to provide both stability and to limit ingress of groundwater. These measures would be expected to reduce the amount of dewatering required if micro boring or auger boring techniques are adopted. It is also noted that the duration of dewatering would be relatively short in this scenario.

6.3.8 A **high** sensitivity has been identified for the Principal Aquifer and low magnitude of impact is assessed for the proposed potential dewatering works which takes into account the distance of these abstractions from the LoD. This results in an overall pre-mitigation effect upon the local groundwater resource that is of **moderate adverse** significance. The potential impact associated with dewatering activities on surface waters is considered further in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology*.

Soil and Groundwater Contamination

Construction Workers – Human Health

6.3.9 Construction workers are considered to have a **very high** sensitivity due to the potential for exposure to hazardous materials which if not controlled may occur through dermal contact, inadvertent ingestion or inhalation. The probability of significant harm occurring to human health is defined as **low** taking into consideration the adoption of standard PPE and site controls which are a prerequisite to construction. The potential consequence classification is considered **mild**. The potential effects upon construction workers would be limited for the duration of the construction phase activities. As such, the overall pre-mitigation classification of risk upon health of construction workers during the construction phase is considered to be **low**.

Neighbouring Site Users, Occupiers and the General Public – Human Health

6.3.10 Neighbouring residential and commercial human receptors identified within the Zone of Influence are assigned a **high** and **low** sensitivity, respectively. This considers relative exposure duration between a resident (continuous) and an employee (working hours), together with the proximity of each type of receptor from the construction works. The consequence of effects on human health resulting from exposure to soil dusts and/or uncontrolled run off is defined as **minor** with a probability of it occurring being **low**. As such, provided good construction practices are adopted, the overall pre-mitigation risk from the uncontrolled release of potentially contaminated soil-derived dust or run off upon the health of neighbouring site users, occupiers and the general public during the construction phase is considered to **very low**.

Groundwater and Surface Water

6.3.11 The proposed DC cable route crosses the River Lymn in two locations through Route Section 2. The River Lymn is designated as a Chalk Stream by the EA and is fed from the underlying Chalk aquifer (Principal Aquifer). The potential consequence of the potential impacts described in Section 6.1 to the underlying Principal Aquifer (assessed as a receptor of **high** sensitivity) and the River Lymn (classified as a **very high** sensitivity receptor) that may receive impacted

groundwater or run off from construction is considered to be **medium**. The probability of an event occurring, assuming good construction practices are adopted, is **low**. The overall pre-mitigation risk is therefore assessed to be **moderate** to **low**.

Longer Term, Operational and Permanent Impacts

6.3.12 There are not considered to be any longer term, operational or permanent impacts on geology and hydrogeology.

Decommissioning Impacts

6.3.13 Decommissioning effects are assumed to be similar to, but no worse than, the temporary construction effects described earlier in this section.

6.4 Route Section 3 A16 (Keal Road) to River Witham

Temporary Impacts

Geological Setting

Ground Stability

6.4.1 Any settlement of land would represent a low magnitude of change to land stability, which is of **low** sensitivity given the general absence of development that might be affected. Therefore, it is assessed that the construction activities would result in an effect of **negligible** significance on land stability, although this assumes typical construction practices; for example shoring, benching, retention or struts, will be adopted and will suffice to ensure excavation stability, where it is required. Further information on excavation stability is provided in the Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4.

Geological Site Designations

6.4.2 There are no geologically designated sites identified within the Route Section 3 Zone of Influence.

Mineral Site Designations

6.4.3 There is one sand and gravel MSA located 15 m north of the proposed northern LoD of Route Section 3. The ground investigation in this area encountered sequences that appear to confirm that the proposed LoD is at the margins of the MSA. This is considered to be the margins as only a discontinuous cover of sand and gravels was encountered with a maximum proven thickness of 1.0 m identified beneath a cover of the Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits). The MSA is afforded a **high** sensitivity. A **negligible** magnitude of impact has been

assigned to reflect the ground investigation findings and the LoD being just beyond its southern limits. This results in an overall pre-mitigation effect upon mineral resources that is considered to be of **minor adverse** significance.

Hydrogeological Setting

Dewatering and Drainage

6.4.4 One groundwater abstraction borehole has been identified within the Route Section 3 Zone of Influence, located approximately 220 m from the proposed LoD. The published geological mapping indicates that this borehole is most likely abstracting groundwater from the river and Glaciofluvial Deposits (Secondary A Aquifer) for spray irrigation. The majority of Route Section 3 is underlain by Unproductive (Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits)) and Secondary Undifferentiated (Till (Boulder Clay)), including the areas of the proposed DC cable route that are closest to the abstraction well. Whilst some dewatering may be required transmissivity and connectivity to the Secondary A aquifer is anticipated to be limited. The closest main river (Hagnaby Beck) where a trenchless crossing may be required, and hence potentially higher amounts of dewatering, is over 1 km south west of this abstraction well.

6.4.5 The main factors with regards to impact on abstractions which require consideration during design development are outlined in paragraph 6.1.9. Further detailed assessment would be required as part of design development.

6.4.6 The preferred cable installation method in Route Section 3 is open cut trenching which will typically extend to 1.5 m depth and some dewatering is likely to be required particularly where granular strata are encountered. Where trenchless techniques are required, HDD is likely to be the adopted solution and launch and reception compounds/pits are likely to be required, which may require dewatering. Auger boring or micro boring are also options that may be considered. For these methods launch and reception pits would be required, but typically deeper than any HDD excavations. The launch pits, where micro boring or auger boring is adopted, will include a temporary concrete floor (to create a clean working area) and a concrete “thrust” wall on the back section to provide resistance for the hydraulic jack. Depending on the ground conditions these excavations may need to be sheet piled to provide both stability and to limit ingress of groundwater. These measures would be expected to reduce the amount of dewatering required if micro boring or auger boring techniques are adopted. It is also noted that the duration of dewatering would be relatively short in this scenario.

6.4.7 Shallow groundwater dewatering activities are unlikely to impact on the water supply at the identified abstraction well, given the intervening Unproductive and Secondary Undifferentiated aquifer and distance to the abstraction well. A **medium** sensitivity has been identified for the Secondary A Aquifer from which the well abstracts and a **negligible** magnitude of impact is assessed for the potential dewatering works required. This results in an overall pre-mitigation effect upon the local groundwater resource that is of **negligible** significance. The potential impact

associated with dewatering activities on surface waters is considered further in *ES-2-B.04, Volume 2, Chapter 8: Water Resources & Hydrology*.

Soil and Groundwater Contamination

Construction Workers – Human Health

6.4.8 Construction workers are considered to have a very **high** sensitivity due to the potential for exposure to hazardous materials which if not controlled may occur through dermal contact, inadvertent ingestion or inhalation. The probability of significant harm occurring to human health is defined as **low** taking into consideration the adoption of standard PPE and site controls which are a prerequisite to construction. The potential consequence classification is considered **mild**. The potential effects upon construction workers would be limited for the duration of the construction phase activities. As such, the overall pre-mitigation classification of risk upon health of construction workers during the construction phase is considered to be **low**.

6.4.9 Construction workers have the potential to be exposed to UXO during below ground excavations although Zetica have reported a general low UXO hazard potential (Ref: 7-48). The potential consequence classification is considered **severe** and based on the findings of the initial UXO desk study the probability of an exposure linkage being present is assessed as **low**. As such, the overall pre-mitigation classification of risk upon health of construction workers during the construction phase is considered to be **moderate**.

Neighbouring Site Users, Occupiers and the General Public – Human Health

6.4.10 Neighbouring residential and commercial human receptors identified within the baseline route Section 3 Zone of Influence are assigned a **high** and **low** sensitivity, respectively. This considers relative exposure duration between a resident (continuous) and an employee (working hours), together with the proximity of each type of receptor from the construction works. The consequence of effects on human health resulting from exposure to soil dusts and/or uncontrolled run off is defined as **minor** with a probability of it occurring being **low**. As such, provided good construction practices are adopted, the overall pre-mitigation risk from the uncontrolled release of potentially contaminated soil-derived dust, or run off, upon the health of neighbouring site users, occupiers and the general public during the construction phase is considered to be **very low**.

6.4.11 The potential also exists for neighbouring residential and commercial human receptors to be impacted by blast damage from UXO during the construction phase. The nearest residential and commercial receptors in areas around RAF East Kirkby are approximately 125 m from the LoD and 15 m within the LoD, respectively. The probability of this occurring is considered to be **low** but given the consequence is classed as **severe**, this results in an overall pre-mitigation risk of **moderate**.

Groundwater and Surface Water

6.4.12 The potential consequence of the potential impacts described in Section 6.1 to the underlying Unproductive Strata; assessed as a receptor of **negligible** sensitivity is considered to be mild. The potential consequence to crossed or adjacent surface water features (classified as **very high** and **high** sensitivity receptors) that may receive impacted groundwater or run off from construction is considered to be **medium**. The probability of an event occurring, assuming good construction practices are adopted, is **low**. The overall pre-mitigation risk is therefore assessed to be **moderate** to **low**.

Longer Term, Operational and Permanent Impacts

6.4.13 There are not considered to be any longer term, operational or permanent impacts on geology and hydrogeology.

Decommissioning Impacts

6.4.14 Decommissioning effects are assumed to be similar to, but no worse than, the temporary construction effects described earlier in this section.

6.5 Route Section 4 River Witham to the Proposed Converter Station

Temporary Impacts

Geological Setting

Ground Stability

6.5.1 It is considered that any settlement of land would represent a low magnitude of change to land stability, which is of **low** sensitivity given the general absence of development that might be affected. Therefore, it is assessed that the construction activities would result in an effect of **negligible** significance on land stability although this assumes typical construction practices; for example shoring, benching, retention or struts, will be adopted to ensure excavation stability, where it is required. Further information on excavation stability is provided in the Preliminary Ground Investigation Report that was prepared by AECOM in May 2017 and issued formally in July 2017 (Ref: 7-33). This is included in *ES-4-B.03 Volume 4, Chapter 7 Geology and Hydrogeology* as Appendix 7.4.

Geological Site Designations

6.5.2 There are no geologically designated sites identified within the Route Section 4 Zone of Influence.

Mineral Site Designations

6.5.3 There are no designated minerals sites, MSA or MCA within the Route Section 4 Zone of Influence, and hence no potential for severance or sterilisation of local, regional or nationally significant mineral reserves.

Hydrogeological Setting

Dewatering and Drainage

6.5.4 There are no sensitive groundwater abstractions identified in the baseline review that could be affected by dewatering activities.

6.5.5 The preferred cable installation method in Route Section 4 is open cut trenching which will typically extend to 1.5 m depth and therefore some dewatering is anticipated particularly where granular strata are encountered. Where trenchless techniques are required, HDD is likely to be the adopted solution and launch and reception compounds/pits are likely to be required, which may require dewatering. Auger boring or micro boring are also options that may be considered. For these methods launch and reception pits would be required, but typically deeper than any HDD excavations. The launch pits, where micro boring or auger boring is adopted, will include a temporary concrete floor (to create a clean working area) and a concrete "thrust" wall on the back section to provide resistance for the hydraulic jack. Depending on the ground conditions these excavations may need to be sheet piled to provide both stability and to limit ingress of groundwater. These measures would be expected to reduce the amount of dewatering required if micro boring or auger boring techniques are adopted. It is also noted that the duration of dewatering would be relatively short in this scenario.

6.5.6 A **negligible** sensitivity and low magnitude has been identified for groundwater resources. This results in an overall pre-mitigation effect upon the unproductive aquifer and resource potential that is of **negligible** significance. The potential impact associated with dewatering activities on surface waters is considered further in *ES-2-B.03, Volume 2, Chapter 8: Water Resources & Hydrology*.

Soil and Groundwater Contamination

Construction Workers – Human Health

6.5.7 Construction workers are considered to have a **very high** sensitivity due to the potential for exposure to hazardous materials which if not controlled may occur through dermal contact, inadvertent ingestion or inhalation. The probability of significant harm occurring to human health is defined as **low** taking into consideration the adoption of standard PPE and site controls which are a prerequisite to construction. The potential consequence classification is considered **mild**. The potential effects upon construction workers would be limited for the duration of the construction phase activities. As such, the overall pre-mitigation classification of risk upon health of construction workers during the construction phase is considered to be **low**.

Neighbouring Site Users, Occupiers and the General Public – Human Health

6.5.8 Neighbouring residential and commercial human receptors identified within the baseline Zone of Influence are assigned a **high** and **low** sensitivity, respectively. The consequence of effects on human health resulting from exposure to soil dusts and/or uncontrolled run off is defined as **minor** with a probability of it occurring being **low**. As such, provided good construction practices are adopted, the overall pre-mitigation risk from the uncontrolled release of potentially contaminated soil-derived dust or run off upon the health of neighbouring site users, occupiers and the general public during the construction phase is considered to **very low**.

Groundwater and Surface Water

6.5.9 The potential consequence of the potential impacts described in Section 6.1 to the underlying Unproductive (Barroway Drove Beds (Marine Deposits/Tidal Flats Deposits) and Secondary Undifferentiated (Till (Boulder Clay) aquifers (assessed as receptors of **negligible** sensitivity) is considered to be **mild** with a **low** probability. This results in a pre-mitigation risk of **low**. The potential consequence to adjacent surface water features (classified as **very high** and **high** sensitivity receptors) that may receive impacted groundwater or run off during construction is considered to be **medium**. The probability of an event occurring, assuming good construction practices are adopted, is **low**. The overall pre-mitigation risk is therefore assessed to be **moderate** to **low**.

Longer Term, Operational and Permanent Impacts

6.5.10 There are not considered to be any longer term, operational or permanent impacts on geology and hydrogeology.

Decommissioning Impacts

6.5.11 Decommissioning effects are assumed to be similar to, but no worse than, the temporary construction effects described earlier in this section.

7 Mitigation

7.1 Overview of Mitigation

Design Mitigation

7.1.1 Mitigation by design has been a consideration since the early routeing stages of the proposed DC cable route. Opportunities have been taken, where possible, to avoid potential geological, geomorphological and hydrogeological constraints. Further information on this is presented in *ES-2-A.02, Volume 2, Chapter 2: Development of the UK Onshore Scheme.* In addition, the LoD approach allows for cable routeing refinement to take place once detailed design and additional survey data has been collected, which will provide flexibility to reduce construction and impacts as the detailed design stage develops.

7.1.2 Further ground investigation will be undertaken during design development. This information will inform how the proposed DC cable route will be constructed and the extent to which excavation support and dewatering may be required. It will also be used to confirm the depth that the proposed DC cables will be placed, taking due account of any minimum vertical clearances specified by affected asset owners, for example, the IDB and the presence of watercourses and land drains. It is assumed that where excavation support is deemed to be necessary, as defined by prior ground investigation, this will be adopted during construction.

7.1.3 A low potential for existing soil and/or groundwater contamination to impact upon the development of the proposed DC cable route has been identified and no significant impacts (i.e. no moderate or major adverse or beneficial effects) to the geological setting during construction or operation have been identified.

7.1.4 In view of the high sensitivity of the hydrogeological setting in certain sections of the proposed DC cable route, the potential exists for construction activities to result in significant impacts of up to moderate adverse effect in the absence of appropriate levels of design led control, e.g. effective design of temporary works. This concerns the potential impact of dewatering of excavations.

7.1.5 There is always the potential for unexpected soil and/or groundwater to be encountered, which recognises the inherent limitations of ground investigation compared to the extent of excavation works that will be required to be undertaken during construction. General mitigating controls that will be adopted during construction that influence how construction interacts with the geological and hydrogeological environment as well as potential contamination and UXO risk, are set out in the remainder of Section 7.1 and where applicable, route section specific mitigation is described in Sections 7.2 to 7.5.

Construction Mitigation

Legislation and Regulations

7.1.6 A significant amount of legislation bears relevance to construction work and its actual and potential interactions with ground conditions. A Construction Environment Management Plan CEMP) will be developed and secured by planning condition, that will contain measures to ensure compliance with relevant standards and legislation. The CEMP will set out the environmental mitigation requirements and also the project level expectations on how the proposed DC cable route will be constructed.

Ground Stability

7.1.7 There may be a requirement to provide temporary support for site excavations. Such support may include benching of excavations, shoring or the construction of retaining walls (e.g. sheet piles) or struts to mitigate the risk of settlement or excessive spalling. It is expected that the need for such control would be established during detailed design and where specified and implemented correctly, would be sufficient to mitigate any residual effects.

Soil and Groundwater Pollution Control Mitigation

7.1.8 Measures contained within the CEMP would be designed to limit the potential for dispersal and accidental releases of potential contaminants, soil-derived dusts and uncontrolled run-off to occur during construction. For example the CEMP will set out how material is to be excavated and stockpiled to minimise the potential for run-off, soil degradation or wind dispersal of dusts. The use of biodegradable netting and the binding of the surface through temporary grass seeding will be specified together with dampening procedures during dry weather. Sheeting may be used if any material is identified to be hazardous with a view to limited water ingress and potential leachate generation. Soil storage and handling areas will be defined prior to construction commencing. In the event of uncontrolled releases occurring, the CEMP and the Contractor's own method statements contained in their Construction Phase Plan (CPP) would also set out the measures required to ensure that the extent and impact of any such releases are contained and ultimately remediated.

7.1.9 A Pollution Response Plan will be in place prior to the commencement of construction works. The plan will outline key pollution mitigation measures to be adopted including a Control of Substances Hazardous to Health (COSHH)/fuel inventory and key contacts to be notified in the event of a significant pollution incident, which may subsequently lead to the contamination of controlled waters or soils. All bulk fuel and COSHH items will be stored in accordance with the relevant EA Pollution Prevention Guidance notes (Ref: 7-57) withdrawn but widely considered good practice) and storage regulations. Tanks and dispensing pumps will be locked when not in use to prevent unauthorised access.

7.1.10 Any hazardous materials will be stored in designated locations with specific measures to prevent leakage and the release of their contents. This will include a requirement to position storage

areas at least 10 m away from surface water features/drains (and take into consideration the positions of groundwater abstraction wells), on an impermeable base with an impermeable bund that has no outflow and is of adequate capacity to contain at least 110% of the contents. Valves and trigger guns will be protected from vandalism and kept locked when not in use.

7.1.11 Only well maintained plant will be used during construction to minimise the potential for accidental pollution from leaking machinery or damaged equipment. Static machinery and plant are expected to be stored in hard standing areas when not in use and, where necessary, to make use of drip trays beneath oil tanks/engines/gearboxes/hydraulics. Spill response kits containing equipment that is appropriate to the types and quantities of materials being used and stored during construction will be maintained on site for the duration of the works.

7.1.12 The CEMP will establish procedures for dealing with unexpected soil or groundwater contamination that may be encountered. This would typically require affected works to stop to enable appropriate people to be notified, and further characterisation and risk assessment to be undertaken, before remediation or mitigation proposals are agreed with all required stakeholders.

7.1.13 Potential exposure impacts specific to construction workers during site preparation and construction would be mitigated by the following measures and through working in accordance with CIRIA C692 3rd Edition 'Environmental Good Practice On Site' (2010) (Ref: 7-58).

- 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 construction site workers;
- monitoring of confined spaces for potential ground gas accumulations, restricting access to confined spaces, i.e. to suitably trained personnel only, and use of specialist PPE, where necessary; and
- preparation and adoption of a site and task specific health and safety plan as is required under Health and Safety legislation (Ref: 7-55).

Excavated Materials Management

7.1.14 Prior to construction, a strategy will be prepared as part of the design development, which will set out how the earthworks stage of the construction phase will be undertaken. Where necessary the strategy will consider what excavated materials can be reused, or are required within the development of the proposed DC cable route, and what materials are surplus and require either disposal or onward management to ensure appropriate re-use. The strategy will also define whether any geotechnical improvement may be required, prior to re-use or disposal.

7.1.15 To minimise the effects on soil resources during any earthworks, high standards of soil handling and management will be employed with a view to minimising where possible the double handling of soils and the extent to which exposed soils will be left vulnerable to erosional processes. An

outline soil handling and storage protocol will be prepared further details of which are provided in *ES-2-B.05, Volume 2, Chapter 09: Agriculture and Soils.*

7.1.16 The re-use of excavated materials during construction will be governed by either a Materials Management Plan developed in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice (Ref. 7-59), an environmental permit or a relevant exemption. The CL:AIRE Code of Practice is a voluntary framework for excavated materials management and re-use. Following this framework results in a level of information being generated that is sufficient to demonstrate to any regulator that excavated material has been re-used appropriately and is suitable for its intended use. It demonstrates that waste material has not been used in the development. The Materials Management Plan details the procedures and measures that will be taken to classify, track, store, reuse and dispose of all excavated materials that will be encountered during the development works.

7.1.17 The disposal of soil waste, contaminated or otherwise to landfill sites would be best mitigated by minimisation of the overall quantities of waste generated during construction, and by ensuring that excavated material consigned to landfill cannot, as an alternative, be put to use either on site or on other sites.

7.1.18 Where there is a requirement to dispose of surplus excavated materials off site as waste, the material will be characterised to determine firstly whether it is Hazardous or Non-Hazardous waste in accordance with the EA's Technical Guidance WM3 (Ref: 7-60) and then once this is established, the appropriate disposal facility will be determined through Waste Acceptance Criteria (WAC) analysis, as required.

Groundwater and Dewatering

7.1.19 If groundwater is not adequately controlled then excavations may flood or become unstable, and the efficiency of construction operations will be impacted. Where the volume of groundwater requiring dewatering exceeds twenty cubic metres a day then an abstraction permit will be obtained from the EA. Consents will also be obtained where discharging to watercourses including IDB managed water courses or public sewer.

7.1.20 The adopted dewatering techniques will be appropriate to the type of excavation and hydrogeological conditions. The hydraulic conductivity of the ground within each excavation or trench section will be considered to establish the required abstraction volume to achieve the necessary drawdown of groundwater levels. The type of dewatering undertaken may include the use of cut off walls, sump dewatering and potentially well point dewatering with some provision for attenuation capacity to allow for water treatment and/or settlement prior to final discharge.

7.1.21 The inclusion of attenuating capacity for dewatering will ensure that discharge rates are controlled and this will effectively mitigate against the capacity of the receiving surface water environment being exceeded.

7.1.22 Further detailed hydrogeological assessment will be undertaken to design temporary works and dewatering, during detailed design particularly in areas that desk study and/or ground

investigation has identified a potential shallow groundwater table, highly permeable deposits or where dewatering is required and there are groundwater abstractions located nearby. Examples include the buried channels confirmed by the ground investigation in Route Section 3, areas and known groundwater abstractions across the Lincolnshire Wolds in Route Section 2 and localised areas of river and Glaciofluvial Deposits in Route Sections 3 and 4. Further hydrogeological assessment may include targeted ground investigation and permeability testing, groundwater level monitoring, or pumping tests whereby water from a test well is pumped at a controlled rate whilst the flow rate from the well, and the drawdown in an array of observation wells at varying distances from the test well, is observed. The information from these tests will be used to construct a hydrogeological model to predict the potential transmissivity and drawdown effects of dewatering.

7.1.23 Routeing within the LoD will seek to be at least 50 m away from any groundwater abstractions. During dewatering operations and where abstractions are identified that could be impacted upon, a monitoring programme will be implemented during the cable installation and dewatering to monitor actual impact on the water level in the surrounding area. Monitoring will also identify whether there is a potential for temporary derogation of the well supply at any given abstraction point and the possible need for the provision of an alternative supply to affected parties.

7.1.24 Whilst SPZ Zone 3 has been identified across a large proportion of Route Section 1, the SPZ concerns the confined Chalk aquifer at depth. Construction is not expected to interface with the Chalk here as a mantle of superficial deposits, predominantly comprising Till (Boulder Clay), exists that is up to approximately 20 m thick in places and which would afford some protection to the underlying Chalk aquifer.

7.1.25 Due to the requirement to protect controlled waters (groundwater and surface water), further risk assessments will need to be undertaken at all trenchless crossing locations to ensure that the ground model is understood and potential risks quantified prior to construction. Detailed design will seek to control the potential for ground or surface water contamination to occur, for example, through specifying vertical alignments that minimise the potential for "break out" of drilling fluids, or other fluids used in construction, therefore reducing potential impacts on ground and surface water quality. This is particularly relevant where designing works within granular materials e.g. around the River Witham or in particularly sensitive groundwater environments.

Unexploded Ordnance (UXO)

7.1.26 The Zetica UXO desk study (Ref: 7-47) recommended that a further detailed UXO desk study and risk assessment be undertaken. This was completed in June 2017 (Ref: 7-48) and confirmed a generally low UXO risk to the proposed cable route. Where a specific potential UXO hazard is identified, a UXO Risk Mitigation Management Plan will be provided summarising the mitigation measures and common working practices required in accordance with good practice and Health and Safety legislation (Ref: 7-59).. The assessment will also define the need for on-site UXO clearance to take place, as required.

7.2 Route Section 1 Proposed Landfall to Well High Lane

7.2.1 The baseline review for Route Section 1 identified one shallow groundwater abstraction within relatively close proximity to the central cable alignment (60 m north and adjacent to the LoD). The sensitivity of this abstraction well, whilst identified as being a shallow abstraction taking groundwater from Unproductive strata (Salt Marsh and Tidal Creek Deposits), is considered to be of medium sensitivity which reflects the apparent increased permeability of the superficial ground conditions in this area and its local resource value. Given the proximity of this abstraction well to the proposed trench excavation works and its abstraction from the superficial deposits, the potential exists for dewatering activities to affect the water supply in this well and a minor adverse impact was assessed.

7.2.2 Further detailed hydrogeological modelling will be undertaken, which will allow the potential impact on this abstraction well to be evaluated further in line with the dewatering strategy for Route Section 1. This will determine extent of groundwater monitoring required during construction and whether an alternative water supply needs to be temporarily be provided. It is expected that this will be a condition of planning.

7.2.3 Within this route section, construction work will avoid interacting with the Chalk aquifer which is confined by up to 20 m of superficial predominantly Till (Boulder Clay).

7.3 Route Section 2 Well High Lane to A16 (Keal Road)

7.3.1 A potential impact of moderate adverse significance on the hydrogeological setting of Route Section 2 has been identified as a result of potential dewatering activities within a Principal aquifer and SPZ Zone 3. This reflects the high sensitivity of the underlying aquifer across the majority of the route (Principal Aquifer). The closest groundwater abstraction well (for agricultural use) is located 270 m from the LoD at its closest point. Further detailed hydrogeological modelling will be undertaken as part of the detailed design stage which will allow the significance of the identified impact to be quantified, which will inform the dewatering strategy in this location so that impact on water levels is minimised and/or controlled. This further assessment will also define the extent of any groundwater monitoring programme required during the construction phase. It is expected that this will be a condition of planning.

7.4 Route Section 3 A16 (Keal Road) to River Witham

7.4.1 A low risk of UXO potential has been identified in the eastern extent of Route Section 3 associated with a former military airfield (RAF East Kirkby) which resulted in potential significant impacts to construction workers and neighbouring properties being identified. A UXO Risk Mitigation Management Plan will be developed and followed. UXO clearance, if deemed to be a requirement, will be carried out.

7.4.2 Within this route section, the LoD pass close to the southern margins of an MSA. Ground investigation has confirmed that the sand and gravel resource at this margin is discontinuous and

limited. The proposed DC cable route will be positioned to avoid the MSA, i.e. within the proposed LoD. This will reduce any actual or perceived impact.

7.5 Route Section 4 River Witham to the Proposed Converter Station

7.5.1 No specific mitigation measures above those outlined in Section 5.1 have been identified for Route Section 4 which is a reflection on the limited sensitivity of the geological and hydrogeological setting and the low potential for existing soil and/or groundwater contamination.

8 Residual Effects

8.1 Route Section 1 Boygrift to Well High Lane

Temporary Effects

8.1.1 Following the implementation of mitigation measures outlined in Section 7 which will be embedded in the proposed DC cable route, it is anticipated that all construction effects identified in Section 6.2 will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

Longer Term, Operational and Permanent Effects

8.1.2 No longer term, operation and permanent impacts have been identified.

Decommissioning Effects

8.1.3 Decommissioning effects are assumed to be similar to (and no worse than) the temporary residual effects identified.

8.2 Route Section 2 Well High Lane to A16 (Keal Road)

Temporary Effects

8.2.1 Following the implementation of mitigation measures outlined in Section 7 which will be embedded in the proposed DC cable route, it is anticipated that all construction effects identified in Section 6.3 will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

Longer Term, Operational and Permanent Effects

8.2.2 No longer term, operational and permanent impacts have been identified.

Decommissioning Effects

8.2.3 Decommissioning effects are assumed to be similar to (and no worse than) the temporary residual effects identified.

8.3 Route Section 3 A16 (Keal Road) to River Witham

Temporary Effects

8.3.1 Following the implementation of mitigation measures outlined in Section 7 which will be embedded in the proposed DC cable route, it is anticipated that all construction effects identified in Section 6.4 will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

Longer Term, Operational and Permanent Effects

8.3.2 No longer term, operation and permanent impacts have been identified.

Decommissioning Effects

8.3.3 Decommissioning effects are assumed to be similar to (and no worse than) the temporary residual effects identified.

8.4 Route Section 4 River Witham to the Proposed Converter Station

Temporary Effects

8.4.1 Following the implementation of mitigation measures outlined in Section 7 which will be embedded in the proposed DC cable route, it is anticipated that all construction effects identified in Section 6.5 will be reduced so that residual effects are negligible for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

Longer Term, Operational and Permanent Effects

8.4.2 No longer term, operational and permanent impacts have been identified.

Decommissioning Effects

8.4.3 Decommissioning effects are assumed to be similar to (and no worse than) the temporary residual effects identified.

9 Monitoring

9.1 Proposed Monitoring

Construction Phase

9.1.1 Depending on the outcome of additional detailed studies during design development, there may be a requirement to implement a groundwater monitoring plan in Route Section 1 and Route Section 2 during the construction phase. This will be to monitor the effectiveness of mitigation during dewatering and the actual effects of dewatering on the surrounding area, and in particular on the water levels in the identified closest groundwater abstraction wells. Monitoring will also identify whether there is a potential for temporary derogation of the well supplies and the possible need for the provision of alternative supplies.

9.1.2 The requirement for groundwater monitoring is subject to the findings of detailed hydrogeological modelling and development of a dewatering strategy being undertaken during detailed design stage.

Operational Phase

9.1.3 No requirements for monitoring once the proposed DC cable route is operational have been identified.

10 Cumulative Effects

10.1 Scope of Cumulative Assessment

10.1.1 There are eighteen schemes in the vicinity of the proposed underground DC cable route which could have the potential to result in inter-project cumulative effects. Further details on these schemes are provided in *ES-2-D.01, Volume 2, Chapter 28: Cumulative Effects*.

10.1.2 Since the construction activities associated with the installation of the proposed underground DC cable installation at the landfall will be the same as those associated with the Offshore Scheme (i.e. HDD), no intra-project cumulative effects have been identified for the intertidal zone. This is discussed further in *ES-2-D.01, Volume 2, Chapter 28: Cumulative Effects*.

10.2 Cumulative Effects

10.2.1 A number of development sites have been identified for consideration within the cumulative assessment. These comprise the construction of solar energy farms, the erection of new overhead power lines, modifications to existing farm facilities (new poultry sheds, grain stores, biomass boilers and anaerobic digestion plant), a new wind farm, the extension of an existing recycling centre and the creation of a new area of woodland. The planning application boundaries for two overhead powerline schemes and a large solar panel farm cross the proposed underground DC cable route centre alignment and the wind farm scheme is positioned adjacent to the LoD.

10.2.2 Provided that the requirements of relevant policy and legislation relating to land contamination and remediation are adopted in design, and that appropriate mitigation measures are applied during the construction phases of each development, it is considered that the residual effects of the identified developments on Geology and Hydrogeology will be of **negligible** significance. In addition, given the nature of the identified schemes identified within 100 m of the proposed underground DC cable route centre alignment, groundwater dewatering is not expected since excavations are likely to be minimal. Should the identified schemes require groundwater dewatering from excavations the timing of such activities may need to be considered and programmed accordingly to minimise cumulative impacts occurring.

10.2.3 Once the identified schemes have been completed, it is considered that there may be beneficial effects to the local environment as any potential soil or groundwater contamination that may have been encountered will have been managed as part of the development and as required by any planning controls.

11 Summary of Assessment

11.1 Summary

Overview of Baseline Conditions

11.1.1 The baseline review has shown that the proposed DC cable route is underlain by varied geological strata and associated groundwater receptors including Unproductive strata (Saltmarsh and Tidal Creek Deposits/Marine and Estuarine Deposits), Secondary A aquifers (Glaciofluvial and Alluvial deposits), Secondary Undifferentiated aquifers (Till (Boulder Clay)) and Principal solid geology aquifers (Spilsby Sandstone and Chalk). Some areas of the proposed DC cable route are located within a groundwater SPZ 3 (Route Section 2) and cross a number of main rivers and several IDB maintained watercourses.

11.1.2 There is only one LGS that interacts with the edge of the LoD and this is Dalby Hill Chalk Quarry in Route Section 2. Only one MSA (sand and gravel) has been identified close to the northern LoD in Route Section 3. There are no other MSAs, LGSs or geologically designated SSSI within the Zone of Influence.

11.1.3 The main historical and current land use within the Zone of Influence has been agriculture with no discernible historical land uses identified that could have given rise to significant soil or groundwater contamination. The potential to encounter contaminated ground within the former RAF East Kirkby military airfield from operations conducted here historically are considered to be generally low since the former runway and taxiways and hangers are some distance from the LoD. It has also been considered that any impacted ground, e.g. fuel spillages to ground in the area of the airport would likely have restricted mobility in the ground due to the presence of low permeability Till (Boulder Clay) in the area of the former airfield. The potential for localised impacts to have occurred throughout the airfield, for example, from airfield accidents, cannot be entirely ruled out though.

11.1.4 Two preliminary ground investigations were carried out, one at the proposed landfall site in July 2016 and a second at selected locations along the proposed DC cable route between January and March 2017. The soil results from both investigations showed that concentrations of tested determinands were below the relevant human health screening criteria which indicated the soils sampled would not pose a significant risk to human health when considered within a residential context (most sensitive end use). The controlled waters assessment concluded that the soil baseline conditions are broadly consistent with natural background concentrations and where concentrations of metals and inorganics exceeded the GAC, these were considered to most likely reflect background concentrations as a result of the natural geology and the widespread agricultural activities undertaken in the area.

11.1.5 The findings of a UXO desk study undertaken in June 2016 identified a generally low potential for UXO. A former military airfield (RAF East Kirkby) encroaches into the LoD of Route Section 3 but more detailed assessment by Zetica (Ref: 7-48) identified a low potential albeit there could be small arms ammunition. A UXO Risk Mitigation Management Plan will be developed and followed. UXO clearance, if deemed to be a requirement, will be carried out.

Overview of Residual Effects

11.1.6 Following the implementation of mitigation measures described, it is anticipated that temporary residual effects will be reduced to **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination. Therefore, no significant effects to geology and hydrogeology are expected through the construction works associated with the proposed DC cable route provided the mitigation outlined is adopted. Key elements of the mitigation for geology and hydrogeology concerns the effective and efficient management of excavated materials through the development of a materials management strategy, controls on how construction materials are handled and stored to prevent uncontrolled releases to ground and the design of earthworks, the DC cable trench and trenchless installation locations. Further detailed ground investigation and hydrogeological modelling will be undertaken in relation to informing how the proposed DC cable route will be constructed and development of a dewatering strategy.

11.1.7 The residual effects associated with the completed and operational proposed DC cable route are anticipated to be **negligible**.

11.1.8 Table 7.44 presents a summary of the residual effects of the proposed DC cable route on geology and hydrogeology.

Residual Effects in East Lindsey District Council

11.1.9 Following the implementation of mitigation measures, it is anticipated that all construction effects will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

11.1.10 Following the implementation of mitigation measures, it is anticipated that all effects associated with the complete and operational proposed DC cable route will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** for receptors affected by soil and/or groundwater contamination.

Residual Effects in Boston Borough Council

11.1.11 Following the implementation of mitigation measures, it is anticipated that all construction effects will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

11.1.12 Following the implementation of mitigation measures, it is anticipated that all effects associated with the complete and operational proposed DC cable route will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** for receptors affected by soil and/or groundwater contamination.

Residual Effects in North Kesteven District Council

11.1.13 Following the implementation of mitigation measures, it is anticipated that all construction effects will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

11.1.14 Following the implementation of mitigation measures, it is anticipated that all effects associated with the complete and operational proposed DC cable route will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** for receptors affected by soil and/or groundwater contamination.

Residual Effects in South Holland District Council

11.1.15 Following the implementation of mitigation measures, it is anticipated that all construction effects will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** and **low** for receptors affected by soil and/or groundwater contamination.

11.1.16 Following the implementation of mitigation measures, it is anticipated that all effects associated with the complete and operational proposed DC cable route will be reduced so that residual effects are **negligible** for geological and hydrogeological receptors and **very low** for receptors affected by soil and/or groundwater contamination.

Table 7.44 Summary of assessment: Geology & Hydrogeology (underground cable)				
Description of receptor	**Value/ sensitivity**	**Description of residual effect**	**Significance**	**Significant**
Temporary Impacts				
Geological Setting – ground instability (buildings and infrastructure)	Low	The residual effect is of negligible significance as construction activity e.g. excavations and dewatering resulting in ground instability is unlikely to take place adjacent to existing development. Where they do engineering controls are to be included in the design. Where excavation support is required typical construction practices like shoring, benching, retention or struts, will be adopted.	Negligible	No
Geological setting - geologically designated sites and mineral sites, safeguarding or consultation areas	Low to High	Impacts on geologically designated sites like LGS, may occur where construction activities interact directly within the designated site and in doing so removes or disturbs any aspect of the geological feature. There is only one LGS located within Route Section 2 that interacts with the limits of the LoD. Impacts on mineral resources occur where construction over the mineral reserves may sterilise the potential for future mineral abstraction. Only one MSA located in Route Section 3 extends up to the LoD. The proposed DC cable route alignment and working width would actively seek to avoid these geological features for both environmental and engineering reasons, consequently the residual effect is of negligible significance.	Negligible	No

Table 7.44 Summary of assessment: Geology & Hydrogeology (underground cable)				
Description of receptor	**Value/ sensitivity**	**Description of residual effect**	**Significance**	**Significant**
Hydrogeological setting – groundwater abstractions	Medium to High	Dewatering of excavations may impact on nearby groundwater abstractions by lowering the groundwater table and potentially reducing the supply of groundwater to the abstraction well. Routing of the proposed DC cable within the LoD will seek to be at least 50 m away from any groundwater abstractions to limit adverse impact on the water level during dewatering. Further detailed hydrogeological assessment will also be undertaken at detailed design stage to allow the potential impact to be evaluated further in line with the dewatering strategy and define the extent of groundwater monitoring required during construction and whether alternative supplies are required. Following the implementation of mitigation measures the residual effect of dewatering activities and the drawdown of the groundwater table on groundwater abstractions is considered to be of negligible significance	Negligible	No

Table 7.44 Summary of assessment: Geology & Hydrogeology (underground cable)				
Description of receptor	**Value/ sensitivity**	**Description of residual effect**	**Significance**	**Significant**
Human health – contractors carrying out construction works	Very High	Construction workers have the potential to come into contact with fuels and other chemicals during construction activities but through the application of measures contained in the CEMP and the Principal Contractor's Construction Phase Plan, together with consideration of the measures in CIRIA C692 (Ref: 7-56), a low risk has been assessed. A low UXO potential has been identified and there is a former RAF airfield extending to within the LoD in the eastern extent of Route Section 3. A UXO Risk Mitigation Management Plan will be developed and followed. UXO clearance, if deemed to be a requirement, will be carried out.	Low Risk	No
Human health – Neighbouring residential properties within 250 m of construction works.	High	Surrounding residents and workers may be exposed to construction generated soil dust or run off if not controlled. Measures contained within the CEMP with regards to soils handling and storage would control the impact resulting in a low and very low risk to these receptors.	Low Risk	No
Human health – Neighbouring commercial human receptors within 250 m of construction works.	Low		Very Low Risk	No

Table 7.44 Summary of assessment: Geology & Hydrogeology (underground cable)				
Description of receptor	**Value/ sensitivity**	**Description of residual effect**	**Significance**	**Significant**
Groundwater (Unproductive Strata to Principal Aquifer)	Negligible to High	Reduction in groundwater quality from the uncontrolled release of pollutants, uncontrolled discharges of drilling fluids during trenchless installation of the DC cables, potential break out of fluids into surface watercourses, and potential accidental release of hazardous materials to groundwater during construction. The impact will be controlled through appropriate hazardous materials storage and handling, pollution response and environmental management; the principles of which will be set out in the CEMP.	Low Risk	No
Surface water features	High to Very High	Reduction in surface water quality due to impacted groundwater migration and/or surface water run-off resulting from uncontrolled release of pollutants. The impact will be controlled through appropriate hazardous materials storage and handling, pollution response and environmental management; the principles of which will be set out in the CEMP.	Low Risk	No
Long Term, Operational and Permanent Impacts				
Geological setting - geologically designated sites and mineral sites, safeguarding or consultation areas	Low	There are not expected to be any significant longer term, operational or permanent residual effects on geology.	Negligible	No
Hydrological setting – groundwater abstractions	Medium to High	There are not expected to be any significant longer term, operational or permanent residual effects on the hydrogeological setting.	Negligible	No

Table 7.44 Summary of assessment: Geology & Hydrogeology (underground cable)				
Description of receptor	**Value/ sensitivity**	**Description of residual effect**	**Significance**	**Significant**
Groundwater (Unproductive Strata and Principal Aquifer (in Route Section 2))	Negligible to High	There are not expected to be any significant longer term, operational or permanent residual effects on the groundwater quality.	Negligible	No
Surface water features	Medium to Very High	There are not expected to be any significant longer term, operational or permanent residual effects on the surface water quality.	Negligible	No

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Ref: 7-27: British Geological Survey Map Sheet No. 115 Horncastle Solid and Drift, 1:50,000 Scale;

Ref: 7-28: British Geological Survey Map Sheet No. 128 Boston Solid and Drift, 1:50:000 Scale;

Ref: 7-29: British Geological Survey Map Sheet No 116 Skegness, Solid and Drift, 1:50,000 Scale;

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