Tween Bridge Solar Farm

Environmental Statement
Chapter 9: Ground Conditions

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

APFP Regulation 5(2)(a)

Document Reference: 6.2.9

August 2025

Revision 1

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9 Ground Conditions

9.1 Introduction

9.1.1. This chapter presents an assessment of likely significant effects arising from the construction, operation (including maintenance) and decommissioning of the Scheme upon land, soil and groundwater. The full description of the Scheme is provided within **ES Chapter 2 Scheme Description [Document Reference 6.1.2]** of this ES.

9.1.2. This chapter is supported by the following appendices:

ES Appendix 9.1- Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1]

ES Appendix 9.2- Phase 1 Ground Condition Desk Study, Volume 3: Tween Bridge Wind Farm Factual Site Investigation Report, Donaldson Associates 2009 & Headland Archaeology Report 2015 [Document Reference 6.3.9.2]

9.2. Consultation

9.2.1. Discussions were held with various Local Authority (City of Doncaster and North Lincolnshire Council) and other statutory consultees (e.g. Environment Agency, Canal & Rivers Trust, Mining Remediation Authority etc) during the EIA Scoping exercise. Subsequent revisions and amendments were made following feedback from these authorities

9.2.2. A summary of consultation undertaken in relation to the geology, hydrogeology and contaminated land assessment was conducted and a summary of this is provided in **Table 9-1**. These updates were taken into account during the collation of this Environmental Statement (ES).

Table 9-1: Summary of Consultation – Scoping Opinion

Consultee	Summary of consultee response	How response has been addressed by Applicant
Planning Inspectorate	The ES assessment should also be informed by the Environment Agency's Land Contamination Risk Management Procedures.	
Planning Inspectorate	It is noted that third party data such as a Landmark or Groundsure information report, which typically informs a preliminary risk assessment/ desk study (as provided within Appendix 7.1 of the Scoping Report) has not been provided. The Scoping Report also uses vague terminology such as "several to many metres" to describe the depth of the underlying geology. The ES should provide a detailed description of the baseline environment with reference to the data sources used. The ES should be based on sufficient baseline data to support a robust assessment of likely significant effects as required by the EIA Regulations 2017.	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]** updated: Updated Desk Study reports include specific distances to identified off-site features etc and Groundsure reports covering the full areas of Land Parcels A to E are appended. Sufficient desk-based information has been considered assessed support a robust assessment
Planning Inspectorate	Table 7.1 of the Scoping Report ('Anticipated Shallow	Detailed geology baseline presented in Table 9-11 to 9-16

Consultee	Summary of consultee response	How response has been addressed by Applicant
	Soils') is described as a summary, with the reader referred to Appendix 7.1 for full details. However, no information is given as to the specific location of the relevant evidence within Appendix 7.1. Where the ES Ground Conditions Chapter is to cross refer to appendices or figures, specific paragraph numbers/ figure numbers to the relevant evidence should be provided	
Planning Inspectorate	Relevant figures accompanying the ES Ground Conditions assessment should consistently and accurately illustrate the red line boundary and applicable study area. The figures should clearly present baseline information across the entirety of the application site.	Figures cover and include Order Limits for the Scheme.
Planning Inspectorate	The scoping consultation response from City of Doncaster Council (Appendix 2 of this Opinion) states that "the scoping area" is partially within a Mineral Safeguarding Area and a Petroleum Exploration and Development	Potential impacts on mineral resources included in assessment in Section 9.5

Consultee	Summary of consultee response	How response has been addressed by Applicant
	Licence (PEDL) area. The ES should identify potential impacts on mineral and hydrocarbon resources, including those resulting from sterilisation of the resources during the lifetime of the Proposed Development. Any likely significant effects should be assessed. Effort should be made to discuss and agree the approach with the relevant local planning authorities.	
North Lincolnshire Council (NLC)	Contaminated Land Officer satisfied with baseline study to date and notes intrusive investigation to be undertaken at future stage. Requested clarity on which parts of study relate to differing Local Authorities. Queried gas risk from peat soils.	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]** updated: Local Authority areas clarified in text by colour highlighting in text and boundary used on all drawings embedded into appendices as appropriate. Gas risk considered & assessed (**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1],** Section 3.3).
Environment Agency (EA)	Sustainable Places team provided response in Scoping Opinion (13 March 2023):	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1)**

Consultee	Summary of consultee response	How response has been addressed by Applicant
	Source Protection Zones (SPZ) and groundwater vulnerability to be considered, refer to Contaminated Land Special Site to southwest of site, need for land quality assessment where directional drilling proposed, historic landfill site potential for ground gas.	**[Document Reference 6.3.9.1]** updated: Contaminated Land Special Site located 144m to the west of Land Parcel D and SPZ shown in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcel D Appendix D (Appendix 9.1) [Document Reference 6.3.9.1]** Assessment of risks to groundwater from directional drilling covered in Section 9.5
Canal & River Trust	Provided response in Scoping Opinion. Noted proximity to Stainforth & Keadby Canal and risk to water pollution from unintentional run-off from exposed soils or dust. A CEMP could offer an appropriate measure to address risks to the canal. We advise that dust prevention mmeasures and specific measures (such as trenches and hoarding) should be incorporated to reduce the risk of pollution towards the canal	Potential impacts to surface water receptors from unintentional run-off included in assessment in Section 9.5
City of Doncaster Council (CDC)	Provided response in Scoping Opinion. Noted southwestern section partially in a mineral	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]**

Consultee	Summary of consultee response	How response has been addressed by Applicant
	safeguarding area and PEDL license area. Noted potential for some areas of concern regarding contaminated land and need for Phase II investigation and CEMP	Mineral Safeguard Area assessed for consented sites, areas of search and proposed sites allocations within period of Adopted Local Plan. (**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E Appendix 9.1. [Document Reference 6.3.9.1]** , Appendix D PEDL licenses clarified (**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E Appendix 9.1**. **[Document R**eference 6.3.9.1], Section 2.5.6.2). Consultation with North Sea Transition Authority confirmed direct consultation with license holders is appropriate as of May 2025.
Coal Authority (CA)	No requirement to consider coal mining legacy	Summarised in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]**

9.2.3. **Table 9-2** outlines the comments which have been raised by statutory consultees in relation to the Ground Conditions formal PEIR chapter submitted for the Scheme.

Table 9-2 Summary of Consultation – Statutory Consultation

Consultee	Summary of consultee response	How response has been addressed by Applicant
City of Doncaster Council (CDC)	Provided response in Stat Consultee Response: Table 7.1 (PEIR Chapter 7) sets out that CDC have previously questioned whether an assessment be undertaken on peat soils and the impact of the Scheme on carbon sequestration, and that this will be addressed in Chapter 9 of the ES. However, very little information is provided within Chapter 9 of the PEIR to enable further comment at this stage.	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]** updated: Desk based review of publicly available borehole logs and previous site investigations (where available) to determine approximate spatial and vertical extent of peat deposits. A Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) will include drilling/augering within each land parcel to accurately calculate the extent of peat across the scheme. From this geological data, assessments of carbon sequestering can be undertaken.
Coal Authority (CA)	Provided response in Stat Consultee Response: We have reviewed the site location plan provided and can confirm that the site falls within the Coal Authority's defined Development Low Risk Area. On this basis we have no specific comments to make. However, in the	Summarised in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]**

Consultee	Summary of consultee response	How response has been addressed by Applicant
	interest of public safety, it is requested that the Coal Authority's Standing Advice note is drawn to the applicant's attention, where relevant.	
Ministry of Defence	Provided response in Stat Consultee Response: I can confirm that, following review of the application documents, the proposed development falls outside of MOD safeguarded areas and does not affect other defence interests. The MOD, therefore, has no objection to the development proposed.	Summarised in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]**
Canal & River Trust	Provided response in Stat Consultee Response: We believe it is important that risks of runoff and dust towards the canal are addressed within any future Construction Environmental Management Plan (CEMP) that seeks to specifically address this risk. We would request that any Framework CEMP submitted alongside a future application submission should address this matter. The Trust have raised comment with regards to the risks of horizontal directional	The risks to the Stainforth& Keadby canal are considered further in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1].** Any future intrusive work within influencing distance of the canal will be carried out under appropriate specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions as reviewed and

Consultee	Summary of consultee response	How response has been addressed by Applicant
	drilling below the Stainforth & Keadby Canal, and the need to protect the canal from vibrational impacts below. 9.7.15 in Chapter 9 of the latest PEIR addresses this point, and highlights that specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions, will be undertaken and agreed with consultees, stakeholders and regulators prior to commencement. The Trust welcome this approach. We request that this matter should be covered as part of Protective Provisions for the Trust within the DCO.	accepted by consultees, stakeholders and regulators prior to commencement.
UK Health Security Agency	Provided response in Stat Consultee Response: Emissions to Land We are aware that the boundary changes to the proposed scheme have changed and some parcels of land have not been subject to a Preliminary Risk Assessment at this stage. This is acknowledged and further details will be considered. A generic	All land parcels have now been considered in in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1].** Where required, a scheme of Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) has been recommended to assess soil and groundwater contamination and mitigation to

Consultee	Summary of consultee response	How response has been addressed by Applicant
	Quantitative Risk Assessment is earmarked to take place, although it is not clear when, ideally this would be undertaken prior to the submission of the Environmental Statement. Ground gases from natural peat deposits have now been considered and a suitable scheme of risk assessment has been proposed. Mitigation details should be incorporated into any future design details.	key receptors. Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) including a generic risk assessment, are to be carried out, where required, post-consent.
Natural England	Provided response in Stat Consultee Response: Given that the proposed development is located on mapped areas of peat, it would be expected for the potential impact of the development on peat to be included in the assessment, including the potential impact on the carbon within the peat as per the IEMA (2022) guidance. Natural England welcome the provision of information provided with regards to peat soils (highlighted in Chapter 9 - Ground Conditions and Chapter 14 - Air Quality and Greenhouse Gases). We look forward to a more detailed	**ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]** Desk based review of publicly available borehole logs and previous site investigations (where available) to determine approximate spatial and vertical extent of peat deposits. A Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) will include drilling/augering within each land parcel to accurately calculate the extent of peat across the scheme. From this geological data, assessments of

Consultee	Summary of consultee response	How response has been addressed by Applicant
	assessment provided in the ES including 'Volume of peat to be disturbed, and subsequently the effect on carbon sequestration, as a result of the Scheme' as set out in Chapter 14. Natural England highlights that fenland peat soils may have highly acidic subsoils which can influence the ALC grade by restricting rooting depth and causing a drought limitation. Determination of pH should be carried out for areas comprising peaty soils to assess the depth(s) at which highly acidic conditions (if any) occur. When assessing the sensitivity of topsoil and subsoil in Table 1 of Technical Appendix 15.1, we advise peat and peaty soils should also be considered. Natural England advises that potential damage to the soil resource (including peat) caused by inappropriate soil handling for temporary works may result in a downgrading of the ALC grade.	carbon sequestering can be undertaken. Where required, a scheme of Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) has been recommended to assess soil and groundwater contamination, to include chemical assessment of topsoil and subsoil.

Consultee	Summary of consultee response	How response has been addressed by Applicant
	3.3.2. Water level raising on peat soils There may be opportunities within the development site to raise water levels on peaty soils. Managing these areas with water levels high enough that the peat becomes saturated could have significant carbon benefit, in addition to biodiversity benefits. We recommend using Natural England peat mapping, LiDAR mapping and field augering when considering areas suitable for wet habitat creation.	
Yorkshire Water	Provided response in Stat Consultee Response: The Preliminary Environmental Information Report (PEIR), Chapter 9 – Ground Conditions identifies western and central site area located in Source Protection Zone 3. The significance of effect to groundwater quality during construction is assessed as minor to locally moderate adverse. Areas of potential source contamination are in array areas only and due to limited earthworks required where solar arrays are proposed	Summarised in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1].** Any future intrusive work within influencing distance of an SPZ will be carried out under appropriate specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions as reviewed and accepted by consultees,

Consultee	Summary of consultee response	How response has been addressed by Applicant
	flow pathways are unlikely to be altered. Mitigation measures relevant to groundwater quality will be embedded in the design and mitigation measures highlighted within the CEMP. The CEMP must detail required mitigation measure to safeguard the SPZ.	stakeholders and regulators prior to commencement
Environment Agency (EA)	Provided response in Stat Consultee Response: As outlined in Section 9.5.7. the western and central site areas are within Source Protection Zone (SPZ) 3. A small area of the draft order limits falls within SPZ1 and 2 to the west, but we understand based on the information submitted, that no cabling is proposed in this area. It is important that the proposed cable route avoids sensitive receptors, as far as practicable, to protect groundwater from contamination in SPZs. The CEMP will need to assess the risks to controlled waters associated with the chosen construction methods and detail any required mitigation measures. It is unclear whether certain activities that could pose a risk to	Location to SPZs and sensitive groundwater abstractions are summarised in **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1].** Any future intrusive work within influencing distance of an SPZ will be carried out under appropriate specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions as reviewed and accepted by consultees, stakeholders and regulators prior to commencement. Site specific detailed assessments of Unexploded Ordnance will take place post-consent.

Consultee	Summary of consultee response	How response has been addressed by Applicant
	controlled waters will be included in the CEMP; of particular concern are the risks associated with horizontal directional drilling and foundation works, especially where there is presence of principal aquifer and within SPZs. We acknowledge that private water supplies have been noted in Table 10.3 of Chapter 10. We advise that these are identified within the ES as a receptor due to their vulnerable nature. We recommend that an up-to-date list of private water supplies are acquired from the Local Authority's to inform your future assessments. We would like to request the latest copy of the UXO report to review if it has been undertaken. Potential contaminant linkages are identified within the Preliminary Risk Assessment. These linkages should be assessed further through site investigation as part of a Phase II Generic Quantitative Risk Assessment. We are satisfied that detailed investigations	Where required, a scheme of Phase 2 Geotechnical & Geoenvironmental Investigation(secured via the CEMP) has been recommended to assess soil and groundwater contamination and mitigation to key receptors. Phase 2 Geotechnical & Geoenvironmental Investigation (secured via the CEMP) including a generic risk assessment, are to be carried out, where required, post-consent.

Consultee	Summary of consultee response	How response has been addressed by Applicant
	can be secured at the detailed design stage post-consent as suggested in Paragraph 9.5.21. of Chapter 9. Sections 10.3.7. and 10.3.8. refer to the Water Framework Directive (WFD) and Table 10.6 (3.9.6) outlines that Section 10.5 of the PEIR assesses the likely significant effects of the project on surface and groundwater bodies. However, no WFD assessment has been provided as part of the PEIR and the Report has not considered the potential effects on water bodies with regard to the relevant River Basin Management Plan (RBMP). We advise that further consideration of the potential impact on water quality and geomorphological disturbances is required and would expect a WFD assessment to be submitted with the ES.	

9.3. Approach to the Assessment

Assessment Methodology

Establishment of Baseline Environment

9.3.1. A desk-based assessment has been undertaken in order to develop an understanding of the physical environment and setting of the Scheme. Baseline data was obtained from the following sources:

- British Geological Survey (BGS) – geology mapping (superficial and solid), landslip data, and mineral prospecting data;
- An environmental database (Groundsure) reports appended to **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1].**, that incorporates data from:
    - EA – Groundwater vulnerability maps, groundwater source protection zones, licensed groundwater abstractions, landfills (historic and present), and pollution incidents; and
    - Local authority (NLC and CDC) – pollution incidents, landfills, sensitive land use, location of made ground and potentially contaminative sites; and
- Historic mapping.
- Site walkovers undertaken in 2023 on the original Land Parcels A to E

9.3.2. Noting site walkovers were previously completed in 2023, a review of recent aerial imagery and purchase of latest historic / environmental records has taken place to confirm there are no significant changes in contemporary land uses or classifications on or adjacent the site.

9.3.3. In addition to the ground conditions baseline information and assessment presented in this report, a Preliminary Risk Assessment has been undertaken to assess risks from contaminated land, in line with Land Contamination Risk Management (LCRM) guidance and is presented in **ES Appendix 9.1 Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1].**

9.3.4. Potential impacts have been identified from data gathered during the desk study. This data has been assessed with the knowledge and experience of the impacts from similar construction projects, leading to the development of appropriate mitigation measures.

Study Area

9.3.5. The Study Area is the land within the Order Limits for the Scheme shown in **ES Figure 1.1 Order Limits [Document Reference 6.4.1.1]**plus a surrounding distance within an approximate 250m radius of the Order Limits, although certain sources and/ or sensitive targets further than 250m distance and up to 1km from the site may also have been considered.

Assessment of significance

9.3.6. The assessment of likely significant environmental effects as a result of the Scheme has taken into account the construction, operational and decommissioning stages on both the environment and the physical components of the Scheme.

9.3.7. The following sections define the approach adopted within the assessment for the determination of sensitivity (or value/importance), magnitude of change (or impact), the level of effect and significance. The likelihood of the impact occurring has also been considered.

Determining Sensitivity of Receptor

9.3.8. The sensitivity of affected receptors has been considered on a scale of high, medium, low or negligible. Criteria adopted in the assessment are presented in **Table 9-3**.

Table 9-3: Receptor importance / sensitivity

Receptor sensitivity	Examples
High	• Areas of existing mineral extraction and areas designated in Local Authority Plans as preferred areas for mineral extraction • Areas of contaminated land • Areas of known high risk of landslips or where landslips have occurred • Primary aquifers

	• Little or no soil cover (attenuation capacity) • Soils at high risk of damage or erosion during construction • Areas of known/confirmed contaminated groundwater • Future site users (residential/commercial) • Construction workers • Future infrastructure/buildings
Medium	• Soils with moderate risk of damage during construction • Secondary (A, B or undifferentiated) aquifers • Areas with intermediate groundwater vulnerability
Low	• Soils with low risk of damage during construction • Unproductive strata • Areas with low groundwater vulnerability

Determining the Magnitude of Change

9.3.9. The magnitude of change has been considered as the change experienced from the current baseline conditions at the sensitive receptor and has been considered on a scale of large, medium, small or negligible. Criteria adopted in the assessment are presented in **Table 9-4**.

Table 9-4: Magnitude of change

Receptor sensitivity	Examples
Large	Irreversible or long-term change well outside the range of natural variation where recovery could be protracted (>10 years) to a large area or an area remote from the development. Potential health hazard.
Medium	A change outside the bounds of natural variation to a large area or an area remote from the development, which will recover over a medium period of time (5-10 years).
Small	A slight change (within the bounds of natural variation) to an area in close proximity to the development, which will recover over a short period of time (1-5 yrs).
Negligible	No impact detectable

Determining the Level of Effect

9.3.10. The level of effect has been informed by the magnitude of change due to the Scheme and the evaluation of the sensitivity of the affected receptor. The level of effect has been determined using professional judgement and **Table 9-5** has been a tool which has assisted with this process.

9.3.11. Whilst **Table 9-5** provides ranges, the level of effect is confirmed as a single level and not a range, informed by professional judgement. For each effect, it has been concluded whether the effect is 'beneficial' or 'adverse'.

Table 9-5: Matrix to Support Determining the Level of Effect

		Sensitivity (or value / importance)			
		High	**Medium**	**Low**	**Negligible**
Magnitude of Change	**Large**	Major	Moderate to Major	Minor to Moderate	Negligible
	Medium	Moderate to Major	Moderate	Minor	Negligible
	Small	Minor to Moderate	Minor	Negligible to Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

9.3.12. The following terms have been used to define the level of the effects identified and these can be 'beneficial' or 'adverse':

- **Major effect**: where the Scheme is likely to cause a considerable change from the baseline conditions and the receptor has limited adaptability, tolerance or recoverability or is of the highest sensitivity;
- **Moderate effect**: where the Scheme is likely to cause either a considerable change from the baseline conditions at a receptor which has a degree of adaptability, tolerance or recoverability or a less than considerable change at a receptor that has limited adaptability, tolerance or recoverability.;
- **Minor effect**: where the Scheme is likely to cause a small, but noticeable change from the baseline conditions on a receptor which has limited adaptability, tolerance or recoverability or is of the highest sensitivity; or where the Scheme is likely to cause a considerable change from the baseline conditions at a receptor which can adapt, is tolerant of the change or/and can recover from the change.; and

- **Negligible**: where the Scheme is unlikely to cause a noticeable change at a receptor, despite its level of sensitivity or there is a considerable change at a receptor which is not considered sensitive to a change.

9.3.13. The duration of the effect has been assessed as either 'short-term', 'medium-term' or 'long-term'. Short-term is considered to be up to 1 year, medium-term is considered to be between 1 and 10 years and long-term is considered to be greater than 10 years.

Determining Significance

9.3.14. For each effect, a statement has been made as to whether the level of effect is '**Significant**' or '**Not Significant**'. An effect is classified as Significant when defined as moderate or above as per **Table 9-5**. This determination has been based on professional judgement and/or relevant guidance/legislation where applicable.

Identification and Assessment of Impacts and Mitigation Measures

9.3.15. Potential impacts have been identified from data gathered during the desk study. This data has been assessed with the knowledge and experience of the impacts from similar projects, leading to the development of appropriate mitigation measures.

9.3.16. An assessment has been made of the significance of the potential effects on both the environment and the physical components of the Scheme, taking into account the importance and sensitivity of the receptor, the magnitude of impact, the duration or persistence of the impact and the likelihood of the impact occurring.

9.3.17. Criteria adopted in the assessment are presented in **Tables 9-6, 9-7, 9-8 & 9-9.**

Table 9-6: Receptors value and sensitivity

Receptor	Receptor Sensitivity			
	High	Medium	Low	Negligible
End users, workers	Residential, allotments	Landscaping or open space, play areas	Commercial areas	'Hardcover' use e.g., roads or industrial areas
Surrounding land uses	Residential	Open space or commercial areas	Commercial areas	'Hardcover' use e.g., roads or industrial areas
Construction workers	Extensive earthworks, demolition	Limited earthworks	Minimal/ localised earthworks	No earthworks
Controlled waters	Principal aquifers, source protection zones, main rivers	Secondary A Aquifers, Source Protection Zones, Surface Water Courses	Secondary B Aquifers, Surface Water Courses	Non-Aquifers No surface water /drainage courses
Soils/ geology	High cultivation, ecological mineral, or scientific value/ sensitivity	Medium cultivation, ecological, mineral or scientific value/ sensitivity	Low cultivation, ecological, mineral or scientific value/ sensitivity	Absent/ no cultivation, ecological, mineral or scientific value/ sensitivity
Built Environment	Historic or other highly sensitive buildings (e.g.	Low or High rise residential development,	Commercial / industrial development	Not applicable

Receptor	Receptor Sensitivity			
	High	Medium	Low	Negligible
(ground movement / subsidence)	hospitals or Grade I listed structures)	schools, Grade II listed structures or municipal buildings		

Table 9-7: Magnitude of Impact on Contamination Risk

Magnitude of Contamination Risk	Definition by example
High	Significant contamination represents an unacceptable risk to identified receptors across much of the site. Site not suitable for current/proposed use without significant remediation. Enforcement action possible. Urgent action required.
Medium	Contaminants may represent an unacceptable risk to identified receptors across parts of the site. Site probably not suitable for current /proposed use without remediation. Action required in the medium term.
Low	Contaminants may be present but are unlikely to create unacceptable risk to identified receptors. Site probably suitable for current use, may require localised remediation for proposed use. Action unlikely to be needed whilst site remains in current use.
Negligible	If contamination sources are present they are considered Minor in nature & extent, and not likely to present a risk to identified receptors. Site suitable for current/proposed use. No further action required.

Table 9-8: Magnitude of Impact on Geology and Soils

Magnitude of Impact on Soils, Geology and Groundwater	Definition by example
High	Soils on a large proportion of the site will be removed (or improved) by the development. Important geological features or high quality agricultural soils will be destroyed. Important mineral resources will be sterilised or made inaccessible by the development. Groundwater resources will be subject to an identifiable change in groundwater flow regime, aquifer use or artesian flows.
Medium	Access to important geological features will be restricted (or improved) by the development. Localised damage (or improvement) to soils quality or geological features. Groundwater resources will be subject to an identifiable change in local groundwater flow regime or aquifer use.
Low	Access to some localised geological features may be restricted (or improved) by the development. Very localised damage (or improvement) to soils or geological features. Measurable change in groundwater levels, but no appreciable change in groundwater flow regime, status or potential use.
Negligible	No damage to important soil, mineral resources or geological features, and only Minor disturbance (or improvement) of soils. No or very limited impact on groundwater resources.

Note: Impacts can be adverse or beneficial

9.3.18. The significance of effect for land and soil is based on the sensitivity of the receptor and the magnitude of impact (change), as outlined in **Table 9-9**.

9.3.19. The significance of an effect is reported as either 'significant' or 'not significant'. Any effects determined as 'minor to moderate' or above are considered to be significant. Any effects determined as 'minor' or below are considered not significant.

Table 9-9: Significance of Residual Effects

	Sensitivity			
Magnitude	**High**	**Medium**	**Low**	**Negligible**
High	Major	Major/ Moderate	Moderate	Minor
Medium	Major/ Moderate	Moderate	Minor	Negligible
Low	Minor/Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

9.3.20. The **ES Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E (Appendix 9.1) [Document Reference 6.3.9.1]** is was provided to the local authorities and Environment Agency for review and comment as par, as part of the consultation process for the EIA scoping. The scope and location of proposed specific targeted Phase II intrusive investigation and risk assessment will be agreed with these regulators in due course and undertaken after consent during the detailed design phase.

Legislative and policy framework

9.3.21. The principal legislation designed to protect the physical environment, including land quality, waste management and water resources, and which may be relevant to construction, operation and decommissioning of the Scheme, in addition to planning policy and guidance, is shown in **Table 9-10** overleaf.

Table 9-10: Key Relevant Legislation/ Policy

Document	Summary
Part 2A of the Environmental Protection Act (EPA) 1990 (the Contaminated Land Regime) [**Ref. 9-1**]	Under Part 2A of the EPA 1990 sites are identified as 'contaminated land' if they are causing harm or if there is a significant possibility of significant harm or if the site is causing, or could cause, significant pollution of controlled waters. Part 2A mostly applies to the existing use of the site and its enforcement is the responsibility of the Local Planning Authority. As a minimum, newly developed sites should not be able to be classed as contaminated land as defined by Part 2A of the EPA 1990. The EPA 1990 endorses the principle of a 'suitable for use' approach for contaminated land, where remedial action is only required if there is an unacceptable risk to human health or risk of pollution of the environment, taking into account the use of the land and its environmental setting. The Contaminated Land Statutory Guidance describes a risk-based approach based on a 'source- pathway-receptor' model of the site. For the land to be determined as contaminated in a regulatory sense, and thereby require remediation, all three elements (a source of contamination, a receptor and a pathway by which the receptor could be exposed to the contamination) must be present.
The Contaminated Land Regulations (England) 2006, [**Ref. 9-2**] The Contaminated Land (England) (Amendment) Regulations 2012, [**Ref. 9-3**]	he Contaminated Land (England) Regulations 2006 consolidate the provisions of the Contaminated Land (England) Regulations 2000 and the Contaminated Land (England) (Amendment) Regulations 2001 with amendments and extend the existing contaminated land regime under Part 2A of the Environmental Protection Act 1990 to cover radioactivity.

Document	Summary
	Specifically, the regulations, which apply to England only, set out provisions relating to the identification and remediation of contaminated land under Part 2A of the 1990 Act. The regulations make provision for an additional description of contaminated land that is required to be designated as a special site, i.e. land which is contaminated land as a result of radioactive substances in, on or under that land.
The Water Act 2003 [**Ref. 9-4**]	The Water Act 2003 amended the Water Resources Act 1991 and makes numerous provisions, including those related to contaminated land. The Water Act 2003 (and various commencement orders) brings into effect changes to the definition of contaminated land in the EPA 1990 so that, in relation to the pollution of controlled waters, for land to be determined as contaminated land it must cause significant pollution or there must be a significant possibility of such pollution of controlled waters.
The Water Resource Act 1991 (as amended) [**Ref. 9-5**]	The Water Resources Act 1991 (as amended) seeks to protect the quality of water by setting out the functions of the Environment Agency and describing offences relating to water and discharges to it.
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 [**Ref. 9-6**]	Establishes a framework for action relating to water policy in England and Wales.

Document	Summary
The Groundwater (Water Framework Directive) (England) Direction 2016 [**Ref. 9-7**]	Sets out obligations to protect groundwater.
The Environmental Damage (Prevention and Remediation) Regulations 2009 [**Ref. 9-8**]	The Environmental Damage (Prevention and Remediation) Regulations 2009 implement the European Union Directive (2004/35) in respect of environmental liability and remedying environmental damage. They introduced obligations to ensure that the polluter pays for damage caused, supplementing existing legislation. Various enforcing authorities include the Environment Agency in relation to damage to water, Natural England in relation to biodiversity and Local Planning Authorities (LPA) in relation to land damage.
National Planning Policy	
Overarching National Policy Statement for Energy (NPS EN-1) (2023) designated in January 2024 [**Ref. 9-9**]	Section 5.11 related to land use and includes details of planning policy relating to land contamination, soil and agricultural land.
The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (2023) designated in January 2024 [**Ref. 9-10**]	Section 2.10 considers issues relating to soil quality for solar development, including the consideration of land types on which schemes could be developed.
National Policy Statement for Electricity Network Infrastructure (NPS EN-5) (2023) designated in January 2024 [**Ref. 9-11**]	Details issues relating to underground cables, in connection with soil and contamination, although predominantly dealing with overhead cables.

Document	Summary
National Planning Policy Framework (NPPF) (Dec 2024) [**Ref. 9-12**]	Section 15 'Conserving and enhancing the natural environment'; para 196 to 197 requires planning policies to ensure that sites suitability for development is assessed with respect to ground contamination and natural / man-made hazards. Where risks are identified it is the responsibility of the developer and/or landowner to secure the site for safe development.
The Environmental Permitting (England and Wales) Regulations 2016 [**Ref. 9-13**]	The Environmental Permitting (England and Wales) Regulations 2016 provide a unified framework for regulating activities that could harm the environment or human health. They consolidate various former consenting regimes into a single system of environmental permits for regulated facilities. The regulations aim to protect the environment, encourage best practices, and minimize the regulatory burden on businesses.
Local Planning Policy	
Doncaster Council Local Plan 2015-2035 (adopted 2021) [**Ref. 9-14**]	Includes: Policy 55 Contamination and Unstable Land (designed to ensure full and effective use of land in an environmentally acceptable manner); Policy 60 Protecting and Enhancing Doncaster's Soil and Water Resources (seeks to conserve, protect and enhance land quality, soil and water resources); Policy 61 Providing for and Safeguarding Mineral Resources (aims to plan for steady, adequate, efficiently and sustainably sourced minerals during the plan period, and supports non-mineral development where it will not prevent economically viable mineral resource from being extracted in the future. Temporary development is

Document	Summary
	an exemption from the Mineral Safeguarding Policy.
North Lincolnshire Council Local Development Framework 2010 [**Ref. 9-15**] Local Plan 2020-2038 (submission made in Nov 2022) [**Ref. 9-16**]	Includes policies and strategies to safeguard mineral resources and protect the environment. Temporary planning permission is an exception from their minerals safeguarding policy. Other Adopted Planning Policy documents include supplementary document Planning for Solar Photovoltaic (PV) Development, 2016 which provides policy considerations to manage impacts of construction and groundworks.
Guidance	
Land Contamination Risk Management (Environmental Agency, 2023) [**Ref. 9-17**]	
Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance [**Ref. 9-18**]	
Ministry of Agriculture, Fisheries and Food (1988). Agricultural Land Classification for England and Wales: Revised Guidelines and Criteria for Grading the Quality of Agricultural Land [**Ref. 9-19**]	
Likelihood of Best and Most Versatile Agricultural Land Strategic scale maps (Natural England, 2017) [**Ref. 9-20**]	
Institute of Environmental Management and Assessment (IEMA) Guide: A New perspective on Land and Soil in Environmental Impact Assessment (2022) [**Ref. 9-21**]	
Technical Information Note TIN049: Agricultural Land Classification: protecting the best and most versatile agricultural land, 2nd edition (2012) [**Ref. 9-22**]	
Department for Food, Environment and Rural Affairs (Defra) Local Lands, Soils and Groundwater Management Technical Guidance (TG22) [**Ref. 9-23**]	
Design Manual for Roads and Bridges LA 113: Road Drainage and the Water Environment, Revision 1 (2020) [**Ref. 9-24**]	

Document	Summary
Design Manual for Roads and Bridges LA 104: Environmental Assessment and Monitoring, Revision 1 (2020) [**Ref. 9-25**]	
A Green Future: Our 25 Year Plan to Improve the Environment [**Ref. 9-26**]	
The Environment Agency's approach to groundwater protection, Version 1.2 (2018) [**Ref. 9-27**]	
The Environment Agency, protect groundwater and prevent groundwater pollution (August 2024 update) [**Ref. 9-28**]	

Limitations to Assessment

9.3.22. This chapter is based on the findings of the **ES Appendix 9.1 - Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1]** and site reconnaissance, as given in Appendix 9.1. No intrusive investigation has been completed for the current proposals at this stage. The factual data used to complete the desk study includes the previous (2009) investigation findings for the Tween Bridge Wind Farm and borehole records provided as Open Government License data by the British Geological Survey. Given the site's predominantly greenfield nature, a review of desk based information and the limited available site investigation data is considered sufficient for the assessment of potential significant effects. Specific targeted contamination investigation at critical locations during detailed design stage is proposed, in combination with geotechnical investigation for foundation design and directional drilling.

9.3.23. It is noted several areas that have been added to the Scheme area since the initial **ES Appendix 9.1 Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1]** and walkover was undertaken in 2023. These areas include additional areas in the east of Land Parcel B, the east of Land Parcel D, the central and western areas of Land Parcel E and a small land parcel to the east of Land Parcel E known as the 'Biodiversity Mitigation Area'.

In reference to the two option layouts (Layout Option 1 - fixed and tracker panel and Layout Option 2 - fixed panel), it is not considered that layout selection will impact the ground conditions assessment and the assessment of impacts. There

would be no material change in conclusions on the significance of effects and/or mitigation measures between design options.

9.4. Baseline Conditions

9.4.1. This section summarises the findings of **ES Appendix 9.1- Phase 1 Ground** Conditions **Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1]** undertaken in 2025 for Land Parcels A to E.

Order Limits Description and Context

9.4.2. The Order Limits lies east of Thorne and west of Crowle, bounded north by the Humberhead Peatlands National Nature Reserve and south by Hatfield Moors and the Isle of Axholme. It comprises approximately 1,831 hectares of agricultural Land Parcels (named as Parcels A to E and Parcel E – Biodiversity Mitigation Area) within the lowland basin of the former Rivers Don and Idle. The land is typically at 1-4m OD with very low or negligible gradients, drained by ditches and larger drains, with the River Torne forming the southeast boundary. It is crossed by a network of roads, railway and canal.

Geology

9.4.3. The baseline geology at the Order Limits summarised on **Table 9-11 to 9-15** overleaf.

Table 9-11: Order Limits Geology (Land Parcel A)

Land Parcel	Strata	Description	Depth (m)
Land Parcel A -West *(based on 2009 site investigation for the Wind Farm and geology mapping)*	Topsoil	Topsoil	GL to 0.3-0.5
	Hemingbrough Glaciolacustrine Formation	Soft occasionally firm orange brown and grey sandy CLAY or occasionally loose clayey silty SAND	0.3-0.5 to 1.4-2.1
	Hemingbrough Glaciolacustrine Formation	Soft to firm or firm thinly laminated brown sandy CLAY or SILT	1.4-2.1 to 3.8-8.8

Land Parcel	Strata	Description	Depth (m)
	Fluvioglacial sand & Gravel or Hemingbrough Formation	Medium dense red brown silty fine to medium SAND	3.8-8.8 to 10.0-11.0
	Sherwood Sandstone Group	Weak, occasionally very weak red brown medium to coarse grained SANDSTONE, becoming weak to medium strong. With occasional very weak to weak thinly laminated MUDSTONE.	Below 11.0-14.5 +
Land Parcel A – East *(based on available BGS boreholes and geology mapping)*	Topsoil/ Subsoil	Made Ground/ warp Soils (loamy and clayey)	GL to 1.0-1.25
	Reworked Peat/ Alluvium	Soft to firm organic very silty odorous Clay	1.0-1.25 to 3.4
	Flandrian Alluvium/ Hemingbrough Formation	Very soft or firm brown silty sandy Clay with organic fragments	3.4 to 4.5-5.2
	Hemingbrough/ Concealed Sand?	Loose rapidly medium dense brown Sand	4.5-5.2 to 6.8
	Concealed Sand and Gravel/ Weathered Bedrock	Dense red brown slightly silty sand with occasional gravel	6.8 to 9.6-10.0m+

Table 9-12: Order Limits Geology (Land Parcel B)

Land Parcel	Strata	Description	Depth (m)
Land Parcel B *(based on available BGS boreholes and geology mapping)*	Topsoil/ Subsoil	Peaty, loamy and clayey	GL to 0.1-1.0
	Flandrian Alluvium and Peat	Very soft grey and brown organic alluvial Clay/ Silt	0.3-1.0 to 1.0-2.5
		Very soft or soft clayey Peat	0.3-1.0 to 1.5-9.5
		Soft organic alluvial Clay/ Silt or firm clayey sandy Silt	1.5-9.5 to 5.0-12.0
	Hemingbrough Formation	Loose becoming medium dense laminated clayey sandy Silt or firm Silt/ Clay, gravelly in parts	5.0-12.0 to 10.0-12.0
	Mercia Mudstone Group	Medium dense or dense red brown clayey SAND to very weak Sandstone/ Mudstone	10-12.0 +

Table 9-13: Order Limits Geology (Land Parcel C)

Land Parcel	Strata	Description	Depth (m)
Land Parcel C – West (based on available BGS boreholes	Topsoil/ Subsoil	Sandy and loamy	GL to 0.3-0.9
	Alluvium	Soft to firm or firm brown and grey mottled and peaty sandy Clay	0.3-0.9 to 1.0-4.0
	Blown/ Sutton Sand Formation	Loose grey silty Sand	1.0-2.6 to 2.4-3.3

Land Parcel	Strata	Description	Depth (m)
and geology mapping)	Hemingbrough Formation	Soft to firm laminated brown Clay with silt partings and loose sand horizons	2.3-4.0 to 6.5-7.6
	Hemingbrough/ Concealed Sand and Gravel?	Mixed grey silty Clay and Sand with some gravel becoming Medium dense silty Sand	4.5-7.6 to 10.6-16.0
	Chester Formation	Red Marl and Sandstone	Below 10-16.0 +
Land Parcel C – East (based on available BGS boreholes and geology mapping)	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.8
	Blown sand/ Sutton Sand Formation	Medium dense grey brown silty Sand (thin in south, thickening northwards)	0.3-0.8 to 0.5-4.0
	Hemingbrough Formation	Soft to firm brown laminated silty Clay with silt lenses	0.5 to 3.5
	Peat (in southeastern corner)	Very soft brown peat	0.5-1.6
	Concealed Sand and Gravel	Medium dense brown Sand and Gravel	3.5 to 6.5
	Chester Formation	Sandstone	Below 6.5

Table 9-14: Order Limits Geology (Land Parcel D)

Land Parcel	Strata	Description	Depth (m)
Land Parcel D - Northeast (based on available BGS boreholes and geology mapping)	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.6
	Peat	Soft dark brown clayey PEAT	0.3-1.2 to 1.0-2.5
	Flandrian Alluvium and Peat	Soft brown silty Clay or medium dense grey brown silty Sand with organic traces	0.5-2.5 to 1.8-3.7
	Hemingbrough Formation	Soft to firm or firm dark brown silty or silty Clay with silt laminations and fine sand lenses	1.8-3.7 to 6.0-12.0
	Concealed Sand and Gravel	Sand and fine Gravel	6.0-12.0 to 15 +
	Chester Formation	Red Sandstone	Below 15 +
Land Parcel D - Northwest (based on available BGS boreholes and geology mapping)	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.6
	Flandrian Alluvium	Medium dense brown silty Sand or firm sandy Clay, occasionally peaty	0.3-0.6 to 1.3-3.0
	Hemingbrough Formation	Soft or firm brown silty Clay with silt laminations and fine sand lenses	1.3-3.0 to 3.0-4.2
	Concealed Sand and Gravel	Loose becoming medium dense and dense Sand with some fine to coarse Gravel, clayey pockets and cobbles in parts	2.8-4.2 to 5.0-7.0
	Chester Formation	Red sandstone	Below 7.0 +
	Topsoil/ Subsoil	Sandy and loamy with a little gravel	GL to 0.5

Land Parcel	Strata	Description	Depth (m)
Land Parcel D -South (based on available BGS boreholes and geology mapping)	Blown sand/ Sutton Sand Formation/ Breighton Sand	Loose or medium dense grey brown slightly silty fine and medium SAND	0.5 to 2.3
	Hemingbrough Formation	Soft or firm laminated brown very silty Clay to clayey Silt with some sand horizons, becoming gravelly below 4.3m	2.3 to 4.6
	Concealed Sand and Gravel	Dense to very dense Sand with some gravel	4.6 to 7.5
	Chester Formation	Red Sandstone	Below 7.5 +

Table 9-15: Order Limits Geology (Land Parcel E including Biodiversity Mitigation Area)

Land Parcel	Strata	Description	Depth (m)
Land Parcel E East (based on available BGS boreholes and geology mapping)	Topsoil/ Subsoil	Loamy and sandy with peat	GL to 0.3-0.6
	Peat – western area	Soft brown peat	Localised not shown on logs
	Sutton Sand Formation	Medium dense brown sand	0.2-4.0
	Mapped localised in the east - Alluvium - Clay, silt, sand and gravel	Red sandy clay	4.0-11.0
	Mercia Mudstone Group	Red marl with gypsum layers	11.0 - 63
	Chester Formation	Red sandstone	8.0 -356

9.4.4. Made ground is likely to be present in certain areas of the Order Limits, though based on desk study information it is anticipated to be confined to small previously developed areas such as former farm buildings, tracks, paths and access roads. Several former ponds and former sand pits are also present which may have been infilled with unknown materials, however, it is considered likely that any infill consisted of natural and/or inert soils.

Hydrogeology

9.4.5. The Sutton Sand Formation and permeable alluvial deposits are designated as a Secondary A Aquifer, while the peat and Hemingbrough Glaciolacustrine Formation are classified as Unproductive Strata, offering negligible contribution to water supply or base flow.

9.4.6. The Mercia Mudstone Group also forms a Secondary A Aquifer, with limited groundwater storage and yield potential, primarily associated with localised fissuring, thin permeable horizons, and weathered zones. Chester Formation forms a Principal Bedrock Aquifer which are designated by the EA as strategically important rock units that have high permeability and water storage capacity.

9.4.7. The local details of groundwater vulnerability are complex; however, the Secondary Superficial Aquifers are typically of medium groundwater vulnerability in the central and western Order Limits area. Parts of the eastern and northeastern areas, and of the southwest have high groundwater vulnerability in the Secondary Superficial Aquifer, mainly where sands occur.

9.4.8. According to the available logs groundwater elevations across the Order Limits vary between 0.5 and 8.0 m bgl. Groundwater elevations are likely to vary with seasonal and temporal changes and is likely to be at shallower depths in proximity to drainage ditches.

9.4.9. Within 1.00-10.00m distance of drainage ditches, groundwater may be maintained at 1.00-2.00m below GL much of the year and 0.50-1.00m below GL in winter. More remote than 8.00-10.00m probably between 0.50-2.00m below GL most of year in most areas. In some areas groundwater will stand at less than 0.50m below GL in winter, or at field capacity i.e. at ground surface in worst periods.

9.4.10. Overall, groundwater is expected to flow generally from west to east across the study area with rectilinear drainage pattern controls, and little or no flow locally.

9.4.11. The western and central Order Limits area (Land Parcel C, Land Parcel D and central and southern portion of Land Parcel A, and the western extent of Land Parcel E) falls within Zone 3 (Total Catchment) of the groundwater Source Protection Zone (SPZ). The designation is associated with an abstraction borehole at Sandtoft Road Pumping Station, located approximately 830m to the west of Land Parcel D.

9.4.12. One licensed groundwater abstraction is recorded on-site, situated at Grove Farm in the western portion of Land Parcel C, previously used for general farming and domestic purposes. However, this abstraction is classified as historical and is no longer active.

Hydrology

9.4.13. The Order Limits are crossed by numerous watercourses and a system of drainage ditches. Named watercourses located on site include the Old River Don, Hatfield Waste Drain. Stainforth & Keadby Canal (Sheffield and South Yorkshire Navigation) – with North and South Soak Drains running parallel on either side and the River Thorne, run adjacent to the Order Limits. The River Trent, is located approximately 250m east of the Order Limits (Land Parcel E), flowing northward.

9.4.14. Numerous surface water abstractions are recorded on Order Limits for agricultural/irrigation purposes.

Order Limits History

9.4.15. The Order Limits has primarily remained as agricultural land since the earliest available mapping from the late 1800s. Other than occasional farm buildings, ponds, tracks and access roads the following historic features were noted on each Order Limits:

- Land Parcel A - tramway sidings shown in the east Order Limits to be associated with peat extraction, unspecified tank and Tween Bridge Wind Farm in the central and eastern area since 2014.

- Land Parcel B - Medge Hall Peat Works and tramway in the southwest of the Order Limits and a water pumping station in the southwestern corner of the Order Limits.
- Land Parcel C – unspecified ground workings in the southeast of the Order Limits and a pumping station in the southwest.
- Land Parcel D - two infilled sandpits and a pump house in the central area of Order Limits and unspecified tank.
- Land Parcel E - a bomb store area for the WWII Sandtoft airfield extended north to Woodcarr Small Drain, lying within the southwestern extension of Land Parcel E.

Mining and Quarrying

9.4.16. The Order Limits lie within the Mining Remediation Coal Reporting Area but does not lie within a Development High Risk Area. Thorne Colliery operated 1925-58 from two shafts approximately 875m north of the Order Limits and not within influencing distance. There are no recorded coal mining legacy hazards at shallow depths that could pose a risk to public safety or surface stability. The Coal Authority have confirmed there is no requirement to consider mining legacy within the EIA.

9.4.17. Mineral Safeguarding Areas are identified by NLC for Sand and Gravel and for Brick Clay, and by CDC for Sand and Gravel, within parts of the Order Limits. Neither of NLC or CDC respective consented extraction sites, areas of search, nor proposed sites allocations lie within the Order Limits. Development which is deemed a Mineral Safeguarding Exception within the relevant Local Plan policies includes the Exemption Criteria of temporary planning permissions, which (by definition) includes renewables schemes with time limited permission and an integral decommissioning phase.

Environmental permits, landfills and incidents

9.4.18. A number of waste management licences are reported within the Order Limits relating to farming activities.

9.4.19. Numerous potentially infilled ponds and pits are indicated on historic mapping to be located across all areas of the Order Limits however given the Order Limits'

undeveloped nature it is likely that these were infilled with natural material rather than made ground.

Unexploded Ordinance

9.4.20. A review of publicly available UXO risk maps indicate that the Order Limits are located in an area with low potential for wartime ordnance (**Ref: 9-29**) however a bomb store area for the WWII RAF Sandtoft airfield extended into the southwestern extension of Land Parcel E. RAF aerial photographs of 1946 & 1948 and maps of 1967-68 indicate layout of small mounds (likely ordnance storage bunkers) and huts centred on coordinates 475550 409150. This area is shown as taxi routes only on the 1973-1986 maps.

Sources

9.4.21. The Initial Conceptual Exposure Models in **ES Appendix 9.1 Phase 1 Ground Conditions Desk Study reports for Land Parcels A to E [Document Reference 6.3.9.1]** identified the following potential sources:

- Made ground associated with localised farm buildings, ponds and pits (all areas)
- Storage/usage of oils/chemicals within farmsteads (all areas)
- Railway/historic tramway (Land Parcels A and B)
- Historic RAF Sandtoft adjacent to and extending into the south of Area E where taxiways and possible bomb store were indicated (Area E)
- Unspecified tanks (Land Parcels A and D)
- Pumps (Land Parcels B, C and D)

9.4.22. Potential ground gas sources were identified as natural peat and alluvium deposits underlying the Order Limits and made ground associated with localised development (agricultural buildings, tracks and airfield taxiway).

9.4.23. The Conceptual Exposure Model Receptors identified are construction workers, future construction and maintenance staff, drainage ditches and water courses, groundwater within the Secondary Superficial Aquifer and principal and secondary

bedrock aquifers, and the solar Scheme infrastructure and plant. There are no residential receptors within 250m of the proposed substations and BESS areas.

9.4.24. The Conceptual Exposure Model Pathways identified by which contaminant sources could impact on these receptors are dermal exposure and inhalation, migration of ground gas, contact with unexploded ordnance, creation of new water migration pathways during construction, surface water run-off, and direct contact of construction materials with contaminated ground.

Scheme Considerations

9.4.25. There are a number of locations across the site that will require trenchless cable works requiring horizontal directional drilling at surface water and road crossing points. The indicative locations for these are presented in Figure 2.4 Indicative HDD Crossing Plan.

9.4.26. The qualitative risk assessment concludes that the shallow construction activity required for the solar Panel Areas will not create an adverse or worsening impact on the contaminant exposure model. A Construction Environmental Management Plan will be required and is secured as a requirement through the DCO. Further consideration may be needed for structures, confined spaces and sensitive plant, battery storage areas and substations once site investigation data for these locations is available.

9.4.27. It is considered that specific targeted contamination investigations at the critical historical land use or environmental features identified within the conceptual exposure model can be undertaken at detailed design stage following receipt of planning consent. It is envisaged these ground contamination assessments can be considered and controlled via the use of pre-commencement planning conditions relating to contaminated land concerns.

9.4.28. For geotechnical design purposes a range of solar PV module foundations are available, including both screw pile and concrete ballast types, dependent on the soil conditions in various parts of the Order Limits. The BESS units will be raised on concrete pads or plinths sat above a gravel base.. Access roads and tracks are likely to require use of geogrid reinforcement to minimise pavement thickness and materials import, and cable trenching should be scheduled for drier periods.

9.4.29. Geotechnical investigation should develop the ground model following receipt of the planning consent and as part of the detailed design process, particularly where former river channels occur, by use of probing traverses to capture the range of ground conditions, with select control boreholes to aid interpretation. Additional boreholes are needed at directional drilling locations. Foundation trials for solar PV modules could be used to optimise design and construction.

Future Baseline

9.4.30. In the absence of the Scheme, it is likely that the ground conditions within the Order Limits would remain as existing.

9.5. Assessment of Likely Significant Effects

Construction

9.5.1. Site levelling works are not typically envisaged at most locations within the prevalent very low slope angle topography in this area. For the solar PV modules there will be no removal of soil, mineral resources or geological features, and only minor disturbance during construction. At substations and the BESS areas, topsoil will be stripped and stockpiled for reuse during construction or restoration.

9.5.2. Construction of the Scheme is likely to involve installation of cable runs to between 1.2-1.6m below existing ground level and installation of solar PV modules by driving steel pin piles to between 1.5 and 3m depth or adopting concrete ballast foundations. It may be necessary to adopt piled foundations for specific substations and the BESS, dependent on the anticipated loadings and ground conditions. This will reduce the need for large amounts of mass concrete or trench foundations.

9.5.3. New internal access tracks will require stripping of topsoil and placement of aggregate, very likely with geogrid reinforcement to reduce the thickness of new construction required. At inverter stations, substations and the BESS areas, along with temporary construction compounds and stores, it is likely that topsoil will be stripped, an aggregate blanket placed and reinforced concrete slabs constructed to support plant, or piled foundations installed. Topsoil would be appropriately stored to minimise damage and provide for initial and final site restoration.

9.5.4. The requirement to minimise disturbance of peat soils during construction and maintenance in order to minimise release of carbon dioxide and maximise the carbon balance savings of the Scheme is considered in **ES Chapter 14 Air Quality [Document Reference 6.2.14]** .. Potential effects of disturbance on carbon dioxide release are most likely to occur during the construction period.

9.5.5. Given the current degraded ('wasted') soils at the shallow depths anticipated for construction of Panel Areas across the majority of the peaty soils areas, and the current agricultural operations, it is considered that minimal additional disturbance will occur. Where peaty soils occur in areas for compounds, BESS areas or substations, micro siting to reduce potential carbon release will be considered at detailed design stage. Reuse of excavated soils and minimising waste will provide further mitigation.

9.5.6. At horizontal directional drilling crossing points, it is likely that multi-duct installations will be required, with launch and receive pits for the drilling equipment, drilling platforms and potentially a drilling mud storage pit or recycling area pit, along with conventional construction compounds, access and storage areas. A specialist contractors method statement and environmental management plan will be required for this aspect of the construction (as will be outlined in the CEMP to be prepared by the Principal, Contractors).

9.5.7. The determination of the unmitigated effects relating to soils and water resources and potential contamination during the construction phase is given in **Table 9-16** overleaf.

Table 9-16: Significance of effects during construction

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
Soils & Underlying Geology	Loss of Topsoil / Subsoil	Solar Panel Areas: Negligible as no removal of important soil, mineral resources or geological features, and only slight disturbance of soils. Substations, BESS areas, compounds: Low as Localised removal and reuse possible	Low or Medium due to current agricultural use and resilience to structural damage.	Minor or Minor to Moderate **(Not Significant)**
Soils	Damage to soils by compaction, rutting and poaching	Low– Short term work at each area for array installation. Heavier trafficked routes and compounds more likely to be	Medium due to current agricultural use, short term and recoverable	Minor to Moderate **(Not Significant)**

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
		damaged if abnormal weather and wet soils		
Mineral Resource of Underlying Geology	Resource inaccessible	Low – access to local areas restricted only during lifetime of development. No depletion or damage to resource and development temporary.	Safeguarded areas: Medium value as no current consents or areas of search proposals within current Local Plans. Remainder of Order Limits area: Negligible mineral value.	Minor to Moderate **(Not Significant)**
Peat Stability	Unacceptable differential settlement beneath new loaded areas. Stability of excavations. Very localised damage or disruption of	Low – very localised damage or disruption	Medium – construction activities, structures or services	Minor to Moderate **(Not Significant)**

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
	continuity possible.			
Groundwater Quality **Source Protection Zone 3 on-site (Total Catchment)**	Changes to pollutant pathways (Minor nature of most construction limits significant disturbance/ release of contaminants; penetrative foundations could increase potential changes). Short term changes to local groundwater flow regime for new crossing points.	Low – those very few areas of potential (low level) source contamination identified are in array areas only and so unlikely to be disturbed significantly. As required, and following review of ground investigation results post planning (and identification of any areas of potentially contaminated land); any penetrative or deeper foundations such as piling) may require further assessment and mitigation via a Piling Risk Assessment (in accordance with EA guidance). Groundwater level or flow changes short-lived.	Medium or High – Secondary Aquifer in Superficial Deposits, low to Medium permeability soils, Source Protection Zone 3, some areas of High Vulnerability, groundwater & surface water connectivity assumed	Minor or locally Moderate Adverse **(Significant)**

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
Surface Water Quality Substations, BESS and compounds, new roads/tracks	Disturbance of contamination or run-off to water courses	Medium - those very few areas of potential (low level) source contamination identified are in array areas only and so unlikely to be disturbed significantly. due to degree of construction activities proposed, proximity of water courses, likely connectivity with shallow perched groundwater.	Medium – assume likely connectivity between shallow perched groundwater & surface water courses	Moderate - adverse **(Significant)**
Surface Water Quality All areas near drainage or water courses where substations, BESS, compounds or new roads/tracks	Mobilisation of clay/silt fines due to machinery traffic during wet weather	Medium - due to degree of construction activities proposed, proximity of watercourses	Medium – currently agricultural plant operating similarly across majority of area. Locally High sensitivity	Moderate – adverse **(Significant)**
Surface Water Quality	Disturbance of contamination, run-off to water courses,	Medium – proven construction techniques proposed with	High – due to proximity of water courses and	Major-adverse **(Significant)**

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
Horizontal Directional Drilling Sites	potential use of polluting materials and plant	integral preventative measures	assumed likely connectivity between shallow groundwater & water courses	
Ground Gas Regime On-site localized made ground (low gas generation potential)	Linkage of receptors with ground gas	Low - predominantly outdoors usage, with shallow array installation only at these locations. Substations only accessed occasionally for short time periods	Medium – confined spaces & sensitive infrastructure potential at substations and BESS areas	Minor to Moderate **(Not Significant)**
Ground Gas Regime Naturally occurring peat /organic sources	Linkage of receptors with ground gas	Low - predominantly outdoor usage. Shallow array installation. Very low potential for new pathway creation due to shallow construction and 'wasted peat' regime. Confined spaces & sensitive infrastructure potential at substations and BESS	Medium – confined spaces & sensitive infrastructure potential at substations and BESS areas	Minor to Moderate **(Not Significant)**

Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
Surrounding Land Uses	Disturbance /release of contamination beyond Order Limits boundary	Negligible –no works beyond Order Limits boundary.	Low – agricultural or open space. No residential properties within 250m of substations or BESS areas	Negligible **(Not Significant)**
Construction Workers	Exposure to contaminants	Low – if contamination sources present they are considered Minor in nature and extent, & short term exposure	Medium – limited earthworks typically	Minor to Moderate **(Not Significant)**
Construction Workers	Unexploded Ordnance (former airfield / bomb store)	High – UXO would represent an unacceptable risk	Medium – limited earthworks for arrays and inverter stations	Major – adverse **(Significant)**

9.5.8. During the construction phase, risks to human health for ground workers, site visitors and neighbours by exposure to any contaminants present will be controlled by the contractor as part of their obligations under the Construction (Design & Management) Regulations 2015 (CDM) by use of Personal Protective Equipment, dust suppression, vehicle sheeting and wheel washing as necessary, prevention of entry to confined spaces without monitoring or equipment etc.

9.5.9. The processes are well practiced and the risks well understood, therefore the construction would have a remaining Minor adverse **(Not Significant)** potential risk to human health once the risks are correctly controlled.

9.5.10. During the limited groundworks, there will be a low likelihood of exposure of workers to any contaminated soils (and potentially to abnormal ground gases in any confined spaces). The unexploded ordnance risk in the former airfield area remains unknown and Preliminary and Detailed UXO risk assessments from a specialist are to be obtained. This is considered a Major Adverse effect, and therefore **Significant**. It requires mitigation by means of specialist risk assessment to identify the degree of risk. If that assessment concludes that UXO site supervision and watching brief during groundworks in this area is required, then it will be controlled by the contractor under their CDM obligations and secured by implementation of the Detailed Construction Environmental Management Plan (CEMP), broadly in line with the general principles set out in the **Outline Construction Environmental Management Plan [Document Reference 7.1]** submitted with this DCO application The exposure would have a remaining Minor or Negligible adverse **(Not Significant)** potential risk to human health once the risks are correctly controlled.

9.5.11. There is clearly potential, as with most construction sites, for oil/diesel or other contaminants to be accidentally spilled or to leak from plant and equipment during the works. In critical locations, this could potentially impact on the groundwater quality, or run-off to surface water courses. The significance of this potential effect in this Order Limits context is considered Moderate Adverse (**Significant**) and will therefore require mitigation by design at the detailed design phase post consent and management identified within the Detailed CEMP.

9.5.12. There is a low potential for contaminants to be present in any shallow depth Made Ground and Negligible for natural soils. The limited amount of earthworks required for the majority of the area where solar arrays or inverters are proposed will limit disturbance to such soils. The actual degree of contamination present at the substation, BESS areas and compounds areas or where potentially contaminative features or areas have been identified, and where watercourses are in close proximity, is considered a plausible Moderate Adverse effect and therefore **Significant**. This will be clarified during further assessment walkover and research and confirmed during post-consent investigation to inform both detailed design and the Detailed CEMP There are not considered to be any short-term increased

risk of dust generation from soils due to the limited nature of proposed earthworks and the predominantly cohesive soils. However, this requires control measures identified within the Detailed CEMP), broadly in line with the general principles set out in the **Outline Construction Environmental Management Plan [Document Reference 7.1]**.

9.5.13. There is a Moderate Adverse potential for mobilisation of fines within run-off during abnormal or extreme wet weather combined with intense traffic movements of construction machinery. While there is currently frequent heavy agricultural plant using similar techniques, this aspect is considered **Significant** and requires mitigation. The Detailed CEMP must include control measures, requirements for use of protective systems such as track matting or membrane cover and protocols for work adaption.

9.5.14. The directional drilling proposals, particularly where adjacent to watercourses are considered a plausible Major Adverse (**Significant**) effect due to the type of construction activity in proximity to surface water and with potential to intersect the groundwater table.

9.5.15. Based on the Indicative HDD locations identified in Figure 2.4 there is no directional drilling proposed in the southwest of Land Parcel D which is the area closest to a Contaminated Land Special Site located 144m to the west of the site. However directional drilling is proposed at the southern boundary of Land Parcel E in the location of the former wartime RAF airfield. Site investigation of these areas will be required to identify any residual contamination that may be present.

9.5.16. A specialist directional drilling contractor's method statement and environmental management plan will be required for this Significant aspect of the construction to mitigate the potential effects. Any mitigation measures of note will be included within specific method statements for the delivery of these works.

9.5.17. For Safeguarded Minerals Areas within the Order Limits the temporary nature of the development and the fact that it would not deplete or damage the resource for the longer term indicates a Minor to Moderate (**Not Significant**) effect.

9.5.18. Groundwater levels and flow pathways are unlikely to be altered by installation of array foundation pin piles or shallow cabling due to their typical size and length. In cohesive soils the driven installation forms a rapid 'seal' around the pin, thus precluding formation of new vertical pathways.

9.5.19. Where peaty soils are present, these are classed as 'wasted' due to prolonged drainage and agriculture. The limited degree of disturbance caused by array piles is unlikely to create any further enhanced drainage or wasting due to the installation. Groundwater within the deeper organic deposits beneath the pin piles would be unaffected.

Operation

9.0.1 Following commissioning, maintenance engineers would visit on occasion as necessary. Grass pasture will be retained or upgraded between and beneath the arrays which will be available for small livestock grazing.

9.0.2 This land use will maintain or lower the probability of future ground contamination of soils and geology occurring. This is a low magnitude effect on a Medium sensitivity receptor and therefore will produce a Minor Neutral or Beneficial (**Not Significant**) effect.

9.0.3 The end users and surrounding land uses are limited to maintenance staff during periodic visits and surrounding agriculture or open space sites. The Order Limits usage will maintain or lower the probability of exposure to any ground contaminants, by reducing agricultural intervention such as ploughing or digging. This is a low magnitude effect on Medium sensitivity receptors and therefore will produce a Minor Neutral or Beneficial (**Not Significant**) effect.

9.0.4 Due consideration and appropriate mitigation strategies will be required in the event of a fire at the Order Limits, owing to the fact firewater run off may lead to the leaching of chemical components from battery components that could enter into either surface water courses or cause contamination of underlying soils. These risks are considered as part of the **Outline Battery Safety Management Plan [Document Reference 7.4]**, **ES Chapter 10 Water Resources [Document Reference 6.2.10]** and **ES Appendix 10.1 - Flood Risk Assessment [Document Reference 6.3.10.1]**.

Decommissioning

9.0.5 The decommissioning phase is considered to create potential similar effects to that during construction, or of lesser magnitude. All above ground plant and equipment, and all cabling above 1m below ground would be removed. Any cabling buried 1m+ below ground will not be removed at decommissioning.

9.5.20. Bunded topsoil from the initial stripped areas can be reused for Order Limits restoration. Where steel pin piles are adopted, these installations can be removed easily and economically.

9.6. Mitigation, Enhancement and Residual Effects

Construction Phase - Mitigation by Design

9.6.1. Environmental effects on ground conditions which are determined as Moderate or Major would be mitigated within the embedded design measures and secured through implementation of the Detailed CEMP, broadly in line with the general principles set out in the **Outline Construction Environmental Management Plan [Document Reference 7.1],** for the Scheme. Additionally, effects considered above as Minor to Moderate will be mitigated by inclusion within embedded design considerations, the Detailed CEMP and good construction practice.

9.6.2. Those embedded measures will be secured by adoption of agreed Outline and Detailed Construction Environmental Management Plans. The measures are summarised in **Table 9-17** and described further below.

9.6.3. Peat stability will be assessed during detailed design at any specific locations where existing geological data or intrusive investigation indicates a sufficient peat thickness would be intersected by the proposed construction, such as at new accesses, tracks or where structures are proposed. Critical areas will be identified and protocols for groundworks activities in these areas developed.

9.6.4. Selection of appropriate plant and best practice working methods would be adopted to control or reduce creation of new pathways during penetrative foundations i.e. piling.

9.6.5. Appropriate buffer or non-working zones would be integral to the construction layout alongside surface water courses to prevent fines run-off, or mobilisation of chemicals entering the water courses.

9.6.6. Appropriately located storage areas would be allocated for all construction products, in particular hydrocarbons or petrochemicals in accordance with Control of Substances Hazardous to Health (COSHH) Regulations 2002 .

9.6.7. For crossing points requiring horizontal directional drilling, specific risk assessments, method statements and environmental management plans, based

on location specific topography, ground and groundwater conditions, will be undertaken and agreed with consultees, stakeholders and regulators prior to commencement.

9.6.8. Assessment of shallow depth ground gas regime at sensitive infrastructure locations such as substations and BESS areas is required, with adoption of appropriate gas protection within ground slab design if appropriate. Location specific unexploded ordnance risk assessments would be undertaken by specialist consultancy at detailed design stage and their recommendations embedded in the Detailed CEMP. This may require on-site supervisory watching brief and in situ testing during works.

9.6.9. Environmental effects on ground conditions which are determined as Moderate or Major would be mitigated within the embedded design measures and secured through implementation of the Detailed CEMP for the Scheme. Additionally, effects considered above as Minor to Moderate will be mitigated by inclusion within embedded design considerations, the CEMP and good construction practice.

Additional Mitigation

During Construction

9.6.10. No additional mitigation measures are currently envisaged as required prior to and during construction, since the potential effects detailed above are considered localised and temporary, or would be controlled by the embedded design and management measures secured by the CEMP, or controlled by contractors obligations under CDM Regulations.

During Operation

9.6.11. With the implementation of the embedded mitigation measures and those undertaken during the construction phase, the effects on Ground Conditions aspects during operation of the Scheme are considered Negligible (**Not Significant**).

9.6.12. Maintenance activities involving potentially contaminative products would be controlled under the Detailed Operational Environmental Management Plan (OEMP) broadly in line with the general principles set out in the **Outline Operational Environmental Management Plan [Document Reference 7.1],** submitted with this

DCO application. The Surface Water Drainage Strategy (included within **ES Appendix 10.1 - Flood Risk Assessment [Document Reference 6.3.10.1]**) has been designed to preclude potentially contaminated run-off. Maintenance works involving in-ground working or excavations would require similar strategy and control to those adopted at construction stage, and again be specified within the Detailed OEMP.

9.6.13. Similarly, as mentioned, consideration has been given to management of any firewater run off in the event of a fire on site to prevent introduction of new sources of contamination being introduced to site soils or surface water courses, as detailed in the **Outline Battery Safety Management Plan [Document Reference 7.4]** and **ES Chapter 10 Water Resources [Document Reference 6.2.10]** and accompanying **ES Appendix 10.1 - Flood Risk Assessment [Document Reference 6.3.10.1]**.

9.6.14. No additional mitigation measures are envisaged therefore during operation for ground conditions aspects.

During Decommissioning

9.0.6 At the end of the Scheme operation, it is anticipated that decommissioning works would have similar effects on ground conditions aspects to those during the construction stage. A Detailed Decommissioning Environmental Management Plan (DEMP) will be produced before the decommissioning phase, broadly in line with the general principles set out in the **Outline Decommissioning Environmental Management Plan [Document Reference 7.3],** submitted with this DCO application, secured through the DCO as a requirement. The Detailed DEMP will secure and control management measures during the decommissioning phase.

Table 9-17: Mitigation Measures by Design and CEMP

Ref	Measure to avoid, reduce or manage any adverse effects and/or to deliver beneficial effects	To be secured by CEMP
1	Peat stability assessment	x
2	Prevent changes to pollutant pathways or prevent new pathways creation	X
3	Prevent disturbance of contamination or run off to water courses	X
4	Horizontal Directional Drilling Method Statement and CEMP	X
5	Gas Risk Assessment	x
6	Unexploded Ordnance Risk Assessment and potentially on-site supervision / watching brief and in situ testing	X
7	Phase 2 Geotechnical & Geoenvironmental Investigation	x
8	Contractors watching brief for unforeseen contamination	X

Residual Effects

9.0.7 Residual effects are only considered in the assessment assuming implementation of the mitigation measures described above.

9.0.8 It is therefore considered that if the mitigation measures are implemented and adhered to then there should be **No Significant Residual Adverse** effects to the soils, geology, hydrogeology, contaminated land, ground gas regime during the construction, operation and decommissioning phases of the Scheme.

9.7. Summary

Introduction

9.7.1. This chapter of the ES assesses the likely significant effects of the Scheme on Ground Conditions, including soils, geology, groundwater and contaminated land.

Baseline Conditions

9.7.2. This Order Limits is predominantly large agricultural fields with isolated farmsteads, crossed by a network of roads, railway and canal. It forms part of the lowland basin of the former Rivers Don and Idle, being low-lying at typically 1-4mOD, with very low to Negligible natural gradients. The fields are typically bounded by a grid of numerous drainage ditches and larger watercourses.

9.7.3. The area is underlain by thick sequences of complex superficial deposits including former lake laminated silt/clay deposits, sands and gravels and infill sediments to deep glacial period channels. Thick alluvial clay and silt blankets these and overlap marginal peat deposits. The old rivers have been historically diverted and artificial alluvium (floodwarp) deposited to provide better draining agricultural soils.

9.7.4. Surface soils are loamy or clayey, slowly to moderately permeable, or relatively impermeable and seasonally wet with impeded drainage. This helps maintain a naturally high groundwater table. There are no bog peat soils mapped.

9.7.5. There is no requirement to consider coal mining legacy within the Order Limits. Peat soils were formerly more extensive, but peat cutting, drainage, ploughing and flood warping has lowered and compacted the relatively thin surface peats, such that they are classed as 'wasted' within the Order Limits area. Parts of the western and eastern areas are included in Minerals Safeguarding Areas for sands and gravels, although these do not include any operational extraction sites, consented, proposed or search areas within the current Local Plans.

9.7.6. The Scheme area lies beyond the Hatfield Moors gas field and two Petroleum Exploration and Development Licence areas cover parts of the western Order Limits. The area has a prolonged agricultural history with isolated farmsteads. Peat working is not specifically mapped but has likely occurred historically, with peat works beyond the boundaries. A World War II airfield and bomb stores in the extreme southeast has been returned to agriculture.

9.7.7. Permeable alluvial superficial deposits typically form a Secondary A Aquifer, whilst the peat and laminated silt/clay deposits are Unproductive. Sherwood Sandstone at depth forms a Principal Bedrock Aquifer. Groundwater levels are maintained below ground level for much of the year by drainage and there is likely hydraulic continuity between groundwater and water courses. The overall level and flow will also be controlled by local factors such as former drainage courses or historical features. The western and central zones are in Source Protection Zone (SPZ) 3, due to a SPZ 1 at a pumping station 600m west of the Order Limits, and SPZ 2, 250m West. Groundwater vulnerability to pollution is typically Medium, with parts being High where sands of the Secondary Superficial Aquifer occur.

9.7.8. Other potential sources of contamination identified include the former RAF Sandtoft airfield extending into the south of Land Parcel E including a possible bomb storage area.

9.7.9. Potential Source-Pathway-Receptor linkages identified for assessment can be summarised as: dermal and inhalation exposure and UXO risk to construction workers at the former sand workings, adjacent waste site and airfield; leaching or migration of liquid or mobile contamination to surface water or groundwater; fines laden run-off to water courses if heavy machine working in adverse weather conditions; migration of abnormal ground gases to sensitive structures; direct contact of construction materials with contaminated soils; directional drilling at crossing points adjacent water courses.

9.7.10. Assessment concludes that the shallow construction for solar panel areas will not create an adverse or worsening effect. A Construction Environmental Management Plan (CEMP) will be required.

9.7.11. Further consideration is required for structures, confined spaces and sensitive plant. Specific targeted contamination investigation at critical locations during detailed design stage is proposed, in combination with geotechnical investigation for foundation design and directional drilling.

Likely Significant Effects

9.8.1 The assessment indicates that during construction the majority of effects can be controlled by CDM Regulations and the CEMP as they are well understood and practised. The limited and shallow groundworks create low likelihoods of exposure.

9.8.2 Those potential effects deemed Moderate or Major Adverse (**Significant**) comprise: UXO risk at the former airfield/bomb stores; potentially polluting construction plant and materials working near water courses; disturbance of any contaminated soils where deeper or larger scale construction proposed for substations and BESS area; fines run-off to water courses if heavy machinery working during adverse weather; and directional drilling at surface water crossing points.

Mitigation and Enhancement

9.8.3 Environmental effects determined as Moderate or Major would be mitigated within the design measures of the Scheme to prevent, reduce and offset those effects. Those embedded mitigation measures will be secured by adoption of agreed Outline and Detailed CEMP's.

9.8.4 With the adoption and implementation of the agreed embedded mitigation measures, the effects identified for construction, operation and decommissioning of the Scheme are Negligible (**Not Significant**).

Conclusion

9.8.5 The short duration construction period and shallow depth intrusive construction method for the majority of the Scheme are determined as creating only localised and temporary environmental effects. Those elements determined as potentially giving rise to Moderate or Major effects would be mitigated by implementation of a well understood and practiced CEMP and controlled under CDM Regulations, secured under the DCO. The residual effects are therefore Negligible and **Not Significant**.

9.7.12. **Table 9-18** overleaf provides a summary of effects, mitigation and residual effects.

Table 9-18: Summary of Effects, Mitigation and Residual Effects

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Construction								
Soils & Underlying Geology	Loss of Topsoil / Subsoil	Temporary Direct	Medium	Low	Local	Minor or Minor to Moderate Adverse (Not significant)	None required	Negligible (**Not Significant**)
Soils	Damage by compaction or rutting	Temporary Direct	Medium	Low	Local	Minor to Moderate Adverse (Not significant)	None required	Negligible (**Not Significant**)

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Mineral Resource of Underlying Geology	Resource inaccessible	Temporary Direct	Medium	Low	Borough / District	Minor to Moderate Adverse (Not significant)	None required	Negligible (**Not Significant**)
Peat Stability	Settlement, stability, damage, disruption	Permanent Direct	Medium	Low	Local	Minor to Moderate Adverse (Not significant)	Design and CEMP	Negligible (**Not Significant**)
Aquifers, Groundwater Quality, Source	Change to pathway, flow Change in quality	Temporary Direct	Medium or High	Low	Borough / District	Moderate Adverse (Significant)	Design and CEMP	Negligible (**Not Significant**)

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Protection Zones								
Surface Water Quality	Disturbance of contamination Mobilisation of Fines	Temporary Direct	Medium	Medium	Borough / District	Moderate Adverse (Significant)	Design and CEMP	Negligible (**Not Significant**)
Surface Water Quality Directional Drilling Sites	Disturbance of contamination, run-off, polluting materials / plant	Temporary Direct	High	Medium	Borough / District	**Major** **Adverse** (Significant)	Risk Assessment, Design and CEMP	Negligible (**Not Significant**)
Ground Gas Regime	Linkage of receptors with ground gas	Permanent Direct	Medium	Low	Local	Minor to Moderate Adverse	Design and CEMP	Negligible (**Not Significant**)

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
						(Not significant)		
Natural Ground Gas (Peat)	Linkage of receptors with ground gas	Permanent Direct	Medium	Low	Local	Minor to Moderate Adverse (Not significant)	Design and CEMP	Negligible (**Not Significant**)
Surrounding Land Uses	Release of contaminants beyond boundaries	Temporary Indirect	Low	Negligible	Local	Negligible (Not significant)	CEMP	Negligible (**Not Significant**)
Construction Workers	Exposure to contaminants	Temporary Direct	Medium	Low	Local	Minor to Moderate Adverse	CDM CEMP	Negligible **(Not Significant**)

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
						(Not significant)		
Construction Workers	Unexploded Ordnance	Temporary Direct	Medium	High	Local	Major Adverse (Significant)	UXO Assessment CDM CEMP	Negligible (**Not Significant)**
Operation								
Soils	Future ground contamination	Temporary Direct	Low	Low	Local	Minor Neutral or Beneficial	Not required	Negligible (**Not Significant**)
End Users and	Future contamination exposures	Temporary Indirect	Medium	Low	Local	Minor Neutral or Beneficial	Not required	Negligible (**Not Significant**)

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Surrounding Uses								
Decommissioning								
Similar to Construction Phase								

9.8. References

9.8.1. Ref 9-1: Defra (2012), Part IIA of the Environmental Protection Act 1990, Contaminated Land Statutory Guidance, April 2012.

9.8.2. Ref 9-2: The Contaminated Land Regulations (England) 2006, https://www.legislation.gov.uk/

9.8.3. Ref 9-3: The Contaminated Land (England) (Amendment) Regulations 2012, https://www.legislation.gov.uk/

9.8.4. Ref 9-4: The Water Act 2003 (c 37)

9.8.5. Ref 9-5: Water Resources Act 1991 (c. 57)

9.8.6. Ref 9-6: Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

9.8.7. Ref 9-7: The Groundwater (Water Framework Directive) (England) Direction 2016

9.8.8. Ref 9-8: The Environmental Damage (Prevention and Remediation) Regulations 2009

9.8.9. Ref 9-9: Department for Energy Security & Net Zero, Overarching National Policy Statement for energy (EN-1) 2023

9.8.10. Ref 9-10: Department for Energy Security & Net Zero, National Policy Statement for renewable energy infrastructure (EN-3) 2023

9.8.11. Ref 9-11: Department for Energy Security & Net Zero, National Policy Statement for Electricity Networks Infrastructure (EN-5)

9.8.12. Ref 9-12: National Planning Policy Framework (NPPF) 2024

9.8.13. Ref 9-13: The Environmental Permitting (England and Wales) Regulations 2016

9.8.14. Ref 9-14: Doncaster Local Plan 2015-2035 adopted 2021

9.8.15. Ref 9-15: The North Lincolnshire Local Development Framework 2010

9.8.16. Ref 9-16: The North Lincolnshire Local Plan 2020-2038 Submitted 2022

9.8.17. Ref 9-17: Environment Agency (2023), Land contamination risk management, https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm, 2023.

9.8.18. Ref 9-18: Defra (2012), Part IIA of the Environmental Protection Act 1990, Contaminated Land Statutory Guidance, April 2012.

9.8.19. Ref 9-19: Ministry of Agriculture, Fisheries and Food Agricultural Land Classification of England and Wales Revised guidelines and criteria for grading the quality of agricultural land, 1988

9.8.20. Ref 9-20: Likelihood of Best and Most Versatile Agricultural Land Strategic scale maps (Natural England, 2017)

9.8.21. Ref 9-21: Institute of Environmental Management and Assessment (IEMA) Guide: A New perspective on Land and Soil in Environmental Impact Assessment (2022)

9.8.22. Ref 9-22: Technical Information Note TIN049: Agricultural Land Classification: protecting the best and most versatile agricultural land, 2nd edition (2012)

9.8.23. Ref 9-23: Department for Food, Environment and Rural Affairs (Defra) Local Lands, Soils and Groundwater Management Technical Guidance (TG22), 2024

9.8.24. Ref 9-24: Highways England, Design Manual for Roads and Bridges LA 113: Road Drainage and the Water Environment, Revision 1 (2020)

9.8.25. Ref 9-25: Highways England, Design Manual for Roads and Bridges LA 104: Environmental Assessment and Monitoring, Revision 1 (2020)

9.8.26. Ref 9-26: HM Government, A Green Future: Our 25 Year Plan to Improve the Environment, 2018

9.8.27. Ref 9-27: Environment Agency, The Environment Agency's approach to groundwater protection, Version 1.2 (2018)

9.8.28. Ref 9-28: The Environment Agency, protect groundwater and prevent groundwater pollution (August 2024 update)

9.8.29. Ref 9-29: Zetica, Zetica UXO Risk Maps (2025)

9.9. Glossary

Table 9-19: Glossary and Acronyms for Ground Conditions

Terms	Description
BGS	British Geological Survey
CDC	City of Doncaster Council
CA	Coal Authority
CEMP	Construction Environmental Management Plan
CDM	Construction (Design & Management) Regulations 2015
COSHH	Control of Substances Hazardous to Health
EA	Environment Agency
EPA	Environmental Protection Act
ES	Environmental Statement
LCRM	Land Contamination Risk Management
LPA	Local Planning Authorities
NLC	North Lincolnshire Council
OEMP	Operational Environmental Management Plan

Terms	Description
PEDL	Petroleum Exploration and Development Licence
RBMP	River Basin Management Plan
SPZ	Source Protection Zone
WFD	Water Framework Directive