The Sizewell C Project

6.6 Volume 5 Two Village Bypass

Chapter 11 Geology and Land Quality

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11. Geology and Land Quality

11.1 Introduction

11.1.1 This chapter of **Volume 5** of the **Environmental Statement** (**ES**) presents an assessment of the potential effects on geology and land quality arising from the construction and operation phases of the two village bypass (referred to throughout this volume as the 'proposed development'). This includes an assessment of potential impacts, the significance of effects, the requirements for mitigation and the residual effects.

11.1.2 Detailed descriptions of the two village bypass site (referred to throughout this volume as the 'site'), the proposed development and the different phases of development are provided in **Chapters 1** and **2** of this volume of the **ES**. A glossary of terms and list of abbreviations used in this chapter is provided in **Volume 1, Appendix 1A** of the **ES**.

11.1.3 The government's good practice guide for Environmental Impact Assessment[1] (EIA) outlines the potential environmental effects that should be considered for geology and land quality, e.g. physical effects of the development, effects on geology and effects on contamination (Ref. 11.1). Further information on these potential environmental effects and those which have been scoped in to the geology and land quality assessment can be found in **Volume 1**, **Appendix 6N** of the **ES**.

11.1.4 This assessment has been informed by data from the following other assessments:

- **Chapter 10** of this volume: Soils and agriculture.
- **Chapter 12** of this volume: Groundwater and surface water.

11.1.5 This assessment has also been informed by data presented in the following technical appendices:

- **Appendix 11.A** of this volume: Two Village Bypass: Phase 1 Desk Study Report, 2020.
- **Appendix 11.B** of this volume: Conceptual Site Models.
- **Appendix 11.C** of this volume: Impact Assessment Tables.

1 It should be noted that this document has been withdrawn; however, it still constitutes good advice and should be referred to in the absence of alternative guidance documents

11.2 Legislation, policy and guidance

11.2.1 **Volume 1, Appendix 6N** of the **ES** identifies and describes legislation, policy and guidance of relevance to the assessment of the potential geology and land quality impacts associated with the Sizewell C Project across all **ES** volumes.

11.2.2 This section provides an overview of the legislation, policy and guidance specific to the assessment of the proposed development.

a) International

11.2.3 International legislation or policy relevant to the geology and land quality assessment includes the Water Framework Directive (WFD) 2000/60/EC and the Waste Framework Directive 2008. The requirements of these, as relevant the geology and land quality assessment, are described in **Volume 1**, **Appendix 6N** of the **ES**.

b) National

11.2.4 National legislation and policies relating to the geology and land quality assessment include:

- Part IIA of the Environmental Protection Act 1990.
- Water Resources Act 1991 (as amended).
- The Control of Substances Hazardous to Human Health Regulations 2002 (as amended).
- Construction (Design and Management) Regulations 2015.
- Waste Management Regulations 2016 (as amended).
- Landfill (England and Wales) Regulations 2005.
- Hazardous Waste (England and Wales) Regulations 2005.
- The Environmental Permitting (England and Wales) Regulations 2016.

The requirements of these, as relevant to the geology and land quality assessment, are set out in **Volume 1, Appendix 6N** of the **ES**.

i. Planning policies

11.2.5 National Policy Statements (NPS) set out national policy for energy infrastructure. The overarching NPS for Energy (NPS EN-1) (Ref. 11.2), and NPS for Nuclear Power Generation (NPS EN-6) (Ref. 11.3) provide the

primary policy framework within which the proposed development will be considered. The requirements of these, as relevant the geology and land quality assessment, are described in **Volume 1**, **Appendix 6N** of the **ES**.

11.2.6 Other national policies relevant to the geology and land quality assessment include the National Planning Policy Framework 2019 (Ref. 11.4), Planning Practice Guidance 2019 (Ref. 11.5) and the Government's 25 Year Environment Plan 2018 (Ref. 11.6). The requirements of these are described in **Volume 1**, **Appendix 6N** of the **ES**.

c) Regional

11.2.7 No regional policy is deemed relevant to the assessment of geology and land quality for this site.

d) Local

11.2.8 **Volume 1, Appendix 6N** of the **ES** summarises the requirements of Suffolk Coastal District Council Local Plan Core Strategy and Development Management Polices (Ref. 11.7), and Suffolk Coastal District Council Final Draft Local Plan (Ref. 11.8), as relevant to the geology and land quality assessment.

e) Guidance

11.2.9 Guidance relating to the geology and land quality assessment include:

- The Department for Environment, Food and Rural Affairs (Defra) Contaminated Land Statutory Guidance 2012 (Ref. 11.9).
- Contaminated Land Report 11[2] (Ref. 11.10).
- Guiding Principles for Land Contamination (GPLC) (Ref. 11.11).
- The Definition of Waste: Development Industry Code of Practice (DoWCoP) (Ref. 11.12).
- The Design Manual for Roads and Bridges (2008) Volume 11, Section 2, Part 5 Assessment and Management of Environmental Effects (Ref. 11.13).
- The Design Manual for Roads and Bridges (1993) Volume 11, Section 3, Part 11 Geology and Soils (Ref. 11.14).

[2] It is noted that CLR11 is due to be withdrawn early 2020 and replaced by updated online guidance: Environment Agency Land contamination: Risk Management (LCRM).

- Department of the Environment (DoE) (1995) Industry Profiles for previously developed land, Environment Agency (Ref. 11.15).
- Construction Industry Research and Information Association C552 (2001) Contaminated Land Risk Assessment – A Guide to Good Practice (Ref. 11.16).
- National House-Building Council and Environment Agency (2008) Guidance on the Safe Development of Housing on Land Affected by Contamination (R&D66) (Ref. 11.17).
- Construction Industry Research and Information Association C665 (2007) Assessing Risks Posed by Hazardous Ground Gases to Buildings (Ref. 11.18).
- British Standards (2015) BS 8485 +A1:2019 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (Ref. 11.19).
- Construction Industry Research and Information Association C681 (2009) Unexploded Ordnance (UXO) – A Guide for the Construction Industry (Ref. 11.20).
- Construction Industry Research and Information Association C733 (2014) Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks (Ref. 11.21).
- Construction Industry Research and Information Association C682 (2009) The Volatile Organic Contaminants Handbook (Ref. 11.22).
- British Standards (2015) BS 5930 – Code of practice for ground investigations (Ref. 11.23).
- British Standards (2017) BS 10175:2011+A2:2017 – Code of Practice for Investigation of Potentially Contaminated Sites (Ref. 11.24).

11.2.10 Further detail on this guidance, as relevant to the geology and land quality assessment is set out in **Volume 1, Appendix 6N** of the **ES**.

11.3 Methodology

a) Scope of the assessment

11.3.1 The generic EIA methodology is detailed in **Volume 1**, **Chapter 6** of the **ES**.

11.3.2 The full method of assessment for geology and land quality that has been applied for the Sizewell C Project is included in **Volume 1, Appendix 6N** of the **ES**.

11.3.3 This section provides specific details of the geology and land quality methodology applied to the assessment of the proposed development, and a summary of the general approach to provide appropriate context for the assessment that follows. The scope of assessment considers the impacts of the construction and operation phases of the proposed development.

11.3.4 The scope of this assessment has been established through a formal EIA scoping process undertaken with the Planning Inspectorate. A request for an EIA scoping opinion was initially issued to the Planning Inspectorate in 2014, with an updated request issued in 2019, see **Volume 1, Appendix 6A** of the **ES**.

11.3.5 Comments raised in the EIA scoping opinion received in 2014 and 2019 have been taken into account in the development of the assessment methodology. These are detailed in **Volume 1, Appendices 6A** to **6C** of the **ES**.

- Physical effects of the development: such as changes in topography, soil compaction, soil erosion, ground stability, etc.
- Effects on geology as a valuable resource: such as mineral resource sterilisation, loss or damage to regionally important geological sites, geological sites of special scientific interest (SSSIs), etc.
- Effects on soil as a valuable resource: such as loss or damage to soil of good agricultural quality.
- Effects associated with ground contamination that may already exist on-site: such as introducing or changing pathways and receptors.
- Effects associated with the potential for polluting substances used (during the various phases) to cause new ground contamination issues on-site, such as introducing or changing the source of contamination and, or pathways.
- Effects associated with re-use of soils and waste soils: such as re-use of site-sourced materials on- or off-site, disposal of site-sourced materials off-site, importation of materials to the site, etc.

11.3.6 The proposed development is considered unlikely to have an impact on important geological sites as no geological SSSIs or local geological sites have been identified within the study area, as described in **section 11.3** of this chapter**.** However, given the comments in the revised scoping opinion

received in 2019 in relation to effects on geology as a valuable resource, an assessment of the effects on mineral resources has been included.

11.3.7 Physical effects in relation to changes in topography are discussed in **Chapter 6** of this volume. The effects on soil as a valuable resource are discussed in **Chapter 10** of this volume. Management of site-sourced waste materials, other than site soils (i.e. general waste materials from construction and operational phases) is summarised in **Chapter 2** of this volume, with further details provided in the **Waste Management Strategy** provided in **Volume 2, Appendix 8A** (Doc Ref. 6.3).

11.3.8 Therefore, the following remaining environmental effects have been considered and form part of the assessment in this chapter:

- Physical effects of soil erosion, soil compaction and ground stability.
- Mineral resource loss, damage or sterilisation.
- Effects associated with existing ground contamination and potential new ground contamination issues.
- Effects associated with the re-use or disposal of site sourced soils and waste soils.

11.3.9 Potential impacts from existing and new contamination sources on controlled waters have been considered as part of the geology and land quality assessment to determine and classify potential effects associated with ground contamination. Further description of the effects from contamination to groundwater and surface water is provided in **Chapter 12** of this volume.

11.3.10 This chapter provides an initial indication of chronic long-term risks to construction and maintenance workers. In accordance with the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11), short-term acute risks should be assessed, managed and mitigated by the Contractor with appropriate risk assessments and methods statements, and subsequent control measures.

b) Consultation

11.3.11 The scope of the assessment has also been informed by ongoing project-wide consultation and engagement with statutory consultees throughout the design and assessment process as outlined in **Volume 1, Appendix 6N** of the **ES**.

c) Study area

11.3.12 To consider the physical effects of the proposed development and the effects associated with mineral resources, the re-use of soils and waste soils, the study area is defined as the area within the site boundary. The site boundary of the proposed development is presented in **Chapter 1, Figure 1.1** of this volume.

11.3.13 The study area for the consideration of effects on human receptors, controlled waters, ecological receptors and property receptors includes the site and land immediately beyond it to a distance of 500 metres (m). This takes into account the transport and final destination of potential contaminants of concern in the environment, and the connectivity of these contaminants via pathways of migration, or exposure to the receptors identified.

11.3.14 Based on the contaminated land desk study provided in **Appendix 11A** of this volume, the study area was considered sufficient for the assessment of the potential land contamination and associated potential contaminant linkages (PCL)[3] risks as the land has previously undergone limited development. The contamination, if present, is likely to be limited in extent or have a limited lateral mobility if present.

d) Assessment scenarios

11.3.15 The assessment of effects on geology and land quality includes the assessment of the construction and operational phases of the proposed development, rather than specific assessment years.

e) Assessment criteria

11.3.16 As described in **Volume 1, Chapter 6** of the **ES**, the EIA methodology considers whether impacts of the proposed development would have an effect on any resources or receptors. For physical effects and effects associated with mineral resources, waste soils, and soil re-use, the assessments broadly consider the magnitude of impacts, and value or sensitivity of resources, or receptors that could be affected in order to classify effects. For land contamination the assessment considers the change in the level of contaminative risks to the relevant receptors in order to classify effects.

[3] Where a linkage exists or is considered likely to be present between a potential contamination hazard/source, pathway and receptor relevant to the site.

11.3.17 A summary of the two assessment methods and assessment criteria used in the geology and land quality assessment is presented in the following sub-sections.

i. Physical effects and effects associated with mineral resources, waste soils and soil re-use

11.3.18 An impact assessment of the potential physical effects of the proposed development on geology and the effects associated with mineral resources, soils re-use and waste soils has been undertaken using a qualitative approach which considers the effects of the construction and operational phases of the proposed development.

Value/sensitivity

11.3.19 The value/sensitivity of a receptor is considered when determining the consequence of an effect in the impact assessment. Where the attribute falls within two value/sensitivity criteria, the worst case value/sensitivity is selected. The value/sensitivity of soil and geological receptors has been determined using the classifications given in **Table 11.1**.

Table 11.1: Criteria for classifying the value and/or sensitivity of environmental resources/receptors.

Value/ sensitivity	Criteria	Description
High	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a very low capacity to accommodate the proposed change.	Regionally important mineral resource. Within a mineral safeguarding area. Major ground stability, soil compaction or erosion hazards currently present at the site. High potential for soils re-use.
Medium	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a low capacity to accommodate the proposed change.	Moderately economically viable mineral resource. Adjacent to a mineral safeguarding area. Moderate ground stability, soil compaction or erosion hazards currently present at the site. Moderate potential for soils re-use.
Low	Attribute only possesses characteristics which are locally significant. Attribute has some tolerance to accommodate the proposed change.	Low economically viable minerals. Low ground stability, soil compaction or erosion hazards currently present at the site. Limited opportunity for soils re-use.
Very low	Attribute characteristics do not make a significant contribution to local character or distinctiveness. Attribute is generally tolerant and can accommodate the proposed change.	No economically viable minerals. No ground stability, soil compaction or erosion hazards currently present at the site. No opportunity for soils re-use.

Magnitude

11.3.20 Following determination of the value/sensitivity of the receptors, the magnitude of potential impacts are determined. The criteria for the assessment of impact magnitude for physical effects and effects associated with mineral resources, waste soils and soils re-use are defined in **Table 11.2**.

Table 11.2: Assessment of magnitude of impacts for physical effects and effects associated with mineral resources, waste soils and soil re-use.

Magnitude	Criteria
High	Total loss or major alterations to one or more of the key elements, features or characteristics of the baseline. The situation will be fundamentally different.
Medium	Partial loss or alteration to one or more of the key elements or characteristics of the baseline. The situation will be partially changed.
Low	Minor loss or alteration to one or more of the key elements, features or characteristics of the baseline. The change will be discernible but the underlying situation will remain similar to the baseline.
Very low	Very minor loss or alteration to one or more of the key elements, features or characteristics of the baseline, such that the change will be barely discernible, approximating to the 'no change' situation.

Effect definitions

11.3.21 The overall potential significance of physical effects and effects associated with mineral resources, waste soils and soil re-use is defined using the matrix presented in **Table 11.3**, which describes the relationship between the value/sensitivity of the receptor as defined in **Table 11.1** and the magnitude (change) of the potential impact as defined in **Table 11.2**.

11.3.22 Following the classification of an effect as presented in **Table 11.3**, a clear statement is made in the assessment as to whether the effect is 'significant' or 'not significant'. As a general rule, major and moderate effects are considered to be significant, and minor and negligible effects are considered to be not significant. However, professional judgement is also applied where appropriate.

Table 11.3: Criteria for determining the significance of physical effects and effects associated with mineral resources, waste soils and soil re-use.

		Value/Sensitivity of Receptor.			
		Very low.	Low	Medium	High
Magnitude	Very low.	Negligible	Negligible	Minor	Minor
	Low	Negligible	Minor	Minor	Moderate
	Medium	Minor	Minor	Moderate	Major
	High	Minor	Moderate	Major	Major

11.3.23 Physical effects, and effects associated with mineral resources, waste soils and soil re-use are described as adverse/negative or beneficial/positive considering the value of the receptor, area over which the impact may occur, whether the impact is direct or indirect, the duration of the impact (short-term: less than three years, medium term: three to ten years or long-term: greater than ten years), and whether the impact is permanent or temporary.

11.3.24 The classifications of physical effects and effects associated with mineral resources, waste soils and soil re-use are described in **Table 11.4**.

Table 11.4: Classification of Effects.

Classification	Effect
Major adverse.	Major sterilisation of mineral resources from either an active mining/quarrying site or mineral safeguarding area. Major soil erosion, soil compaction or ground instability that is permanent in nature. The generation of major volumes of soils classified as hazardous waste requiring off-site disposal.
Moderate adverse.	Moderate sterilisation of a mineral resource or mineral safeguarding area. Moderate soil erosion, soil compaction, or ground instability that is either permanent or long-term in nature. The generation of moderate volume of waste requiring off-site disposal.
Minor adverse.	Minor sterilisation of a mineral resource or mineral safeguarding area. Limited medium-term soil erosion, soil compaction, or ground instability. The generation of a minor amount of waste soil requiring off-site disposal.
Negligible	No change to a mineral resource or mineral safeguarding area. No measurable impact on soil erosion, soil compaction, waste volumes, or ground instability or impacts that are only temporary in nature (less than three years). No change in contamination risks.
Minor beneficial.	Minor improvement in access to a mineral resource potentially facilitating

Classification	Effect
	future mineral extraction. Limited medium-term reduction in existing soil erosion, soil compaction, or ground instability issues. A minor amount of materials re-use on-site, thereby reducing off-site disposal volumes.
Moderate beneficial.	Moderate improvement in access to a mineral resource facilitating future mineral extraction. Moderate permanent or long-term reduction in existing soil erosion, soil compaction, or ground instability issues. A moderate amount of materials reuse as part of the development, thereby reducing off-site disposal volumes by a significant extent.
Major beneficial.	Major improvement in access to a mineral resource facilitating future mineral extraction. Major permanent reduction in existing soil erosion, soil compaction or ground instability issues. Sustainable reuse of materials on-site with no, or only minimal, off-site disposal of waste soils.

ii. Land contamination

11.3.25 The generic EIA methodology as described in **Volume 1, Chapter 6** of the **ES** is not used to consider the effects on land contamination from the proposed development. Instead, the assessment considers the risks to various receptors from land contamination, and the change in this risk profile during construction and operation. As such the magnitude of the impact is not determined, being replaced by the change in risk level to the various receptors, which is subsequently used to define the effect.

11.3.26 The assessment of the potential impacts of the proposed development on land contamination has been undertaken over two stages including:

- Stage 1 – a land contamination risk assessment.
- Stage 2 – a land contamination impact assessment.

Stage 1 – Risk assessment

11.3.27 A Phase 1 Desk Study Report, provided in **Appendix 11A** of this volume, was prepared for the site which sets out the baseline environmental characteristics for the proposed development and study area. The baseline assessment was undertaken using existing data, publicly available information and historical records. This Phase 1 Desk Study Report also defines the preliminary conceptual site model.

11.3.28 Based on the preliminary conceptual site model, qualitative risk assessments have been undertaken in accordance with relevant guidance, as seen in **section 11.3** of this chapter, considering the potential sources, pathways and receptors present during the baseline, construction, and operational phases. These are included in **Appendix 11B** of this volume.

11.3.29 To assist in the risk assessment process by helping to determine the consequence of contamination being present, as seen in **section 11.3** of this chapter, a value/sensitivity has been assigned to each of the contaminated land receptors. The definition of each of these is given in **Table 11.5.**

Table 11.5: Assessment of the value or sensitivity of receptors associated with land contamination.

Value/sensitivity	Criteria	Description
High	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a very low capacity to accommodate the proposed change.	Principal aquifer providing potable water to a large population, within an inner or outer groundwater source protection zone (SPZ) (SPZ 1 or SPZ 2). WFD high status water body (surface water) providing potable water to a small population. Sensitive human health receptors, for example young children/other users of residential areas, schools and parks. Buildings, including services and foundations but of high historic value or other sensitivity for example statutory historic designations, schools, residential dwellings. Ecological statutory designations with high sensitivity or international designations for example special area of conservation, special protection area, Ramsar site etc. Crops and livestock with a high commercial/economic value.
Medium	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a low capacity to accommodate the proposed change.	Principal aquifer beyond a SPZ, secondary aquifer providing abstraction water for single private potable water supplies, agricultural or industrial use. WFD good status water body (surface water). Moderate sensitivity human health receptors, for example. commercial/industrial. Buildings and infrastructure of high regional value or high sensitivity for example schools, hospitals, residential dwellings. Ecological statutory designations with medium sensitivity or national designations for example SSSI, national nature reserve, area of outstanding natural beauty, marine conservation zone, etc. Crops and livestock with a medium commercial/economic value. Local Geological Sites or Regionally Important Geological Sites.

Value/sensitivity	Criteria	Description
Low	Attribute only possesses characteristics which are locally significant. Attribute has some tolerance to accommodate the proposed change.	Secondary aquifer not currently used for groundwater abstraction. WFD moderate status (surface water). Less sensitive human health receptors, for example construction workers using mitigation measures. Buildings and infrastructure of local importance or low sensitivity (commercial/industrial buildings, main roads, railways). Ecological statutory designations with low sensitivity or sites with local designations for example local nature reserve. Crops and livestock with a low commercial/economic value.
Very low.	Attribute characteristics do not make a significant contribution to local character or distinctiveness. Attribute is generally tolerant and can accommodate the proposed change.	Non-productive strata (groundwater). WFD poor status (surface water). No sensitive human receptors. Locally important infrastructure (local roads, bridges, footpaths). Land with low sensitivity and/or non-statutory designations. No crop or livestock receptors.

11.3.30 The risk assessment then applies the principles given in the National House Building Council and Environment Agency report R&D66 and Construction Industry Research and Information Association C552, which provide guidance on the preparation and application of the consequence and probability matrix (as presented in **Table 11.6**) for contaminated land risk assessment.

11.3.31 The potential risk to a receptor is a function of the probability and the consequence of a PCL being realised. Probability (likelihood of an event occurring) takes into account both the presence of the hazard and the receptor, and the integrity of the exposure pathway. Consequence takes into account both the potential severity of the hazard and the value/sensitivity of the receptor. Definitions of probability, consequence and the classified risks adopted for this assessment are detailed in **Volume 1**, **Appendix 6N** of the **ES**.

Table 11.6: Land quality estimation of the level of risk by comparison of consequence and probability.

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High likelihood.**	Very high risk.	High risk.	Moderate risk.	Moderate/low risk.
	Likely	High risk.	Moderate risk.	Moderate/low risk.	Low risk.
	Low likelihood.	Moderate risk.	Moderate/low risk.	Low risk.	Very low risk.
	Unlikely	Moderate/low risk.	Low risk.	Very low risk.	Very low risk.

11.3.32 The descriptions of the classified risks and likely action required as given in R&D66 are detailed in **Volume 1**, **Appendix 6N** of the **ES**.

Stage 2 – Impact assessment

11.3.33 The impact assessment has been undertaken by comparing the baseline risk assessments with the construction and operation phase risk assessments. This approach enables changes in the contaminated land status during the various phases to be identified and recorded.

Effect definitions

11.3.34 The effects of the proposed development are described as adverse/negative or beneficial/positive and major, moderate, minor or negligible on the basis of **Table 11.7.**

Table 11.7: Classification of effects.

Classification	Effect
Major adverse.	An increase in contamination risk from the existing baseline conditions of four or five risk levels in the risk matrix, e.g. land that has a very low contamination risk in the baseline becomes a high or very high risk. Land that does not meet the statutory definition of contaminated land in the existing baseline becomes capable of being determined under Part IIA.
Moderate adverse.	An increase in contamination risk from the existing baseline conditions of two or three risk levels in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate or high risk. Land that does not meet the statutory definition of contaminated land in the existing baseline becomes capable of being determined under Part IIA.
Minor adverse.	An increase in contamination risk from the existing baseline conditions of one risk level in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate to low risk.

Classification	Effect
Negligible	No change in contamination risks.
Minor beneficial.	A reduction in contamination risk from the existing baseline conditions of one risk level in the risk matrix, e.g. land that has a moderate to low contamination risk in the baseline becomes a low risk.
Moderate beneficial.	A reduction in contamination risk from the existing baseline conditions of two or three risk levels in the risk matrix, e.g. land that has a high contamination risk in the baseline becomes a moderate to low or low risk. Land that meets the statutory definition of contaminated land in the existing baseline is no longer capable of being determined under Part IIA.
Major beneficial.	A reduction in contamination risk from the existing baseline conditions of four or five risk levels in the risk matrix, e.g. land that has a very high contamination risk in the baseline becomes a low or very low risk. Land that meets the statutory definition of contaminated land in the existing baseline is no longer capable of being determined under Part IIA.

11.3.35 Following the classification of an effect as presented in **Table 11.7**, a clear statement is made as to whether the effect is 'significant' or 'not significant'. Major and moderate effects are considered to be significant, and minor and negligible effects are considered to be not significant.

11.3.36 It should be noted that, given the information known at the time of writing, professional judgement has been applied in certain circumstances where the introduction or removal of a receptor has automatically triggered a minor adverse or minor beneficial effect.

f) Assessment methodology

11.3.37 Detailed assessment methodologies for geology and land quality are presented in **Volume 1, Appendix 6N** of the **ES**. A summary is provided in the following sections.

i. General approach

11.3.38 The approach to the geology and land quality assessment comprises:

- establishing the baseline conditions for the study area with respect to geology, ground stability, hydrology, hydrogeology, contaminated land (including the potential for unexploded ordnance and ground gases) and historical uses;
- identification of potential impacts on identified resources and receptors from the construction and operation phases of the proposed development;

- assessment of the significance of likely effects from the proposed development including the consideration of mitigation measures; and
- identification of any residual effects and secondary mitigation where required.

ii. Establishing the baseline

11.3.39 The baseline assessment has relied on existing data, previous desk study and historical records. The following sources have been reviewed:

- historical mapping and additional environmental information including historical landfill information and contemporary trade directories provided in an Envirocheck report, which is appended to the Phase 1 Desk Study Report, provided in **Appendix 11A** of this volume;
- publicly available information from the British Geological Survey (BGS) (Ref. 11.25) online mapping resource;
- Suffolk County Council (SCC) Minerals Local Plan (Ref. 11.26);
- Suffolk Biodiversity Information Service website (Ref. 11.27);
- publicly available information from the Department of Environment, Food and Rural Affairs (Defra) Multi-Agency Geographic Information for the Countryside website (Ref. 11.28);
- publicly available information from the Environment Agency (Ref. 11.29);
- the Yell website (Ref. 11.30); and
- Zetica online UXO risk maps (Ref. 11.31).

iii. Assessment of effects

11.3.40 An assessment of the potential physical effects of the proposed development on geology, and the effects associated with soils re-use and waste soils has been undertaken using a qualitative approach considering the effects on soil erosion, mineral resources, the potential for soil re-use and waste soil generation in accordance with the methodology outlined previously.

11.3.41 The assessment of the potential effects of the construction and operation phases of the proposed development on land contamination has been undertaken in accordance with the methodology outlined previously.

g) Assumptions and limitations

11.3.42 The following assumptions have been made in this assessment:

- all assessment considers development within the site parameters as set out in the description of development in **Chapter 2** of this volume and as illustrated in **Work Plans** reproduced in **Appendix 2A** of this volume;
- stockpiling of materials during construction (where required) would remain within the site boundary;
- vegetation, topsoil and potentially subsoil would be stripped in accordance with the outline **Soil Management Plan**, provided in **Volume 2, Appendix 17C** of the **ES**;
- the use of grid connections for electricity for the permanent lighting and the temporary contractor's compounds, rather than generators to reduce the potential for storage of diesel oil on-site;
- following construction, the temporary haul routes, temporary compound (including any in ground utilities and drainage), plant/equipment storage/laydown areas, etc will be decommissioned and returned as far as practicable to agricultural use. As such, risks and effects of this work has been considered as part of the construction phase and appropriate mitigation incorporated; and
- for the operational phase assessment, it has been assumed that all primary, tertiary and secondary mitigation measures proposed for construction have been adopted / implemented.

11.3.43 The following limitations have been identified:

- ground investigation data is not available for the site and the baseline has been prepared using BGS mapping.

11.4 Baseline environment

11.4.1 This section presents a description of the baseline environmental characteristics within the study area.

11.4.2 Further detail can also be found in **Appendix 11A** of this volume.

a) Current baseline

i. Site visit

11.4.3 A site visit from public roads was undertaken during March 2019 to gain further information on the site setting, and study area to consider the context of the site, and to support the desk study mapping and aerial photographs. Additionally, it was an opportunity to identify potential visual or olfactory contamination present at the site at the time of the visit.

11.4.4 The site includes farmed agricultural land with associated access tracks and local roads. The western and eastern site boundaries are formed by the existing A12. The site's northern and southern boundaries are formed by agricultural land. No ground hazards or evidence of contamination were observed during the site visit. Further details on observations made during the site visit including photographs can be found in the Phase 1 Desk Study Report, provided in **Appendix 11A** of this volume.

ii. Site history

11.4.5 The following section summarises the key historical land use information for the study area. This has been compiled using an Envirocheck report, provided in **Appendix 11A** of this volume, which covers the study area.

Table 11.8: Historical development of the site.

Map Date.	Key Contamination Sources On-Site.	Key Contamination Sources In Study Area.
1883 (1:2,500) 1884–1885 (1:10,560).	The majority of the site is shown as enclosed agricultural fields. Unnamed roads are present at the western and eastern extents of the site running between Stratford St Andrew and Farnham (later named the A12, and the A1094 Friday Street). Several other minor unnamed roads, and tracks also cross the centre of the site. The Belts woodland is at the centre of the site. The River Alde and surface drains cross the western section of site flowing from north to south.	The surrounding area mainly comprises of agricultural land and associated farm houses, woodland (including Pond Wood, Whim Covert and The Belt) and isolated residential properties. Little Glemham Park is located 200m west of the site. The villages of Stratford St Andrews and Farnham are present 500m to the north-east and north of the site. A smithy is present 500m to the north of the site. Surface drains and ponds are located in all directions within the study area. Five pits (including sand pits, unnamed pits and old sand pits) are identified within the study area; the closest is located 200m to the south of the site. St Mary's Church including a graveyard are present 450m north of the site.
1904 (1:2,500).	No substantial changes.	No substantial changes.

Map Date.	Key Contamination Sources On-Site.	Key Contamination Sources In Study Area.
1905 (1:10,560).		
1950–1951 (1:10,560).		
1957–1958 (1:10,000).		
1975 (1:2,500) 1975–1978 (1:10,000).	The A12/A1094 junction has been widened to two lanes along the A12 section. The road at the western extent of the site is now labelled as the A12(T).	The smithy is no longer shown on the maps. The pits are now shown as disused.
1980–1983 (1:10,000).	No substantial changes.	Stratford plantation is present 100m to the west of the site.
1990 (1:10,000).	No substantial changes.	No substantial changes.
1995 (1:2,500).		
2000 (1:10,000) 2000 (1:2,500).		
2006 (1:10,000).		
2019 (1:10,000).		

iii. Geology

11.4.6 Made Ground is not shown on the BGS online mapping, but is likely to be present associated with the construction of the A12 and other minor roads. In addition, due to the nature of the site there is the potential for fly tipping in the area as well as the potential for farmers tips, the contents of which will be unknown.

11.4.7 Available BGS records indicate that the superficial geology underlying the site comprises Lowestoft Formation (diamicton) described as poorly-sorted matrix-supported deposits in the western and eastern sections of the site, in the vicinity of the junctions with the A12. Alluvium is shown as present underlying the network of drains and River Alde crossing the west of the site. Superficial deposits are recorded absent in some areas in the east of the site.

11.4.8 According to the BGS website, the site is underlain by three different bedrock strata. The majority of the site is underlain by Chillesford Church Sand Member, described as shallow-water marine and estuarine sands,

gravels, silts and clays. There is a small area of red crag formation in the west of the site, underlying the River Alde, described as 'coarse-grained, poorly sorted, cross-bedded, abundantly shelly sands'. The north-east of the site is underlain by the crag group, described as 'shallow-water marine and estuarine sands, gravels, silts and clays'.

11.4.9 Borehole records TM35NE53 and TM35NE32 are located within the western part of the site at National Grid Reference (NGR) 636230 259910 and 635430 259740, respectively. These describe shallow deposits and also indicate that the shallow geology of the site comprises predominately poorly sorted sands interbedded with gravel, clays and silts.

11.4.10 The Envirocheck report indicates that there is either no hazard or very low to low potential for collapsible ground, landslides, running sand ground stability hazards, shrinking or swelling clay and ground dissolution stability hazards at the site. There is no hazard to moderate potential for compressible ground hazards. There are no geological faults located on or within the study area.

iv. Mineral extraction

11.4.11 The Envirocheck report indicates that the site is in an area unlikely to be affected by mining for coal or other mineral resources.

11.4.12 Four historical mineral sites were identified within the study area including Foxburrow Wood Sand Pit (approximately 180m west, NGR 636846, 259639), Pond Barn Sand Pit (approximately 230m south-east, NGR 636453, 259156), Friday Street Sand Pit (approximately 290m north, NGR 637209, 260062) and Farnham Clay and Shale Pit (approximately 430m north-east, NGR 636444, 260291). All these mineral sites are reported to have ceased operations, but no dates or further details have been provided.

11.4.13 The SCC Minerals Local Plan indicates that the site is not located within a mineral safeguarding area, and there are no areas of planned mineral extraction within the study area.

v. Local geological sites

11.4.14 According to protected sites mapping on the Suffolk Biodiversity Information Service website, the study area is not located within a geological SSSI or local geological site.

vi. Hydrogeology

11.4.15 According to the MAGIC website the superficial Alluvial deposits underlying the site are classified as a secondary A aquifer[4], and the Lowestoft Formation (diamicton) deposits underlying the site are classified as a secondary (undifferentiated) aquifer[5].

11.4.16 The Crag Group, Red Crag Formation and the Chillesford Church Sand Member bedrock strata underlying the site are classed as a principal aquifer[6]. The site and study area do not lie within a groundwater SPZ[7].

11.4.17 There are six licensed groundwater abstractions within the study area for the abstraction of groundwater within the Lowestoft Formation (diamicton) deposits and Crag Group for general farming, domestic and spray irrigation purposes. There is the potential for unknown private water supplies to be in use within the study area. Should any private water supplies exist, they would likely be associated with the farm buildings and residential properties in the study area.

11.4.18 Further baseline hydrogeology information for the site is provided in **Chapter 12** of this volume**.**

vii. Hydrology

11.4.19 The River Alde is present crossing the western section of the site near Parkgate Farm flowing in a southerly direction. A network of surface water drains are present adjacent to the north-west and south-west of the site draining into the River Alde. There are also 25 within the study area.

11.4.20 The Envirocheck report indicates that there are no water abstractions relating to surface water within the study area.

11.4.21 The Envirocheck report indicates that there are six discharge consents located approximately 150m to the south-east (NGR 636070, 259230), and five between 400m and 500m to the north-east of the site at (NGR 635840:260020, 635796:259966 and three consents at NGR 636280:260080). The consents are for agricultural and surface water trade

[4] A secondary A aquifer includes permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
[5] A secondary (undifferentiated) aquifer is designated in cases where it has not been possible to attribute either category Secondary A or Secondary B to a rock type.
[6] Principal aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
[7] SPZs show the risk of contamination from activities that might cause pollution in the area. The closer the activity, the greater the risk.

discharges and final/treated effluent sewage discharges onto land, or into the River Alde.

11.4.22 Further consideration of the hydrology of the site is provided in **Chapter 12** of this volume.

viii. Flood risk

11.4.23 The Environment Agency flood risk map, contained within the Envirocheck report, indicates that the site is located within Flood Zones 1, 2 and 3 associated with flood risk from the River Alde which crosses the site.

11.4.24 The site is indicated to have a low risk of flooding from tidal or coastal sources and the majority of the site is also at very low risk of flooding from surface water. However, within the west of the site there are areas of high and medium surface water flood risk. These areas drain into the River Alde to the south of the site. There are also small areas of low surface water flood risk where the River Alde crosses the site. At the eastern extent of the site around Friday Street Farm there is also an area of high surface water flood risk immediately north of the A1094.

11.4.25 The BGS susceptibility to groundwater flooding map identifies there is a high potential for groundwater flooding to occur at the surface in parts of the site that cross the River Alde and its floodplain.

11.4.26 Further details on flood risk are provided in the **Two Village Bypass Flood Risk Assessment** (Doc Ref. 5.5).

ix. Historic and environmentally sensitive sites

11.4.27 There is an Ancient Woodland (Foxburrow Wood) located 50m to the east of the site.

11.4.28 The site is located within a nitrate vulnerable zone.

11.4.29 A review of the MAGIC website indicates that there are eight Grade II listed buildings located within the study area including Benhallstock Cottages, Hill Farmhouse, Farnham Manor and a number of properties within the villages of Farnham and Stratford St Andrews.

11.4.30 Further consideration of designated sites, both statutory and non-statutory is given in **Chapter 7** and **Chapter 9** of this volume.

x. Waste management and other permitted sites

11.4.31 The Envirocheck report indicates that there is a historical landfill site (Farnham Landfill) located 360m to the east of the site. There were no

known restrictions on the source of the waste and the licence is listed as lapsed or cancelled. However, no further details are provided.

11.4.32 The Envirocheck report also indicates that there are none of the following facilities within the study area:

- authorised landfill sites;
- waste transfer sites;
- control of major accident hazards sites;
- explosive sites;
- notification of installations handling hazardous substances;
- planning hazardous substance consents; and
- planning hazardous substance enforcements.

xi. Service stations

11.4.33 The Envirocheck report indicates that Stratford service station is located approximately 490m north-west of the site off the A12 to the south of Farnham.

xii. Industrial and other potentially contaminative land uses

11.4.34 The Envirocheck report indicates there are two further active contemporary trade directory entries within the study area that could have the potential to use contaminants of concern. These include an electricity generating, and distributing equipment manufacturer (465m north, NGR 635755:260060), and a picture frame renovating and restoring services (485m north, NGR 635732:260095). It is also noted that the land use within the site includes agricultural use, and there are several farms within the study area which have the potential to generate some contaminants of concern.

xiii. Potential for Unexploded Ordnance

11.4.35 A Zetica UXO map was obtained to assess the risk of encountering UXO at the site and is appended to the Phase 1 Desk Study Report. The map indicates that the site is within an area with a low risk of encountering UXO.

xiv. Previous ground investigations

11.4.36 There have been no previous ground investigations undertaken at the site.

b) Future baseline

11.4.37 There are two committed developments which have been identified within the study area as summarised in **Table 11.9.**

Table 11.9: Committed developments.

Planning Application Ref.	Site Address.	Description of Development.	Date of Approval.	Status	Distance (m).
DC/18/0322/FUL	Glemham Estate Reservoir Land north of Hill Farm Road Farnham IP17 1LU.	To construct an 80,000 cubic metres (m^3) reservoir covering an area of approximately 3.5 hectares (ha). The reservoir will be used to store and supply water to the in hand farming business for the irrigation of crops during the Summer months.	25/06/2018	Construction not commenced.	153
DC/17/1331/FUL	Pond Farm Hill Farm Road Farnham Suffolk.	Full planning application for the conversion of three existing agricultural barns to form two dwellings.	09/01/2018	Construction not commenced.	58

11.4.38 The construction timeline for these committed developments is unconfirmed. However, planning permissions generally require construction to commence within three years of the grant of planning permission or reserved matters upon which the planning permission lapses. As such, it has been assumed, given the nature of the applications, that the developments will have commenced construction prior to 2022. These committed developments have, therefore, been considered as future receptors, and a potential future source of contamination as part of the baseline for the land contamination risk assessments, and within the assessment of physical effects and effects associated with mineral resources, soils re-use and waste soils.

c) Preliminary Conceptual Site Model

11.4.39 A preliminary conceptual site model identifies the potential or known sources of contamination, receptors, and pathways between the two. Where all three are present or are considered likely to be present (source-pathway-receptor linkage), they are called a PCL.

11.4.40 Three preliminary conceptual site models (baseline, construction and operational) have been produced for the proposed development using the information summarised previously. A summary of potential contamination sources is provided in **Table 11.10**, and a summary of potential pathways and receptors identified is provided in **Table 11.11**.

Table 11.10: Existing potential sources of contamination for the proposed development.

Potential Source Of Contamination.	Potential Contamination.	Approximate Location.
Made Ground associated with the construction of the existing roads including the A12, A4109, unnamed road and tracks as well as activities associated with their operation.	A range of inorganic and organic contaminants including polycyclic aromatic hydrocarbons (PAHs), coal tars, asbestos and ground gases. Fuels and oils attributed to spills from vehicles on the roads included within the site boundary, plus exhaust particulates.	On-site
Farmland within site boundary. Potential for unmapped farmers tips.	Contamination risk from herbicides, pesticides, silage, effluent, and fuel/engine oils. Risk of inorganic and organic contamination including metals and hydrocarbons, polychlorinated biphenyls (PCBs), asbestos, etc.	
Stratford Service Station located 490m north-west of the site.	Metals and organic contaminants including petroleum, petrol additives, diesel, oils/lubricants.	Off-site
Farms in the area surrounding the site including Parkgate Farm and Red House Farm. Potential for unmapped farmers tips.	Contamination risk from herbicides, pesticides, silage, effluent, and fuel/engine oils. Risk of inorganic and organic contamination including metals and hydrocarbons, PCBs, asbestos, etc.	
Made Ground associated with the disused sand pits located within the study area.	Ground gas and a range of inorganic and organic contaminants including the potential for asbestos.	
Former smithy 500m to the north of the site.	A range of inorganic and organic contaminants including hydrocarbons, PAHs, metals and asbestos.	
Farnham landfill located 360m to the east of the site.	A range of inorganic and organic contaminants including hydrocarbons, PAHs, metals and the potential for ground gas and asbestos.	

Table 11.11: Potential receptors and contaminant exposure and migration pathways at baseline and resulting from the proposed development.

Receptor group.	Receptor	Principal Contaminant Migration Pathways.
Human health (on-site).	Construction and maintenance workers.	Dermal contact with and ingestion of contaminants in soils, soil-derived dusts and water.
	Farmers and workers on	Inhalation of soil-derived dust, fibres, gas and

Receptor group.	Receptor	Principal Contaminant Migration Pathways.
	agricultural land.	vapours.
	Pedestrians and road users using existing roads, footpaths and fields within the site.	
	Pedestrians and road users using new road, crossings and footpaths.	
Human health (off-site).	Occupants of nearby residential and commercial properties.	Dermal contact with and ingestion of contaminants in soil-derived dusts and water that may have migrated off-site. Inhalation of soil-derived dust, fibres, gas and vapours which may have migrated off-site.
	Pedestrians accessing surrounding roads.	
	Farmers and workers on agricultural land.	
Controlled waters: Groundwater (on-site and off-site).	Groundwater in Principal bedrock aquifer. Groundwater in Secondary A/Undifferentiated superficial aquifer.	Leaching of contaminants in soil to groundwater in underlying aquifers. Migration of contaminated water through preferential pathways such as underground services, pipes and granular material to groundwater in underlying aquifers.
Controlled waters: Surface Waters (on-site and off-site).	River Alde, drains, ponds and reservoir.	Lateral migration of contaminated groundwater with discharge to surface watercourses as base flow. Discharge of contaminants entrained in groundwater and, or surface water run-off followed by overland flow and discharge.
Property (on-site and off-site).	Existing on-site and off-site services and structures including listed buildings	Direct contact of contaminants in soil and, or groundwater with existing and proposed structures and buried services. Migration of contaminated groundwater, ground gas and, or vapours along strata and preferential pathways such as service routes or differentially permeable strata.
	Proposed on-site services and structures.	
	Crops and livestock.	Migration of contaminated waters/dust/fibres and subsequent uptake by crops or ingestion/inhalation/dermal contact by livestock.
Ecological	Foxburrow Wood Ancient Woodland (off-site).	Migration of contaminated waters/dust/fibres and subsequent uptake by flora or ingestion/ inhalation/dermal contact by fauna.

11.5 Environmental design and mitigation

11.5.1 As detailed in **Volume 1**, **Chapter 6** of the **ES**, a number of primary mitigation measures have been identified through the iterative EIA process and have been incorporated into the design and construction planning of the proposed development. Tertiary mitigation measures are legal

requirements or are standard practices that would be implemented as part of the proposed development.

11.5.2 The assessment of likely significant effects of the proposed development assumes that primary and tertiary mitigation measures are in place. These measures are summarised in this section so that it is clear where and why these measures have been included, and the way in which they have contributed to the management and reduction of environmental effects.

a) Primary mitigation

11.5.3 Primary mitigation is often referred to as 'embedded mitigation' and includes modifications to the location or design to mitigate impacts; these measures become an inherent part of the proposed development.

11.5.4 Primary mitigation measures for the proposed development would include:

- the design of the road and the selection of construction materials would be in accordance with the Design Manual for Roads and Bridges, British Standards and best practice guidance at the time of the design. The design would be required to take into account the ground conditions including the potential for ground movement, compaction, ground gas and ground aggressivity;
- gas mitigation measures for relevant structures would be designed where required dependent on the risk profile, and the nature/usage of the structure; and
- the use of appropriate drainage systems in accordance with the **Drainage Strategy**, provided in **Volume 2, Appendix 2A** of the **ES**, to reduce the potential for contamination to migrate and impact on the ground, groundwaters and surface waters. Water draining from the road infrastructure will pass through appropriate drainage, including the incorporation of SuDS (e.g. swales), and bypass separators for the removal of hydrocarbon contaminants as necessary. This will allow infiltration to the superficial aquifer as well as protect the ground and underlying groundwater from hydrocarbon contamination.

b) Tertiary mitigation

11.5.5 Tertiary mitigation will be required regardless of any EIA assessment, as it is imposed, for example, as a result of legislative requirements and/or standard sectoral practices.

11.5.6 Tertiary mitigation measures to be incorporated into the proposed development during construction, as set out in the **CoCP** (Doc Ref. 8.11) include:

- prior to stockpiling or other groundworks, topsoil present would be removed and appropriately stored for potential re-use in landscaping areas, subject to demonstrating suitability for reuse criteria. This process would reduce the potential for buried topsoil to generate ground gas beneath the proposed development which may pose a risk to human health;
- development of health and safety risk assessments and method statements by the contractor (including emergency response procedures), and provision of appropriate personal protective equipment (PPE) for the protection of construction workers;
- implementation of a contamination watching brief by suitably qualified and experienced personnel would be completed for the proposed development when excavating areas of potential contamination risk. If unidentified contamination is encountered, works will be temporarily suspended in the area, and appropriate investigations, and remediation will be discussed and agreed with stakeholders and completed in accordance with current best practice;
- implementation of appropriate dust suppression measures to reduce migration of contaminated dust, further details are provided in **Chapter 5** of this volume;
- minimising the area and duration of soil exposure and timely reinstatement of vegetation or hardstanding to reduce soil erosion and reduce temporary effects on soil compaction;
- stockpile management (such as water spraying and avoiding over stockpiling to reduce compaction of soil and loss of integrity) to reduce windblown dust and surface water run-off;
- clear segregation between stockpiled material including imported material, excavated material stockpiled for re-use and excavated waste material stockpiled for treatment and/or off-site disposal;
- stockpiles would be located a minimum of 10m from the nearest watercourse;
- implementation of working methods during construction to ensure that surface water run-off from the works, landscape bunds, stockpiles or working area is minimised, and captured prior to entry into adjacent surface watercourses or leaching into underlying groundwater in accordance with best practice;

- implementation of appropriate pollution incident control for example plant drip trays and spill kits and suitable training and toolbox talks completed; and
- implementation of appropriate and safe storage of fuel, oils, chemicals and equipment during construction in accordance with Control of Substances Hazardous to Human Health Regulations and Oil Storage Regulations.

11.5.7 Additional tertiary mitigation that would be anticipated and referenced in the **CoCP** (Doc Ref. 8.11) includes:

- implementation of an appropriate materials management strategy to document how the excavated materials would be dealt with via Materials Management Plan(s) and verification report(s) to record the excavation and placement of materials at the site. Further details are provided in the **Materials Management Strategy** provided in **Volume 2, Appendix 3A** of the **ES**;
- implementation of a site waste management plan in accordance with the **Conventional Waste Management Strategy** provided in **Volume 2, Appendix 8A** of the **ES**;
- implementation of an outline **Soil Management Plan** provided in **Volume 2, Appendix 17C** of the **ES**; and
- piling risk assessment in accordance with Environment Agency guidance may be required to ensure that piling techniques deemed appropriate are implemented at the site by identifying and managing potential risks as a result of creating pathways to the aquifer.

11.5.8 For the operational phase, storage and disposal of wastes and hazardous substances where required would be managed in accordance with current guidance and legislative requirements.

11.6 Assessment

a) Introduction

11.6.1 This section presents the findings of the geology and land quality assessment for the construction and operational phases of the proposed development.

11.6.2 This section identifies any likely significant effects that are predicted to occur and **section 11.7** of this chapter highlights the secondary mitigation and monitoring measures that are proposed to minimise any adverse significant effects (if required).

b) Construction

i. Physical effects

11.6.3 A qualitative approach has been undertaken to assess the likely physical effects of the proposed development. The effects have then been categorised in accordance with the methodology described in **Volume 1, Appendix 6N** of the **ES**, and summarised in **section 11.3** of this chapter, and confirmed as either temporary or permanent, adverse or beneficial and significant (moderate or major effects) or not significant (minor or negligible).

11.6.4 The construction phase of the proposed development may result in soil erosion, soil compaction and ground instability issues associated with stripping of topsoil, vegetation clearance, earthworks, stockpiling, movement of heavy plant, temporary works and construction of new infrastructure. These are discussed in more detail in the following section.

Soil erosion

11.6.5 Earthworks, including areas for temporary works, would be required for the construction of the proposed development including construction of embankments and excavation of cuttings proposed for the main road alignment and associated junctions, roundabouts, footpath diversions, cattle path, with excavations and/or piling also required for proposed bridge foundations, lighting columns, utilities, signage, swales, infiltration basins, gullies, flood relief culverts, mammal migration culverts, fencing and planting. Temporary stockpiles and temporary haul roads would be required and are anticipated to be located within the site boundary to allow movement for earthworks across the length of the proposed new road. The land required for the temporary contractor compound would also need reinstating after the road is constructed requiring further earthworks and excavations. Piling is also anticipated to be required for the proposed for the River Alde overbridge and Foxburrow Wood footbridge. Therefore, there is the potential for soil erosion across the proposed development.

11.6.6 Earthworks would be managed in accordance with the **CoCP** (Doc Ref. 8.11) to minimise soil exposure as far as practicable, and areas required for temporary works and the temporary contractor compound during the construction phase would be reinstated as soon as practicable when they are no longer required.

11.6.7 Stockpiles would be managed in accordance within primary and tertiary measures set out in **section 11.5** of this chapter and the **CoCP** (Doc Ref. 8.11) to reduce soil erosion and dust generation by management practices which may include water spraying. The impact on soil erosion during the

construction phase are therefore considered to be temporary, short-term and direct.

11.6.8 Given the current mainly agricultural use of the site, the potential for soil erosion is likely to be low, the value/sensitivity of the receptor is classed as low. With the primary and tertiary mitigation measures set out in **section 11.5** of this chapter, the magnitude of the impact is considered to be low. The overall effect is therefore considered to be minor adverse and classed as **not significant**.

Ground stability and soil compaction

11.6.9 No ground stability hazards or geological faults are recorded present within the study area, and the site is also identified as having a low UXO risk. Ground conditions indicated sands, gravels and clay deposits with limited Made Ground associated with roads crossing the proposed development and the potential for farmers tips. The proposed development is not within an area of coal or non-coal mining, although some small scale quarrying of sands, clay and shale has taken place historically. The impact on ground stability during the construction phase is therefore considered to be temporary, short-term, and direct.

11.6.10 Soil compaction may arise through the earthworks and from heavy plant movements within the site. All new embankments would also need to be constructed in layers and compacted to the design requirements. The Envirocheck indicates that, although there is very low to low potential for collapsible ground, landslides, ground stability hazards, and shrinking or swelling clay, there is up to a moderate potential for compressible ground hazards. The impact on soil compaction during the construction phase is therefore considered to be temporary, short-term, and direct.

11.6.11 Given that there is a moderate potential compressible hazards at the site associated with the ground conditions and the earthworks proposed, the value/sensitivity is classed as medium. With the implementation of primary and tertiary mitigation set out in **section 11.5** of this chapter, the magnitude of the impact is considered to be low. The overall effect is therefore considered to be minor adverse, which is considered to be **not significant**.

ii. Mineral resources

11.6.12 A qualitative approach has been undertaken to assess the likely effects of the proposed development on mineral resources in accordance with the methodology outlined in **Volume 1, Appendix 6N** of the **ES** and summarised in **section 11.3** of this chapter.

11.6.13 The proposed development has the potential to impact mineral resources and associated mineral safeguarding areas through the loss, damage or sterilisation of an important mineral resource.

11.6.14 The baseline assessment identified the presence of historical mineral extraction sites (sands, clay and shale) within the study area. However, the site and study area are not located within a coal mining area, an area of planned mineral extraction or a minerals safeguarding area. In addition, the pits identified within the baseline assessment are indicated to be historical, being first identified on the 1883 to 1885 maps. Therefore, there would be a limited impact on the current regional mineral resources. The impact on mineral resources during the construction phase are, therefore, considered to be temporary, short-term and direct.

11.6.15 Given that there are limited valuable mineral resources located within the study area, the value/sensitivity of the receptor is classed as low. The magnitude of the impact is considered to be very low as there would be limited loss of regional mineral resources. The overall effect is therefore considered to be negligible and classed as **not significant**.

iii. Effects associated with ground contamination

11.6.16 The construction preliminary conceptual site model and risk assessment are presented in **Appendix 11B** of this volume and the impact assessment in **Appendix 11C** of this volume. The construction impact assessment is undertaken by comparing the baseline land contamination risks to those predicted during construction, while considering any new sources and pollution pathways introduced by construction activities.

11.6.17 The construction phase would potentially introduce new sources of contamination and disturb and mobilise existing sources of contamination. Construction activities, such as excavation and piling may introduce new pathways for migration of existing contamination and exposure of contaminated soil, remobilisation of contaminants through soil disturbance and the creation of preferential pathways for surface water run-off and ground gas migration. Potential changes to the baseline situation creating PCLs, which have been assessed within this chapter are:

- the potential for mobilising contaminants by excavation and stockpiling of material, increasing the risk to controlled water receptors through leaching and run-off. Earthworks could provide opportunities for run-offs to contain suspended solids carried out in line with required management procedure;

- the potential for exposure of human receptors by generation of potentially contaminated dust and vapours released by the construction works; and
- the potential for creation of new pathways to groundwater during groundworks, through opening up ground temporarily and construction activities, such as earthworks, installation of drainage and other below-ground services.

11.6.18 The impacts on land contamination during the construction phase are considered to be permanent, long-term and direct. Primary and tertiary mitigation measures would be incorporated into the construction process as outlined in **section 11.5** of this chapter. These would include the adoption of working methods during construction to manage groundwater appropriately, implementation of appropriate pollution incident control and implementation of appropriate and safe storage of fuel, oils and equipment.

11.6.19 A summary of the construction phase preliminary conceptual site model and impact assessment is provided in **Table 11.12**, and includes the risks identified to the receptors. Further details of the construction risk and impact assessment is provided in **Appendices 11B** and **11C** of this volume.

11.6.20 It is considered that with the primary and tertiary mitigation measures adopted, the risks identified to human health, controlled waters, property and ecological receptors during construction are assessed as very low to moderate/low. Compared to the existing baseline, the level of risk to receptors has generally remained the same or slightly increased during the construction phase. An overall negligible to minor adverse effect has therefore been predicted, which is classed as **not significant**.

Table 11.12: Construction phase effects for the proposed development.

Receptor	Value/Sensitivity	Baseline Risk.	Construction Risk.	Classification of Effect.
Human (on-site).	High	Low	Low	Negligible (**not significant**).
Human (off-site).	High	Very low.	Very low.	Negligible (**not significant**).
Controlled waters: groundwater (on-site and off-site).	Medium	Low	Moderate/low	Minor adverse (**not significant**).
Controlled waters: surface water (on-site and off-site).	Medium	Very low.	Low	Minor adverse (**not significant**).
Property: existing and future structures	Medium	Very low.	Very low.	Negligible (**not significant**).

Receptor	Value/Sensitivity	Baseline Risk.	Construction Risk.	Classification of Effect.
and services (on-site and off-site).				
Property: crops and livestock (on-site and off-site).	Medium	Very low.	Very low.	Negligible (**not significant**).
Ecological: (off-site).	High	Very low.	Very low.	Negligible (**not significant**).

iv. Effects associated with waste soils and soil re-use

11.6.21 Waste soils would be generated during construction through the proposed earthworks, excavations and the installation of drainage/services. There is the potential that waste soil generated from the earthworks, piling, foundation construction (signage, lighting, barriers, bridge piers, etc.), culverts, utilities, drainage (infiltration basins, gullies, swales), fencing and planting would be classified as geo-technically, and/or chemically unsuitable for reuse on-site or hazardous, therefore requiring removal from site. Waste soils would be dealt with in accordance with the **Waste Management Strategy** presented in **Volume 2, Appendix 8A** of the **ES**.

11.6.22 A Materials Management Plan in accordance with the **Materials Management Strategy** provided in **Volume 2, Appendix 3A** of the **ES**, would set out how material is managed on-site during construction and removal and reinstatement in accordance with appropriate guidance such as the Contaminated Land: Applications in Real Environments Development Industry Code of Practice (Ref. 11.12) to allow the sustainable re-use of suitable soils during the construction of the proposed development. An outline Soil Management Plan would also be implemented to manage the reinstatement of agricultural land.

11.6.23 In line with the waste hierarchy, the design would seek, as far as reasonably practicable, to reduce the amount of soil/materials excavated and/or of a hazardous nature, to reuse and recycle waste soils/materials on-site where possible and to manage soils/materials suitably including off-site disposal of waste, if required, in accordance with relevant legislation. Therefore, impacts associated with waste soils and soil re-use during the construction phase are considered to be temporary, short-term and direct.

11.6.24 Given the scale of the proposed development, the fact that the majority of the road goes through agricultural land which has remained undeveloped and that Made Ground is only likely to be associated with the existing roads crossing the proposed development, and therefore very limited or absent at the site, the value/sensitivity of the receptor is classed as medium. With the primary and tertiary mitigation measures, the magnitude of the impact is

considered to be very low. The overall effect is therefore considered to be minor adverse and therefore is considered to be **not significant**.

v. Inter-relationship effects

11.6.25 This section provides a description of the identified inter-relationship effects that are anticipated to occur on geology and land quality receptors between the individual environmental effects arising from construction of the proposed development.

11.6.26 There are anticipated to be inter-relationship effects between geology and land quality, soils and agriculture, ecology, heritage and groundwater and surface water in relation to potential receptors which could be impacted by ground contamination during the construction of the proposed development.

11.6.27 Potential impacts would include the contamination of sensitive/high value receptors such as good quality or BMV agricultural land, SSSIs, listed buildings, principal aquifers, WFD rivers and groundwater SPZs during construction works. Construction activities may introduce new sources of contamination, new pathways for migration of contamination and disturb and mobilise existing sources of contamination.

11.6.28 However, given the primary and tertiary mitigation measures proposed in relation to these disciplines as outlined in **section 11.5** of this chapter, it is not expected that the combined impact of these inter-relationship effects would be greater than those effects predicted for the geology and land quality assessment as presented within this chapter. Only minor adverse inter-relationship effects are anticipated, which are classified as **not significant**. Further details are provided in **Chapter 10** and **Chapter 12** of this volume.

c) Operation

i. Physical effects

11.6.29 Physical effects are considered to be mainly related to the construction phase. During operation, there would be limited physical effects through maintenance operations. Suitable design and subsequent maintenance works would also minimise physical effects, and the proposed development would be operated in accordance with the relevant regulations and best practicable measures.

Soil erosion

11.6.30 Soil exposure during operation of the road is only likely to occur during maintenance operations through local excavations within the road, embankments, cuttings or associated infrastructure for maintenance. There

may also be some limited exposure through failure of landscaping such as grass, shrubs and trees dying to expose the soils. However, as maintenance operations are likely to be limited in lateral extent, time and should not, generally, entail excessive earthworks, the likelihood of substantial soil exposure and subsequent soil erosion would be low. The impacts on soil erosion during the operational phase are therefore considered to be temporary, short-term, and direct.

11.6.31 Given that the value/sensitivity of the receptor is classed as low, with the primary and tertiary mitigation measures the magnitude of the impact is considered to be very low. Therefore, it is considered that soil erosion would remain as negligible, and classed as **not significant**.

Ground stability and soil compaction

11.6.32 As discussed in the construction phase, there is a moderate potential for compressible ground hazards although there is limited risk of ground instability from coal and non-coal mining/quarrying. The impacts on ground stability and soil compaction during the operational phase are considered to be temporary, short-term, and direct.

11.6.33 Given that there are potential compressible hazards at the site associated with the ground conditions, and the earthworks proposed, the value/sensitivity of the receptor is classed as medium. With primary and tertiary mitigation, the magnitude of the impact is considered to be low. Therefore, it is considered that physical effects would remain as minor adverse and classed as **not significant**.

ii. Mineral resources

11.6.34 Effects in relation to mineral resources during the operation phase relate to the permanent sterilisation/loss of minerals, preventing future extraction. The impacts on mineral resources during the operational phase are therefore considered to be permanent and direct.

11.6.35 Given that there are limited valuable mineral resources located within the study area, the value/sensitivity of the receptor is classed as low. The magnitude of the impact is considered to be very low, as there would be limited loss of regional mineral resources. Effects in relation to loss, damage or sterilisation of mineral resources would stay as negligible (**not significant**).

iii. Effects associated with ground contamination

11.6.36 The operational preliminary conceptual site model and risk assessment are presented in **Appendix 11B** of this volume and the impact assessment in **Appendix 11C** of this volume. The operational impact assessment has

been undertaken by comparing the baseline land contamination risks to those predicted during operation, while considering any new sources and pollution pathways introduced by operational activities. The operation of the proposed development would potentially introduce new sources of contamination. Spillages and leaks may occur and below ground services could create additional potential pathways for the migration of potential contamination that were not present at baseline. The impacts on land contamination during the operational phase are considered to be permanent and direct.

11.6.37 A summary of the operational phase contamination effects is provided in **Table 11.13**. A more detailed assessment of construction risk and impact assessment is provided in **Appendices 11B** and **11C** of this volume. It is considered that with proposed mitigation, risks identified to human health, controlled waters, property and ecological receptors during operation are assessed as very low. Compared to the existing baseline, the level of risk to receptors has generally remained the same or slightly reduced. An overall negligible to minor beneficial effect are therefore anticipated which are classed as **not significant**.

Table 11.13: Operational phase effects for the proposed development.

Receptor	Sensitivity/ value	Baseline risk.	Operation Risk.	Classification of effect.
Human (on-site).	High	Low	Very low.	Minor beneficial (**not significant**).
Human (off-site).	High	Very low	Very low.	Negligible (**not significant**).
Controlled waters: groundwater (on-site and off-site).	Medium	Low	Very low.	Minor beneficial (**not significant**).
Controlled waters: surface water (on-site and off-site).	Medium	Very low.	Very low.	Negligible (**not significant**).
Property: existing and future structures and services (on-site and off-site).	Medium	Very low.	Very low.	Negligible (**not significant**).
Property: crops and livestock (on-site and off-site).	Medium	Very low.	Very low.	Negligible (**not significant**).
Ecological: (off-site).	High	Very low.	Very low.	Negligible (**not significant**).

iv. Effects associated with waste soils and soil re-use

11.6.38 The proposed development may also generate limited waste soils during operation due to maintenance requirements which may include excavations

for landscaping and for repairs and maintenance of services. The proposed development would be operated in accordance with the relevant regulations and best practice pollution prevention guidance. Therefore, the impacts associated with waste soils and soils reuse during the operational phase are assessed to be temporary, short-term and indirect.

11.6.39 Given that there is less potential for soil reuse during the operational phase, the value/sensitivity of the receptor is classed as low. With the primary and tertiary mitigation measures, the magnitude of the impact is considered to be very low. The overall effect is therefore assessed to be negligible and classed as **not significant**.

v. Inter-relationship effects

11.6.40 This section provides a description of the identified inter-relationship effects that are anticipated to occur on geology and land quality receptors between the individual environmental effects arising from operation of the proposed development.

11.6.41 There are anticipated to be inter-relationship effects between geology and land quality, soils and agriculture, ecology, heritage and groundwater and surface water in relation to potential receptors which could be impacted by ground contamination during the operation of the proposed development.

11.6.42 Potential impacts would include the contamination of sensitive/high value receptors such as good quality or BMV agricultural land, SSSIs, listed buildings, principal aquifers, WFD rivers and groundwater SPZs during operation. Operation of the proposed development may introduce new sources of contamination and new pathways for migration of contamination.

11.6.43 However, given the primary and tertiary mitigation measures proposed in relation to these disciplines as outlined in **section 11.5** of this chapter, it is not expected that the combined impact of these inter-relationship effects would be greater than those effects predicted for the geology and land quality assessment as presented within this chapter. Only minor adverse inter-relationship effects are anticipated, which are classified as **not significant**. Further details are provided in **Chapter 10** and **Chapter 12** of this volume.

11.7 Mitigation and monitoring

a) Introduction

11.7.1 Primary and tertiary mitigation measures which have been accounted for as part of the assessment are summarised in **section 11.5** of this chapter. Where further mitigation is required this is referred to as secondary

mitigation, and where reasonably practicable, secondary mitigation measures have been proposed.

11.7.2 This section describes the proposed secondary mitigation measures for geology and land quality as well as describing any monitoring required of specific receptors/resources or for the effectiveness of a mitigation measure.

b) Mitigation

11.7.3 A ground investigation would be undertaken to inform the detailed design of the proposed development and confirm ground conditions, contamination status and other ground related risks. This would be completed prior to the commencement of construction works. Where the ground investigation and subsequent generic risk assessments identify unacceptable levels of contamination and ground related risks, further detailed quantitative risk assessment followed by, where necessary, remediation of soil and groundwater contamination prior to construction may be required.

c) Monitoring

11.7.4 A programme of short-term gas and groundwater monitoring would be designed as part of the ground investigation, and would be required prior to construction works commencing. The results of this short-term monitoring would determine whether further long-term gas and groundwater monitoring is required during the construction and operational phases.

11.8 Residual effects

11.8.1 The following tables present a summary of the geology and land quality assessment. They identify the receptor(s) likely to be impacted, the level of effect and, where the effect is deemed to be significant, the tables include the mitigation proposed and the resulting residual effect.

Table 11.14: Summary of effects for the construction phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Secondary Mitigation.	Residual Effects.
Geology	Soil erosion.	Health and safety risk assessments, method statements and appropriate PPE for the protection of construction	Minor adverse.	Ground investigation and relevant risk assessments completed prior to detailed	Minor adverse (**not significant**).
	Soil compaction and ground instability.		Minor adverse.		Minor adverse (**not significant**).

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Secondary Mitigation.	Residual Effects.
Mineral resources.	Loss, damage or sterilisation.	workers. Implementation of measures in the **CoCP** (Doc Ref. 8.11) during construction works. Preparation of a piling risk assessment in accordance with Environment Agency guidance. Design and selection of construction materials in accordance with best practice.	Negligible	design and construction works. Remediation of soil and groundwater if necessary. Longer term gas and groundwater monitoring if necessary.	Negligible (**not significant**).
Human health.	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Controlled waters (groundwater).	Contamination from on-site and off-site sources.		Minor adverse.		Minor beneficial (**not significant**).
Controlled waters (surface water).	Contamination from on-site and off-site sources.		Minor adverse.		Negligible (**not significant**).
Property (existing and future structures and services).	Contamination from on-site s and off-site sources.		Negligible		Negligible (**not significant**).
Property (crops and livestock).	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Ecological	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Soils	Impacts from waste generated during construction works.		Minor adverse.		Minor adverse (**not significant**).

Table 11.15: Summary of effects for the operational phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Secondary Mitigation.	Residual Effects.
Geology	Soil erosion.	Use spill response kits and adequate staff training.	Negligible	Longer term gas and groundwater monitoring if necessary.	Negligible (**not significant**).
Geology	Soil compaction and ground instability.		Minor adverse.		Minor adverse (**not**

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of Effects.	Additional Secondary Mitigation.	Residual Effects.
		Use of hardstanding to reduce impact from spills and leaks. Incorporation of bypass separators within the drainage design where considered necessary. The use of appropriate sustainable drainage system schemes. The use of grid connections for electricity rather than generators. Appropriate storage and disposal of chemicals, oils, fuels, materials and wastes in accordance with current guidance.			**significant**).
Mineral resources.	Loss, damage or sterilisation.		Negligible		Negligible (**not significant**).
Human health.	Contamination from on-site sources.		Negligible to minor beneficial.		Negligible to minor beneficial (**not significant**).
Controlled waters (groundwater).	Contamination from on-site and off-site sources.		Minor beneficial.		Minor beneficial (**not significant**).
Controlled waters (surface water).	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Property (existing and future structures and services).	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Property (crops and livestock).	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Ecological	Contamination from on-site and off-site sources.		Negligible		Negligible (**not significant**).
Soils	Impacts from waste generated during operation.		Negligible		Negligible (**not significant**).

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