10 Ground Conditions

10.1 Introduction

10.1.1 This chapter assesses the likely impacts of the proposed development on the environment in respect of land contamination and geology/ground conditions.

10.1.2 The range of effects associated with the construction and operation of the proposed development have been considered.

10.1.3 The assessment considers the environmental site setting of the Site in relation to published information on geology, hydrology, hydrogeology and contaminated land issues. The likely impacts of the proposed development on topography, ground stability, soil compaction, re-use of soils and contamination of the Site have been considered. The assessment includes the identification of potential impacts resulting from the proposed development, the requirements for mitigating any residual effects and the significance of these effects.

10.1.4 This chapter should be read in conjunction with the Geoenvironmental Phase I Desk Study, the Preliminary Geoenvironmental Ground Investigation, the Coal Mining Risk Assessment and Coal Recovery Reports, the site preparation and earthworks strategy report and the preliminary slope stability report as listed in Paragraph 10.2.1, which are provided in Appendix 10.1 to 10.8.

10.1.5 This chapter has been prepared by JPG (Leeds) Limited. The assessment team are members of the following professional institutes:

- Fellow of the Geological Society of London;
- Chartered Scientist with the Institution of Environmental Sciences.

10.2 Assessment Approach

10.2.1 In preparing this chapter, reference has been made to a number of information sources and technical reports including:

- Appendix 10.1 – Eastwood and Partners Consulting Engineers. Geotechnical and Geo-Environmental Site Appraisal Commentary. Barnsley West. Report Ref. 36284. Dated 4 October 2013, for Strata.
- Appendix 10.2 – JPG Leeds Limited. Geoenvironmental Desk Study Report. Barnsley West. Report Ref: JBW/DS/4848.v3. Dated July 2019, for Strata Sterling Barnsley West Limited.
- Appendix 10.3 – JPG Leeds Limited. Preliminary Geoenvironmental Ground Investigation. Barnsley West. Report Ref: 4848-JPG-SW-XX-RP-G-0603-S2-P02. Dated July 2019, for Strata Sterling Barnsley West Limited
- Appendix 10.4 – JPG Leeds Limited. Coal Mining Risk Assessment and Coal Recovery Report. Residential Development (Remainder of Site), Barnsley West. Report Ref: 4848-JPG-Z1-XX-RP-G-1101-S2-P02. Dated August 2019, for Strata Sterling Barnsley West Limited.
- Appendix 10.5 – JPG Leeds Limited. Coal Mining Risk Assessment and Coal Recovery Report. Employment Land, Barnsley West. Report Ref:

4848-JPG-Z2-XX-RP-G-1102-S2-P02. Dated August 2019, for Strata Sterling Barnsley West Limited.

- Appendix 10.6 – JPG Leeds Limited. Coal Mining Risk Assessment and Coal Recovery Report. Residential Development (Pogmoor), Barnsley West. Report Ref: 4848-JPG-Z3-XX-RP-G-1103-S2-P02. Dated August 2019, for Strata Sterling Barnsley West Limited.

- Appendix 10.7 – JPG Leeds Limited. Site Preparation and Earthworks Strategy. Barnsley West. Report Ref: 4848-JPG-SW-XX-SP-G-0605-S4-P01. Dated May 2021, for Strata Sterling Barnsley West Limited.

- Appendix 10.8 – JPG Leeds Limited. Preliminary Slope Stability Assessment. Barnsley West. Report Ref: 4848-JPG-SW-XX-RP-G-0608-S2-P01. Dated May 2021, for Strata

10.2.2 The aforementioned JPG reports were completed with reference to the latest legislation, guidance and best practice, provided in the following publications.

- DEFRA, 2012, "Environmental Protection Act 1990: Part 2A".

- Environment Agency, 2020, "Land contamination Risk Management (LCRM)".

- PPG, 2019, "National Planning Practice Guidance".

- PPG, 2014, "Land Affected by Contamination"

- PPG, 2015, "Water Supply, Wastewater and Water Quality"

- The Contaminated Land (England) Regulations (2006).

- British Standards (BS), 2017, "BS10175:2011+A2:2017: Investigation of Potentially Contaminated Sites – Code of Practice".

- Environment Agency, 2010, "Guiding Principles for Land Contamination".

- BS, 2020, "BS5930:2015+A1:2020 Code of Practice for Site Investigations".

- BS, 2015, "BS8485:2015 Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings".

- CL:AIRE, 2011, "The Definition of Waste: Development Industry Code of Practice, Version 2".

- CIEH/LQM "Generic Assessment Criteria for Human Health Risk Assessment, 2nd Edition".

- CIEH/LQM, 2015, "S4Uls for Human Health Risk Assessment".

- CIRIA C665 "Assessing Risks Posed by Hazardous Ground Gases to Buildings".

- BRE Special Digest I, 2005, "Concrete in Aggressive Ground".

- UK Contaminated Land Exposure Assessment (CLEA) Framework Documents and Software; and,

- HazWasteOnline™

10.2.3 The National Policy is set out within the National Planning Policy Framework (NPPF (19)) and is relevant to the Proposed Development. NPPF (19) sets out the Government's planning policy for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other developments can be produced. The main purpose of the planning framework is to 'contribute to the achievement of sustainable development'.

10.2.4 The Local Policy with regard to contaminated land and pollution is set out within the Barnsley Local Plan, adopted in January 2019.

10.2.5 The mitigation measures proposed in this chapter have been informed by the historical and recent site investigation works.

10.2.6 The baseline conditions and identified risks and associated geotechnical and environmental effects have been assessed using risk assessments in line with current UK Government approach and industry good practice, including the Environment Agency (EA), CLR11, "Model Procedures for the Management of Contaminated Land".

10.2.7 Since issue of the geoenvironmental phase I desk study and the preliminary phase geoenvironmental ground investigation report, CLR11 has been superseded by the Environment Agency's manual Land Contamination: Risk Management (LCRM), published in June 2019 and last updated on 19 April 2021. However, this does not change the conclusions of the JPG reports and the assessments contained within.

10.2.8 The assessment was used to identify the risks under the Site's current conditions and existing land use, including geotechnical risks and soils and groundwater contamination. The assessment proceeds to enable the identification of any potential risks to the proposed development outlined in the planning application and associated risks during the construction and operational phases, where mitigation is detailed later in this chapter.

10.2.9 The assessment will be underpinned by a geotechnical risk register and involves identifying the potential contaminant source-pathway-receptor linkages and the significance of any potential risks identified. This is carried out by establishing the sensitivity of the receptor to the risk and the magnitude of the potential impact.

Geology and Soil

10.2.10 The geological conditions and characteristics on site were originally identified from a desk-based review and assessment and review of historical site investigation records (Appendix 10.1 to 10.6). The findings of the desk study were confirmed through analysis of soil samples, gas and groundwater monitoring wells and 42 exploratory holes across the Site (Appendix 10.3).

10.2.11 The main potential impacts on geology and soil are associated with soil contamination as a result of current and historical land uses both on and off site, land stability (associated with previous opencast excavations, settlement of backfilled materials and subsidence of future buildings and/or infrastructure), shallow recorded and unrecorded coal workings (including mine entries),

foundation designs and the creation of preferential pathways, earthworks, significant obstructions present on site and concrete design. Magnitude of the impact of the scheme on geology and soils is based on the criteria shown in Table 10.1.

Hydrogeology

10.2.12 Groundwater and surface water represents a potential receptor for any potential pollutant originating from the development, either during construction or operation. Information relating to the aquifer classification (bedrock), recorded groundwater abstraction licences, groundwater source protection zones and potential sensitive receptors (i.e. receiving inland rivers) was identified during the JPG geoenvironmental desk study. Baseline soil and leachate results were obtained during the preliminary geoenvironmental ground investigation.

10.2.13 A generic quantitative risk assessment (GQRA) was carried out on the soil and leachate chemical concentrations, with comparisons made against the relevant generic assessment criteria (GAC).

10.2.14 The assessment carried out in the preliminary geoenvironmental ground investigation report encountered an elevated leachate concentration in one exploratory hole location.

10.2.15 No groundwater or surface water samples were collected as part of the preliminary geoenvironmental ground investigation.

Contaminated Land

10.2.16 The assessments in the geoenvironmental phase I desk study and the preliminary geoenvironmental ground investigation report (Appendix 10.2 and 10.3) use a risk-based approach following the source-path-receptor methodology. This methodology assesses the nature of the potentially contaminated locations (on and off site) in relation to the potential pathways and to the proximity of any sensitive receptors such as residential developments or controlled waters.

10.2.17 The current environmental assessment considers those sources that present the greatest potential risk of an adverse environmental impact. Tables 10.1 to 10.3 have been used to assess the potential impact.

10.2.18 The assessment of potentially contaminated soils was undertaken in accordance with The Contaminated Land Exposure Assessment (CLEA) model, used for assessing risk to human health from land contamination. The CLEA software has been used to derive Generic Assessment Criteria (GAC) which are reference concentrations for specific substances.

10.2.19 The assessments were carried out using the statutory and industry guidance screening levels to carry out a generic quantitative risk assessment (GQRA).

10.2.20 It was considered appropriate to use the criteria known as LQM/CIEH Suitable 4 Use Levels (S4ULs), published in 'The LQM/CIEH, S4Uls for Human Health Risk Assessment' document. In the absence of S4Uls, Category 4 Screening Levels (C4SLs) were considered appropriate to use in the assessment.

10.2.21 Based on the proposed mixed-use development, residential with homegrown produce was used as the end use parameter, the most conservative threshold criteria, for the preliminary phase assessment.

10.2.22 The assessment carried out in the preliminary geoenvironmental ground investigation report encountered no elevated concentrations of soil determinands.

10.2.23 Further soil sampling, laboratory testing and assessment will be required post earthworks for each development phase to confirm the chemical status of the shallow soils (topsoil and subsoil) and the requirements for a clean cover system, to the satisfaction of the Local Authority.

Ground Gas

10.2.24 Potential ground gas sources were derived in the Phase 1 desk study (Appendix 10.2). The potential ground gas sources were investigated and monitored as part of the preliminary ground investigation (Appendix 10.3). Monitoring was carried out over a six-week period and included the measurement of methane, carbon dioxide, oxygen, hydrogen sulphide, carbon monoxide, gas flows and atmospheric pressure.

10.2.25 The ground gas results from the preliminary ground investigation were assessed in accordance with BS: 8485:2015+A1:2019 "Code of Practice for the Characterisation and Remediation of Ground Gas in Affected Developments".

10.2.26 The Gas Screening Value (GSV) for the Site was calculated based on the gas concentrations (methane and carbon dioxide) and the borehole flow rate.

10.2.27 The GSV provides the Characteristic Situation (CS) for the Site, which in turn determines the protection measures required for the development.

10.2.28 Further ground gas monitoring and assessment will be required post earthworks for each development phase to confirm the ground gas regime and the requirements for ground gas protection measures, to the satisfaction of the Local Authority.

Assessment Criteria

10.2.29 Baseline conditions have been assessed for the Site and surroundings based on the current condition of the Site and the land in its vicinity. The assessment of potential effects of the proposed development on geology and wider ground conditions (including soil contamination) has been carried out on the basis of those elements that could potentially result in environmental impacts, which may be any variance (positive or negative) from the baseline conditions.

10.2.30 The assessment of impacts addresses both the construction and operational phases of the development.

Magnitude

10.2.31 Magnitude refers to the 'size' or 'amount' of an impact. It is a function of other aspects such as the 'extent' of an impact being the area over which the impact occurs, the duration, the likelihood and reversibility. The level of 'magnitude' is defined in Table 10.1.

Sensitivity

10.2.32 The sensitivity or value of a receptor is a function of a variety of factors e.g. environmental sensitivity and economic value. The sensitivity or potential

sensitivity of a receptor can be determined by the geographical context. The level of sensitivity is defined in Table 10.2.

Significance

10.2.33 The 'significance' reflects the relationship between the 'magnitude' of an impact and the sensitivity of the affected resource or receptor.

10.2.34 To assist in the assessment, Table 10.3 has been used to determine the level of impact significance.

Table 10.1: Magnitude of Impact

Magnitude of Impact	Criteria for Assessing Impact	Examples
High	Total loss or major/substantial alteration to key elements/ features of the baseline (pre-development) conditions such that the post-development character/composition/ attributes will be fundamentally changed.	Change in risk resulting in a change of more than one Flood Zone (e.g. 1-3; 3-1). Additional or fewer properties flooded internally. Failure of utility service affecting a wide area. Increase or decrease in groundwater qualitative or quantitative WFD status. Pollution or loss of potable source of abstraction.
Medium	Loss or alteration to one or more key elements/features of the baseline conditions such that post- development the character/composition/attributes of the baseline will be materially changed.	Change in risk resulting in a change of a single Flood Zone (e.g. 1-2, 2-3). Existing internally flooded properties flooded to a greater or lesser depth. Additional or fewer properties flooded externally. Change in performance of utility service affecting a wider area. Increase or decrease in the yield or quality of an aquifer, but insufficient to change its WFD classification.
Low	A minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-development circumstances/situation.	Change in risk but insufficient to change the Flood Zone. Existing external flooding increased or decreased but no change in properties affected. Localised change in performance of a utility service affecting the immediate area surrounding the Site. Localised change in water quality immediately adjacent to the Site. Reversible change in the yield or quality of an aquifer, but insufficient to change its WFD classification.
Negligible	Very little change from baseline conditions. Change barely distinguishable, approximating to a 'no	No/minimal change in flood risk. No/minimal change in utility performance.

Magnitude of Impact	Criteria for Assessing Impact	Examples
	change' situation.	No/minimal change in water quality. No significant impact on the economic value of the feature. No change to the integrity of an aquifer.

Table 10.2: Receptor Sensitivity

Sensitivity	Characteristics of Receptor	Examples
High	The receptor/resource has little ability to absorb change without fundamentally altering its present character, or is of international or national importance, with very limited potential for substitution.	Existing residential properties. Principal aquifer with public water supply abstractions. Site is within Inner or Outer Source Protection Zones (SPZ 1 to 2). WFD classification 'High'. Site protected/designated under EC or UK habitat legislation (SAC, SPA, SSSI), Water Protection Zone (WPZ), Ramsar site.
Medium	The receptor/resource has moderate capacity to absorb change without significantly altering its present character, or is of high quality and rarity on regional scale or medium quality and rarity on regional or national scale, with limited potential for substitution.	Principal aquifer providing locally important resource or supporting river ecosystem. Site is within a Catchment SPZ (SPZ 3). Secondary A aquifer with limited water supply abstractions for industrial or agricultural use. Site is within Inner or Outer SPZ (SPZ 1 to 2). WFD classification 'Good'. Local sewerage systems. Water supply networks.
Low	The receptor/resource is tolerant of change or is of medium quality and rarity on regional scale or low quality and rarity on national scale, with limited potential for substitution.	WFD classification 'Moderate'. Secondary Aquifer with limited water supply abstractions for industrial or agricultural use. SPZ3 (total catchment). Highway areas.
Negligible	Feature characteristic do not make a significant contribution to the character or distinctiveness locally. Feature not designated. Feature possesses low biodiversity, social/ community value and/or economic value. Feature is common.	Minor residential/ industrial development. Surface Waters: River Ecological Quality Poor. Secondary (Class B) Aquifer with limited connection to surface water. Low quality agricultural land.

Table 10.3: Significance of Potential Effect

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

Scoping and Consultation Response

10.2.35 The scope of the assessment is to assess the likely impacts of the proposed development on the environment in respect of land contamination and geology/ground conditions.

10.2.36 The ES Scoping Report set out the proposed approach to the Ground Conditions Chapter and was submitted to Barnsley Metropolitan Borough Council (BMBC), the Coal Authority and the South Yorkshire Mining Advisory Service (SYMAS).

10.2.37 The consultation responses are outlined below:

Barnsley Metropolitan Borough Council (BMBC)

10.2.38 The contaminated land officer at BMBC has confirmed they are satisfied with the assessment outlined in the scoping report.

The Coal Authority and the South Yorkshire Mining Advisory Service (SYMAS)

10.2.39 There has been no response from the Coal Authority.

10.2.40 SYMAS are satisfied with assessment outlined in the scoping report and provided the following response.

'Ultimately the studies will make suitable recommendations for appropriate ground remediation/ mitigation/ stabilization to ensure the site can be safely and sustainably developed and in consideration of NPPF sections 178 a,b,c. 179 and 170 e & f'

Limitations to the Assessment

10.2.41 Following the preliminary geoenvironmental ground investigation, gaps were identified in the data, including limited geotechnical testing and a requirement for further soil and water chemical analysis targeting potential areas of contamination i.e. existing farms. Therefore it is possible that further contamination could be encountered. A proposed future ground investigation would look to address these data gaps. However, based on the available information, an informed judgement can be made and would be adopted for this assessment.

10.2.42 The current assessment has been based on the relevant and available information identified at the time of writing and associated risk assessments were completed using professional experience, best practice and judgement. This information does not indicate that baseline conditions would be likely to change before the commencement of construction and the baseline provided here is considered appropriate for the assessment.

10.2.43 The site baseline conditions are summarised from the documentation listed in paragraph 10.2.1. It is recommended reference is made to the complete findings of each report for further information regarding baseline conditions.

10.3 Baseline Conditions

10.3.1 This section describes the baseline conditions at the Site (and surrounding area as appropriate). The baseline conditions have been determined based on information gathered in the documents listed in paragraph 10.2.1 and included as Appendices 10.1 to 10.6.

10.3.2 For effects associated with ground contamination sources, receptors covered by the Site (shown by the red line boundary) and within 500m of the Site are considered in the assessment. The study area has been selected to consider the transport and final destination of potential contaminants of concern in the environment and the connectivity of these contaminants via pathways of migration/exposure to receptors.

10.3.3 In relations to physical effects (e.g. ground stability), the study area will be the Site as defined by the red line boundary.

10.3.4 The assessment has considered the following baseline receptors:

Table 10.4: Baseline Receptors

Designation	Receptors
Very High (e.g. International)	-
High (e.g. National)	-
Medium (e.g. Regional/County)	Secondary A aquifer (bedrock) below and in the vicinity of the site. Construction and Maintenance Workers.
Low (e.g. local)	Surface water features i.e. streams/drainage channels, on and off site Agricultural land Geology and the geological setting Amenity uses Site end users/visitors

Designation	Receptors
	Occupants/users of adjacent land Structures on or near to the site Other property (including utilities, livestock and crops)
Negligible	-

10.3.5 Table 10.5 sets out the rationale for designation of receptors.

Table 10.5: Designation of Baseline Receptors

Designation	Receptors
Very High (e.g. International)	Receptor with a very high importance and very limited potential for substitution and generally of an international scale.
High (e.g. National)	Receptor with a high importance and very limited potential for substitution and generally of a national scale.
Medium (e.g. Regional/County)	Receptor with a medium importance and very limited potential for substitution and generally of a regional scale. e.g. Secondary A aquifer in the bedrock.
Low (e.g. local)	Receptor with a low importance and very limited potential for substitution and generally of a local scale. e.g. on site surface water features.
Negligible	Receptor with a very low importance.

10.3.6 The Phase I Geoenvironmental Desk Study (Appendix 10.2) identified potential geotechnical and environmental issues that may represent constraints to the proposed redevelopment of the Site. The geoenvironmental desk study included the following:

- Site Description

Sloping arable and grazing land, divided into fields by hedgerows, fences and small watercourses. Farmsteads and outbuildings are present in the centre-east of the site and on the north-eastern boundary.

- A review of historical maps obtained from GroundSure.

Based on the review of the historical maps it is evident that most of the Site has undergone opencast coal extraction. The Site was restored to agricultural use by the 1970s. The only built development on the Site consists of Hermit House Farm and Cottage and Red Brook farm, the farms dating from the nineteenth century. The surrounding land has also been used predominantly for agricultural use with also a long legacy of coal mining activity in the area.

Historical contaminative industries near the Site also include a bleach works, located approximately 150m to the north east of the site.

- A review of publicly-available environmental data, including geology, hydrogeology and pollution.

A review of British Geological Survey (BGS) Maps, including Sheets No.87 and SE30NW. Large areas of the Site are underlain by a significant thickness of non-engineered made ground, consisting of colliery discard associated with the backfilled opencast coal sites. No superficial deposits are recorded on Site. The underlying bedrock is shown to comprise the Pennine Middle Coal Measures strata of mudstone, siltstone, sandstone and coal seams. The Pennine Middle Coal Measures is classified as a Secondary A Aquifer.

A review of The Coal Authority, Con29M, Consultants Coal Mining Reports (Ref: 51001983537001 and 51001983537002) and the relevant coal mining abandonment plans. The Coal Authority information confirmed that the Site is underlain by several backfilled opencasts, namely the Craven I and Craven II, Hunters Cottage and Hunters Cottage Extensions and Farm House Lane. There is also the potential for parts of the Site to be at risk from unrecorded coal workings in the shallow coal seams, in particular below highwalls. There are 14 recorded mine entries on the site, or within 20m of the site.

- A review of previous investigations by Eastwood and Partners (Appendix 10.1).

- Completion of an outline qualitative environmental risk assessment.

10.3.7 The preliminary geoenvironmental ground investigation report (Appendix 10.3) identified the potential geotechnical and environmental issues that may represent constraints to the proposed redevelopment of the Site. The geoenvironmental ground investigation included the following:

- *A description of the ground investigation works carried out, i.e. factual reporting.*

- *Assessment of potential contaminants using generic assessment criteria specific to the proposed end use.*

- *A quantitative screening assessment using source-pathway-receptor linkages.*

- *Engineering assessment to include recommendations with respect to foundations, ground floor and pavement design, including a geotechnical risk register.*

- *Comments on the likely requirements for remedial measures on the site, to address potential contamination and ground gas issues.*

- *The investigation was carried out between 11 March and 8 April 2019 and on the 16 May 2019. The fieldwork comprised the excavation of 14 trial pits and the drilling of 28 rotary open hole boreholes. Gas and groundwater monitoring wells were installed in seven boreholes to assess the ground gas and groundwater regime in the made ground and natural strata beneath the Site. The wells were monitored on six occasions. Four extensometers have been installed in selected boreholes within each of the historical opencast coal sites. Soil samples were obtained and submitted for chemical testing and geotechnical testing. Reworked topsoil was encountered across the Site. Made ground was found to be present across the Site with deeper areas of made ground being recorded to a maximum*

depth of 38.50m bgl in the areas of the historical opencast coal sites. The underlying natural ground comprised firm medium strength residual soil overlying extremely weak mudstone of the Pennine Middle Coal Measures outwith the historical opencast coal sites. The natural strata beneath the opencast coal sites comprised bedrock of the Pennine Middle Coal Measures. No unrecorded underground coal workings were encountered across the Site.

- *On completion of the intrusive investigation groundwater was recorded in the monitoring wells at depths of between 4.51m bgl and 33.92m bgl. No significant potential sources of soil contamination were identified. The results of the gas monitoring have been assessed in accordance with BS8485:2015. It is recommended that gas protection measures in accordance with Characteristic Situation 2 are installed. However, it should be noted that this is a preliminary classification; further ground gas assessment is required to confirm the ground gas regime. No radon protective measures are required.*

10.3.8 The three Coal Mining Risk Assessment and Coal Recovery Reports (Appendix 10.4 to 10.6) assessed the site-specific coal mining risks and set out the proposed mitigation strategy to show that the site can be made safe and stable for the proposed development. The objectives of the coal mining risk assessment and coal recovery reports were to:

- Present a desk-based review of all available information on the coal mining issues which are relevant to the application site.

- Use that information to identify and assess the risks to the proposed development from coal mining legacy, including cumulative impact of issues.

- Set out appropriate mitigation measures to address the coal mining legacy issues affecting the site, including any necessary remedial works and/or demonstrate how coal mining issues have influenced the proposed development.

- Demonstrate to the Local Planning Authority that the application site is, or can be made, safe and stable to meet the requirements of national planning policy with regard to development on unstable land.

10.3.9 Based on the findings of the coal mining risk assessment and coal recovery reports (Appendix 10.4 to 10.6), past mining activities do pose a risk to the proposed development. However, following the implementation of the mitigation methods outlined in the reports, the development area will be suitable for the construction of commercial units and residential dwellings with associated infrastructure.

10.3.10 Further investigation and subsequent treatment of coal workings, if proven, will be required prior to development. Further settlement analysis will be carried out prior to development to confirm that future total and differential settlement will be within tolerable limits.

10.3.11 Coal may be encountered during the earthworks operations.

10.3.12 Should the site not be developed and is continued to be used as arable and grazing land. It is considered likely that there would be no change to the baseline conditions.

10.4 Alternatives Considered and In-built Mitigation

10.4.1 The proposed development of the Site has been designed to allow the re-use of materials where possible to ensure that the most sustainable approach is taken. This includes the re-use of excavated soils in surcharging and preloading resulting from the cut and fill earthworks.

10.4.2 The cut and fill earthworks have been developed to achieve a materials balance on the Site, negating the requirement for the importation or export materials on or off site. The proposed layout has also been designed to retain as much site-won topsoil as possible in the landscaped areas.

10.4.3 Surcharging/ preloading and the re-use of material is the most sustainable ground improvement technique suitable for this development. Surcharging/preloading does not produce a noise impact and it does not increase traffic in the local area.

10.4.4 Following the preliminary ground investigation (Appendix 10.3), it was considered that the colliery spoil, made ground and natural soils and bedrock were suitable to be engineered to create the development platforms. In order to retain as much as possible of these materials on Site, slope assessment is to be carried out to confirm maximum slope angles. This slope assessment will include the re-use of site won materials.

10.5 Assessment of Likely Significant Effects

10.5.1 This section sets out an assessment of the potential environmental impacts the proposed development will have on the identified receptors. It takes into consideration both the construction and operational phases of the proposed development. In summary the elements of the proposed development which could give rise to effects on ground conditions are the earthworks and ground improvement operations.

10.5.2 The earthworks have been designed as such that the employment development (Phase 1b) is independent from the link road and residential developments (Phases 1a, 2 and 3), therefore the earthworks and ground treatment for the employment area can be carried out as a stand-alone process prior to the earthworks and ground treatment for the link road and residential areas.

10.5.3 The earthworks and ground treatment for the link road and residential developments can be carried out in a phased approach from the northern boundary to the southern boundary of the residential development area.

10.5.4 Initially the earthworks will involve removal of the topsoil. Following the site scrape, the topsoil is to be stockpiled, tested for suitability and reused within the garden areas and soft landscaping. Additionally, the topsoil stockpiles are to be used as part of the surcharging (ground improvement) process.

10.5.5 The bulk earthworks (cut and fill operations) will take place several years prior to the construction of the dwellings and commercial plots. Immediately following on from the cut and fill operations, the bulk fill material (topsoil and colliery spoil) will be used for surcharging (ground improvement) of the land parcels.

10.5.6 Details of the earthworks are contained in the site preparation and earthworks strategy report (Appendix 10.7).

10.5.7 The bulk earthworks will also include the construction of embankments and cuttings which will help form the development plateaus across the Site. A preliminary stability assessment of these slopes has been carried out in the preliminary slope stability report (Appendix 10.8).

Construction Phase

10.5.8 The potential significant environmental impacts which may occur during the construction phase are assessed below and summarised in Table 10.6.

Importation of Materials to site

10.5.9 Materials likely to be imported to Site would be for construction use only e.g. build-up of the roads and units. Significant importation of bulk fill material to develop the plateaus is not anticipated. There is the possibility that any contaminated materials could be imported onto the Site. The magnitude of the impact is considered **Low/Negligible**, and the sensitivity is considered to be **Low**. Therefore the significance of the effect is **Minor/Negligible (Adverse)**.

Earthworks – cut and fill operation

10.5.10 Earthworks, including a large scale cut and fill operation and surcharging is proposed to be carried out. The earthworks, including the surcharging mounds, will be carried out using site won materials to achieve a materials balance. Topsoil will be retained on Site and reused in garden areas and soft landscaping. Additionally, any shallow coal seams encountered during the earthworks will be excavated and removed under an incidental coal agreement with The Coal Authority (removal of combustible shallow coal). The magnitude of the impact is considered **Medium**, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Moderate (Beneficial)**.

Possible impact on the development with respect to unstable ground conditions

10.5.11 There may be the potential for construction workers or future site users to be exposed to unstable ground conditions, primarily uncontrolled opencast backfill material, proposed and existing slopes, natural groundwater springs, mine entries and possible underground coal workings. Any exposure to unstable ground conditions could be detrimental to human health. The uncontrolled opencast backfill will be improved by surcharging/preloading. New or existing slopes will be subject to a slope stability assessment. The natural groundwater springs will require remediation and mitigation. Any mine entries and unrecorded underground coal workings will be subject to remediation and mitigation e.g. drilling and grouting (including capping the mine entries). The magnitude of this impact is considered to be **Medium** and the sensitivity is considered to be **Medium/Low**. Therefore the significance of the effect is **Moderate/Minor (Adverse)**.

Creation of preferential pathways through construction techniques

10.5.12 The creation of preferential pathways allowing the migration of potential contaminants through construction activities such as removal of surface soils/ earthworks or piling into bedrock and thereby creating a pathway into the underlying bedrock may occur given the proposals for the Site preparation. The magnitude of the impact is considered **Low**, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Minor (Adverse)**.

Loss of or disturbance of soils, e.g. topsoil scrape

10.5.13 Given that much of the Site is currently arable and grazing farmland, the loss of or disturbance of soils, e.g. topsoil, may occur due to mixing with the underlying natural strata or with the made ground colliery spoil during the site scrape. The magnitude of the impact is considered **Low**, and the sensitivity is considered to be **Low**. Therefore the significance of the effect is **Minor (Adverse)**.

Introduction of contamination e.g. accidental (non-routine) spills and/or leaks

10.5.14 Introduction of contamination may occur during the construction phase of the proposed development, as it is likely that items such as fuels and solvents may be used and stored on Site. Any accidental spillages or leaks of potentially contaminated materials may impact the underlying soils and groundwater/on site surface water features. The magnitude of the impact is considered **Low**, and the sensitivity is considered to be **Low**. Therefore the significance of the effect is **Minor (Adverse)** for the soil and groundwater/surface water.

Release of and exposure to hazardous ground gases and/or soil vapours

10.5.15 During the construction phase, workers may be exposed to hazardous ground gases and/or soil vapours. Exposure to elevated concentrations of hazardous ground gases and soil vapours; if at sufficiently high concentrations or for prolonged periods of time, can be detrimental to human health. The magnitude of the impact is considered **Medium**, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Moderate (Adverse)**.

Exposure to contamination within underlying soils

10.5.16 There may be the potential for construction workers and/or visitors to be exposed to potential contamination within the underlying soils during the works, e.g. in excavations for drainage and foundations which may be detrimental to human health. The magnitude of the impact is considered **Medium**, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Moderate (Adverse)**.

Exposure to contamination during demolition of existing structures

10.5.17 There may be the potential for construction workers to be exposed to potential contamination when demolishing the existing structures, e.g. Hermit House farm, which may be detrimental to human health. The magnitude of the impact is considered **Medium/Low**, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Moderate/Minor (Adverse)**.

Table 10.6: Significance of Potential Effect – Construction Phase

Activity	Receptor	Effect of Potential Impact			Mitigation Required	Comments
		Sensitivity	Magnitude	Significance		
Importation of materials to site	Low (i.e. Land use – commercial and residential)	Low	Low/Negligible	Minor/Negligible (Adverse)	No	Importation of bulk fill materials is not anticipated. Any construction materials brought onto site will need to be tested for suitability.
Earthworks – cut and fill operation	Low/Medium (i.e. Land use – geology and geological setting, construction workers and structures)	Medium	Medium	Moderate (Beneficial)	Yes	Soil stripping for reuse and working practices will be adopted to minimise long term degradation of soils, such as covering or sealing stockpiles to prevent infiltration of rainwater. Excavation of combustible soils and offsite disposal will be required to reduce the risk to construction workers.
Possible impact on the development with respect to unstable ground conditions.	Low/Medium (i.e. construction workers and future site users)	Medium/Low	Medium	Moderate/Minor (Adverse)	Yes	Any evidence of coal mining (workings and/or mine entries) will require remediation and mitigation, e.g. drilling and grouting.
Possible impact on the development with respect to unstable ground	Low/Medium (i.e. construction workers and future site users)	Medium	Medium	Moderate (beneficial)	Yes	Any new or existing slopes will be subject to a slope stability assessment. Natural groundwater springs will require remediation and mitigation, e.g. drainage included in the embankments/cuttings.

Activity	Receptor	Effect of Potential Impact			Mitigation Required	Comments
conditions.						The uncontrolled opencast backfill will be subject to ground improvement techniques, such as surcharging/preloading.
Creation of preferential pathways through construction techniques.	Medium (i.e. Secondary A Aquifer)	Medium	Low	Minor (Adverse)	Yes	This is a concern where construction will take place directly over the aquifer following the site cut or where piling into bedrock is proposed. Good site management practices will be adopted to reduce potential for spills and leaks.
Loss of or disturbance of soils e.g. topsoil	Medium (i.e. Secondary A Aquifer)	Low	Low	Minor (Adverse)	Yes	Good site management and care to be taken when carrying out the topsoil strip.
Introduction of contamination e.g. accidental (non-routine) spills and/or leaks	Low to Medium (i.e. Secondary A Aquifer or surface water)	Low	Low	Minor (Adverse)	Yes	This is a concern where construction will take place directly over the aquifer following the site cut. Good site management practices will be adopted to reduce potential for spills and leaks.
Release of and exposure to hazardous ground gases and/or soil vapours	Medium (i.e. construction workers)	Medium	Medium	Moderate (Adverse)	Yes	Potential exposure to ground gas and/or soil vapours, particularly when working below ground in excavations or confined spaces. Appropriate gas detection and mitigation measures to be employed to reduce risk.
Exposure to contamination within	Medium (i.e. construction	Medium	Medium	Moderate (Adverse)	Yes	The appointed contractor is to produce a Construction Environmental Management Plan

Activity	Receptor	Effect of Potential Impact			Mitigation Required	Comments
underlying soils	workers)					(CEMP).
Exposure to contamination during demolition of existing structures	Medium (i.e. construction workers)	Medium/Low	Medium	Moderate/Minor (Adverse)	Yes	The appointed contractor is to produce a Construction Environmental Management Plan (CEMP). The correct guidance should be adhered to regarding the control of dust, vapours, odours and noise, etc.

10.5.18 Based on the absence of any significant sources of contamination identified to-date on the Site and the absence of any significant sensitive receptors. None of the recorded effects are considered to be significant, i.e. will not have a significant influence on the environment.

Operational Phase

10.5.19 The potential significant environmental impacts which may occur during the operational phase are assessed below and summarised in Table 10.7.

Degradation of building materials

10.5.20 Degradation of building materials may occur during the lifetime of the proposed development. If soils with aggressive contaminants come into contact with the proposed development, these have the potential to cause degradation which could ultimately result in failure of the foundations. The magnitude of the impact is considered **Low**, and the sensitivity is considered to be **Low**. Therefore the significance of the effect is **Minor (Adverse)**.

Introduction of contamination into underlying soils/groundwater or surface water e.g. accidental spills and/or leaks

10.5.21 Introduction of contamination may occur during the operational phase of the proposed development, as it is likely that items such as fuels may be used and stored on Site. Any accidental spillages or leaks of potentially contaminated materials may impact the underlying soils/groundwater or surface waters. The magnitude of the impact is considered **Low**, and the sensitivity is considered to be **Low**. Therefore the significance of the effect is **Minor (Adverse)** for the soil and groundwater/surface water.

Exposure to contamination in the underlying soils or groundwater

10.5.22 During the operational phase, maintenance workers and site end users may be exposed to contamination within the underlying soils or groundwater, e.g. in excavations, which may be detrimental to human health. The magnitude of the impact is considered **Medium** for maintenance workers and **Low** for site end users, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Minor (Adverse)** site end users (commercial) and **Moderate (Adverse)** for maintenance workers and site end users (residential).

Release of and exposure to ground gas and/or soil vapours

10.5.23 During the operational phase of the site, maintenance workers and future site end users may be exposed to hazardous ground gases and/or soil vapours. Exposure to elevated concentrations of hazardous ground gases and soil vapours; if at sufficiently high concentrations or for prolonged periods of time can be detrimental to human health. The magnitude of the impact is considered **Medium** for maintenance workers and **Low** for site end users, and the sensitivity is considered to be **Medium**. Therefore the significance of the effect is **Minor (Adverse)** site end users (commercial) and **Moderate (Adverse)** for maintenance workers and site end users (residential).

Table 10.7: Significance of Potential Effect – Operational Phase

Activity	Receptor	Effect of Potential Impact			Mitigation Required	Comments
		Sensitivity	Magnitude	Significance		
Degradation of building materials	Low (Structures – Commercial and residential)	Low	Low	Minor (Adverse)	Yes	In accordance with BRE Special Digest I:2005, development design needs to take into account the concrete classification based on the assessment of aggressive chemicals.
Introduction of contamination into underlying soils/groundwater or surface water e.g. accidental spills and/or leaks	Low/Medium (e.g. Tertiary River and Secondary A Aquifer)	Low	Low	Minor (Adverse)	Yes	Development design needs to take into account any potentially contaminated surface water run-off is captured and that no hydrocarbons enter the receptors.
Exposure to contamination in the underlying soils or groundwater	Low (e.g. site end users – commercial)	Medium	Low	Minor (Adverse)	Yes	Appropriate health and safety procedures and mitigation measures should be put in place.
Exposure to contamination in the underlying soils or groundwater	Medium (e.g. maintenance workers and site end users – residential)	Medium	Medium	Moderate (Adverse)	Yes	Appropriate health and safety procedures and mitigation measures should be put in place.
Release of and exposure to ground gases	Low (e.g. site end users –	Medium	Low	Minor (Adverse)	Yes	Appropriate gas protection measures should be incorporated into the detailed design.

Activity	Receptor	Effect of Potential Impact			Mitigation Required	Comments
and/or soil vapours	commercial)					
Release of and exposure to ground gases and/or soil vapours	Medium (e.g. maintenance workers and site end users – residential)	Medium	Medium	Moderate (Adverse)	Yes	Appropriate health and safety procedures, training and PPE should be used for all maintenance workers. Appropriate gas protection measures should be incorporated into the detailed design.

10.5.24 Based on the existing ground conditions, anticipated ground conditions (on completion of the earthworks) and absence of any sensitive receptors. None of the recorded effects are considered to be significant.

10.5.25 Although no significant effects have been identified, all of the adverse effects will be mitigated through the implementation of a Construction Environmental Management Plan (CEMP). This will be developed to avoid, minimise or mitigate any construction effects on the environment. This will include detailed method statements/risk assessments for excavations and construction and pollution prevention measures to be implemented during construction and operation.

10.5.26 A remediation strategy and earthworks strategy where necessary will also address key potential environmental impacts arising through the proposed development of the Site.

10.6 Mitigation and Enhancement

10.6.1 This section details the measures that are required and will be put in place to mitigate environmental impacts. It includes both mitigation which is inherent in the design, in addition to that which was set out in Section 10.4, and additional mitigation measures to address any further potential effects identified in Section 10.5.

10.6.2 All works would be undertaken following current UK regulations, guidance and industry best practice.

Construction Phase

Importation of Materials to site

10.6.3 To limit any negative effects caused by importation of materials onto Site, a remediation strategy report will be produced, which will discuss the requirements for any imported materials.

10.6.4 The concentrations thresholds presented within the report will be used to ensure that only materials with concentrations of potential contaminants below their respective Generic Assessment Criteria (GAC) are brought onto site.

10.6.5 For the proposed development, the GAC are for a residential with home grown produce end use, as it is the most conservative threshold criteria.

10.6.6 By implementing such mitigation measures, the environmental impact will be **negligible**.

Earthworks – cut and fill operations

10.6.7 The earthworks operation will reconfigure the Site's topography and enable the proposed development to retain material on Site (where possible), therefore reducing the quantity of material requiring removal off Site.

10.6.8 To limit any negative effects, the material on Site must be optimized and proven to be geotechnically suitable for re-use. This will be done by detailed analysis and sampling regimes and validation procedures. This will be implemented through compliance with an earthworks strategy and remedial strategy.

10.6.9 By implementing such mitigation measures, the environmental impact will be **negligible**.

Possible impact on the development with respect to unstable ground conditions

10.6.10 To date, no underground unrecorded coal workings or mine entries have been encountered.

10.6.11 The uncontrolled opencast backfill material will be subject to surcharging/preloading outlined in an earthworks strategy in order to mitigate risk of future settlement.

10.6.12 The cut and fill operations will create embankments and cuttings around the site. The stability of such features will be assessed, and mitigation measures will be put in place to ensure long term stability can be achieved.

10.6.13 Any natural groundwater confirmed will be remediated and mitigation by use of drainage. This will reduce the groundwater level below the development plateaus, embankments and cutting.

10.6.14 Any features (mineshafts or mine adits) confirmed will be removed/treated as part of these works.

10.6.15 Following the above mitigation measures, the environmental impact will be **negligible**.

Creation of preferential pathways through construction techniques

10.6.16 A CEMP will be implemented for all site activities. The creation of preferential pathways through activities like topsoil removal are considered to be a short-term effect and would therefore be **negligible**.

Loss of or disturbance of soils e.g. topsoil scrape

10.6.17 The removal and stockpiling of site-won topsoil will be carried out in accordance with the earthwork's strategy. Site-won topsoil will be incorporated into the Site's landscaping proposals which would support sustainable re-use of soils. The retention of site-won soils within the proposed development is considered a beneficial long-term effect and by implanting this, the environmental impact would be **negligible**. Topsoil surplus to requirements may be used on other sites depending on chemical and textural suitability.

Introduction of contamination e.g. accidental (non-routine) spills and/or leaks

10.6.18 The mitigation of potential contamination via leaks and/or spillages, would be achieved through the correct implementation of the CEMP.

10.6.19 The CEMP will provide the health and safety procedures, which will include spills-drills, daily checks of machinery, checks on the correct storage of fuels (bunded areas), Control of Substances Hazardous to Health (COSHH) and appropriate labelling of potentially hazardous substances. The impact if any accidental spills or leaks would be dependent on the sensitivity of the receptors. The Secondary A Aquifer is medium sensitivity, whist the on site surface water bodies are low sensitivity.

10.6.20 If the appropriate mitigation measures are in place, the impact due to spills and/or leaks would be **negligible**.

Release of and exposure to hazardous ground gases and/or soil vapours

10.6.21 Appropriate health and safety procedures should be the implemented in accordance with the CEMP. This will include the use of appropriate levels of PPE to protect against the inhalation of hazardous ground gases/soil vapours. The inhalation of hazardous ground gases and/or soil vapours would be a short-term negative effect. However, it has the potential to cause long-term negative effects on human health.

10.6.22 Staff working in confined spaces must be provided with appropriate training along with implementing appropriate health and safety procedures, e.g. hazardous gas monitoring and provision of rescue kits. In doing so, the environmental impact would be **negligible**.

Exposure to contamination within underlying soils

10.6.23 A CEMP will be implemented for all site activities. All workers and visitors would be required to comply with the requirements of the CEMP. A remediation strategy would outline the procedure if any unexpected contamination is identified during the construction phase.

10.6.24 The report would provide an extensive set of mitigation measures and a series of remedial works which would be required as part of the proposed development.

10.6.25 By implementing such mitigation measures, the environmental impact will be **negligible**.

Exposure to contamination during demolition of existing structures

10.6.26 A CEMP will be implemented for all site activities. A remedial strategy will be adopted that will comprise appropriate protocols for the identification and management of unforeseen contamination.

10.6.27 All contractors appointed will be appropriately licensed and experienced, working within the requirements of the Construction (Design and Management) Regulations 2015.

10.6.28 The CEMP will give guidance for the control of dust, vapours, odours and noise, etc.

10.6.29 By implementing such control measures, the environmental impact will be **negligible**.

Operational Phase

Degradation of building materials

10.6.30 The potential for aggressive contaminants within the ground have been assessed during the preliminary ground investigation, samples of made ground and natural ground were submitted for testing in order to specify which concrete classification should be used. The concrete mix will be modified based on this

classification, in accordance with BRE Special Digest 1:2005, to be protective of chemical attack to subsurface concrete.

10.6.31 By assessing and identifying the Site's concrete classification, the risk to below-ground structures and services from sulphate attack is considered to be **negligible**.

Introduction of contamination into underlying soils/groundwater or surface water e.g. accidental spills and/or leaks

10.6.32 A suitable drainage strategy is to be designed to ensure that any potentially contaminated surface water run-off is captured and diverted away from the on-site and off-site receptors.

10.6.33 If appropriate mitigation measures are implemented, then the risk to both the Secondary A Aquifer and the surface water features is considered to be **negligible**.

Exposure to contamination in the underlying soils or groundwater

10.6.34 Mitigation of potential contamination should be achieved through appropriate health and safety procedures, this may include spill-drills, checks on the correct storage of fuels (bunded areas), COSHH and appropriate labelling of potentially hazardous substances. Any tanks which are to be located on Site should be bunded and a spill kit should be onsite to prevent or limit any spills and/or leaks.

10.6.35 If the appropriate mitigation measures and controls are put in place, then contamination due to accidental spills and/or leaks is considered **negligible**.

Release of and exposure to ground gas and/or soil vapours

10.6.36 Any future maintenance workers involved with excavations or entering confined spaces, the appropriate use of health and safety procedures should be implemented.

10.6.37 This will include the use of appropriate training and levels of PPE to protect against the inhalation of hazardous ground gases and/or soil vapours.

10.6.38 For site end users (commercial and residential), the appropriate use of gas protection measures i.e. membrane within the floor slab, should be incorporated into the building design in order to adequately protect human health. The ground gas regime is to be confirmed by post-earthworks monitoring.

10.6.39 If the appropriate measures are implemented, then the impact on maintenance workers and futures site end users will be **negligible**.

Residual Impacts

10.6.40 Residual impacts are only considered in the assessment following the implementation of the mitigation measures described above.

10.6.41 It can be concluded that if the suggested mitigation measures are implemented and adhered to then there should be **no significant** residual adverse impacts to the geology and soil, hydrogeology, contaminated land and ground gas regime

during both the construction and operational phases of the proposed development.

10.7 Additive Impacts (Cumulative Impacts and their Effects)

10.7.1 For the purposes of this assessment we define the additive cumulative effects as:

'*Those that result from additive impacts (cumulative) caused by other existing and/or approved projects together with the project itself* '

10.7.2 An adjacent residential development (Application Number: 2020/0977) is proposed to the north east of the Site.

10.7.3 No approved layout has been provided for this area of the Site. However, it is considered that dwellings for both developments will be offset from the Site boundary and it is proposed to improve the ground conditions of the Site. Therefore, the proposed development will not impact the geology, hydrology, hydrogeology and land quality of the development to the north east.

10.7.4 Two proposed roundabouts are located to the north (Barugh Green Road – application number: 2019/1567 and 2020/0027) and south (Higham Common Road – application number: 2020/0028) of the proposed development.

10.7.5 It is proposed to improve the ground conditions beneath the roundabouts and beneath the Site. Therefore, both proposed developments will not impact the geology, hydrology, hydrogeology and land quality.

10.7.6 The adjacent developments will be subject to the planning process which requires the land to be suitable for its intended use and not cause harm to potential receptors.

10.7.7 No significant cumulative effects are therefore assessed.

10.8 Summary

10.8.1 The Site has a legacy associated with farming and coal mining, which is known to have altered the land quality and the geotechnical properties of the soils and rock beneath the site, respectively. The geotechnical and environmental constraints have been assessed through a geoenvironmental Phase 1 desk study, a preliminary geoenvironmental Phase 2 ground investigation and coal mining risk assessments and coal recovery reports, the results of which have been used to inform this current assessment.

10.8.2 This ES Chapter has assessed the geology and ground conditions beneath and immediately adjacent to the Site's red line boundary. This has included an assessment of the general ground conditions, the presence of any potential contamination and any potential geotechnical impacts, such as ground stability.

10.8.3 Potential activities were identified for both the construction and operational phases of the proposed development and were assessed in terms of the receptor value and the sensitivity, magnitude and significance of the potential impact. Minor/negligible, minor and moderate effects were identified, with either a beneficial or adverse impact on the environment.

10.8.4 Mitigation measures and good working practices outlined in this assessment will reduce the significance of the effects. The residual significance of effect for all the identified impacts have been reduced to negligible.

10.8.5 In summary, the impact of the proposed development on the geology and ground conditions is considered to be negligible following the implementation of the mitigation measures and are therefore not significant.

10.8.6 This assessment has been produced to the best of the author's ability based on the current information available. To increase the confidence level of this assessment, it is proposed that further ground investigation would be undertaken prior to the development commencing, including additional geotechnical and chemical testing. Post earthworks validation testing is also proposed.