

8 Ground Conditions

8.1 Introduction

- 8.1.1 This chapter assesses the likely impacts of the proposed development on the soil and groundwater on the site and surroundings. Consideration has been given to the potential effects from the construction and operation of the development on Human Health and Controlled Water risks from the current known soil and groundwater contamination during construction and final development proposed use.
- 8.1.2 The chapter describes the methods used to assess the impacts, the baseline conditions currently existing at the site and surroundings, the potential direct and indirect impacts of the development arising from construction and operations with regards to contaminated land and groundwater, the mitigation measures required to prevent, reduce, or offset the impacts and the residual impacts.
- 8.1.3 This chapter should be read in conjunction with the Phase I Desktop Study, Phase II Site Investigation reports, and the Detailed Quantitative Risk Assessment (DQRA) reports as listed in Paragraph 8.2.1 which are provided at Appendix 8.1 – 8.17.
- 8.1.4 This chapter has been prepared by Envestigate Ltd and the assessment team are members of the following professional institutes:
- Chartered Water and Environmental Manager with CIWEM
 - Chartered Engineer with the Engineering Council

8.2 Assessment Approach

- 8.2.1 In preparing this chapter, reference has been made to a number of information sources and technical reports including:
- Appendix 8.1 - Environmental Risk Assessment 16492-R1 (01), 2011 RSK Group
 - Appendix 8.2 - Groundwater Sampling 321453 (H) L01 (00) 2013 RSK Group
 - Appendix 8.3 - Data Review of Monkton Production Facility 321789 (H)-R1 (00) 2014 RSK Group
 - Appendix 8.4 - Ground Investigation Report G15009, 2015 Patrick Parsons Ltd
 - Appendix 8.5 - Ground Investigation Factual Report G15009 2016 Patrick Parsons Ltd
 - Appendix 8.6 - Remediation Strategy, G15009, 2016 Patrick Parsons
 - Appendix 8.7 - Remediation Strategy G15009, 2017 Patrick Parsons
 - Appendix 8.8 - Environmental Site Survey, 7102, Moorehead Consulting Ltd

- Appendix 8.9 - Environmental Due Diligence - Monkton Coke and Colliery Works, 12022228, 2005, WSP
- Appendix 8.10 - Coal and Brine Report, including shaft plans and data sheets, Coal Authority
- Appendix 8.11 - Site Investigation, 1997, Pro-Soils Surveys
- Appendix 8.12 - CQA Compliance Report for Capping Works, 2004, LJ Church Laboratory Services Ltd
- Appendix 8.13 - Data Review and Gap Analysis, Former Monckton Coking Works, October 2019, GEO2, Ref: 19/B0010.1.2
- Appendix 8.14 - Site Investigation Scope of Works, Former Monckton Coking Works, December 2019, GEO2 / Envestigate Ltd, Ref: ESG/FG2/SoW
- Appendix 8.51 - Environmental Site Assessment: Former Monckton Coking Works, July 2020, GEO2, Ref: 20.B0010.4.1
- Appendix 8.16 - Quantitative Risk Assessment: Former Monckton Coking Works, July 2020, GEO2 Ref: 20B0010.5.1
- Appendix 8.71 - Options Appraisal and Remediation Strategy: Former Monckton Coking Works, July 2020, GEO2, Ref: 20.B0010.6.1

8.2.2 In addition to the above, discussions were held with John Scott the Contaminated Land Officer at Barnsley Metropolitan Borough Council. These discussions involved the scope of subsequent site investigation works and possible remediation proposals coming from this.

8.2.3 To ensure conformity with the latest legislation, guidance and best practice, the above mentioned GEO2 reports were completed with reference to guidance provided in the following publications

- BS 10175 "Investigation of potentially contaminated sites: Code of Practice"
- BS 5930 "Code of Practice for site Investigations"
- BS8485 "Code of Practice for the characterisation and remediation from Ground Gas in Affected Developments."
- CIEH/ LQM "Generic Assessment Criteria for Human Health Risk assessment, 2nd Edition"
- CIEH/ LQM "S4ULs for Human Health Risk Assessment, 2015"
- CIRIA C665 "Assessing risks posed by hazardous ground gases to buildings"
- CL:AIRE, The Definition of Waste: Development Industry Code of Practice, Version 2, March 2011
- Environment Agency, CLEA 2009 Science reports SR2, SR3 and SR4

- Environment Agency, 2004, Contaminated Land Report 11 (CLR11), Model Procedures for the Management of Land Contamination
- Environment Agency, 2006, Remedial Target Methodology, Hydrological Risk Assessment for Land Contamination,
- Environment Agency, 2009, Soil Guideline Value Reports, SC050021/SGV
- NHBC R&D publication 66 "Guidance for the Safe Development of Housing on Land Affected by Contamination"
- The Water Supply (Water Quality) Regulations, 2000 (UK DWS)
- UK EQS Values for the Protection of Surface and Groundwater Resources taken from "The River basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2009)"

8.2.4 Mitigation measures proposed in this chapter have been informed by the site investigation works (both historic and recent).

8.2.5 The baseline conditions and identified contamination at the site have been assessed using risk assessment in line with current UK government approach and industry good practice, in particular the report produced by the Environment Agency (EA), CLR11, Model Procedures for the Management of Contaminated Land .

8.2.6 The assessment was used to identify the risk from contamination within the soil and groundwater at the site under its current conditions and site use. The assessment progresses to identify the potential risks to the future development under the planning application and associated risks during the construction and operational phases, where mitigation is detailed later in this chapter. The assessment involves identifying potential source, receptor and pathways and the significance of any potential risks identified. This is carried out by determining the sensitivity of the receptor to the risk and the magnitude of the potential impact.

Geology and Soil

8.2.7 Site geological conditions and characteristics were initially identified from a review of the desk based assessments and previous site investigation records (Appendix 8.1 to 8.17). The findings were tested through analysis of soil samples collected from the installation of over 100 exploratory holes across the site (Appendix 8.15).

8.2.8 The main potential impacts on geology and soils are associated with loss or damage to soils, the contamination of soils as a result of industrial activity both on and off site, and aggregation of soils from redevelopment works (and associated ground stability concerns). Magnitude of the impact of the scheme on geology and soils is based on the criteria shown in Table 8.1.

Hydrogeology

8.2.9 Groundwater and surface water represents a potential receptor for any pollutant emanating from the development, either during construction or operation. Information regarding aquifer classification, groundwater sensitivity and potential sensitive receptors was identified during the desk based stages of investigation. Baseline soil and groundwater quality information was obtained during the

intrusive site investigations to further assist with the assessment of risk posed to controlled waters.

- 8.2.10 Initially for Level 1/ Level 2, a Generic Quantitative Risk Assessment (GQRA) was carried out which involved the comparison of soil and groundwater chemical concentrations with relevant water quality standards, usually comprising of Environmental Quality Standards (EQS) or UK Drinking Water Standards (DWS) where environmental quality standards are absent.
- 8.2.11 Aquifers that are a source of public water supply or that connect directly to surface water bodies are particularly sensitive to pollution incidents. The magnitude of potential impacts on the hydrological resources that may be affected by the development is based on the criteria shown below in Table 8.1.

Contaminated Land

- 8.2.12 Contaminated land Phase I desk studies (Appendix 8.13 and 8.14) and Phase II site investigations (Appendix 8.15) were carried out in accordance with the guidance contained within CLR11. The assessment uses a risk-based approach following the source-pathway-receptor methodology promoted by the Environment Agency, which considers the nature of potentially contaminated areas in the relation to the proximity of any sensitive receptors such as controlled waters or residential developments.
- 8.2.13 The current environmental assessment considers those sites that present the greatest potential risk of an adverse environmental impact. The potential impact is based on the criteria presented in Tables 8.1-8.4. Where sites have been categorised as 'major' risk sites, recommendations have been presented for ground investigations or for remedial and/ or mitigation measures as part of the scheme development.
- 8.2.14 The assessment of potentially contaminated soils was undertaken in general 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.
- 8.2.15 The assessments were carried out using the statutory guidance and industry guidance screening levels to carry out a Generic Quantitative Risk Assessment (GQRA).
- 8.2.16 Using the CLEA model, screening levels have been derived for a number of contaminants to assess chemical concentrations again as an initial screen and indication to the risk posed by those chemicals.
- 8.2.17 For the purpose of the assessment, it was considered appropriate to use the Category 4 Screening Levels (C4SLs), where available, for a residential with gardens end use as the parameter. The C4SLs, are a set of screening criteria produced by DEFRA, to be used as a simple test to see if land is suitable for use for set contaminants.
- 8.2.18 In the absence of C4SL, the criteria known as Suitable 4 Use Levels (S4ULs), which were developed by Land Quality Management Ltd using the CLEA model, published in the following document 'The LQM/ CIEH, S4ULs for Human Health Risk Assessment'. Where no S4UL exist, reference has been made to Soil Generic Assessment Criteria (SGAC) produced by CL:AIRE/ EIC/ AGS in 2009. These were

also developed to be used to determine whether land can be considered suitable for use.

Ground Gas

- 8.2.19 An assessment of potential ground gas sources was derived and carried through to the Phase II site investigations (Appendix 8.15). Regular monitoring of ground gases (mainly carbon dioxide and methane) was carried out at all the development parcels.
- 8.2.20 An assessment of the Phase II ground gas results was carried out in accordance with BS: 8485:2015+A1:2019 "Code of Practice for the Characterisation and Remediation of Ground Gas in Affected Developments".
- 8.2.21 The Modified Wilson and card Classification table was used to calculate Gas Screening Values (GSVs) for each area. This method uses both gas concentrations and borehole flow rates to define a characteristic situation.
- 8.2.22 Following assessment using the Modified Wilson and card Classification, which provides the protection measure required for the development based on the classification.

Assessment of Potential Impacts

- 8.2.23 The EIA provides an assessment of the likely significant effects of the proposed development in relation to site preparations and construction activities, and operational activities.
- 8.2.24 The environmental effects have been predicted with reference to definitive standards and legislation where available. Where it has not been possible to quantify effects, qualitative assessment has been carried out based on available knowledge and professional judgement. Where uncertainties exist, this has been noted.
- 8.2.25 The potential significance of predicted impacts has been determined by reference to criteria for each topic. Broadly, the significance of the impact is determined with reference to the magnitude of the potential impact, the value of the receiving environment or receptor and the likelihood of the impact occurring and its duration. In order to provide a consistent approach to expressing the outcomes of each assessments, the following terminology has been used to assist in determining the degree of significance.
- 8.2.26 An Impact Assessment Matrix (IAM) has been used to provide guidance in setting the level of impact significance and whole process has been guided and moderated by professional judgement where appropriate.

Magnitude

- 8.2.27 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 i.e. the time for which the impact is expected to last prior to recovery or replacement of the resource or feature, the likelihood (i.e. the chance that the impact will occur) and reversibility. An irreversible (permanent) impact is one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it. The level of 'Magnitude' is defined in Table 8.1.

Value

- 8.2.28 The value or sensitivity of a receptor is a function of a variety of factors e.g. biodiversity value, social/ community value and economic value. The value or potential value of a resource or feature can be determined within a defined geographical context. The level of value is defined in Table 8.2.

Significance

- 8.2.29 Using the value of the environmental receptor, together with the determined magnitude of the impact and consideration of factors such as the sensitivity of the receptor to change, the significance of an impact can be determined.
- 8.2.30 The classification of significance aids in the identification of the main environmental effects of the proposed development and what weight should be given to these effects. There is no statutory definition of what constitutes a significant effect and guidance is of a generic nature. However, it is widely recognised that 'significance' reflects the relationship between the magnitude of an impact and the value of the affected resource or receptor.
- 8.2.31 To assist in the assessment process, an impact matrix (Table 8.3) has been used in determining the level of impact significance.

Table 8.1: Assessment of Magnitude

Magnitude	General Impact	Geology & Soils	Contaminated Land	Ground Gas	Groundwater
High	Significant, permanent loss/ irreversible changes, to key characteristics, features or function of an environmental parameter. Impact may occur over a significant area (>50%). Significant Impact certain or likely to occur.	An internationally or nationally designated site, such as an Site of Special Scientific Interest (SSSI) or a significant area of high quality or rare soil type that will be significantly damaged or destroyed by the proposed development.	An area where contaminated zones are present or likely. Impacts from contamination and disturbance will affect the surrounding built and natural environment during construction and operation. Extensive, long term mitigation measures required to avoid adverse impacts.	An area where ground gas zones are present or likely. Impacts from ground gases and disturbance will affect surrounding built environment during construction and operation. Extensive long term mitigation measures required to avoid adverse impacts.	Pollution, damage or destruction of an aquifer within a Source Protection Zone (SPZ), public water supply or Principle Aquifer.
Medium	Damaging significant changes to key characteristics or features or function, over a moderate area (15% to 50%). Likely to last more than two year. Impact likely to occur	A locally designated or proposed site of geological interest, an area of high quality soil type. Loss of good agricultural land that will be significantly damaged.	An area where contaminated zones are present or likely. Impacts that affect the surrounding natural environment will be prevalent during construction, but are unlikely to affect the operation of the scheme. Moderate/ short term mitigation measures to be incorporated.	An area where ground gas zones are present or likely. Impacts that affect the surrounding built environment will be prevalent during construction, but are unlikely to affect the operation of the scheme. Moderate/ short term mitigation measures to be incorporated.	Pollution or damage to Secondary (Class A) Aquifer providing local resource/ base flow to rivers.
Low	Noticeable but not significant changes (temporary/ potentially reversible), over a partial area (<15%), to keep characteristics or features of an environmental parameter. Impact will	Slight damage to locally designated site of geological interest or damage to non-statutory protected soil or good agricultural land.	An area where contaminated zones are possible, but where it is considered very unlikely that contamination will affect the environment during construction or operation. No mitigation measures anticipated. Minor site investigation may be required.	An area where ground gas zones are possible, but where it is considered very unlikely that ground gas will affect the environment during construction or operation. No mitigation measures anticipated. Minor site investigation may be required.	Pollution or damage to a Secondary (Class B) aquifer or Secondary (Class A) Aquifer that is used for industrial or agricultural purposes.

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Magnitude	General Impact	Geology & Soils	Contaminated Land	Ground Gas	Groundwater
	possibly occur.				
Very Low	Noticeable temporary/ reversible, changes for less than 6 months, or barely discernible changes for any length of time, over a small area, to keep characteristics or features of an environmental parameter. Impact unlikely to occur.	Slight damage to other sites of geological interest (non-statutory), soils or poor agricultural land that is in the vicinity of the site but will not be affected by the development.	Potentially contaminated site in the study area that is sufficiently distant from the development that it will not affect, or be affected by, its construction or operation.	Potentially ground gas at the site in the study area that is sufficiently distant from the development that it will not affect, or be affected by, its construction or operation.	Minor pollution of Secondary (Class B) Aquifer and/or where there is no significant groundwater resources.

Table 8.2: Assessment of Receptor Value

Value	Description	Examples
High	Features possessing key characteristics which contribute significantly to the distinctiveness, rarity and character of the site. Features possessing very significant biodiversity, social/ community value and/ or economic value at the national level. Feature is extremely rare.	Significant residential/ industrial development. Strategic sites e.g. hospital. Surface water: fisheries. River Ecological Quality High. Designated sites protected under International or UK wildlife legislation. Groundwater: Principle Aquifer providing a regionally important resource, Public water supply abstractions, SPZ or supporting site protected under wildlife legislation.
Medium	Feature possessing key characteristics which contribute significantly to the distinctiveness and character of the site. Feature possessing significant biodiversity, social/ community value and/ or economic value at the regional level. Feature is uncommon.	Site of Special Scientific Interest (SSSIs). Regionally Important Geological Sites (RIGS). Significant transport links e.g railway, airport. Significant utilities. Species protected under EU or UK wildlife legislation. Surface water: River Ecological Quality Good. Groundwater: Secondary Aquifer providing a locally important resource or supporting river ecosystem. High quality agricultural land.
Low	Feature possessing characteristics that are locally significant. Feature not designated or only designated at regional/ local level. Feature possesses moderate biodiversity, social/ community value and/ or economic value at the local level	Surface Water: River Ecological Quality Moderate. Groundwater: Secondary (Class A) Aquifer providing water for agricultural or industrial use.
Very Low	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 8.3: Impact Significance

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

8.2.32 The ratings derived through the assessment process and as set out in Table 8.3 can also generally be described in a generic manner as shown in Table 8.4. The descriptors for the various significance ratings given in Table 8.4 can be used as a framework for confirmation (or not) of the ratings and also provide a greater understanding of the nature, scale and type of determined impact.

Table 8.4: Generic Significance Descriptors

Significance	Generic Significance Ratings
Major	Very large or large change in environmental or social-economic conditions. Effects, both adverse and beneficial, which are important considerations at a national to regional level because they contribute to achieving national/ regional objectives, or, likely to result in exceedance of statutory objectives and/ or breaches of legislation.
Moderate	Intermediate change in environmental or social-economic conditions. Effects that are likely to be important considerations at a district to local level because they contribute to achieving local objectives, or, may result in exceedances of local statutory objectives and/ or breaches of legislation.
Minor	Small change in environmental or socio-economic conditions. These effects may be raised as local issues but are unlikely to be of importance in the decision making process.
Negligible	No discernible change in environmental or socio-economic conditions. An effect that is likely to have a negligible or neutral influence, irrespective of other effects.

8.2.33 Although Tables 8.1 to 8.3 generally consider adverse effects that have a negative influence on receptors and resources potential impacts from the development may also be beneficial and have a positive influence on receptors or provide opportunities for improvement. Consequently, final residual significance rating may include

- Major, Moderate, Minor, Negligible Beneficial impacts; and
- Major, Moderate, Minor, Negligible Adverse Impacts.

8.2.34 The rating of the impact significance may provide a strong indication as to whether mitigation may be required and determines whether, following the use of mitigation measures, identified impacts may be avoided, reduced or offset. The scale of significance is presented in Table 8.4, and describes generic descriptors for each scale of significance.

8.2.35 Only moderate and major significance will be considered to be taken forward for mitigation.

Assumptions

8.2.36 The current assessment has been based on information available at the time of writing and associated risk assessments completed using professional experience, best practice and judgement.

8.2.37 Information regarding the site baseline conditions has been summarised from the previously listed site investigation reports. It is recommended reference is made to the complete findings of each report for further information regarding baseline conditions.

8.3 Baseline Conditions

8.3.1 This section describes the baseline conditions at the site (and surrounding area as appropriate). The baseline conditions have been determined through Phase I desk studies, Phase II site investigations and Detailed Qualitative Risk Assessments (DQRAs).

8.3.2 The information gathered to determine the baseline conditions for the site has been collected and described further in the documents listed in Paragraph 8.2.1 and included as Appendices 8.1 to 8.18.

History

Year	Description
1854	The site and surrounding land are shown as undeveloped agricultural land. A railway is present in its current location and the Barnsley Canal is shown.
1874	Monckton Main Coal Colliery Limited is established.
1875	A 'Clay Mill' was established and sinking operations associated with two shafts started, completed in 1878.
1879	Twelve beehive ovens were established.

1884	The by-products plant and ten ovens were established.
1886	Erection of gas plant occurs.
1893	Monckton Main Colliery occupies the northern part of the site, comprising coke ovens, shafts and railway tracks. A gasworks is located to the southwest of the site (described as being in the location of the current effluent storage tanks). A mineral railway is present in the east of the site which runs to the northeast corner of the site. Two powder magazines are noted in the central portion of the site. A small old quarry is located in the south east part of the site. Deposited colliery spoil is marked in the north of the site and waste materials have been tipped in the area of the current By-Products area. The southern end of the site is shown as containing terraced housing and a Methodist Church. At this time the western parcel of land is shown as a Spoil Heap and is connected to the Main site by a railway line. Spoil is also shown as having been tipped across much of the low-lying area in the west of the site.
1906	Monckton Main colliery has expanded within the northern part of the subject site. Additional coke ovens and rail lines have been developed with filter beds (in two locations close to the railway), above ground tanks and a waste spoil heap also present. The powder magazines are no longer shown. The gas purification area is now occupied by a gasometer and spoil heaps. The northeastern area is no longer shown as a brick works, although kilns are still present. Offsite, the western parcel of land shows a single gasholder.
1917-18	The coke ovens are shown in their current location, with a number of features in the by-products area labelled as tanks. A railway line indicated on earlier plans is shown as running within a tunnel. In addition to the two mine shafts a third air shaft is shown close to the centre of the site. The gasworks is no longer shown on the site, or on the western parcel of land.
1932-33	Spoil heaps are shown associated with the onsite colliery, which extend offsite to the east, onto the Rabbit Ings site and to the north. Two circular features are shown on the southern part of the western parcel of land.
1962	The northern part of the site is labelled as a mine, with a large building with railway track connections located on the northern boundary. This is linked

	to the Works in the centre of the site. Water tanks are shown on this plan, consistent with the location of the existing Quench ponds in the North West. The mine appears connected with buildings to the East of Lund Hill Lane. The western parcel of land has become annotated as Works also. Distinct areas of tipping have expanded into the neighbouring land to the north and east.
1970	The Benzole Rectification Plant closed and demolished, and shafts infilled and concrete capped.
1980	The Biological Effluent Treatment Plant is constructed.
1981	The site has been rationalised, with a number of buildings and railway lines associated with the mine no longer apparent. The mine itself is listed as disused. Residential properties in the south are no longer present. Spoil heaps offsite, to the north are now labelled as active workings and land to the east of Lund Hill Lane is now shown as a drift mine.
1990	The number of structures on the site is shown to decrease, with buildings in the north of the site shown to have been removed.
1994	The railway lines have been removed from the site.
2006	The office block and CHP plant (built 1998) are shown in their current configuration. Offsite spoil heaps are now shown as wooded or parkland and the drift mine is no longer shown.
2014 onwards	The site is largely in its current configuration, with demolition and stockpiling of materials from the coke ovens.

Current Use and Surroundings

- 8.3.3 At the time of writing, most of the site has been reduced to slab, or sub slab level, with few structures remaining associated with the historical workings of the site, either in a state of dereliction or retained for maintenance and operation of utility supplies.
- 8.3.4 The former engineering workshop, on the eastern boundary remains operational as a leased unit and a portion of the land, also on the eastern boundary has been redeveloped into offices and car parking for Hargreaves Industrial Services plc.
- 8.3.5 The site is accessed from two main entrances along the eastern boundary, from Lund Hill Lane, the northernmost entrance allowing access through a weighbridge to the former stockyard and Engineering Workshops, the southern entrance allowing access to the Hargreaves property (which will be considered as offsite in this assessment) and an effluent treatment plant in the far south of the site.
- 8.3.6 The Western Area lies to the west of the railway lines. This parcel of land is understood to be out with the boundaries of this site. It is understood that this area was formerly linked with a bridge to the main site and historically has been

used for deposition of colliery spoil and more recently gas purification, storage and distribution.

8.3.7 Surrounding land uses are currently as follows:

North	Agricultural land and commercial facility, approximately 120m to the north. Beyond which lie disused industrial and agricultural land.
East	Lund Hill Lane (B6428), beyond which lies grassed disused industrial land and a timber recovery facility.
South	Lund Hill Lane (B6428), beyond which lies former industrial land now Rabbit Ings Country Park.
West	Railway Cutting, beyond which lies agricultural land and residential properties approx. 120m beyond the site boundary. The Barnsley Canal lies approximately 200m to the west.

Geology and Soils

8.3.8 The site geology has been determined from the Phase I reports and confirmed in the Phase II reports through intrusive site investigations. The geology was logged to BS: 5930 standards during borehole drilling and trial pit excavations.

8.3.9 The underlying bedrock geology has been reported as Undifferentiated Carboniferous Middle Coal Measures, comprising Mexborough Rock sandstone, beneath the majority of the site, apart from the north and southernmost parts. No superficial deposits are listed on BGS records.

Hydrology

8.3.10 There are a number of local surface water courses within the vicinity of the site as summarised below.

Water Feature	Quality	Distance	Direction
Lineside Dyke	Unclassified	Adjacent to the northern part of the western boundary of the main coking works site. Flows in a generally southerly direction joining Cudworth Dyke approximately 140m to the south of the site.	
Wakefield Brook	Unclassified	Within 10m of the western boundary of the former gas purification area (the western parcel of land), approx. 100m from the current site boundary, close to the Barnsley Canal. Flows in a southerly direction, joining Cudworth Dyke, approximately 220m south of the site.	

Cudworth Dyke	Unclassified	Located approximately 140m to the south of the site. This flows in a southerly direction, joining the Sandybridge Dyke to become Poole Dyke. Eventually flows into the River Dearne approximately 5km south of the site.	
Barnsley Canal (disused)	'F' or 'poor'	35 to 50m	West

8.3.11 Reports suggest that abstractions had been made from these water courses during the operational life of the site, none of which remain active currently.

8.3.12 The Moorehead Consulting report suggests that discharges were made from the site during its active life to the Barnsley Canal.

8.3.13 A 2002 report indicates that the presence of a railway cutting along the western boundary may affect local groundwater flow and suggests a component of flow to the west along the site margin. This is consistent with observations (ARP 2002) of leachate discharges along the steep western bank.

Hydrogeology

8.3.14 The underlying bedrock has been designated as a Secondary A aquifer, there is no designated groundwater within any superficial deposits.

8.3.15 Groundwater vulnerability mapping indicates that the site has a high leachability potential, although it should be noted that this is due to poor data coverage in the area and is a worst-case scenario.

8.3.16 Comments in the RSK report 2011 (Appendix 8.1), indicate that the shallow groundwater encountered is not considered to be a continuous body across the site. A comment in the same report characterises the shallow groundwater as 'discrete pockets of shallow, perched, groundwater, were encountered within the made ground...at these locations the saturated horizon was found to directly overlie the sandstone bedrock, with no impermeable horizon in between.' The report states that it is 'likely that surface waters and perched groundwater will infiltrate vertically into the sandstone bedrock and impact the groundwater within.

8.3.17 However, GEO2's later investigation (Appendix 8.15) suggests that a single continuous water body is present within the sandstone, bounded by a deeper mudstone horizon.

8.3.18 Deeper boreholes suggest a potential groundwater flow direction within the deeper groundwater within the sandstone bedrock towards the north, assuming a single continuous water body is present beneath the site. Although other reports suggest no clear groundwater flow direction and the potential for multiple groundwater bodies.

8.3.19 Recent data suggests two groundwater flow directions, most of the site is influenced by a regional northern flow. The topographically elevated sandstone in the production area appears to act as a boundary where after groundwater to the south and western slopes down towards Lineside Dyke.

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Ground Conditions

8.3.20 Data for the Western Site is very limited however reports suggest a tentative flow to the southwest. It is also suggested that there may be a secondary waterbody on the site within the superficial deposits.

8.3.21 Groundwater levels as recorded in the 2020 investigations are recorded below:

Location	Depth to NAPL (m bgl)	Depth to Water (m bgl)	Depth to Water (m AOD)	Depth to Base (m bgl)	Response Zone (m)	Target Strata
Production Area						
BH203	-	-	-	2.3	-	-
BH305	-	15.096	55.672	>30m	22m-30	Sandstone
RBH4	-	10.137	56.391	17.53	14-18	Sandstone
RBH4A	-	9.995	56.401	19.09	14.5-19.5	Sandstone
WS20-05C	-	-	-	1.657	0.5-1.5	Made Ground
WS20-06B	-	-	-	2.8	1-2	Made Ground
WS20-09E	-	-	-	1.337	0.5-1.0	Gravel
BH19-01	-	4.372	61.182	12.218	4.5-12	Sandstone
BH19-02	-	1.941	66.257	12.259	4-12	Sandstone
BH19-03	-	2.425	67.417	12.299	4-12	Sandstone
BH19-04	-	6.831	64.485	12.43	3-12	Sandstone/Mudstone
BH19-05	-	4.803	64.004	20.361	5-20	Sandstone/Mudstone
BH19-06	-	8.145	63.619	19.104	5.5-20	Sandstone/Mudstone
BH19-07	14.10*	6.492	65.566	20.345	4-20	Sandstone/Mudstone
BH19-08	-	9.337	59.462	20.331	4-20	Sandstone/Mudstone
Coal Stockyard						
RBH1	-	7.451	55.854	15.41	12-16	Sandstone
RBH1D	-	7.396	55.899	15.78	11.5-15.5	Sandstone and Mudstone
RBH2	-	7.421	55.921	15.688	12-16	Sandstone

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Ground Conditions

RBH2A	-	7.25	55.963	17.774	13-17	Mudstone
WS4	-	-	-	3.141	1-3	Made Ground and Sand
WS20-01	-	-	-	1.504	0.6-1.6	Made Ground
WS20-02B	-	-	-	1.527	0.6-1.6	Made Ground and Clay
WS20-03	-	3.79	58.259	3.945	1-4	Made Ground and Clay
WS20-04	-	-	-	-	1-3	Made Ground, Silt and Gravel
Southern Area						
WS9	-	2.497	59.513	3.792	2-5	Clay
WS20-10	-	3.327	-	4.16	1-4	Weathered Mudstone
(* product not recorded on the Interface probe, however, 6.245m of product present on the interface probe – potential DNAPL)						

Contaminated Land Quality

8.3.22 In order to assess the soil contamination at the site, a considerable quantity of site investigation works have been undertaken on the site over the years. The most recent was carried out by GEO2 in June 2020. For detailed information on the previous site investigations and associated risk assessments the reports listed in Section 8.2 and provided as Appendix 8.1 to 8.17 should be reviewed.

8.3.23 The data recently obtained by GEO2 in conjunction with historical information has been used carry out a DQRA to assess the risk of contamination in the ground to sensitive receptors.

8.3.24 The risk assessment is based upon identifying pathways between sources of contamination and actual and possible receptors. This is termed as a pollutant linkage. The assessments also address the land as being 'suitable for use'. This means the acceptable concentrations and conditions will vary depending on the site uses and nature of receptors

8.3.25 All of the risk assessments for the site were assessed against the criteria that the land will be developed for a residential with gardens end use, which puts the receptor for contaminated soils as human health of the end users.

8.3.26 The stockyard area is largely free from significant contaminative impact aside from shallow breeze deposit. In addition, localised cyanides noted in the area of ponds in the north west.

8.3.27 The production area is impacted with significant coal tar present in shallow soils associated predominantly with infrastructure, although some buried tar sumps remain close to the former Quench tanks. Around benzole plant and tanks area in centre and west of this area impact becomes more significant and appears to

have vertically migrated into the underlying sandstone, with DNAPL encountered and gross concentrations of hydrocarbons encountered at the western boundary.

8.3.28 Impact in groundwater is generally moving northward, migration has been limited to date, a portion of this impact is draining through fractures into the railway cutting and lineside dyke at west.

8.3.29 The main sites southern area appears to exhibit low to moderate land contamination.

Coal Workings / Mining Risk

8.3.30 Four trial pits (TP1 – TP4) were advanced to identify the three mine shaft caps within the coal stockyard area. Historic reports state the caps are 20m x 20m x 2m concrete covers over the top of three historic mine shafts. TP2 – TP4 identified the concrete caps and the location of these have been confirmed. The caps were identified at between 2.9 and 3.5m bgl.

8.3.31 No evidence of mine workings or worked seams were recorded within influencing distance of ground level.

Summary of Baseline Conditions

8.3.32 The baseline conditions have been assessed within the relevant site investigation reports for the site. The Significant Pollutant Linkages (SPL) are summarised within Table 8.5 which identified the source, contaminant of concern, pathway and receptor.

Table 8.5: Significant Pollutant Linkages

Area	Linkage	Contaminant	Source	Pathway(s)	Receptor
Main Site	SPL1	PAH, Metal and Asbestos Contamination within Made Ground	Shallow soils	Dermal Absorption, Ingestion, Consumption of produce, Inhalation of dusts	Future site users Construction workers
	SPL2	Silica Bricks	Stockpiled on site	Ingestion, Consumption of produce, Inhalation of dusts	Future site users Construction workers
	SPL3	Hydrocarbon and Tar / Oil Contamination	Shallow soils	Uptake by plants	Flora and fauna
	SPL4	Hydrocarbon and Tar / Oil Contamination	Shallow Soils	Dermal Absorption, Ingestion, Consumption of produce, Inhalation of dusts, Inhalation of Vapours	Future site users Construction workers
	SPL5	Hydrocarbon and Tar / Oil Contamination	Groundwater	Inhalation of Vapours	Future site users Construction Workers Employees working on

Area	Linkage	Contaminant	Source	Pathway(s)	Receptor
					land adjacent to site
	SPL6	Hydrocarbon and Tar / Oil Contamination	Soil	Migration via unsaturated and saturated zones	Local Streams
	SPL7	Hydrocarbon and Tar / Oil Contamination	Groundwater	Migration via saturated zone	Local Streams and underlying aquifer
	SPL8	PAH, Hydrocarbon and Tar / Oil Contamination	Soil	Direct Contact	Foundations & services, including water pipes
	SPL9	Combustible Soils	Soil	Direct Contact Instability in event of combustion	Future site users
	SPL10	Ground Gas	Shallow Soil	Accumulation of vapours and gases	Future site users Off site land users

8.4 Embedded Mitigation

8.4.1 Mitigation measures which are already included as part of the design of the proposals, known as Embedded mitigation has been discussed as part of the additional mitigation measures section 8.6. It is acknowledged that whilst this embedded mitigation has been identified, and would be implemented, in line with best practice this has not been considered as being implemented when identifying the potential effects of the proposed development in section 8.5 below. It is therefore important to focus primarily on the assessment of residual effects at section 8.7, as this sets out those effects that would remain after the mitigation has been implemented.

8.5 Potential Impacts

8.5.1 This section details the potential impacts of the proposed development, prior to the consideration of the mitigation which is to be implemented, and its potential significance, should the mitigation not be put in place.

Demolition and Construction

8.5.2 Potential impacts due to site demolition and construction activities are summarised in Table 8.6.

8.5.3 Key activities that have the potential to impact environmental ground conditions largely relate to the clearance and preparation of the site prior to the construction of infrastructure and buildings, including:

- Land clearance and fencing;
- Stripping of topsoil and excavation of subsoil with transfer to stockpile or storage area(s);
- Demolition of existing buildings and removal of concrete bases and pads;

- Construction of infrastructure networks including roads, drainage networks;
- Preparation of development platforms;
- Construction of temporary and permanent structures.

Geology and Soil

- 8.5.4 It is considered that the impacts on geology and soil during the construction phase of the development will be minimal.
- 8.5.5 Top soil (where present) will be stripped and stockpiled for reuse to preserve its quality.
- 8.5.6 All stockpiled material will be sealed or covered to ensure infiltration of rainwater does not affect its geotechnical properties or allow the release of leachate.

Hydrology / Hydrogeology

- 8.5.7 Due to significant contamination identified within the soil and groundwater across the main site area, without mitigation there is a direct impact on the quality of the groundwater and underlying aquifer. A potential pathway has been identified from the contaminated groundwater to surface water receptors. It should be noted that neither the surface water receptors or underlying groundwater have any potable abstractions within influencing distance of the site.
- 8.5.8 In addition, it is considered that without mitigation there could be a negative impact from the potential release of oil, fuels or chemical stored during the construction phase.

Contaminated Land

- 8.5.9 There are a number of identified sources and potential pathways whereby, without mitigation remediation workers could be exposed to chemical contamination and asbestos above protective thresholds. Such pathways include direct contact with contaminated soils, inhalation of fugitive dust, inhalation of soil vapours, inhalation of groundwater vapours and ingestion of soil. This would be a local moderate adverse significance with a short and long term timescale, depending on the effects on the worker.
- 8.5.10 There are also a number of identified sources and pathways whereby without mitigation local receptors such as offsite residents or the remaining tenants at the site, could be exposed to chemical contamination and asbestos above protective thresholds. The pathways include inhalation of fugitive dust, inhalation of vapours and ingestion of dust. This would be a local moderate adverse significance with a short and long term timescale, depending on the effects on the local receptor.

Ground Gases

- 8.5.11 There are a number of identified areas where there were exceedances in ground gas concentrations, where without mitigation ground workers could be affected if working in low depressions or within confined spaces or drains. This would be a moderate adverse significance with a short-term timeframe.

Coal Workings / Mining Risk

- 8.5.12 There is an identified presence of mine shafts on the site which without mitigation could affect groundworkers and building construction. This would be a moderate adverse significance with a short to long-term timeframe.

Table 8.6: Demolition and Construction Impacts (before consideration of mitigation)

Effect of Potential Impact						
Activity	Potential Impact	Effect of Potential Impact			Mitigation Required	Comments
		Sensitivity/ Value	Magnitude (Probability)	Significance		
Geology and Soils						
Site Clearance, enabling works and construction	Permanent/ Temporary damage to Soil Quality	Very Low	Very Low	Negligible	Yes	Soil stripping for reuse and working practices will be adopted to minimise long term degradation of soils, such as covering or sealing stockpile to prevent infiltration of rainwater.
Hydrology and Hydrogeology						
Contaminated groundwater	Contamination to the surface water receptors through groundwater movement	Medium	Medium	Moderate Adverse	Yes	Contaminated groundwater would continue to potentially impact the sensitive surface water receptors.
Local dewatering during excavations	Disruption of groundwater flow in aquifers	Low	Very Low	Negligible	No	It is considered that the development will cause minimal disruption to the flow of water within the underlying bedrock aquifer.
Site activities – storage of fuel, oil and materials	Spillage and leakage of oil, fuel and other	Low	Low	Minor Adverse	Yes	This is a concern where the construction occurs directly over the aquifer. Good site management practices will be adopted to

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Activity	Potential Impact	Effect of Potential Impact			Mitigation Required	Comments
	potentially polluting substances that could impact groundwater					reduce potential for spills and leaks.
Off Site Receptors						
Nearby industrial and leisure sue and other site users	Offsite migration of contaminants towards adjacent properties via the release of windblown dust and contaminated surface/ groundwater runoff.	Medium	Medium	Moderate Adverse	Yes	Site development works have the potential to release contamination and asbestos fibres towards offsite receptors. The risk is to be managed through the production of a Construction Environmental Management Plan (CEMP).
Surface Water (numerous small streams)	Offsite migration of contaminants via direct overland flow/ runoff	Medium	Medium	Moderate Adverse	Yes	Remediation of contaminated soils and groundwater to reduce the source. Remediation to criteria set to be protective of controlled waters following DQRA. Use and storage of oil, fuel and chemicals to be managed during the construction phase through good construction practices. Not to be stored next to river and stored in a bund. Emergency response plan to be produced and spill kits readily available. Contaminated soils to be stockpiled away from the river to prevent being washed

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Ground Conditions

Activity	Potential Impact	Effect of Potential Impact			Mitigation Required	Comments
						into the river in the event of flooding.

Table 8.7: Demolition and Construction Impacts – Contaminated land

Activity/ Source	Potential Impact	Effect of Potential Impact			Mitigation beyond Embedded Mitigation	Comments
		Sensitivity/ Value	Magnitude (Probability)	Significance		
Main Site						
Combustible Shallow Soils (Coal Stockyard)	Adverse impacts on health of construction workers as a result of direct contact, inhalation and ingestion.	Medium	Medium	Moderate Adverse	Yes	Excavation of combustible soils and offsite disposal will be required to reduce the risk to construction workers.
Silica Bricks	Adverse impacts on health of construction workers as a result of direct contact, inhalation and ingestion.	Medium	Medium	Moderate Adverse	Yes	Excavation of stockpiled material and either removed from site or encapsulated under license.
PAH, Metal and asbestos contamination within Made-ground (Production Area and Coal Stockyard)	Adverse impacts on health of construction workers and offsite receptors, as a result of direct contact, inhalation and ingestion of contaminated soil/	Medium	Medium	Moderate Adverse	Yes	Excavation of contaminated soils and abstraction of impacted groundwater will require appropriate mitigation and management to reduce risk to identified receptors. In addition, their reuse may only be following completion of remedial targets.

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Activity/ Source	Potential Impact	Effect of Potential Impact			Mitigation beyond	Comments
	groundwater					
Hydrocarbon and Tar / Oil Contamination	Adverse impacts on health of construction workers and offsite receptors, as a result of direct contact, inhalation and ingestion of contaminated soil/ groundwater	Medium	Medium	Moderate Adverse	Yes	Excavation of contaminated soils and abstraction of impacted groundwater will require appropriate mitigation and management to reduce risk to identified receptors. In addition, their reuse may only be following completion of remedial targets.
Ground Gas and Vapours on Site	Adverse impact on the health of construction workers due to exposure to poisonous, flammable or asphyxiating ground gases and vapours	Low to Medium	Medium	Moderate Adverse	Yes	Potential exposure to ground gases, particularly when working below ground in excavations or confined spaces. Appropriate gas detection and mitigation measures to be employed to reduce risk.
Coal Workings / Mine shafts	Impact on future developments – destruction	Medium	Medium	Moderate Adverse	Yes	Effect of mine shafts and worked seams on building construction Development design to take in to account known locations.
Remediation activities, primarily at the Soil Treatment Hospital to be located on site	Remediation activities are expected to be carried out in phases. There is medium term exposure risk for off-site receptors.	Medium	Medium	Moderate Adverse	Yes	Potential exposure to harmful vapours, dust and fibres to be managed throughout the project to prevent unsafe exposure limits being exceeded on the site boundary. Soil Treatment Hospital to be set up to be protective of off-site receptors and prevent the release of environmental emissions.

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Ground Conditions

Activity/ Source	Potential Impact	Effect of Potential Impact			Mitigation beyond	Comments
						Long term management plan to be prepared, with regular review.

Completed Development

- 8.5.13 The remediation of soil and groundwater contamination (where deemed to be necessary) will have a direct, long term major beneficial significance impact to human health at the site.
- 8.5.14 The remediation of soil and groundwater contamination (where determined to be necessary), will have a direct, long-term major beneficial impact significance impact to surface waters (River Aire).
- 8.5.15 The implementation of gas protection systems will have a direct, long term major beneficial impact to human health at the site.
- 8.5.16 Coal shafts will be avoided during the detailed master-planning at the reserved matters stage to ensure no significant risk is presented. As such any risk here will be mitigated by design and no effect would arise.

8.6 Mitigation Measures

- 8.6.1 This section details the measures that are required and will be put in place to mitigate any significant environmental impacts. It includes both mitigation which is inherent in the design and additional mitigation measures to address any further potential significant effects identified in section 8.5 above.
- 8.6.2 Due to concerns from the Local Authority regarding contamination on the site, it was agreed that a detailed Remediation Strategy would be submitted as part of the planning application.
- 8.6.3 The mitigation described here, and general remediation approach has already been discussed with the Contaminated Land Officer at the Council and this section therefore represents the submitted Remediation Strategy, which would be expanded upon further as necessary at the reserved matters stage.
- 8.6.4 All works would be undertaken following current UK regulations, guidance and industry best practice.

Demolition and Construction

- 8.6.5 A Remediation Strategy will be adopted that will comprise of appropriate protocols for the identification and management of unforeseen contamination.
- 8.6.6 All contractors appointed will be appropriately licensed and experienced, working within the requirements of the Construction (Design and Management) Regulations 2007. The appointed remediation contractor will also produce a Construction Environmental Management Plan (CEMP) to control dust, vapours, odours and noise etc. With these control measures in place, the residual effect is considered to be minor.

Geology and Soil

- 8.6.7 No significant loss for geology is anticipated during the construction phase, and therefore mitigation measures are not required for geology.
- 8.6.8 It is intended that all soils will remain on site for reuse within the development. Soils that fail the re-use and remediation target values will be remediated to concentrations compliant with the targets for reuse or removed from site. It is

anticipated at this stage that all material will be able to be treated to a level suitable for use at the site. Soils will also be geotechnically compliant for use within the development, which will be defined following development platform design works. The geotechnical requirements of the soil and final platform level will be provided as part of reserved matters application and discussed within the Remediation Strategy.

- 8.6.9 Due to the land raise requirements for construction of the development platform and to provide a remedial cap, soils imported onto the site will comply with the chemical and geotechnical import criteria for the site.
- 8.6.10 Owing to the scale of the anticipated remediation and the phasing of the works, a Soil Treatment Hospital (STH) will be built at the site at the start of construction and maintained throughout the duration of the development to enable remediation of the soil and groundwater throughout each phase of the works.
- 8.6.11 Import of material to be utilised as capping will either be through a Environment Agency Bespoke Permit or a Materials Management Plan (MMP) in accordance with the CL:AIRE Definition of Waste Code of Practice. Imported material should be tracked and emplacement position recorded.
- 8.6.12 Good practice regarding excavation and segregation of clean/ contaminated soils to ensure the appropriate management streams are followed. Soils of different types/ condition will be stockpiled, labelled and managed appropriately, including covering where necessary.

Hydrogeology

- 8.6.13 It is expected that groundwater improvement will be undertaken through source removal and localised treatment where cost effective.
- 8.6.14 The excavations may expose groundwater and may require dewatering to enable works. In these instances, groundwater will be abstracted and treated to pre-determined concentration for discharge to Foul Sewer under a Discharge Consent or discharge back to ground under an Environmental License granted by the Environment Agency.
- 8.6.15 A Foundation Risk Assessment and Design will be undertaken prior to construction in accordance with relevant guidance. It will assess the piling and foundation method being undertaken and the likelihood of piling through contaminated ground and hence the risk to groundwater quality in the aquifer.
- 8.6.16 Regular monitoring and sampling from the surface water receptors and site wide groundwater (where practicable) will be undertaken regularly throughout the construction works to identify potential negative effects from the development. This will be carried out by a competent environmental engineer.
- 8.6.17 Fuels and chemicals would be stored in accordance with the Control of pollution (Oil Storage) Regulations in either double skinned tanks, or within appropriately sized bunds. Such storage containers would be inspected regularly for leaks or damage prior to construction, all emergency response would be set up to deal with incidents of construction spillage.
- 8.6.18 Surface water drainage at the site and arising from the works will need to be managed to prevent release of contaminated liquids or material into the drainage systems and into local surface water receptors. Good practice guidance notes for working in and near to water courses shall be followed.

Contaminated Land

- 8.6.19 A land raise will be required to facilitate construction of the development platform, this will also act as a remedial cap. Soil capping will meet the targets derived to be protective of human health at the site.
- 8.6.20 Treatment of grossly impacted soils will be undertaken within a soil hospital installed on site for the duration of earthwork activities.
- 8.6.21 All excavations and removal of underground structures will undergo a Watching Brief to identify potentially unidentified contamination.
- 8.6.22 Use of clean soil capping system within all gardens and public space to break exposure pathways between site users and potentially contaminated soils.
- 8.6.23 A Construction Environmental Management Plan (CEMP) shall be produced to detail the management and monitoring of nuisance emissions associated with the contaminated soils and remediation works. The CEMP should be agreed with the Regulators prior to commencing construction works.
- 8.6.24 The production of a Site Waste Management Plan (SWMP) is a requirement in England for all aspects of construction works (including preparatory works such as demolition and excavation. Disposal of material offsite may require waste classification in order to allow disposal in accordance with current legislation. This will be addressed where necessary via the appropriate Environment Agency Permits.
- 8.6.25 As part of the contractors RIP and Construction Phase Health and Safety Plan (CPHASP), details of task-specific risk assessment and use of appropriate Personal Protective Equipment (PPE) will be detailed. This will mean that pollutant linkages will be managed whilst groundworks or remediation activities are undertaken.
- 8.6.26 All works with identified or suspected ACM will be in line with published guidance such as CAR 2012. An asbestos discovery and management strategy is to be produced for the remediation and construction works by the contractor.

Ground Gas

- 8.6.27 The development buildings will be installed with ground gas and vapour protection measures where it has been determined to be required.

Coal Workings / Mine Shafts

- 8.6.28 No evidence of mine workings has been detected.
- 8.6.29 Mine shafts have been accurately mapped and their inherent risk will be mitigated through design.

Table 8.8: Mitigation Measures - Construction

Identified Impact	Proposed Mitigation Measures
Geology and Soil	

Identified Impact	Proposed Mitigation Measures
Management of soils	Production of Material Management Plan (MMP) in accordance with the CL:AIRE Definition of Waste Industry Code of Practice or through the use of an EA Bespoke Permit. Information to be kept updated and material tracking implemented throughout the construction phase. Segregation of soils through a Watching Brief by experienced geo-environmental engineer.
Existing site services	A detailed survey to be carried out of all site services such as existing drainage, gas mains, water mains, foul sewer, electricity, telecommunication. cables etc. This is to be completed in advance of any site clearance or excavations. Where works will be close to services, the service operator shall be contacted and relevant stand-off distances and specific procedures observed. Clean and validated service corridors to be created where services are expected to be present and installed below the clean capping layer. Contaminated soils left remaining in-situ are to be sampled to assess the level on contamination remaining. Where it is required, a barrier system will be installed to prevent cross contamination of this material to the remediated soils on the site.
Hydrology and Hydrogeology	
Contamination within the groundwater with risk to groundwater and surface water	Delineation of groundwater contamination plumes under controlled conditions. Removal of contaminant sources. Monitoring of emissions through CEMP. Controlled handling and storage of contaminated groundwater prior to treatment such as use of bunds, emergency spill kits. Production of a monitoring regime for the long-term monitoring of on and off site groundwater and surface water to ensure the construction and development works are not having a negative impact on site groundwater, offsite groundwater and surface water. Action plan to be implemented if negative trends are identified.
Surface water drainage	Surface water drainage through drainage systems or overland are to be managed to prevent release of harmful liquids, leachate or material from being released through the drains or into surface waters. Surface water management to be proposed such as blocking drains, treating sump water and good practice on site.
Contaminated Land	
Management of	Following approval of the Remediation Strategy with the Council, the approved contractor to carry out the remediation and earthworks must

Identified Impact	Proposed Mitigation Measures
contamination	produce a Remediation Implementation Plan or Remediation Method Statement detailing how they will carry forward the methods proposed in the Remediation Strategy. The appointed contractor will adhere to health and safety regulations and guidance.
Contamination within the soil with risk to human health and controlled waters	Treatment of contaminated material to enable reuse at the site. Dispose of grossly contaminated material offsite to licensed facility that is not deemed suitable for reuse at the site. Monitoring of emissions (dust, vapour odour and noise) and employ mitigation that will be discussed in the Construction Environmental Management Plan (CEMP). Controlled movement of material around site. Watching brief to be adopted at all excavations for presence of grossly contaminated materials. Discovery Strategy to be prepared to enable management of material found that is unexpected. Validated soil capping to be applied to top soils to act as human health break layer, depths will be detailed within the Remediation Strategy, agreed with the Council.
Asbestos within shallow soils	Asbestos Plan of Works to be prepared for the site in line with Control of Asbestos Regulations 2012 and supporting guidance. Excavation of ACM and treatment (picking) or buried at depth in an agreed location within the development. Use of air monitoring and dust/ particle management with dust suppressing mitigation methods if necessary All operatives working with ACM to be suitably trained.
Ground Gas	
Ground Gas generation (on-site)	Further assessment and characterisation of ground gas regime to be completed as investigation works completed, Remediation Strategy will be amended as necessary. Monitoring to be carried out in accordance with CIRIAC669 methodology. Secondary assessment of site ground gas regime following completion of fill and construction of the development platforms (where applicable). Update the ground gas risk assessment to assist with the specification of ground gas protection measures. Installation and independent validation of gas protection measures by suitably qualified contractors and consultants.
Coal Shafts	

Identified Impact	Proposed Mitigation Measures
Coal Shafts	Position of shafts has been recorded, the location of these will be avoided when planning the development works mitigating the risk by design.

Completed Development

- 8.6.30 The proposed land raise as part of the planning application, will raise the land, by approximately 2m on average across the site. This will create a break in the identified pathway from the source contaminants within the surface soils to the receptor (end users). The break is in the direct contact exposure pathway.
- 8.6.31 The remediation of the contaminated soils and (where practicable) groundwater that will be carried out as part of the development, will ensure that the end users are not at risk from contamination within the ground and groundwater by occupying the site, this would be a major beneficial impact.
- 8.6.32 The remediation of the contaminated soils and (where practicable) groundwater will reduce detrimental impact on local surface water receptors and the underlying aquifer.
- 8.6.33 The development buildings will be installed with ground gas and vapour protection measures where it has been determined to be required. These are to be maintained during the completed development.
- 8.6.34 Any future user will have restriction of extending dwellings/ building over ground as part of the deeds to ensure appropriate ground gas protection is installed/ maintained.
- 8.6.35 All material, whether it is imported or 'site won', will be validated to ensure its suitability prior to reuse. This will ensure that no contaminants are present at levels which will result in further contamination to the groundwater and surface water receptors.
- 8.6.36 All material, whether it is imported or 'site won', will be validated to ensure its suitability prior to reuse. This will ensure that no contaminants are present at levels which will result in further contamination to the human health.
- 8.6.37 A validation plan for the remediation works at the site will be produced and followed to ensure the site is validated and verified at the end of the development works.

Table 8.9: Mitigation Measures – Completed Development

Impact	Mitigation Measure
Contamination in Soils	Maintenance of clean capping solution.

Ground gases	Restrictions on extensions and building over land without a gas protection membrane.
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8.7 Residual Impacts

- 8.7.1 The residual impact assessment assumes that the mitigation within the embedded mitigation and the additional mitigation described above have been implemented.

Demolition and Construction

Geology and Soil

- 8.7.2 Residual impacts relating to soils during the construction phase are predicted to be no greater significance than negligible with the mitigation measures in place. This mainly relates to the low quality of the soils within the construction areas.

Hydrogeology

- 8.7.3 No significant changes to groundwater levels are predicted, either within shallow localised groundwater or deeper groundwater. Whilst dewatering may be required during foundation and deep structure excavation and removal, the effects of this would be localised and would occur only for a relatively short period of time.
- 8.7.4 Mitigation measures outlined for the control of site activities are expected to control any potential releases to groundwater or surface water. Potential risks to groundwater and surface water during construction are therefore considered to be **negligible**.

Contaminated Land

- 8.7.5 As soil treatment will occur as part of the construction phase it is considered that the release of contaminants into controlled waters will be **negligible** if the works are managed correctly.
- 8.7.6 With regards to contaminant risk to human health during construction, it is the duty of the site operator and any contractors to ensure Health and Safety of all personnel involved in the site development or located within the vicinity of the scheme that may be affected. Consequently, all potential impacts on Human health are required to be **negligible**, and the mitigation measures implemented will meet this obligation.

Ground Gas

- 8.7.7 If the control described within the mitigation measures are followed, along with industry guidance and personal alarmed gas monitoring, the effects of ground gas during the construction phase are considered to be **negligible**.

Coal Shafts / Workings

- 8.7.8 If the control described within the mitigation measures are followed, along with industry guidance, the effects of the presence of coal shafts during the construction phase are considered to be **negligible**.

8.8 Conclusions

- 8.8.1 The site has a long and varied history with a legacy of contamination from the former coking works which is known to have impacted on land quality. The parameters of the site and the nature of the contamination in the soil and groundwater have been assessed through Phase I, Phase II and risk assessments, the results of which have been used to inform this current assessment.
- 8.8.2 Results of chemical testing of the soil indicated the presence of elevated levels of potentially hazardous substances, such as PAH's, hydrocarbons, coal tars, metals and asbestos in the ground and groundwater across parts of the site.
- 8.8.3 The site represents a risk to human health for the intended residential end use and a risk to controlled water receptors (both groundwater and surface water). The planned redevelopment, including remediation of the soil and groundwater as set out in the mitigation measures, presents an enhancement of the current situation. The remediation seeks to remove or reduce the source of the contamination and breaking contaminant exposure pathways towards identified receptors.
- 8.8.4 The implementation of the remediation and adherence to the mitigation measures will bring major beneficial impacts to both the site and the local environment, which would be considered 'significant' beneficial effects as identified by the EIA Regulations.

List of Appendices

- Appendix 8.1 - Environmental Risk Assessment 16492-R1 (01), 2011 RSK Group
- Appendix 8.2 - Groundwater Sampling 321453 (H) L01 (00) 2013 RSK Group
- Appendix 8.3 - Data Review of Monkton Production Facility 321789 (H)-R1 (00) 2014 RSK Group
- Appendix 8.4 - Ground Investigation Report G15009, 2015 Patrick Parsons Ltd
- Appendix 8.5 - Ground Investigation Factual Report G15009 2016 Patrick Parsons Ltd
- Appendix 8.6 - Remediation Strategy, G15009, 2016 Patrick Parsons
- Appendix 8.7 - Remediation Strategy G15009, 2017 Patrick Parsons
- Appendix 8.8 - Environmental Site Survey, 7102, Moorehead Consulting Ltd
- Appendix 8.9 - Environmental Due Diligence- Monkton Coke and Colliery Works, 12022228, 2005, WSP
- Appendix 8.10 - Coal And Brine Report, including shaft plans and data sheets, Coal Authority
- Appendix 8.11 - Site Investigation, 1997, Pro-Soils Surveys
- Appendix 8.12 - CQA Compliance Report for Capping Works, 2004, LJ Church Laboratory Services Ltd
- Appendix 8.13 - Data Review and Gap Analysis, Former Monckton Coking Works, October 2019, GEO2, Ref: 19/B0010.1.2
- Appendix 8.14 - Site Investigation Scope of Works, Former Monckton Coking Works, December 2019, GEO2 / Envestigate Ltd, Ref: ESG/FG2/SoW
- Appendix 8.15 - Environmental Site Assessment: Former Monckton Coking Works, July 2020, GEO2, Ref: 20.B0010.4.1
- Appendix 8.16 - Quantitative Risk Assessment: Former Monckton Coking Works, July 2020, GEO2 Ref: 20B0010.5.1
- Appendix 8.71 - Options Appraisal and Remediation Strategy: Former Monckton Coking Works, July 2020, GEO2, Ref: 20.B0010.6.1