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INTRODUCTION

- 8.1 This chapter of the ES considers the potential impact of the development proposal on the water environment (which comprises both surface water and groundwater and can also be referred to as hydrology and hydrogeology respectively). The chapter considers the potential effects upon the quality and quantity of the water environment along with any potential impact on other water-dependent receptors such as ecological sites or water abstractions.
- 8.2 This chapter describes the scope, relevant legislation, assessment methodology and the baseline conditions currently existing at the application site and its surroundings. It then considers any potential significant environmental impacts the proposed development (as described in Chapter 3) would have on this baseline environment; the mitigation measures required to prevent, reduce or offset any significant adverse impacts; and the likely residual impacts after these measures have been employed.
- 8.3 The assessment has involved the following approach:
- detailed desktop study to establish current baseline geological, hydrological and hydrogeological conditions;
 - identification of possible measures to avoid and mitigate against any adverse impacts resulting from the proposed development; and
 - evaluation of the residual significance of these impacts by consideration of the sensitivity of the baseline features of the application site, potential magnitude of these impacts and the probability of these impacts occurring, following mitigation.
- 8.4 The extent of the desktop study was based on professional judgment and was undertaken in order to:
- collect geological and hydrogeological information;
 - describe surface water hydrology, including watercourses and springs within and adjacent to the application site boundary;
 - identify flooding risks; and
 - identify sensitive hydrogeological and hydrological features which may potentially be impacted by the proposed development.
- 8.5 Further details of the assessment methodology is provided within the 'Methodology' section of this Chapter, whilst further information regarding the baseline conditions at the site is provided within the 'Baseline Conditions' section.

METHODOLOGY

Legislation, Guidance and Planning Policy

- 8.6 The proposals for the development of the application site have had regard to technical guidance, relevant Pollution Prevention Guidelines and other codes of best practice in order to limit the potential for contamination of ground and surface waters, the potential for flooding to be caused by the development, and other potential impacts on the water environment. The development of the application site would therefore be in accordance with the following legislation and policy.

Legislation

European Legislation

- 8.7 The key piece of European Legislation that protects the UK's water environment is the Water Framework Directive (2000/60/EC). This Directive protects all elements of the water cycle and seeks to enhance the quality of groundwaters, surface waters, estuaries and coastal waters.

National Legislation

- 8.8 Key national legislation and policy relevant to this proposed development includes:
- Environment Act 1995;
 - the Environment Agency's (EA) statutory obligations over the management and control of pollution into water;
 - the Environment Agency's Groundwater Protection policy, March 2017 (<https://www.gov.uk/government/collections/groundwater-protection>);
 - The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 in England and Wales;
 - Flood and Water Management Act, 2010;

Guidance

- 8.9 Relevant UK guidance on good practice for construction projects is detailed in the following documents:
- Control of Water Pollution from Construction Sites - Guide to Good Practice, CIRIA 2002; and
 - Environmental Good Practice on Site C741, CIRIA 2015.
- 8.10 The Pollution Prevention Guidelines (PPG), which were officially withdrawn on the 17th December 2015, and their replacement guidance series Guidance for Pollution Prevention (GPPs) identified

below provide environmental good practice guidance for England that are related to the site activities:

- GPP 1: Understanding your environmental responsibilities - good environmental practices (October 2020)
- GPP 2: Above Ground Oil Storage Tanks (January 2018)
- GPP3 3: Use and Design of Oil Separators in Surface Water Drainage Systems (April 2006)
- GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer (November 2017)
- GPP 5: Works and maintenance in or near water (January 2017)
- GPP 13: Vehicle washing and cleaning (April 2017)
- GPP 21: Pollution incident response planning (July 2017)
- GPP 22: Dealing with spills (October 2018)
- GPP 26: Safe storage - drums and intermediate bulk containers (February 2019)

8.11 Guidelines for surface water management and flood risk assessment are as follows:

- The SuDS Manual (Report C753). CIRIA, 2015;
- National Planning Policy Framework, department for Communities and Local Government (last updated June 2019);
- CIRIA Report C624, Development and flood risk – guidance for the construction industry (October 2004);
- BS8533:2017, Assessing and managing flood risk in development – Code of Practice (December 2017);
- Department for Environment, Food & Rural Affairs and Environment Agency (2015). Flood risk assessment: local planning authorities (Accessed 4 November 2019 at <https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>); and
- Planning Policy Guidance, Ministry of Housing, Communities & Local Government, Flood Risk and Coastal Change (2014) (<https://www.gov.uk/guidance/flood-risk-and-coastal-change>).

Policy

National Planning Policy Framework

8.12 This chapter takes due regard for policy in relation to flood risk and climate change as outlined within the National Planning Policy Framework (NPPF) as outlined in the following:

- National Planning Policy Framework, Published by the Ministry of Housing, Communities & Local Government, July 2020; and
- National Planning Policy Framework Planning Practice Guidance Documents, Published by the Ministry of Housing, Communities & Local Government (<https://www.gov.uk/government/collections/planning-practice-guidance>).

Local Planning Policy and Strategy

8.13 The main local planning policy documents include:

- Barnsley Metropolitan Borough Council, Barnsley Local Plan, Adopted 3rd January 2019
- Barnsley Metropolitan Borough Council, Barnsley Local Plan Supplementary Planning Document: Biodiversity and Geodiversity, Adopted May 2019
- Barnsley, Doncaster and Rotherham Joint Waste Plan (Adopted March 2012)

Information Sources

8.14 The following sources of information have been consulted in order to characterise the geology, hydrogeology and hydrology of the area within and surrounding the application site:

- BGS Earthwise Website for details on the Westphalian Coal Measures (http://earthwise.bgs.ac.uk/index.php/Westphalian_Coal_Measures,_Carboniferous,_Nort_hern_England);
- BGS Geoindex Onshore (<http://mapapps2.bgs.ac.uk/geoindex/home.html>) for Superficial Deposits and Bedrock aquifer designations and borehole scans;
- BGS Lexicon for lithological descriptions of the Pennine Upper Coal Measures Formation (<https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=PUCM>);
- BGS online maps (www.bgs.ac.uk/data/mapViewers/home.html) for details of geology and borehole logs;
- BGS Technical Report WD/00/4 (2000) on 'The physical properties of minor aquifers in England and Wales' for details on aquifer properties of the Coal Measures;
- Boreholes from previous site investigations in order to determine the on-site geological conditions;

- Consultations with the EA and Barnsley Metropolitan Borough Council for details on the locations of licensed and unlicensed water abstractions respectively;
- EA Flood Map for Planning Service for flood risk and Water Framework Directive classifications for groundwater and rivers (<https://flood-map-for-planning.service.gov.uk>);
- EA Historic Landfill Sites Polygon Dataset for details on the location and types of historic landfills in the region (<https://data.gov.uk/dataset/17edf94f-6de3-4034-b66b-004ebd0dd010/historic-landfill-sites>);
- EA Permitted Waste Sites - Authorised Landfill Site Boundaries Polygon Dataset for details on the locations and types of currently licensed landfills in the region (<https://data.gov.uk/dataset/ad695596-d71d-4cbb-8e32-99108371c0ee/permited-waste-sites-authorised-landfill-site-boundaries>);
- EA Website (<https://magic.defra.gov.uk/MagicMap.aspx>) for details on aquifer classification, source protection zones, SSSI, SAC and groundwater vulnerability;
- MET Office UK climate averages for rainfall and climatic data (<https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcp4eqcmh>);
- Ministry of Agriculture, Fisheries and Food Technical Bulletin 34 (1976) on 'Climate and Drainage' for details of rainfall and potential transpiration;
- Morris B.L. (BGS, 2005) 'Hydrogeological notes for the Sheffield District (sheet 100)' for further understanding of the hydrogeological nature of the Coal Measures; and
- Wardell Armstrong (November 2017) 'Carlton Main Landfill – Hydrogeological Risk Assessment Review, V1.0' for further details on the local hydrogeology.

Scoping Opinion

- 8.15 As noted in Chapter 4 above, a scoping opinion relating to the geology and water environment has been provided by Barnsley Metropolitan Borough Council.

Assessment Methodology

- 8.16 A qualitative risk assessment methodology has been used to assess the significance of the potential effects associated with the proposed development. Two factors have been considered using this approach: the sensitivity of the receiving environment and the potential magnitude of impact, should that potential impact occur.
- 8.17 This approach provides a mechanism for identifying the areas where mitigation measures are required and for identifying mitigation measures appropriate to the risk presented by the scheme. This approach also allows effort to be focused on reducing risk where the greatest benefit may result.

- 8.18 Criteria for determining the significance of effects are provided below. Effects of 'major' and 'moderate' significance are considered to be 'significant' in terms of the EIA Regulations.

Study Area

- 8.19 The proposed Southern Extension area is located at National Grid Reference (NGR) SE 41619 07973 and a location plan is included as **Drawing 01**.
- 8.20 The study area is as outlined within the red line boundary presented on **Drawing 01**. The study area has been extended up to 5km from the site boundary to identify any potential hydrological or hydrogeological receptors which could be impacted from the proposals. The study area has been derived from professional judgement based on the site setting and scale of the proposed development.

Sensitivity Criteria

- 8.21 The sensitivity of the receiving environment (i.e. the baseline quality of the receiving environment as well as its ability to absorb the impact without perceptible change) is defined in Table 8-1.

Table 8-1
Sensitivity Criteria for Water Environment Receptors

Sensitivity	Definition
Very High	International importance. Receptor with a high quality and rarity, regional or national scale and limited potential for substitution / replacement.
High	National importance. - Receptor with a high quality, local scale and limited potential for substitution / replacement; or - Receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement.
Medium	Regional importance. - Receptor with a medium quality and rarity, local scale and limited potential for substitution / replacement; or - Receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement.
Low	Local importance. - Receptor with a low quality and rarity, local scale. - Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.

Magnitude of Change (Impact)

- 8.22 The criteria that have been used to assess the magnitude of the impacts are defined in Table 8-2.

Table 8-2
Magnitude of Impact Criteria and Definitions

Magnitude	Criteria	Definition
Major	Results in loss of attribute.	Fundamental (long term or permanent) changes to hydrology, hydrogeology and water quality, such as: Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to the application site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns; Major changes to the water chemistry or hydro-ecology; Major changes to groundwater levels, flow regime and risk of groundwater flooding.
Moderate	Results in impact on integrity of attribute or loss of part of attribute.	Material but non-fundamental and short to medium term changes to hydrology, hydrogeology and water quality, such as: Some fundamental changes to watercourses, hydrology or hydrodynamics. Changes to application site resulting in an increase in runoff within system capacity. Moderate changes to erosion and sedimentation patterns. Moderate changes to the water chemistry of surface runoff and groundwater. Moderate changes to groundwater levels, flow regime and risk of groundwater flooding.
Minor	Results in minor impact on attribute.	Detectable but non-material and transitory changes to hydrology, hydrogeology and water quality, such as: Minor or slight changes to the watercourse, hydrology or hydrodynamics. Changes to application site resulting in slight increase in runoff well within the drainage system capacity. Minor changes to erosion and sedimentation patterns. Minor changes to the water chemistry of surface runoff and groundwater. Minor changes to groundwater levels, flow regime and risk of groundwater flooding.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity.	No perceptible changes to geology, hydrology, hydrogeology and water quality, such as: No impact or alteration to existing important geological environs; No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; No pollution or change in water chemistry to either groundwater or surface water; No alteration to groundwater recharge or flow mechanisms.

Significance of Effect

8.23 The sensitivity of the receiving environment together with the magnitude of the impact defines the significance of the potential effect, as identified within Table 8-3.

Table 8-3
Significance of Potential Impact

Magnitude of Effect	Sensitivity of Receptor				
		Very High	High	Medium	Low
	Major	Major	Major	Moderate	Minor
	Moderate	Major	Moderate	Minor	Neutral / Negligible
	Minor	Moderate	Minor	Minor	Neutral / Negligible
	Negligible	Neutral / Negligible	Neutral / Negligible	Neutral / Negligible	Neutral / Negligible

8.24 The characteristics of the impacts are described in terms of adverse/beneficial, direct/indirect, temporary (reversible)/permanent (irreversible), together with timescales (short, medium, long term).

8.25 Where an effect is classified as substantial or major, this is considered to represent a 'significant effect' in terms of the EIA Regulations. Where an effect is classified as moderate, this may be considered to represent a 'significant effect' but should always be subject to professional judgement and interpretation, particularly where the sensitivity or magnitude of change (impact) are not clear or are borderline between categories or the impact is intermittent. The level of effect matrix provided in Table 8-3 above therefore provides a guide to decision making but is not a substitute for professional judgement.

Mitigation Hierarchy

8.26 A hierarchy to mitigation is undertaken in order of preference as follows:

- Avoid – mitigation which avoids the impact occurring through a change of design or working practice. This is typically built into the design process and may therefore not be explicitly stated within this chapter;
- Reduce – mitigation which reduces the magnitude of impact through a change of design, alteration of working practice or implementation of mitigation measures;
- Remedy – where an impact cannot be avoided during the construction or active phase mitigation measures are outlined to ensure the impact is short-term and the impact is duly remedied prior to completion of working;

- Compensate – if an adverse impact on a receptor cannot be avoided then additional compensation is included within the design as a replacement for the lost receptor.

BASELINE CONDITIONS

Site Setting

Location

- 8.27 As set out in Chapter 2 the Carlton Main Brickworks and its associated quarry are located approximately 7km to the east of Barnsley and 4.4km to the south west of South Kirkby, with Wakefield lying 15.5km to the north northwest. More specifically, the quarry is located to the south of Grimethorpe, on the eastern side of the A6195 Park Spring Road.
- 8.28 The existing quarry is broadly rectangular in shape with the northern boundary mainly formed by residential properties on the southern edge of Grimethorpe. The eastern boundary abuts a cemetery and open land, the southern boundary abuts New Park Springs Country Park (a reclaimed colliery tip) and the western boundary is formed by the A6195, sewerage pumping station and Springvale industrial estate
- 8.29 The proposed extension area, which extends to around 3.5ha, is to the south-east of the main quarry and is bounded by New Park Springs Country Park to the west, and woodland to the east and south. by comparison, the existing quarry covers an area of approximately 19ha (be it the planning permission extends to around 28ha).
- 8.30 The proposed extension area is hereafter also referred to as ‘the Site’.

Topography

- 8.31 The regional topography is moderately undulating. There is a local highpoint of around 117m AOD at a distance of some 1.5km to the northeast of the Site. The gradient becomes gentler to the south – south-east of the Site and decreases in elevation to the south, where around 0.6km from the Site the ground elevation falls below 30m AOD.
- 8.32 The proposed extension area is moderately sloped. The east north-east of the extension area is at a maximum elevation of around 70m AOD and the southwest of the Site is currently at an elevation of around 50m AOD.

Geological Setting

Regional Geology

- 8.33 The geology of the area around Grimethorpe comprises late Carboniferous (Westphalian) strata of the Middle and Upper Pennine Coal Measures. The geology of the area is shown on the British Geological Survey 1:50,000 scale map no. 87 (Barnsley) and documented in the associated memoir.

A detailed geological map of the Site is presented on **Drawing 02** (superficial) and **Drawing 03** (bedrock).

8.34 Further details regarding the Regional geological setting are set out in Chapter 9.

Local Geology

8.35 According to the online BGS Geoindex mapping service, the proposed extension area is underlain by mudstones, siltstones and sandstones of the Pennine Upper Coal Measures Formation. The BGS Lexicon¹ describes this formation as '*interbedded grey mudstone, siltstone and pale grey sandstone, commonly with coal seams, but no mudstones containing marine fossils are present*'. The BGS² further state that rocks of the Pennine Upper Coal Measures Formation '*are largely sandstone and mudstone, mostly reddened to some degree, with a few thin coals and claystone seatearths*'.

8.36 Borehole logs within and surrounding the proposed extension area indicate that there are numerous mudstone, siltstone and sandstone bands of variable thickness. These borehole logs are provided in **Appendix 8/1** and locations shown on **Drawing 06**.

8.37 A review of the available borehole logs across the extension area (specifically Borehole GNP19, GNP220 and GNP221 located in and around the proposed extension area) is provided in Chapter 9.

8.38 Bands of sandstone logged in previous site investigations that would likely be adjacent to the sidewalls and above the proposed base of excavations are no more than a metre in thickness.

8.39 The various Hydrogeological Risk Assessments and Risk Assessment Reviews (HRA and HRARs)⁶ for the landfill element of the northern quarry indicate two main sandstone bands recorded across the existing quarry, as follows:

- Sandstone Unit A: recorded in the base of the quarry and along the northern and southern sidewalls of the quarry the unit dips eastwards beneath the base of the quarry and is projected to be c. 2m thick and visible within the final base of the quarry at between c.31.9 and 33.2mAOD. The sandstone continues to dip to the east and is therefore not visible along the eastern quarry wall;
- Sandstone Unit B is located much higher in the geological sequence and is present at between 49.6 and 58.5mAOD. The unit is currently visible along the northern boundary of the existing quarry and projected to runout along the eastern boundary.

Coal Mining

8.40 There is a long history of coal mining across the region with numerous historic shafts and collieries throughout Yorkshire. The main coal mining areas in the vicinity of the application site are outlined in Chapter 9.

¹ British Geological Survey Lexicon of Named Rock Units: Pennine Upper Coal Measures Formation, available at: <https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=PUCM> (accessed 28th August 2020)

² British Geological Survey Earthwise Website: Westphalian Coal Measures, Carboniferous, Northern England, available at: http://earthwise.bgs.ac.uk/index.php/Westphalian_Coal_Measures,_Carboniferous,_Northern_England (accessed 28th August 2020)

- 8.41 All of the highlighted coal seams are located well below the base of the quarry and it is not anticipated that the quarry site would intercept any previously worked coal seams, although it is noted that there are potentially former mine workings present at depth beneath the Site.

Geological SSSI and RIGS / Local Geology Sites

- 8.42 The central and western parts of the existing quarry excavation are designated as a geological site of special scientific interest (SSSI), which extends across 15.5 ha of the existing quarry site. The location of the SSSI is presented on **Drawing 04**.
- 8.43 The particular interest is a horizon which is the highest Coal Measures marine band (the Westphalian C Top Marine Band, also known as the Cambriense Marine Band in more recent publications) and is the latest evidence of normal marine conditions in this country during the Carboniferous period.
- 8.44 The excavation of the quarry has created what is considered one of the best exposures of the Cambriense (Top) Marine Band in the Pennine Coalfields. The Cambriense (Top) Marine Band at Carlton Main quarry is understood to dip gently to the east, becoming progressively deeper in the excavation as it is worked to the east.
- 8.45 There is a possibility that if faulting is present between the existing quarry and Southern Extension, the faulting may have uplifted the Top Marine Band in the Southern Extension. The unit of interest may not be present if the tectonics and subsequent glaciations of the landscape have caused erosion and weathering of the unit of interest.

Hydrogeological Setting

Recharge Mechanisms

- 8.46 The average monthly rainfall for the period 1991-2020 is presented below in Table 8-4. The MET Office Sheffield Cdl observation station, located c.21.5km to the southwest of the Site.

Table 8-4
MET Office Climate Averages

Month	Rainfall (mm)
January	75.67
February	67.01
March	59.50
April	58.82
May	54.50
June	75.12
July	62.17
August	65.11
September	63.47

Month	Rainfall (mm)
October	78.67
November	84.65
December	86.86
Annual	831.55

- 8.47 The effective rainfall of the inland area which encompasses Grimethorpe is presented in Table 8-5. These data are from the MAFF Technical Bulletin 34³ on 'Climate and Drainage'.

Table 8-5
Effective Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall Average (mm)	75	60	50	52	59	55	71	91	74	67	84	69	807
Potential Transpiration Average (mm)	1	8	28	52	79	88	85	70	41	19	3	0	474
Effective Rainfall Average (mm)	74	52	22	0	0	0	0	21	33	48	81	69	400

- 8.48 Groundwater recharge is likely to take place within any sandstone horizons present across the base of the quarry and present near the surface geology across the wider area. Where the near surface geology is predominantly lower permeability mudstones or siltstones it is likely recharge will be limited with incidental rainfall predominantly forming run-off.
- 8.49 The review of the local geology within the vicinity of the proposed extension indicates that near ground conditions typically comprise of low permeability clays and mudstones, potentially overlain by made ground in the south. These are likely to present limited potential for groundwater recharge and surface water run-off is likely to dominate.

Aquifer Classification and Vulnerability

- 8.50 The Pennine Middle Coal Measures are classified by the Environment Agency as a 'Secondary A aquifer' described as *'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers'*.
- 8.51 The alluvial deposits to the west of the Site are also classified by the Environment Agency as a 'Secondary A aquifer' but these do not extend across either the existing quarry or proposed extension area.

³ Ministry of Agriculture Fisheries and Food (1976) Technical Bulletin 34: Climate and Drainage

- 8.52 The groundwater vulnerability mapping indicates that the groundwater vulnerability at the Site is “High” indicating a high risk from pollution events to groundwater quality.
- 8.53 There are no Source Protection Zones (SPZs) within 10km of the Site.
- 8.54 The hydrogeological setting is presented on **Drawing 05**.

Aquifer Characteristics

- 8.55 The BGS⁴ indicates that sandstones of the Coal Measures are ‘*very well cemented, extremely hard and dense and in consequence possess very little primary porosity or intergranular permeability. Sandstone permeability is directly related to the distribution and size of fractures present in sandstone horizons.*’
- 8.56 Mining subsidence has led to increased fracturing within the Coal Measures, particularly in the Upper Coal Measures. Increased fracturing has resulted in the disruption of the complex multi-layered aquifer system and in certain cases individual sandstones horizons that used to act as separate aquifers are now hydraulically connected.
- 8.57 In some areas of Coal Measures deposits the hydraulic continuity extends between aquifer horizons and mine workings.
- 8.58 The laterally extensive marine bands and coal seams generally have little hydrogeological significance.
- 8.59 Site-specific aquifer properties within the underlying Coal Measures are difficult to predict due to mining subsidence. It is expected that the thin sandstone layers encountered in previous site investigations have limited primary porosity or intergranular permeability; however, flow will predominantly occur through fractures within the sandstone horizons which will potentially have been enhanced by mining subsidence.
- 8.60 Thicker sandstone layers underlying the proposed base of the Site may have increased aquifer properties and will potentially provide significant groundwater flow.

Groundwater Levels and Flow

Regional Groundwater Levels and Flow

- 8.61 The regional hydraulic gradient is unclear as due to the varying permeabilities of deposits in the region there are confined and perched aquifer units that have little or no direct hydraulic connection.
- 8.62 Historically regional groundwater levels have been controlled by dewatering from the extensive network of deep mineshafts in the region. Since dewatering operations to enable coal mining in

⁴ Jones H.K., Morris B.L., Cheney C.S., Brewerton L.J., Merrin P.D., Lewis M.A., MacDonald A.M., Coleby L.M., Talbot J.C., McKenzie A.A., Bird M.J., Cunningham J., and Robinson V.K. (2000) The physical properties of minor aquifers in England and Wales. *British Geological Survey Technical Report*, WD/00/4. 234pp. Environment Agency R&D Publication 68.

the area were stopped in 1992 there was a significant increase in groundwater levels within mine shafts located in the region. The 2007 HRA⁵ indicates that two monitoring locations have previously been provided by the EA for monitoring of the coal measures in the vicinity of the Grimethorpe Colliery, both located approximately 1.5km south-east of the Site (Moor Lane 1 and Moor Lane 2).

- 8.63 The monitoring data from Moor Lane 1 and Moor Lane 2 boreholes indicated that regional groundwater levels rebounded from below -190m AOD in 1992 to -20m AOD by 1996, 0m AOD by 1998 and c.20m AOD in 2002. Since 2002 it appears that groundwater rebound has largely stabilised. The 2017 HRA⁶ indicates that between 2006 and 2017 levels have typically fluctuated between 22m and 27m AOD.
- 8.64 The November 2017 Hydrogeological Risk Assessment Review (HRAR) for the landfilling within the existing quarry area to the north-west of the proposed extension also provides monitoring data for the nearby Hodroyd Shaft at Brierly, located approximately 2.5km north of the Site. It indicates a similar trend with a significant rise in levels recorded up to 2002 but with a limited rise since. The levels in Hodroyd shaft show a steady rise from c. 24m AOD in 2006, peaking at c.35m AOD in 2013. Between 2013 and 2017 water levels appear to be relatively stable at between 32m – 36m AOD.
- 8.65 Responding to a request regarding groundwater monitoring points in July 2020 the EA responded that there were no EA monitoring points within 5km of the Site.

Carlton Quarry Groundwater Levels and Flow

- 8.66 Groundwater levels are monitored from five boreholes installed around the existing quarry area for which the locations are shown on **Drawing 06**.
- 8.67 Groundwater level data for the monitoring period January 2009 - August 2020 are provided below in Table 8-6.

Table 8-6
Carlton Quarry Groundwater Levels

Monitoring Point	Description	Location (Easting, Northing)	Ground level (mAOD)	Groundwater Levels (mAOD)				
				Monitoring Period	Count	Min	Mean	Max
BH 02/01	SSSI at the middle east of the main quarry area	441156 E, 408268 N	41.02	January 2009 - August 2020	52	28.16	30.43	32.74
BH 05/05	Rockery near the northeast of the extension area	441414 E, 408017 N	46.08	January 2009 - August 2020	52	25.02	30.05	32.06

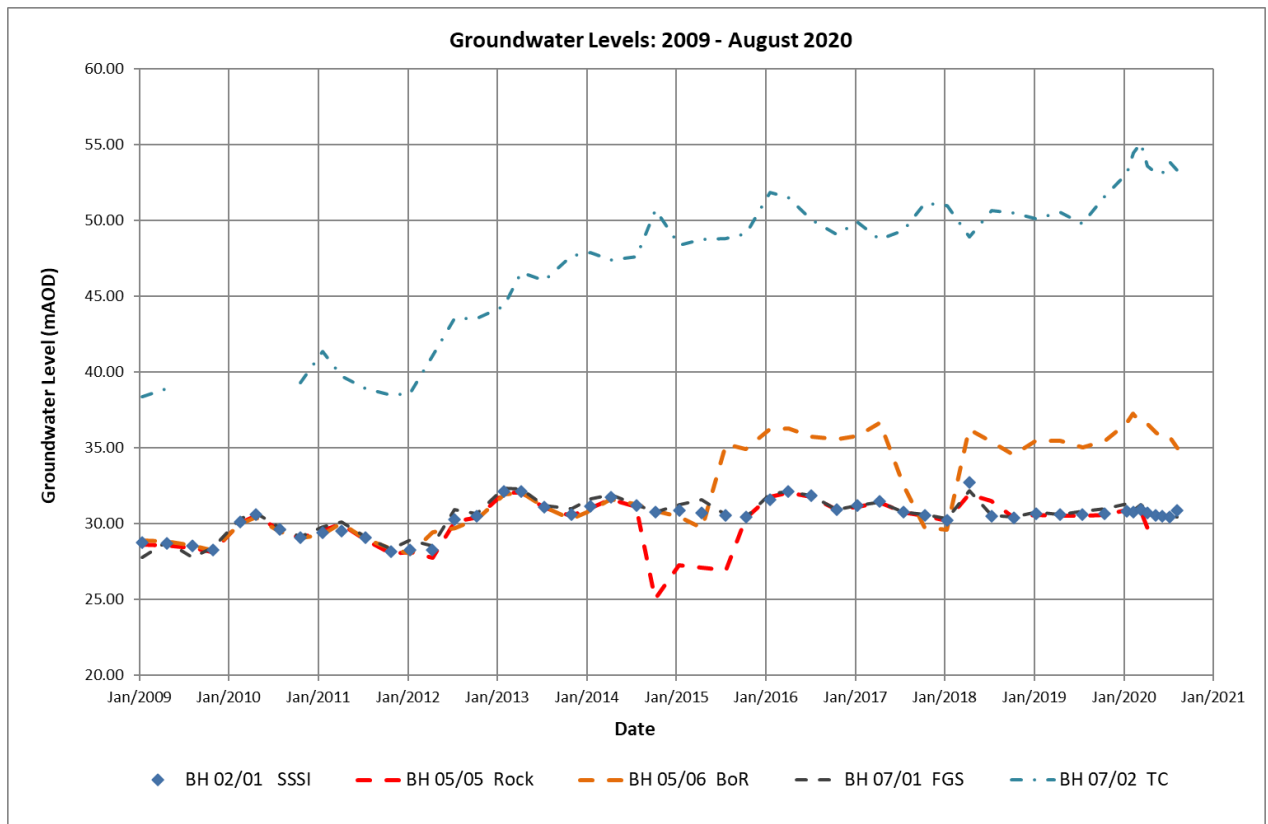
⁵ Carlton Main Brickworks Ltd (November 2007) *Carlton Brick Landfill PPC Application, Section B – Hydrogeological Risk Assessment*

⁶ Wardell Armstrong (November 2017) *Carlton Main Landfill – Hydrogeological Risk Assessment Review, V1.0*.

Monitoring Point	Description	Location (Easting, Northing)	Ground level (mAOD)	Groundwater Levels (mAOD)				
				Monitoring Period	Count	Min	Mean	Max
BH 05/06	Bottom of ramp in the southern part of main quarry area	441417 E, 408111 N	35.96	January 2009 - August 2020	52	28.01	32.55	37.25
BH 07/01	Flue gas scrubber by Carlton Main Brickworks	441042 E, 408090 N	43.18	January 2009 - August 2020	52	27.75	30.56	32.33
BH 07/02	Top northeast corner of main quarry area	441537 E, 408411 N	75.12	January 2009 - August 2020*	47	38.37	47.86	55.13
Table notes: *Gap in monitoring between April 2009 and October 2010								

- 8.68 Groundwater levels for the monitoring period January 2009 – August 2020 are also presented below as a hydrograph on Figure 8-1.
- 8.69 The monitoring data indicate a similar pattern to the regional groundwater monitoring. There was an historic steady rise in groundwater levels between 2009 and 2013 which appears to have largely stabilised since c.2013.
- 8.70 Groundwater levels in BH02/01, 05/05, 05/06 rose from <25m AOD in 2006⁵ to c.31m - 32m AOD in 2013 and have largely remained stable since, although it is noted that BH05/06 records a notable jump of approximately 5m in 2014 (it isn't clear whether this is due to an error in the datum level or a jump in water levels).
- 8.71 BH07/01 indicates a similar trend with groundwater levels having risen from c.27m AOD at the time of installation to a peak of 32m AOD in January 2013 with groundwater levels largely stable since 2013 .
- 8.72 The groundwater elevations of BH02/01, 05/05, 05/06 and BH07/01 appear to correspond with the elevations of the lower sandstone unit (Unit A) across the existing quarry.
- 8.73 BH07/02 appears to be monitoring a separate perched groundwater horizon which is likely to be associated with the upper sandstone band recorded within the sidewall of the main quarry. Given the limited lateral extent of this sandstone band this is considered to represent a limited perched aquifer. Evidence from the Site suggests limited groundwater seepage has been recorded from this sandstone suggesting it is not a significant aquifer unit.
- 8.74 The groundwater levels along with the regional monitoring data suggest that the historic groundwater rebound associated with former coal mining in the area has largely stabilised and the groundwater levels currently being recorded around the Carlton Main quarry are likely to be reflective of long-term groundwater levels.

Figure 8-1
Carlton Quarry Groundwater Levels: 2009 – August 2020



- 8.75 The base of the proposed extension area is to a minimum elevation of 35m AOD and is therefore considered to be slightly above the main water table which appears to be at between 30m - 32m AOD.

Groundwater Quality

- 8.76 Groundwater quality is regularly monitored at the boreholes surrounding the main quarry as part of the Environmental Permit requirements. Recent groundwater quality (2016-2020) for key determinands is presented in Table 8-7 and selected Chemographs are presented in **Appendix 8/2**.

Table 8-7
Carlton Quarry Groundwater Quality: 2016 - 2020

	Parameter	Units	DWS	02/01		02/04		05/05		05/06		07/01		07/02	
				Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Monthly readings	pH (site)	pH units	6.5 - 9.5	6.90	7.57	6.38	6.85	6.30	7.03	6.51	6.92	6.74	7.26	6.44	7.18
	pH (lab)	pH units	6.5 - 9.5	7.18	8.60	7.45	8.60	6.50	8.20	7.08	8.30	7.14	8.30	5.93	7.80
Quarterly readings	Temperature	°C		10.88	12.3	10.425	13.4	10.71	13.9	10.88	13.5	12.38	15.4	10.16	12.3
	Conductivity (site)	µs/cm	2500	1368.1	2130.0	1466.8	2710.0	1945.2	2949.0	2521.9	3120.0	2039.8	2920.0	1197.4	2090.0
	Conductivity (lab)	µs/cm		1032.5	1600.0	1317.5	2600.0	2037.5	3600.0	2700.0	3200.0	2062.5	2500.0	1061.3	1200.0
	TDS	ppm		700.6	1070.0	756.8	1410.0	988.4	1500.0	1281.8	1620.0	1041.5	1520.0	595.6	930.0
	DO	mg/l		8.13	9.50	7.43	7.90	6.61	8.80	7.29	8.80	5.64	8.80	4.13	8.80
	Ammoniacal Nitrogen	mg/l	0.39	0.36	1.40	0.35	0.77	0.91	1.90	0.41	1.20	0.64	1.60	0.99	3.30
	COD	mg/l		18.2	77.0	31.0	66.0	17.9	54.0	78.7	560.0	18.8	29.0	482.9	3900.0
	Chloride	mg/l	250	26.5	57.0	222.3	480.0	125.7	350.0	27.0	34.0	100.3	140.0	36.2	46.0
Annual readings	Alkalinity	mg/l		185.3	320.0	188.0	340.0	139.8	290.0	317.5	370.0	347.5	380.0	34.8	83.0
	BOD	mg/l		2.13	4.00	2.67	4.00	2.63	6.00	1.93	<4	1.78	<4	2.93	5.00
	Nitrite	mg/l	0.1	0.02	0.04	0.01	0.02	0.02	0.04	0.02	0.03	0.04	0.07	0.02	0.06

	Parameter	Units	DWS	02/01		02/04		05/05		05/06		07/01		07/02	
				Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
	Nitrate	mg/l	50	2.42	3.30	0.86	1.50	0.98	2.60	0.95	2.50	0.53	1.12	0.29	0.84
	Sulphate	mg/l	250	674.5	790.0	136.7	190.0	1252.5	1700.0	1670.0	2300.0	1072.5	1400.0	571.3	720.0
	TON	mg/l		0.84	1.50	0.18	0.34	0.40	0.80	0.47	1.10	0.35	1.10	0.28	0.80
	TOC	mg/l		6.3	5.9	7.6	17.0	7.2	19.0	6.6	16.0	8.2	21.0	7.6	18.0
	Calcium	µg/l		102.5	140.0	54.7	110.0	207.5	300.0	255.0	300.0	195.0	250.0	78.0	94.0
	Cadmium	µg/l	5	0.07	0.11	0.04	<0.08	0.83	2.30	0.07	0.12	0.08	0.16	0.03	<0.08
	Chromium	µg/l	50	2.1	7.0	1.6	3.8	1.6	5.3	1.7	5.5	1.4	3.1	0.8	2.0
	Copper	µg/l	2000	1.70	3.10	0.77	1.30	8.20	24.00	0.84	1.40	1.45	2.40	0.75	1.10
	Iron	µg/l	200	155.0	310.0	257.0	680.0	475.0	1500.0	315.0	570.0	587.5	880.0	28155.0	74000.0
	Lead	µg/l	10	0.40	<1	0.50	<1	0.40	<1	0.40	<1	0.40	<1	0.40	<1
	Magnesium	mg/l		128.5	170.0	59.3	120.0	167.5	210.0	357.5	380.0	150.0	180.0	82.3	84.0
	Nickel	µg/l	20	8.2	9.0	4.1	7.4	166.9	390.0	8.1	18.0	8.0	9.9	26.7	52.0
	Manganese	µg/l	50	224.8	450.0	140.3	320.0	5220.0	11000.0	124.8	260.0	2300.0	3400.0	4250.0	4900.0
	Potassium	mg/l		7.95	8.60	23.33	61.00	14.93	24.00	10.38	11.00	14.75	16.00	9.73	10.00
	Zinc	µg/l		29.38	44.00	11.67	13.00	155.75	390.00	52.33	80.00	27.20	41.00	47.25	73.00
	Sodium	mg/l	200	24.50	32.00	34.33	54.00	108.00	260.00	44.00	47.00	195.00	250.00	43.25	52.00

8.77 A review of the monitoring data indicates:

- Most determinands fall within their respective UK Drinking Water Standards (DWS) with the main exceptions being ammoniacal nitrogen, sulphate, iron and manganese which have been recorded above their DWS in all of the boreholes across the Site.
- The presence of sulphate, iron and manganese are likely to be related to the natural chemistry of the Coal Measures Strata as these are common substances associated with Acid Mine Drainage, this is confirmed by the typically slightly acidic nature of the groundwater samples;
- The source of the ammoniacal nitrogen is unclear however it is noted that there appears to be a generally improving trend over the available monitoring period;
- There have been no detections of hazardous organics within the monitoring period 2016-20 at monitoring boreholes located within and adjacent to the main Carlton quarry area

8.78 The BGS^{Error! Bookmark not defined.} indicated in a 2005 Hydrogeological review that *‘Once mine dewatering ceases, and water levels naturally rebound, the quality of groundwater in the Coal Measures may deteriorate. This is because the oxidation state of minerals in the rocks may have changed in the time that the strata were dewatered, increasing their solubility in water and often resulting in poor quality groundwater when the former workings flood’.*

Made Ground and Landfill Sites

8.79 The existing quarry area north of the Site is a permitted landfill (EA/EPR/VP3238LC/A001 issued September 2007).

8.80 There are no further currently active permitted landfills within 2km of the Site according to the EA available polygon dataset⁷.

8.81 The country park, within which the proposed extension to the quarry is located, is a former coal tip reclamation site. Although the geographical limits and depths of historical waste are uncertain, boreholes GNP219, GNP220 and GNP221, which have provided site investigations in the proximity of the proposed extension area, indicate made ground thicknesses of 0.7m – 5.6m with the thickest made ground present in the South of the Site.

8.82 The thickness and top elevations of made ground in the proximity of the proposed extension area as indicated by previous drilling work (dated October-November 1997) are presented below in Table 8-8. No detailed description of the type of Made Ground is provided in these borehole logs, which are provided in **Appendix 8/1**.

⁷ Environment Agency: Permitted Waste Sites - Authorised Landfill Site Boundaries Polygon Dataset, available from: <https://data.gov.uk/dataset/ad695596-d71d-4cbb-8e32-99108371c0ee/permited-waste-sites-authorised-landfill-site-boundaries>

Table 8-8
Made Ground

Borehole Reference	Grid Reference	Top Elevation of Made Ground (mAOD)	Thickness of Made Ground (m)
GNP219	441683.71E, 408018.04N	67.53	0.7
GNP220	441680.89E, 407655.41N	56.31	5.6
GNP221	441479.56E, 407968.73N	50.92	0.7

- 8.83 Adjacent to the western boundary of the Site there was a historic commercial landfill of c.0.37 ha in area. The National Coal Board surrendered its licence for this landfill in February 1993.
- 8.84 Historic landfills within 2km of the Site according to the available EA polygon dataset⁸ are displayed below in Table 8-9. These have the potential to alter the background water quality beneath the application site.

Table 8-9
Historic Landfills

Type of Waste Accepted	Reference	Date Licence Surrendered	Landfill Area (Ha)	Distance from Site
Commercial	EAHLD04410	February 1993	0.37	Adjacent to West of Site
Inert & Industrial	EAHLD34206	August 2005	1.45	0.3km W-NW
Industrial & Liquid Sludge	EAHLD04409	February 1996	12.88	0.3km W-SW
Commercial	EAHLD31725	Null	2.89	0.45km SE
Null	EAHLD04411	Null	2.48	0.8km NW

Hydrological Setting

Regional Hydrology

- 8.85 The Site is located within the catchment of the River Dearne, an EA main river located around 975m to the southwest of the proposed Southern Extension area at its closest.
- 8.86 The River Dearne rises around 25km to the west and flows in a broadly east or south-easterly direction through Barnsley prior to passing to the south-west of the quarry before turning south to

⁸ Environment Agency: Historic Landfill Sites Polygon Dataset, available from: <https://data.gov.uk/dataset/17edf94f-6de3-4034-b66b-004ebd0dd010/historic-landfill-sites>

south-easterly to its ultimate confluence with the River Don, around 23km to the south-east of the Site.

- 8.87 The river runs through the base of the valley at an elevation of around 30m AOD and is therefore considered to potentially be in continuity with the regional groundwater.
- 8.88 A minor un-named tributary of the River Dearne flows to the west of the quarry. This watercourse flows in a southerly direction immediately to the west of the A6195 (Park Spring Road) prior to its ultimate confluence with the River Dearne. There are also several other minor drainage ditches within the country park to the south of the Site.
- 8.89 A minor watercourse is shown on Ordnance Survey (OS) mapping to rise within the proposed extension area, close to the southern edge of the current quarry, and flow in a south-easterly direction through New Spring Park. This ultimately drains to a localised low point which includes a pond. Given that this is a topographical hollow it is assumed that any flows along this ditch will ultimately discharge to ground.
- 8.90 Given that the drainage ditches to the south are located on the former colliery tip it is considered that these will receive only surface water run-off with little or no baseflow component.

Surface Water Management

- 8.91 Surface water run-off from the current quarry is managed within sumps located in the base of the quarry. Incidental rainfall, along with any groundwater ingress, will be routed to the sump where it is allowed to settle prior to being pumped to discharge to the west into the minor tributary of the River Dearne discussed above.

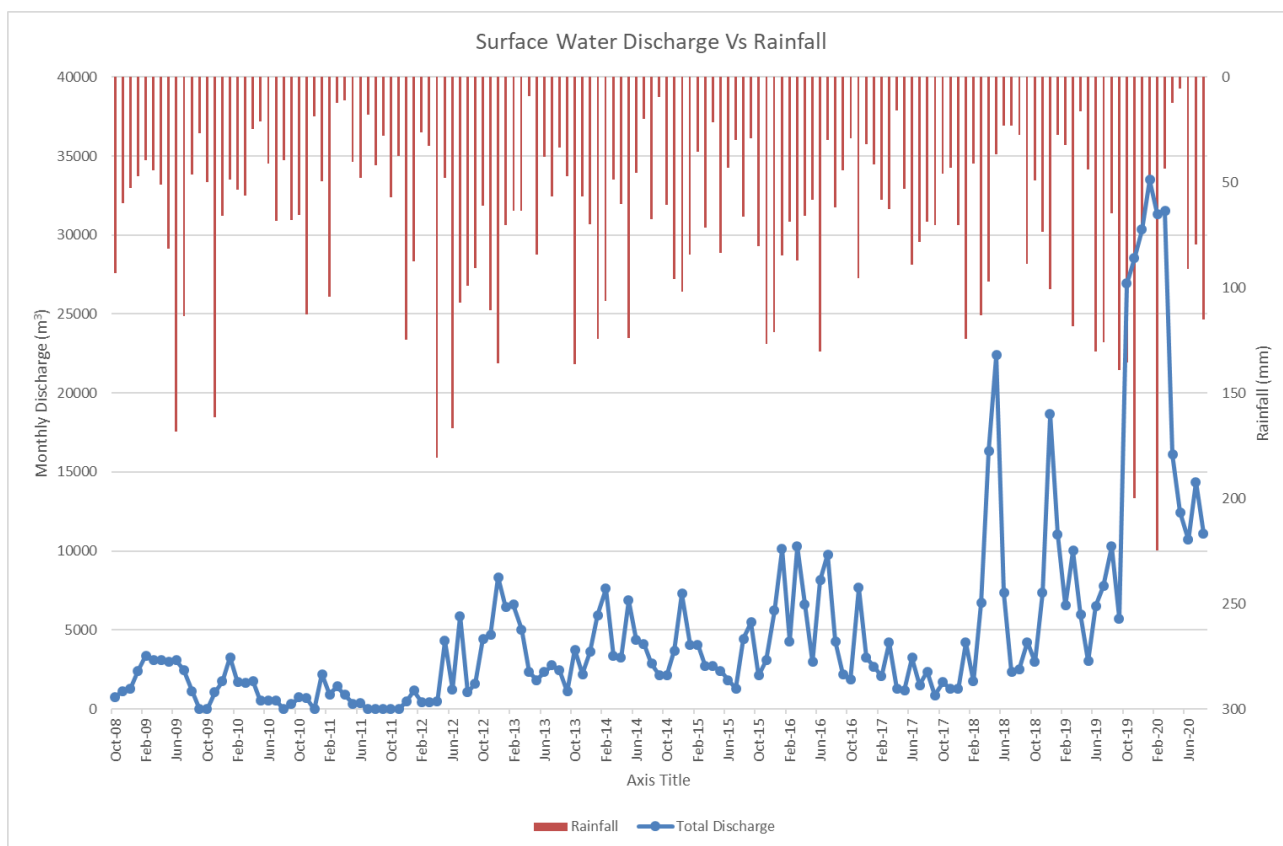
Discharge Consent

- 8.92 The current quarry has an existing discharge consent (Consent No. 3774), which is located at SE 4076 0805 as shown on **Drawing 05**. This consent allows for both the discharge of settled quarry drainage and treated sewage effluent to the limits discussed below. Both sources of discharge are made via a common outlet into Grimethorpe Dyke.
- 8.93 The settled quarry discharge is sampled at NGR SE 4093 0822 (SWA) and the treated sewage effluent is sampled at NGR SE 4102 0825 (SWB).
- 8.94 The discharged settled quarry drainage water has the following limits:
- The rate of discharge is not to exceed 12.5 litres per second, and the volume discharged is not to exceed 1080 cubic metres per day;
 - The discharge is not to contain more than 100 milligrams per litre of suspended solids (measured after drying at 105 degrees Celsius); and
 - The discharge is to have a pH between 6 and 9;

Surface Water Discharge Rates

- 8.95 Monthly surface water discharge rates have been provided by the applicant for their consented discharge and monitoring data from 2008 to 2020 are presented in Figure 8-2.
- 8.96 The monitoring data and hydrograph indicate that there has been a gradual increase in the volume of surface water discharge in recent years, partially reflecting the increase in quarry area since 2008, and also reflecting the significant rainfall recorded in late 2019 / early 2020.
- 8.97 Discharge rates have typically been well below the discharge limit of 1080m³/day, the only occasions that this limit has been reached throughout the history of the quarry was between January and February 2020 following significant rainfall over the winter period. Total Rainfall for the September 2019 to February 2020 period was approximately 860mm, slightly higher than the average annual rainfall for the area.
- 8.98 Based on a quarry area of c.19ha the above 860mm total rainfall would equate to a potential run-off volume of 156,978m³, almost identical to the total discharge volume during this period of 156,320m³. This therefore suggests that the majority of water discharged from the quarry area is surface water run-off as opposed to groundwater ingress. Between April and June 2020 when rainfall was low, surface water discharge remained at an average of c.400m³/day, likely reflecting limited groundwater ingress within the base of the quarry where excavation has dropped below the regional groundwater table.

Figure 8-2
Surface Water Discharge Rates



Water Abstractions and Ecological Setting

Water Abstractions

- 8.99 There are two licensed water abstraction points within 5km of the Site, as displayed below in Table 8-10. Locations are shown on **Drawing 05**.

Table 8-10
Licensed Water Abstractions

Licence No.	NGR and Distance from Site (km)	Source Type	Use Description	Period Start & End	Max Annual Quantity (m³)	Max Daily Quantity (m³)
2/27/08/090	SE 3977 0705; 1.6km from Site	Surface Water: River Dearne	Spray irrigation - direct	01/04 - 31/10	144,000	3,408
2/27/08/090			Spray irrigation - storage	01/11 - 31/03	144,000	3,408

Licence No.	NGR and Distance from Site (km)	Source Type	Use Description	Period Start & End	Max Annual Quantity (m ³)	Max Daily Quantity (m ³)
NE/027/0009/007	SE 45650 10260; 4.6km from Site	Groundwater: Upper Coal Measures	General use relating to industrial, commercial and public services	01/04 - 31/03	83,220	410

Water Dependent Ecological Sites

8.100 A review of the DEFRA Magic Map website confirms that there are two designated ecological sites located within a 2km radius of the Site, these are:

- Carlton Main Brickworks SSSI which is located within the site boundary and is designated for the exposures of the Top Marine Band. Assessments of the potential impact of the proposals on this geological SSSI are included in Appendix 8/1, this is not however considered a water dependent site;
- Dearne Valley Wetlands located approximately 500m to the south-west of the Site, to the west of Park Spring Road. This is designated for its diverse assemblages of breeding birds as well as mixture of lowland damp grasslands, lowland scrub and a mixed assemblage of lowland open waters, their margins and lowland fen. The SSSI includes extensive wetland habitat and is therefore considered to be water dependent.

8.101 The only other designated site within a 5km radius is Stairfoot Brickworks Site of Special Scientific Interest (SSSI) is located over 4km to the south-west of the Site and is also of geological interest and not considered to be water dependent.

FLOOD RISK ASSESSMENT

8.102 The Site is in an area classified by the UK Government as a 'Flood Zone 1'. An area classified as being in a 'Flood Zone 1' comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year. Flood mapping is presented on **Drawing 04**.

8.103 However, as the Site covers an area of greater than 1ha, and with reference to footnote 50 of the National Planning Policy Framework⁹ (NPPF), any planning application for the Site must be accompanied by a site-specific flood risk assessment; this is outlined below.

Best Practice

8.104 This assessment has been undertaken in accordance with the advice and requirements prescribed in current best practice documents relating to the management of flood risk in development

⁹ National Planning Policy Framework, Department for Communities and Local Government (Last updated June 2019)

published by the Construction Industry Research and Information Association (CIRIA)¹⁰, the British Standards Institution (BSI) BS8533¹¹ and the Environment Agency's National Standing Advice on Development and Flood Risk¹².

Flood Risk Vulnerability and Compatibility

- 8.105 With reference to PPG *Table 2: Flood Risk Vulnerability Classification* the proposed development is considered 'less vulnerable' in terms of flood risk vulnerability classification.
- 8.106 Therefore, with reference to PPG *Table 3: Flood risk vulnerability and flood zone 'compatibility'* at PPG Paragraph 067 (reproduced as Table 8-11), the proposed development would be considered an 'appropriate' form of development.

Table 8-11
Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification (PPG Table 2)		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (functional floodplain)	Exception Test Required	x	x	x	✓

Key: ✓ Development is appropriate x Development should not be permitted

- 8.107 Given that the proposed development is considered appropriate development for the flood risk posed to the Site, it is considered that the sequential test has been passed and there is no requirement to assess the exception test.

Flood Risk Screening

- 8.108 A screening study has been completed to identify whether there are any potential sources of flooding at the Site which may warrant further consideration. If required, any potential flooding issues identified in the screening study would then be considered in subsequent sections of the assessment. A summary of the potential sources of flooding and a review of the potential risk posed by each source at the application site is presented in Table 8-12

¹⁰ CIRIA Report C624, Development and flood risk – guidance for the construction industry (October 2004)

¹¹ BS8533:2017, Assessing and managing flood risk in development – Code of Practice (December 2017)

¹² Department for Environment, Food & Rural Affairs and Environment Agency (2015). Flood risk assessment: local planning authorities (Accessed on 1 September 2020 at <https://www.gov.uk/guidance/flood-riskassessmentlocal-planning-authorities>)

Table 8-12
Potential Flood Risk Posed by Flooding Sources

Potential Source	Potential Flood Risk to Application Site	Reason for Decision
Fluvial/Tidal flooding	No	All of the proposed development is located remote from the sea and major rivers. The existing and proposed extension are located entirely within 'Flood Zone 1'.
Flood Defence Breach (Failure)	No	The application site is remote from any flood defences.
Flooding from rising / high groundwater	Minor	The excavation is within variable mudstone, siltstone and sandstone strata and the main groundwater table is below base of the proposed quarry at c.35mAOD but some minor groundwater ingress is likely. Any groundwater ingress would be dealt with as part of the existing water management of the wider site.
Overland flow flooding	Minor	Incidental rainfall to the quarry and surrounding areas would continue to be routed to the base of the quarry void which could potentially result in localised flooding, however this forms part of the sites surface water management system and is unchanged from the current situation.
Flooding from artificial drainage systems	No	Given the nature of the site it is considered that flooding from artificial drainage systems is unlikely
Flooding due to infrastructure failure	No	The site is remote from any water-related infrastructure which may cause flooding
Flooding from Reservoirs	No	The EA flood mapping confirms that the Site is not within an area at risk of flooding from reservoirs.

- 8.109 The flood screening assessment has confirmed that the Site is not deemed to be at risk of flooding and there is no requirement for further risk assessment.

ASSESSMENT OF IMPACTS

Sensitivity

- 8.110 A qualitative risk assessment methodology has been used to assess the significance of the potential effect associated with the proposed development, as described within the assessment methodology. Two factors have been considered using this approach: the sensitivity of the receiving environment and the potential magnitude of impact, should that potential impact occur.
- 8.111 Groundwater within the underlying and adjacent Coal Measures aquifer is classified as a Secondary A aquifer which indicates that it is capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. This aquifer has been determined as the primary receptor. The baseline groundwater quality of the aquifer underlying the Site is generally poor due to the historical impact of coal mining regionally. The sensitivity of the aquifer has therefore been assessed as '**medium**'.

- 8.112 The review of the hydrological setting indicates that there is no direct surface water drainage route from the Site to any main watercourses. It is possible that the groundwater within the underlying aquifer will provide some baseflow to watercourses at a significant distance away from the Site, but the argillaceous and thin sandstone deposits that would be intercepted during excavation are likely have very limited aquifer properties and hydraulic connections. It is noted that there is a drain within the boundary of the site which would be impacted, this watercourse has a limited geographical extent and is believed to ultimately infiltrate to ground and does not provide flow to other down-stream watercourses. The sensitivity of this watercourse is therefore assessed as 'low'.
- 8.113 The Dearne Valley SSSI located to the south-west of the Site comprises a mixture of shallow and deep open waters which help to support a range of habitats in addition to breeding birds. OS mapping indicates that these ponds include drains and an overflow discharge to the River Dearne suggesting that the waterbodies are not being controlled by groundwater, rather surface water inflows (via direct rainfall and localised run-off). There is no hydrological connection between the site and the SSSI, however the depth of the ponds is unknown and therefore an element of connection to groundwater cannot be ruled out and there is therefore a possible hydraulic connection between the Site and the SSSI. Given its designation the sensitivity of the SSSI is assessed as **'High'**.
- 8.114 The existing site (but not the proposed extension) forms part of the Carlton Main Brickworks SSSI. A site designated for its exposure of the Coal Measures strata, including one of the best available exposures of Top Marine Band (Westphalian C) in the Middle Coal Measures. The sensitivity of this designated site is therefore assessed as **'high'**.
- 8.115 There are no identified licensed water abstractions within a 2km radius of the Site which are dependent on groundwater present at the Site and therefore no further assessment of impact on water abstractions is required.

Operational Phase

Groundwater Levels and Flow

- 8.116 Available data suggest that the groundwater table is expected to remain below the proposed maximum quarry depth in the proposed extension area. It is therefore anticipated that no dewatering would be required, although there is the potential for minor seepages from perched sandstone horizons experience around the wider quarry suggests these are typically negligible and do not result in the requirement for significant dewatering. It should also be noted that the proposed extension area is shallower than the existing quarry and therefore even in the event that groundwater rises above the base of the quarry the magnitude of impact would be less than that of the existing quarry. The potential magnitude of impact on groundwater levels and flow is therefore assessed as **'negligible'** to **'low'**. Based on a sensitivity of **'medium'** the overall significance of impact is assessed as **'negligible'** to **'low'**.
- 8.117 The proposed extension would not significantly alter this current situation with all run-off generated from the Site routed to sumps in the base of the existing quarry, where some limited infiltration potentially occurs however the majority of water ponds within the sump and is

ultimately pumped for use in dust suppression or discharged off-site. The current ground conditions across the extension area comprise of made ground overlying mudstones therefore current recharge rates across the Site are likely to be limited. The potential magnitude of impact of excavation works on groundwater recharge is therefore assessed as **'negligible'** to **'minor'**. Based on a sensitivity of **'medium'** the overall significance of impact is assessed as **'negligible'** to **'minor'**.

Groundwater Quality

- 8.118 The existing quarry to the north of proposed extension area includes an area of landfilling and currently holds a licence for the acceptance of inert waste. There are also further areas of historic industrial, liquid sludge and commercial landfills to the west of the proposed extension area within the New Springs Country Park. The proposed development would not directly impact this area but an assessment of the potential impact of the existing waste has been undertaken.
- 8.119 As there is no significant dewatering expected there are not expected to be any significant adverse effects through dewatering operations mobilising contaminants within adjacent landfill sites, consequently the potential magnitude of impact and associated significance of impact are assessed as **'negligible'**.
- 8.120 During excavation works at the Site there also is the potential to intercept perched aquifers. However, site investigations indicate that the likely sources of perched groundwater, which is predominantly the sandstone bands, are of limited permeability and thickness. Consequently, any inflow from these perched groundwater sources would be of limited volume and if the water is of an acidic nature / poor quality it would be effectively diluted by other sources of on-site water and rainfall. Monitoring data from the existing quarry confirm that the vast majority of water pumped from the quarry consists of rainfall run-off. Consequently, intercepted groundwater presents a **'minor'** potential magnitude of impact. Based on a sensitivity of **'medium'** the overall significance of impact is assessed as **'minor'**.
- 8.121 Furthermore, in the event that dewatering is required or groundwater is intercepted in the proposed extension area, this would be managed in line with operations in the currently permitted quarrying area. Thus any discharges from the existing discharge point would still need to comply with currently permitted water quality standards, and there would not be likely to be any significant increase in risk of any elevated discharge concentrations.
- 8.122 The working of the Site would involve the use of mobile plant which could give rise to fuel spills which have the potential to contaminate groundwater. However, these potential impacts are mitigating through the operation of the Site in accordance with best practice techniques to be incorporated within the management procedures for operational activities onsite in order to protect the water environment from pollution incidents. The mitigation measures can be summarised as follows:
- during operation there would be heavy plant and machinery required on site and as a result it is appropriate to adopt best working practices and measures to protect the water environment, including those set out in the Guidelines for Pollution Prevention (GPP1);
 - in accordance with GPP2 all above ground on-site fuel and chemical storage would be bunded;

- an emergency spill response kit would be maintained on site;
- a vehicle management system would be put in place wherever necessary to reduce the potential conflicts between vehicles and thereby reduce the risk of collision; and
- a speed limit would be imposed on site to reduce the likelihood and significance of any collisions.

8.123 Given the above, the potential magnitude of impact is assessed as **minor** with a receptor sensitivity of **'medium'** and a **'minor'** significance of impact.

Surface Water Flows

8.124 The proposed extension would result in the loss of a c. 200m section of drain which runs in a south-easterly direction through the extension area. This is located at the head of the catchment and there is no up-stream catchment for the drain. It is also considered that the drain would be reliant on surface run-off only with no baseflow likely. The loss of this up-stream end of the stream would slightly reduce flows within the ditch down-stream of the Site; however, it is noted that the drain does not connect to any other watercourses and is considered to ultimately drain to ground. Given that the proposed working of the Site would encourage run-off from the extension area to drain to ground the overall impact on water flows or groundwater recharge is relatively limited.

8.125 The potential magnitude of impact on surface water flows is assessed as **'minor'** to **'moderate'**. Based on a sensitivity of **'low'** the overall significance of impact is assessed as **'negligible'**.

Flood Risk and Surface Water Management

8.126 As clarified within the Flood Risk Assessment in paragraphs 8.102 to 8.109, the flood risk posed to the Site is considered to be low with only minor risk identified associated with either groundwater ingress or surface water run-off.

8.127 As outlined above the risk from groundwater ingress is assessed as low. Rainfall run-off from the proposed extension area, along with any groundwater ingress, would be routed to the quarry void within the existing quarry area from where it would be pumped as required to the permitted discharge point. Whilst this would potentially result in a slight increase in overall run-off the discharge would continue to be limited to the permit limit and there would therefore be no impact on off-site flood risk. This could result in a minor increase in the flooded volume within the void given the significant size of the void in comparison to the extension area the magnitude of impact on flooding to the existing quarry is considered to be **'negligible'** to **'minor'**. Based on a sensitivity of **'medium'** (based on the flood risk vulnerability classification of Less Vulnerable) the overall significance of impact is assessed as **'negligible'** to **'minor'**.

Designated Ecological Sites

8.128 It is noted that there is a potential hydrogeological connection between the Site and Dearne Valley SSSI, however as outlined above the extension will not extend below the regional groundwater table and therefore there will be no impact on groundwater flows to the SSSI. Any perched

groundwater intercepted by the extension will be in within minor sandstone bands which are of limited permeability, thickness and lateral extent and are therefore considered highly unlikely to extend as far as the SSSI or affect baseflow to the ponds. The potential magnitude of impact on the SSSI with relation to groundwater levels and flows is therefore assessed as '**negligible**'. Based on a sensitivity of '**High**' the overall significance of impact is assessed as '**negligible**'.

- 8.129 The assessment on groundwater quality also indicates that given the embedded mitigation built into working of the site, and based on how they work the existing site the potential impact on groundwater quality locally has been assessed as '**negligible**' to '**minor**'. The potential impact on the water quality of the SSSI can therefore be similarly assessed as '**negligible**' to '**Minor**'

Restoration Phase

Groundwater Levels and Flow

- 8.130 The proposed revised restoration scheme would create a sloping landform which would drain in an easterly direction to a low point in the east / south-east of the void. The south-eastern corner of the quarry would be located on sandstone bedrock to act as a soakaway. Given that current ground conditions across the extension area comprise of low permeability made ground and mudstones the proposals represent an improvement and net increase on groundwater recharge across the extension area.
- 8.131 The existing permitted restoration scheme was to restore the Quarry to pre-development ground elevations by landfilling with non-hazardous wastes, which would have provided little or no recharge to groundwater. The proposed changes to the restoration scheme would therefore provide a net improvement to both the current situation across the extension area and the currently approved restoration scheme.
- 8.132 As the proposed extension area is located above the regional groundwater table it would cause no impact on groundwater flow from the restored void.
- 8.133 The proposed restoration scheme includes backfilling the lower part of the existing quarry void; however, this is unchanged from the currently permitted scheme. The potential impact on groundwater flow is therefore considered to be the same as the currently permitted development.
- 8.134 Based on the above the potential magnitude of impact from the proposed restoration of the extension area and revised restoration of the wider site would provide a **minor positive** magnitude of impact with an associated **minor positive** overall significance of impact on groundwater levels and flows.

Groundwater Quality

- 8.135 The restoration of the Site would include the use of site won overburden and interburden material and imported inert materials. Any imported materials would meet the requirements for 'inert

waste', as classified by the Landfill Directive (1999)¹³. Inert waste is defined in Article 2e of the directive as:

"inert waste' means waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant and in particular not endanger to quality of surface water and/or groundwater."

- 8.136 This installation would be regulated by the EA through either a Recovery Permit or an Environmental Permit (EP). The hydrogeological risk would be addressed in a Hydrogeological Risk Assessment (HRA) before the permit is issued.
- 8.137 The final design and construction of the installation would be confirmed within the HRA.
- 8.138 A qualitative HRA would likely be required due to the limited risk posed by inert wastes to groundwater quality.
- 8.139 Given that the risk from the restored Site would be managed through the permitting process the potential impact of the restoration scheme on groundwater quality is assessed as **'negligible'** to **'low'**. Based on a sensitivity of **'medium'** the overall significance of impact is assessed as **'negligible'** to **'minor'**.

Flood Risk and Surface Water Management

- 8.140 The proposed restoration scheme would route surface water run-off to the base of the quarry from where it would be allowed to infiltrate to the underlying sandstone bedrock. It is possible that following significant rainfall events the volume of run-off would exceed the infiltration capacity of the sandstone, resulting in shallow flooding of the base of the restored Site. However, it should be noted that the base of the restored Site (36m AOD) is at least 6m lower than the lowest point around the perimeter of the restored Site (42m AOD within the vicinity of the brickworks along the western boundary) therefore the potential for floodwater to propagate off-site is considered to be **'negligible'**.
- 8.141 The restoration of the Site as amenity open space is considered to be 'water compatible' development and therefore localised flooding of the base of the restored Site following restoration is considered to be compatible with the proposed restoration scheme. The potential magnitude of impact on flooding on-site is therefore assessed as **'minor'** to **'moderate'** however given a sensitivity of **'low'** (due to being water compatible) the overall significance of impact is assessed as **'negligible'**.

¹³ Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

Ecological Sites

- 8.142 Given that the potential impact on both groundwater levels and quality is assessed as **'negligible'** to **'minor'** in the event that there is any hydraulic connection between the application site and SSSI the potential impact on the ponds is similarly assessed as **'negligible'** to **'minor'**.

Mitigation Measures

- 8.143 The above assessment indicates that given the mitigation measures (as detailed in the relevant sections) incorporated in the design the overall risk to groundwater is generally low. However, a potential risk to groundwater quality is posed by the proposed restoration material.
- 8.144 As outlined above the inert materials to be accepted as part of the restoration of the Site would be assessed using a qualitative risk assessment to ensure that the design of the Site is undertaken in accordance with the Environmental Permitting Regulations, 2016 and the Landfill Directive and that the proposed development has no impact on groundwater quality.

Residual Effects

- 8.145 There are no anticipated residual effects for the operational or restoration phases of the development.

Cumulative Effects

- 8.146 The proposed development would be undertaken in conjunction with the existing quarrying activities undertaken at existing quarry area and would utilise much of the same infrastructure, such as infiltration ponds, site offices etc. There is therefore considered that there would be no significant cumulative effects beyond those already assessed within this chapter.

CONCLUSIONS

- 8.147 This chapter provides a description of the baseline hydrological and hydrogeological conditions at the application site and an assessment of the potential impact of the proposed quarrying and restoration activities on groundwater and surface water receptors.
- 8.148 The baseline assessment indicates that the main receptor from the proposed development relates to groundwater within the underlying and adjacent Coal Measures, there are no surface water receptors or water dependent ecological within the vicinity of the Site.
- 8.149 Appropriate mitigation measures have been outlined as required.