Pam Brown Associates



September 2020

Phase I Desk Study and Phase II Geo-Environmental Site Investigation

PLOT 7, DEARNE VALLEY PARKWAY

BARNSLEY

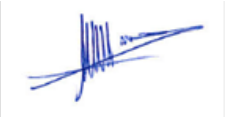
S70 5SZ

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Pam Brown Associates

PHASE I DESK STUDY
AND
PHASE II GEO-ENVIRONMENTAL SITE INVESTIGATION

PLOT 7, DEARNE VALLEY PARKWAY
BARNSLEY
S70 5SZ

	NAME	SIGNATURE	DATE
PREPARED BY:	GABRIELE RUDOKAITE		28/AUG/2020
CHECKED BY:	DR. MELISSA MORALES		02/09/2020

Client: Glanville Group

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Issued By:

Pam Brown Associates Ltd
Needwood House, Lancaster Park,
Newborough Road, Needwood,
Burton on Trent, DE13 9PD

Telephone: 01283 575733
Web site: www.pambrownassociates.co.uk

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Executive Summary	
Site Location and Description	The site is located off Dearne Valley Parkway, Barnsley, S70 5SZ. National Grid Reference: 435122E, 400858N. The site covers an area of 0.51ha which is irregular in shape and currently comprises an area of an open grassland with no trees or shrubs on site.
Proposed Development	McDonalds restaurant and drive thru' with associated car parking and soft landscaping.
Geology	Artificial and made ground deposits are recorded on site described as infilled ground and made ground (undivided) overlying Pennine Middle Coal Measures Formation (Bolsovian Sub-age – Duckmantian Sub-age) described as mudstone, siltstone and sandstone. Eighteen (18No.) records of inferred/observed coal seams and inferred faults have been recorded within 500m of the site. There are two (2No.) coal seams recorded on site (inferred and observed). Risks identified in association with geological hazards include: • Very low risk from collapsible deposits • Very low risk from landslide • Very low risk from running sands • Moderate to Very low risk from compressible deposits • Very Low to Negligible risk from shrinking and swelling clay ground stability hazards. • Negligible risk from ground dissolution of soluble rocks Six (6No.) historical underground workings have been identified on site noted as 'Colliery'. Ten (10No.) historical surface ground workings were recorded on site. These include disused workings, colliery and a refuse heap. Nine (9No.) British Pits were recorded within 500m of the site with the closest record 58m north-west of the site associated with surface coal mining. This activity is noted as being 'Ceased'.
BGS Records	There is a record for a borehole ~120m to the north of the site, according to the records from the British Geological Society (Appendix 2).
Radon	Less than 3% of properties are estimated to be at or below the Action Level. According to Building Research Establishment publication BR211 (2015) 'Radon: Guidance on Protective Measures for New Dwellings', no radon protection measures are necessary in the construction of new dwellings or extensions.
Coal Mining	The site is recorded as being within a known coal mining affected area with inferred and observed coal seams recorded on site. The property is within a surface area that could be affected by underground mining in seven (7No.) seams of coal at 140m and 340m depth, last worked in 1962. There are no recorded mine entries within, or within 20m of, the site boundary. Reserves of coal exist in the local area which could be worked at some time in the future.

	The property is within the boundary of the Rockingham opencast site from which coal has been removed by opencast methods. The property does not lie within 200 metres of the boundary of an opencast site from which coal is being removed by opencast methods.
Mining / Mineral Abstraction	Mining for Iron Ore (bedded) has been recorded on site and within 1km of the site. Other non-coal mining (including; clay, tin, brine and gypsum extraction) affected areas have not been identified within 1km of the site.
Hydrogeology, abstractions and discharges	Bedrock has been designated as 'Secondary A' aquifer. The permeability of the bedrock is recorded as 'Low to High' via fracture flow, whilst the artificial deposits are recorded as having a 'Low to Very High' permeability via mixed flow. Groundwater vulnerability on site is recorded as 'Medium'. There is one record (1No.) of WFD Groundwater bodies recorded on site under the name of Don & Rother Millstone grit & Coal Measures Groundwater body and classed as an abandoned mine with an overall 'Poor' status (measured in 2015). There are no active groundwater abstraction licences, nor potable abstraction licences recorded within 2km of the site. The site is not within a Groundwater Source Protection Zone.
Hydrology, abstractions and discharges	A series of inland watercourses (non-tidal) were recorded within 500m of the site. The nearest watercourse is a non-tidal inland river 30m north-east of the site, within the Dearne Catchment Area. WFD Surface water body has been identified 546m north of the site. The overall quality rating for the river was classed as 'Moderate' in 2016. There are five (5No.) licensed discharge consents within 500m of the study site for trade / sewage discharges, the closest one recorded 258m south-east. No active surface water abstraction licences have been recorded within 2km of the site.
Flooding Issues	The site is at 'Negligible' risk of flooding from rivers or the sea and is not susceptible to groundwater flooding associated with superficial deposits.
Environmental Database	One (1No.) current Part A(2)/B permit was noted 455m south east of the site, for 'Unloading of petrol into storage at service stations'. Five (5No.) discharge consents were identified within 500m radius of the site, with the closest one 258m south east and with the status noted as 'revoked'. One (1No.) pollution incident was noted within 500m of the site, 443m south associated with construction and demolition materials.
Environmental Sensitive Sites	There are no records of environmental sensitive sites within 2km radius of the study site.
Site History	Historically, the site and wider area was subject to deep underground mining (Rockingham Colliery pre-1893 to 1980) and used for opencast coal mining (1991 to 1995). Subsequent backfilling and restoration were completed by 2002. Between 1893 and 1987 the topography of the area appears to alter, with additional and expanding spoil heaps. By 2002 the

	general site area appears to have been levelled with no spoil heaps or buildings shown to be present.
Scope of Ground Investigation	• Non-intrusive survey of underground services to clear exploratory locations • 3No. windowless sample boreholes • 3No. rotary open holes • TRL CPT testing at 7No. locations • Dynamic Probing in six (6 No.) locations • Coring in 3No. locations • Chemical analysis of soils, groundwater and WAC testing • Geotechnical testing • 4No. post completion monitoring visits
Ground Conditions	The exploratory holes have encountered a significant thickness of variable Made Ground (9.3m to 11.1m bgl) overlying very weak to weak mudstone of the Pennine Middle Coal Measures Formation, proven to 30m below existing ground level. No evidence of coal mining or coal was identified on site. Groundwater was encountered during fieldwork at depths between 1.27m and 24.50m bgl. Subsequent monitoring round encountered groundwater present in a single well, with resting levels of 2.23 - 2.61m bgl.
Environmental Assessment	None of the made ground soil samples, subjected to a suite of contamination testing, presented contaminant concentrations which exceed generic assessment criteria for land under a commercial / industrial use. No asbestos fibres or asbestos containing materials were identified in those samples subjected to asbestos screening analysis. Groundwater testing results revealed that the sample, subject to the contamination testing, generally complied with the assessment criteria for land under a commercial / industrial use. Only one exceedance above UK DWS was recorded for nickel at 97µg/l at 2.54m bgl (BH3). From an environmental perspective, the site is considered to pose a '**Low Risk'** of harm to sensitive receptors based on the findings of the ground investigation and revised conceptual site model.
Geotechnical Assessment	Based on the ground conditions encountered and type of proposed development, shallow depth raft foundations would be suitable at this site, subject to additional testing, anticipated structural loadings and tolerance of structure to settlement. Piled foundations would also be suitable at this site, providing they are taken down to the Coal Measures bedrock. Alternatively, the use of controlled modulus columns (CMCs) could be suitable ground improvement alternative. It is recommended that for foundations the Design Sulphate Class for the site, as defined in BRE Special Digest 1(2005), be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. Results of in-situ testing have given average values of CBR in the range 29% to 81% near surface. Based on the above results and ground conditions encountered, it is recommended for preliminary design purposes a CBR value of 2% for any near surface cohesive material and 10% for granular material.

Waste Classification	Results for the WAC-inert analysis performed in three (3No.) samples suggest potential arisings within the top 1.0 may be able to be deposited in an Inert Landfill, however deeper materials (i.e. WS2 1.3-1.5m bgl) may need to be deposited in a Non-hazardous Landfill.
Ground Gas Assessment	Maximum methane and carbon dioxide concentrations recorded on site were in the order of <0.1%v/v and 4.7 %v/v, respectively. A Characteristic Situation 1 - 'Very low' risk is considered adequate for the site on a preliminary basis, for which no special precautions are required for new buildings.
Recommendations	• Use of protective pipework for potable water supply. • Use of adequate PPE by construction / maintenance workers. • Monitoring of ground gases / vapours which may accumulate within deep excavations during groundworks. • Site workers to be vigilant of unexpected ground conditions or asbestos containing materials which may be encountered during development. • Additional testing such as plate bearing tests should be conducted in case shallow depth raft foundations are being considered. • Further CBR tests would be required across external areas after cut / fill works have concluded and once formation levels are known, to confirm design CBR values.

1.0 INTRODUCTION

Pam Brown Associates Ltd (PBA) have been appointed by Glanville Group to undertake a Phase I Desk Study and Phase II Geotechnical & Environmental Site Investigation at a site located off Dearne Valley Parkway, Barnsley, S70 5SZ. The site investigation was based on the Harris Partnership Architects drawing 'Feasibility Site Layout Option 4' Drawing No.: 11627_AEW_8415_F004 Revision A, dated April 2020.

The purpose of the investigation is to provide information to assist with the design of the proposed development scheme, as well as to provide an assessment of geotechnical and environmental properties of the ground and groundwater.

The reporting process aims to characterise the site based upon the procedures identified within Environment Agency (2019) 'Contaminated Land: Risk Management'. These procedures relate to 'past' contamination, and assume that legislative controls such as Pollution Prevention and Control authorisations control current potentially polluting activities. Emphasis is therefore upon historic use and the overall approach in dealing with past land contamination is one of risk management.

The Phase I Desk Study has been undertaken with the purpose of characterising the geological and environmental setting of the site by reviewing available data obtained within Groundsure Reports, including: geological, hydrological, hydrogeological, historic and Environment Agency (EA) data. The information obtained is then used to evaluate the environmental sensitivity (vulnerability) of aquatic, human and ecological systems in the site's vicinity in support of the identification and assessment of pollutant linkages.

A conceptual site model (CSM) is formulated by reviewing the environmental setting of the site, its physical characteristics and identifying historic/current potential contaminative uses to detect potential contamination sources, pathways and receptors. This is undertaken in accordance with CIRIA C552 (2001)[1] to determine whether significant harm is being caused or there is a significant possibility of such harm being caused as outlined in EPA1990: Part IIA[2] and further described in DEFRA (2006, 2012) statutory guidance[3,4]. The classification of risk is obtained by combining the severity of the harm likely to arise from a given on/off site activity and the probability that harm may arise to a particular sensitive receptor.

The Phase II Geo-Environmental Investigation was undertaken to provide geotechnical data for foundation and slab design. Information was also obtained with regard to soil/groundwater quality and ground gas / vapour generation potential.

In accordance with CLR 11, the process of investigation and risk assessment is iterative, the findings of the Phase II investigation were subsequently used to review the CSM for the site and reassess risk to receptors, and ultimately confirm the potential requirement or otherwise for remedial action.

This report should be read in conjunction with the following documents:

- PBA 'Coal Mining Risk Assessment' Ref. 2023-20. August 2020.

[1] Rudland, D., Lancefield, R.M., Mayel, P.N. (2001) "Contaminated land Risk Assessment: A guide to good practice. CIRIA C552. UK. pp.80.
[2] Environmental Protection Act 1990: Part IIA. Contaminated Land. Section 78A (ii).
[3] Department of Environment, Food and Rural Affairs (2006) DEFRA Circular 01/2006 – Environmental Protection Act 1990: Part2A. September 2006. U.K.
[4] Department of Environment, Food and Rural Affairs (2012) Environmental Protection Act 1990:Part2A – Contaminated Land Statutory Guidance. April 2012. U.K.

Limitations

The conclusions reached within this report are restricted to those that can be determined from the available data and within the inherent limitations of a discrete investigation. Conclusion and/or recommendations made in this report may be subject to amendment in the light of additional information becoming available.

The information provided by third parties is presented in good faith; however, PBA cannot accept any responsibility/liabilities for the information derived from these and/or for discrepancies or inaccuracies found in the data.

The report presents the findings of the ground investigation exploratory logs, tests and monitoring results and interpretation of this data which is limited to the specific exploratory locations and scope under which the study was commissioned. As with any site, there may be differences in conditions between exploratory hole locations, the data included in the report reflects the observations made at the time of the investigation. Seasonal fluctuations may occur in groundwater and ground gas levels which may not be accounted for as part of this study. PBA cannot take responsibility for conditions that have not been revealed by the exploratory holes, or variations which may occur between them.

This report has been prepared solely for the use of Glanville Group for the specific purpose under which the investigation was commissioned. If the document is used/viewed by any other party for any other purpose than the one specified above, reference must be made to PBA to confirm its suitability for use. No responsibility will be accepted where a third party uses this report, either in part or in its entirety, unless formally re-assigned.

This report should be reviewed at all stages of construction by someone familiar with the terms and assumptions it contains. It is essential that a suitably qualified and experienced engineer be appointed for design purposes, and to supervise construction.

2.0 SITE OVERVIEW

2.1 SITE LOCATION AND DESCRIPTION

The site is located off Dearne Valley Parkway, Plot 7, Birdwell, Barnsley approximately 2.97km south-west of Elsecar Railway Station. An extract of the 1:50,000 Ordnance Survey map showing the general location of the site is included as Figure 1.

The approximate National Grid reference for the site is 435122E, 400858N. An aerial photograph of the site is presented below with the site boundary marked in red.



The site covers an area of approximately 0.51ha and is roughly rectangular in shape. The site is unoccupied with uneven terrain, covered with rough grass. Two billboards are present on the southern part of the site. A wooden fence is found along the site's perimeter. There are no mature trees or shrubs on site.

The site is bounded by an access road (Kestrel Way) to the surrounding business park and by Dearne Valley Parkway (A6195) to the south of the site. The business park extends to the north, east and west of the site with undeveloped open grassland beyond Dearne Valley Parkway in the south.

The current site layout is presented as Figure 2.

2.2 PROPOSED DEVELOPMENT

The proposed development includes the construction of a McDonalds restaurant with associated car parking and drive-thru areas. The proposed development plan is included as Figure 3.

2.3 ENVIRONMENTAL SETTING

A review of available physical and environmental information relating to the site has been undertaken including mapped references and extracts from the Groundsure Enviro+Geo Insight report and a CON29M Coal Mining Report (Appendices 1 & 2). A summary of the site's environmental setting and sensitivity is included in Table 1.

Table 1. Environmental Site Setting

Physical Characteristics	
Topography	The site is in a generally flat area with elevations of approximately 134 metres Above Ordnance Datum (AOD), increasing towards the southwest to 138m AOD.
Geology	The geology of the site is recorded on the British Geological Survey (BGS) 1:10,000 and 1:50,000 maps. Artificial and made ground deposits are recorded on site described as infilled ground and made ground (undivided) overlying Pennine Middle Coal Measures Formation (Bolsovian Sub-age – Duckmantian Sub-age) described as mudstone, siltstone and sandstone. Eighteen (18No.) records of inferred/observed coal seams and inferred faults have been recorded within 500m of the site, two (2No.) of these recorded on site - coal seams (inferred and observed). An inferred fault was noted at 347m southwest. Risks identified in association with geological hazards include: • Very low risk from collapsible deposits • Very low risk from landslide • Very low risk from running sands • Moderate to Very low risk from compressible deposits • Negligible to Very Low risk from shrinking and swelling clay ground stability hazards. • Negligible risk from ground dissolution of soluble rocks Nine (9No.) records of historical underground workings have been identified within 1km of the site, with six (6No.) of them located on site (colliery). These include collieries, air shaft and unspecified workings. Forty-one (41No.) historical surface ground workings were recorded within 250m of the site boundary, including collieries, reservoirs, filter beds, sewage tanks, refuse heaps and cuttings. Records on site inlcude disused workings, colliery and a refuse heap. Nine (9No.) British Pits were recorded within 500m of the site with the closest record 58m north-west of the site associated with Rockingham Open Cast site where surface coal mining was undertaken. This activity is noted as being 'Ceased'. The Rockingham Colliery expanded further the north / northeast / northwest and also conducted deep coal mining and has 2 reported shafts in the vicinity at 185 and 230m NE. Three other 3No mining sites (extracting coal and sandstone) were recorded beyond a 300m radius. Mining for Iron Ore (bedded) has been recorded on site and within 1km of the site. Other non-coal mining (including; clay, tin, brine and gypsum extraction) affected areas have not been identified within 1km of the site.

Coal Mining	The site is recorded as being within a known coal mining affected area with inferred and observed coal seams recorded on site. A CON29M Coal Mining Report was commissioned, and is included in Appendix 3. A standalone Coal Mining Risk Assessment has been prepared for the site, which includes an assessment of the risk posed by the coal mining legacy on and around the site. The property is within a surface area that could be affected by underground mining in seven (7No.) seams of coal at 140m and 340m depth, last worked in 1962. The property is not within a surface area that could be affected by present underground mining. The property is not in an area where the Coal Authority has received an application for, and is currently considering whether to grant a licence to remove or work coal by underground methods. The property is not in an area where a licence has been granted to remove or otherwise work coal using underground methods. The property is not in an area likely to be affected from any planned future underground coal mining. However, reserves of coal exist in the local area which could be worked at some time in the future. There are no recorded mine entries within, or within 20m of, the site boundary. The Coal Authority is not aware of any damage due to geological faults or other lines of weakness that have been affected by coal mining. The property is within the boundary of the Rockingham opencast site from which coal has been removed by opencast methods. The site is not within 200m of the boundary of a current working opencast site nor within 800m of the boundary of a future-planned opencast site. The coal authority has not received a damage notice or claim for the properly or within 50m of the boundary since 31st October 1994. There is no record of mine gas, remedial works, or working facilities order for the property. The property is in an area where a notice to withdraw support was given in 1950. Examination of the Coal Authority online interactive map viewer indicates the site is within a “Development High Risk Area”, associated with probable unrecorded shallow coal mine workings.
BGS Records	A record for a BGS borehole at ~65m north is available from the British Geological Society (Appendix 2). The borehole describes light grey sandstone up to 5.8m bgl over dark grey mudstone with ironstone lenses to a proven depth of 6.6m bgl underlying coal from Swallow Wood Seam to a depth of 6.93m bgl.

Radon	According to the Health Protection Agency (HPA), the property is in a lower probability radon area, as less than 3% of properties are estimated to be at or below the Action Level. According to Building Research Establishment publication BR211 (2015) 'Radon: Guidance on Protective Measures for New Dwellings', no radon protection measures are necessary in the construction of new dwellings or extensions.
Estimated Background Soil Chemistry	Arsenic 15-25 mg/kg Cadmium 1.8 mg/kg Chromium 60-90 mg/kg Nickel 15-30 mg/kg Lead 100 mg/kg
Hydrogeology	Bedrock geology has been designated as 'Secondary A' aquifer; this describes 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. The permeability of the bedrock is recorded as 'Low to High' via fracture flow, whilst the artificial deposits are recorded as having a 'Low to Very High' permeability via mixed flow. Groundwater vulnerability on site is recorded as 'Medium'. There is one record (1No.) of WFD Groundwater bodies recorded on site under the name of Don & Rother Millstone grit & Coal Measures Groundwater body and classed as an abandoned mine with an overall 'Poor' status (measured in 2015). There are no active groundwater abstraction licences, nor potable abstraction licences recorded within 2km of the site. The site is not within a Groundwater Source Protection Zone.
Surface Water Hydrology	A series of inland watercourses (non-tidal) were recorded within 500m of the site. The nearest watercourse is a non-tidal inland river 30m north-east of the site, within the Dearne Catchment Area. The site is identified as being within the River WB catchment – Dove from source to river Dearne. In addition, a WFD Surface water body has been identified 546m north of the site (possibly Short Wood Dike), with an overall quality rating of 'Moderate' in 2016. There are five (5No.) licensed discharge consents within 500m of the study site for trade / sewage discharges, the closest one recorded 258m south-east. No active surface water abstraction licences have been recorded within 2km of the site.
Flood Risk	According to the Environment Agency, the site is not within a flood risk area and there are no identified River and Coastal Zone 2 floodplain or Zone 3 floodplains within 250m of the site. The Environment Agency Risk of Flooding from Rivers and the Sea (RoFRaS) database indicate that the risk of both surface and groundwater flooding on site is classed as 'Negligible' with less than 1 in 1,000 chance of flooding in any given year. Also, there are no flood defences or flood storage areas within 250m of the study site.

Nitrate Vulnerable Zone (NVZ)	There are four (4No.) records of Nitrate Vulnerable Zones within 2km of the site, including River Dearne NVZ on site. There are no records of Nitrate Sensitive Areas within 2km of the site.	
Designated Ecologically Significant Areas	There are no records of Sites of Specific Scientific Interest (SSSI) within 2km of the site. There are no records of Conservation Areas, Ancient Woodlands, Areas of Outstanding Natural Beauty or National Parks recorded within 2km of the site.	
Environmental Sensitivity	Groundwater	**Low to Moderate** - The site is underlain by Secondary A aquifers with low to very high permeability. The site is not within a groundwater source protection zone (SPZ) and no groundwater abstraction were noted within 2km.
	Surface water	**Low to Moderate** – The nearest surface water receptor is located 30m north-east. There are no active surface water abstraction licenses recorded within 2km.
	Humans	**Moderate** - The site is located in a mixed use commercial and industrial area.
	Ecological systems	**Moderate** – One record of a Local Nature Reserve is noted within 2km of the study site and eleven records of ancient woodland have been noted within 2km. There are four (4No.) active Nitrate Vulnerable Zones within 2km, with one record on-site.

2.4 REGULATORY LICENCES

The Groundsure Enviro+GeoInsight report has been reviewed to identify potentially polluting activities and enforcement mechanisms associated with the site and the surrounding area. The most relevant findings are detailed in Tables 2, 3 and 4 below.

Table 2. Regulatory Mechanisms

Licences	Name	Description	Location	Comments
Part A(2)/B Activities and Enforcements	G B Trucks Ltd	Process: Respraying of Road Vehicles Status: Historical Permit	291m SE	No Enforcements Notified
	Hartwood Exports (Machinery) Ltd	Process: Waste Oil Burner 0.4 MW Status: New Legislation Applies	453m SW	No Enforcements Notified
	Cross Keys Garage (Barnsley) Ltd	Process: Unloading of Petrol into Storage at Service Stations Status: Current Permit	455m SE	No Enforcements Notified

Licensed Discharge Consents	Cross Key Lane Works	Effluent Type: Trade Discharges - Site Drainage (Contaminated Surface Water, Not Waste Site) Permit Number: C5082 Permit Version: 1	258m SE	Status: Transferred from COPA 1974 Issue Date: 13/05/1988 Revocation Date: 20/06/1994
	Cross Key Lane Works	Effluent Type: Trade Discharges - Site Drainage (Contaminated Surface Water, Not Waste Site) Permit Number: C5082 Permit Version: 2	258m SE	Status: Lapsed under Schedule 23 Environment Act 1995 Issue Date: 21/06/1994 Revocation Date: 01/10/1996
	Cross Key Lane Works	Effluent Type: Trade Discharges - Site Drainage (Contaminated Surface Water, Not Waste Site) Permit Number: WRA7281 Permit Version: 1	258m SE	Status: Revoked – Unspecified Issue Date: 28/01/1997 Revocation Date: 28/10/2015
	G.B. Trucks Services LTD	Effluent Type: Sewage Discharges - Final/Treated Effluent - not Water Company Permit Number: S/P/1181 Permit Version: 1	291m SE	Status: Undetermined 1961 Application Issue Date: 19/05/193 Revocation Date: -

Table 3. EA/NRW Recorded Pollution Incidents (within 500m)

Incident Date	Contaminant Details	Location	Recorded Impact
22/03/2003	Pollutant: Inert Materials and Wastes Pollutant Description: Construction and Demolition Materials and Wastes	443m S	Water: Minor Land: Minor Air: No Impact

Table 4. Waste Management Facilities (within 500m)

Landfill Site	Name	Description	Location	Comments
EA Historic Landfill Sites	British Rail Railway Cutting	Waste Type: Inert, Commercial Waste Licence: Yes	195m SW	Licence Holder: Hartwood Exports First Recorded: 31/05/1983 Last Recorded: 31/12/1989
Historical Waste Sites	N/A	Type of Site: Ground Workings and Refuse Heap	71m SW	Planning application reference: N/A Data source: Historic Mapping
	N/A	Type of Site: Ground Workings and Refuse Heap	235m NE	Planning application reference: N/A Data source: Historic Mapping
EA/NRW Licensed Waste Sites	Hartwood Exports	Type: Metal Recycling Site (Vehicle Dismantler) Size: 25,000 tonnes Waste Licence Number: HAR002 EPR Reference: - Waste Management Licence Number: 60553 Annul Tonnage: 0	455m SW	Issue Date: 22/11/1996 Expiry Date: -
	Hartwood Exports	Type: Metal Recycling Site (Vehicle Dismantler) Size: 25,000 tonnes Waste Licence Number: HAR120 EPR Reference: EA/EPR/CP3695LB/S003 Waste Management Licence Number: 60553 Annual Tonnage: 0	455m SW	Issue Date: 22/11/1996 Effective Date: 30/01/2008 Surrendered Date: 16/02/2009

Potentially contaminative historical uses within 250m:

- Railway Sidings
- Colliery
- Disused Workings
- Refuse Heap
- Unspecified Disused Tip
- Filter Beds
- Cuttings
- Railway Building
- Unspecified Tank
- Unspecified Workshops
- Slurry Ponds
- Unspecified Ground Workings
- Powder Magazine
- Sewage Tanks
- Unspecified Commercial/Industrial

Historical Tanks
Thirty-two (32No.) records of tanks including gasometers, tanks, Urban District Council sewage tanks and unspecified tanks, are recorded within 500m of the site boundary. The nearest was a tank recorded 34m southeast.

Historical Energy Features
There are sixteen (16No.) records of electrical substations, gasometers and gas works noted within 500m of the site, the nearest was located 253m to the south west.

Historical Garage and Motor Vehicle Repair Sites
Five (5No.) records of garages were recorded within 500m of the site. The nearest was noted 434m to the south east.

Potentially contaminative active uses within 250m:
- Electrical Features
- Measurement and Inspection Equipment
- Ropes, Nets and Cordage
- Petrol and Fuel Stations
- Waste Storage, Processing and Disposal
- Metals Manufacturers, Fabricators and Stockholders
- Water Pumping Stations

Potentially Infilled Land
Ten (10No.) records of potentially infilled land were identified within 500m of the site, infilled ground, worked ground and made ground. The nearest records are of infilled ground and made ground on site.

Petrol or Fuel Sites
Two (2No.) active petrol sites were recorded within 500m of the site, 222m southwest and 452m southeast.

3.0 REGRESSIVE MAP ANALYSIS

A series of superseded Ordnance Survey Maps, covering the period from 1855 to 2020, have been reviewed to determine the development history of the site and identify any relevant activities that took place in the vicinity (Appendices 4 and 5). The maps and plans have been summarised in Table 5.

Table 5. Historic Use of the Site and Surrounding Area

Date	The Site	Surrounding Area
1855	The 'Sheffield Branch' of the South Yorkshire Railway line ran along the southern boundary. The remaining portion of the site was noted as open land.	• Old Sandstone Quarry ~550m west • Old Sandstone Quarry ~450m north-east • Birdwell Railway Station ~600m southwest
1891 - 1894	Coke Ovens from Rockingham Colliery, a bridge and various railways sidings occupy the south eastern part of the site.	• Reservoir ~25m south east • Rockingham Colliery – immediately northeast • Shafts associated with the colliery ~200-250m northeast • Saw Mill ~275m northeast • Rockingham Gas Works ~400m south west • Powder Magazine ~175m south east • Quarry ~650m south west • Old Sandstone Quarries were no longer recorded
1903 - 1906	No changes were observed to the site layout.	• Filter beds ~100m south east • Clay pit ~750m north east • Sewage works ~750m south west • Sewage tanks ~225m south east
1929	The coke ovens were no longer recorded on site, although the railways sidings remain. A road associated with the colliery was noted across the centre of the site. An aerial cable was identified across the north western section of the site.	• Clay pit to the north east was no longer recorded • Allotment gardens ~400m north west, 500m north west, ~550m south east • Unspecified heap ~350m north east

Date	The Site	Surrounding Area
1931	No significant changes were observed to the site layout.	• Tanks associated with Rockingham Colliery ~60m north east • Water cooler associated with the colliery ~200m north east • Filter beds ~250m south west • Chimney ~275m south west • Travelling crane ~300m south west • Water cooler ~300m south west
1938 – 1948	No changes were observed to the site layout.	No significant changes were recorded in the surrounding area.
1951 – 1960	A road running from north to south is recorded across the central part of the site. A weighbridge and a signal post are recorded in the south western part of the site.	• Crane ~100m south east • Unspecified pit ~100m south west • Tank ~175m north east • Spoil / refuse heap ~200m north east • Mine ~250m north east • Opencast mining ~600m south east • Crane, filter beds and chimney to the south west were no longer recorded.
1965 – 1966	The site underwent no changes during this period.	• Works ~600m north west
1970 – 1974	No changes were noted to the site layout.	• Tanks ~40m south east • Water tower ~100m north east • Slurry ponds ~150m south east • Sludge beds ~200m north east • Electric substation ~260m south west
1977 – 1980	No significant changes were noted to the site layout.	• Quarries noted a ‘disused’ • Works ~300m south • Major road ~600m south west
1986	Railway previously in the south of the site was noted as ‘dismantled’.	No significant changes were recorded in the surrounding area.
1987 – 1992	The road, weighbridge and a signal post are no longer recorded on site.	• Disused tips ~50m east, extending further north • Disused working ~100m north • Disused workings ~500m east • Rockingham Colliery was no longer recorded

Date	The Site	Surrounding Area
1993	Part of a coal yard to the west recorded in the western corner of the site.	No changes to the surrounding area were observed.
2001	The coal yard was no longer recorded on site.	• Works ~450m south west • Garage ~600m north west • Tips to the east and north were no longer recorded • Dearne Valley Parkway adjacent to the eastern boundary
2003	No changes were noted on site.	No changes were recorded in the surrounding area.
2010	No changes were recorded on site.	No significant changes were noted in the surrounding area
2020	No changes were recorded on site.	• Surrounding area to the immediate north and west redeveloped to comprise commercial/light industrial units.

4.0 PRELIMINARY RISK ASSESSMENT

Under the terms of the Environment Act 1995, a plausible pollutant linkage must exist to link the source to the receptors in order for an environmental risk to exist. Once these have been identified, the likelihood and severity of each pollutant linkage are considered such that the scenarios of most concern can be addressed. A preliminary assessment of risk is then undertaken using a risk evaluation method, based on an EA/CIRIA scoring system[1,5,6], which aims to categorise the significance of risk in terms of the probability of the receptors being exposed to a given hazard (i.e. high likelihood, likely, low likelihood, unlikely) and the magnitude / severity of the environmental harm resulting from the hazard.

The risk categories are then assessed based upon the consequence vs. probability assigned to each scenario, based upon guidance originally produced by the DETR. These categories are outlined in Appendix 6. The risk assessment has been based upon the proposed future use for a McDonald's restaurant.

Potential Contamination Sources

On-Site

Historic map records from the late 1890s indicate that the south eastern portion of the site was a part of Rockingham Colliery with the coke ovens built within the current site boundary. In 1993, a coal yard was recorded in the western corner of the site. By 2001, all previously mentioned features were no longer noted.

Historically, potentially polluting activity on site was the operation of coke ovens that were a part of the Rockingham Colliery, with the likely contaminants including ammonia, benzene, PAHs carbon monoxide, nitrogen oxides, phenols, cadmium, arsenic, and mercury. However, the Colliery was no longer recorded in the historical maps since 1987 and the area has undergone restoration since then. After 2002, there is little evidence of the presence of the former mining (colliery or opencast workings) as the land has been infilled.

Off-site

Several potentially polluting activities were identified in the site's vicinity with the potential to cause contamination on-site, amongst these are the Rockingham Colliery, railway land / sidings, refuse tips, spoil heaps, saw mill, gas works, slurry beds, filter / sludge beds, sewage tanks, tanks, etc.

Potential pollutants associated with these may include metals, inorganic chemicals, asbestos, phenols, acetone, oil/fuel, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, PCBs, dioxins and furans and organo-lead compounds.

Other possible nearby sources of contamination currently within 250m of the site include Electrical Substations and Industrial Products, such as Ropes, Nets and Cordage and Measurement and Inspection Equipment.

The following table identifies the potential pollutant pathways based on the CIRIA guidance[1] based on the potential contamination of soils and groundwater beneath the site.

[5] Environment Agency (2004) Environmental Risk Management and Strategic Environmental Assessment Guidance Note. Version 6. pp 1-5.
[6] DEFRA (2002) Guidelines for Environmental Risk Assessment and Management. Available at: http://www.defra.gov.uk/environment/risk/eramguide/index.htm

Table 6. Potential Pollutant Pathways

Pathway	Receptor	Harm	Likelihood	RISK
Direct contact, ingestion and Inhalation of contaminated-dust/soil	Site Users	Mild	**Low** – hardstanding surfaces are proposed to cover the majority of the site.	**L**
Ingestion and Inhalation of contaminated dust/soil	Adjacent users	Mild	**Low** – most of the study site will be covered in hardstanding with minimal soft landscaping.	**L**
Direct contact, ingestion and inhalation of contaminated dust/soil during any groundworks	Construction/ Maintenance Workers	Mild	**Likely** – Ground workers would excavate into the near surface materials allowing for exposure to potentially contaminated materials.	**L/M**
Surface runoff of contaminated water	Inland river (30m NE)	Mild	**Low** – It is anticipated that a surface water drainage scheme would be implemented as part of the new development which would capture any surface water run-off.	**L**
Lateral migration of near surface groundwater			**Likely** – due to distance of the inland river from the site	**L/M**
Vertical mobilisation of contaminants through the soil profile	Secondary A aquifer	Mild	**Likely** – due to soft landscaping being retained allowing for infiltration to occur.	**L/M**
Migration of vapours/gases into building/service runs and subsequent inhalation/explosion	Future site users	Mild	**Likely** – gases can collect in service runs which also provide pathways into the building.	**L/M**
	Construction/ maintenance workers			
Direct contact	Buildings and buried services	Mild	**Likely** – organic compounds, sulphates, low pH in the soils could impact water pipes/attenuation structures / buried concrete.	**L/M**
Plant uptake of leachable contaminants/direct contact	Vegetation / soft landscaping	Mild	**Likely** – assuming the retention of soft landscaping.	**L/M**

KEY
M – Moderate
L/M – Low to Moderate
L – Low

Based on the highest level of risk estimated, it is considered a **'Moderate'** risk that harm could arise to sensitive receptors given the contaminative issues which could be present on site as a result of historic off-site activities.

Assuming a worst-case scenario and in accordance with a '**Moderate**' risk classification (CIRIA 522)[1], 'it is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.

Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term'.

Site investigation works are recommended to assess ground conditions on site from an environmental perspective, aiming to identify potential contaminative issues in soil, groundwater and concentrations of ground gases/vapours. The investigation should be combined with a geotechnical assessment of underlying materials on-site and to facilitate the design of building foundations and pavements as well as clarify the risk from coal mining.

PHASE II – GEOTECHNICAL & ENVIRONMENTAL SITE INVESTIGATION

5.0 PHASE II – GEOTECHNICAL & ENVIRONMENTAL SITE INVESTIGATION

5.1 GENERAL

On instructions from the Client (Glanville Group) and in order to address the findings of the Phase I Desk Study, a ground investigation was designed based on the methodology provided in Environment Agency (2020) 'Land contamination: risk management' and undertaken in accordance with BS5930 (2015) 'Code of Practice for Site Investigations', Eurocodes 7, BS10175:2011+A2:2017 (2011) 'Investigation of Potentially Contaminated Sites – Code of Practice' and the requirements of the client and engineers (unless otherwise stated).

The site investigation works were commissioned with the following objectives:

Geotechnical

- To carry out an assessment of the geotechnical characteristics of the made ground and natural materials to the depth of 30.0m bgl.
- To provide ground density data (TRL results) through the use of in-situ testing to support the design process.
- To advise on suitable foundation strata and bearing properties with data for foundation and floor slab design.
- To provide indicative pavement design comment.
- To provide a preliminary indication of infiltration rates.
- Investigate the potential for shallow coal workings beneath the site.

Environmental

- To assess the environmental quality of the materials on site and reassess the CSM, using site specific data.
- To monitor ground gas & groundwater levels on site.
- To assess the quality of the underlying groundwater.
- To identify on a preliminary basis if remedial works are required to mitigate unacceptable risks posed by identified levels of contamination.

Coal mining

- To investigate ground conditions beneath the proposed development and establish whether voided ground occurs above any former shallow (<30m) workings.

Fieldworks were carried out between 7th – 14th July 2020 and included the excavation of three (3No.) Windowless sample boreholes to a maximum depth of 6.0m below ground level (bgl) with associated dynamic probing, three (3No.) Dynamic Sampled Rotary holes with open hole follow-on to a depth of 30.0m bgl, seven (7No.) TRL's to a maximum depth of 1.0m bgl and one (1No) trial pit / soakaway test.

All exploratory hole locations were scanned for buried services using a Cable Avoidance Tool (CAT) and Ground Penetrating Radar (GPR).

Equipment brought onto site was inspected by PBA personnel prior to commencement of the investigation and confirmed as being in a clean, safe and tidy condition free of any leaks of fuel, hydraulic, engine and gear oil.

The logging of soils and rocks was undertaken in accordance with BS5930:2015+A1:2020, except where superseded by the soil and rock description methodology in BS EN14688-1:2002 +A1:2013, BS EN14688-2:2017 and BS EN14689:2018.

5.2 WINDOWLESS SAMPLE BOREHOLES

Three (3No.) windowless sample holes (WS1-WS3) were excavated to depths between 3.7-6.0m below existing ground level (bgl). WS2 was terminated at 3.7m bgl due to a machine refusal.

A plan showing the location of the exploratory windowless sample holes is included as Figure 4.

The exploratory locations were positioned with the aim to assess the ground conditions across the proposed building footprint to facilitate the foundation and external pavement design as well as provide coverage of other areas of the site.

Dynamic probing was undertaken adjacent to each of the windowless sample boreholes prior to the main phase of borehole excavation, as described in Section 5.5.2.

The windowless sample boreholes were excavated using an Archway Competitor 130 windowless sampling rig. Windowless sampling comprises advancing 1.0m steel samplers in to the ground using the tracked windowless sampling rig. Samplers are advanced in to the ground by means of a 63.5kg weight being mechanically lifted and permitted to freefall 750mm on to an anvil connected by steel rods to the top of the sampler. When advanced its full length the sampler is recovered using the hydraulic-powered ram mounted on the mast of the rig or by using an auxiliary jacking system. Removable plastic liners contained within each sampler, ranging from 90mm to 50mm internal diameter, permit a continuous profile of the soil to be described and sampled for subsequent testing.

A PBA engineer was present on-site full time to examine and supervise the excavations. The recovered core liners were split, photographed, logged and sub-sampled for environmental purposes prior to being sealed and clearly labelled. These were transported to the drilling Contractor to enable subsequent sampling and testing for geotechnical purposes. Samples obtained were representative of made ground and natural materials encountered, and where visual or olfactory contamination was identified. Samples were subsequently sent for further laboratory examination, chemical and geotechnical analysis at UKAS accredited laboratories.

The logs including descriptions of the strata encountered can be consulted in Appendix 7.

The soil profile and other significant features were recorded based on the cores abstracted from each exploratory hole. Groundwater observations were made during the investigation works (where possible). These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations.

5.3 ROTARY DRILLING

Three (3No.) boreholes (designated BH1-BH3) were drilled using a track-mounted rotary coring rig using a combination of dynamic sampling methods until the bedrock was encountered. The boreholes were progressed through the bedrock using a combination of rotary open hole drilling and rotary coring to a depth of 30.0m below existing ground level (bgl) to investigate the potential for worked coal seams to be present beneath the site. Water was used as the flushing medium.

A plan showing the location of the boreholes is included as Figure 4.

Work was undertaken in accordance with the Coal Authority's Permit Reference 20225, dated 26th June 2020 and BS 5930:2015+A1:2020 and BS 1377-1:2016 and in general accordance with the methodologies identified in CIRIA C758D. All excavations, in-situ testing and logging was conducted/supervised by PBA.

Standard Penetration Tests (SPT's) were undertaken in the boreholes in accordance with BS EN ISO 22476-3:2005+A1:2011 and recorded on the borehole logs (Appendix 7).

Water levels may have been affected by the installation of casing to the boreholes or the use of air as a flushing medium. In addition, water level observations are those at the time of the investigation and do not necessarily reflect seasonal fluctuations.

The details regarding the type and depth of each sample recovered are provided in the borehole logs included in Appendix 7. The samples collected were sent to a UKAS Accredited laboratory to be scheduled for a suite of chemical and geotechnical testing as described in Sections 5.8 and 5.9.

On completion, 50mm HDPE standpipes were installed in three (3No.) of the exploratory locations (BH1, BH2, BH3) to allow for subsequent gas, vapour and groundwater monitoring. Additional detail on installation depth and response zones is provided in Section 5.7.

5.4 ROTARY CORING

Once the bedrock was encountered (circa 9.30-11.10m bgl), the boreholes were progressed using rotary coring and open drilling techniques.

In encountering hard strata, the rig can then switch to conventional coring. The coring head is also mounted on the mast adjacent to the hydraulic hammer. The head is moved over the borehole position and a triple tube coring barrel is attached to the drilling rods which are lowered down the borehole. Each rod is 1.5m in length and is held in clamps situated at the bottom of the drilling mast whilst additional rods are attached.

When coring in hard materials a flush medium is required to clear the drill bit and bring cuttings to the surface. In this instance, water was used as a flush medium.

Rock core samples were logged on site and placed into core boxes for transport and subsequent testing at a UKAS certified laboratory.

5.5 In-Situ Geotechnical Testing

5.5.1 TRL Hand Held Dynamic Cone Penetrometer Testing (CBR Testing)

The density (expressed as California Bearing Ratio (CBR)) of near surface materials was examined using a hand held dynamic cone penetrometer (TRL Probe).

A total of seven (7No.) tests were undertaken within areas of proposed external hardstanding, as shown on the proposed development layout (Figure 3). The locations of the test positions are shown on Figure 4.

Each test was undertaken from the existing ground surface, and was performed using an 8kg weight, dropping from a height of 575mm and driving a 20mm diameter, 60° cone into the sub-soil. The blow counts are recorded against penetration achieved and the results are plotted graphically. The CBR value of the various layers was then obtained in accordance with TRL Road Notes 8 & 3.

Test result certificates are included in Appendix 8.

5.5.2 Dynamic Cone Penetrometer Testing (Dynamic Probing)

Dynamic probing was undertaken adjacent to each of the windowless sample and rotary borehole locations, as shown on Figure 4.

Probing was carried out from the surface to maximum depth of 9.9m bgl using the same window sampler type rig that was used to undertake the windowless sampling element.

The probing was carried out in general accordance with BS EN ISO 22476-2:2005+A1:2011. The test involves the use of a chain-driven trip hammer to drive a solid steel penetrometer into the ground. The 'Super Heavy' Dynamic Probing (DPSH) was employed at the site, which involved the use of a 50.5mm diameter cone, driven by a weight of 63.5kg falling over a distance of 750mm. The resistance of the ground to each 100mm increment of penetration is recorded, and referred to as DPN_{100}.

The driving of the probe was undertaken continuously as far as was practicable.

The dynamic probe results are included in Appendix 8.

5.6 Trial Pitting & Soil Infiltration Testing

One (1No.) trial pit was excavated (TP1) to a depth of 2.9m below ground level (bgl), using a mechanical excavator. Arisings were placed at the surface adjacent the pit for inspection and logging. Subsequently, soil infiltration tests were then undertaken in accordance with BRE Digest 365 (2016) Soakaway Design.

The location of the trial pit is shown in Figure 4, whilst the description of the strata encountered can be consulted in Appendix 7.

Test results are discussed in Section 9.9.

5.7 INSTRUMENTATION AND MONITORING

On completion, monitoring wells were installed in three (3No.) exploratory locations to allow subsequent monitoring of ground gas / vapours and groundwater levels.

Details of the installations are summarised in Table 7 and are also included within the borehole logs (Appendix 7).

Table 7. Installation details

Exploratory Hole	Standpipe Response zone (m bgl)
BH1	22.0 – 26.0
BH2	4.6 – 7.0
BH3	2.0 – 8.0

Groundwater levels were measured by means of an oil/water dip meter. Ground gas concentrations were determined using a GA2000+ S/N 11567 instrument whilst volatile organic compounds were recorded with a Minirae 2000 PID.

5.8 CHEMICAL LABORATORY TESTING

Eight (8No.) soil samples were taken from exploratory locations representative of made ground materials. Samples were stored within appropriate glass and plastic containers and kept within cool boxes at approximately 4°C. The samples were sent within a 48hr-period to a UKAS accredited laboratory to be subject to a suite of contamination testing based on current site use and field observations. The tests undertaken comprised the following:

- Metal and metalloid suite, including arsenic, boron, cyanide and ammonia
- Petroleum hydrocarbons with aliphatic/aromatic speciation by CWG methodology
- Speciated polyaromatic hydrocarbons (PAHs)
- Speciated Cyanide – Complex, total and thiocyanate
- Sulphate, sulphide and sulphur
- Organic matter content
- Total phenols
- Soil pH
- Asbestos Screen - 5No. samples
- Waste Acceptance Criteria – Inert – (3No.)

Certificates for the chemical analysis of soil samples are presented in Appendix 9.

5.9 GEOTECHNICAL LABORATORY TESTING

A programme of laboratory testing was carried out on samples taken from the strata encountered to assist in classification and to determine the engineering properties of the materials underlying the site. The testing was carried out at a UKAS accredited laboratory operated by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377-1:2016 and ASTM, unless otherwise stated. Details of the specific tests carried out are provided in Table 8.

Table 8. Geotechnical Testing Schedule

Test	Standard	No.
Sulphate content of 2:1 soil:water extract	BS1377-1:2016 Part 3, Clause 5	4
pH Value	BS1377-1:2016 Part 3, Clause 9	4
Particle size distribution (wet sieve)	BS1377-1:2016 Part 2, Clause 9.2	4
Point Load Index Strength (rock)	ASTM D5731	6

The results of the laboratory geotechnical tests are included in Appendix 11 and are discussed in Section 7.0.

6.0 GROUND CONDITIONS ENCOUNTERED

6.1 GENERAL

On the basis of published geological information and the findings of the investigation the strata encountered in the exploratory holes included:

- Made Ground
- Pennine Middle Coal Measures Formation

The depths of the various materials encountered in each of the exploratory holes are summarised in the following table. Ground conditions encountered are discussed below.

Table 9. Summary of Ground Conditions Encountered

Hole	Depth to stratum (m)				Groundwater
	MADE GROUND			COAL MEASURES BEDROCK	
	Sandy/gravelly CLAY FILL with occ. cobbles	Sandy/clayey GRAVEL FILL	Silty clayey gravelly SAND FILL	MUDSTONE	
WS1	GL – 0.35 2.10 – 4.18 5.00 – 6.00	0.35 – 2.10	4.18 – 5.00		Dry
WS2	GL – 0.30 0.75 – 1.07	1.07 – 2.85	0.30 – 0.75 2.85 – 3.70		Dry
WS3	GL – 2.00 2.80 – 3.55 5.00 – 5.47	2.00 – 2.80 3.55 – 5.00 5.47 – 6.00			5.10m
BH1	GL - 1.65 2.25 - 9.30	1.65 – 2.25		9.30 – 30.00	5.99m & 24.5m
BH2	GL – 1.45 1.60 – 10.10 10.30 – 11.10	1.45 – 1.60 10.10 – 10.30		11.10 – 30.00	5.40m
BH3	GL – 1.00 1.30 – 5.00 5.75 – 8.00 8.20 – 9.50	1.00 – 1.30 5.00 – 5.75 8.00 – 8.20		9.50 – 30.00	5.0m
TP1	GL – 2.90				1.27m & 2.75m

Reference should also be made to the exploratory hole records (Appendix 7) for further detail on the nature and depth of the strata observed in each exploratory hole.

Made Ground

Made Ground was encountered in all exploratory locations, between GL - 11.1m bgl, comprising:

- Clay with gravel and cobbles of mudstone, limestone and coal. With fragments of brick and concrete in places. Rare glass and plastic fragments encountered in TP1.

- Silty sandy clayey gravel of mudstone, ironstone with occasional cobbles.
- Clayey silty sand with coal, ironstone and mudstone gravel (WS1, WS2 only).

Pennine Middle Coal Measures Formation

Pennine Middle Coal Measures Formation strata were encountered in BH1, BH2 and BH3 beneath the made ground and proven to a maximum depth of 30.0m bgl. The deposits were generally described as light grey extremely weak to medium strong MUDSTONE.

No olfactory or visual signs of contamination were identified within the natural soils.

No evidence of shallow depth coal mining, such as broken ground, voids and loss of drilling flush was not encountered in any of the boreholes. No coal seams or partings were encountered in any of the boreholes.

6.2 GROUNDWATER

Groundwater strikes were recorded during fieldwork in TP1, WS3, BH1, BH2 and BH3 at depths between 1.27m (TP1) and 24.50m bgl (BH1).

Groundwater was only recorded within one of the installations (BH3) at depths between 2.23m and 2.61m bgl, during the monitoring period - 24th July and 27th August 2020.

Full details of the groundwater levels observed throughout the monitoring period are in Appendix 9.

6.3 GROUND GAS MONITORING

Four (4No.) ground gas and vapour monitoring visits were undertaken between 24th July – 27th August 2020. Atmospheric pressures during the monitoring period ranged between 999mb – 1010mb.

The results are summarised in Table 10 below and copies of the monitoring certificates are provided in Appendix 10.

Table 10. Summary of Ground Gas Monitoring Results 24th July – 27th August 2020

Exploratory Hole	BH1				BH2				BH3			
	24/07	12/08	19/08	27/08	24/07	12/08	19/08	27/08	24/07	12/08	19/08	27/08
CH_4 Steady (%vol)	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO_2 Steady (%vol)	0.4	3.4	3.6	4.0	4.4	2.5	2.1	3.8	1.9	3.7	2.9	4.6
O_2 Steady (%vol)	19.9	12.8	12.8	11.4	11.9	15.4	15.4	12.3	18.8	16.3	16.3	15.5
VOC peak (ppm)	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.2	0.2	0.2	0.2	0.1
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Maximum steady-state Methane and Carbon Dioxide concentrations observed during the monitoring visits were 0.2%v/v and 4.6%v/v, respectively. Steady-state oxygen concentrations were generally low, recorded between 11.4%vol and 19.9%vol. Peak Volatile Organic Compound (VOC) readings were recorded in the range of <0.1 and 0.2ppm.

Recorded gas flow rates were consistently below instrument levels of detection (<0.1l/hr).

Based on the guidance in BS 8485:2015+A1:2019[7], a preliminary calculation of the hazardous gas flow rate (Q_{hg}) has been undertaken based on the maximum concentration of a hazardous gas observed on site, in this instance carbon dioxide, as recorded methane levels were low and, in most cases, below the limits of detection. The preliminary Q_{hg} estimate is provided below:

$$Q_{hg} \text{ (BH2)} = 0.1 \times 4.6 / 100 = 0.0046 \text{ l/hr}$$

The findings of the site investigation would suggest a worst case Q_{hg} of 0.0047 l/hr for the site, which would suggest a Characteristic Situation 1 (CS1) - 'Very Low Risk' would be an appropriate classification, with regard to new developments, according to BS8485:2015+A1:2019.

Details provided by the client about the proposed development suggest the building type as per Table 3 of the BS8485:2015+A1:2019 would be 'Type C', as it would comprise a commercial premise with small to large room sizes.

Based on the assumption that development will have central building management control and with the information available to date, the gas protection score for the site would be '0', predicated by a 'CS1' designation, combined with building type C and determined using Table 4 of the BS guidance. Based on this, specific gas protection measures are therefore unlikely to be required for the proposed development.

6.4 Evidence of Shallow Depth Coal Mining

Evidence of shallow depth coal mining, such as broken ground, voids and loss of drilling flush was not encountered in any of the boreholes.

No coal seams or partings were encountered in any of the boreholes.

[7] BS8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.

7.0 LABORATORY TESTING AND ANALYSIS

7.1 SUMMARY OF LABORATORY GEOTECHNICAL TEST RESULTS

A summary of the Laboratory geotechnical testing is included in the table below. The results are discussed in Section 8.0.

Table 11. Summary of Laboratory Geotechnical Test Results

Hole	Depth (m)	Stratum	Classification				Strength	Chemical	
			PSD Cobbles (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt/Clay (%)	Point load Index Strength (MN/m^2)	pH	Water Soluble Sulphate (mg/l)
WS1	0.50	MG						8.3	85
WS2	1.10	MG						8.0	430
WS3	0.70	MG						8.1	180
WS3	1.70	MG						8.3	26
BH1	0.60	MG						8.5	270
BH1	1.65	MG	20	55	5	20			
BH1	2.50	MG						9.1	350
BH1	5.30	MG	0	48	27	25		6.8	370
BH1	10.55	Mudstone					0.08		
BH1	12.03	Mudstone					0.39		
BH2	0.00	MG						8.4	180
BH2	2.40	MG	0	27	8	65		6.7	390
BH2	8.80	MG	0	48	27	25		7.0	410
BH2	12.03	Mudstone					0.34		
BH2	13.56	Mudstone					0.87		
BH3	0.38	MG						8.4	96
BH3	5.00	MG						6.8	280
BH3	10.75	Mudstone					0.18		
BH3	11.10	Mudstone					0.42		

*MG = Made Ground

8.0 ENGINEERING PROPERTIES OF MATERIALS ENCOUNTERED

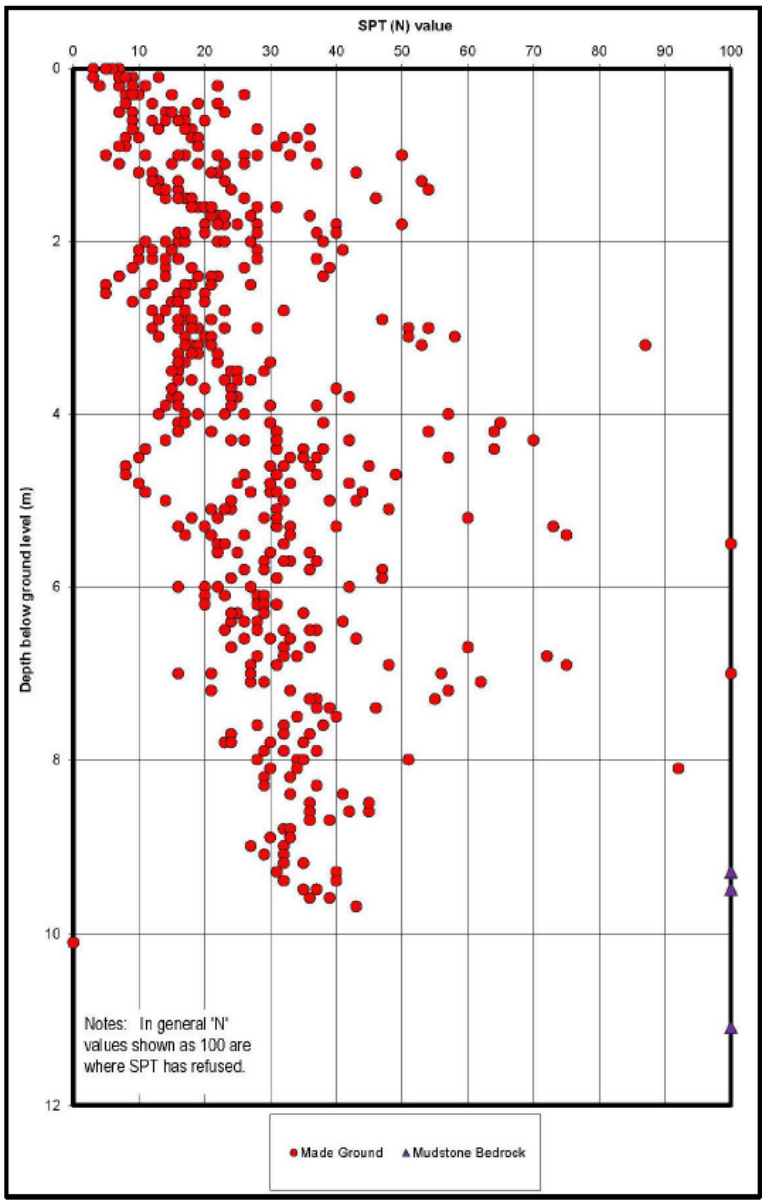
The following sections discuss the engineering and chemical properties of the strata encountered, based on results of in situ testing and laboratory testing obtained during this investigation.

8.1 MADE GROUND

Laboratory particle size distribution (PSD) tests suggests that the samples tested are variable and either silt/clay with varying amounts of sand and gravel or silty/clayey gravel with varying amounts of sand and cobbles.

SPT N values are variable and range from 5 to >50 (refusal) as can be seen from Graph 1 below. These results suggest the Made Ground is variably very soft to very stiff where cohesive and variably very loose to very dense where granular.

Graph 1. SPT v Depth Plot



Laboratory tests have given values of Water Soluble Sulphate in the range of 26mg/l to 430mg/l and pH Values ranging from 6.7 to 9.1.

8.2 PENNINE MIDDLE COAL MEASURES FORMATION

SPT N values are all >50 (i.e. refusal) which is to be anticipated in bedrock.

Point Load tests carried out on mudstone core samples have given results of Point Load Strength Index (I_{s50}) in the range 0.08MN/m^2 to 0.87MN/m^2. Using a factor of 24 as given by Broch & Franklin(1972), these results are converted to unconfined compressive strengths in the range 1.92MN/m^2 to 20.88MN/m^2, suggesting the mudstone is very weak to weak.

8.3 RESULTS OF IN-SITU TESTING

The results of in-situ TRL Dynamic Cone Penetrometer testing (equivalent CBRs) have resulted in average values of CBR in the range 29% to 81% over depths from ground level to a maximum depth of 0.91m, as summarised in the table below.

Results can be consulted in Appendix 8 and the location of each test position is shown in Figure 4.

Table 12. Summary of In Situ CBR Test Results.

Location	Depth (m)	Minimum CBR Value (%)	Average CBR Value (%)
TRL1	0.00 – 0.91	2	49
TRL2	0.00 – 0.84	3	48
TRL3	0.00 – 0.80	4	73
TRL4	0.00 – 0.87	2	79
TRL5	0.00 – 0.89	3	34
TRL6	0.00 – 0.86	4	81
TRL7	0.00 – 0.89	1	29

9.0 GEOTECHNICAL ASSESSMENT

9.1 PROPOSED DEVELOPMENT

It is proposed to construct a new McDonalds restaurant with associated infrastructure. Details of the proposed development are included as Figure 3. At the time of writing this report, anticipated structural loadings were not known.

9.2 GROUND CONDITIONS ENCOUNTERED

The exploratory holes have encountered a significant thickness of variable Made Ground (9.3m to 11.1m) overlying very weak to weak mudstone of the Pennine Middle Coal Measures Formation, proven to 30m below existing ground level.

Groundwater was encountered during fieldwork in BH1, BH2, BH3, WS3 and TP1 at depths of between 1.27m (TP1) and 24.50m (BH1). Subsequent monitoring, encountered water in only one installation (BH3) at depths between 2.23m and 2.61m bgl. Standpipes in BH1 and BH2 were dry. Slightly elevated levels of carbon dioxide were encountered in standpipes.

9.3 RISKS POSED BY SHALLOW DEPTH COAL MINING

Evidence of shallow depth coal mining, such as broken ground, voids and loss of drilling flush was not encountered in any of the boreholes. No coal seams or partings were encountered in any of the boreholes.

The site is located within a former opencast site and any shallow depth coal seams are likely to have been removed by opencast methods associated with this site. Ground conditions have encountered a significant thickness of Made Ground which represents backfill to the opencast pit.

Coal Authority records indicate ‘deeper’ worked coal seams at depths of between 140m to 340m, which are considered sufficiently deep enough not to affect any development at the surface.

Based on the above, it is considered the risk posed by shallow depth coal mine workings beneath the site is **‘Low’**. However, the presence of significant thickness of backfill to the former opencast site could cause the following problems:

- Variable bearing and consolidation properties, making it unsuitable as foundation stratum.
- Significant thickness of fill could generate land gas.

A detailed appraisal of coal mining issues and associated risks on site can be consulted in the PBA ‘Coal Mining Investigation Report’ August 2020, which supplements this document.

9.4 FOUNDATION CONSIDERATIONS

The main consideration for the site is the presence of a significant thickness of variable Made Ground across the area. Made Ground is not suitable as a founding stratum due to its inherent variability and risk of intolerable differential settlement.

Conventional shallow depth (strip/pad) foundations will not be suitable on site. Therefore, alternative foundation options will need consideration. Shallow depth raft foundations could be an option, subject to additional testing, anticipated structural loadings and tolerance of structure to settlement.

Ground improvement and controlled modulus columns may not be suitable on site given the significant thickness of Made Ground encountered and depth of treatment possible for these methods. Piled foundations will be suitable taken down to the Coal Measures bedrock.

9.4.1 Raft Foundations

A shallow depth thickened edge raft foundation may be suitable at this site, depending on size of building footprint and also the practicality of adequately reinforcing the raft, so it acts as a rigid structure.

If a raft foundation is to be considered additional in situ testing, such as plate bearing tests should be carried out to confirm loads the shallow depth Made Ground can take and associated settlements at those loadings.

9.4.2 Ground Improvement

Ground treatment (e.g. vibro displacement) may be an option, subject to environmental and noise/vibration constraints and effective depth of treatment.

For example, vibro stone columns are often used to solve a wide range of static, dynamic and seismic foundation problems by using powerful depth vibrators to densify soils of form stone columns that compact or reinforce soils in situ. Vibro systems can be used to treat granular deposits, fills, made ground and soft clays/silts.

Soils treated by vibro could offer an allowable bearing pressure in the range 100kN/m^2 to 200kN/m^2, depending on column spacings and ground encountered.

Once the treatment has been carried out, spread foundations may be adopted across the site, and designed to the loadings given above. Providing that any imported fill material between the tops of the columns and the underside of the floor slab is placed in a controlled manner, floor slabs may be ground bearing. Positive assurances should be sought from an experienced specialist contractor that the proprietary system proposed is capable of providing the required working loads in the ground conditions encountered, with a guarantee on maximum settlement for both footings and floor slabs.

9.4.3 Controlled Modulus Columns

Where traditional ground improvement techniques may not be suitable due to either poor soil strength, high loadings or tight settlement criteria, controlled modulus columns (CMCs) provide a fast and economical ground improvement alternative to piling.

The technique installs low strength concrete columns, 280mm to 500mm in diameter, up to 50m in depth using our displacement tools.

The benefits are:

- Ground bearing foundation solution utilising a distribution mattress.
- The rig working platform can be used as part of the distribution mattress.
- No breaking down of CMCs. Trimming is undertaken while the CMCs are still wet.
- The vibration free displacement process creates minimal spoil.

The technique can be used for a wide range of structures including heavily loaded commercial/industrial floor slabs, road and rail embankments, silos, tanks and wind turbines and residential buildings traditionally founded on driven piles.

Positive assurances should be sought from an experienced specialist contractor that the proprietary system proposed is capable of providing the required working loads in the ground conditions encountered, with a guarantee on maximum settlement for both footings and floor slabs, and effective depth of treatment possible in the ground conditions encountered.

9.4.4 Piled Foundations

The proposed building may be founded on piles taken down to the mudstone bedrock, encountered at depths of between 9.3m and 11.1m below existing ground level.

A variety of pile types may be used, including bored and continuous flight auger (CFA) piles. Driven piles may be suitable, subject to environmental and noise/vibration constraints. The presence of cobbles and boulders in the Made Ground during logging should be noted as it may influence type of piling methods used.

Because of the various advantages and limitations of each pile type, and the cost implications, advice should be sought from specialist piling contractors to determine the most suitable and cost-effective type. They should also be able to give recommended pile diameters and depths and likely pile capacities, with guaranteed performance. It is recommended a pile test be carried out to confirm pile capacities. In assessing the pile capacities, contractors should make an allowance for the effects of negative skin friction, particularly in the made ground.

There may be differential settlement between piled structures and the surrounding ground level. Provision should, therefore, be made to make up ground levels at threshold positions, loading bays, vehicle access doorways, etc. Alternatively, these materials should be removed and replaced in a controlled manner by suitable existing materials or imported engineered fill.

It is essential the advice of a specialist piling contractor is sought and that positive assurances are provided by the piling contractor that their proprietary system is capable of providing the required working loads in the ground conditions encountered.

9.5 PAVEMENT DESIGN

Based on the near surface ground conditions encountered, and results of in situ CBR tests it is recommended for preliminary design purposes a CBR of 2% is used for cohesive materials and 10% for granular materials.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site.

For guidance, the following table gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

Table 13. Comparison of Capping Thicknesses with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of Grids	Total	Thickness Saving
0.5%	Design Not Suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements the advice of a specialist contractor should be sought.								

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

9.6 CHEMICAL ATTACK ON BURIED CONCRETE

The results of the chemical testing for (water soluble) sulphate and pH values within soil samples are summarised in Tables 14 and 15. The test certificates are included in Appendix 9 and Appendix 11.

Table 14. Environmental Soil Sample Results

Test Type	No. of Tests	Min Value	Max Value	Characteristic Value	Design Sulphate Class	ACEC
Made Ground						
pH value (soil)	8	8.0	9.1	8.0	DS-1	AC-1s
Water soluble sulphate (mg/l SO_4)		<40	160	160		

Table 15. Geotechnical Soil Sample Results

Test Type	No. of Tests	Min Value	Max Value	Characteristic Value	Design Sulphate Class	ACEC
Made Ground						
pH value (soil)	4	6.7	7.0	6.7	DS-1	AC-1s
Water soluble sulphate (mg/l SO_4)		28	41	41		

Chemical tests (Appendix 9 & 11) show generally low levels of water soluble sulphate and slightly acidic to slightly alkaline conditions.

Based on these conditions, it is recommended that for foundations the Design Sulphate Class for the site, as defined in BRE Special Digest 1[(2005)], be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s.

9.7 SUITABILITY OF EXCAVATED MATERIALS

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer, once these have been prepared by the relevant parties.

The Made Ground on site could be re-used as structural fill, subject to further compliance testing and providing it is not contaminated.

9.8 TEMPORARY WORKS

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in the Made Ground will be unstable and should be battered back to an angle of 1 in 1, or a system of close sheeting and shoring adopted to ensure stability, and in particular where personnel are required to enter excavations.

All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered in excavations, near surface, particularly during wetter periods. If required pumping of excavations from a suitable located sump should be adequate to keep excavations dry.

All personnel and plant should be protected against the effects of land gas and monitoring of gas levels and vapours should be maintained whilst excavation works are performed.

9.9 INFILTRATION TESTING & DRAINAGE

Results of the in-situ soakaway test performed on site, render infiltration rates of $1.41x10^{-5}$ (Test 1) and $7.02x10^{-5}$ m/s (Test 2).

Although the results indicate soakage is occurring within the made ground strata, it is unlikely this is a feasible alternative due to the varied nature and increasing thickness of the strata, which could result in contamination solubilisation and migration down the soil profiled. Therefore, in this instance, the use of soakaways is not recommended.

10.0 ENVRONMENTAL ASSESSMENT

10.1 METHODOLOGY

The results of the site investigation works have been assessed utilising a Tier 1 quantitative risk assessment. The risk assessment methodology used is taken from the Environment Agency (EA) (2006) *'Remedial Targets Methodology'*, which supersedes R+D Publication 20 *'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources'*.

The tiered approach acts as a screening process whereby low risk sites are eliminated in order to identify sites that present the greatest environmental risks. The information obtained from the site investigation is used to characterise any contaminant source and subsequently to identify any sensitive environmental receptors and appropriate target concentration at the receptor.

Any requirement for further quantitative analysis or remedial action is based on comparison of the soil and/or groundwater concentrations for each contaminant with current applicable screening criteria. A decision is then made as to appropriate action to be taken which includes; no action, continuation to the next tier assessment or to take remedial action. In a Tier 1 Assessment generic guidelines and screening values are adopted in the first instance as remedial target values as a conservative approach.

The adopted approach currently involves the following stages:

- selection of generic Tier 1 screening criteria
- comparison of measured contaminant concentrations with the generic screening criteria as part of a Tier 1 assessment
- where the Tier 1 screening level is exceeded then the Conceptual Site Model (CSM) is refined to summarise sources of contamination, potential migration/exposure pathways and potential receptors that may exist at the site and could be characterised by significant levels of risk

10.2 ENVIRONMENTAL LABORATORY RESULTS - SOIL

Soil contaminant concentrations determined by the chemical analyses have been compared against LQM CIEH (2015) 'Suitable for Use Levels for Human Health Risk Assessment' (S4ULs). Where no S4UL is available, the analytical results have been compared against CLEA (2009) Soil Guideline Values (SGVs) and CL:AIRE Category 4 Screening Levels (C4SLs). EIC/AGS/CL:AIRE (2010). The specific S4UL, SGV and C4SL criteria used for comparison purposes with soil analysis results correspond to values for land under a 'commercial/industrial' end use scenario. A copy of the assessment criteria is included as Appendix 13, and the soil analysis certificate is included in Appendix 9.

The soils assessment criteria for organic contaminants are dependent upon the organic matter content (%) of the soil. In this instance, the generic criteria used for comparison purposes corresponds to a soil organic matter (SOM) of 2.5% for made ground as the average is 2.49%, excluding an outlier of 17% SOM from one sample.

Metals and Metalloids
None of the metal/metalloid determinands were recorded at concentrations which exceeded their respective generic assessment criteria.

Cyanide (Complex, Free and Total) & Thiocyanate
Cyanide was not recorded at concentrations which exceed the respective generic assessment criterion.

Ammonium (Water Soluble)
Water soluble ammonium was recorded at concentrations ranging between 2.4mg/kg and 20.0mg/kg. The highest concentration was identified at 2.5-3.0m bgl in BH1 on the south western section of the site.

Total Petroleum Hydrocarbon (TPH)
All TPH contaminants analysed were found to comply with their respective assessment criterion for a commercial/industrial end use.

Polycyclic Aromatic Hydrocarbons (PAHs)
None PAH contaminants analysed were recorded at concentrations above their respective assessment criterion for a commercial/industrial end use.

Asbestos
Asbestos screening was undertaken on five (5No.) samples. No asbestos containing materials or fibres were identified in any of the samples.

Total Phenols
Total phenols were not identified above the laboratory limits of detection.

Waste Acceptance Criteria - Inert
Three (3No.) samples, representative of made ground materials retrieved between 0.35-1.5m bgl were subject to a Waste Acceptance Criteria Testing Suite.

Results suggest materials within the top 1m may be able to be deposited in an Inert Waste Landfill, whilst deeper materials (WS2 at 1.3 – 1.5m) may require disposal at a Non-hazardous Waste Landfill, given the sulphate concentration observed (1300mg/kg), which exceeds the acceptance criteria (1000mg/kg) for Inert Waste facilities.

It is recommended that a HazWaste Online assessment is completed and that a full set of results is forwarded to the waste disposal facilities to confirm the classification of arisings for off-site disposal and acceptance of the materials. Further tests may be required by the facilities in order to achieve the above.

pH
Soil pH was generally alkaline, ranging between 8.1 to 9.1.

10.3 ENVIRONMENTAL LABORATORY RESULTS – GROUNDWATER

The analysis results for groundwater samples taken from the monitoring wells across the site were compared against Environmental Quality Standards (EQS) for freshwater. Where EQS are not available, UK Drinking Water Standards (DWS) or World Health Organisation guidelines for drinking water were applied. Where a range of EQS values are provided, the concentration used for comparison purposes is generally dependent upon the water hardness of the area.

Water hardness data has been provided by Yorkshire Water, as 'Moderately Soft' (38.1 mg/l $CaCO_3$). Copies of the groundwater analysis certificates are presented within Appendix 9, and the results are summarised below.

Metals and Metalloids

Most of the metal/metalloid determinands were recorded at concentrations below their respective assessment criteria with the exception of nickel.

Nickel was recorded above the UK DWS of 20 µg/l in a sample from BH3 at 2.54m bgl with a concentration of 97 µg/l.

Cyanide (Complex, Free and Total) & Thiocyanate

Cyanide and Thiocyanate were not recorded above the laboratory's limit of detection.

Ammonium (Free)

Ammonia was below the laboratory limit of detection.

Total Petroleum Hydrocarbon (TPH)

None of the individual petroleum hydrocarbon contaminants were identified above the laboratory's limit of detection.

Polycyclic Aromatic Hydrocarbons (PAHs)

The concentrations of individual PAH determinands were below the laboratory's limit of detection.

Total Phenols

The concentration of total phenols was below the limit of detection.

pH

Water pH was recorded at 7.0, indicating neutral conditions.

11.0 REVISED CONCEPTUAL SITE MODEL

The conceptual site model established as part of the Phase I Desk Study has been refined based upon the available data. The CSM has been produced within the context of the proposed commercial development.

11.1 IDENTIFIED CONTAMINANTS AND SOURCES

The chemical analysis results carried out on soils at the site, has not identified any soil contaminant concentrations above the current generic assessment criteria for a proposed commercial end use.

However it is possible contamination may be present in other areas / materials which were not targeted as part of the investigation, given the highly variable nature of the made ground encountered on site and historic use.

Based on the findings of the investigation, it is considered that '**mild**' harm could arise to future site users and adjacent site users (human health) and controlled waters from the environmental quality of the soils and groundwater on site.

11.2 REVISED RISK ASSESSMENT

Under the terms of the Environment Act 1995, a plausible pollutant linkage must exist to link the source to the receptors in order for an environmental risk to exist. Once these have been identified the likelihood and severity of each pollutant linkage are considered such that the scenarios of most concern can be addressed. A preliminary assessment of risk is then undertaken using a risk evaluation method, based on an EA/CIRIA scoring system, which aims to categorise the significance of risk in terms of the probability of the receptors being exposed to a given hazard (i.e. high likelihood, likely, low likelihood, unlikely) and the magnitude/severity of the environmental harm resulting from the hazard.

The risk categories are then assessed based upon the consequence vs. probability assigned to each scenario, in accordance with guidance originally produced by the DETR. These categories are outlined in Appendix 6.

The identified pathways and receptors with assigned risk categories are described in Table 16 below. Further details on receptor types can be found in Tables 8 and 9, of the DEFRA (2012) Contaminated Land Statutory Guidance[4].

Table 16. Identified Sensitive Receptors and Likelihood of Pathway being established

Pathway	Receptor	Harm	Probability	RISK
Direct contact, ingestion and Inhalation of dust/soil	Site Users	Mild	**Low** – hardstanding surfaces are proposed to cover the majority of the site.	**L**
Ingestion and Inhalation - dust/soil	Adjacent users	Mild	**Low** – most of the study site will be covered in hardstanding with minimal soft landscaping.	**L**
Direct contact, ingestion and inhalation of contaminated dust/soil during any maintenance works requiring the ground to be broken	Construction / Maintenance Workers	Mild	**Low** – no contaminative issues were identified, although it is possible for exposure to occur as ground workers would be in contact with materials during groundworks or maintenance works that require breaking ground. This likelihood could be reduced via the use of appropriate PPE and mitigation measures.	**L**
Surface runoff of contaminated water	Inland river (30m NE) Inland river (45m SE)	Mild	**Low** – It is anticipated that a surface water drainage scheme would be implemented as part of the new development which would capture any surface water run-off.	**L**
Lateral migration of near surface water			**Low** – near surface groundwater was not encountered during the monitoring period, minimising the potential for lateral migration to nearby surface water receptors.	**L**
Vertical migration of contaminants through the soil profile	Secondary A aquifer	Mild	**Likely** – an infiltration test indicated the made ground was permeable and given its variable nature there is potential for contaminant migration to occur down the soil profile.	**L/M**
Migration of gases into building/service runs and subsequent inhalation/explosion	Future site users Construction/ maintenance workers	Mild	**Low** – gas generation potential of the underlying geology is low and a CS1 – Very Low risk situation is deemed appropriate for the site, on a preliminary basis.	**L**
Concentration of gases in exploratory holes and/or excavated trenches	Construction/ Maintenance Workers	Mild	**Low** – Whilst drainage runs/ excavations would allow for the concentration of any ground gases, the flow rates and ground gas levels are very low. Additionally, the risk is further mitigated by providing appropriate risk assessment prior to entry into confined spaces.	L
Direct contact	Buildings and buried services	Mild	**Low –** no evidence of organic contamination or corrosive conditions was identified in the shallow soils which could impact water pipes/attenuation structures/buried concrete.	**L**
Plant uptake of leachable contaminants / direct contact	Vegetation / soft landscaping	Mild	**Low** – plants are intrinsically in close contact with soils. However, no significantly elevated concentration of phytotoxic contaminants has been identified.	**L**

KEY
M – Moderate, L/M – Low to Moderate, L - Low

Based on the comparison of the magnitude of the harm and the likelihood that a contaminant pathway would be established, it is considered a '**Low risk**' that harm could arise to human health and/or environmental receptors from contaminative issues arising as a result of the current and past site use and off-site activities. This assumes appropriate PPE/RPE is used by construction/maintenance workers.

In accordance with a '**Low Risk**' classification based on CIRIA C552, 'it is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.'

Given the history of the site and variable nature and thickness of the made ground materials encountered during the investigation, the possibility to encountered unexpected contamination should not be discounted.

Low levels of inorganic contamination were identified in a single groundwater sample which coupled with the slight infiltration observed within the made ground materials, suggest there is a '**Moderate Risk'** contaminants may migrate down the soil profile.

12.0 CONCLUSIONS & RECOMMENDATIONS

The site is located off Dearne Valley Parkway, Birdwell, Barnsley and currently comprises an open grassland area. The site and wider area were subject to deep underground mining (Rockingham Colliery pre-1893 to 1980) and used for opencast coal mining (1991 to 1995). Subsequent backfilling and restoration were completed by 2002.

The current development proposal includes the construction of a McDonalds restaurant and drive thru' with associated car parking and soft landscaping areas.

The site investigation undertaken on 7th – 14th July 2020 comprised three (3No.) windowless sample boreholes to a maximum of 6.0m below ground level (bgl) with associated geotechnical testing, three (3No.) rotary open hole boreholes to 30.0m bgl, seven (7No.) TR L tests to a maximum depth of 0.91m bgl and one (1No.) trial pit / soakaway test.

The exploratory holes have encountered variable Made Ground (up to 11.1m thickness), overlying light grey very weak to medium strength mudstone encountered between 11.1m and 30.0m bgl representing Pennine Middle Coal Measures Formation strata.

Groundwater was encountered during the fieldwork at depths of between 1.27m and 24.50m bgl. During subsequent groundwater monitoring, groundwater was only encountered in one installation at depths between 2.23m and 2.61m bgl.

Samples representative of made ground were subject to a suite of contamination testing. All contaminant concentrations were within the guidelines appropriate to the proposed commercial end-use and no asbestos fibres or asbestos containing materials were identified within screened samples.

Results for the WAC-inert analysis performed in a selected number of samples suggest potential arisings may be able to be deposited in an Inert Landfill, although deeper deposits may require to deposited in a Non-hazardous Landfill.

Maximum steady-state methane and carbon dioxide concentrations recorded on site were in the order of <0.1%v/v and 4.6 %v/v, respectively. These results suggest a Characteristic Situation 1 - 'Very low' risk is considered adequate for the site, with no special precautions required for new buildings.

Based on the ground conditions encountered and type of proposed development, shallow depth raft foundations could be an option, subject to additional testing, anticipated structural loadings and tolerance of structure to settlement. Further testing would be necessary in the form of plate bearing test, to provide further data to support a raft design. Piled foundations will be suitable for this site, considering they are taken down to the Coal Measures bedrock. Alternatively, the use of controlled modulus columns (CMCs) could provide a fast and economical ground improvement alternative to piling.

It is recommended that for foundations the Design Sulphate Class for the site, as defined in BRE Special Digest 1(2005), be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s.

Results of in-situ testing have given average values of CBR in the range 29% to 81% in the near surface.

Based on the above results and ground conditions encountered, it is recommended for preliminary design purposes a CBR value of 2% is adopted for near surface cohesive material and 10% for any near surface granular material.

Evidence of shallow depth coal mining, such as broken ground, voids and loss of drilling flush was not encountered in any of the boreholes. No coal seams or partings were encountered in any of the boreholes. It is therefore considered the risk posed by shallow depth coal mining features beneath the site is low.

Whilst soakaway tests results suggest infiltration occurs within the made ground, it is unlikely for soakaways to constitute a suitable drainage alternative on site, given the nature and extent of the made ground as well as potential for residual contamination to be present, which could be mobilised.

No specific remedial measures are anticipated to be required to protect human health, environmental receptors or controlled waters and render the site suitable for its intended commercial use. However, the following recommendations are made:

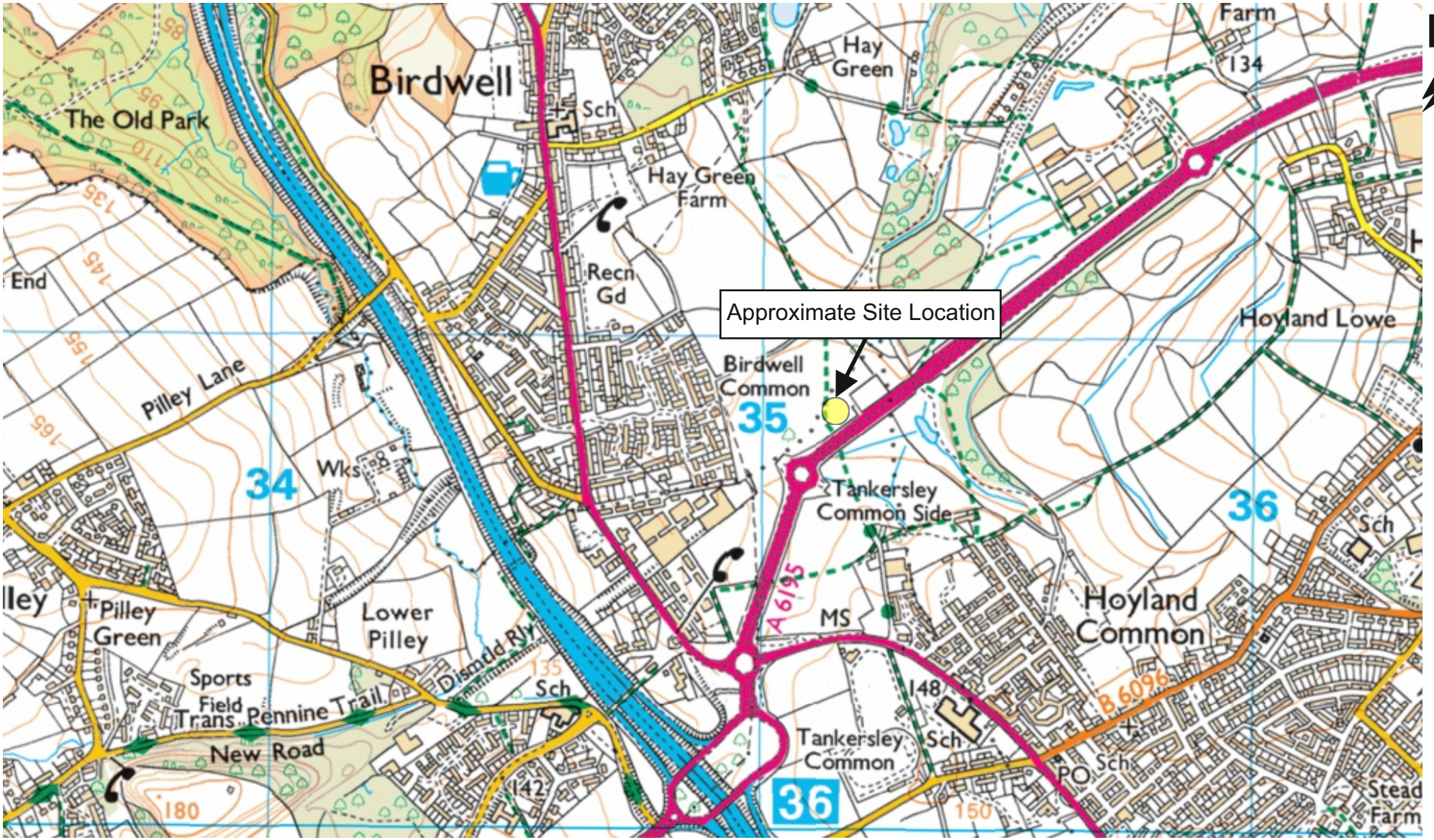
- Although a UKWIR assessment has not been conducted, due to the site history and nature of made ground materials, the use of protective pipework for the potable water supply is recommended.
- Use of appropriate PPE and good hygiene standards by construction/maintenance workers
- Ground workers should be briefed for the potential presence of unexpected contamination and/or asbestos containing materials which may be encountered during development.
- Additional testing such as plate bearing tests should be conducted in case shallow depth raft foundations are being considered.
- Further CBR tests would be required across external areas after cut / fill works have concluded and once formation levels are known, to confirm design CBR values.

Pam Brown Associates
September 2020

Terms and Conditions

1. Interpretative assessments are based upon the ground conditions as revealed by trial pits and boreholes, together with the results of any field or laboratory testing, plus other relevant data, which may have been obtained including previous site investigations. Due to the nature of geotechnical or contamination issues, there can be no certainty that any or all such areas will have been located and/or sampled.
2. Should at a future date, any additional information be made available with regard to special conditions associated with the site, the findings may be subject to amendment.
3. Where any data supplied by the client or from other sources, including that from previous site investigations, has been used it has been assumed that the information is correct. However it is always advised that without the appropriate indemnification all data supplied by others should be verified, and no responsibility can be accepted by Pam Brown Associates Ltd for inaccuracies within the data.
4. Whilst an opinion may be expressed on possible ground conditions between or beyond trial pit or borehole locations, or on the possible presence of features based on either visual, verbal or published evidence this is for guidance only and no liability can be accepted for the accuracy thereof.
5. Comments on groundwater conditions will be based upon observations made at the time of the investigation unless otherwise stated. Groundwater conditions may vary due to seasonal or other effects. Where possible an assessment of likely changes will be made for guidance purposes. Additional investigation may be required for confirmation.
6. The quotation has been prepared in the context of an agreed scope of work and should not be used in a different context. Furthermore, new information, improved practices and changes in legislation may necessitate a re-interpretation of the findings in whole or part after its original submission.
7. The copyright in the written materials shall remain the property of Pam Brown Associates Ltd, but with a royalty-free perpetual licence to the Client deemed to be granted on payment in full to Pam Brown Associates Ltd by the Client of the outstanding amounts.
8. The report is provided for sole use by the Client and is confidential to them and their professional advisers. No responsibility whatsoever for the contents of the report will be accepted to any persons other than the Client.
9. These terms apply (or in addition to another written contract which may be in place instead thereof) unless specifically agreed otherwise in writing.
10. Fees are based on the methods and evaluation stated in this proposal. This fee proposal will be void and a revised fee proposal will be produced if the client alters or requires an alteration to be made to the proposal. This quote will remain valid for three months from the date of this quote
11. The client shall be entitled to use documents prepared by the consultant in the execution of this agreement provided that: i) all fees due to the consultant at that stage have been paid, ii) the use relates only to the project or part of the project for which the material was prepared.
12. If either party to this agreement considers modifications to the project to be necessary, full details must be provided in writing.
13. Fees associated with the acquisition of data, ground investigation, laboratory testing, monitoring, etc. shall be paid in full prior to the final factual and/or interpretive report of the findings is issued. The findings of any investigation and assessment shall remain the property of PBA and may not be able to be disclosed until full payment for the above has been received.
14. Terms of payment are **strictly 30 days** from date of invoice. Payment shall be made via BACS.
15. In accordance with Late Payment of Commercial Debts Regulations (2002), Pam Brown Associates reserves the right to charge interest on any outstanding amount after the payment due date. We reserve the right to charge interest at 3% over bank base rate on overdue invoices.
16. It is the policy of the company to recover all debts, associated costs, and legal fees incurred in so doing.

FIGURES



Pam Brown Associates
Environmental Consultants
Needwood House, Lancaster Park
Newborough Road, Needwood
Burton on Trent, DE13 9PD
Tel: 01283 575733
www.pambrownassociates.co.uk

Project:

Plot 7
Dearne Valley Parkway
Barnsley
S70 5SZ

Title:

Site Location Plan

Scale: NTS

Job No.: 2023-20

Figure 1



Pam Brown Associates
Environmental Consultants
Needwood House, Lancaster Park
Newborough Road, Needwood
Burton on Trent, DE13 9PD
Tel: 01283 575733
www.pambrownassociates.co.uk

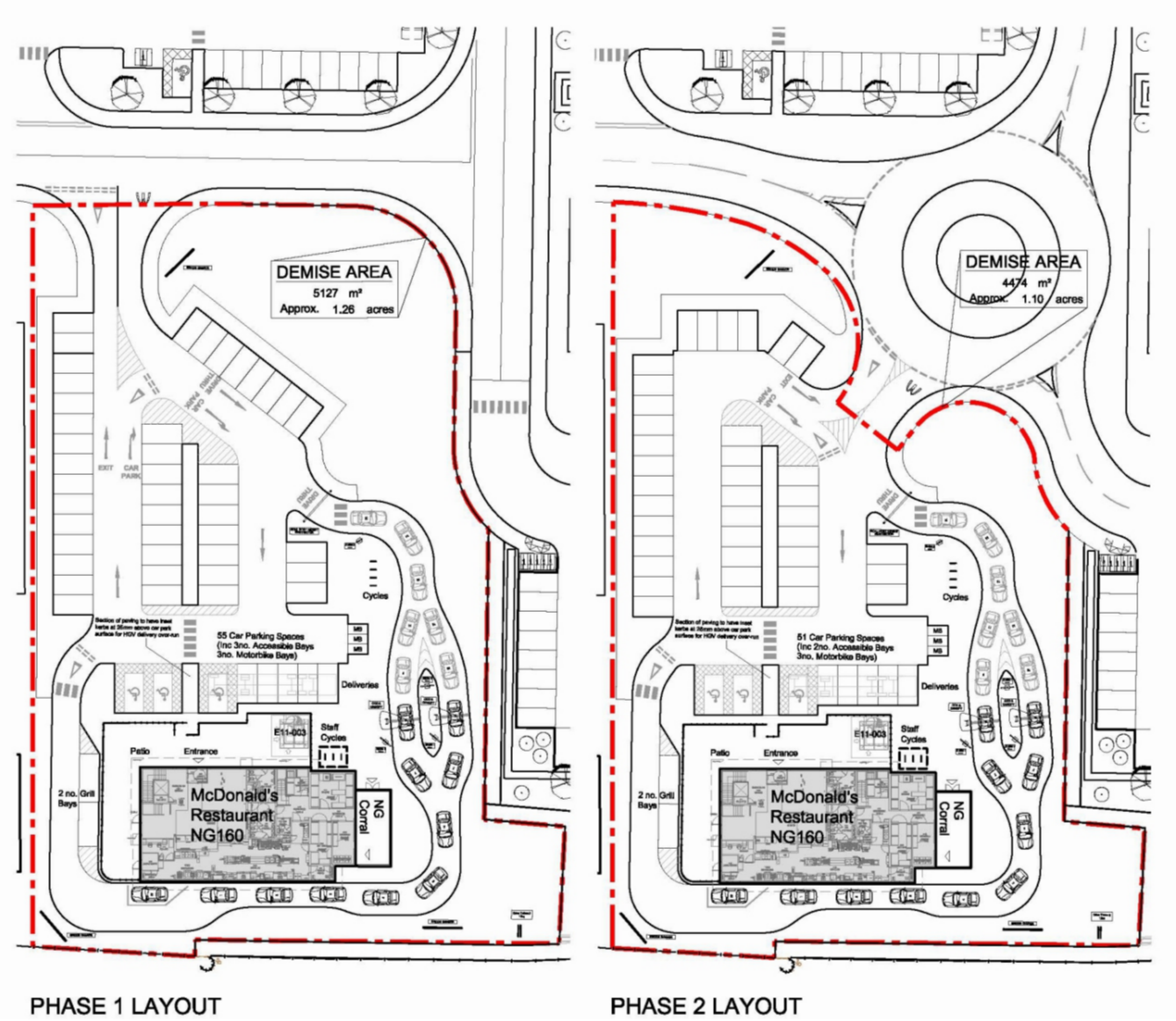
Project:
Plot 7
Dearne Valley Parkway
Barnsley
S70 5SZ

Title:
Existing Site Plan

Scale: NTS

Job No.: 2023-20

Figure 2



Based on the AEW Architects Drawing Ref. 11627_AEW_8415_F004, Rev. A, 19/05/2020

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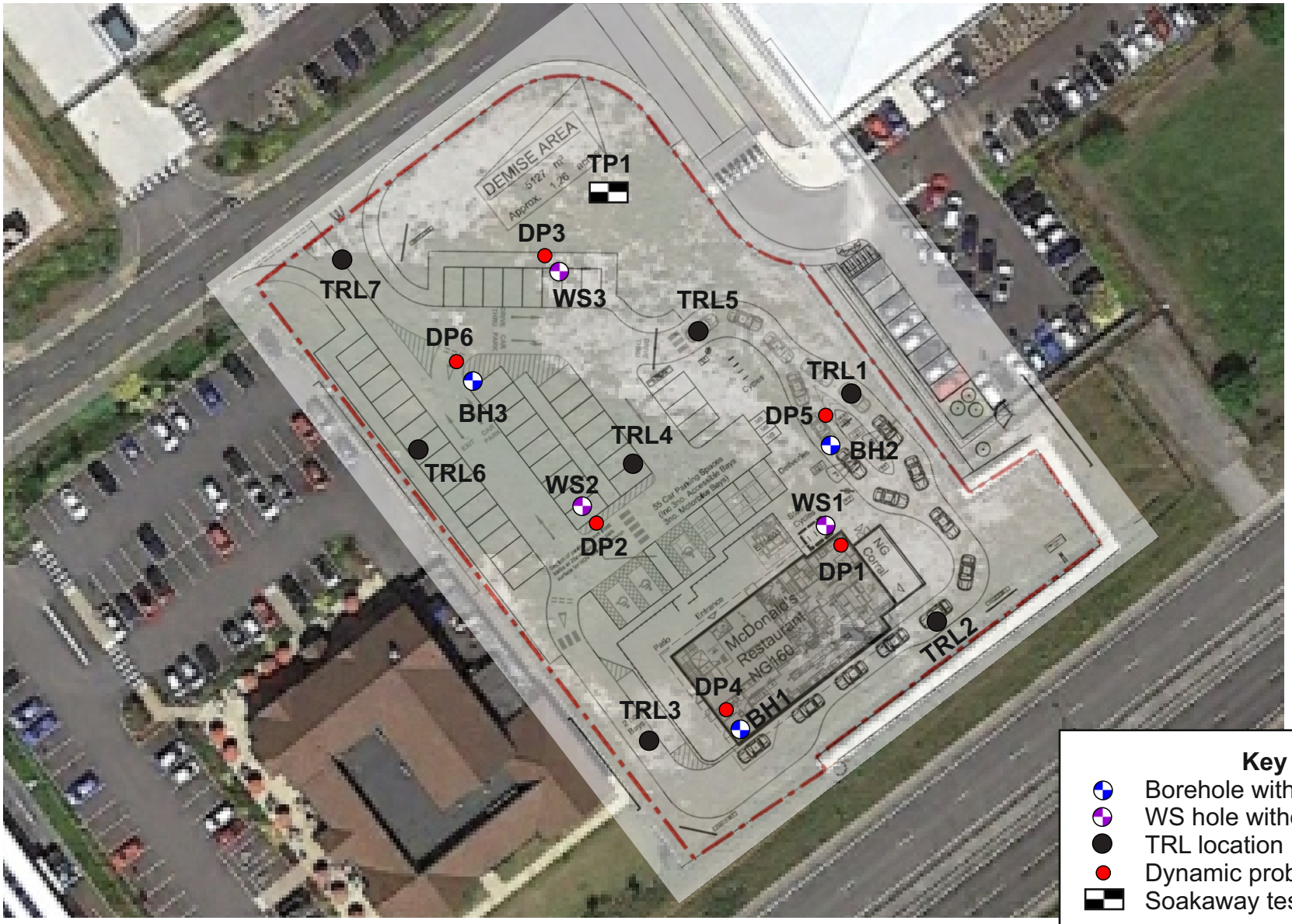
Project:
Plot 7
Dearne Valley Parkway
Barnsley
S70 5SZ

Title:
Proposed Site Plan

Scale: NTS

Job No.: 2023-20

Figure 3



Pam Brown Associates
Environmental Consultants
Needwood House, Lancaster Park
Newborough Road, Needwood
Burton on Trent, DE13 9PD
Tel: 01283 575733
www.pambrownassociates.co.uk

Project:

Plot 7
Dearne Valley Parkway
Barnsley
S70 5SZ

Title:

Exploratory Location Plan (Final)

Scale: NTS

Job No.: 2023-20

Figure 4