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WHALEY ROAD, BARUGH GREEN, BARNSELEY

PHASE 2 SITE INVESTIGATION REPORT

MELIA SMITH & JONES LIMITED

Report No. K0030-BLP-ENV-R-003

18th March 2022

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Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.

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1 Introduction

1.1 Instruction

ByrneLooby Partners UK Limited (ByrneLooby) was instructed by Melia Smith & Jones Ltd (the Client) to carry out a Phase 2 site investigation for a site at Whaley Road, Barugh Green, Barnsley, S75 1HT (the site). The site's location is shown in Figure 2 and the site boundary is shown on Figure 3.

1.2 Objectives

The purpose of the report is to provide information on conditions at the site for a proposed commercial/industrial development.

This report has been devised to comply with the relevant principles and requirements of a range of guidance with regards to potentially contaminated land, including but not limited to:

- Part IIA of the Environment Protection Act, 1990;
- Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, April 2012);
- National Planning Policy Framework (HCA, February 2019);
- BS5930:2015: "Code of practice for site investigations";
- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice";
- The Building Regulations 2010. Part C (HM Government 2013);
- Environment Agency Online Guidance (October 2020): Land Contamination Risk Management Land Contamination (LCRM) (which replaced Report CLR11 (2004) Model Procedures for the Management of Land Contamination);
- Environment Agency (2011) Report GPLC1 "Guiding Principles for Land Contamination"; and,
- Environment Agency (2017) "The Environment Agency's Approach to Groundwater Protection" November 2017 Version 1.1.

The 'Service Constraints Report Limitations & Planning Requirements' are presented as **Appendix A**, and a description of Environmental Risk Assessment Methodology and Terminology is presented in **Appendix B**.

1.3 Development Proposals

The proposed development of the site is understood to comprise:

- A new build commercial portal frame warehouse building in the northern area of the site with a new concrete apron extending from the new build to the northern boundary;
- A 21m x 21m square grey water collection tank, 1.6m in depth, will be situated between the proposed structure and the north-eastern boundary.
- 2 No. gantry wash plants to be constructed in the eastern area of the site;
- Demolition of existing buildings within the western site boundary.
- Construction of a tarmacadam hardstanding area in the southwestern area of the site for car parking.

The findings and conclusions of the risk assessments have been set out and recommendations given relative to the proposed light industrial units end use. If there is a subsequent change in the proposed land the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

The proposed end use has been based on the client's external works drawing reference: *221062-MSJ-XX-XXDR-D-3000 External works and Proposed Drainage Modified*. The drawing is undated; however, ByrneLooby understands that this is the most recent version and as such has been referenced for the purpose of this assessment, and has been reproduced as Figure 1.

1.4 Planning Status & Requirements

This report is designed to comply with the requirements of The National Planning Policy Framework (NPPF, 2019) and is intended to be used by the developer as part of the submission to gain planning for the works.

- To monitor the ground gas conditions at the site and undertake a ground gas risk assessment;
- Develop a conceptual site model and refine this according to the findings of the investigation;
- Should the investigation indicate that remediation of contaminants be required, provide recommendations of feasible remedial measures to facilitate development of the site for industrial end use; and,
- Provide preliminary geotechnical information on the ground conditions for foundation and floor slab design.

1.6 Previous Investigations

To the best of our knowledge, there have been no previous external published publicly available ground investigations for this site either available from online sources or direct data which our client has the benefit of.

Having reviewed the British Geological Survey borehole database, 2 No. boreholes (SE30NW902 and 903) and 4 No. trial pit (SE30NW924, 926, 927 and 930) were drilled/excavated across the site; however, were recorded as being confidential. Additionally, there were significant numbers of boreholes surrounding the site within adjacent industrial parcels. All were referenced AMCO site Barugh Green Barnsley. ByrneLooby is currently in discussion to have this information released from the contractor (SOCOTEC).

The log of a borehole drilled by Messrs A.C. Potter in 1929 for the Low Carbonisation Ltd Coalite Works situated on the opposite side of the railway beyond the north-eastern boundary (http://scans.bgs.ac.uk/sobi_scans/boreholes/83859/images/10099260.html) was consulted to determine the local deep strata. The reference for this was SE30NW8/B (from the 6" quarter sheet 274NW), and the borehole was drilled to a total depth of 300ft (91.44m). Clay was encountered to a depth of 5'6" (1.68m), with bedrock noted to be shale at the base of the clay to a depth of 16'6" (4.42m). The upper rock units were described as blue bind, mottled clay, blue and mottle shale, until hard blue shale was encountered at 73'6" (22.4m). Coal had been noted at the following depths:

- 108'6" (33.07m) shale with coal; with a thickness of 7' (2.13m)
- 153'6" (46.79m) black shale with coal; with a thickness of 1'6" (0.46m).
- 294' (90.53m) grey sandstone, black and blue shale and coal; with a thickness of 3' (0.91m).

It should be noted that the coal was referenced within shale rather than as a seam per se, although it is uncertain as to whether this related to flecks, inclusions or thin layers/beds of coal.

A second borehole was situated slightly north-west of the above noted borehole and was reference SE30NW8/A (http://scans.bgs.ac.uk/sobi_scans/boreholes/83858/images/10099259.html). The log for this borehole indicated 4ft (1.22m) of made ground, underlain by light mottled clay (1.22m to 4.88m), light grey clay and claystone (4.88m to 18.59m) and 'blackstone' (18.59m to 19.2m). Grey rock (assume mudstone/siltstone) was encountered at 67' (20.4m) with coal encountered at the following depths:

- 115' (35.05m) coal (potentially the Swallow Wood Seam); with a thickness of 2' (0.61m)
- 117' (35.66m) grey shale and coal; with a thickness of 4' (1.22m)
- 149' (45.42m) coal; with a thickness of 1' (0.3m)

ByrneLooby has completed the following:

- Phase 1 Geo-Environmental Report, reference 14-K0030-000-ST-R001 (Revision 1), dated 6 August 2021.
- Factual Ground Investigation Phase 2 Report, reference K0030-BLP-GEO-R-000, dated 23 December 2021.

Between the Phase 1 and Phase 2 reports, both the site boundary as well as the proposed end use of the site had been amended by client. The site boundary was extended to the north-east, and the size and orientation of the proposed structure had been amended. The ground investigation data presented within the factual report has been replicated within this report. The information contained within the Phase 1 report can be relied upon; however, interpolation of the data contained within the search reports for the appended land will be required.

A revised Groundsure database had been obtained for the additional circa 100m of site extending beyond the north-eastern boundary of the original red line boundary presented within the Phase 1 report. The revised Groundsure reference is GS-8570600, dated 7 March 2022. The Groundsure report is contained in Appendix O.

A topographic survey had been completed by Holden Surveys Ltd for the benefit of the client, dated 4 May 2021, Drawing No. MWA_234_Wordsworth. All existing topographic levels will be referenced against this survey. ByrneLooby has assumed that all levels are correct and based upon Ordnance Datum, and will not be liable or responsible for any errors or omissions within this document/plan.

2 The Site

2.1 Site Location

Table 2.1 below provides details of the location and size of the site, including site address and/ or nearest postcode, grid reference and current land use both on and in the vicinity. The site location is shown in **Figure 2** and the approximate site boundary in **Figure 3**.

Table 2.1 Site Location

Site Location	
Site Address	Whaley Road, Barugh Green, Barnsley
Nearest Town/City	Barugh Green – 1km west Redbrook – 1km south east Barnsley – 3km south east
Postcode (Nearest)	S75 1HT
National Grid Reference	SE 3217 0833
X (Easting) Y (Northings)	432174, 408333
Size of Site (Approx.)	1.15 ha (2.84 acres)
Site Shape	Site is approximately 150m by 85m and is roughly rectangular in shape
Topography	<p>The site comprises predominantly loose surfacing with an isolated area of concrete hardstanding in the central area of the north-western boundary fronting small portal frame structures. The topographic survey for the site indicated a significant stockpile of ‘crushed materials’ within the north-eastern area of the site (circa 8m to 10m in height).</p> <p>The general land profile ranged from 69.6m aOD (southern corner), 68.1m aOD (western corner), 65.5m aOD (northern corner) and 67.6m aOD (eastern corner). The site appeared to have a gentle slope from south-west to north-east.</p> <p>At the time of the ground investigation, the stockpile within the north-eastern area of the site had been partially removed.</p>

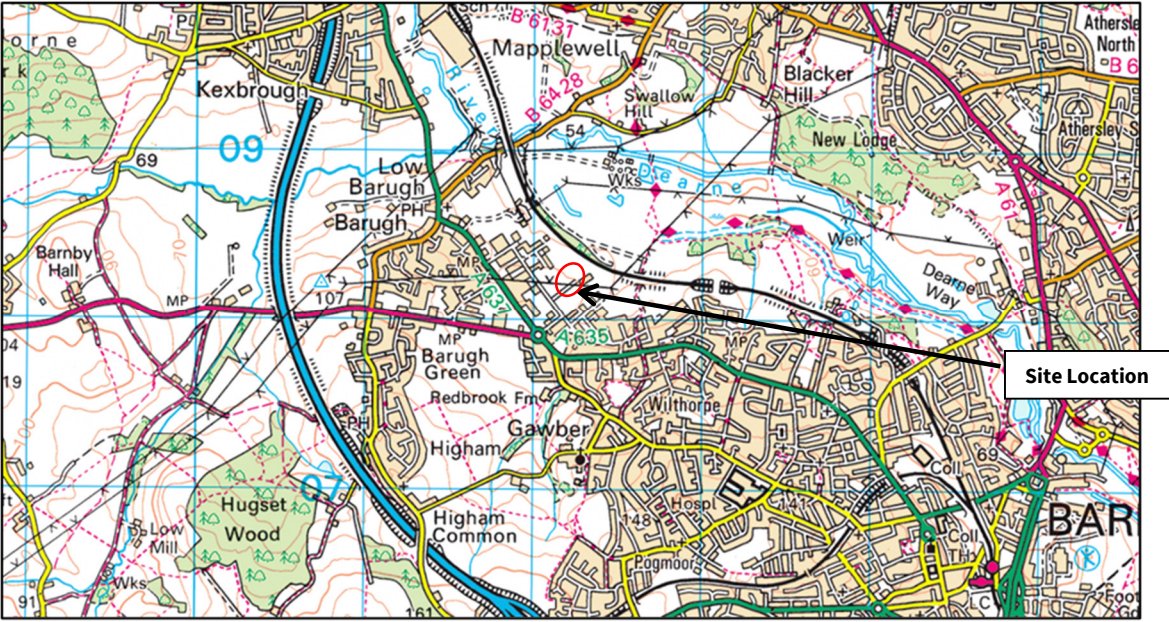


Figure 2 Site Location Plan

Reproduced from Ordnance Survey 1:50,000 Map with the permission of Ordnance Survey® on behalf of the Controller of Her Majesty's Stationary Office © Crown copyright (2008) All Rights Reserved Licence number 100035365.

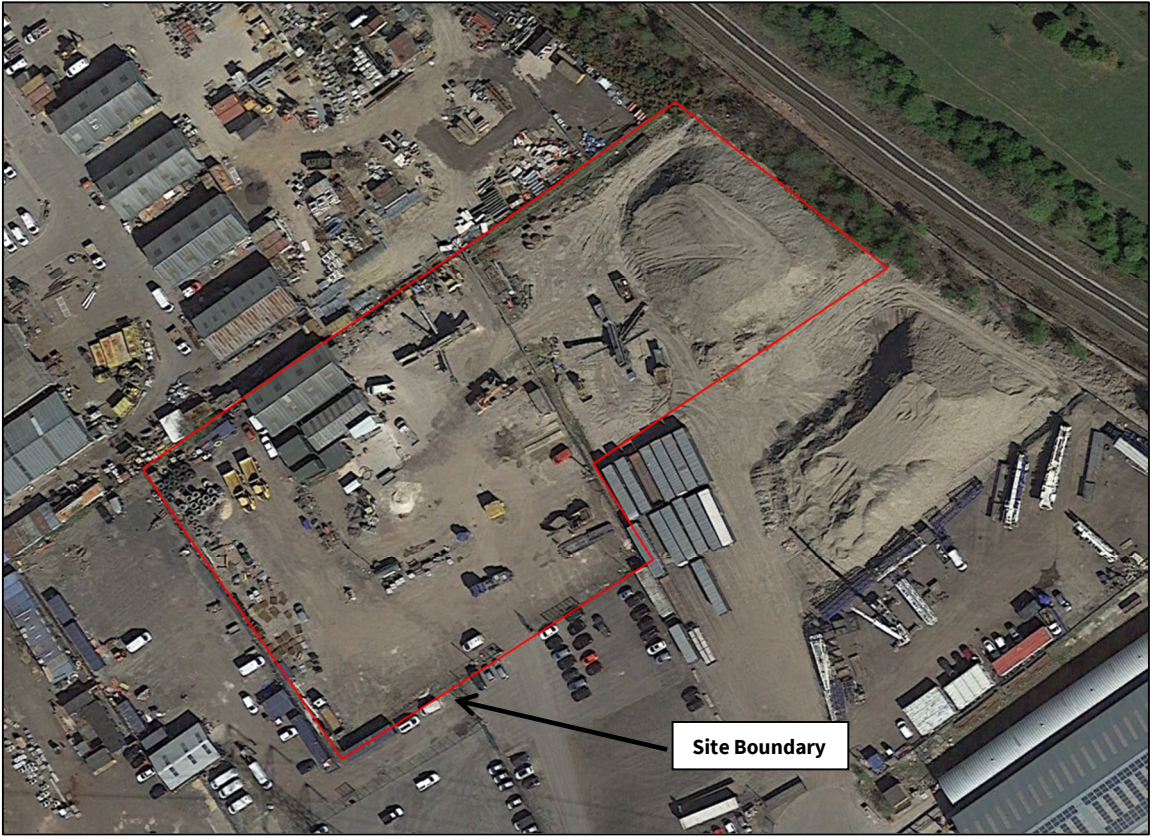


Figure 3 Approximate Site Boundary Plan (Google Earth)

2.2 Site Description

Site work was undertaken on the 8th and 9th November 2021. The site description and its environs are summarised in **Table 2.2** below:

Table 2.2 Site Description and its Environs

Site Description and its Environs	
Current Land Use	<p>At the time of the ground investigation, the site was occupied by the Wordsworth Excavations compound area. This comprised several steel portal frame units with concrete floor slabs predominantly utilised for the maintenance of vehicles, with portacabin offices adjacent, and a small concrete apron with the surrounding land used for storing plant equipment and construction materials. There did not appear to be any obvious service pits within the ground floor slab of the portal frame units. Most of the remaining ground surface appeared to be compacted crushed concrete/MOT Type 1 gravel.</p> <p>Above ground fuel tanks for fuelling of construction plant (described below) were present within the south-eastern area of the site, and a concrete area for plant and equipment washdown was also recorded.</p> <p>Mobile concrete stanchions/blocks, metal trellis/racking, construction materials as well as drainage sections were stored within the south-western half of the site. Drums of lubricant (used and full) were present within designated areas of the site around the portal frame unit, with IBC's (intermediate bulk containers) of AdBlue situated within close proximity to the above ground fuel storage tanks.</p>
Boundaries	<p>The north-western boundary comprised a concrete post and chain link fence, with an incised channel drain within the northern half of this boundary. Beyond this boundary were storage areas for small industrial/commercial works buildings. The contents of the materials stored were not inspected or reviewed at the time of the site walkover or during the ground investigation phase. However, at the time of the ground investigation, from observations made within the proposed development site, these did appear to comprise predominantly of construction materials (pre-cast concrete and steel work), with an area of containers (IBC cubes) potentially containing fuel/chemicals noted.</p> <p>The north-eastern boundary was the open crest of a wooded cutting, with an active railway line at the base. The height of the embankment was circa 5.5m.</p> <p>The northern half of the south-eastern boundary was open, beyond which was a significant stockpile of crushed material. According to the available topographic survey, the height was circa 8m. The southern section of this boundary comprised a steel mesh fence. An offset dogleg of the boundary was present midway and was denoted by an open incised drainage channel and pre-cast concrete dividers at the top of the bank.</p> <p>The south-western boundary comprised a steel mesh fence, beyond which was an unsurfaced compound area with parking immediately beyond the fence line.</p> <p>The drainage channels along the northern boundary and the south-eastern dogleg appear to contain water with evidence of long-standing ponding.</p>


<p>Historical Land Use</p>	<p>On the initial Ordnance Survey map edition (1850), the site was noted to comprise pasture with a tree lined ditch in the southern area of the site in an east-west direction, and a field boundary (ditch/hedgerow) running north north-east. The Lancashire and Yorkshire Railway was present along the north-eastern site boundary. A sandstone quarry (Clay Cliff) was situated approximately 270m beyond the western boundary (and omitted/flooded by 1890). A golf course was present beyond the south-eastern boundary from 1904.</p> <p>The Barugh Coke and By-Product Works were present approximately 900m south-west, west and north of the site boundary in 1929. The site was established in 1913 by the Yorkshire Electric Power Co. fuelled by gas from the coke ovens of the Old Silkstone Collieries. The coking works included chemical works (125m beyond the site boundary), railway sidings, tanks (approximately 345m north-east), cooling ponds, spoil mounds, cuttings, a gas works (400m beyond the site boundary), as well as other undefined industrial works. On the opposite side of the railway was the Coalite Works and will not impact the proposed development.</p> <p>By 1948, the coking works encroached the south-western half of the site comprising a stockpile with a mineral railway running north and west of the site boundary. A possible area of ponding/flooding was present approximately 100m north of the site boundary (adjacent the crest of the railway embankment).</p> <p>By 1956, an overhead high voltage electric cable crossed the site.</p> <p>By 1966, the entire site was shown to be covered by madeground with the overhead cables and coking works omitted, and was described as a disused tip in 1973.</p> <p>By 1982, the site was shown as an open area of land with the area of the former coking works redeveloped as many compounds of depots and unidentified works buildings. The south-eastern unit of a block of 5 parallel depot structures were present within the northern boundary. Several garages were noted approximately 220m south-west of the site boundary from 1970. On the 2001 map edition, the site was noted to be part of the South Yorkshire (Redbrook) Industrial Estate, accessed from Whaley Road.</p>
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According to the Google Earth imaging, from **1999**, the south-western half of the site was utilised for storage of building products and included bowzers and 2 No. portal frame structures. The north-eastern half of the site was a parking area for plant (crusher and flat bed wagons).



By **2009**, the site had been cleared and covered by hardcore, with several stockpiles and plant.



	<p>By 2018, the north-eastern half of the site was utilised for soil storage/processing</p> 
<p>Access</p>	<p>The site was accessed from a non-surfaced haul road, from a spur off Whaley Road, beyond the south-eastern boundary. There was a fence and gate bisecting the north-eastern and south-western parcels of the site.</p>
<p>Existing Buildings & Structures</p>	<p>2 No. steel portal frame units were present along the north-western boundary with concrete floor slabs. Several stacked portacabins and shipping containers were associated with the permanent structures.</p>
<p>Site Surface</p>	<p>The majority of the site was covered in compacted hardcore/non-surfaced, with a small concrete hardstanding apron associated with the existing portal frame units.</p>
<p>Vegetation</p>	<p>The site was essentially unvegetated, although low lying scrub was present associated with the 2 No. open incised drainage channels.</p>

Storage Tanks

Below Ground Tanks:
No evidence/none suspected.


Above Ground Tanks:
1 No. yellow square apparently double bunded (2 No. parallel) above ground diesel tanks with 2 No. fuel pumps (Fuel Safe 5000 bunded fuel tank noted on rear of the unit).



1 No. large capacity (15,000 litre) diesel tank (assumed double bunded with single filling pump). IBC's with AdBlue situated adjacent.



Drums of 210 litre capacity Rock Oil lubricants (silver drums) and 150 gear oil (blue drums) were noted around the site. Shipping containers were also present on site which were noted to contain drums of AdBlue and Rock Oil lubricants with no evidence of spillages. An area of used/empty drums was present on site. Empty/used drums were stored on pallets separate from full drums.

	<p>Storage of transient site (metal and blue plastic Tuffa tanks) double banded diesel tanks were present. Drums of bituminous emulsion were present situated on crates and covered with hessian.</p>  <p>A small area had been put aside for the outdoor storage of vehicle batteries.</p>
Services	<p>The site had private supplies of electricity and water, with evidence of shallow black/yellow corrugated ducting within the area of the jet washing area as well as the spotlight posts situated around the site boundary. No overhead services were situated within the site boundary, with high voltage electric cables supported on pylons being situated beyond the eastern boundary.</p>
Asbestos	<p>Asbestos was not observed during the course of the walkover either incorporated within the non-surfaced materials that cover the majority of the site, or within the areas where crushed materials had been deposited. The assessments were cursory, and it would be prudent for a specialist asbestos consultant should undertake a walkover of the site to confirm this assessment.</p> <p>There was no record of asbestos being used in the superstructure of the existing buildings; however, this must be confirmed by undertaking a thorough pre-demolition survey of the buildings and any ancillary structure present on site.</p>
Waste Disposal/ Materials Storage	<p>There was a moderate degree of control on material storage within the site, although it is anticipated that dedicated areas for storage were transitory and varied with workload of the land user.</p> <p>The north-eastern half of the site does appear to have been utilised exclusively for the reprocessing of materials processed by a mobile crushing plant.</p>
Surrounding Area	<p>The site was surrounded to the south-east, south and west by industrial units with compounds occupied by AMCO Drilling, VHE Construction, AmcoGiffen, Whitshaw Aggregates and Naylor's Concrete Products. Beyond the north-eastern boundary was an existing railway line situated within a cutting, with open restored grassland beyond.</p>
Ecology	<p>The potential scope for ecological constraints are considered low due to the current landuse; however high roofed portal frame units may form roosting areas for nesting birds and/or bats and an ecological survey should be completed to confirm that mitigation measures are not required by the client.</p>
Local/ Background Knowledge	<p>n/a</p>

2.3 Site Ownership

It is understood that the site is currently occupied and owned by Wordsworth Excavations.

2.4 Services Search

The following organisations have been contacted and services information was requested:

- British Telecom, Virgin Media, Cable & Wireless (telecommunications; cable);
- Cadent (formerly National Grid) (National electric and gas transmission networks);
- United Utilities (electricity, water supply and sewerage);
- Linesearch (BP Exploration Purbeck Southampton Pipeline, BPA BT GEO Network, Centrica Energy, ConocoPhillips (UK) Ltd, ConocoPhillips Ltd, Humber Refinery, Coryton Energy Co Ltd (Gas Pipeline), E-on UK Plc (Gas Pipelines Only), Esso Petroleum Company Limited, Government Pipelines & Storage System, Ineos TSEP (formerly BP TSEP), Mainline Pipelines Limited, Manchester Jetline Limited, NPower CHP Pipelines, Premier Transmission Ltd (SNIP), Sabic UK Petrochemicals (formerly Huntsman), Scottish Power Generation Ltd, Shell UK Ltd, Total Pipeline Operations.

There were no recorded, public services noted to enter or cross the site; however, high voltage cables supported by an overhead pylon were present south of the site.

All services underlying the site appeared to be private and hence not recorded on the public record.

Private ducted water and electric pipe/cabling were noted during the course of the walkover, and was anticipated to connect the existing steel portal frame units as well as the portacabins, with the areas along the boundary designated for jet washing points and overhead spotlights.

A private drain was noted running from the southern corner of the portal frame units, towards the south-east, diagonally across the site. A manhole was noted and lifted between the portal frame units and the bunded fuel tanks; however connecting manhole covers were not encountered.

2.5 Geology, Hydrogeology and Hydrology

A summary of the geology, hydrogeology and hydrology for the site is presented in **Table 2.3** below:

Table 2.3 Geology, Hydrogeology and Hydrology

Geology, Hydrogeology and Hydrology	
Geology	<p>Made ground/artificial ground was indicated to be present over the entire site. This is likely to be associated with the stockpiles associated with the tip for the former Barugh Coking works situated to the west of the site boundary as identified on the historical maps.</p> <p>According to the 1:50,000 scale geological map sheet 87 (Barnsley), the site was underlain by Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone, of Carboniferous age. A significant sandstone unit was noted immediately beyond the eastern boundary, trending approximately north south. The Dunsil [Harley] (0 to 1.7m) and Gawber (0 to 0.7m) coal seams as well as an unnamed thin coal seam are recorded to subcrop beneath the site/to the south-west of the site.</p> <p>Superficial deposits were not indicated to be present on site, according to the 1:50,000 GIS Geology of Britain Viewer. According to the available borehole logs on the British Geological Survey, discussed in Section 1.6, glacial till was anticipated to be sitewide underlying the made ground.</p> <p>According to the boreholes drilled beyond the northern boundary, on the opposite (northern) side of the railway line, the bedrock was described as mudstone (assumed as relating to the grey rock and much of the shale references), shale and sandstone.</p> <p>Unnamed faults were present north-west of the site boundary. The fault following this boundary was downfaulted to the southeast, with the trend being north-east south-west. Within the coal measures, these identified features tend to be indicative of a significant faulted block area with many unrecorded faults present.</p> <p>In accordance with the 1:10,560 geological map (Yorkshire County Series 274NW, dated 1933), the site was situated within a general featureless area noted to be Middle Coal Measures with no other geological features. 2 No. collieries were situated west of the site, with 2 No. shafts associated with the Barugh Colliery and Coking Works. These were noted to access the Top Haigh Moor (Swallow Woods), Low Haigh Moor and Lidget seams. A single shaft was noted associated with Clay Cliff House and accessed the Swallow wood coal seam. No subcrops of coal seams were noted within the vicinity of the site.</p> <p>The 1:10,000 National Grid geological sheet SE30NW indicated that the site was situated east of the conjectured subcrop for the Dunsil coal seam (as indicated on the 1:50,000 scale map discussed above), with an unnamed thin seam of coal conjectured to subcrop through the site in a roughly north-east south-west direction. The general strata dip was 5° to the east. The site was noted at the time of the mapping to comprise industrial refuse and quarry debris on colliery waste. The fault recorded on the 1:50,000 scale map is unnamed; however, it is noted that this was encountered during deep seated coal mining and was downthrown to the south-east by between 23m (in the Lidget coal seam) and 27m (in the Flockton Thick coal seam).</p>

<p>Cont'd Geology</p>	<p>The significant throw on the unnamed fault may be a reason for the Coal Authority not considering the Dunsil, and the underlying Gawber to have been mined beneath the site. The thin unnamed seam was considered an unviable resource within this region. It should be noted that shallow seams may have been exploited very locally due to thin cover or exposures uncovered such as the railway cutting beyond the north-eastern boundary, although there is no evidence. During the groundworks for this site, should unusual features be encountered (such as circular or rectangular areas of different madeground), works must be suspended and a suitably qualified geologist from ByrneLooby appointed to undertake inspections and further investigation.</p>
<p>Hydrogeology</p>	<p>The superficial stratum is considered to be the primary stratum for groundwater; however, this has not been designated a status and is anticipated to be ephemeral or perched.</p> <p>The bedrock for 500m beyond the site boundary is noted to be a Secondary A aquifer unit. This type of stratum has permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases form important baseline flows for local watercourses.</p> <p>A comment in the documents that accompanied the borehole logs obtained from the British Geological Survey indicated that the boreholes drilled in 1929 were used for groundwater abstraction, with the water noted to be turbid with a strong sulphurous odour for use only within the cooling purpose.</p> <p>There were no licensed groundwater abstractions, surface water or potable water sites within 2,000m.</p> <p>The soils underlying the site have been classified by the Environment Agency (EA) as having a medium Soil Vulnerability Category with intermediate leaching potential.</p>
<p>Hydrology</p>	<p>There were 2 No. open incised drains becoming culverted along the northern boundary and between the north-eastern and the south-western parcels.</p> <p>The closest watercourse beyond the site boundary was unnamed and was 142m north-west of the site boundary.</p> <p>The site was not situated within an area noted to be impacted by flooding from rivers and seas. According to the online GIS Government data base for flood risk (https://check-long-term-flood-risk.service.gov.uk/map), the risk for potential flooding associated with surface water was generally low and associated only with the course of the open drain between the north-eastern and south-western halves of the site. This assessment meets the requirements of the EU Floods Directive 2007/60/EC.</p>

2.6 Historic Coal Mining and Other Mining

According to the revised Groundsure report (contained in Appendix O), reference GS-8570599, dated 7 March 2022, the site is situated within an area which has evidence of surface ground works, and localised small scale underground mining is possible. There are 2 No. registers of BritPits (British Pits) indicated and neither are anticipated to impact the proposed development site. These comprised the Clay Cliff Quarry (sandstone) 303m west, and Whaley Road OCCS for coal surface mining. Both operations have ceased.

The surface ground workings are anticipated to comprise the refuse tip noted on site within the historic mapping between the 1940's and 1970's.

Bedded iron ore was noted to potentially underlie the proposed site which may have the potential for localised, small scale, underground mining may have occurred. There were no further records for this.

An assessment for the potential for difficult ground conditions are unlikely or localised, and are at a level where they need not be considered (Category B risk level – data source 55 British Geological Survey).

In accordance with the revised Coal Authority Consultants Coal Mining Report, reference 51002948890001, dated 7 March 2022 (contained in Appendix Q), the site is underlain by coal which has been extracted; however, the shallowest depth was 126m within the Flockton Thick seam (worked to the north-west at a dip of 5.4°), and was 0.6m thick. The last year of extraction was 1955. The Coal Authority considers the probability of unrecorded shallow workings to be none, with no spine roads at shallow depths. There were no mine entries recorded within the site boundary; however, on the Coal Authority GIS system, a mine entry was noted on the opposite side of the railway, beyond the north-eastern boundary.

The anticipated position of the Dunsil coal seam, in accordance with the Coal Authority position on their GIS map, was circa 55m west of the site boundary. The anticipated dip of the seam is towards the west and hence will underlie the site. The majority of the site will comprise hardstanding (tarmac and concrete), with the proposed structure situated within the north-eastern area of the site (approximately 120m east of the anticipated sub-crop for this seam). The dip angle of the seam, based on data provided for known worked seams in the Coal Authority report was circa 5°. On this basis, assuming the sub-crop was at surface, the depth the seam is likely to be present at the closest boundary of the site will be 5m, and 10.5m by the proposed structure. Bedrock was noted to vary between circa 4m and in excess of 6.5m from existing ground levels.

Within the tabulated geological section above, it had been noted that a significant fault was present between the Barugh Colliery and the site, with a downthrow of between 23m and 27m, and anticipate that this is the reason for the Coal Authority stating there was no conjectured shallow workings in this area. It should be noted that these seams may have been exploited historically if they were present close to surface, although we are not aware of any disturbance at surface due to the former land use. It is unlikely that these shallow seams were exploited from the shaft situated on the opposite side of the railway as this could have compromised the integrity of the railway line situated within a cutting and usually these were protected by sterile strips where shallow mining was not permitted.

2.7 Radon

According to the initial Groundsure report, reference GS-8047021, dated 15 July 2021, the site is situated within an area which has between 1% and 3% of properties potentially impacted and no mitigation measures are required. This has been confirmed in the revised Groundsure report.

2.8 Environmental Designations

The site is not located within near vicinity of Greenbelt zone, although the land on the opposite side to the railway was Greenbelt. There are no SSSI or other environmentally sensitive sites within the vicinity of the site.

2.9 Planning and Other Constraints

According to the Zetica regional unexploded bomb risk map, the site is situated within a low risk area.

2.10 Health and Safety Issues

There is an open boundary for the crest of the railway embankment which forms the north-eastern boundary of the site.

There is the potential for asbestos to be present in fragmented or fibrous form within the crushed processed materials present within the north-eastern parcel of the site, as well as within the crushed surfacing covering the majority of the site.

3 Summary of Previous Investigations and Required Further Works

3.1 Phase 1 Geo-environmental Report

ByrneLooby was commissioned by the client to undertake a Phase 1 Geo-environmental report which was issued on 6 August 2021 (as Revision 1).

The report conclusions have been summarised below:

Environmental

- The site was a historic tip associated with the former coking works beyond the western boundary. The contents of the tip were unrecorded. It is uncertain as to the extent of earthworks undertaken when the site was developed from the tip to the existing industrial estate. Contaminants are likely to comprise metals, PAH compounds, asbestos, hydrocarbon compounds. There is the potential for generation of ground gases from relic ground surfaces and the tipped strata.
- Bunded fuel tanks (in situ as well as transitory for offsite use) were present on site and may be a source of contamination for spilt fuel.
- Vehicle washdown areas may be a potential source of contaminants from offsite sources as well as due to processing imported soils for processing. Contaminants are likely to comprise metals, PAH compounds, asbestos, hydrocarbon compounds.
- Processing imported soils on site via crushing plant and grading has the potential to introduce contaminants, such as metals, PAH compounds as well as asbestos on site. The crushing process may breakup asbestos fragments as asbestos containing materials or adhered to brickwork or concrete. This fragmented and pulverised material may impact the site and beyond the boundary as windblown dust.
- Based on the information presented within this report and with due regard to the proposed development, it is the opinion of ByrneLooby that the site generally represents a low to moderate risk to human health and a low risk to controlled waters. The primary receptors of any potential risk will be contractors working on site and the management of materials during redevelopment. Identification of mobile contamination from fuelling points as well as from the previous waste management on site is required.
- There is potential for the migration onto the site, of mobile contaminants from the former chemical works and railway land associated with the coking works which were situated to the west of the site boundary.
- An assessment of the potential risk associated with ground gas for both on and offsite receptors will be required.

Geotechnical

- The north-eastern boundary was open, beyond which was the cutting for a live railway. The stability of the currently wooded slope is beyond the scope of the previous, as well as this report, although measures to mitigate the risk of failure associated with works on site will require addressing.
- Earthworks are likely to be required for the site development, to create suitable level development platforms. Cut is likely to generate a variety of materials, cohesive and possibly granular. Cut materials will need to be assessed to determine their suitability for re-use as engineered fill. The majority of engineered materials are likely to comprise made ground associated with the historic disused tip, as well as engineered materials utilised to create the industrial estate, although the majority of the site was considered low risk geotechnical end use for the existing land use.
- Earthworks may result in the need for localised slopes and/or retaining structures to accommodate local variations in ground level.
- Due to the anticipated deep made ground on-site, it will not be feasible to utilise shallow spread foundations to support the proposed development structures. However, it will be necessary to extend structural foundations through engineered fill, to competent natural ground. Alternatively, ground improvement may be required, in areas of deeper made ground/engineered fill.
- Ground investigation on-site will need to identify the extent of the made ground which could be incompetent/compressible, and may not be suitable for the support of structural foundations
- Ground investigations on-site will also need to identify the limits of the made ground associated with the colliery spoil heap on-site, as this material is likely to be incompetent/compressible and is unlikely to be suitable for the support of structural foundations. If such soils are found to extend beneath the footprints of proposed structures, shallow spread foundations may be precluded and ground improvement or piled foundations may be required, together with suspended ground floor slabs.
- The design of new site roads and areas of hardstanding will need to be based on appropriate design criteria (CBR values) for underlying formation strata. This will not be addressed at this stage, but following the completion of the engineering works to confirm the works undertaken.
- The indicated site geology and ground conditions have the potential to be aggressive on buried concrete. Nevertheless, the proposed ground investigation should include for appropriate sampling and testing to confirm this.

3.3 Proposed Further Works

The further works proposed within the Phase 1 report were based upon the layout and site boundary at the time of the time of initial contract. Both the proposed development and the site boundary have subsequently changed, and hence the extent and number of further works required reappraising. The proposed works noted below have been retained as specified within the report; however, within Section 4.1, the extent of site works had been remeasured in accordance with the changes in boundary and end use.

- Shallow boreholes to depths circa 5m to 6m to assess the depth of made ground and determine the composition of the made ground and the underlying natural strata.
- Shallow trial pits across the site to obtain a general view of the composition of the made ground. Trial pits would be excavated within close vicinity to the bunded fuel storage tanks as well as the stored AdBlue IBC's and other petroleum-based products.
- Chemical analysis of soils and groundwater obtained from both boreholes and trial pits.
- Geotechnical analysis of soils obtained from both boreholes and trial pits.
- Installation of ground gas (and associated groundwater) monitoring wells within the boreholes.
- Detailed/Quantitative Risk Assessment of chemical analysis results.

4 Investigation Methodology

4.1 Investigation Strategy

The purpose of the various exploratory holes are presented in **Table 4.1** below:

Table 4.1 Site Investigation Rationale

Exploratory Holes	Target Area
Boreholes formed by Dynamic Percussive (Window sampler) methods. (WS)	To assess shallow ground conditions and allow Standard Penetration Tests (SPT's) to be undertaken. To assess the depth of the known made ground on site and allow SPTs and samples for geotechnical characterisation. To allow collection of samples for contamination and geotechnical testing. Located to gain a spread across the site, avoiding underground services. To install monitoring installations. All boreholes to be drilled within the footprint of the proposed building.
All trial pits formed by mechanical excavator. (TP)	To assess shallow ground conditions both laterally and vertically. To allow collection of samples for contamination and geotechnical testing. Located to gain a spread across the site, avoiding underground services and inaccessible areas.
Trial pits TP4 and TP5	These trial pits were utilised as soakaway pits in accordance with BRE365. Depth of these trial pits were restricted to 2.5m.
Trial pits TP5 and TP7	Excavated within the near vicinity of a proposed SuD's underground surface water storage tank.

It had been proposed to undertake exploratory investigations within close vicinity of the existing fuelling tanks and AdBlue IBC storage area. At the time of the investigation, it was not possible to drill/excavate within these areas due to vehicle movements on site at the time and the presence of a private onsite combined drain running within this area (only one manhole was located) as well as potable water pipes. Cables were also detected underlying this area using the cable avoidance tool (CAT Scanner). A request to undertake a ground probing radar survey of this area to confirm areas which did not have buried services was not approved, and hence it was not appropriate to undertake works within health and safety guidance associated with buried services. It is recommended that following removal of the tanks and IBC's, ground investigation will be required within these areas to determine whether localised remediation will be required prior to any excavation groundworks commencing.

Trial pits were excavated to a maximum depth of 4m, unless progress due to obstructions was sufficient to terminate the pits. Trial pits which were utilised as soakaway pits were terminated early to accommodate the required dimensions for the specific test. After inspection and sampling, all of the trial pits were back-filled with the as-dug excavated material.

The positions of the exploratory holes are shown on the exploratory hole location plan presented as **Drawing K0030-BLP-GEO-DWG-001**.

4.2 Chemical and Geotechnical Testing Strategy

The general strategy was to analyse the majority of stratum types present on site (natural and made ground) to determine whether mitigation measures will be required during the construction phase of the site development, as well as to assess whether strata can be retained on site. All samples were collected in single use containers and stored in accordance with the requirements of the laboratory depending upon the analytes being tested. Where required, samples requiring temperature sensitive analysis were stored within cool boxes with ice/chill packs.

Samples for geotechnical testing and strata description were taken during the formation of the exploratory holes in general accordance with the specification, BS5930:2015, BS10175:2011 and BS EN ISO 22475-1:2006. Soil samples for laboratory geotechnical testing were despatched directly to Professional Soils Laboratory.

Soil and water samples for geochemical analysis were taken in accordance with the specification and stored in cool boxes for despatch directly to The Environmental Laboratory (ELab) Ltd.

Due to limited water levels within the boreholes, groundwater sampling was limited to a grab sample (hand bailer) from WS02 only.

Screening of soil analysis data against published assessment guidelines (C4SLs and S4ULs) was undertaken assuming a commercial / industrial land use. A soil organic matter content of 1% was conservatively assumed.

Groundwater concentrations were assessed against the England and Wales Drinking Water Standards 2016 and the Water Framework Directive for Surface Waters 2015. Should these not be available, alternative guidance such as the WHO Drinking Water Quality 2017 or UK freshwater Environmental Quality Standards 2004 were adopted.

4.3 Monitoring Strategy

Nominal ground gas monitoring was undertaken on site comprising 3 No. visits to determine a rudimentary assessment of the ground gas potential within existing made ground and the potential for the underlying coal bearing bedrock to produce ground gas. Should ground gas be encountered during the course of the monitoring programme, the duration of the investigation should be appropriately increased in accordance with Table 5.5 of CIRIA C665 (2007).

4.4 Regulatory Authority Liaison

ByrneLooby have not held any discussions with the relevant authorities prior to and/or during the site investigation.

5 Fieldwork

5.1 General Observations

The ground investigation comprised the following work:

- 5 No. window sampler boreholes to confirm ground conditions below the proposed warehouse;
- Installation of 3 No. gas monitoring wells (51mm HDPE with slotted sections having a 250 µm geotextile filter wrap);
- 7 No. trial pit excavations to confirm ground conditions across the site;
- 2 No. soakaway tests within trial pits TP5 and TP6.
- Sampling and testing of soils and groundwaters.
- Description of the ground encountered in accordance with BS5930:2015 “Code of Practice for Site Investigations”; and,
- Gas and groundwater monitoring.

The exploratory holes were logged by an engineer in accordance with the recommendations of BS5930:2015 +A1:2020, which incorporates the requirements of BS EN ISO 14688-1, 14688-2:2018 and 14689:2018. Methods of formation and geological descriptions, together with sample records, in situ test results and observations made during formation of the exploratory hole are given in the logs presented in **Appendix D and E** and should be read in conjunction with the key included therein. Core/trial pit photographs are presented in **Appendix C**.

A summary of the exploratory holes formed is listed in the following table.

Table 5.1 Summary of the exploratory holes/locations.

Location ID	Start Date	End Date	Easting	Northing	Final Depth (mbgl)
WS01	08/11/2021	08/11/2021	432172.00	408362.00	5.45
WS02	24/09/2021	29/09/2021	432193.00	408329.00	4.93
WS03	11/10/2021	11/10/2021	432202.00	408356.00	5.45
WS04	08/10/2021	08/10/2021	432218.00	408343.00	5.94
WS05	05/10/2021	07/10/2021	432190.00	408378.00	6.45
TP01	04/10/2021	04/10/2021	432119	408288	3.40
TP02	01/10/2021	01/10/2021	432131	408261	3.50
TP03	07/10/2021	07/10/2021	432104	408308	4.00
TP04/SA01	14/09/2021	14/09/2021	432157	408348	2.50
TP05/SA02	14/09/2021	14/09/2021	432202	408386	2.50
TP06	14/09/2021	14/09/2021	432191	408355	3.00
TP07	14/09/2021	14/09/2021	432241	408358	2.70

Key; WS – Window Sampler ; TP – Trial Pits; m aOD – metres above Ordnance Datum, mbgl – metres below ground level.

Prior to commencement, all exploratory positions were checked for services by reference to available plans, visual inspection and CAT/Genny survey. Inspection pits were excavated by hand and rechecked with a CAT at all borehole locations.

Fieldwork photographs showing the site conditions are presented in **Appendix C**.

The depths of exploratory holes, descriptions of strata encountered and comments on groundwater conditions are given on the records in **Appendix D**.

5.2 Trial Pits

Seven trial pits (TP01 to TP07) were carried out using a Doosan Midi DX85 tracked excavator. The trial pits were excavated to depths of between 2.5m bgl (for soakaway tests) to 4m bgl.

TP01 and TP02 refused at 3.4m and 3.5m bgl respectively within natural clay/weathered mudstone.

TP06 and TP07 refused at 3m and 2.7m bgl within made ground/colliery fill.

All locations were backfilled with arisings from the pits.

The trial pit photographs and trial pits logs are presented in **Appendix C**.

5.3 Dynamic (Window) Sample Boreholes

Five dynamic sampling boreholes (WS01 to WS05) were carried out using a tracked Terrier rig. These boreholes were drilled across the site to depths of between 4.93m bgl (WS02) to 6.45m bgl (WS05). The boreholes were commenced by hand dug inspection pits from surface to 1.2m bgl.

Standard Penetration Tests (SPTs) were carried out at 1 m intervals in the boreholes in general accordance with BS EN ISO 22476-3:2005. The dynamic sample logs and the SPT Calibration Certificate are presented in **Appendix D**.

All locations were backfilled with appropriate installations or bentonite pellet seals.

5.4 Soakaway Tests

Two soil infiltration (soakaway) tests were carried out in accordance with BRE Digest 365 (2016) in trial pits TP5 and TP6. Due to the relatively slow infiltration rate each test was carried out a single time. Neither soakaway pit used gravel and was an open excavation. The results of the infiltration tests are presented in **Appendix D**.

5.5 CBR Tests

No CBR tests were completed on site.

5.6 In Situ Shear Tests

Where natural clay strata were encountered within the trial pits, shear tests were completed just below the level when the stratum was exposed, and every metre following within large blocks of clay where the disturbance was considered relatively low and the unit was competent. Three tests were completed at each vane position. The minimum vane reading (using the standard mid-vane) was 91kPa, with the sample retrieved at depth (1m within the clay stratum) recording values exceeding 120kPa.

5.7 Samples and Sample Containers

Soil samples for chemical analysis each comprised a pair of samples: a plastic tub for metals and inorganics, and an amber glass jar for organics.

Prior to taking any water samples, the wells were developed and a grab sample of water was taken using a disposable hand bailer. Low recharge rates did not allow for low-flow sampling.

A range of different sample containers were used for sampling groundwater:

- 1 litre plastic bottles metals and inorganics;
- Water samples and soil samples for organic analysis were stored in a cool box, with plastic tubs stored in a plastic crate directly to the testing laboratory.

5.8 Monitoring

After completion of the fieldwork, 6 No. visits were made to the site to carry out monitoring of groundwater levels and ground gas concentrations. Ground gas monitoring was carried out in accordance with BS8576:2013 and comprised measurement of:

- VOCs using an Ion Science Photo Ionisation Detector (PID);
- Landfill gases using a GasData GFM435 infra-red meter to measure gas flow rate, methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.

The results of this monitoring are presented in **Appendix G**, together with details of the instrumentation specifications.

No free phase hydrocarbons were encountered in any of the monitoring wells.

6 Laboratory Testing

6.1 Chemical Laboratory Testing

The samples were submitted to ELab in Hastings who are UKAS accredited in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

The selection of samples for laboratory testing and analytes to be determined were made based on the Phase 1 assessment, the excavation records and other observations during the investigations. The sample selection rational was as follows:

- To gain a good coverage across the site and of the various material types and strata encountered;
- To characterise samples which had visual or olfactory evidence of contamination;

The selected soil and groundwater samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study and from observations made on site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.

Each of the soil samples were analysed for the 'total' concentration of a suite of potential contaminants.

The results of the laboratory analysis are presented in **Appendix H**. The various suites of analysis for the soil are presented in **Table 6.1** below:

Table 6.1 Suites of Analysis for Environmental Soil Samples

Determinand	Soil Suite 1	Water Suite
Number of Samples	15	1
Index Tests		
Asbestos Screen / Quantification	✓	-
pH	✓	✓
Electrical Conductivity	-	✓
BOD	-	✓
COD	-	✓
Dissolved Solids	-	✓
Alkalinity	-	✓
Hardness	-	✓
Metals		
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (all totals)	✓	✓
Boron (water soluble on soil samples)	✓	✓
Ca, Fe, K, Mg, Mn, Na		✓
Inorganics		
Ammonium	-	✓
Cyanide - Total	✓	✓
Sulphate (2:1 extract on soil samples)	✓	✓
Organics		
Phenols - Total (monohydric)	✓	✓
Total Organic Carbon (TOC)	✓	-
PAH (Speciated USEPA 16)	✓	✓
TPH (C8 to C36) TPH CWG Speciation	-	✓
Mineral Oil (C10 to C40)	-	-
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	-	✓
PCB compounds		✓
<p>NOTES: ✓ = Test carried out on all samples **= Test required on selected samples only</p> <p>1. All soil samples to be tested and reported in accordance with EA MCERTS for Soils Scheme</p> <p>2. In addition to the above, 10 No. samples were also tested for the presence of asbestos fibres.</p>		

6.2 Geotechnical Laboratory Testing

Samples were submitted to PSL Limited in Doncaster who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken with the results of this testing presented in **Appendix I**:

- 6 No. natural moisture contents
- 6 No. liquid and plastic (Atterberg) limits;
- 5 No. analyses for sulphate and aggressive chemical environment classification for buried concrete (the full BRE SD1 suite, Building Research Establishment 2005);
- 3 No. particle size distribution wet sieve analyses;

7 Ground Conditions

7.1 General

The site investigations have allowed the site-specific ground conditions to be described and this information was used to provide an improved conceptual ground model. The sequence of the strata encountered during the site investigations generally confirms the anticipated geology as interpreted from the desk study and geological map.

A summary of the general strata encountered across the site is shown in **Table 7.1** below, with more detailed description given in the following sub sections.

Table 7.1 Summary of Strata Encountered

Geological Strata	Description	Max. Depth Below Ground Level to Base of Strata (m)	Strata Thickness (m)
Topsoil	Not present	Not applicable	
Made ground	Brown, sandy, gravelly clay with wood, clinker and timber (remnant material from imported crushing stockpile) – TP5, TP6 and TP7.	>2.7	1.0 to >2.7
	Brown, silty, sandy gravel of concrete, brick and limestone (compacted running surface).	1.0	0.1 to 1.0
	Soft, black, sand, gravel and silt with brick, concrete, limestone, tile, mudstone, coal and ash and clinkers and a section of tree trunk (Coking Works Tip Waste)	>5.45	1.5 to >3.5
	Firm, brown, mottled grey, slightly sandy, slightly gravelly clay (reworked natural strata)	2.0	0.5 to 1.2
		Min to Max Depth Encountered (m)	
Drift	Firm to very stiff, brown mottled grey, slightly gravelly CLAY (potentially highly weathered bedrock)	2.0 to 6.1	
Bedrock	MUDSTONE (weak weathered)	3.4 to >6.45	

7.2 Ground Surface

The majority of the site was overlain by a compacted hardcore, with the area fronting the existing portal frame units comprising a concrete hardstanding apron.

7.3 Anthropogenic Materials

Made ground was encountered site wide, with the north-eastern area of the site overlain by the remnants of stockpiles associated with crushing and material sorting of imported aggregate. The surface was irregular within the north-eastern area. A rudimentary assessment of the surface material during the walkover did not identify obvious asbestos containing material (albeit the engineer was not a specific asbestos engineer).

Buried hardstanding had been encountered within WS1 (tarmac and concrete 0.15m), WS2 (bricks 0.2m), WS3 (concrete 0.15m), WS4 (brick 0.2m), with the depth of cover ranging from 0.1m to 1.0m.

A granular compacted surfacing comprising sand and gravel of fragment brick, concrete and limestone was encountered within the vicinity of boreholes WS1 to WS3, and WS5, and trial pits TP1 to TP4.

The strata noted as colliery spoil is anticipated to comprise the remnant made ground associated with the tip from the adjacent coking works. This strata was typically described as soft, black sandy, gravelly silt/slightly sandy gravelly clay with mudstone, ash (and clinker), coal fragments, as well as fragmented brick and concrete. The coal was noted to potentially contain pyrite. Trial pit TP5 and TP6 encountered rare fragments of plastic and metal, as well as tree trunks.

Trial pits TP6 and TP7 encountered significant volumes of demolition rubble, with ash and clinker, rebar and plastic. These trial pits were excavated within the former stockpiles of crushed building material and soils.

No odours were recorded within either the trial pit or borehole logs.

There were no sheens or visual indication of hydrocarbon contamination.

No asbestos was recorded or potentially identified as being present within any of the made ground.

7.4 Natural Deposits (Superficial)

Natural drift deposits comprised firm to very stiff, brown, mottled grey clay, which rapidly graded into inferred highly weathered bedrock. Shear vane readings varied between 91kPa and in excess of 120kPa.

7.5 Natural Deposits (Bedrock)

Bedrock was noted to comprise weak mudstone, and was encountered within both the boreholes and trial pits. The extent of penetration for either the borehole, or the ability of the excavator to rip the bedrock was up circa 0.15m. The duration to excavate the bedrock was not recorded.

7.6 Groundwater

Groundwater was not encountered during the excavation of the trial pits; however, was encountered within all boreholes drilled on site. The depth of groundwater strike varied between 2.0m (WS3) and 4.7m (WS5). The strata were noted to be saturated below these levels. The water levels were not noted to rise/lower from the strike.

7.7 Surface Water

Surface water was only noted within the incised drainage channels along the central eastern and north-western boundaries.

7.8 Live Root Depth

No significant vegetation was noted on site.

7.9 Foundation Details

There were no excavations around existing structures. It was not possible to discern the foundations of the existing portal frame units.

8 Generic Quantitative Risk Assessment

8.1 Introduction

The assessment of contamination has been carried out in accordance with the overall guidance presented in Land Contamination: Risk Management (LCRM) using the procedures as indicated in **Appendix B**.

Generic risk assessment is a two-stage process. Firstly, in the Risk Estimation stage, the measured contaminant concentrations are compared to the relevant GACs or C4SLs/S4ULs where they have been published. Where there is a suitable dataset, this is done after carrying out statistical analysis to determine the upper confidence limit on the true mean. Otherwise, maximum or specific data points are compared directly. The second stage, Risk Evaluation, comprises an authoritative review of the findings with other pertinent information, in cases where the C4SLs or GACs are exceeded, in order to consider if exceedance may be acceptable in the particular circumstances.

The aspects of risk from substances in the ground considered below are as follows:

- Human Health;
- Plant Life;
- Pollution of Controlled Waters;
- Water Supply Pipes;
- Below Ground Concrete; and,
- Ground Gases.

8.2 Assessment for the Protection of Human Health

The Generic Qualitative Risk Assessment (GQRA) is based on a soil with a Soil Organic Matter of 1% was carried in accordance with the methodology for assessing soil samples set out in **Appendix B** based on a commercial/industrial end use. A full summary of the chemical test results is presented in **Appendix H** and a summary of chemical analysis of soils is presented in **Appendix J**.

Exceedance of applicable Generic Assessment Criteria (GAC) threshold concentrations are indicated in yellow (note that the results highlighted in orange do not pose a risk to health but relate to concrete design). A discussion on the various exceedances is presented below.

8.2.1 Metals

No results exceeded the threshold concentrations for industrial/commercial land use.

8.2.2 Polycyclic Aromatic Hydrocarbons (PAH compounds)

Of the 16 No. PAH compounds analysed, only benzo(a)pyrene was noted to exceed the industrial/commercial threshold value (14mg/kg) with a concentration of 18mg/kg within WS3 (1.5m). This stratum was noted to comprise coal and ash (and clinker). The sample was also noted to contain enhanced concentrations of naphthalene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene and dibenzo(ah)anthracene, but none exceeded the specific land use threshold. Excluding the sample from WS3 (1.5m), the concentration of benzo(a)pyrene ranged from <0.1mg/kg to 5.8mg/kg, all of which were significantly below the commercial/industrial threshold. Statistically, the slight exceedance of benzo(a)pyrene does not impact the site and it is a localised outlier. Due to the depth of this sample (and the associated stratum), no mitigation is considered to be required.

A source signature double ratio plot risk assessment was undertaken to determine where the concentrations of compounds are anticipated to have derived. By comparing 4 No. PAH compounds, research from Costa and Sauer determined that it was possible to have degree of reliability whether the source of PAH compounds were from mobile sources such as fuel and petroleum, or from low mobility sources such as coal and combusted coal. Samples from WS1, WS3, TP1, TP4 and TP7 were all assessed using this risk assessment tool, and all were found to be coal derived. The risk assessment sheet, as well as further explanation have been included within Appendix L.

Although the concentration from WS3 failed the assessment against SGV/GAC, the secondary assessment for pC4SL passed, as the threshold was 77mg/kg for benzo(a)pyrene.

Although enhanced concentrations of PAH compounds were encountered within the made ground, these are anticipated to be associated with coal present, and is not considered to pose a risk to the proposed development.

8.2.3 Petroleum Hydrocarbon Compounds (PHC)

There were no concentrations of PHC which exceeded the threshold for commercial/industrial land use. The only sample which may be considered to be enhanced was WS1. It is likely that the presence of coal and ash contributed to this concentration and was assessed not pose a risk.

There were no significant concentrations of BTEX compounds encountered.

At the time of the ground investigation, it was not possible to investigate within the near vicinity of the above ground fuel storage tanks, drums of lubricant or AdBlue IBC's as a significant number of live services ran beneath these areas. It is likely that should there be a spillage, this would be localised; however, mobile contamination may follow service pipes and their backfill as preferential pathways extending areas of contamination. Following the decommissioning of the above ground tanks, the removal of the drums, and the services being decommissioned, additional ground investigation will be required within these areas.

8.2.4 Asbestos

Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g., asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. During the ground investigation, Byrne Looby carried out a visual inspection of the made ground encountered for the presence of bulk ACMs. During the fieldwork no suspected ACMs were identified.

The laboratory analysis confirmed that asbestos was not present in the 10 No. tested soil samples.

A demolition asbestos survey will be required prior to decommissioning the existing structures. Should asbestos be encountered due to hidden areas/inaccessible areas of the existing structure, these will require appraising by an appropriately qualified person and the asbestos removed in accordance with regulations. This report should also include a walkover of the site to confirm no obvious ACM within the made ground surface of the site. An inspection of the site surface for ACM should be repeated following demolition, before the commencement of earthworks.

Vigilance will be required during all phases of the works on site regarding the potential for undisclosed or buried asbestos to be present on site which was not observed, or was not obvious, at the time of the ground investigation. Should asbestos be encountered, all works must be suspended and further investigation be undertaken of the area where asbestos is suspected, as well as in corresponding strata associated.

8.2.5 Risks to Human Health (Construction Phase)

During the construction works there will be a risk from dust to on-site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Control of dust generation (see below);
- Workers wear suitable Personal Protective Equipment (PPE);
- Having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- All groundworkers should have been trained in asbestos awareness and should keep a look out for this being encountered during excavations. The earthworks contractor should have a contingency plan in place before any works commence in case the presence of asbestos is suspected in groundworks;
- Only permitting smoking or eating on site in appropriate pre-designated areas.

Given the proximity of industrial receptors to the east, south and west and construction workers on site, control of fugitive dust will be a priority. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance and that the following measures will be introduced to assist with control of dust generation:

- Access roads and stockpiles should be regularly damped down with water;
- All vehicles entering and leaving the site during the construction period should pass through a wheel wash facility;
- Vehicles used to transport materials and aggregates should be enclosed or tarpaulined;
- Local roads should be regularly cleaned;
- Vehicle movements and speed should be kept to a minimum within the site;
- Dust generating equipment (e.g., mobile crushing and screening equipment) should be located to minimise potential nuisance impacts to receptors as far as practicable; and,
- Minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

Entry into all below ground excavations should be carried out in accordance with The Confined Spaces Regulations (1997) and The Management of Health and Safety Regulations (1999).

8.3 Risk to Plant Life

The concentrations of the phytotoxic metals (copper, chromium, nickel and zinc) have the potential to be harmful to plants. All the measured concentrations of these metals are lower than the guideline values for the protection of plants as presented in the MAFF document “Code of Good agricultural practice for the protection of soil”. Therefore, there is no risk to plants at the site due to phytotoxicity should any be planted in the ground as part of the proposed development.

8.4 Assessment for the Protection of Controlled Waters

The risks to controlled waters (groundwater and surface waters) from contaminants on-site have been assessed in accordance with the EA documents “The Environment Agency’s Approach to Groundwater Protection” (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Agency’s ‘limit’ pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

Information on the remedial targets assessment methodology is presented in **Appendix B**. Laboratory certificates are presented in **Appendix H** and a summary of chemical analysis of Water and Leachate is presented in **Appendix K**.

In accordance with groundwater risk assessment, the conservative measure is considered to be the World Health Organisation Drinking Water Standards 2017. It is considered not appropriate to assess the groundwater within this region for drinking water due to the geology. As there may be the potential for infiltrated groundwater to form baseflow for surface water bodies, the Water Framework Directive 2015 Inland Surface Waters Parts 1, 2 and 3 have been adopted. The only exceedance was associated with 1,710mg/l of sulphate (400mg/l UK freshwater EQS 2004) and 1.3mg/l of ammonia as NH₄ (0.26mg/l WFD 2015).

Whilst there are elevated concentrations of Chemicals of Potential Concern, and subject to agreement with the Environment Agency, ByrneLooby does not believe the site poses a significant risk to Controlled Water because:

- The site is underlain by non-productive strata;
- The shallow groundwaters at and in the vicinity of the site are not abstracted for human consumption;
- The nearest surface water is situated along the boundary of the site and comprises an open culvert,

ByrneLooby recommends that discussion with the Environment Agency is entered into at the earliest opportunity, particularly associated with the discharge of groundwater from excavations.

8.5 Imported Material

All imported inert fill required for backfilling or regrading should comprise a good quality fill, free of demolition detritus (such as bricks, brick ties, etc) as well as deleterious materials (such as timber, glass and asbestos). These should have provenance and chemical analysis to prove the strata to be imported as inert prior to acceptance on site. The analysis from the provider of the inert fill must be current and relevant for the material being imported. Additional independent analysis should be completed to confirm the source documents once the strata had been received on site. The Tier 1 parameters to be adopted for all imported material to this site are included in Appendix N.

8.6 Water Supply Pipe Material Assessment

Plastic pipe materials are potentially vulnerable to attack from elevated concentrations of hydrocarbon compounds, and can potentially lead to contamination of potable water supplies. Water supply companies require an assessment to be made regarding the potential for attack on pipework as well as the risk to their workers from other contaminants in the ground. The assessment has been completed in accordance with the current UK Guidance for the Specification of Water Supply Pipes to be used in Brownfield Sites (UK Water Industry Research Ltd. UKWIR, 2014) together with guidance from Yorkshire Water. This guidance provides threshold concentrations for different pipe material for various chemical groups.

The pipeline materials considered by the guidance are PE, PVC, wrapped steel, wrapped ductile iron or copper pipe and barrier pipe. PE are assessed using threshold concentrations for various chemical groups including volatile organic compounds (VOC) with tentatively identified compounds (TICs), semi-volatile organic compounds (SVOC) with TICs, mineral oils, aldehydes, ketones etc. Wrapped steel, wrapped ductile iron and copper pipe are assessed using corrosive properties. The default recommendation for water supply pipes is to use PE with other types of pipework only used if the limits for PE pipes are exceeded. When assessing the ground for water supply pipes the suite of potential contaminants to be tested only needs to be those contaminants that are potentially present on site based on the desk study. At this site the desk study did not identify there to be a risk from SVOCs (including chlorinated phenols, cresols), aldehydes, ketones, ethers, nitrobenzene and amines so no analysis was carried out for these compounds.

Table 8.1 summarises the relevant analytical results compared to pipeline threshold concentrations. An assessment of the chemical test results indicates that special consideration of pipe materials for water supply pipes may be required, and/or protective measures such as the use of trenches backfilled with clean imported fill material may also be required. Due to the elevated concentrations of hydrocarbon compounds, it is considered appropriate to adopt barrier pipework. It is recommended that discussions are commenced with the water supply company to confirm their requirements.

Table 8.1 Soil Data Compared to Pipeline Threshold Concentrations

Test Group	Testing Required	PE Threshold (mg/kg)	Maximum Site Concentrations (mg/kg)	Pass or Fail PE Threshold
Total VOCs	Where Preliminary Risk Assessment (PRA) has identified land potentially affected by contamination	0.5		Not tested
Total BTEX & MTBE		0.1	0.025	Pass
Total SVOCs (excluding PAHs and those Substances marked with an *)		2		Not tested
EC5-EC10 aliphatic and aromatic hydrocarbons		2	5.4	Fail
EC10-EC16 aliphatic and Aromatic hydrocarbons		10	461.8	Fail
EC16-EC40 aliphatic and aromatic hydrocarbons		500	822.8	Fail
Phenols* (from SVOC analysis)		2		Not tested
Cresols and chlorinated phenols*(from SVOC analysis)		2		Not tested
Ethers *	Only where identified	0.5	-	Not tested
Nitrobenzene *		0.5		Not tested

Test Group	Testing Required	PE Threshold (mg/kg)	Maximum Site Concentrations (mg/kg)	Pass or Fail PE Threshold
Ketones *		0.5	-	Not tested
Aldehydes *		0.5	-	Not tested
Amines *		0.5	-	Not tested
Corrosive	Conductivity, Redox and pH	See [1]	Pass	Pass

Notes:

[1] Threshold: For wrapped steel, corrosive if pH<7 and conductivity >400 µS/cm. For wrapped ductile iron corrosive if pH<5, Eh not neutral and conductivity >400 µS/cm. For Copper, corrosive if pH<5 or >8 and Eh positive. For barrier pipe – Pass.

Highlighted where concentrations exceed the threshold for PE.

Where concentrations exceed the threshold for PE then Barrier pipe or Metal Pipe is required.

8.7 Chemical Attack on Below Ground Concrete

Below ground concrete structures are potentially at risk in areas of elevated sulphates and where there is low pH.

Table 8.2 Specification for assessing concrete class designations

Stratum	No. Samples	Water Soluble Sulphate (2:1) (mg/l)	Total Potential Sulphate (%)	Design Sulphate Class (DS)	pH	ACEC Class (AC)	Design Chemical Class (DC)
Cohesive madeground	10	0.06 – 2.28	0.64 – 3.62 (3)	DS-3	7.1 – 9.4	AC-2s	DS-3, AC-2s, DC-2
Granular madeground	2	1.81 & 1.93	5.28 (1)	DS-3	7.3 & 9.3	AC-3s	DS-3, AC-3s, DC-3
Natural CLAY	3	0.47 – 0.83	<0.01 (1)	DS-2	7.2 – 7.8	AC-1s	DS-2, AC-1s, DC-1
Groundwater	1	1710	-	DS-3	6.5	AC-3	DS-3, AC-3, DC-3 *

* The concrete design chemical class for at least 100yr intended working life should adopt one additional protective measure which may comprise addressing the drainage for the site (APM5). The entire site will overlain with hardstanding and surface water drainage will significantly minimise the potential for infiltration around foundations.

An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that the concrete classification for below ground concrete will comprise DS-3, AC-3s, DC-3. We anticipate that the hardstanding coverage and the proposed surface water drainage will address the requirement of an additional protective measure to adopt 100yr lifetime for the buried concrete.

Permanent Ground Gases

8.7.1 Measured Gas Concentrations

In accordance with Table 4.2 of CIRIA C665 (Assessing risks posed by hazardous ground gases to buildings), the former use of the site as a ‘tip’ associated with the coking works was considered to pose a low ground gas hazard, based the made ground being noted to have limited degradable materials (predominantly partially combusted materials). The site did not appear to have domestic waste content and there were no disused shallow mine workings noted in the vicinity of the site. The proposed end use is commercial and according to Table 5.5b, the sensitivity of the development is considered low. The idealised/typical periods of monitoring are 4 No. visits; however, considering the made ground and concentrations encountered, 6 No. visits were considered appropriate.

The proposed development will comprise 1 No. portal frame structure and will be considered as a Situation A development type according to clause 8.3.1 of CIRIA C665.

Six rounds of gas monitoring were undertaken by ByrneLooby for the 3 No. boreholes with gas monitoring wells installed. The weather and the atmospheric conditions were cloudy and overcast with pressures ranging from 983 to 1,019 mbar between 18 November and 1 December 2021. Two of the monitoring visits were carried out with atmospheric pressures less than 1,000 mbar. The highest VOC, flow rates, methane and carbon dioxide concentrations, together with the lowest oxygen levels (i.e., a combination of the worst-case temporal conditions recorded) from the monitoring visits are summarised in **Table 8.3** below:

Table 8.3 Summary of Ground Gas Monitoring

Borehole	Response Zone (m bgl)	Contamination Evidence	No. of Monitoring Occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Carbon Monoxide (ppm)	Hydrogen sulphide (ppm)	PID Readings (ppm)	Water Level (m bgl)
WS1	2.0 – 4.0	No	6	0	0	0 – 6.9	2.4-20.0	0	0	0	Dry
WS2	1.0 – 4.0	No	6	0	0 – 5.7	0-1.4	1.3 – 20.2	0	0	0	Dry – 2.42
WS3	2.0-4.0	No	6	0	0 – 0	0.6 – 2.5	0.1 – 19.8	0	0	0	3.37 – 3.21

8.7.2 Ground Gas Assessment

Background information relating to the origin and production of landfill and ground gases are presented in **Appendix M**, together with current guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst-case temporal conditions may not have been measured during the monitoring period. However, as gas concentrations were measured at atmospheric pressures of 983 and 993 mbar, it is anticipated that the worst-case temporal conditions will not be significantly worse than those presented in **Table 8.7** above. The gas flow rates measured across the whole of the site at all of the monitoring visits was less than the instrument detection limit of 0.1 l/hr. From Table 8.5 of CIRIA C665 the worst-case Characteristic Situation (CS) for the site are as follows in Table 8.4 below:

Table 8.4 Characteristic Gas Situations

Borehole Number	Steady State Flow	CH ₄			CO ₂		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
WS1	0.1	0.1	0.0001	1	6.9	0.0069	1
WS2	0.1	5.7	0.0057	1	1.4	0.0014	1
WS3	0.1	2.5	0.0025	1	2.5	0.0025	1

$$\text{Gas Screening Value (GSV)} = \text{Flow Rate} \times (\text{concentration (\% by volume)} / 100)$$

Table 8.5 of CIRIA C665 specifies that for a CS1 outcome (no protection measures required), methane is typically less than 1% v/v and carbon dioxide is typically less than 5% v/v, otherwise consideration is to be given to increasing to CS2 (some protection required). Both the concentrations of methane and carbon dioxide exceeded the respective additional factor assessments of 1% and 5% by volume, in accordance with Table 8.5 of CIRIA C665. As there has been no ground gas flow encountered within the boreholes monitored above the instrument’s detection limit, it is anticipated that there is no requirement to escalate the ground gas mitigation measures from CS1 to CS2; hence, no mitigation measures will be required.

To illustrate this low risk, in order to achieve a gas screening value comparable to CS2, based on using the limit of detection for flow of 0.1 l/h, the respective concentrations of ground gas would need to be 70% by volume to cause CS2 conditions to be reached. The maximum concentration of both gases was 5.7% by volume (methane) and 6.9% by volume (carbon dioxide).

It should be noted that during construction works, the ground surface will be disturbed and the installation of surface and foul water drainage will allow dilution and dispersion of ground gases which maybe present within confined granular areas to occur.

8.8 Ground Gases – Radon

The proposed development does not require mitigation measures for radon.

8.9 Updated Conceptual Site Model

The initial conceptual site risk model presented within the Phase 1 report determined that there were significant potentials for risk associated with the site or materials present on site. Rather than completing a similar tabular form, a high-level assessment will be completed for each of the risk items to determine if there is any residual risk based upon the existing situation of the site, and the potential.

Thick Made Ground

Representative samples of the made ground were analysed and determined as not posing a risk based on the land use being commercial. No mitigation measures will be required based on the samples analysed.

Should made ground not recorded within the borehole or trial pit logs be encountered or deleterious materials are encountered (such as asbestos, unsuitable materials or locally present contaminated materials), all works should stop and this should be inspected and designated as suitable for use.

Bunded Fuel Tanks

It was not possible to investigate the area of the bunded fuel tanks, the areas of AdBlue and the drummed storage of full and empty lubricant drums due to existing services which were live beneath these areas.

Once the services are all severed and cut off within this area, and the tanks and drums are removed, an assessment regarding the potential for remnant contamination directly below and within the near vicinity of the transient features. It should be noted that any spillage areas are potentially to migrate vertically and horizontally, as well as along preferential pathways such as service ducts and trenches.

Further investigation required.

Vehicle washdown area

There was no evidence of noticeable contamination associated with this washdown feature. Potential contaminants were considered to be fuels from the vehicles as well as asbestos and metals.

No further works required.

Heavy Plant

Heavy plant require maintenance to ensure spillages and leakage of fuels and lubricants do not occur.

Historical landfill

The site was recorded as a historical tip and hence there was the potential for significant industrial wastes to be present associated with the adjacent coking works. It is anticipated that to facilitate the industrial trading park, deleterious materials were removed from site. The made ground present was noted to comprise low organic content clays and colliery fill, with areas of the crushed demolition rubble associated with recent processing of imported soils and aggregate. There were no obvious indication of industrial landfilling associated with the former adjacent coking works, other than the presence of colliery fill.

The potential risk based upon the findings of the ground investigation were assessed to be low based on the low organic content and limited potential for ground gas generation, and lack of deleterious material. It should be noted that a watching brief should be undertaken whilst working within this stratum in case pockets or deleterious material are encountered.

Further works to comprise a watching brief and support service by ByrneLooby should deleterious materials be uncovered.

Contaminants may include hydrocarbons, heavy metals, ACMs, VOC's, PAH's, hazardous ground gases.

Analysis of samples obtained during the course of the ground investigation did not encounter any contamination above the threshold for the proposed commercial land use.

It should be noted that areas of the site were inaccessible at the time of the ground investigation as discussed above, and will require further investigation/confirmatory clearance.

Further works required upon removal of existing stores and above ground fuel storage tanks. Upon demolition of existing buildings, additional investigation will be required within these inaccessible areas.

Asbestos containing materials within the building fabric

A demolition asbestos survey will be required for all structures on site. No demolition will be permitted prior to this being undertaken.

Survey required

Potential Risk to Off Site Receptors

The site is not considered to pose a significant risk for surrounding land uses. Should contamination be encountered during subsequent ground investigation of inaccessible areas, the risk assessment will be updated accordingly.

8.10 Disposal and Control of Excavated Soils

Where materials are excavated for construction purposes these should be retained on site for engineering purposes where considered suitable for use. There are 2 No. paths for developers to pursue regarding the control of materials on site. The initial pathway which is currently being phased out is by utilising Waste Management Exemptions from the Environment Agency with the second path being the CL:AIRE Code of Practice.

The developer is therefore advised to complete all works under the CL:AIRE Development Industry Code of Practice for the Definition of Waste, Version 2 (or superseding versions if relevant). This guidance expects a Remediation Strategy to be produced for the site (assuming it to be potentially contaminated) to determine which strata or areas of the site are considered to be contaminated with regard to the proposed land use (Route A). A Design Statement may be utilised for those sites which have no contamination (Route B). **As no contamination had been encountered on this site to date, we anticipate that a design statement will be required (Route B).**

This strategy has been included above, however is likely to be revised following further investigation following clearance of the remaining building and the supplies noted above.

When applying for approval of the Code of Practice for this site, all engineering works on site have to be known. As part of the requirements, a full material management plan will be required. This will designate what material (including volumes) will be excavated, the likely positioning of stockpiles on site, as well as the fate of the soils. All aspects associated with site management and excavation works should be completed by the groundwork's contractor, or an engineer supervising the groundwork's contractor.

Tracking systems of materials, stockpiles and remediation processes will be required to be robust within the site management systems. Should the process of material tracking be considered not robust, this may fail the test whether excavated materials may be considered non-waste. It should be noted that it must be proved that the volume of soils to be transferred will be utilised on the receiving site, otherwise this material may be considered waste.

Direct transfer of naturally occurring soils may be undertaken, however a robust assessment of the materials have to be undertaken to confirm this material is suitable for use and uncontaminated. It should be noted that all materials on this site encountered to date may be subject to direct transfer.

The Code of Practice requires 4 No. factors to be addressed within the Material Management Plan:

- (1) Protection of human health and protection of the environment
- (2) Suitability of use, without further treatment
- (3) Certainty of use
- (4) Quantity of material

With regard to Box A within the Code of Practice (c.3.7, p.13), the material types encountered have been classified to determine the ‘Categorisation of materials within the ground’. Should areas and volumes of strata be noted below, these are approximate values and require assessment by a qualified quantity surveyor. These volumes do not represent the volumes of soils likely to be excavated through any part of the demolition/construction phase of the site redevelopment, rather the anticipated total volume of that stratum. Additional investigation may be required to obtain more accurate detailed quantities:

Table 8.5: Categorisation of materials within the ground in accordance with CL:AIRE Code of Practice

- (1) Material that is capable of being used in another place on the same site without treatment*;
 - (2) Material that is capable of being used in another place on the same site following ex-situ treatment on site*;
 - (3) Material that is capable of being used in another development site without treatment (Direct Transfer);
 - (4) Material that is capable of being used in another development site following ex-situ treatment on another site e.g. Hub site*;
 - (5) Material that is not capable of being used on the site or elsewhere and requires recovery or disposal offsite as waste; or
 - (6) Material that will be surplus to requirements and requires recovery or disposal off site as waste.
- * Having regard to the conceptual model (receptors and pathways) and appropriate risk assessment of the location where materials are to be used. We do not consider damping down to be treatment

Granular Fill

The granular made ground present on site was suitable for use across the site and was geotechnically suitable for use. It is likely that this stratum will require occasional grading, but will be geotechnically suitable for re-use on site (1), (4) and (6).

Cohesive Made Ground

This strata is considered suitable for reuse, although during excavation, grading and riddling oversized and/or unsuitable materials if encountered will be required. This strata may be geotechnically sensitive to weather conditions and hence following excavation, appropriate storage will be required to ensure the material remains geotechnically suitable. Should the strata not be managed appropriately and the strata degrades in quality due to the weather, this material should be disposed of as unsuitable unless restorative measures are adopted (1), (4) and (6).

Natural Clay

This strata is considered suitable for reuse, although during excavation, grading and riddling oversized and/or unsuitable (soft) materials if encountered will be required. This stratum may be geotechnically sensitive to weather conditions and hence following excavation, appropriate storage will be required to ensure the material remains geotechnically suitable. Should the strata not be managed appropriately, and the strata degrades in quality due to the weather, this material should be disposed of as unsuitable unless restorative measures are adopted. As this is natural strata and is uncontaminated, this may be removed from site as direct transfer (1), (3), (4) and (6).

Hydrocarbon Impacted Soils

Should soils be found to be contaminated by hydrocarbon compounds following further investigation of the areas inaccessible, and currently overlain by existing tanks, these should be segregated from those not contaminated. These maybe treated on site as localised remediation issues or removed from site to a hub for ex situ treatment. For all on site treated soils, the method of remediation must be such that retains the geotechnical properties of the soils to enable these to be suitable for reuse on site (2), (4) and (6).

8.11 Design Statement

A Design Statement relating to the proposed material management on site of excavated soils will be required. Should contamination be encountered, for instance associated with the area of the existing above ground fuel storage tanks, either an area specific remediation strategy should be completed to address this issue, or the design statement is replaced by the strategy and will be dependent on extent of the issue.

8.11.1 Clean Cover

No inert cover is required based on the elements and compounds encountered on site; however, no topsoil was present, and it is unlikely that any of the in situ stratum will be considered as a growing media. Should soft landscaping be incorporated within the site, topsoil and subsoil is anticipated to be required for these areas to a minimum depth of 450mm. It should be noted that although validation of the depth of inert cover is not required, the composition of the imported soil will be required.

The testing requirements will be 1 sample per 50m³ of imported soil with a minimum of three samples tested from any individual source. The imported soils should also meet the requirements of: BS 3882: 2015: 'Specification for topsoil and requirements for use' and BS 8601: 2013 : 'Specification for subsoil and requirements for use.'

8.11.2 Tank Removal

All tanks on site were noted to be above ground and will require decanting for offsite disposal following decommissioning. The tanks should be confirmed as gas free and removed from site for either reuse or disposal. Method statements and risk assessments for the works will be required.

Following removal of the tanks, and decommissioning of the services which underlie this area, further investigation will be required. The investigation should include the immediate area of the tank footprints, the area around refuelling points as well as below ground service lines where fuel may have migrated.

An assessment should be made on the feasibility of treating any hydrocarbon impacted soils on site, or these soils should be transferred to a hub site for pre-treatment prior to disposal if reuse is not possible. This ground should be excavated and disposed at a suitably licensed landfill site if contaminated and unsuitable for use.

The volume of material to be excavated should be determined when excavating the area by using visual and olfactory evidence. Once this excavation is complete, the material in the floor and walls of the excavation should be sampled and tested to confirm that hydrocarbon levels within the material remaining are within acceptable limits. Ex situ remediation of impacted soils will require risk assessment and method statements completing.

8.11.3 Unexpected Contamination

As with any project on a brownfield site there is the possibility of encountering unexpected contamination. If this occurs, then the procedures set out in **Appendix R** should be implemented.

8.12 Verification of Remediation

At this stage, no remediation has been identified; however, there were areas of the site which were inaccessible at the time of the ground investigation, including areas of above ground fuel storage. Should contamination be encountered, the following procedure should be adopted.

All stages of the remediation works should be verified independently by suitably qualified and experienced personnel. Verification reports should be prepared for each stage. The verification should include:

- A description of the works, sample location plan, test results, photographs, interpretation;
- Sampling and testing of the ground around the excavations prior to them being backfilled to ensure that the concentration of contaminants in the remaining ground is lower than the remedial targets.
- Confirmation that hydrocarbon contamination does not extend off site, or if it does it is adequately investigated, assessed and remediated if required;
- Confirmation of the chemical properties of the treated material meet the remedial targets;
- Confirmation of the chemical properties of the material used to backfill the excavations meets the specification;
- Confirmation of thickness and suitability of the capping;

- In order that regulatory compliance can be confirmed, a copy of all site licences, consents and Waste Transfer Notes shall be included.

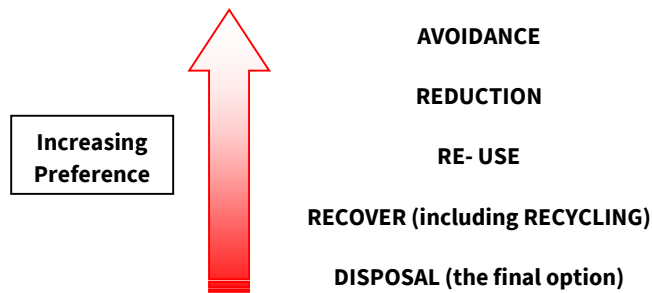
On completion a copy of the Verification Report should be sent to the local authority Environmental Health Officer and the Environment Agency Contaminated Land Officer for their approval so that planning conditions can be discharged.

It is strongly advised that approval be sought to any remediation works from these organisations prior to the commencement of development.

9 Waste Assessment

9.1 Waste Hierarchy

In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



The site for proposed development had been utilised as a compound for a construction company, and hence there are construction products, plant as well as fuel and lubricants for plant. It is anticipated that all stores will be removed from site as usable items. Any stores not removed will be considered for either recycling or for disposal.

It is recommended that that any remnant materials present on site will require quantification, separation into several waste types on site to enable recovery/recycling of materials to minimise off-site disposal along the following lines:

- **Metal** – recover and sell as scrap.
- **Timber, tree roots and vegetation** – chip and use in landscaped areas.
- **Plastic & polystyrene** – send to landfill.
- **Concrete, tarmac, bricks, gravel and tiles** – crush and use as hardcore.
- **Tyres** – send off-site to be shredded or incinerated.
- **Asbestos- containing materials** (if encountered during the demolition asbestos report or through site works – dispose at a suitably licensed landfill site in accordance with legislation and EA Guidance.
- **Drums of chemicals** – disposed of in accordance with COSHH.

As with most developments, there will be waste materials produced from excavations for drainage/services. Where possible, these arisings should be incorporated into soft landscaping with the arisings being separated into made ground and Glacial Till as they are excavated in order to facilitate the re-use. It should be noted that all soils once excavated are considered as being potentially waste, and hence an assessment to confirm their suitability for reuse on site will be required in accordance with the Definition of Waste: Code of Practice (currently version 2).

It is the responsibility of the designers to show/prove that excavated materials on site are capability and suitable for reuse and this should be completed for the materials present within the Design Statement for this site. The declaration to adopt the Code of Practice **MUST** be made prior to works being undertaken on site.

9.2 Waste Characterisation and Classification

If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from earthworks is presented in **Appendix N**. A two-phase approach is required comprising:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

9.2.1 Waste Characterisation and Classification

Waste Management Plans require the identification of the classification of materials intended for disposal offsite (inert, non-hazardous, stable non-reactive, or hazardous) and volume targets for disposal of each type.

Environment Agency Technical Guidance WM3 - Hazardous Waste, details the requirements for classifications of materials as hazardous waste. The soils will typically be classified as:

17 05 03 soil (including excavated soil from contaminated sites), stones and dredging spoil [soil and stones containing dangerous substances], (WAC analysis required for disposal) or

17 05 04 soil and stones other than mentioned in 17 05 03 – not containing dangerous substances. (WAC analysis not required).

The hazard rating 'H' classifications for compounds and elements have been obtained in accordance with Appendix C (of WM3), from Occupational Health Safety datasheets and Table 3.1 within Annex VI to Directive 67/548/EEC (the EU classification and labelling system prior the implementation of GHS).

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation are anticipated to be classified as hazardous; however, the sample obtained from WS1 (1.5m) was noted to exceed the 1,000mg/kg threshold concentration for total petroleum hydrocarbons which triggers the assessment for unknown oils. Having reviewed the elevated concentrations of polycyclic aromatic hydrocarbon compounds, we anticipate that the enhanced concentrations of aromatic phase compounds are associated with coal and ash rather than oils and petroleum. There were no olfactory or visual indications of petroleum sourced hydrocarbons to be present within the stratum sampled. As such, we anticipate that either the risk assessment is forwarded to proposed landfills to confirm our assessment, or further investigation is undertaken within this area to determine if this is processed on site that any coal content can be reduced.

We anticipated that the strata present on site, based upon the soils analysed will be non-hazardous. It should be noted that inert soils can only be determined by undertaking Waste Acceptance Criteria (WAC) analysis.

Soils should be assessed for their waste classification once stockpiled and designated as waste for disposal. Representative samples will be required (dependent upon the size of the stockpile and the requirements of preferred landfill sites) of the stockpiles to determine their classification. Where possible, different strata should be kept segregated to prevent less onerous wastes being detrimentally impacted by higher waste classification strata. The Principal Contractor has responsibility for appropriate segregation and classification of materials to minimise waste, as well as appropriate disposal.

9.3 Materials Management and Reuse of Arisings On-site

The assessment and appraisal for suitability of use had been discussed previously in Clause 8.10.

When soil is excavated it is technically a waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose. Soils can only be re-used if it fulfils the following requirements:

- There is a planned use for the material;
- There is planning permission for the proposed re-use;
- The material when re-used will not be a risk to flora, fauna or controlled waters; and,
- Appropriate procedures are followed to demonstrate the above criteria are met and the re-use of materials is recorded in a systematic way and appropriate permissions/permits are gained and relevant procedures followed.

As soil is technically a waste when it has been excavated, it cannot be re-used on site unless one of the following four procedures are implemented:

- The procedures are followed in the CL:AIRE Code of Practice ‘The Definition of Waste: Development Industry Code of Practice’ Version 2 (2011).’ If these procedures are followed, excavated arisings can be re-used without them being defined as waste “where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated.” or;
- The site registers a waste exemption with the Environment Agency in accordance with The Environmental Permitting (England and Wales) Regulations 2016 (as amended) so the material can be placed without an Environmental Permit (note that the rules for permit exemptions have been changed and the maximum quantity covered by a permit exemption for re-using soil is 1,000 T), or;

- The site applies for a full Environmental Permit (either standard rules permit or a bespoke permit) from the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (as amended); or
- WRAP 'Quality Protocol: Aggregates from inert waste.' Only granular aggregates (e.g., Class 1 or Class 6 materials etc. apply, Class 2 materials are not covered by the WRAP Protocol).

The length of time taken for the above regimes also need to be considered:

- CL:AIRE Code of Practice (CoP) takes between 7 and 28 days to gain approval and fees of £40.00 plus £0.01 per m³ of soil used is payable to CL:AIRE;
- An Environmental Permit exemption typically takes up to 7 days to gain approval and there are no fees due;
- Allow a minimum of 12 weeks to develop a Waste Recovery Plan and gain approval or the Environmental Permit from the Environment Agency and there are significant costs preparing an application and for the fees payable to the Agency (typically in excess of £7,000) for the permit.
- There are no fees to pay for the WRAP Aggregates protocol and there are no notice periods or statutory liaison required.

ByrneLooby recommend that the CL:AIRE CoP is implemented for this development and a Materials Management Plan is used for the site to allow the re-use of soils at the site.

If the CL:AIRE procedures are followed, excavated arisings from other sites can be re-used on this site if the soil is natural uncontaminated soil; or made ground can be imported and reused if it has been treated to a required specification under an Environmental Permit. Note, untreated made ground cannot be imported in accordance with the CL:AIRE Code of Practice

10 Geotechnical Assessment and Recommendations

10.1 Fieldwork and Laboratory Data Review

The thickness of made ground on-site was noted to range from 2.0m (TP2) to 6.1m (WS5). The topography of the site slopes from 69.5m OD (SW corner) to 66.4m OD (NE corner). There were areas of the site which were inaccessible at the time of the ground investigation, although for the area of the proposed structure, a borehole was drilled within each corner, as well as the centre.

Underlying the made ground was firm to very stiff, with mudstone bedrock encountered between 0.4m (TP1) and 2.5m (TP2) of the interface. Trial pits TP1 (3.4m) and TP2 (3.5m), and boreholes WS2 (4.93m) and WS4 (5.94m) terminated early due to refusal on bedrock. Trial pits TP6 and TP7 were noted to refuse at 3.0m and 2.7m respectively within the made ground.

The shallowest potential natural bearing stratum was noted to comprise natural clay, with mudstone situated within a relatively shallow depth. It should be noted that to prevent differential settlement as well as differing allowable bearing capacities, foundations should not span superficial stratum and bedrock. Where bedrock is encountered, this should be the bearing stratum for the entire foundation.

There were no trees within the vicinity of the proposed structure, and were only present along the north-eastern boundary along the cutting for the railway. An assessment regarding the potential heave/desiccation associated with the removal of trees is not required, although the trees will require protection and a stand off area to prevent deleterious actions to the slope occurring as the roots are considered to potentially bind and support this feature.

Samples obtained during the ground investigation were analysed by Professional Soils Laboratory, with the certificate referenced PSL21/9205, dated 13 December 2021.

Six samples of glacial till (firm to very stiff clay) were submitted to a geotechnical laboratory for Atterberg Limit testing. Corrected Plasticity Indices (PI) ranged from 13.6% to 42.27%. Samples tested from borehole WS2 and trial pit TP2 both had PI's of 42.27% and 37% respectively with associated high moisture contents. The high moisture contents were not anticipated to be associated with sand content due to practically the whole sample from both exploratory hole passing a 0.425mm sieve. These values are very high for the general parameters of natural clay within this region, and are considered potentially anomalous. The moisture content for the remaining samples ranged between 15% and 26%. The natural clay was classified as having an Intermediate Plasticity.

The natural clay was tested in the field using a hand shear vane, with 3 No. tests per sample. The values ranged between 91kPa and in excess of 120kPa. Three tests were completed for each shear vane assessment.

SPT N-values were recorded throughout each borehole and are summarised in **Table 10.1** below for the material encountered. The listed N-values have been corrected to the standard Energy Ratio of 74% and are therefore reported below as N_{60} values:

Table 10.1 Summary of SPT N_{60} Values

Hole No	Test Depth (m)	SPT N-Values	SPT N_{60} -Values		Estimated Shear Strength
			Sand *	Cohesive *	Cu **
WS01	1.2	8		10.8	54
	2.0	24	32.4		
	3.0	24	32.4		
	4.0	8	10.8		
	5.0	6	8.1		
WS02	1.2	7		9.5	47.5
	2.0	22		29.7	148.5
	3.0	6		8.1	40.5
	4.0	17		23.0	115
	4.5	50+		68+	340
WS03	1.2	13		17.6	88
	2.0	5		6.8	34
	3.0	13		17.6	88
	4.0	8		10.8	40
	5.0	19		25.7	128.5
WS4	1.2	41		55.4	277
	2.0	6		8.1	40.5
	3.0	8		10.8	54
	4.0	13		17.6	88
	5.0	50+		68+	340+
	5.5	50+		68+	340+
WS5	1.2	6		8.1	40.5
	2.0	6		8.1	40.5
	3.0	8		10.8	54
	4.0	11		14.9	74.5
	5.0	10	13.5		
	6.0	11		14.9	74.5
Min		5	8.1	5	34
Average		16.7	19.4	23.3	93.4
Max		50+	32.4	68+	340+

* SPT hammer Energy ratio (Er) = 74%

** correlation factor = 5 based on Plasticity Index - Stroud and Butler (1975)

The SPT Hammer certificate is presented in **Appendix D**.

The SPT N_{60} values vary greatly within the sand deposits varying from 8 (loose to medium dense) to 32 (dense). The N_{60} values from the cohesive glacial till ranges from 5 to 68+ (refusal). The SPT values indicate a shear strength typically in the range of high strength.

The natural clay stratum has been highlighted in light green in the above table, and the average shear strength was 223kPa with a minimum strength of 74kPa. All the other strata comprise variable madeground, and hence the strength of this strata was also variable.

Three particle size distribution tests were completed. Trial pits TP6 and TP7 were both described as being demolition rubble and have a high granular content, with only between 20% and 30% cohesive content. WS02 encountered what has been described as colliery spoil with coal brick and ash, with a high cohesive content (30%). These results have been compiled with the figure below.

Summary of Laboratory Particle Size Data

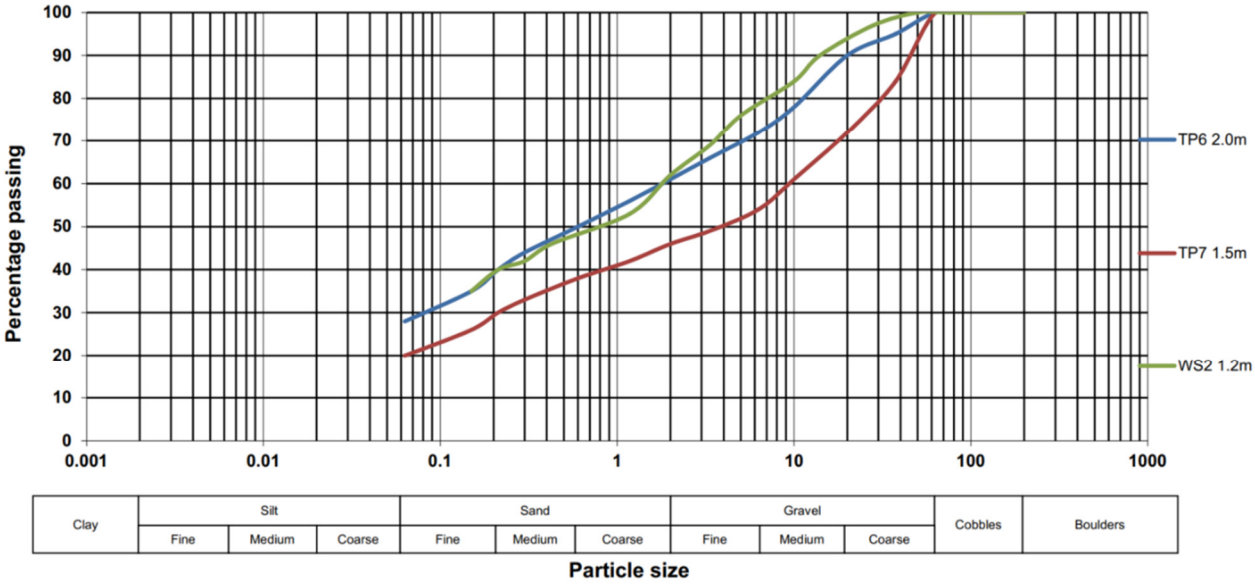


Figure 4 Summary of Laboratory Particle Size Distribution Data

10.2 Trees

The only trees present on site were situated along the cutting which forms the north-eastern boundary. These trees are unlikely to pose a risk to the proposed development with regards to desiccation or heave.

It should be noted that the presence of the trees is anticipated to be a stabilising factor on the cutting slope which is beyond the proposed site boundary. A stand off zone will be required to avoid damage and disturbance.

10.3 Foundation Recommendations

The proposed development will comprise a steel portal frame large span warehouse in accordance with the client’s drawing referenced 221062-MSJ-XX-XXDR-D-3000 External works and Proposed Drainage Modified.

According to the Structural engineer (from Melia Smith & Jones) associated with this project, the proposed loads are anticipated to be:

Dead Load	200kN
Live Load	200kN
Working Loads	150kN (+/-)

10.3.1 Recommended Foundations

The proposed building will be a portal frame structure which will have column loads. It is recommended that this structure is end bearing pre-cast concrete piles with an associated ground beam. Alternatively, bored and cast in situ CFA (continuous flight auger) pile may also be an option, although these are considered to more costly options.

The anticipated depth of pile is anticipated to range from 5m to 8m from existing ground levels. Assuming the ground surface was as had been topographically surveyed in the drawing reference MWA_235_Whaley Rd, the anticipated mudstone interface is considered to be between (circa) 59m aOD (rear left corner) to 63m aOD (front right corner). Mudstone had not been encountered within 3 of the 5 No. boreholes, and hence an interpolation of the anticipated depth to bedrock has been made.

The bedrock was noted to comprise mudstone and is anticipated to have a minimum allowable bearing pressure of 400kN/m² in accordance with Tomlinson (General Principles of Foundation Design) Table 2.4. for a moderately weak mudstone. It should be noted that the highly weathered surface of the mudstone is likely to behave similarly to the natural stiff clay, and a set will be obtained once the weathering profile has been driven through.

The bedrock is considered suitable to end bear upon as there has been no evidence presented by the Coal Authority for concerns regarding shallow mining on, or within the close vicinity of this site.

The proposed pile diameters and spacing will be dependent on the specific loadings for the structure and will be designed by the structural engineer, with pile design undertaken by the preferred specialist piling contractor. It is considered prudent to utilise piling contractors design packages as these are typically part of the cost of the piling. It should be noted that all standard driven piles are typically constructed from DC4 concrete and hence there will be no additional cost due to the concrete classification for subsurface concrete.

Due to the ground floor slab being situated over variable made ground, with areas for drainage underlying the plot, it is recommended that a reinforced suspended concrete slab is adopted. The slab will be supported on a granular blanket, either recovered during the reprofiling of the site, and repurposed from the piling blanket, or imported if necessary. Ground bearing floor slabs may be adopted with significant preparatory works to mitigate cracking and differential settlement.

Due to the depth and variability of made ground pads are not considered suitable for use.

A specialist piling contractor should be contacted with regards to the selection of appropriate pile design and construction method. Geotechnical information within this report should be provided to give design parameters. Pile caps and ground beams will require designing in accordance with BS EN 1997-1: 2004 +A1 2013: Eurocode 7 – Geotechnical Design – Part 1: General rules (including UK National Annex of November 2007) and BS8004: 2015 : Code of practice for foundations.

A piling risk assessment with regard to contamination is not required, as no significant contamination was encountered during the course of the ground investigation. Should localised contamination be encountered during the course of the groundwork's, it is anticipated that ex situ treatment of impacted soils will remove the potential risk. There is considered no risk of opening preferential pathways or push contamination to depth considering the geology and the overlying made ground.

Any piling works undertaken from existing ground levels will require a suitable piling mat/platform constructed in accordance with BRE Report 470 (2004). A geotextile may be incorporated into the platform to reduce the required thickness and the platform could be designed as part of the engineering fill required for any earthworks to alter final site levels. ByrneLooby can assist in the design if required once the VSC/piling rig types are known.

10.4 Retaining Walls

Retaining walls maybe required either within the site, or around the boundaries to accommodate the proposed site levels.

Retaining walls should be designed in accordance with BS EN 1992 Design of concrete structures, BS EN 1996 Design of masonry structures, BS EN 1997-1 and 2 Geotechnical design, Ground investigation and testing, BS 8002:2015: Code of practice for earth retaining structures and BRE Good Building Guide 27: Building brickwork and blockwork retaining walls. All retaining structures, more than 600mm high, should be designed by an engineer.

10.5 Groundwater & Excavations

It is not expected that groundwater will be encountered in any excavations at this site. It is anticipated that any groundwater in excavations can be controlled by sump pumping. If inflows are relatively localised, this may cause softening of the ground and require localised excavation support in order to prevent instability of the sides of excavations.

Excavations through the soils to a depth of approximately 2.0m should be stable in the short term (up to 3 to 4 hours). However, it is anticipated that where the granular soils are encountered at depth these will gradually collapse into excavations undercutting the overlying clays, leading to instability of the sides of excavations. No excavations should be entered regardless of the perception of the side wall stability without appropriate shoring. All excavations should be carried out in accordance with CIRIA Report 97 “Trenching Practice” and BS6031: 2009: Code of Practice for Earthworks.

Further guidance on this aspect of site works is given in the British Standards for “Workmanship on Building Sites”, BS 8000, Parts 1 and 14, and in the Construction Industry Training Board’s Site Safety Note 10.

Excavation depths should generally be readily achieved using conventional hydraulic plant (e.g., wheeled JCB or similar) although larger plant (tracked 360° or similar) will have higher excavation rates as these machines will be better suited to excavations within the bedrock.

10.6 Buried Concrete and Pipework

The results of laboratory pH and sulphate content indicate that ACEC Class AC-3s conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore, no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

Any fill material to be imported onto the site should be tested and should not exceed the classifications given below.

Table 10.1 Sub-structure ready mix concrete designations by commercial end use

Use as substructure and ground floors	Ready-mixed concrete (designated mix)
General Use	
Rough blinding (non-structural)	FND3z
Infill	FND3z
Unreinforced oversite concrete below timber floors	FND3z
Structural blinding and overbreak	FND3z
In situ external concrete for drives and paths	PAV1
In situ external concrete foundations for precast concrete paving slabs	FND3z
Fill to wall cavity	FND3z
Solid filling under steps	FND3z
Foundations:	
Strip foundations	FND3z
Trench fill	FND3z
Other mass concrete foundations	FND3z
Reinforced concrete footing	FND3z
Floor Slabs:	
House or garage with reinforced concrete floor slab, either suspended or precast. -	RC35
House with non-reinforced slab (ground bearing) with either: a) Permanent finish to be added, e.g., screed or floating floor. b) No permanent finish to be added, e.g., carpet.	GEN1 GEN2
Garage with non-reinforced slab (ground bearing)	GEN3
Notes:	
1) Worst case sulphate conditions over the entire site are ACEC Class DS-3/AC-3z, and Design Chemical Class DC-3z.	
2) Classification and designation in accordance with NHBC guidance, Section 2.1 – Table 1, and BS8500-1, 2006.	
3) The above conditions represent the worst-case conditions identified within the testing of soils on the site.	
4) Any fill material to be imported onto the site should be tested and should not exceed the classifications given above.	

10.7 Drainage

Further settlements in the made ground deposits are possible and therefore measures should be incorporated into the design of the drainage to deal with this possibility.

All pipes should be flexible with flexible and watertight joints. In order to make allowance for future settlement, the design gradients should be steeper than the minimum allowed for the flow rate and pipe size.

In addition to the above, it is recommended that trenches are over-excavated to a depth of 600mm and backfilled with compacted granular material prior to pipe laying.”

10.8 Soakaways

Soakaways were undertaken on this site in accordance with BRE365; however, the 2 No. tests failed on the initial run of three. It is not considered appropriate for soakaways to be adopted for the discharge to ground of surface water.

It should be noted that no slope stability assessment has been carried out on the cutting which forms the north-eastern boundary of the site. The cutting is circa 5m to 8m in height, with a railway at the base. It is considered prudent to divert where possible surface water from entering the slope. Gradients for hardstanding should shed surface water away from the slope where possible.

10.9 Road Design

Based on the types of near surface material encountered, it is recommended for preliminary design purposes a CBR value = 2% is adopted. Based on the types of near surface material encountered during the investigation, the likely subgrade material will comprise made ground. A CBR value of 1-2% is therefore recommended for preliminary design purposes.

Consideration should also be given to the use of geotextiles to allow reduction of 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.

It should be noted that 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 that further in situ CBR testing is carried out once formation levels are known to confirm design CBR values and reference should be made to the ‘Design Guidance for Road Pavement Foundations’, Interim Advice Note 73/06, Revision 1 (2009), when considering the CBR value appropriate for use.

Exposed subgrades are likely to deteriorate rapidly on exposure to wet weather and should be shaped to shed water. Subbase should be placed as soon as possible to minimise the exposure of subgrade to adverse weather conditions.

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.

In accordance with Volume 7, Section 2 of the Department of Transport, Departmental Standard Interim Advice Note 73/06 Revision 1 – Design Manual for Roads and Bridges, the granular subgrade is estimated to have a CBR of between 20% and 40% or greater after proof rolling and soft spot removal, and clay subgrades are estimated to have a CBR of 2% to 5% or greater after proof rolling and soft spot removal.

Proposals are subject to the review of Barnsley Council – Highways Department. However, we would recommend that all sub-grade materials are in situ CBR tested at proposed road formation level prior to final pavement design.

It is recommended that if initial roads and sewer construction is proposed to commence during the winter months then a longer period should be allowed for construction due to the potential for weather disruptions to the site.

Based upon the nature of the ground conditions encountered during on-site intrusive investigations undertaken, it may be expected that abnormal works and/or special precautions will be required to be adopted for road and sewer construction.

Further to any redevelopment works being undertaken within this site, we would recommend the undertaking of CBR testing in order that sub-base requirements for road design and sewers be established.

10.10 Neighbouring Structures

All works undertaken should satisfy the requirements of the Party Wall Act taking into account the effect of excavation and vibration on the site's party walls in both the design and during foundation construction.

10.11 Proposals for Further Geotechnical Investigation

Further ground investigation with regard to geotechnical assessment is anticipated to be limited to the left half of the proposed structure as the depth of made ground was not encountered. It would be prudent to drill 3 No. cable percussive boreholes to bedrock, with rotary follow on to obtain cores of the bedrock to complete point load tests and to obtain compressive tests to confirm bearing capacities for this stratum. The depth of drilling is anticipated to be circa 7m using cable percussive drilling, and a further 2m using rotary coring.

Should the client or designer not commission the recommended works, piling contractors may provide overly conservative designs to compensate for the missing information.

11 Conclusions and Recommendations

11.1 Ground Profile

The site investigation revealed the following general downward succession:

- Site surface: demolition rubble with limited concrete apron.
- Topsoil – not present.
- Made ground (2.0m to in excess of 6.45m) comprising silts, sands and clay with mudstone, limestone, coal, ash and clinker.
- Glacial Till – Firm to very stiff from 2m begl to in excess of 6.45m begl
- Bedrock – weak mudstone (3.4m to in excess of 6.45m)
- Groundwater – 2m to 4.7m where encountered

11.2 Environmental Risk Assessment

In order to make a more detailed assessment of the potential hazards, a Phase 2 intrusive investigation was carried out to develop a more comprehensive conceptual ground model of the site. This detailed the characteristic ground conditions and elements of the surrounding environment and has assisted with identifying the potential contaminants of concern, the potential receptors of the contamination and the potential pathways between them.

The results of the risk assessments indicated that there were no significant source of contaminants present at the site, within the vicinity of the exploratory holes completed, so there was a negligible risk to all receptors (based on commercial land use) including humans, controlled waters and ecological receptors. No specific precautions are required with respect to landfill type ground gases, radon and hydrocarbons for the development.

Areas of the site were inaccessible at the time of the ground investigation due to live services as well as the site being use. These areas comprised above ground fuel storage tanks as well as drummed lubricants and IBC's of AdBlue. Further ground investigation will be required once the services are disconnected and the tanks removed.

A watching brief should be maintained during the groundwork's phase of the development to confirm the absence of asbestos.

The risk assessments have concluded that no remediation measures are required to address risks to any potential receptors. However, as with any project on a Brownfield site there is the possibility of encountering unexpected contamination. If this occurs then the procedures set out in **Appendix R** should be implemented.

11.3 Geotechnical Design

The geotechnical hazards associated coal mining at the site are low and no special precautions are required to be made in relation to the proposed development.

In addition to the environmental hazards, there are also geotechnical hazards associated with the proposed development. These include:

- Significant variable depth across the footprint of the proposed development, underlain by variable depths of bedrock. To mitigate the risk of differential settlement, the bedrock should be utilised as the bearing stratum for the proposed development.
- The potential differential settlement due to variable made ground is anticipated to require a suspended reinforced concrete floor slab.
- Additional boreholes maybe required to confirm the depth to bedrock in the left half of the proposed development for the purpose of addressing the pile lengths. Alternatively, the piling contractor may make conservative assessments regarding the anticipated total pile length. It is anticipated to vary between 5m and 8m.

Below ground concrete structures are potentially at risk in areas of elevated sulphates and where there is low pH. An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that ACEC Class AC-3s conditions prevail. Therefore, no special precautions are required at the site for the design of concrete in terms of the durability and structural performance with regards to pre-cast concrete piles, although drainage should be reviewed.

11.4 Recommendations for Further Works

Further action which may be required to progress the contract to Detailed Report status, could include, but not necessarily be limited to:

- Tree survey to address protection of existing trees along the crest of the railway cutting;
- Discussions with Local Authority EHO regarding ground gas issues;
- Discussions with Local Authority regarding ecological issues (i.e., bat roosting);
- All building materials and other surface waste materials require waste classification and then require removal from site. Sampling required for general contaminants as well as asbestos;
- Make safe the building and undertake a pre demolition and construction asbestos survey;
- Arrange demolition of existing buildings and site clearance;
- Emptying large capacity hydrocarbon above ground tank to tanker for suitable off-site disposal (including, any fluid content which may be present within the bund). (ByrneLooby in attendance);

- Intrusive investigation beneath the area of large capacity hydrocarbon above ground tank and drummed lubricants to determine the presence/extent of hydrocarbon contamination present around this feature;
- Remediation of hydrocarbon contamination if present on site and validate works undertaken;
- Discussions with United Utilities to confirm initial assessment with regards to potable water supply pipes contained in this report;
- Excavated soils surplus for use should be segregated and analysed for the Waste Acceptance Criteria to determine potential disposal of this material;
- Discussions with piling contractors.
- Additional geotechnical testing;
- Additional geochemical testing;
- In situ CBR testing for proposed roads and parking areas;
- Prepare structural drawings once layout and slab levels finalised;
- Complete Detailed Quantitative Risk Assessment.

11.4.1 Regulatory Liaison

Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g., local authority environmental health officer, Environment Agency etc) to obtain Planning Permission prior to commencement of the works and should be agreed with the NHBC or similar, or with the local authority building control officer prior to commencement of the works. Where remediation works are required, a verification report should be submitted to the relevant authorities for approval in accordance with relevant Planning Conditions.

11.4.2 Dewatering

In accordance with Section 30 of the Water Resources Act 1991 and the Water Act 2003, if any groundwater is abstracted from the site, an abstraction license should be sourced from the Environment Agency if the abstraction is to be greater than 20 m³ per day. Disposal of abstracted water will require on site treatment before it is discharged to sewers or the storm drains. Consent shall also be gained from the local utility company before discharging water to sewers or the storm drains.

11.4.3 Re-use of Soil on-site and Importation of Fill

See **Section 9.3** for full details. However, it should be noted that it is recommended that the development implements the procedures in the CL:AIRE document ‘The Definition Of Waste: Development Industry Code of Practice,’ Version 2 (2011) to enable legal re-use of arisings and importation of excavated arisings from other sites if the imported soil is natural uncontaminated soil (or made ground can be imported and reused if it has been treated to a required specification under an Environmental Permit). Note, untreated made ground cannot be imported in accordance with the CL:AIRE Code of Practice.

11.5 Geotechnical and Environmental Risk Register

The geotechnical and environmental risks are summarised in the following risk register (**Table 11.1**):

Table 11.1 Geotechnical and Environmental Risk Register

Hazard Description			Risk Rating (Prior to Risk Control Measures Being Applied)	Risk Control Measures	Current Risk Rating (After Implementation of Risk Control Measures)
1	Unexpected/unfavourable Ground	Possibility of thick made ground	Moderate	Remove any soft spots and replace with appropriate structural fill during construction of shallow foundations <ul style="list-style-type: none"> • Use experienced site geotechnical personnel to inspect foundation pits in order to provide advanced warning of potential problems. • Adopt appropriate design parameters and methods as a mitigation to any potential • unexpected ground conditions 	Low
2	Underground Obstructions (Historical Foundations, basements)	Risk of delay in construction works and additional cost	Moderate	Removal of any expected existing underground structures prior to construction.	Low

Hazard Description			Risk Rating (Prior to Risk Control Measures Being Applied)	Risk Control Measures	Current Risk Rating (After Implementation of Risk Control Measures)
3	Unexpectedly high groundwater levels adversely affecting foundation/formation levels and Basement	Seasonal variations may increase groundwater levels during the winter	Moderate to Low	Consider increasing the monitoring to provide further information on seasonal variations.	Low
4	Chemical attack on buried structural elements due to acid and/or sulphate in soil or groundwater	pH and Sulphate attacks on buried concrete	Low	Design to include assessment of aggressivity of soil/groundwater.	Low
5	Long term settlement of compressible soil/differential settlement	Settlement within the cohesive Glacial Till	Low	Serviceability Limit Checks associated with Settlement should be undertaken as part of the design, this will provide a better understanding of the risk to the building and whether the buildings could allow for any settlement calculated, an alternative would be a piled foundation to reduce settlement.	Low
6	Unexploded Ordnance	The site was considered low risk of UXO according to the Zenica report	Low	Extra care and monitoring taken during groundworks.	Low
7	Excavation collapse	Collapse of excavation within the mixed made ground.	High	Appropriate shoring/sidewall support is required during excavation, and possible dewatering.	Low
8	Asbestos in made ground	Whilst not found during the investigation there is potential for Asbestos to be present in made ground	Moderate to High	All groundworkers should have asbestos awareness training and the site should have appropriate procedures to implement if suspected asbestos is encountered.	Low

11.6 Health and Safety

As outlined within the HSE publication “Successful Health and Safety Management – HSG65” this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

In accordance with the Construction Design and Management (CDM) Regulations 2015, ByrneLooby has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report, ByrneLooby has discharged and completed all contractual and legal requirements for these positions, and we have no further involvement with the project.

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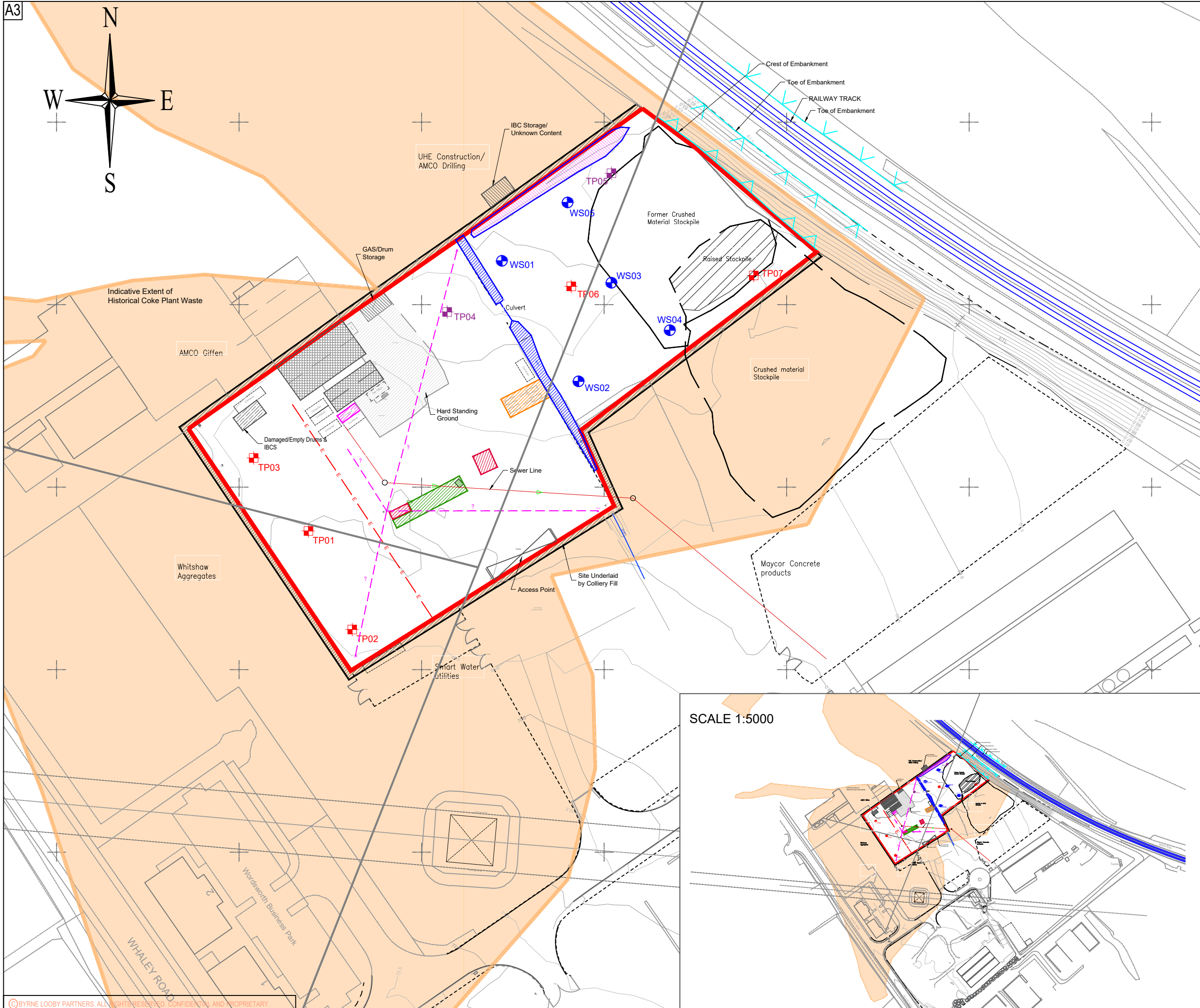
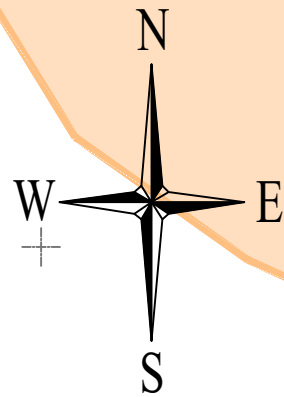
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13 Drawings

Drawing Reference	Revision	Scale (Paper Size)	Title
K0030-01-001	-	1:1,000 (A3)	Site Plan
K0030-01-002	-	1:1,500 (A3)	Geological Plan

A3



GENERAL NOTES

Notes

- ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.
- DO NOT SCALE FROM THIS DRAWING.
- ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF BYRNE LOOBY

Legend

- Site Boundary
- Above Ground Fuel Storage Tanks
- Washdown Area
- Adblue and Fuel Bowser Storage
- Ditchlines/Standing Water
- Ditchlines/Dry
- Vehicle Lube Storage
- Site Underlaid by Colliery Fill
- Existing Buildings
- Damaged/Empty Drums & IBCS
- IBC Storage/ Unknown Content
- Hard Standing
- Shipping Container
- Site Office
- Culvert
- Indicative Extent of Historical Coke Plant Waste (Encompasses Whole Site) Taken from 1962 National Grid Historical map
- Indicative Location of Ditch Line Taken from 1893 County Series Historical Map
- EV Cable
- Indicative CCTV Line
- Manhole
- Sewer Line
- Trial Pits Excavated By Byrne Looby 09/11/21
- Soakaway Trial Pit Test By ByrneLooby on 08/11/21
- Window Sampler Boreholes Drilled By Byrne Looby 08/11/21
- Crest of Railway Cutting
- Toe of Railway Cutting

Rev	Date	Description	By	Chk	App

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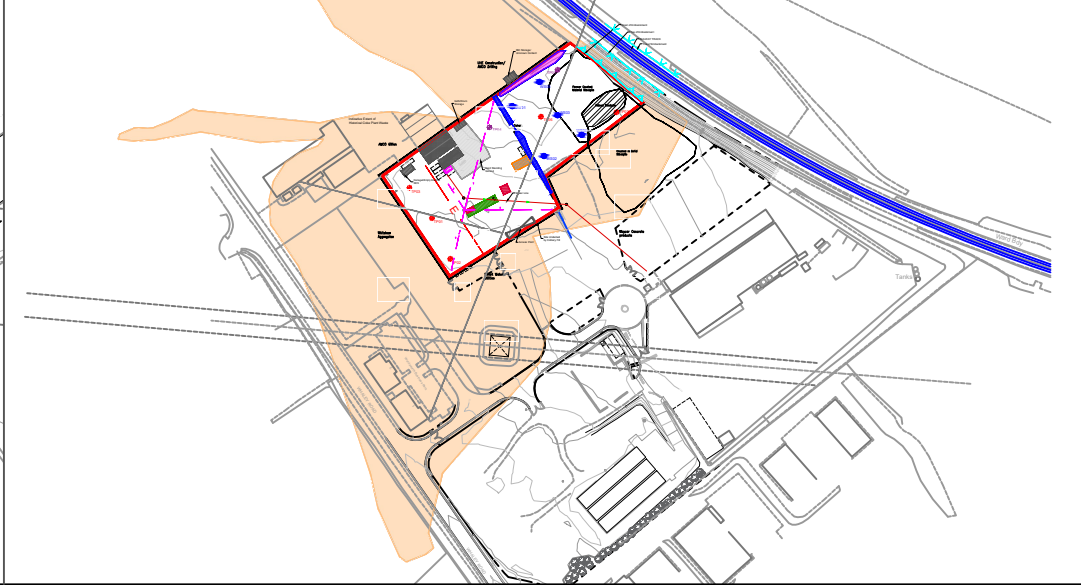
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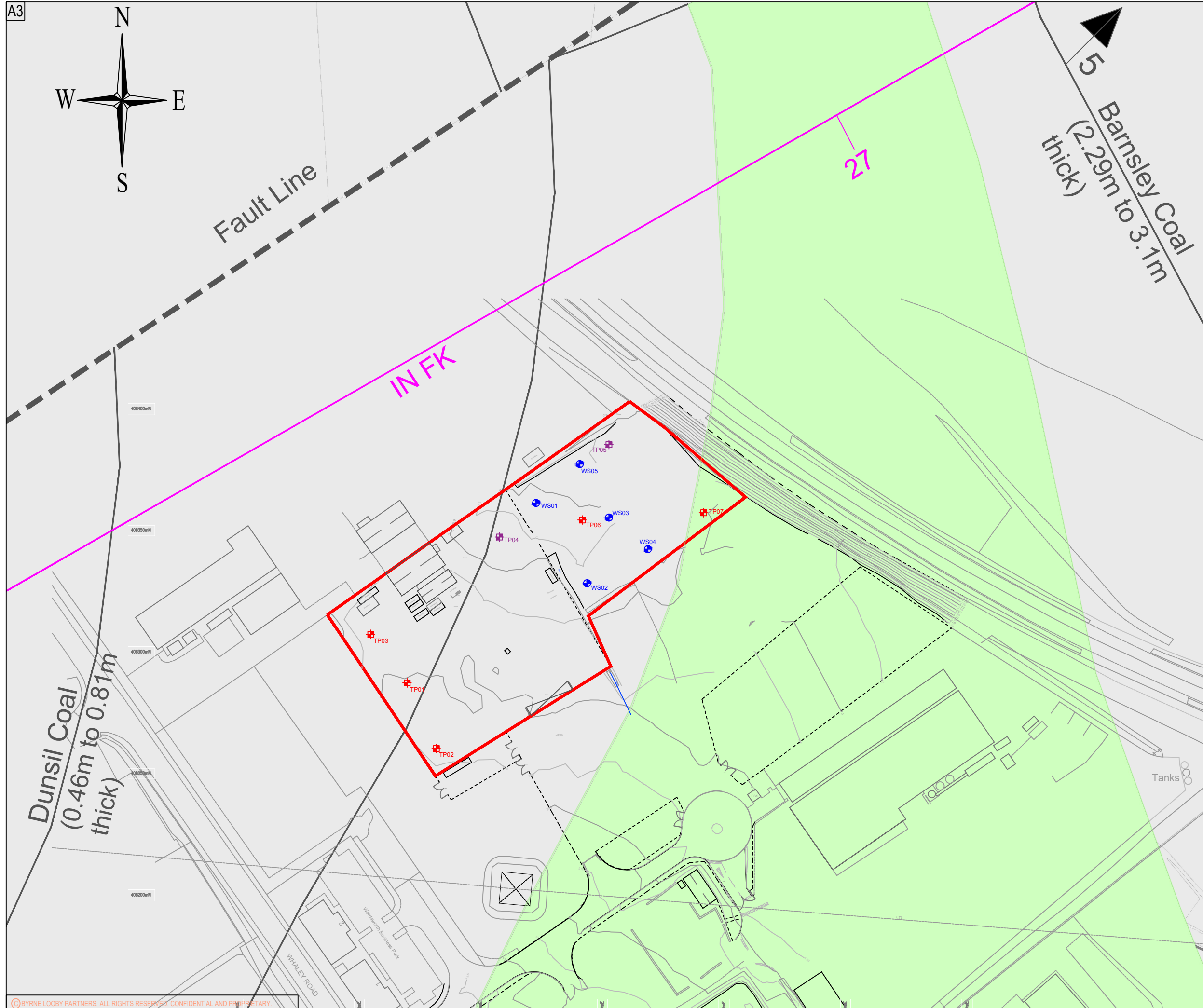
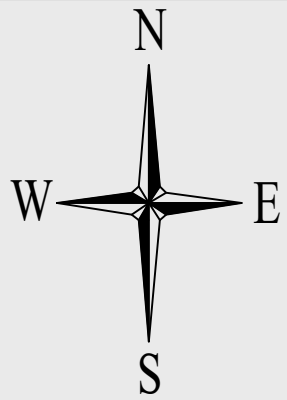
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SITE PLAN

STATUS
FOR CONSTRUCTION

Date: 03/22	Scale: 1:1000	Drawn: JM	Chk: AK	App:
Project No: 14-K0030	Drg. No: K0030-01-001	Rev:	00	

SCALE 1:5000





GENERAL NOTES

Notes

- 1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.
- 2. DO NOT SCALE FROM THIS DRAWING.
- 3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF BYRNE LOOBY

Legend

- Site Boundary
- Existing Buildings
- Trial Pits Excavated
- Soakaway Trial Pit Test
- Window Sampler Boreholes Drilled
- Sandstone
- Pennine Middle Coal Measures Formation
- Coal Seams
- Fault Line

Rev	Date	Description	By	Chk	App

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PROJECT
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DRAWING TITLE
GEOLOGICAL PLAN

STATUS
FOR CONSTRUCTION

Date: 03/22	Scale: 1:1500	Drawn: JM	Chk: AK	App: [Signature]
Project No: 14-K0030	Drg. No: K0030-01-002	Rev: 00		