REPORT C4855R1
MARCH 2013

PRELIMINARY INVESTIGATION

of land at
BARUGH GREEN, BARNSLEY

prepared for
HALLAM LAND MANAGEMENT LTD & COMMERCIAL ESTATES PROJECTS

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PREPARED FOR:	HALLAM LAND MANAGEMENT LTD & COMMERCIAL ESTATES PROJECTS		
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PRELIMINARY INVESTIGATION (DESK TOP STUDY)

of land at

BARUGH GREEN, BARNSLEY

Prepared for

HALLAM LAND MANAGEMENT LTD & COMMERCIAL ESTATES PROJECTS

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NTS: Not to Scale

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EXECUTIVE SUMMARY

Introduction	Sirius Geotechnical and Environmental Ltd (Sirius) were commissioned by Hallam Land Management Ltd (HLM) and Commercial Estates Projects (CEP) to undertake a preliminary investigation (desk study) of land at Barugh Green, Barnsley (the "site"). It is understood that HLM and CEP, who jointly own the site, are proposing to redevelop the property for a low rise residential end-use, with associated gardens/landscaping, roads and areas of public open space. Sirius have previously undertaken a geoenvironmental appraisal for the central and southern parts of the proposed development site (Report Ref: C1277, dated July 2006). This desk study report expands on the previous Sirius geoenvironmental appraisal, following a review of current search enquires for the entire development site, in addition to the review of the original Sirius geoenvironmental appraisal report, with updated interpretation of chemical results and gas monitoring data.
Site Details	The site is an irregular shaped plot of land, covering an area of approximately 10 hectares. The majority of the site is currently occupied by agricultural fields, with the exception of an area of rough grassland within the south east and a small pond within the north eastern part. An embankment, between approximately 2m and 5m high, is located within the southern part of the site. The embankment was noted to be heavily vegetated with semi-mature trees and low lying shrubs. The far south western area of the site is occupied by two residential properties with private gardens and a small gravel surfaced car park associated with a neighbouring church which fronts onto Barnsley Road.
Site History	Review of historical OS plans indicates that the majority of the site has predominantly remained undeveloped from at least 1854 to the present day, with the exception of a canal and manmade channel within the northern part of the site, cooling ponds within the southern part, and a railway cutting/embankment within the south western and south eastern parts, respectively. The canal, manmade channel, cooling ponds and railway cutting have subsequently been infilled. Within the south western part of the site the area has been occupied by residential properties from c. 1894. Significant features, recorded on the historical OS plans, within approximately 250m radius of the site include several depots, tanks, an industrial estate, reservoir (subsequently infilled), coalite works, coke & by-product works, electricity transformer station, slag heaps and refuse tips.
Anticipated/Proven Ground Conditions	The published geological information and other data gathered by this preliminary investigation indicates that the site is underlain by a variable thickness of made ground (associated with an infilled canal/manmade channel, railway cutting and infilled ponds), which in turn is underlain by alluvium within the northern part, and coal measures strata elsewhere. The made ground, and superficial deposits where present, are reported to be underlain by Haigh Moor Rock (sandstone) and undifferentiated strata of the Middle Coal Measures. The Top and Low Haigh Moor coal seams (reported to be 0.69m – 1.19m and 0.43m – 1.02m thick, respectively) are conjectured to outcrop approximately 100m and 150m to the west of the site, dipping to the north east beneath the property.

	The previous Sirius ground investigation revealed the shallow soils to comprise a variable thickness of made ground, over soft to firm, becoming stiff clay, over weathered coal measures. Rotary drilling undertaken as part of the previous Sirius ground investigation identified the Top and Low Haigh Moor coal seams to dip beneath the site to the north east. The shallowest seam was encountered at a depth of 6.00m bgl in the western part of the property, and at 18.80m bgl (the deepest this top seam was encountered) within the eastern area. This upper coal seam is on average 1.00m thick (ranged between 0.20m and 1.50m thick). A second seam was encountered in six of the eleven boreholes at 14.70m bgl in the western part of the site and 23.00m bgl in the central eastern part. The lower coal seam was recorded to be between 0.30m and 0.80m thick. Voids and/or broken ground were encountered in rotary probeholes located in the southern-central part of the site, at depths of between 9.00m and 10.80m bgl, assumed to be associated with the working of the Top Haigh Moor coal seam.
Flood Risk	According to the Envirocheck Report and the Environment Agency website, the northern and eastern parts of the site lie within an indicative Zone 2 flood plain at risk of flooding from rivers and sea, without defences. A flood risk assessment should be undertaken to determine potential risk to the proposed development. It is recommended that consultation be undertaken with the Environment Agency to determine implications of potential flooding on the proposed redevelopment. The following preliminary recommendations assume that flooding will not affect the proposed development.
Mining & Quarrying	The depth and thickness of the workings encountered as part of the previous ground investigation, in the central southern part of the site, have the potential to affect surface stability and will therefore require consolidation through drilling and pressure grouting. It is considered likely that a proportion of the site (outside the area already identified) will be affected by shallow mine workings in the Top Haigh Moor coal seam. Any housing development on site is likely to require proof drilling for all plots, and will require grouting where workings are found within influencing distance of the surface. At this stage a contingency should be included for such an eventuality. The possibility of encountering unrecorded mine entries on site cannot be discounted. Following a topsoil strip the entire area should be inspected for evidence of mine entries. Inspection of historical OS plans has revealed no evidence of quarrying on the site.
Foundations	**The preliminary foundation recommendations provided below are based on the assumption that appropriate treatment of shallow mine workings will be undertaken and that site levels remain broadly as exist at present.** Based on proven ground conditions, it is recommended that structural loads associated with the proposed residential development be supported on spread (reinforced strip/trench fill) foundations taken through any made ground, and the upper soft low strength natural clay, into natural strata of adequate strength/bearing resistance (at least firm medium strength natural clay). Foundations will need to be designed to cater for residual movement following consolidation of mineworkings; this will typically comprise reinforcement, but could require raft foundations where very shallow workings are encountered. Within the southern and south western parts of the site, within the vicinity of the infilled railway, made ground was encountered to a maximum proven depth of 3.40m

	bgl. It is considered that conventional spread foundations are not feasible within these areas because of the excessive depth required for excavation. It is therefore recommended that piled foundations or vibro-replacement methods are adopted, terminating within the underlying competent bedrock (Middle Coal Measures). For more detailed foundation recommendations please refer to Section 6.3 of this report. Within the northern and south western parts of the site (previously not investigated as part of the original Sirius ground investigation) ground conditions are expected to comprise a variable thickness of made ground (associated with an infilled canal/manmade channel and former residential properties, respectively), over alluvium within the northern part. The made ground, and superficial deposits where present, are reported to be underlain by Haigh Moor Rock (sandstone) of the Middle Coal Measures. The nature and depth of the foundations in these areas will be dependent on the detailed site geology, including: • Thickness of any made ground; • Presence/extent of any substructures; • Bearing capacity of the natural strata; • Presence of worked coal; • Groundwater levels; and, • Proximity of trees where potentially shrinkable soils are present. It is recommended that an intrusive investigation is undertaken within the northern and south western parts of the site in order to confirm the ground conditions and foundation requirements for the proposed development.
Contamination	The updated preliminary conceptual site model indicates that pollutant linkages are possible to a variety of receptors. Potential heavy metals, organic and inorganic contaminants, as well as asbestos fibres, within the made ground and shallow soils may pose a potential risk to construction workers, site end users and controlled waters. It is recommended that a site investigation is carried out to address these matters.
Gas Risk	Limited ground gas monitoring undertaken as part of the previous Sirius ground investigation indicates that the majority of the site is not impacted by hazardous gases. This is with the exception of insitu generation of elevated VOC concentrations within the railway embankment on site and a slightly elevated VOC concentration in borehole R10. Based on the gas monitoring results recorded as part of the previous Sirius ground investigation, and given the potential presence of organic rich soils (alluvium) and areas of deep made ground (associated within the infilled canal/manmade channel, railway cutting, cooling ponds etc) further boreholes and monitoring is required to establish a reliable data set to draw definitive conclusions. In the meantime, and for the purpose of estimating abnormal costs, it is suggested that the following gas protection measures be assumed in all buildings: • A well constructed ground floor slab. • A gas proof, hydrocarbon resistant welded membrane (e.g polypropylene), sealed around service penetrations and across wall cavities. • Minimum penetration of slab by services. • Ventilated subfloor void. The site lies within an area where radon protective measures are not required.

Further Works	The following ground investigation works are recommended to allow foundation/floor slab/pavement design and determination of any outstanding contamination constraints: • Trial pits or window sample boreholes (subject to access restrictions) to further investigate the near surface soil and groundwater conditions and allow recovery of soil and water samples for testing (more specifically within the northern and south western portions of the site). • CBR tests within selected trial pits. • Drilling of rotary probeholes to confirm the presence/absence of workable coal within influencing distance of the surface, and allow determination of abnormal costs associated with drilling and grouting. • Chemical (including pesticides, speciated TPH, asbestos and PCBs) and geotechnical laboratory testing to categorise the shallow soils and groundwater on a site wide basis. • Installation of gas/groundwater monitoring wells in selected window sample boreholes and rotary probeholes to assess adequately the risk from hazardous ground gas. • Gas monitoring – a minimum of 9 No. visits over 6 months. • Reporting. A flood risk assessment should be completed to assess the risks from flooding in relation to the proposed development scheme. A pre-demolition asbestos survey will be required prior to demolition of the existing buildings located within the south western part of the site.
Japanese Knotweed	Given access constraints in the south eastern and eastern parts of the site, it is recommended that an invasive plant survey be completed by an appropriately qualified consultant/contractor. The treatment of any invasive species should take place in advance of the proposed construction works.

The executive summary is an overview of the key findings and conclusions of the report. There may be other information contained in the body of the report which puts into context the findings of the executive summary. No reliance should be placed on the executive summary in isolation, particularly when deriving design detail/abnormal costs.

1. INTRODUCTION

Sirius Geotechnical and Environmental Ltd (Sirius) were commissioned by Hallam Land Management Ltd (HLM) and Commercial Estates Projects (CEP) to undertake a preliminary investigation (desk study) of land at Barugh Green, Barnsley (the "site"), to assist an outline planning application for development.

It is understood that the proposals are to develop the property for a low rise residential end-use, with associated roads, landscaping and areas of public open space.

Sirius have previously undertaken a geoenvironmental appraisal for the central and southern parts of the proposed development site (Report Ref: C1277, dated July 2006). This report included a desk study (preliminary investigation) detailing the previous uses and the environmental setting of the site, presented the results of the Sirius site investigation, and provided preliminary recommendations for foundations, road pavement design, contamination remediation measures and gas protection measures. The report also included a mining risk assessment.

The area investigated as part of the previous geoenvironmental appraisal (dated 2006) and the revised site boundary (incorporating the additional plots of land to the north and south west) are shown on the site features plan presented as Drawing No. C4855/02, within Appendix A.

This desk study report expands on the previous Sirius geoenvironmental appraisal, following a review of current search enquires for the entire development site, supplied by Landmark Information Group (LIG), the British Geological Survey (BGS), the Coal Authority (CA) and Barnsley Metropolitan Borough Council (BMBC), in addition to a review of the original Sirius geoenvironmental appraisal report, with updated interpretation of chemical results and gas monitoring data. A site inspection (walkover survey) was undertaken by a Sirius Geoenvironmental Engineer on 15th June 2012.

The objectives of this investigation were:

- To establish the historical land uses of the development site and immediate surrounding area from a review of historical OS plans;
- To establish the environmental setting of the development site;
- To evaluate whether past mining or other extractive industries could have an influence on the development site;

- To determine the potential risk to the development from hazardous ground gas sources including radon;
- To determine the potential risks from contamination, both within the site and from adjacent properties and/or processes;
- To provide preliminary recommendations in respect of foundation, floor slab and highway/pavement design for the proposed development and measures to deal with potential contamination (soils, water and gas); and,
- To provide recommendations for intrusive works required to resolve any uncertainty in the ground identified as part of this and the previous works.

This report presents the factual information available during this appraisal, interpretation of the data obtained and recommendations relevant to the defined objectives.

It has been assumed in the production of this report that the site is to be developed for a low rise residential end-use. In addition, it is assumed that ground levels will not change significantly from those described in this report. If this is not the case, amendments to the recommendations made in this report may be required.

Where the report refers to the potential presence of invasive plants (such as Japanese Knotweed) or asbestos containing materials (ACMs), such observations are for information only and should be verified by a suitably qualified expert.

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2. SITE DETAILS AND DESCRIPTION.

Table 2.1 Current Site Overview

Location	The site is located to the south of Dearne Hall Road, within the suburb of Low Barugh, approximately 5km north west of Barnsley town centre. A site location plan is included as Drawing No. C4855/01 within Appendix A.
National Grid Reference	E 431690, N 408730.
Site Area	Approx. 10 ha.
Topography & Features	The site is irregular in shape with the long axis running north east/south west. The site slopes gently downwards from west to east, with an approximate elevation difference of up to 16m. Access to the property is gained via Barnsley Road to the south west of the site and Dearne Hall Road to the north. The majority of the site is occupied by agricultural fields, currently planted with rapeseed, with the exception of an area of rough grassland within the south eastern area and a pond within the north eastern part. An embankment, between approximately 2m and 5m high, is located within the southern part of the site. The embankment was noted to be heavily vegetated with semi-mature trees and low lying shrubs. A row of sporadically spaced mature trees, aligned east/west, are located within the northern portion of the site. Overhead power lines, aligned approximately north west/south east and east/west, supported on several electricity pylons and telegraph poles were note within the eastern and southern parts of the site, respectively. At the time of the walkover survey the site was locally waterlogged, particularly within the area of rough grassland located in the south eastern part of the property and adjacent to the pond within the north eastern area. The far south western part of the site is occupied by two residential

	properties with private gardens and a small gravel surfaced car park associated with a neighbouring church which fronts onto Barnsley Road. The boundary of the site is generally delineated by either barbed wire or wooden fencing, interspersed with semi mature trees and shrubs. At the time of the walkover survey, access was limited locally within the south eastern and eastern parts of the site owing to the presence of dense vegetation and crops.
Site Boundaries	The site is bordered to the north by Dearne Hall Road, beyond which are a number of residential properties, a public house and the River Dearne, flowing from west to east. To the north west the site is bordered by residential properties which front onto Dearne Hall Road. To the east the site is bordered by a heavily vegetated, steep railway embankment, approximately 3 to 4m high. Along the toe of the embankment is a drainage ditch which feeds into the pond located within the north eastern portion of the site. To the south east the site is border by a transformer station/electricity substation and large commercial/industrial estate, including a distribution centre, garage and a car sales forecourt. Several of the industrial/commercial premises, including the distribution centre, are constructed on an embankment, elevated approximately 3m to 4m above existing site levels. The elevation of the embankment becomes shallower as the level of the site increases westwards, and becomes level at a central point along the southern boundary.
Invasive Plant Species	None identified at the time of the walkover survey. Although, given access constraints within the south eastern and eastern parts of the site, due to dense vegetation, it is recommended that an ecological survey be carried out to confirm if any invasive plant species are present.

The main site features are shown on Drawing No. C4855/02, in Appendix A to this report.

3. ENVIRONMENTAL SETTING

3.1. Introduction.

Published environmental, geological and historical data relating to the development site has been reviewed. A summary of the relevant information is provided below and a copy of the Envirocheck Report is enclosed as Appendix B. Information obtained from the Coal Authority (CA) and Barnsley Metropolitan Borough Council (BMBC), are included in Appendices C and D, respectively.

3.2. Site History.

Table 3.1 presents a summary of the site history from 1854 to 2011. It is not the intention of this report to describe in detail all of the changes that have occurred on or adjacent to the site, only those pertinent to the proposed development scheme.

Table 3.1 Site History

Map Dates	On-Site Features	Off-Site Features (only features within 500m that may affect the site are listed)
1854 - 1894	The site generally comprises undeveloped agricultural land, with sporadically spaced trees within the central portion. The "Silkstone Coal Branch" railway, aligned approximately north east/south west, is shown within the southern part of site. The railway is shown to be constructed within/on a cutting and embankment within the south western and south eastern parts of the site, respectively. A well is shown adjacent to the railway, within the southern part of the site. By the 1891 OS plan the well has been removed/decommissioned/infilled. A canal (Aire and Calder Navigation Barnsley Branch) and associated locks, is shown within the northern portion of the property, aligned east/west.	The site is located within a predominantly rural setting. The village of Barugh is shown 100m to the south west of the site. The site is bordered to the north by a road (annotated on the later OS plans as Dearne Hall Road), aligned approximately north east/south west. Barugh Mill (Corn) is shown immediately to the north of the site. The site is bordered to the east by the "Lancashire and Yorkshire Railway - Barnsley Branch", aligned approximately north/south. The junction between the "Lancashire and Yorkshire Railway - Barnsley Branch" and "Silkstone Coal Branch" railways (annotated on the later OS plans as Silkstone Junction) is shown immediately adjacent to the eastern site

Map Dates	On-Site Features	Off-Site Features (only features within 500m that may affect the site are listed)
	A channel constructed from the River Dearne (reported on the later OS plans to be flowing from north to south into the canal) is shown within the far northern part of the site.	boundary. A Methodist Church is shown immediately to the south west of the site. A reservoir, annotated as "Wilson's Reservoir (Aire & Calder Navigation)" is shown approximately 50m to the east of the site. The River Dearne is shown 20m, north of the site, flowing from north to south. A tributary to the River Dearne (annotated as Cawthorne Dike on the later OS plans) is shown flowing from west to east approximately 100m to the north west of the site A pump is noted 30m to the north of the site. Several wells are noted within the village of Barugh; the closest of which is located 90m to the south west of the site. A sandstone quarry is evident 240m to the south of the site, referred to as Clay Cliffe Quarry. Belle Vue, Speedwell and New Speedwell collieries, and associated coal pits and ventilation shafts, are shown between 950m and 1.2km to the north east of the site.
1894 - 1931	A row of terrace properties are shown within the south western part of the property.	An area of marshland is shown approximately 75m to the east of the site, adjacent to Silkstone Junction. Darton Colliery, with associated dayhole and air shafts is shown approximately 650m to the north east of the site. An area "liable to flooding" is shown adjacent to the River

Map Dates	On-Site Features	Off-Site Features (only features within 500m that may affect the site are listed)
		Dearne, approximately 650m to the north of the site.
1931 - 1962	Two cooling ponds are shown within the central southern part of the site.	Land immediately to the south and south east of the site is shown to have been developed with numerous industrial properties, including Barugh Coke & By-Products Works, a coalite works, and chemical works, with associated railway sidings, cooling ponds, tanks, chimney, aerial cables, and numerous large slag/stone stockpiles. On the 1956 OS plan Wilson's Reservoir, located 50m to the east of the site, is no longer shown and assumed to have been infilled. Darton Colliery located 650m to the north east of the site is recorded as disused.
1962 - 1970	The two cooling ponds located within the central southern part of the site appear to have been infilled. A drainage channel is shown, flowing approximately from south west to north east, within the vicinity of the former cooling ponds. The canal located within the northern part of the property, appears to have been infilled and the area is shown as marshland. Although the channel constructed from the River Dearne is still evident.	A depot is shown immediately to the south west of the site. The Aire and Calder Navigation Barnsley Branch Canal located to the east and west of the site is annotated as disused, and sections of the canal appear to have been infilled.
1970 - 1980	The drainage channel located within the southern part of the site is no longer shown, and is assumed to have been infilled. The channel constructed from the River Dearne, located within the northern part of the site, is no longer shown and assumed to have been infilled. The railway running along the	Land formerly occupied by Barugh Coke & By-Products Works, the coalite works and chemical works, to the south of the site, is shown to have been cleared, and the area is predominantly annotated as "Tip (disused)'. An electricity transformer station is shown immediately to the south east of the site.

Map Dates	On-Site Features	Off-Site Features (only features within 500m that may affect the site are listed)
	southern boundary of the property has been dismantled. Overhead electricity transmission lines, running north/south and east/west, are present within the eastern and southern parts of the site, respectively.	The depot to the immediate south is referred to as a coach works. Several tanks are noted within the confines of Dearne Hall, located immediately to the west of the site. Several disused tips are annotated to the north east of the site; the closest of which is located 500m from the property. An area of "opencast workings" is annotated approximately 800m to the south east of the site.
1980 - 2006	The cutting associated with the former railway, located within the south western part of the site, appears to have been infilled.	Several works and depots, with associated tanks, are shown immediately to the south of the site.
2006 - 2011	A small pond is shown within the north eastern part of the property.	The works and depots located immediately to the south of the site are collectively annotated as the South Yorkshire (Redbrook) Industrial Estate.

3.3. Geology.

A summary of available published geological information is provided within Table 3.2 below.

Table 3.2 Geological Summary

Sources of Information	The following sources of information have been referenced: • BGS 1:50,000 scale geological map (Sheet 87 Barnsley, Solid and Drift Edition). • BGS 1:10,000 scale geological map (SE 30 NW). • BGS lexicon of named rock units. • The Coal Authority (CA) Mining Report. • BGS on-line borehole records.
Made Ground	Made ground is recorded on the published 1:10,000 scale geology sheet within the south western part of the site, associated with the infilled railway cutting. Although not reported on the geological plans, areas of deep made ground are anticipated within the southern and northern parts of the site associated with the infilled cooling ponds and canal/channel, respectively. Areas of made ground, annotated as "domestic refuse" and "industrial refuse and quarry debris on colliery waste" are shown immediately to the east and south east of the site associated with the former Wilson's Reservoir and disused tips/slag heaps shown on the historical OS plans, respectively. An area of "worked-out opencast coal-seam (backfilled) or backfilled quarry" is reported a short distance to the south west of the site.
Drift Geology	Drift deposits are reported to be absent across the majority of the site with the exception of the northern part which is shown to be underlain by alluvium associated with the River Dearne and its zone of influence.
Solid Geology	The site is reported to be underlain by strata of the Middle Coal Measures (Carboniferous), dipping at approximately 3º to the north east. The Haigh Moor Rock (Sandstone) is shown below the majority of the site, with the exception of the south eastern part of the property, which is reported to be underlain by undifferentiated strata, comprising mudstone, siltstone,

	sandstone and coal.	
Faults	An east/west orientated fault, downthrowing to the north, is conjectured in the northern most part of the site.	
BGS Borehole Records	Exploratory hole records provided by the BGS (available on-line) were examined as part of this preliminary investigation. Available records included four trial pits (SE 30 NW 140 - 143) excavated by Norwest Holst in 1981 approximately 100m to the south west of the property. The trial pit records indicate the area to the south west of the site to be underlain by made ground to approximately 4.20m and 4.90m below ground level (bgl), which in turn is underlain by weathered grey mudstone to a maximum proven depth of 6.50m bgl. A borehole (SE 30 NW 24) drilled by the National Coal Board (dated October 1971) approximately 50m to the south east of the property, was also reviewed. This borehole record refers to a rotary borehole drilled to a depth of c. 150m bgl. The borehole was drilled with rotary open hole techniques to a depth of c. 92m bgl and subsequently no strata description are recorded. Below c. 92m the solid geology was generally recorded to comprise undifferentiated mudstone, siltstone, sandstone and seat earth of the Middle Coal Measures strata. The Silkstone (c. 1.80m thick), Black Band (c. 1.10m thick) and Whitmore (c. 1.18m thick) coal seams were recorded with the borehole at depths of c. 90m, 137m and 147m bgl, respectively.	
Mining and Quarrying	**Coal Seams:**	The Top and Low Haigh Moor coal seams are conjectured to outcrop approximately 100m and 150m to the west of the site, dipping to the north east beneath the property. The Swallow Wood coal seam is conjectured to outcrop immediately to the east of the property. Review of the generalised vertical section provided with the 1:10,000 scale geological plan indicates the Top and Low Haigh Moor coal seams and the Swallow Wood coal seam to be 0.69m to 1.19m thick, 0.43m to 1.02m thick, and 0.30m to 1.15m thick respectively.

	Coal Mining:	The Coal Authority (CA) Report states: • *"The property is in the likely zone of influence from past workings in four seams of coal at shallow to 170m depth, and last worked in 1984"*. • *The property is not in the likely zone of influence of any present underground coal workings".* • *"The property is not in an area for which the CA is determining whether to grant a license to remove coal using underground methods".* Consultation with the CA has confirmed that the shallowest worked seam beneath the site to be the Top Haigh Moor coal seam. A copy of the abandonment plan (obtained from the CA) for the Top Haigh Moor coal seam is included within the previous Geoenvironmental Appraisal Report, contained in Appendix E. This plan confirms the location and extent of the Barugh Colliery and shows that mine workings encroach into the central southern part of the property.
	Mine Entries:	There are no known coal mine entries within, or within 20 metres of, the site.
	Quarries/ Opencast:	The historical OS plans examined as part of this preliminary investigation do not indicate the presence of any pits or quarries on site. However, an infilled sandstone quarry and backfilled opencast workings to the Low and Top Haigh Moor coal seams are annotated/reported on the 1:10,000 scale geological plan a short distance to the south and south west of the site, respectively

3.4. Hydrology and Hydrogeology.

A summary of available information pertaining to hydrology and hydrogeology is presented in Tables 3.3 to 3.5 below.

Table 3.3 Surface Water Features

	Presence/location	Comments
Environment Agency (EA) GQA Classified Watercourses (within 500m)	There are two EA GQA Classified watercourses within 500m of the site. The nearest classified watercourse is the River Dearne, located to the north of the site. The GQA grade of the River Dearne adjacent to the northern site boundary, in addition to 141m and 212m to the north of the site, is classified as River Quality C – Fairly Good.	Cawthorne Dike, located approximately 100m to the north west of the site at its closest point, is also classified under the EQ GQA scheme. The GQA grade of Cawthorne Dike 127m to the north of the site is classified as River Quality C – Fairly Good.
Surface Water Features i.e. Canals, Ponds, and Lakes etc (within 250m)	There is a pond located within the north eastern part of the site.	A pond/surface water feature, previously forming part of the Aire and Calder Navigation Canal (the majority of which has been infilled), is located approximately 150m to the east of the site.
Unclassified Watercourses (within 500m)	A drainage ditch runs along the toe of the railway embankment, located immediately to the east of the site. The drainage ditch issues into the pond located within the north eastern part of the site.	A drainage ditch, flowing approximately from south west to north east, is located immediately adjacent to the south eastern site boundary.

Licensed Surface Water Abstractions (within 1km)	There are no known surface water abstractions within 1km of the site.	
Flood Risk Status	The majority of the site does not lie within an indicative flood plain at risk from flooding from rivers and sea. The exception to this is the northern and north eastern areas of the site, which are reported to lie within a Zone 2 Indicative Fluvial Floodplain, associated with the River Dearne.	Land immediately to the north of the site is indicated to be located within Zone 2 and Zone 3 Indicative Floodplains, associated with the River Dearne and Cawthorne Dike. In addition, land immediately to the north west of the site is classified as a Flood Water Storage Area.

Environment Agency GQA Assessment: A = Very Good to E = Poor

A flood risk assessment should be completed to assess the risks from flooding in relation to the proposed development scheme. It is recommended that consultation be undertaken with the EA to determine the implications of potential flooding on the proposed development.

Table 3.4 Groundwater Occurrence and Abstraction

	Presence/location	Comments
Licensed Groundwater Abstractions (within 1km)	There is one recorded groundwater abstraction within 1km of the development site; this is located 819m to the north.	The status of the license is reported as active and relates to the abstraction of groundwater for commercial use (pubs).
Source Protection Zone.	The site is not located within a source protection zone (SPZ).	
Potable Water Abstraction (within 2km)	There are no recorded potable water abstraction licenses within 2km of the property.	

Table 3.5 Groundwater Vulnerability Status

	Environment Agency Classification
Groundwater Classification	Both the superficial deposits (Alluvium) recorded beneath the northern most part of the site, and the underlying bedrock (Middle Coal Measures) are classified as Secondary A Aquifers under the aquifer classification system developed by the EA. A 'Secondary A Aquifer' is defined as 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

3.5. Landfilling and Waste Management.

Table 3.6 Waste Management Activities

	Presence/location	Comments
Historical Landfill Sites **(within 500m)**	There is one historical landfill site recorded within boundary of the property. This relates to the infilled railway cutting located in the southern part of the property. The landfill waste is recorded as "deposited waste including inert waste".	There are a further seven historical landfill sites within 500m of the property; the closest of which is located approximately 49m to the south east and was licensed to accept "deposited waste including inert waste". The other landfill sites within 500m of the property are recorded to be located approximately 162m to the north and between 347m and 498m to the south. These landfills were licensed to accept inert, industrial and commercial waste.
Local Authority Recorded Landfill Sites **(within 500m)**	There is one local authority recorded landfill site located within the boundary of the property; this relates to the infilled railway cutting within the southern area. Information obtained from Barnsley Metropolitan Borough Council (BMBC) with regard to the landfill on-site indicates that the former railway cutting was infilled with inert material. The landfill has been classified by	A further six landfill sites are recorded within 500m of the property; the closest of which is 42m to the south east. According to BMBC the closest landfill recorded off-site was licensed to accept construction, demolition and excavation waste. This landfill has been classified as a category 4 site by BMBC, indicating that the waste accepted is considered unlikely to give rise to landfill gas in

	Presence/location	Comments
	BMBC as a category 2 site, indicating that insufficient information is available for the local authority to provide an assessment/response on the gassing state of the landfill.	substantial quantities. The other five recorded landfill sites within 500m of the property generally correspond with the historical landfill sites detailed above.
Registered Landfill Sites (within 500m)	There are four registered landfill sites within 500m of the property, the closest of which is located 116m to the south east. The status of the license is reported as "revoked".	This license was held by C Langfield, located at Claycliffe Road Industrial Estate. The landfill was licensed to accept excavation, construction and demolition waste.
Other Licensed Waste Management Facilities (within 500m)	There are no licensed waste management facilities recorded within 500m of the property.	
Evidence of Landfilling on or within 250m of the Site.	In addition to the infilled railway cutting (detailed above), review of historical OS plans has identified an infilled canal and manmade channel within the northern part of the site and two infilled cooling ponds within the southern part.	Review of the 1:10,000 scale geological survey map (sheet SE 30 NW), indicates an area of made ground, annotated to comprise domestic refuse, immediately to the east of the site. This area of made ground is assumed to be associated with an infilled reservoir identified on the historical OS plans.
Walkover Evidence of Fly-Tipping on Site.	None noted. However, access was locally limited at the time of the walkover survey within the south eastern and eastern parts of the	Fly tipped material was noted in the vicinity of the former canal, located approximately 150m to the east of the site.

	Presence/location	Comments
	site, due to dense vegetation.	
Ground Gas Risk Assessment Required?	Yes.	Hazardous ground gas associated with: • Areas of deep made ground on site (more specifically the former railway cutting, cooling ponds and canal/manmade channel located on site). • Potential risk from volatile organic compounds (VOCs) associated with the area formerly occupied by the railway land and areas of deep made ground. • Marsh gas associated with the underlying natural alluvial soils within the northern most part of the property. • Potential mine gases associated with the underlying Middle Coal Measures strata. • Potential risk from areas of deep made ground located off site (including several historical landfill sites and infilled opencast workings, quarries and a canal)

3.6. Radon Risk.

To determine whether the site is at risk from radon gas, the BRE Document "BRE 211 - Radon: Guidance on the protective measures for new dwellings" together with the National Radiological Protection Board (NRPB) "Radon Atlas of England and Wales" have been referenced.

These documents, together with a geological assessment contained within the Envirocheck Report, which includes information obtained from the Health Protection Agency (HPA) and British Geological Survey, state that the site lies within an area in which **radon protective measures are not required**.

3.7. Other.

Other potentially contaminative activities or environmental constraints are listed below. The entries relate to activities within approximately 250m of the site, with the exception of Control of Major Accident Hazard (COMAH) facilities where the assessment is extended to a distance of approximately 1km from the site.

- There are two Local Authority Pollution Prevention and Control licenses recorded within 250m of the property; the closest of which is located immediately to the north of the site and relates to "coal, coke and coal product processes". The status of the license is reported to have been surrendered by the operator.

- There are seventeen EA recorded pollution incidents to controlled waters within 250m of the development site; one of which refers to an incident within the northern part of the property. This incident was reported in April 1997, and involved the discharge of 'fire water' resulting in a Category 3 (minor) impact to water. The receiving water is reported as a freshwater stream/river (River Dearne Tributaries).

- There is one COMAH facility within 1km of the property; this is located approximately 750m to the north and is licensed to Stiller Group North Limited. The status of the license is recorded as active and is classified as an 'Upper Tier' facility.

- There are six active potentially contaminative trade entries within 250m of the site listed within the Envirocheck Report; these include garage services, coal and smokeless fuel merchants/distributers, road haulage services and wire manufacturers.

- There are three current discharge consents within 250m of the site, the closest of which is located approximately 134m to the north east and relates to the discharge of 'sewage effluent: discharge - storm effluent'. The receiving water is reported as "unknown".

- Land to the north, east and west of the site is classified as an area of adopted greenbelt.

3.8. Regulatory Searches.

A request was made by Sirius to the Environmental Health Department of Barnsley Metropolitan Borough Council (BMBC) for any information they have concerning the site with regards to landfill, contaminated land, Part A & B processes, nuisances and reported incidents that may impact the site. Their full reply is included within Appendix D of this report. Salient points not previously referred to are summarised below:

BMBC state that:

- *"We* (BMBC) *have information of previous uses that may have caused contamination to occur. The details are listed below"*

    - *1880/1900 – Railway and canal.*
    - *1930 – Railway, canal and cooling ponds.*
    - *1960 – Railway, infilled canal and infilled cooling ponds.*
    - *1990 – Landfilled railway cutting.*

- *"We have no records of any pollution incidents relating to the site".*
- *"We are not aware of any private water supplies within 1km of the site".*
- *"We have not received any complaints regarding the site that could be investigated for statutory nuisance in the last three years".*
- *"There are no LAIPPC Authorised Processes operating on the above site or within 250 metres".*

Information was requested from the Building Control and Mineral Planning Department at BMBC, but responses were not received.

4. PREVIOUS INVESTIGATION

4.1. Sirius Geoenvironmental Appraisal Report (Ref: C1277, dated July 2006)

A previous investigation has been undertaken at the site by Sirius, dated July 2006 (report ref. C1277, Geoenvironmental Appraisal of land at Barugh Green, Barnsley, prepared for Hallam Land Management Ltd).

The area investigated as part of the original Sirius ground investigation is shown on the site features plan presented as Drawing No. C4855/02, within Appendix A.

An electronic copy (on CD) of the previous Sirius geoenvironmental appraisal report is contained within Appendix E. This report should be read in conjunction with the previous geoenvironmental appraisal report. A summary of salient findings are included below.

Fieldworks

Fieldworks forming part of the original Sirius ground investigation were undertaken between 7th and 15th June 2006 and comprised:

- The excavation of forty-nine machine dug trial pits (TP1 – TP49) to depths of between 1.00m and 4.10m bgl.
- The boring of thirty-one rotary probeholes (R1 – R31) to depths of between 4.50m and 30.00m bgl.
- The drilling of seven window sample boreholes (WS1 – WS7) to depths of between 2.00m and 4.00m bgl.

Gas and groundwater monitoring wells were installed within selected window sample boreholes and rotary probeholes, including WS5 - WS7, R5, R6, R10, R11 and R13.

Ground Conditions

The majority of the site was found to be underlain by reworked topsoil, over clay and weathered bedrock (mudstone and sandstone).

Reworked topsoil, described as sandy locally gravelly clay, was encountered within the rotary probeholes and trial pits to depths of between 0.10m and 0.40m bgl.

Within the window sample boreholes drilled along the existing embankment that housed the former railway line, located within the southern and south eastern parts of the site, made ground was encountered to depths between 0.15m and 2.80m bgl. The made ground typically comprised sand with gravel sized fragments of ash, sandstone and brick.

Within trial pits TP1, TP4, TP7, TP8 (located adjacent to the south western site boundary) and TP44 (located adjacent to the southern boundary of the property), below the reworked topsoil, granular made ground, described as a fine to coarse gravel, was proven to depths of between 2.80m and 3.40m bgl.

Within trial pits TP43 – TP47 located along the southern site boundary, the reworked topsoil was found to be underlain by made ground, described as soft black organic clay with rare gravel, to depths of between 0.80m and 1.90m bgl. These exploratory locations are believed to have been excavated within the former railway cutting.

Trial pits TP48 and TP49 were excavated within the assumed location of the infilled cooling ponds, in the southern part of the site. Below the reworked topsoil, a clay fill was encountered to a depth of 0.90m, which in turn was overlying a gravel fill, described as gravel of sandstone and mudstone, to a proven depth of 2.70m bgl.

The topsoil/made ground was generally found to be underlain by firm and stiff, medium and high strength clay with gravel sized fragments of sandstone and mudstone, to depths of between 1.50m and 4.80m bgl. This material was considered to be representative of the residual bedrock.

Within the central and northern areas of the site an upper layer of soft, low strength clay was encountered to depths typically between 0.50m and 1.20m bgl. The exception to this was TP41 located within the central eastern part of the site, where the soft clay was encountered to a depth of 1.90m bgl.

Atterberg Limit determinations undertaken on selected samples of the cohesive residual bedrock indicated the material to be clay of low to intermediate plasticity and low to medium volume change potential.

Sandstone and mudstone bedrock was encountered beneath the majority of the site, at depths of between 1.50m and 4.80m bgl.

Two coal seams were encountered within the rotary probeholes, dipping toward the north east. The shallowest seam was encountered at 6.00m - 7.00m bgl in borehole R5 located in the western part

of the site, and at 18.80m to 19.80m bgl in borehole R27 (the deepest this top seam was encountered) located within the eastern part. This seam is on average 1.00m thick (ranged between 0.20m and 1.50m).

A second seam was encountered in six of the rotary probeholes at depths of between 14.70m bgl in the western part of the site and 23.00m bgl in the central eastern part. This seam was recorded to have an average thickness of 0.56m (ranging between 0.30m and 0.80m thick). Intervening strata ranged between 5.50m and 8.50m (average 7.50m) in thickness. Triangulation of the borehole data indicates that the strata is dipping at approximately 3.5° to the north east.

Voids and/or broken ground were encountered in boreholes R14, R16, R30 and R31, located in the southern-central part of the site, at depths of between 9.00m and 10.80m bgl in the shallower (Top Haigh Moor) coal seam.

No significant visual/olfactory evidence of contamination was noted as part of the previous Sirius ground investigation. However, locally within TP43 and TP45 - TP47, located within the former railway cutting, a faint hydrogen sulphide odour was recorded within the cohesive made ground soils.

Groundwater Conditions

Rapid inflows of sub artesian groundwater were recorded in rotary probeholes R14 and R16, located within the southern part of the site, at depths of 9.00m and 10.20m bgl, respectively. These inflows correlate with the voids/broken ground recorded within these probeholes, and are considered to be representative of flooded mine workings.

Groundwater was encountered during the drilling of probeholes R1, R2, R4, R10 and R27 at depths of between 8.00m and 17.50m bgl.

Subsequent groundwater monitoring of the gas/groundwater monitoring wells installed within selected rotary probeholes and window sample boreholes indicated the groundwater level, where present, to be between 0.72m and 8.70m bgl.

Laboratory Analyses & Interpretation

Selected samples of soils and groundwater were taken during and post fieldworks and analysed for a range of determinants (including metals, organic compounds and polycyclic aromatic hydrocarbons (PAHs)) at a UKAS accredited chemical laboratory.

A copy of the laboratory data obtained during the previous Sirius ground investigations is provided on a CD, within Appendix E.

As part of the previous Sirius geoenvironmental appraisal the results of the analytical data were compared against Generic Assessment Criteria (GAC) current at the time of issue (July 2006), many of which have since been revised/superseded. The results of the chemical testing (soil, leachate, and groundwater) obtained as part of the previous Sirius geoenvironmental appraisal have been reassessed in relation to current GACs derived for a residential with gardens end-use.

Analytical data from leachate and groundwater testing have been evaluated against GAC values appropriate to the conceptual model for the site, based on Freshwater EQS Levels and a receiving water hardness of 400mg/l (recorded within the groundwater samples tested as part of the previous Sirius ground investigation).

Source data for all GACs are provided in Appendix F.

Usually statistical testing is undertaken for the Planning Scenario by the methods described in CL:AIRE & CIEH “Guidance on Comparing Soil Contamination Data with a Critical Concentration”, May 2008. This statistical testing is undertaken to determine whether there was sufficient evidence that the true mean concentration of each determinant was less than the relevant critical concentration for that component. Statistical analysis has not been considered appropriate in this instance due to the heterogeneous nature of the made ground soils.

Soil Analysis

Table 4.1 provides a summary of the contaminants of concern identified in the samples of made ground and natural soils tested as part of the previous Sirius ground investigation for the combined development site at concentrations greater than the current GAC values for a residential with gardens end-use.

Table 4.1 Summary of Total Soil Concentrations and Generic Quantitative Risk Assessment

Determinand	Current GAC Value (1% SOM - mg/kg)	Range of Concentrations Above Respective GAC(mg/kg)	No. of samples above GAC	Sample Reference exceeding GAC
Metals				
Arsenic	32	37 - 78	2	WS4 - 0.20m TP43 - 0.50m
Inorganics				
Total Sulphate	2400	37,000	1	TP43 - 0.50m
Water Sol. Sulphate	500mg/l	1,800mg/l	1	TP43 – 0.50m
Organics				
Benzo(a)pyrene	0.83	9.8	1	WS5 - 1.80m
Benzo(a)anthracene	3.3	12	1	WS5 – 1.80m
Benzo(b)fluoranthene	5.6	14	1	WS5 – 1.80m
Naphthalene	0.68	1.3 - 16	4	TP43 – 0.50m WS1 – 0.05m WS4 – 0.20m WS5 – 1.80m
Chrysene	6.1	12	1	WS5 – 1.80m
Indeno(1,2,3-c,d)pyrene	3.2	5.7	1	WS5 – 1.80m
Others				
Calorific Value	2MJ/kg	2.1MJ/kg – 2.9MJ/kg	2	WS1 – 0.05m WS4 – 0.20m

Elevated concentrations of arsenic were recorded within WS4 at 0.20m bgl (granular made ground) and TP43 at 0.50m bgl (cohesive made ground), located in the area of the former railway cutting and on the toe of the former railway embankment, respectively.

Elevated concentrations of individual PAH species (including naphthalene, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, indeno(1,2,3-c,d)pyrene and chrysene) were recorded within three samples of granular made ground encountered within the window sample boreholes located on the former railway embankment, and a sample of cohesive made ground encountered within the TP43 excavated into the infilled railway cutting.

Marginally elevated calorific values of 2.1MJ/kg and 2.9MJ/kg were recorded in two samples of made ground obtained from WS1 at 0.05m bgl and WS4 at 0.20m bgl. These samples were noted to both contain fine sand of ash.

An elevated concentration of total sulphate was recorded in a sample of cohesive made ground obtained from TP43 at 0.50m bgl. Sulphate is not considered to pose a significant risk to human health under normal circumstances.

Elevated concentrations of total organic carbon (TOC) were encountered within nine samples of the reworked topsoil between 0.10m and 0.20m bgl and one sample of cohesive made ground. The GAC is based on the Hazardous Waste (England and Wales) Regulations 2005. TOC content in itself does not represent a potential risk to human health. This GAC is provided for indicative assessment of disposal options; in the case that off-site landfill of soil is undertaken. This GAC is specified at the 'Inert' waste threshold and should therefore be considered as for information purposes only.

Leachate Analysis

Laboratory testing revealed elevated levels of leachable phenol within three samples (including natural clay) which exceed the maximum admissible concentration specified in the Water Supply (Water Quality) Regulations 1989. A maximum concentration of 0.91ug/l within TP43 (0.50m) was detected, in comparison to a screening value of 0.5ug/l. All samples were well below the EQS threshold value for phenol.

The pH of two samples tested fell outside the screening range. A pH of 5.1 was recorded within TP2 at 1.0m (natural clay).

However, on the basis that the some of the site will be hardsurfaced, therefore limiting surface water infiltration and leachate generation, and the presence of impermeable cohesive strata underlying the site, hence reducing flow paths, it is considered that the slightly acidic leachate and slightly elevated concentrations of leachable phenol are unlikely to pose a significant risk to controlled waters.

Groundwater Analysis

The results of the groundwater testing revealed an elevated concentration of zinc compared to the EQS threshold value, with a recorded concentration of 510ug/l within borehole R6.

In addition, a pH value of 5.7 was recorded in the groundwater sample collected from borehole R5.

Gas Monitoring

As part of the previous Sirius ground investigation four ground gas monitoring visits were undertaken over a 4 week period.

The results of the ground gas monitoring revealed background concentrations of carbon dioxide (<5.0% v/v) and non detectable concentrations of methane, coupled with locally low initial gas flow rates. No constant gas flow was detected.

In addition to the above, VOC concentrations were monitored with a photo-ionisation device (PID) during three of the monitoring visits. Locally elevated VOC concentrations (>1ppm) were detected within a number of monitoring wells, with a maximum reported concentration of 31.7ppm within WS5.

5. PRELIMINARY CONCEPTUAL SITE MODEL

Based on the findings of the intrusive investigation completed by Sirius in 2006 and this Preliminary Investigation, and in order to include the amended site boundary, the preliminary conceptual site model (PSCM) derived as part of the original Sirius Geoenvironmental Appraisal has been updated/revised. The PCSM has been derived for the proposed future land use (residential with gardens).

The PCSM summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors in order to assess potential pollutant linkages.

In assessing the likely contaminants present at the site, reference has been made to the Industry Profile reports, including *'Railway land'* and *'Waste recycling, treatment and disposal sites: landfills and other waste treatment or disposal sites',* issued by the Department of the Environment and other relevant supporting documentation.

A qualitative risk assessment has also been made of the likelihood of any pollutant linkage operating and its potential significance.

The preliminary conceptual model is presented in schematic form as Drawing No. C4855/03, presented in Appendix A.

In summary, the preliminary CSM has identified the following potential pollutant linkages which could result in an unacceptable risk to the proposed end-use, denoted as moderate or higher risk on the CSM:

- Ingestion, inhalation and dermal contact with potential heavy metals, hydrocarbons (including TPH), within the made ground and shallow natural soils encountered within the northern and south western part of the site (acquired since the issue of the original Sirius geoenvironmental appraisal report).

- Ingestion, inhalation and dermal contact with potential asbestos fibres, pesticides (associated with the agricultural use of the site) and PCBs (associated with former railway land) within the made ground and shallow natural soils encountered at the site.

- Ingestion, inhalation and dermal contact of locally marginally elevated concentrations of arsenic and individual PAH species detected within the shallow made ground encountered within the vicinity of the infilled railway cutting and former railway embankment.

- Leachable heavy metals, inorganic and organic contaminants in the made ground and/or shallow natural soils, encountered within northern and south western parts of the site (acquired since the issue of the original Sirius geoenvironmental appraisal report) with the potential to impact controlled waters (principally the River Dearne, pond feature on site and the underlying Secondary A Aquifers).

- Locally potentially combustible ash fill encountered within the shallow made ground encountered within the vicinity of the former railway embankment within the south eastern part of the site.

- Risk from hazardous gas sources, including areas of deep made ground both on-site and off-site (more specifically associated with the infilled railway cutting, cooling ponds, canal, and man-made channel located on site).

- Risk from naturally occurring hazardous gases (including marsh gasses arising from the natural organic alluvial soils underlying the northern portion of the site and mine gases from the underlying coal seams/workings recorded/identified across the site).

- Inhalation of vapours (VOCs) identified during the initial Sirius ground investigation.

- Asbestos containing materials (ACMs) within the infrastructure of the existing building located within the south western part of the site posing a **low** risk to construction/demolition workers and adjacent site users, **providing an appropriate method of removal/demolition is undertaken.**

- Concrete attack associated with elevated concentrations of sulphate within the shallow made ground encountered within the infilled railway cutting.

6. CONCLUSIONS AND RECOMMENDATIONS.

6.1. General.

It is understood that the proposals are to develop the property for a low rise residential end-use, with associated gardens/landscaping, roads and areas of public open space.

This report has been compiled to assist an outline planning application for the proposed usage, assuming development levels will remain broadly as existed at the time of the investigation.

6.2. Flood Risk.

According to the Envirocheck Report and the Environment Agency website, the northern and eastern parts of the site lie within an indicative Zone 2 flood plain at risk of flooding from rivers.

A flood risk assessment should be compiled in order to assess the risk from flooding to the proposed development. It is recommended that consultation be undertaken with the Environment Agency to determine implications of potential flooding on the proposed development.

The following preliminary recommendations assume that flooding will not affect the proposed development.

6.3. Geotechnical Constraints.

Mining and Quarrying

Based on the site's geological setting and the findings of the previous intrusive investigation a potential risk exists to surface stability at the site from mine workings in the Top and Low Haigh Moor coal seams.

From information obtained from the Coal Authority, Barugh Colliery formerly existed 250m south of the property, from which the Top Haigh Moor coal seam was mined. Workings are known to encroach into the central southern part of the site.

Rotary drilling undertaken as part of the previous Sirius ground investigation identified the Top and Low Haigh Moor coal seams to dip beneath the site to the north east. The shallowest seam was encountered at a depth of 6.00m bgl in the western part of the property, and at 18.80m bgl (the deepest this top seam was encountered) within the eastern area. This upper coal seam is on average 1.00m thick (ranged between 0.20m and 1.50m thick).

A second seam was encountered in six of the eleven boreholes advanced to 30m bgl. This seam was encountered at 14.70m bgl in the western part of the site and 23.00m bgl in the central eastern part. The lower coal seam was recorded to be between 0.30m and 0.80m thick. Intervening strata between the coal seams ranged between 5.50m and 8.50m (average 7.50m) in thickness.

Voids and/or broken ground were encountered in rotary probeholes R14, R16, R30 and R31, located in the southern-central part of the site, at depths of between 9.00m and 10.80m bgl, assumed to be associated with the working of the Top Haigh Moor coal seam. The voids found in the southern-central part of the site are consistent with the recorded extent of workings in the Top Haigh Moor coal seam from Barugh Colliery.

For typical Coal Measures strata, it is generally accepted that there is a risk of surface instability where the thickness of competent bedrock above the worked coal seam is less than 10 times the seam thickness. On this basis it is considered that the depth and thickness of the workings, encountered within the central southern part of the site, have the potential to affect surface stability and will therefore require consolidation through drilling and pressure grouting. Within the exception of the northern and eastern most areas, the upper seam of coal has the potential to affect surface stability, but no evidence of workings have been encountered. It is considered likely that a proportion of the site (outside the area already identified) will be affected by shallow mine workings in the Top Haigh Moor coal seam.

Within the most northern and eastern parts of the site, it is considered likely that there is sufficient competent rock cover above the upper coal seam encountered, to mitigate against any surface instability. This, and the position of the fault, should however be confirmed through rotary probing.

Based on these assumptions it is recommended that a contingency be included for treating potential shallow workings beneath the majority of the site (say approximatey 75% of the total site area). It is recommended that the ground below plots and adoptable highways, located within areas of the site where insufficient rock cover is present to mitigate against surface instability, be stabilised by drilling and pressure grouting on a closely spaced grid. The grid should extend beyond the edge of the structures to cover an area delineated by a line subtended at 15º upwards from the base of the worked seam. A drilling and grouting specification should be agreed with the regulators prior to commencement.

The possibility of encountering unrecorded mine entries on site cannot be discounted, and indeed the likelihood is considered to be quite high. Following a topsoil strip the entire area should be

inspected for evidence of mine workings. Additionally, it is recommended that all excavations be examined for evidence of mine entries. If a mine entry is suspected works should cease and the advice sought of a suitably qualified consultant.

Inspection of historical OS plans has revealed no evidence of quarrying on the site. However, an infilled sandstone quarry and backfilled opencast workings to the Low and Top Haigh Moor coal seams are annotated/reported on the 1:10,000 scale geological plan to the south and south west of the site, respectively. Therefore the possibility of encountering unrecorded backfilled quarries/pits on-site cannot be wholly discounted. It is recommended that all excavations be examined for evidence of infilled quarries/pits. If evidence of infilled quarries/pits is suspected works should cease and the advice sought of a suitably qualified consultant.

Wells

A well was noted on the historical OS plans within the southern part of the site. At this stage it is unknown whether the well has been infilled/treated. It is recommended that as part of the topsoil strip detailed above the location of the well is investigated, in order to determine the location/condition of the well (or at least its absence on site). Treatment will be dependent on the proven location/condition of the well.

The possibility of encountering unrecorded wells on site cannot be discounted. Following a topsoil strip the area should be inspected for evidence of wells. Additionally, it is recommended that all excavations be examined for evidence of wells. If a former well is suspected works should cease and the advice sought of a suitably qualified consultant.

Foundations

The preliminary foundation recommendations provided below are based on the assumption that appropriate treatment of shallow mine workings will be undertaken and that site levels remain broadly as exist at present.

The previous Sirius ground investigation revealed the shallow soils to comprise a variable thickness of made ground, over soft to firm, becoming stiff clay, over competent Middle Coal Measures strata.

The made ground, and locally soft low strength natural clay, are considered unsuitable to support structural loads associated with the proposed residential development due to their inherent variability, low consistency and strength giving rise to the potential for unacceptable total and differential settlements.

It is recommended that spread (reinforced strip/trench fill) foundations be taken through the made ground and soft low strength natural clay into the underlying natural cohesive deposits (at least firm medium strength) and/or competent bedrock at an anticipated minimum founding depth of 0.90m below existing or finished ground level, whichever is the lower of the two.

The natural cohesive deposits (at least firm, medium strength clay) can be assumed to have a characteristic undrained shear strength (Cu) of 50kN/m^2. By way of example, calculations indicate a 0.60m wide reinforced strip bearing on the natural clay at a depth of 0.90m bgl, can impose a maximum line load of 70kN/m run. The application of such a pressure would keep settlements to 25mm or less.

It is anticipated that competent bedrock may be encountered at shallow depth. If foundation excavations encounter bedrock, all of the foundation should be placed onto this strata in order to limit the potential for unacceptable differential settlements. A design bearing pressure of 150kN/m^2 could be assumed for the sandstone or mudstone bedrock (at least extremely to very weak), assuming a 1.0m wide reinforced strip foundation. Should higher allowable bearing pressures be required, confirmatory testing should be undertaken.

The above calculations are based on theoretical foundations. Settlements of foundations upon granular and cohesive materials are dependent on foundation loading and dimensions. It is therefore recommended that foundation settlements are reviewed once final loading arrangements and foundation sizes are known.

Foundations will need to be designed to cater for residual movement following consolidation of mineworkings, this will typically comprise reinforcement, but could require raft foundations where very shallow workings are encountered.

Within the southern and south western parts of the site, within the vicinity of the infilled railway, made ground was encountered to a maximum proven depth of 3.40m bgl. It is considered that conventional spread foundations are not feasible within these areas because of the excessive depth required for excavation. It is therefore recommended that piled foundations or vibro-replacement methods are adopted, terminating within the underlying competent bedrock (Middle Coal Measures).

Piling/vibro contractors have their own proprietary methods of working. It is therefore recommended that consultation with a specialist piling/vibro contractor takes place at an early stage in the construction process.

It must be ensured that piles/vibro columns do not introduce any preferential pathways for the migration of contaminants and the guidance given in the Environment Agency document 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention' should be followed and discussed with the Environment Agency prior to undertaking any piling/vibro operations.

Where pile foundations are proposed, consideration will have to be given to the thickness of competent cover above treated workings. Where insufficient competent rock cover is present piles will need to be extended through the treated seam.

The layout of foundations should consider any relic foundations, substructures or other potential obstructions that may be present within the site (more specifically within the south western part of the site which is currently occupied by residential properties). If any relic foundations/substructures are encountered foundations should be taken to a greater depth than the existing foundations into natural ground of adequate bearing capacity.

Foundations should be taken below a line drawn up at 45° from the base of any existing or proposed services or similar.

Consideration must be given to abnormal costs associated with the removal and off site disposal of potentially contaminated arisings generated by foundation/drainage construction. This is likely to be greater where excavations for spread foundations are proposed.

It should be noted that the above recommendations are based on the assumption that development levels will not change siginificantly from existing site levels. However, should this not be the case foundation recommendations may need to be revised.

Within the northern and south western parts of the site (previously not investigated as part of the original Sirius ground investigation) the published geological information and other data gathered by this preliminary investigation indicate these areas of the site to be underlain potentially by a variable thickness of made ground (associated with an infilled canal/manmade channel and existing residential properties, respectively), over alluvium within the northern part.

The made ground, and superficial deposits where present, are reported to be underlain by Haigh Moor Rock (sandstone) of the Middle Coal Measures.

The nature and depth of foundations in the as yet investigated areas will be dependent on the detailed site geology, including:

- Thickness of any made ground;

- Presence/extent of any substructures;
- Bearing capacity of the natural strata;
- Groundwater levels;
- Presence of coal workings; and,
- Proximity of trees where potentially shrinkable soils are present.

It is recommended that an intrusive investigation is undertaken within the northern and south western parts of the site in order to confirm the ground conditions and foundation requirements for the proposed development.

Floors

In accordance with NHBC Standards 2008 (Chapters 4.2, 4.6 and 5.1), suspended ground floor slabs are required in the following situations:

- Made Ground greater than 600mm thick.
- Where soil swelling may occur.
- Where vibratory ground improvement has been carried out.
- Where the ground has insufficient bearing capacity.

The provision of appropriate gas protection measures should be taken into consideration when assessing floor design.

Sulphate Attack

Based on the laboratory testing undertaken as part of the previous Sirius ground investigation and in accordance with BRE Special Digest 1 (2005) concrete should be designed for an ACEC Class of AC-2z and a design sulphate class of DS-1, assuming brownfield and mobile groundwater conditions. For concrete placed in the made ground encountered within the backfilled railway cutting the design sulphate class should be changed to DS3 and the ACEC class to AC-3.

It is recommended that further samples of shallow soil and groundwater be taken within the northern and south western parts of developments site (yet to be investigation), in order to confirm concrete design requirements within these areas.

Groundworks, Excavation Stability and Groundwater Dewatering

Excavations into existing made ground, topsoil and the underlying natural soils should be assumed to be unstable. No man entry into unsupported excavations should be allowed without an appropriate risk assessment. Reference to CIRIA report 97 (1983) should be made to establish suitable means of support or battering of excavation sides.

Based on the results of the previous investigation, some groundwater seepage into shallow excavations should be expected (<2m). To control this groundwater, localised pumping from sumps should generally be adequate. Deeper excavations may require point dewatering.

It is recommended that in order to reduce the possibility of softening or swelling of cohesive soils at the base of foundation trenches, it should be suitably blinded with concrete.

Pavements and Highways

Based on the recorded ground conditions encountered as part of the previous Sirius ground investigation a CBR value of <2.5% is suggested for the made ground and soft natural soils. Highways Agency document HD25 Interim Advice Note 73/06 Revision 1 (2009) states that where a subgrade has a CBR lower than 2.5%, it is considered unsuitable support for a pavement foundation since it would tend to deform under construction traffic, and must be improved.

For preliminary design a CBR value of 3% is suggested for the medium/high strength natural cohesive deposits.

It is recommended that *in situ* CBR testing is carried out following completion of the enabling works, when final site levels will be known.

All road design should be discussed with the relevant local authority if highways are to be subject to a Section 38 agreement.

6.4. Contamination Constraints

Risk Evaluation for the Proposed Land Use (Residential with plant uptake)

The updated preliminary conceptual site model indicates that pollutant linkages are possible to a variety of receptors based on the sites historical setting and the chemical analyses completed as part of the previous Sirius ground investigation.

The revised conceptual site model confirms significant pollutant linkages may exist to end-users, construction workers and controlled waters (the latter within the northern and south western part of the site only).

Human Health Receptors

Whilst significant contamination was not identified on the body of the site as part of the previous investigation, elevated concentrations of both organic and inorganic contamination (i.e. elevated concentrations of PAH, sulphate and arsenic) have been recorded locally within the made ground encountered within the vicinity of the former railway cutting and embankment, along the southern and south eastern boundary, respectively, which may pose a potentially unacceptable risk to site end-users.

The preliminary conceptual site model also indicates the potential presence of asbestos fibres, pesticides (associated with the agricultural use of the site) and PCBs (associated with former railway land) within the made ground and shallow natural soils encountered at the site, in addition to potential heavy metals, organic and inorganic contaminants in the made ground and shallow soils encountered within the south western and northern parts of the site. These contaminants may pose a potential risk to construction workers and site end users.

Investigation and assessment of possible contamination detailed above will need to be undertaken as part of future site investigation works.

Controlled Waters Receptors

As part of the previous ground investigation no significantly elevated contamination was identified within the areas of the property investigated that are considered to present a potential risk to controlled water receptors.

Within the northern and south western parts of the site potential heavy metals, organic and inorganic contaminants in made ground and shallow soils may pose a significant potential risk to controlled waters.

Utilities

It is recommended that the results of the chemical testing undertaken as part of the previous ground investigation, and that proposed to be undertaken, in addition to details of the proposed

enabling works are provided to the appropriate utility companies to determine the necessity for service protection.

Construction and Maintenance Workers

Contamination may pose a short-term (acute) or long-term (chronic) risk to workers during construction and maintenance. The potential risks must be specifically assessed as part of the health and safety evaluation for the works to be performed in accordance with prevailing legislation. Site practices must conform to the specific legislative requirements and follow appropriate guidance (e.g., HSE, 1991; CIRIA, 1996).

Outline Preliminary Remediation Requirements

In view of the locally elevated concentrations of arsenic and PAH compounds detected within the shallow made ground encountered within the vicinity of the former railway cutting and embankment, it is considered that in areas of proposed hardstanding (whether it be buildings or car parking/roadways) no further remedial action is necessary to protect end-users from direct contact with the identified contamination.

Where this material is in areas proposed for private gardens a subsoil/topsoil "cap" will be required. At this stage, it is recommended that 600mm of "clean" topsoil/subsoil be assumed in areas proposed for private gardens, and a thickness of 450mm for communal gardens, and areas of public open space. These thicknesses are subject to regulatory approval. Deep rooted plants would need to be "potted."

Where impacted soils are to form landscaping, further soil samples should be tested to improve the data set, and results be compared to site specific derived screening values for the end use.

It is recommended that further laboratory testing, including asbestos, PCB and pesticide screens, be undertaken on the shallow made ground and natural soils encountered on a site wide basis in order to confirm preliminary characterisation of the soil conditions and determine the suitability of the topsoil material encountered on site for re-use.

Within the northern and south western parts of the site, investigation and assessment of possible contamination will need to be undertaken as part of future site investigation works.

Asbestos Containing Materials (ACMs)

It is understood that as part of the development works, the existing residential properties within the south western part of the site are to be demolished. It is recommended that a pre-demolition asbestos survey be undertaken prior to the demolition works.

6.5. Hazardous Ground Gases

A risk from hazardous gas sources, located both on and off site, associated with areas of deep made ground (more specifically the infilled railway cutting, cooling ponds and canal/manmade channel), naturally occurring hazardous gases (including marsh gasses arising from the natural organic alluvial soils and mine gases from the underlying coal seams/workings recorded/identified), and locally VOCs identified during the initial Sirius ground investigation, exists at the site.

Ground gas monitoring has been undertaken on four occasions over a four week period as part of the previous ground investigation. The results of the limited ground gas monitoring revealed background concentrations of carbon dioxide (<5.0% v/v) and non detectable concentrations of methane, coupled with locally low initial gas flow rates. No constant gas flow was detected.

Based on the gas monitoring results recorded to date, a worst case gas screening value of 0.0036l/hr for carbon dioxide has been calculated. As such, it is considered that the GSV is representative of “Green” conditions using the NHBC traffic light system for low rise housing with a ventilated 150mm void presented in CIRIA C665 (2007). This initial classification (Green) does not require special precautions with regard to ground gas.

In addition to the above, VOC concentrations were monitored with a photo-ionisation device (PID) during three of the monitoring visits. Locally elevated VOC concentrations (>1ppm) were detected within WS5 and WS6 located within the railway embankment and rotary probehole R10 located within the northern part, with a maximum reported concentration of 31.7ppm within WS5. At this stage it is recommended that a contingency be allowed for the installation of a hydrocarbon resistant gas membrane within the proposed residential properties.

The above assessment should be considered as preliminary only. It is recommended that further gas wells be installed (more specifically within the northern and south western parts of the site) and further monitoring visits be undertaken. In accordance with CIRIA C665, and owing to the nature of the proposed development (residential end use) it is recommend that a minimum of 9 No. monitoring visits be completed over a 6 month period. Further monitoring rounds may be required depending upon the results of the initial gas monitoring visits and the proven ground conditions.

Radon protection measures are not currently required for the proposed development on this site. It is acknowledged that within the previous Sirius geoenvironmental appraisal basic radon protection measures were recommended. However, the recommendations given for radon protection measures within the previous geoenvironmental appraisal (dated July 2006) were undertaken in accordance with the relevant BRE guidance published in 1999 (the current guidance at the time of issue of the aforementioned report). This BRE guidance document has since been superseded and as part of this investigation assessment of radon protection measures required was undertaken in accordance with the 2007 edition of the report.

6.6. Invasive Plant Species

Invasive plant species were not observed on this site at the time of investigation. However, due to limited access in places and the fact that Sirius are not experts in this discipline, it is recommended that the presence/absence of invasive plant species is confirmed by a qualified consultant ecologist and their advice taken on appropriate treatment. The treatment of any invasive species should take place in advance of the proposed construction works.

7. FURTHER INVESTIGATIONS

Based on the findings of the previous intrusive investigation and the revised PCSM the following additional ground investigation works are recommended to allow more detailed foundation/floor slab/pavement design and determination of outstanding contamination constraints (soil, water and gas):

- Trial pits and window sample boreholes to further investigate the near surface soil and groundwater conditions and allow recovery of soil and water samples for testing (more specifically within the northern and south western parts of the site).
- CBR tests within selected trial pits.
- Drilling of rotary probeholes to confirm the presence/absence of workable coal within influencing distance of the surface, and allow determination of abnormal costs associated with drilling and grouting.
- Chemical (including pesticides, speciated TPH, asbestos and PCBs) and geotechnical laboratory testing to categorise the shallow soils and groundwater on a site wide basis.
- Installation of gas/groundwater monitoring wells in selected window sample boreholes and rotary probeholes to assess adequately the risk from hazardous gases owing to areas of deep made ground on site (infilled railway cutting, canal, manmade channel and cooling ponds), the underlying natural strata (including marsh gasses arising from the natural organic alluvial soils and mine gases from the underlying coal seams/workings), and elevated concentrations of VOC detected as part of the previous ground investigation.
- Gas Monitoring (to be undertaken on a site wide basis) – 9 visits over a 6 month period anticipated to be required by the planners. Further monitoring rounds may be required depending upon the gas monitoring results received and proven ground conditions.
- Reporting.

Intrusive exploratory investigation works should be carried out by a suitably qualified geoenvironmental consultant.

The soil strip, in order to investigation for the presence of mineshafts/wells, should be undertaken as part of the enabling works.

A flood risk assessment should be completed to assess the risks from flooding in relation to the proposed development scheme.

A pre-demolition asbestos survey will be required prior to demolition of the existing buildings located within the south western part of the site.

From the information available, it is considered that the recommended investigations, works and mitigation can be carried out post determination of this outline planning application and secured via a planning condition, if necessary.

8. REGULATORY APPROVALS

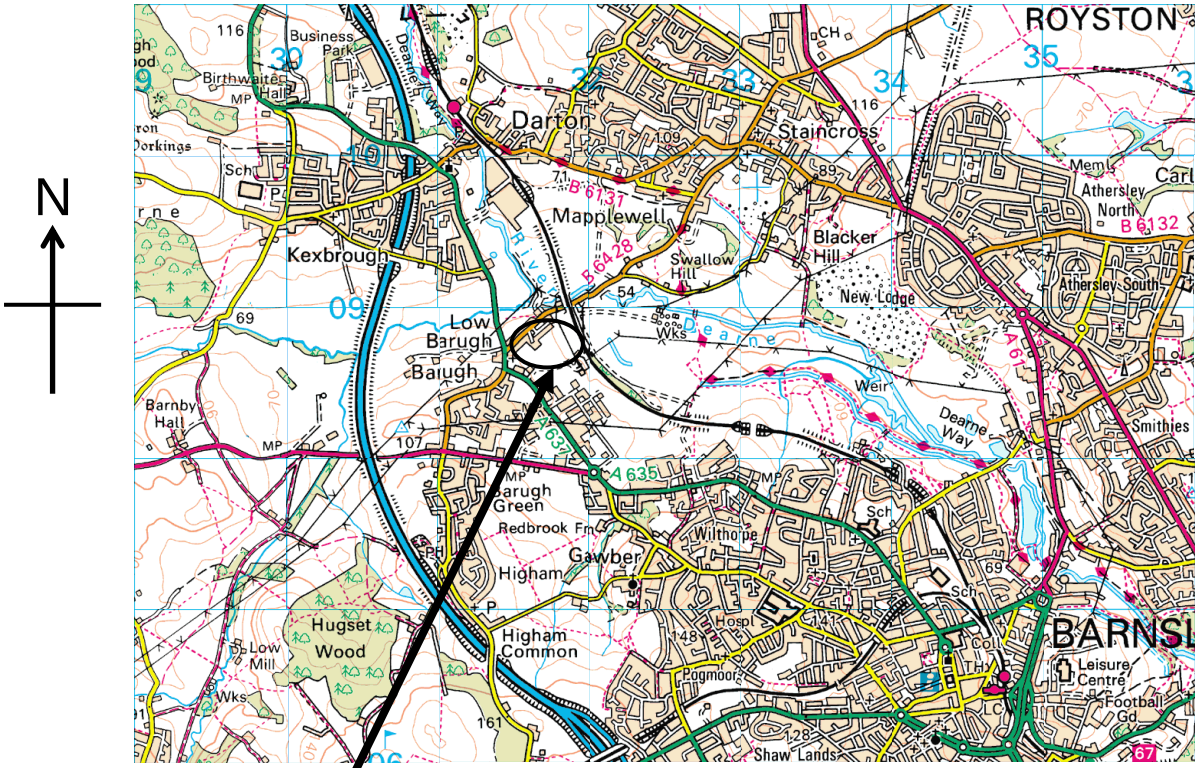
The conclusions and recommendations presented above are considered reasonable based on the findings of the Preliminary Investigation and the previous Geoenvironmental Appraisal Report. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisations for their comment and approval prior to undertaking any works on site.

APPENDIX A

FIGURES & DRAWINGS

Site Location Plan

Contract Number	**C4855**
Contract	**Barugh Green, Barnsley**
Client	**Hallam Land Management Ltd & Commercial Estates Projects**



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Scale	1:50,000		
Drawn by	JL	**Approved**	MB
Drawing Number	C4855/01		

N

A 637

BARNSLEY ROAD

B 6428

Barugh House Farm

Water Mill Court

Dearne River

Pylon

Drainage ditch

Electricity Substation

Fuel Suppliers / Sales (Coal)

DEARNE HALL ROAD

DEARNE HALL FOLD

Residential

Agricultural fields

Railway Line (Embankment)

Overhead lines

Former Coalite works

ROYAL COURT

Royal Hotel
(PH)

Church

Telegraph Poles

Car Park

Residential dwelling and garden

MOT Garage

CLAYCLIFFE ROAD

LANGDALE ROAD

NORWOOD DRIVE

ERISWELL CROFT

BOWBRIDGE WAY

Distribution Centre

WHALEY ROAD

Transformer Station (former Coke and By Product works and latterly a refuse tip)



View to East - Car Park



MOT Garage (Off-site) - South



View of River Dearne to North



View to North



View to South West



View of waterlogged area - South



Transformer Station (Off-site) - East

NOTES

Current Features

- Area Investigated by Sirius in July 2006
- Site Boundary - Additional Areas (2012)
- Flow Direction
- Slope Direction
- Heavily Waterlogged
- Pond
- Heavily Vegetated (long grass, mature trees and low lying shrubs)
- Area of raised embankment
- Electricity substation

Historical Features

- Area of former railway cutting / embankment
- Location of former depot
- Former reservoir / infilled
- Former route of canal / infilled
- Former well
- Former pond features / infilled
- Former cooling ponds / infilled

All historical feature locations are approximate

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CLIENT

Hallam Land Management Ltd / Commercial Estates Group

SITE

Barugh Green, Barnsley

DRAWING TITLE

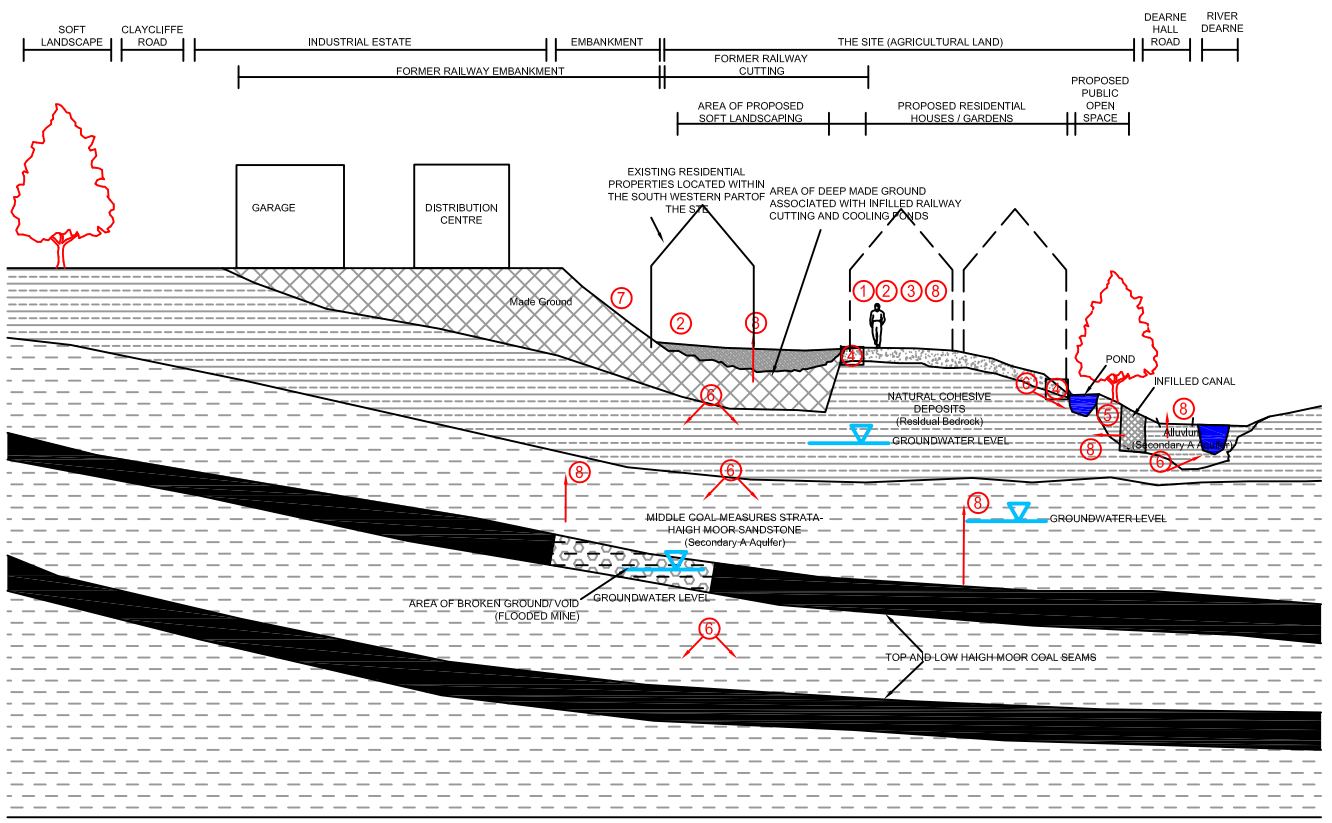
Site Features Plan

DRAWING NO.	REVISION NO.
C4855/03	>>

DRAWN BY	APPROVED BY
ST	MB

DATE	SCALE	PAPER SIZE
July 2012	1:1000	A0

SOUTH WEST NORTH EAST



Contamination Sources	Contamination Pathways	Potential receptors	Risk of significant pollutant linkage
Elevated concentrations of heavy metals, and hydrocarbons (including PAH/TPH) within made ground soils within the northern and south western parts of the site (acquired since the 2006 invstigation).	(1) Direct and indirect ingestion (2) Inhalation of contaminated particles/dust (3) Dermal contact (4) Sulphate attack (5) Plant uptake (proposed / existing)	Construction workers/end users/adjacent land users Construction workers/end users/adjacent land users Construction workers/end users/adjacent land users Built environment Landscaping (existing/proposed)	Moderate / High Moderate / High Moderate / High Low / Moderate Low / Moderate
Elevated concentrations of pesticides, PCBs and asbestos fibres within the made ground and shallow natural soils encountered on site.	(1) Direct and indirect ingestion (2) Inhalation of contaminated particles/dust (3) Dermal contact	Construction workers/end users/adjacent land users Construction workers/end users/ adjacent land users Construction workers/end users/adjacent land users	Low / Moderate Low / Moderate Low / Moderate
Marginally elevated concentrations of arsenic, sulphate and individual PAH species within the shallow made ground encountered within the vicinity of the infilled railway cutting and former railway embankment.	(1) Direct and indirect ingestion (2) Inhalation of contaminated particles/dust (3) Dermal contact (4) Sulphate attack	Construction workers/end users/adjacent land users Construction workers/end users/adjacent land users Construction workers/end users/adjacent land users Built environment	Moderate / High Moderate / High Moderate / High Moderate
Elevated concentrations of leachable metals and hydrocarbons within made ground and shallow natural soils encountered within the northern and south western parts of the site.	(6) Migration via groundwater flow	Underlying Secondary A Aquifers Pond River Dearne	Moderate / High Moderate / High Moderate / High
Locally marginally elevated calorific values in ashy made ground encountered within the vicinity of the former railway embankment within the south eastern part of the site.	(7) Exposure to heat	End users/construction workers	Low
Hazardous ground gases from potential on / off site sources, including areas of deep made ground, organic alluvial deposits, mines gas and volatile vapours from on site made ground soils.	(8) Gas migration	Construction workers / end users & buildings	Moderate / HIgh
Potential risk from ACM products within the infrastructure of the existing buildings on site, providing an appropriate method of removal/demolition is undertaken.	(2) Inhalation of contaminated particles/dust	Construction workers Adjacent land users	Low Low

NOTES

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Hallam Land Management Ltd/ Commercial Estates Projects

SITE

Barugh Green, Barnsley

DRAWING TITLE

Updated Preliminary Conceptual Site Model

DRAWING NO.	REVISION NO.
C4855/03	0
DRAWN BY: S.T	APPROVED BY: J.L
DATE: JULY 2012	SCALE: NTS	PAPER SIZE: A3

APPENDIX B

ENVIROCHECK REPORT

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
39275776_1_1

Customer Reference:
C4855/RIH

National Grid Reference:
431710, 408740

Slice:
A

Site Area (Ha):
9.92

Search Buffer (m):
1000

Site Details:

Site at 431690, 408730

Client Details:

Ms D Broomfield
Sirius Geotechnical & Environmental Ltd
4245 Park Approach
Thorpe Park
Leeds
LS15 8GB

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Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination.
For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client.

In the attached datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

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Report Version v47.0