CCG-C-24-15006

GROUND INVESTIGATION REPORT FOR LAND AT HUDDERSFIELD OPEN MARKET LORD STREET / BROOK STREET HILLHOUSE HUDDERSFIELD HD1 1RX

MAY 2025

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DOCUMENT CONTROL FORM	
Client:	Kirklees Council (the Client) via Turner and Townsend
Project Title:	Ground Investigation Report for land at Huddersfield Open Market, Lord Street / Brook Street, Hillhouse, Huddersfield, HD1
Reference Number:	CCG-C-24-15006
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For and behalf of CC GEOTECHNICAL LTD	
Date:	May 2025
Revision Number:	02
Comments:	Report updated July 2025 to incorporate rotary borehole logs, trial pit logs & photographs, & revised main body of text Report updated July 2025 to allow discussions pertaining to piled foundations
Status:	Final
Distribution:	Kirklees Council (the Client) via Turner and Townsend

1.0 INTRODUCTION

CC GEOTECHNICAL LIMITED (**CCG**) is providing consultancy services to **KIRKLEES COUNCIL** (the *Client*) via **TURNER AND TOWNSEND** in connection with proposed redevelopment works at Huddersfield Open Market, Lord Street / Brook Street, Hillhouse, Huddersfield, HD1.

It is understood that the existing Grade II Listed 1880's open market building is to be retained and refurbished by the installation of 4nr steel framed mezzanine structures, providing additional floor space accommodating community kitchens / bar, ancillary offices, and welfare facilities at ground floor level, with dining seating areas at first floor level.

It is further proposed that an adjoining car park fronting onto Brook Street is to be partially redeveloped as a market yard and pavilion by the construction of 2nr single storey structures, each constructed in traditional brick elevations, with associated communal seating areas.

The existing and proposed layouts of the developments are as illustrated on **GREIG AND STEPHENSON ARCHITECTS** architectural drawings contained within Appendix A.

The proposed development falls within the administrative jurisdiction of **KIRKLEES COUNCIL.**

2.0 PREVIOUS STUDIES

The site was the subject of a Phase I Geoenvironmental Report, prepared by **AECOM** under Report Reference No. 60613541, dated January 2020.

Given the contaminative land uses undertaken at this site and its immediate environs, the report concluded that a Phase II intrusive investigation was required prior to the undertaking of any redevelopment works.

The Phase I report further confirmed the site to be located within a Coal Authority '*Development High Risk Area'*.

This report documents the findings of the Phase II investigation.

The discussions contained within this report should be read in conjunction with the aforementioned desk study report (60613541**),** and with **CCG** Notes on Limitations, contained in Appendix L.

3.0 PURPOSE & AIMS OF THE PHASE II INTRUSIVE INVESTIGATION

The primary purpose of the Phase II intrusive investigation was to confirm the indications of the desk study with respect to:

- The collation of data on the properties of the substrata, insofar as they relate to the selection, design and construction of new foundations, ground slabs, and development infrastructure
- The collation of data on existing foundation configurations insofar as they relate to the assessment of their capacity to accept increased loading
- The assessment of mining borehole investigation findings insofar as they may / may not indicate a risk to surface stability
- The collation of data on soil and groundwater contamination, insofar as they may adversely impact on human and/or environmental receptors

4.0 SITE DATA

The site is located within the commercial sector of Huddersfield. It comprises 2nr distinct parcels of land fronting onto Brook Street, Hillhouse, Huddersfield, HD1 1RX as illustrated on **CCG** Drawing No. CCG-C-24-15006-1 and Aerial Plate No. CCG-C-24-15006-2 contained within Appendix A.

The **ORDNANCE SURVEY** coordinates for the approximate centre of the overall site are c. 414594,417055.

Site 01: Open Market Place

Land forming the open market area comprises a rectangular area which extends to the approximate dimensions of c. 52m x 46m; its long axis being on a north – south alignment. It is bound to the west and east by public pavements extending along Byram Street and Lord Street respectively, beyond which lies a mature development of mixed-use commercial / retail properties. Its southern

boundary is delineated by pedestrian pavements extending along Back Street, with public pavements extending Brook Street forming the northern boundary.

Permanent structures occupying this section of the site comprises a Late-Victorian Grade II Listed open market with associated ancillary offices, cafes, market stalls and welfare facilities. Its construction consists of 6nr rectangular glass roofed bays set on a series of peripheral and internal cast iron columns and decorative wrought iron works, with roller shutter in-fills along its northern southern and eastern boundaries. A full length, single storey extension, constructed of sandstone extends along the southern market boundary.

The surface topography within the market was seen to fall gradually in an easterly direction from around 81maOD at its Byram Street frontage to around c.79maOD at Lord Street, with surface cover consisting of full hard pavement cover (concrete). At the time of undertaking a site walkover survey, it was evident that the units accommodating the southwestern section of the market (tenant café premises) are set at a slightly higher elevation than the remainder of the market.

Numerous manhole covers, Aco drainage systems etc. were observed within the pavement construction.

Site 02: Brook Street Car Park

The land forming the northeastern section of the overall site comprises a rectangular shaped parcel of land which extends to the approximate dimensions of 85m x 27m; its long axis being on an east – west alignment. it is bound to the north by a **TESCO** Retail store and its associated car parking facility, and to the south by public pavements extending along Brook Street. Its western boundary is adjoined by a 2-storey commercial unit, with public pavements extending along Southgate / Unna Way (A62) adjoining its eastern boundary.

The surface topography was seen to be fall gradually from around 78maOD at its western boundary to around c. 76.5maOD, with the surface cover comprising full hard pavement cover (tarmac). At the time of undertaking a site walkover survey, it was understood that the car park was occasionally utilised as an open market.

Numerous manhole covers, aco drainage systems etc. were observed within the pavement construction.

There are no comments within the above referenced desk study report regarding the presence of native and/or non-native plant species within, and/or adjoining, the site boundaries.

4.1 Published Geology

The geology of the site was researched by reference to the 1:50000 scale **BRITISH GEOLOGICAL SURVEY** (**BGS**) Sheet 077 'Huddersfield' Solid and Drift Editions: (2003) and Addison. R. *et.al*. (2005)' '*Geology of the Huddersfield District*'. Sheet description of the British Geological Survey 1:50 000 Series Sheet 77 and Huddersfield (England and Wales): Her Majesty's Stationary office, London.

The BGS 1:50,000 Scale Drift mapping data indicates that the eastern section of the car parking facility fronting onto Brook Street is underlain by artificial made ground deposits of an unknown thickness and composition.

The natural drift deposits extending across the site and its immediate environs are documented to comprise poorly stratified mass movement / head deposits (gravel sands silt and clay) of glacial / post glacial origine (*Pleistocene Epoch - Late Quaternary – Devensian > Holocene Sub Ages*).

The solid bed rock geology underlying the study site Pennine Lower Coal Measures Formation (*formerly the Lower Coal Measures*) of the Pennine Coal Measures Group comprising interbedded argillaceous mudstone, siltstones, fluvial sandstones, seatearths, and productive coal measure, with sandstone associated with the Middle Band Rock (*fluvial sandstones*) encroaching on the southern section of the site. Both geological units being of the Upper Carboniferous Period (*Silesian: Westphalian A: Langsettian Sub Age*).

The general dip of the solid geology within the surrounding area is seen to vary between 2^0 in a southeasterly to 4^0 in an easterly direction.

There are no geological faults within, or within 250m of, the site; with the nearest being the Kirkburton Fault South, c. 406m northeast of the site. its downthrow is seen to be to the east.

The nearest coal seam sub-cropping near the site is documented to comprise the Soft Beds Coal, c. 120m northwest of the site; with the Middle Band and Hard Bed coals sub-cropping c. 242m – 445m to the east of the site.

The above referenced desk study report states that Less than 1 of the properties within the local area are affected by naturally occurring Radon. However, the freely available online Radon mapping data (www.ukradon.org/information/ukmaps) shows that the site is located within an area where it is believed that between 1% - 3% of the properties within the local area are affected with naturally occurring Radon. Notwithstanding this slight discrepancy, it is concluded that Radon Protection Measures of not required.

4.2 Hydrogeology & Hydrology

Information pertaining to hydrogeological and hydrological features of the site may be summarised as follows:

- Made ground deposits, where present, classify as being an Unproductive Aquifer
- The underlying natural drift deposits, Mass Movement / Head Deposits, classifies as being a Secondary A Aquifer
- The underlying solid geology (Pennine Lower Coal Measures Formation) classifies as being a Secondary A Aquifer
- There are records relating to the presence of nearby, active, groundwater abstraction licences, the nearest being c. 9m south of the site (Kirklees MC – Heat Pump Use).
- There are no records relating to the presence of any nearby (<500m) historical / active surface water abstraction points
- There are no records relating to the presence of any nearby (<500m) historical / active portable water abstraction points
- The nearest surface water course / drainage, is documented to comprise the Broad Canal, c. 283m east of the site
- The site is not located within a designated Source Protection Zone
- The site is not located within an Environment Agency Zone II Flood Plain
- The site is not located within an Environment Agency Zone III Flood Plain
- There are no records pertaining to any historical flood events within, or within 250m of, the study site
- The BGS confidence rating for groundwater flooding is '*Low*'
- The is a potential at the surface for surface water / clearwater flooding

5.0 PRELIMINARY CONCEPTUAL MODEL

5.1 Introduction

The risk assessment methodologies adopted by **CCG** are based on current available guidance from several sources and are included in Appendix K.

A Tier 1 Risk Assessment and Preliminary Conceptual Model (PCM) were formulated using the information collated in the Phase I Desk Study and based on the following assumptions:

- The existing Grade II Listed 1880's open market building is to be retained and refurbished by the installation of 4nr steel framed mezzanine structures, providing additional floor space accommodating community kitchens / bar, ancillary offices, and welfare facilities at ground floor level, with dining seating areas at first floor level.

  The adjoining car park fronting onto Brook Street is to be partially redeveloped as a market yard and pavilion by the construction of 2nr single storey structures, each constructed in traditional brick elevations, with associated communal seating areas.

- Drinking water will be from a mains supply.

In constructing the Preliminary Conceptual Model (PCM)**, CCG** applied the guidance contained in Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D: 2008 Volume 1 (*Environment Agency and CIEH*). This recommends use of a Risk Matrix which classifies risk based on the product of Probability of a source being present, and the Consequence of receptors being exposed to the

source. Guidance tables setting out the classifications of probability and consequence together with a risk matrix are given in Tables 1 - 3 hereunder. In using this approach **CCG** recommends intrusive investigation of any Risk Classification of "*Moderate*" or above although a precautionary approach is recommended for residential housing developments, irrespective of the Risk Classification.

Table 1: Matrix of consequences against probability to gain a risk classification [CIRIA C552, 2001]

		CONSEQUENCE			
		SEVERE	MEDIUM	MILD	MINOR
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table 2: Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations **likely** to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA **Category 1** pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01.2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk of buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA **Category 2** pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01.2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to buildings rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health **unlikely** to lead to "significant harm". Equivalent to EA **Category 3** pollution incident including minimal or short-lived effect on water quality; marginal impact on amenity value, agriculture or commerce. Minor or short-lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

Table 3: Classification of Probability Definitions (C552 CIRIA, 2001)

Classification	Definition	Examples
High Likelihood	There is potential contaminant linkage, and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) *Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden.* b) *Ground/groundwater contamination could be present from chemical works, containing a number of UST's, having been in operation on the same site for over 50 years.*
Likely	There is potential contaminant linkage, and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) *Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden or the top 0.5m in a public open space.* b) *Ground/groundwater contamination could be present from an industrial site, containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.*
Low Likelihood	There is potential contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place and is less likely in the shorter term.	a) *Elevated concentrations of toxic contaminants are present in soils at depths of >1m in a residential garden or 0.5-1.0m in a public open space.* b) *Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990's containing a UST in operation over the last 10 years. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.*
Unlikely	There is potential contaminant linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) *Elevated concentrations of toxic contaminants are present below hardstanding.* b) *Light industrial units <10 yrs old containing a double-skinned UST with annual integrity testing results available.*

Table 4 : Classification Définitions (C552 CIRIA, 2001)

CLASSIFICATION	DEFINITION
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard. Or there is evidence that server harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that such harm would be server, or if any harm were to occur it is more likely that harm would be relatively mild. Investigation (if not undertaken already) is normally required to clarify the risk and to determine to potential liability. Some remedial works may be required in the longer term.
Moderate / Low	
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be server.

5.2 Preliminary Conceptual Model

By application of the risk assessment methodology outlined above, the following PCM was constructed.

Table 5: Preliminary Conceptual Model (PCM)

POLLUTANT LINKAGE	SOURCE	PATHWAY	RECEPTOR	PROBABILITY	CONSEQUENCE	RISK RATING
1	Broad spectrum of heavy metals, aggressive pH, hydrocarbons, PAH`s in Made Ground associated with the development of the site & the adjoining area, historical on-site demolition works & the in-filling of historical mill ponds *etc*.	Soil and / or soil dust ingestion Leaching of chemicals & vertical migration via permeable unsaturated strata to shallow &/ or deep groundwater	Construction / maintenance workers Future worker occupants Offsite receptors & Secondary Undifferentiated (Head Deposits), Secondary A Aquifers	Likely	Medium	**Moderate**
2	Asbestos containing materials (ACM) in made ground soils associated with the development of the site, historical on-site demolition works & the in-filling of historical mill ponds *etc*.	Fibre Inhalation	Construction / maintenance Future worker occupants Offsite receptors	Likely	Severe (ACM)	**High**

3	Inhalation of vapours associated with potential made ground deposits associated with historical on-site demolition works & the in-filling of historical mill ponds, historical tram lines *etc*.	Inhalation Leaching through Unsaturated zone Migration through permeable strata into confined spaces	Future worker Water supply pipes Offsite receptors & Secondary Undifferentiated (Head Deposits), Secondary A Aquifers	Unlikely	Medium	**Moderate**
4	Inhalation of ground gases from onsite or offsite sources i.e., made ground deposits associated & on-site demolition works & shallow historical mine workings *etc*.	Inhalation Migration through permeable strata into confined spaces	Future occupants	Unlikely	Medium	**Moderate**
5	pH & Sulphate attack on concrete	Lateral/Vertical migration of impacted groundwater	Future building / concrete & buried services	Likely	Mild	**Moderate / Low**
6	Organic contamination associated with on-site in-filled historical mill ponds, historical tram lines *etc*.	Leaching through Unsaturated zone	Future occupants Offsite receptors & Secondary Undifferentiated (Head Deposits), Secondary A Aquifers Direct contact with water mains	Unlikely	Medium	**Moderate**

The contaminants of concern associated with those risks which require intrusive investigation were researched by reference to published industry profiles, and are summarised hereunder:

Table 6: Summary of Contaminants of Concern based on PCM

LINKAGE NO.	METALS	NON-METALS	ORGANICS	GASES	OTHERS
PL1, PL2, PL3, PL5-PL6	Cd, Cr (total & hexavalent), Ni, Cu, Zn, Pb, Hg, Se, Mo, Sb	As, sulphates, sulphides, boron, free cyanide	TPHCWG, PAH's, BTEX, Volatiles (by PID), VOC's & SVOC's, SOM, PCBs'	-	pH Asbestos
PL4	-	-	-	CH_4, CO_2, CO, H_2S	-
PL1, PL6	-	-	TPHCWG, PAH's, BTEX,	-	-
PL1-PL6	Cd, Cr (total), Ni, Cu, Zn, Pb, Hg, Se, Mo, Sb	As, sulphates, sulphides, boron, free cyanide	TPHCWG, BTEX PAH's, Volatiles (by PID), SOM, PCBs'	CH_4, CO_2, CO, H_2S	pH Asbestos

5.3 Summary of Risks

The foregoing analysis identified a number of potential risks, and if present, these could adversely impact on human or environmental receptors. Given the sensitivity of the proposed end use, an intrusive phase of investigation was undertaken to determine whether the above postulated pollutant linkages are present on site.

6.0 FIELDWORK

6.1 Introduction

A programme of fieldwork investigation was undertaken in February / June 2025. The programme comprised:

General Actions

- The procurement a **COAL AUTHORITY** '*Permit to Drill in Productive Coal Measures*' was obtained / procured (Permit Reference No. 29203, dated November 2024), a copy of which is provided within Appendix B.
- The surveying of exploratory borehole positions for **ORDNANCE SURVEY** (**OS**) coordinates and elevation prior to commencing, and following the completion of fieldwork
- The CAT scanning of all exploratory positions prior to commencing works for the presence of buried electrical services *etc*.

Works within the Market

- The manual excavation, photographing and logging of 17nr foundation inspection pits
- The subsampling of pit arisings for soil contamination – classification testing
- The reinstatement of foundation inspection pits using excavated arisings capped with concrete / tarmac
- The coring of the internal floor slab at 5nr locations

- The manual excavation of 5nr borehole starter pits to a notional depth of 1.2mbgl
- The subsampling of starter pit arisings for soil contamination – classification testing
- The advancement below 3nr cored slab positions by light dynamic sampling with associated *in-situ* testing
- The sampling of borehole arisings for soil classification testing
- The advancement below 2nr cored slab positions by light cable percussive (CP) boring to rockhead level
- The further advancement of CP boreholes into the underlying bedrock formation using rotary open hole drilling methods
- The monitoring of rotary bored boreholes for emissions of mine related gases
- The monitoring of start / end of shift standing water levels at each borehole position
- The reinstatement of boreholes using bentonite / cement to rockhead level, then compacted bentonite clay pellets capped with concrete to GL

External works within Car Park

- The manual excavation of 8nr borehole starter pits to a notional depth of 1.2mbgl
- The subsampling of starter pit arisings for soil contamination – classification testing
- The further advancement of 7nr borehole starter pits by light dynamic sampling with associated *in-situ* testing
- The subsampling of borehole arisings for soil classification testing
- The further advancement of 1nr borehole starter pit by light cable percussive (CP) boring methods to rockhead level
- The further advancement of the CP borehole into the underlying bedrock formation using rotary open hole drilling methods
- The monitoring of the rotary bored borehole for emissions of mine related gases
- The monitoring of start / end of shift standing water levels at each borehole position
- The installation of 50mm HDPE plain and slotted well-tube complete with non-lime pea gravel surround and bentonite seals in 3nr light dynamic sampling boreholes
- The instigation of a gas – groundwater monitoring programme consisting of 4nr rounds over a 1-month period
- The reinstallation of boreholes positions using bentonite / cement to rockhead level, then compacted bentonite clay pellets capped with concrete to GL
- The mechanical excavation of 1nr foundation inspection pit (TP20)
- The subsampling of trial pit arisings for soil contamination / classification testing
- The reinstatement of trial pit using extracted soils capped with thoroughly compacted hot lay tarmac

The fieldwork was planned in accordance with BSEN 1997-1 (2007) Eurocode 7, BS10175: 2011, BS5930: 1999, and the sampling and monitoring methodologies employed by **CCG** as presented in Appendix C, as far as they related to the scope of the investigation.

The layout of the intrusive investigation is as annotated **CCG** Drawing Nos'. 24-15006-3/4 contained in Appendix A.

6.2 Borehole Drilling & Monitoring Installations

6.2.1 Light Dynamic Sampling

9nr boreholes were sunk using light dynamic sampling methods using a Dando Terrier 2000 rig deploying 100mm casings and associated tools.

Each borehole location was positioned clear of all overhead services and scanned for buried electrical services using CAT cable avoidance scanner before and during hand excavation of a starter pit extending to 1.2mbgl.

Boring tools were decontaminated prior to commencement.

In this method of investigation samples of subsoils are recovered by driving and extracting a series of reducing diameter 1m long steel tubes. Standard penetration test's (SPT's) were undertaken at regular depth increments with hand shear vane (HSV) tests being undertaken on recovered cohesive soils.

This method of sampling recovers relatively "undisturbed" soil profiles in Perspex tubes, which are used to line the steel tubes. The Perspex tubes were split and carefully logged and subsampled. Subsamples for potential chemical analysis were removed at appropriate positions from the profile and transferred to chilled amber glass jars and vials for laboratory analysis.

Detailed borehole logs, annotated with **OS** coordinates, elevations, sampling details, SPT '*N*' and *in-lab* HSV (Cu-(kN/m^2) values and details of standpipe construction, are presented within Appendix D.

6.2.2 Cable Percussive / Rotary Open Hole Drilling Works

3nr boreholes were sunk using light cable percussive boring methods using a Dando 150 shell and auger rig deploying 150mm dia. casing and tools, with each borehole being extending into the surface of the underlying bedrock formation.

Each borehole was positioned clear of known buried and overhead services and was scanned using a CAT service scanner for the presence of buried services before and during hand excavation of a starter pit extending to 1.2mbgl.

All boring tools were decontaminated prior to commencement and on completion of each borehole.

Each cable percussive borehole was further advanced into the underlying bedrock formation via rotary open hole drilling methods using a track mounted 'Mazzenza MI3' rotary drilling rig deploying 90mm dia. drilling equipment and water flush. Open hole drilling terminated at 40mbgl in each borehole.

The rate of drilling progress and flush returns at each borehole position were continuously monitored for evidence of voids or loose/broken ground within the borehole column.

Each borehole was continuously monitored for mine gas emissions (O_2, CH_4, and CO_2) using a GA2000 gas analyser, the calibration certificate of which is contained in Appendix E.

Detailed borehole logs, annotated with **OS** coordinates and elevations are presented within Appendix D.

6.2.3 Monitoring Installations

Standpipes comprising 50mm diameter HDPE plain and slotted well tube set in bentonite and non-limestone pea gravel surround were installed at 3nr borehole positions. Each standpipe was fitted with a gas valve connector and was protected by a flush cover set in concrete. Details of standpipe installations are provided on the relevant borehole logs in Appendix D and summarised in the tabulation hereunder:

Table 5: Borehole Installation Details

BOREHOLE	DEPTH OF BOREHOLE (mbgl)	DEPTH OF STANDPIPE [mbgl]	RESPONSE ZONE (mbgl)	
			FROM	TO
BH05	5.45	5.45	0.5	5.0
BH07	5.45	5.45	0.5	5.0
BH09	4.45	4.45	0.5	4.0

The standpipe installations were periodically monitored for flow rate and composition of ground gas using a Geotechnical Instruments GA 2000 infra-red analyser. The installations were also monitored for standing water levels with an electronic dip meter.

The results of the gas and groundwater monitoring, together with calibration certificates of the instruments used are given in Appendix E.

6.2.4 Trial Pitting Using Mechanical Excavator

1nr trial pit (TP20) was mechanically excavated using a 5t 360^0 tracked excavator with associated 600mm excavation buckets.

The pit was positioned clear of overhead services and was CAT scanned before and during excavation work for the presence of buried electrical services. Materials were excavated in thin layers and all arisings placed adjacent to the excavation. The stratigraphy at each position was carefully logged and photographed. The arisings were then returned in the reverse sequence of their excavation to preserve, insofar as was practical, the original lithology.

A descriptive trial pit log annotated with sampling details, together with photographs of the exposure are given in Appendix F.

6.2.5 Foundation Inspection Pits

To examine existing foundations within the marketplace and its adjoining extension, 17nr foundation inspection pits were manually excavated at locations as predetermined by the *Client*.

Descriptive logs of the observations and associated photographs are provided in Appendix F.

7.0 OBSERVED STRATIGRAPHY

The stratigraphy of the boreholes was consistent with the documented geology. The succession may be generalised as tabulated hereunder:

Table 6: Observed Stratigraphy

Location	STRATIGRAPHY
BH01	Bituminous paving overlying concrete & associated sub-base extending to 0.4mbgl. The sequence thereafter continues in natural drift deposits comprising medium dense silty fine & medium grained sands to 1.15mbgl, overlying stiff brown boulder clay proven to 5.45mbgl. Borehole reported to be dry on completion
BH02	Bituminous pavement overlying made ground deposits comprising loose brown / dark grey sands & gravel extending to 1.2mbgl. The sequence thereafter continues in natural drift deposits comprising firm becoming stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH03	Bituminous paving overlying made ground deposits comprising loose dark brown gravelly sand to 1mbgl, overlying reworked clay deposits extending to 1.5mbgl. The sequence thereafter continued in natural drift deposits comprising firm becoming stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH04	Bituminous paving overlying made ground deposits comprising dark brown locally grey sands & gravel to 0.8mbgl, overlying soft reworked clay deposits to 1.4mbgl. The sequence thereafter continued in natural drift deposits comprising soft rapidly becoming stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH05	Bituminous paving overlying made ground deposits comprising grey varying to dark brown sands & gravel extending to 1mbgl. The sequence thereafter continued in natural drift deposits comprising soft becoming firm then stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH06	Bituminous paving overlying made ground deposits comprising grey varying to dark grey / black sands & gravel to 0.75mbgl, overlying firm reworked clay deposits to 1.2mbgl. The sequence thereafter continued in natural drift deposits comprising firm becoming stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH07	Bituminous overlying superficial made ground deposits comprising light brown sands & gravel extending to 0.4mbgl. The sequence thereafter continued in natural drift deposits comprising soft rapidly becoming stiff brown boulder clay, proven to 5.45mbgl. Borehole reported to be dry on completion
BH08	Bituminous paving overlying made ground deposits comprising brown locally red sands & gravel extending to 1.2mbgl, overlying reworked clay deposits to 1.4mbgl. The sequence thereafter continued in natural drift deposits comprising firm becoming stiff brown boulder clay with medium cobble content, locally interbedded at depth with thin sand / silt horizons to 14.9mbgl, underlain with grey mudstone, proven to 40mbgl No loss of flush and/or returns No mine gas emissions recorded
BH09	Bituminous paving overlying made ground deposits comprising grey varying to dark brown sands & gravel locally interbedded with grey / brown reworked clay deposits extending to 1.4mbgl. The sequence thereafter continued in natural drift deposits comprising stiff light brown varying to brown boulder clay, proven to 4.45mbgl. Borehole reported to be dry on completion
BH10	Bituminous paving overlying made ground deposits comprising brown sands & gravel extending to 0.25mbgl, overlying concrete. Unable to progress borehole
BH11	Bituminous paving overlying concrete to 0.3mbgl, overlying made ground deposits comprising brown varying to dark brown sands and gravel to 1.8mbgl. Thereafter the sequence continued in natural drift deposits comprising firm becoming stiff brown boulder clay to 113mbgl overlying grey silty gravelly sands to 12mbgl, then grey weathered becoming competent mudstone with occasional thin siltstone horizons, proven to 40mbgl. No loss of flush and/or returns No mine gas emissions recorded
BH12	Bituminous paving overlying concrete to 0.3mbgl, underlain with natural drift deposits comprising brown locally dark brown gravelly sands to 1.6mbgl. The sequence thereafter continued in natural drift depositions comprising firm becoming stiff brown boulder clay to 11.5mbgl, then grey weathered becoming competent mudstone with occasional thin siltstone horizons, proven to 41mbgl No loss of flush and/or returns No mine gas emissions recorded
TP01	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown clayey gravelly sand with low cobble content extending to 1.1mbgl. The sequence thereafter continued in natural drift deposits comprising firm becoming stiff brown boulder clay, proven to 1.9mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 1.1mbgl, bearing directly on a 350mm thick concrete cap, constructed on brick column. Base of brick column not proven within 1.9m
TP02-A	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown gravelly sand proven to 0.7mbgl. 1nr black 40mm dia. electrical cable & 150mm dia. ceramic drain located within footprint of excavation.

	Relocated to TP02-B
TP02-B	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown gravelly sand proven to 0.87mbgl. 1nr black 40mm dia. electrical cable located within footprint of excavation. Relocated to TP02-C
TP02-C	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown gravelly sand proven to 0.8mbgl. 1nr black 40mm dia. electrical cable and rectangular repair junction box located within footprint of excavation.
TP03	Vinyl flooring overlying thin cementitious screed underlain with reinforced concrete and associated Visqueen membrane to 0.25mbgl, then a 250mm layer of coarse-grained sand overlying concrete slab, proven to 0.49mbgl It was evident that the steel 'I' beam support is set within the under most concrete slab
TP04	Vinyl flooring overlying thin cementitious screed underlain with concrete (no reinforcement present) to 0.17mbgl. Thereafter the sequence continued in made ground deposits comprising dark brown locally clayey sands and gravel with high cobble content to 1.3mbgl, then firm brown boulder clay, proven to 1.8mbgl. Structural wall founded of corbelled brick work, the base of which was seen to stand at 1.25mbgl
TP05	Cancelled at Client request
TP06	Vinyl flooring overlying thin cementitious screed underlain with concrete (no reinforcement present) to 0.15mbgl. Thereafter the sequence continued in made ground deposits comprising dark grey / black cobbly sands and gravel extending to 1.35mbgl. Structural wall founded on large sandstone cobble standing at 1.2mbgl, the base of which not proven
TP07	Bituminous paving overlying concrete (no reinforment present) to 0.21mbgl, overlying 2nr large sandstone cobbles / boulders to 0.55mbgl. The sequence thereafter continued in made ground deposits comprising dark brown sandy gravel with high cobble content to 1.38mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 0.9mbgl, bearing directly on a red brick column. brick column. Base of brick column not proven within 1.38m
TP08	Concrete paving (no reinforcement present) overlying made ground deposits comprising red / brown sands and gravel with medium > high cobble content to 0.57mbgl, then dark brown cobbly sands and gravel to 1.85mbgl. Structural wall founded of corbelled brick work the top of which stands at 1.2mbgl, the base of foundation seen to stand at 1.8mbgl
TP09	Cancelled at Client request due to presence of buried drainage network associated with adjoining public toilets
TP10	Location not shown on Clients drawing and not requested by Client
TP11	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown clayey gravelly sand with low cobble content extending to 1.1mbgl. The sequence thereafter continued in natural drift deposits comprising firm to stiff brown boulder clay, proven to 1.9mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 0.68mbgl, bearing directly on a 360mm thick concrete cap, constructed on brick column. Base of brick column not proven within 1.9m
TP12	Bituminous paving and associated thin sand sub-base overlying concrete (no reinforcement present) overlying brown very clayey sands and gravel with medium cobble content extending to 1.45mbgl. The sequence thereafter continues in natural drift deposits comprising firm / stiff brown boulder clay, proven to 2mbgl. 150mm dia. ceramic drain standing just above the top of concrete pad. Structural steel concealed within concrete. Not possible to detect the presence of founding pad at the base of column. Base of brick column not proven within 2m
TP13	Bituminous paving and associated thin sand sub-base overlying concrete (no reinforcement present) overlying made ground deposits comprising dark brown clayey sands and gravel with medium cobble content extending to 1.41mbgl. Thereafter the sequence continues in natural drift deposits comprising firm brown / grey boulder clay, proven to 1.9mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 0.34mbgl, bearing directly on a 50mm thick sandstone flag, overlying 380mm thick concrete cap. constructed on brick column. Base of brick column not proven within 1.9m
TP14	Bituminous paving overlying concrete (no reinforcement present) overlying made ground deposits comprising brown clayey sands and gravel with medium cobble content extending to 1.41mbgl. The sequence thereafter continued in natural drift deposits comprising firm / stiff brown boulder clay, proven to 1.85mbgl. Structural steel concealed within concrete. Not possible to detect the presence of founding pad at the base of column. Base of brick column not proven within 1.85m
TP15	Bituminous paving overlying made ground deposits comprising dark brown silty sands and gravel with low cobble content to 0.61mbgl, overlying concrete (no reinforcement present) to 0.63mbgl, then 2nr large sandstone cobbles / boulders overlying made ground deposits comprising dark grey clayey sands and gravel, proven to 1.34mbgl. Not possible to progress trial pit due to the presence of buried services within the footprint of the pit Structural column supported on 40mm steel plinth, the top of which standing at 0.85mbgl, plinth supported on a minimum of 2nr large sandstone flags
TP16	Bituminous paving overlying made ground deposits comprising dark brown silty sands and gravel with medium cobble content to 1.58mbgl,

	Structural column supported on 40mm steel plinth, the top of which standing at 0.65mbgl, plinth supported on a minimum of 2nr large sandstone flags constructed on made ground deposits
TP17	Sandstone paving sets and associated coarse sand sub-base overlying made ground deposits comprising dark brown clayey gravelly sand with medium cobble content extending to 1.2mbgl. The sequence thereafter continued in natural drift deposits comprising firm brown boulder clay, proven to 1.8mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 0.55mbgl, bearing directly on a 350mm thick concrete cap, constructed on brick column. Base of brick column not proven within 1.8m 1nr 150mm brown ceramic pipe seen to rest directly on top of concrete pad.
TP18	Bituminous paving overlying thin sand layer then concrete (no reinforcement present) overlying made ground deposits comprising brown clayey sands and gravel with medium cobble content extending to 1.1mbgl. The sequence thereafter continued in natural drift deposits comprising firm / stiff brown boulder clay, proven to 2mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 55mbgl, bearing directly on a 600mm thick concrete cap, constructed on brick column. Base of brick column not proven within 2m
TP19	Sandstone paving sets and associated coarse sand sub-base overlying black bituminous paving extending to 0.32mbgl, overlying made ground deposits comprising dark brown gravelly sand extending to 0.6mbgl. Structural steel column founded on a 40mm thick sleet pad which was seen to stand at 0.41mbgl, bearing directly on a 120mm thick concrete cap, constructed on brick column. 1nr brown ceramic pipe set at 0.14mbgl, dipping to the SE, with 1nr 40mm grey, unspecified pipe running along side. Unable to progress pit due to the presence of buried services within the footprint of the pit
TP20	Bituminous paving overlying made ground deposits comprising light brown sands and gravel (sub-base) to 0.5mbgl, underlain with brown locally clayey gravelly sand with high cobble content to 2mbgl. The sequence thereafter continued in natural drift deposits comprising stiff brown boulder clay, proven to 2.2mbgl Existing structural wall founded on concrete foundation standing at 1.87mbgl, the base of which not proven

8.0 GROUNDWATER REGIME

Groundwater levels monitored via standpipes were recorded in the range 2.28m – 2.47mbgl during the monitoring programme.

9.0 LABORATORY TESTING

9.1 Soil Engineering Test

A programme of soil engineering testing was undertaken at a UKAS / MCERTS accredited laboratory associated with **CCG**. The programme comprised:

- Determination of soil moisture content in accordance with BS: 1377: Part 2: 1990 (20nr)
- Determination of Atterberg Limits in accordance with BS: 1377: Part 2: 1990 (20nr)

The soil classification test results are presented in Appendix G.

9.2 Contamination Analyses

A programme of soil chemical analyses was undertaken at a UKAS / MCERTS accredited laboratory:

- 10nr subsamples of soils were analysed to a broad range of contaminants including metals, non-metals, speciated PAH's, hydrocarbons to the TPHCWG methodology, Benzene/Toluene/Ethylbenzene/Xylene (BTEX compounds), soil pH and water-soluble sulphate content, Polychlorinated Biphenyls (PCBs) compounds
- 10nr subsamples of were screened for asbestos containing materials (ACM's)
- Quantification testing was undertaken on 4nr positive asbestos detections
- 5nr subsamples were subjected to Waste Acceptance Criteria (WAC) analyses
- Groundwater recovered from 1nr borehole position was analysed for a broad range of contaminants including metals, non-metals, and speciated PAH's, hydrocarbons to the TPHCWG methodology

The soil / groundwater contamination test results and certificates are presented in Appendix H.

10.0 ASSESSMENT OF RISKS TO THE BUILT ENVIRONMENT

10.1 Specification of Buried Concrete

The data obtained in the investigations was assessed against the guidance given in BRE Special Digest 1: 2005, as summarised hereunder:

Table 7: Design Chemical Class Based on Soil Data

CONCRETE SPECIFICATION DATA SHEET		
Is the site Brownfield or Greenfield?	Brownfield	
Is the water table static or mobile?	Static	
Highest water-soluble Sulphate results	1510mg/l	Design Sulphate Class of DS-3 Class of AC-2s
Lowest pH result	8.5	
Intended Working Life	50 years	Adopt Design Chemical Classification of **DC-2**

Table 8: Design Chemical Class Based on Groundwater Data

CONCRETE SPECIFICATION DATA SHEET		
Is the site Brownfield or Greenfield?	Brownfield	
Is the water table static or mobile?	Static	
Highest water-soluble Sulphate results	79.4µg/l	Design Sulphate Class of DS-1 Class of AC-1s
Lowest pH result	7	
Intended Working Life	50 years	Adopt Design Chemical Classification of **DC-1**

Based on the foregoing assessments, concrete in the ground should be specified to conform to the compositional requirements of Design Chemical Class **DC 2**, as defined in BRE Special Digest 1: 2005.

Based on the foregoing assessments, concrete in the ground should be specified to conform to the compositional requirements of Design Chemical Class **DC 2**, as defined in BRE Special Digest 1: 2005.

10.2 New Water Mains Supply

The assessment of requirements for new water mains within the investigation area was based on the criteria specified in Paper 10/WM/03/21 '*Guidance for the selection of Water Supply Pipes to be used in Brownfield Sites*' published by UK Water Industry Research (UKWIR) January 2011.

The preliminary findings indicate that the soil concentrations of pertinent hydrocarbon contaminant species are above the permitted threshold concentrations as specified by the UKWIR for the adoption of normal polyethylene (PE) water mains and therefore new water mains for the proposed development should be specified as a PE-AL-PE type construction. Good practice requires that new water mains be laid in a remediated alignment comprising of clean granular fill extending to 600mm + pipe diameter and to 300mm below pipe underside.

Pipes should be laid in accordance with BS EN 12201-2 '*Plastic piping systems for water supply and for drainage and sewerage under pressure*' as stated in UKWIR guidance.

It should be noted that this recommendation is subject to the opinion of the water supplier, and in this instance the local water authority (**YORKSHIRE WATER**) must be consulted to confirm that the proposals above accord with their interpretation of current guidance.

10.3 Assessment of Risk from Ground Gases

Using the data gathered in the monitoring programme, a gas risk assessment was undertaken in accordance with the ground gas risk assessment methodology (See Appendix K) employed by **CCG**. The ground gas risk assessment methodology conforms to current UK guidance on the assessment of risks posed by ground gases.

The potential sources of gas identified in the desk study were considered as sources of "*Low*" generation potential, but since the development is of low - moderate sensitivity, a programme of monitoring comprising of 4nr rounds distributed over a 1-month period was adopted.

A gas risk assessment was undertaken in accordance with current UK guidelines set out in CIRCA C665 2007 "*Assessing Risk Posed by Hazardous Gases to Buildings*". The CIRIA risk assessment methodology uses typical maximum soil gas concentrations and worse case borehole flow rates to define a "*Characteristic Situation*" for the shallow gas regime.

The volumetric gas flow rate used by the risk assessment is termed "Gas Screening Value (GSV)" in the guidance and is defined below.

Table 9: Gas Monitoring Data

Position	WS01	WS03	WS04
No Monitoring Visits	4	4	4
CH_4 (%)	Nil	Nil	Nil
CO_2 (%)	0.2	0.3	1.1
O_2 (%)	20.1	20.2	19.5
H_2S (ppm)	Nil	Nil	Nil
CO (ppm)	Nil	Nil	Nil
Flow (l/hr)	<0.1	<0.1	<0.1
Water Levels (m)	2.47	2.28	2.44
PID response	0.0	0.0	0.0
Pressure Range (mb)	1012-1023mbar		

After 4nr round of monitoring, a Gas Screening Value (GSV) of 0.0011l/hrs is calculated for CO_2, and <0.00001l/hr for CH_4.

Using the above GSV values, the risk to the proposed development was assessed in line with Situation A as defined in CIRIA C665, and on this basis the site complies with Characteristic Situation 1 (CS1) and based on this classification gas protection measures are not required.

11.0 HUMAN HEALTH RISK ASSESSMENT

11.1 Legislative Background to Contaminated Land Assessment

Current approaches (*CLR11- 'Model Procedures for the Management of Land Contamination' and Part IIA of the Environmental Protection Act 1990)* to risk assessment of contaminated land suggest the construction of a Preliminary Conceptual Model. The purpose of this model is to define all possible complete pollution linkages, where the requisite source – pathway – target elements are present; these elements being defined as:

- A contaminant (source) is a hazardous substance or agent, present at levels that have the potential to cause harm or damage a receptor
- A pathway is the means by or through which a contaminant meets, or otherwise affects, the receptor
- A receptor (target) is an entity (human being, aquatic environment, flora, and fauna etc) that is vulnerable to the adverse effects of the contaminant

This relationship is termed a "pollution linkage." It should be recognised that for a health or environmental risk to exist, all three elements of the relationship or linkage must be present*, i.e*.

- If there is no contaminant, or contaminant present at levels below those considered to be harmful or damaging to a receptor, then there can be no adverse effect on a receptor
- If there is no receptor present that can be adversely affected by a contaminant, no harm or damage can arise
- Even where both a contaminant and a receptor are present, no harm or damage will occur if there is no pathway by or through which a linkage between the two can be established

11.2 Risk Assessment Methodologies

The risk assessment methodologies employed by **CCG** are based on the use of CLEA 1.06 and are detailed in Appendix K.

11.3 Basis of Assessment of Risk to Human Health

The Human Health Risk Assessment was carried out in accordance with the **CCG** methodology for assessing soil contamination data as contained in Appendix K, and since it is proposed that the site be redeveloped for continued commercial / residential land use, the assessment was based on criteria contained in publication LQM/CIEH S4UL`s for Human Health Risk Assessment (2015) (**CCG** Licence No. S4UL3233), applicable to the "*Commercial*" land use, scenario. This document does not provide criteria for Lead, for which the results were compared to the C4SL (310mg/kg) published by DEFRA SP1010 Development of Category 4 Screening Levels.

11.4 Assessment of Contamination Data

Based on a Soil Organic Matter content of an average 2.5%, an assessment of the soil data was undertaken as summarised in the tabulations hereunder, and presented on the worksheets in Appendix I.

11.4.1 Assessment of Metal Data

The assessment of the metal data is presented hereunder:

Table 10: Assessment of Metal Data

Contaminant	LQM / CIEH S4UL (mg/kg)	Maximum (mg/kg)	Exceedances	
			(mg/kg)	Location
Cadmium	190	2.4		
Chromium	8600	96		
Copper	68000	330		
Lead	2300	1400		
Mercury	58	0.4		
Nickel	980	28		
Zinc	730000	280		

The above assessment confirms that no contaminant exceeds its respective guideline criterion. Hence, no risk to human health is indicated.

11.4.2 Assessment of Non-Metal Data

The assessment of the non-metal data is presented hereunder:

Table 11: Assessment of Non-Metal Data

Contaminant	LQM / CIEH S4UL (mg/kg)	Maximum (mg/kg)	Exceedances	
			(mg/kg)	Location
Arsenic	640	24		
Selenium	12000	1.1		
Cyanide	120	<1.0		

The above assessment confirms that no contaminant exceeds its respective guideline criterion. Hence, no risk to human health is indicated.

11.4.3 Assessment of PAH Data

The assessment of the non-metal data is presented hereunder:

Table 12: Assessment of PAH Data

Contaminant	LQM / CIEH S4UL (mg/kg)	Maximum (mg/kg)	Exceedances	
			(mg/kg)	Location
Naphthalene	460	8.0		
Acenaphthylene	97000	0.39		
Acenaphthene	97000	9.7		
Fluorene	68000	8.2		
Phenanthrene	22000	72		
Anthracene	540000	19.0		
Fluoranthene	23000	98		
Pyrene	54000	86		
Benz(a)anthracene	170	49		
Chrysene	350	48		
Benzo(b)fluoranthene	**44**	**53**	**53**	**BH06**
Benzo(k)fluoranthene	1200	26		
Benzo(a)pyrene	**35**	**52**	**52**	**BH06**
Indeno(123-cd)pyrene	510	24		
Dibenz(ah)anthracene	**3.6**	**5.5**	**5.5**	**BH06**
Benzo(ghi)perylene	4000	26		

The above assessment confirms exceedances of the guideline criteria for some PAH contaminants in soils recovered from BH06, hence a potential risk to human health is indicated.

11.4.4 Assessment of Petroleum Hydrocarbon Data

The assessment of the Petroleum Hydrocarbon (TPH) data is presented hereunder:

Table 13: Assessment of Hydrocarbon Data

Contaminant	LQM / CIEH S4UL (mg/kg)	Maximum (mg/kg)	Exceedances	
			(mg/kg)	Location
Aromatic EC5-EC7	46000	<0.010		
Aromatic EC7-EC8	110000	<0.010		
Aromatic EC8-EC10	8100	<0.020		
Aromatic EC10-EC12	28000	4.2		
Aromatic EC12-EC16	3700	46		

Aromatic EC16-EC21	28000	280		
Aromatic EC21-EC35	28000	410		
Aliphatic EC5-EC6	5900	<0.010		
Aliphatic EC6-EC8	17000	<0.010		
Aliphatic EC8-EC10	4800	<0.010		
Aliphatic EC10-EC12	23000	<1.0		
Aliphatic EC12-EC16	82000	14		
Aliphatic EC16-EC35	1700000	140		

The above assessment confirms that no contaminant exceeds its respective guideline criterion. Hence, no risk to human health is indicated.

11.4.5 Assessment of Asbestos Data

Asbestos containing materials in the form of Chrysotile (loose fibres) were detected in soils recovered at 4nr sampling positions. Hence a potential risk to human health is indicated.

Quantification testing on the positive Asbestos detection confirm the presence of <0.001% > 0.002% ACM.

11.4.6 Assessment of BTEX / MTBE Data

The appended laboratory contamination results confirm that all BTEX / MTBE compounds are below their limit of detection (LOD) and therefore no risk to human health is indicated.

11.4.9 Summary of Human Health Assessment

The above human health risk assessment confirms the presence of elevated concentrations of:

- Benzo(b)fluoranthene in soils recovered from BH06
- Benzo(a)pyrene in soils recovered from BH06
- Dibenz(ah)anthracene in soils recovered from Bh06
- ACMs' in the form of Chrysotile (loose fibres) in soils recovered from 4nr borehole positions

Quantification testing on the positive Asbestos detection confirm the presence of <0.001% - 0.002% ACM.

Exposure risk associated with asbestos arise via the inhalation pathway and as such good site environmental management practice and some remedial works will be required to mitigate risks.

In considering the above human health risk assessment, taking account of the low incidence of chemical contamination and given that the post development site configuration will comprise full hard pavement cover with no areas of soft landscaping proposed, then no radical remedial works are required since hard cover will break all plausible pathways and no complete pollutant linkages will be present. The main consideration arising from the soil analyses is the presence of asbestos fibres within the soils. All of the positive detects were recorded in the external car park area. None were recorded in samples from the existing market hall. The proposed works will involve removal / disturbance of soils in which positive asbestos detections were recorded in the form of Chrysotile (*loose fibres*). The disturbance of these soils may give rise to airborne releases of fibres posing an inhalation risk to market workers, the general public, and construction operatives. It is incumbent on the developer / contractor to devise a Health and Safety Plan which takes account of the risks of human exposure to airborne fibres during excavation and similar works which may cause disturbance of the ground. Developers / contractors should refer to CIRIA C733: '*Asbestos in Soils and Made Ground: A Guide to Understanding and Managing Risks'*. Further guidance is contained in CL:aire document *'Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials – Industry Guidance.'*

However, should any planting areas be incorporated within the development final design, then it is important to ensure that maintenance workers are not at risk of exposure to the existing superficial made ground soils. To ensure this, it is recommended that site levels in such areas be reduced by a minimum of 600mm below finished design level, with site levels being reconstructed by the placement of clean imported topsoil placed under a strict validation regime comprising 1nr analyses per 50m^3, with a minimum of 4nr analyses per material source. Where made ground deposits remains at the requisite site reduction level, then a suitable woven geotextile fabric, such as '*Terram 1000*', or similar is to be placed at the interface of *in-situ* and imported soils.

In addition to the above, contractors must remain aware that disturbance of the ground may uncover unanticipated features which may give rise to considerations of contamination as far as the exposed conditions may have the potential to impact on receptors including *inter alia* humans, animals, controlled waters, or the fabric of buildings. Any such encounters will require the contractor to halt work, isolate the risk area, and summon **CCG** to site to determine the nature of the exposure and to determine an appropriate course of action. Any such incidents will be fully documented in a detailed site Remediation Report.

12.0 CONTROLLED WATERS RISK ASSESSMENT

12.1 Assessment of Groundwater Metals, Non-Metals & Polycyclic Aromatic Hydrocarbon (PAH) Data

Groundwater recovered from 1nr borehole position (BH05) was analysed for a broad range of contaminants including metals, non-metals, speciated PAH and TPH concentrations. The results were assessed against Environmental Quality Standards (AA-EQS) for freshwater as shown hereunder.

Table 14: Assessment of Groundwater Data

Contaminant	BH05 Result (ug/l)	AA-EQS (ug/l)
Naphthalene	<0.01	2.4
Acenaphthylene	<0.01	-
Fluorene	<0.01	-
Phenanthrene	<0.01	-
Anthracene	<0.01	-
Fluoranthene	0.03	0.1
Pyrene	0.04	-
Benzo[a]anthracene	0.04	0.05
Chrysene	<0.01	-
Benzo[b]flouranthene	<0.01	0.03
Benzo[k]flouranthene	<0.01	0.03
Benzo[a]pyrene	0.03	0.05
Indeno(123-cd)pyrene	<0.01	0.02
Benzo(ghi)perylene	<0.01	0.02
Arsenic	0.51	25
Boron	30	1000
Cadmium	0.15	5
Copper	1.9	40
Lead	0.8	20
Mercury	<0.05	1
Nickel	8.7	150
Selenium	1	-
Cyanide	<1.0	-
pH	7	-
Sulphate	79.4	400000

The above assessment confirms that no contaminant exceeds its respective AA-EQS guideline criteria. Hence no risk to controlled waters is indicated.

12.2 Assessment of Groundwater Hydrocarbon Data

Speciated hydrocarbon results were assessed by comparison with AA-EQS values for inland waters. In case of determinants not covered by AA-EQS values, results were compared to EQS Freshwater Criteria values or where no EQS Freshwater Criterion is available, then WHO guidelines for Drinking Water are adopted.

Table 15: Assessment of Soil Leachate Hydrocarbon Data

Contaminant	BH05 Result (ug/l	AA-EQS (ug/l)	WHO ug/l
Aromatic EC5-EC7 (benzene)	<1.0	-	10
Aromatic EC7-EC8 (toluene)	<1.0	-	700
Aromatic EC8-EC10 (ethyl benzene)	<1.0	-	300
Aromatic EC10-EC12	<10	-	100
Aromatic EC12-EC16	<10	-	100
Aromatic EC16-EC21	<10	-	90

Aromatic EC21-EC35	<10	-	90
Aliphatic EC5-EC6	<1.0	-	15000
Aliphatic EC6-EC8	<1.0	-	15000
Aliphatic EC8-EC10	<1.0	-	300
Aliphatic EC10-EC12	<10	-	300
Aliphatic EC12-EC16	<10	-	300
Aliphatic EC16-EC21	<10	-	(300)*
Aliphatic EC21-EC35	<10	-	(300)*

The above assessment confirms that no hydrocarbon fraction exceeds its respective AA-EQS and/or WHO guideline criteria. Hence, no risk to controlled waters and/or human health is indicated.

12.2 Assessment of Groundwater BTEX / MBTE Data

All BTEX / MTBE compounds are reported to be below their limit of detection. Hence no risk to controlled waters and/or human health is indicated.

12.3 Summary of Controlled Waters Risk Assessment

The above controlled waters risk assessment confirms that no contaminant exceeds its respective AA-EQS and/or WHO guideline criteria. Hence, no risk to controlled waters and/or human health is indicated.

13.0 POST INVESTIGATION CONCEPTUAL MODEL

Based on the findings of the investigation, a post investigation conceptual model may be constructed illustrating proven pollution linkages and summarising the conceptual remediation recommendations discussed above, as tabulated hereunder.

Table 16: Post Investigation Conceptual Model

Source	Pathway	Receptor	Remedial Options
The above human health risk assessment confirms the presence of: • Benzo(b)fluoranthene in soils recovered from 1nr borehole position • Benzo(a)pyrene in soils recovered from 1nr borehole position • Dibenz(ah)anthracene in soils recovered from 1nr borehole position	Oral / ingestion /dermal Pathways	Construction workers / future end users Maintenance workers etc. Surrounding area	In considering the above human health risk assessment, taking account of the low incidence of chemical contamination and given that the post development site configuration will comprise full hard pavement cover with no areas of soft landscaping proposed, then no permanent remedial works are required since hard cover will break all plausible pathways and no complete pollutant linkages will be present. However, should any planting areas be incorporated within the development final design, then it is recommended that site levels in such areas be reduced by a minimum of 600mm below finished design level, with site levels being reconstructed by the placement of clean imported topsoil placed under a strict validation regime comprising 1nr analyses per 50m^3, with a minimum of 4nr analyses per material source. Where made ground deposits remains at the requisite site reduction level, then a suitable woven geotextile fabric, such as '*Terram 1000*', or similar is to be placed at the interface of *in-situ* and imported soils. In addition, -taking into account of the thickness of superficial made ground deposits, these soils will be disturbed in the construction of foundations, floor slabs *etc.* and service installation alignments and a risk to human health of construction workers will ensue. Workers must be provided with appropriate PPE and be counselled in good practice in the avoidance of skin contact, inhalation and dust ingestion. Furthermore, contractors must remain aware that disturbance of the ground may uncover unanticipated features which may give rise to considerations of contamination as far as the exposed conditions may have the potential to impact on receptors including *inter alia* humans, animals, controlled waters, or the fabric of buildings. Any such encounters will require the contractor to halt work, isolate the risk area, and summon **CCG** to site to determine the nature of the exposure and to determine an appropriate course of action. Any such incidents will be fully documented in a detailed site Remediation Report
Asbestos Containing Materials (ACMs) in the form of Chrysotile (loose fibres) in soils recovered from 4nr borehole positions	Inhalation Pathway	Construction workers / future end users Maintenance workers etc. General Public	In considering the above human health risk assessment, taking account of the low incidence of chemical contamination and given that the post development site configuration will comprise full hard pavement cover with no areas of soft landscaping proposed, then no radical remedial works are required since hard cover will break all plausible pathways and no complete pollutant linkages will be present. The main consideration arising from the soil analyses is the presence of asbestos fibres within the soils. All of the positive detects were recorded in the external car park

			area. None were recorded in samples from the existing market hall. The proposed works will involve removal / disturbance of soils in which positive asbestos detections were recorded in the form of Chrysotile (*loose fibres*). The disturbance of these soils may give rise to airborne releases of fibres posing an inhalation risk to market workers, the general public, and construction operatives. It is incumbent on the developer / contractor to devise a Health and Safety Plan which takes account of the risks of human exposure to airborne fibres during excavation and similar works which may cause disturbance of the ground. Developers / contractors should refer to CIRIA C733: '*Asbestos in Soils and Made Ground: A Guide to Understanding and Managing Risks*'. Further guidance is contained in CL:aire document *'Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials – Industry Guidance.'* Where fully suspended precast concrete floors are to be adopted, the base of the subfloor void must receive a 50mm cover of blinding concrete

14.0 PRELIMINARY WASTE CLASSIFICATION

A waste classification exercise was undertaken in relation to potential offsite disposal of excavation arisings. The first stage entailed the assessment of the basic soil contamination data via the **HAZWASTE** online program. The output data from this basic assessment is provided in Appendix J. This program generates the baseline '*Hazardous / Non-Hazardous'* classification of soils.

Asbestos containing materials in the form of Chrysotile (loose fibres) were detected in soils recovered at 4nr sampling positions

Quantification testing on the positive Asbestos detection confirm the presence of <0.001% - 0.002% ACM.

Taking into account the above asbestos detection, with regards offsite disposal, current legislations, '*The Hazardous Waste (England and Wales*) Regulations 2005' and '*The Special Waste Amendment* (Scotland) Regulations 2004', state that any soil having an asbestos content greater than 0.1% weight/weight (w/w) is classified as '*Hazardous Waste'*, and any soil with an asbestos content of less than 0.1% w/w can be classified as '*Non-Hazardous*' waste, unless there are other contaminants present which would make the waste hazardous. Based on this assessment, it is concluded that the positive ACM detections classify as being 'Non-Hazardous'.

The appended **HAZWASTE** report confirms that all soils analysed classify as being '*Non-Hazardous'*, and therefore soils generated for off-site purposes may be disposed at a suability licenced '*Non-Hazardous'* landfill facility.

It should be noted that the final decision on waste classification is at the discretion of the accepting landfill, and it is recommended that consultation with landfill operators be undertaken during the development of the waste management plan.

15.0 GEOTECHNICAL ASSESSMENT

15.1 Introduction

The existing and proposed layouts of the developments are as illustrated on **GREIG AND STEPHENSON ARCHITECTS**, architectural drawings contained within Appendix A.

This intrusive investigation confirms the prevailing ground conditions to comprise hard pavement cover overlying made ground deposits generally comprising sand and gravel locally interbedded / overlying reworked clay deposits extending to depths varying between 0.4mbgl > 1.5mbgl. The sequence thereafter continues in natural drift deposits comprising soft rapidly becoming firm then stiff brown boulder clay, locally overlain with medium dense brown silty fine and medium grained sands. The drift deposits extend to circa 14.9mbgl before continuing in bedrock comprising grey mudstone with occasional thin siltstone bands.

All borehole positions were reported to be dry on completion of fieldworks with monitored standing water levels being in the order of 2.28m – 2.47mbgl during the initial rounds of gas – groundwater monitoring programme.

15.2 Peripheral Trial Pits (TP01, TP10, TP11, TP12, TP13, TP14, TP17, TP18, TP19)

By reference to the sketch logs in Appendix F, it can be seen that each of the ornate steel columns around the building periphery rests directly on a 40mm thick steel pad / plinth which in turn bears on concrete pads of variable thickness, with each concrete pad bearing directly on a red brick column. Each brick column was seen to extend beyond the 2m deep foundation excavations.

15.3 Internal Trial Pits (TP15, TP16)

Foundations to columns within the footprint of the marketplace were seen to be founded at a shallower depth, bearing on large light brown / buff coloured sandstone pads, locally constructed on compacted made ground.

15.4 Trial Pits in Market Extension (TP04, TP06, TP08)

By reference to Table 6 above and to the sketch logs in Appendix F, it can be seen that these trial pits were excavated against internal and external walls and showed brick foundations extending to 1.2mbgl bearing on sandstone flags. Corbelling of the brickwork was observed in TP04 and TP08.

As illustrated within the appended trial pit logs, buried services within the form of brown ceramic drains, and electricity cables were detected at some trial pit locations.

Trial pitting undertaken externally along the southern alignment (TP02A > TP02-C) of the above referenced extension confirmed the presence of buried ceramic drains and electrical services which appear to extend the length of this alignment, along with the presence of 1nr repair to the electrical cable being seen at TP02-C.

15.5 Risk of Surface Instability Associated with Shallow Mining

The assessment of the risk of surface instability is commonly based on the application of the so called 10:1 rule, where the risk of collapse is considered negligible if the ratio of the thickness of competent rock cover to the thickness of any collapsible section is greater than 10. The presence of any deep, competent, deposits of natural drift cover may also be considered in the assessment.

This investigation has proven the presence of hard pavement cover at all exploratory positions overlying made ground deposits extending to depths varying between 0.4m > 1.4mbgl overlying natural drift deposits generally consisting of firm becoming stiff brown boulder clay extending to depths varying between 11.5m > 14.9mbgl, underlain with grey weathered becoming competent mudstone with occasional thin siltstone horizons, proven to 41mbgl. 3nr boreholes advanced to circa 41mbgl in the bedrock did not detect any loss of flush and/or loss of returns. No mine gas emissions were detected. Nor were any viable coal seams penetrated in the borehole depths.

Using CIRIA guidance, the evidence of the investigation is that there is sufficient intact bedrock to prevent any upward migration of any future collapses below 41mbgl. This investigation has not detected any voided and/or broken ground within 41m of existing ground levels, and for void migration (Hv) to rockhead level from a theoretical collapse at >40m below rockhead level arising from a conical collapse mode, the required collapsible void thickness may be calculated by:

$$N,bHv = nt / (B-1)$$

Where

n = 3 for a conical collapse mode
t = extracted seam thickness
B = bulking factor – assumed 1.3 for rock

In this case, a collapse of a void of 4m thickness at depth 40mbgl would be required, and this is discounted as a conceivable possibility, hence it is therefore concluded that the site is safe for development in respect of coal mining related risks.

15.6 Foundations and Floor Slab Construction

15.6.1 New Buildings on Brook Street

Taking into account the above observations, the proposed 2nr single storey brick structures fronting onto Brook Street may be founded on shallow spread foundations. Foundations bearing on the natural firm clay deposits standing at a notional depth of 1.2mbgl may be designed on a Presumed Bearing Value of 100kN/m^2.

Given the slight variations in shallow soil strength, it is strongly recommended that strip foundations be reinforced within the bottom third. It is further recommended that all foundation excavations be inspected by a competent ground engineer to ensure that the predicted ground conditions have been encountered.

Strip foundations should be not less than 300mm thick and be formed in C35 concrete.

The appended Modified Plasticity Index calculations confirm the cohesive soils to have *Low - Medium'* shrinkage potential and whilst there is no evidence of desiccation affecting the soils, a Medium shrinkability classification should be adopted in any amendments to foundation depths based on NHBC Chapter 4.2 where the influence of existing and/or future trees may be relevant.
Where placement of structural concrete does not immediately follow foundation trench excavations, the clay formations should be protected by placement of blinding concrete layer to prevent deterioration.

In the prevailing ground conditions, ground bearing slabs may be adopted, subject to rigorous preparation of the subgrade. Such preparation should include as a minimum:

- Reduction in ground levels to min 400mm below slab underside ensuring all organic soils are removed
- Thorough compaction at reduced dig level grubbing out and refilling in 150mm layers any areas exhibiting excessive deflection
- Placement and compaction of geotextile (Terram 1000) and 2 x 200mm layers DTp Type 1 subbase
- Construction of sand blinding, dpm, insulation, slab and screed

As an alternative to the above, fully suspended, passively vented, block and beam floors may be adopted for each residential unit.

Where fully suspended precast concrete floors are to be adopted, and given the presence of ACMs', the base of the subfloor void must receive a 50mm cover of blinding concrete.

15.6.2 Market Hall Internal Modifications

With regards to the installation of the internal steel framed mezzanine structures, taking into account the SPT 'N' values recorded in boreholes BH01 > BH03, each mezzanine structure may be constructed on reinforced pad foundations, from which structural steel work may be erected. However, given the variable depth of made ground deposits as seen at BH01 and BH03 (0.4m > 1.5mbgl), foundations would need to be carried down to the undisturbed natural clay deposits standing at 1.5mbgl. Pads set at this depth may be designed on a Presumed Bearing Value of 100kN/m^2. It is further recommended that all foundation excavations be inspected by a competent ground engineer to ensure that the predicted ground conditions have been encountered.

As an alternative to the above, and to mitigate against any risks of disturbance of existing internal / external column foundations, the structural steel work for the proposed new mezzanine floors may be founded on pile caps supported on piles, with either steel cased bottom driven, cast *in-situ,* displacement piles, or bored sectional flight auger (SFA) piles being utilised.

Piles will derive their carrying capacity from both shaft friction and end bearing properties.

For bottom driven displacement piles, to avoid risks of lateral forces on existing foundations, these should be pre-bored to a depth of 1.5mbgl. Piles should be driven into the underlying stiff clay deposits to '*refusal*' *or* be installed to depths as calculated by geotechnical methods to equate to the loadings produced in the structural design calculations, the field installation being confirmed by achievement of the `*set*` calculated to equate to the design load.

Piles would carry shallow reinforced pads off which structural steel work may be constructed. For the purposes of preliminary design, the carrying capacity of steel cased bottom driven displacement piles may be taken as:

Table 17: Pile Carrying Capacity

Pile Diameter mm	Carrying Capacity kN
150	130
220	250

With regards to SFA piling, this method will obviate the risk of lateral loading on existing foundations, and the method is relatively quiet and vibration-free, although significant logistical matters need to be considered in terms of the larger plant require, the handling and disposal of spoil, pumping of concrete, and general housekeeping.

For the purpose of preliminary pile design, a 300mm dia. SFA pile installed to a depth of 6mbgl may be estimated to carry a Safe Working Load (SWL) of circa 250kN.

Piling contractors must be required to provide capacity calculations for their own proprietary pile type in isolation and in groups as appropriate to the design.

15.4 Excavations

Excavations in the observed made ground and natural drift soils may be undertaken by light hydraulic excavators.

Excavations in excess of 1.2mbgl will require side support.

15.5 Groundwater Management

All borehole positions were reported to be dry on completion of fieldworks with monitored standing water levels being in the order of 2.28m – 2.47mbgl during the gas – groundwater monitoring programme.

Notwithstanding the above observations, a prudent contractor would allow for pumping to maintain dry working conditions during foundation construction and/or service installations, particularly during periods of heavy and / or prolonged periods of precipitation.

16.0 SUMMARY CONCLUSIONS

The recommendations hereunder are based on the salient sections of the report and should not be referred to in isolation of the relevant sections of the report. All recommendations are subject to Regulatory Local Authority review.

Table 18: Summary of Conclusions

Soil Chemical Contamination & Remediation	The above human health risk assessment confirms the presence of: • Benzo(b)fluoranthene in soils recovered from 1nr borehole position • Benzo(a)pyrene in soils recovered from 1nr borehole position • Dibenz(ah)anthracene in soils recovered from 1nr borehole position In considering the above human health risk assessment, taking account of the low incidence of chemical contamination and given that the post development site configuration will comprise full hard pavement cover with no areas of soft landscaping proposed, then no permanent remedial works are required since hard cover will break all plausible pathways and no complete pollutant linkages will be present. However, should any planting areas be incorporated within the development final design, then it is recommended that site levels in such areas be reduced by a minimum of 600mm below finished design level, with site levels being reconstructed by the placement of clean imported topsoil placed under a strict validation regime comprising 1nr analyses per 50m^3, with a minimum of 4nr analyses per material source. Where made ground deposits remains at the requisite site reduction level, then a suitable woven geotextile fabric, such as '*Terram 1000*', or similar is to be placed at the interface of *in-situ* and imported soils. In addition, -taking into account of the thickness of superficial made ground deposits, these soils will be disturbed in the construction of foundations, floor slabs *etc*. and service installation alignments and a risk to human health of construction workers will ensue. Workers must be provided with appropriate PPE and be counselled in good practice in the avoidance of skin contact, inhalation and dust ingestion. Furthermore, contractors must remain aware that disturbance of the ground may uncover unanticipated features which may give rise to considerations of contamination as far as the exposed conditions may have the potential to impact on receptors including *inter alia* humans, animals, controlled waters, or the fabric of buildings. Any such encounters will require the contractor to halt work, isolate the risk area, and summon **CCG** to site to determine the nature of the exposure and to determine an appropriate course of action. Any such incidents will be fully documented in a detailed site Remediation Report
ACMs' in Soil	ACMs' in the form of Chrysotile (loose fibres) in soils recovered from 4nr borehole positions Quantification testing on the positive Asbestos detection confirm the presence of <0.001% - 0.002% ACM. The main consideration arising from the soil analyses is the presence of asbestos fibres within the soils. The proposed works will involve removal / disturbance of soils in which positive asbestos detections were recorded in the form of Chrysotile (*loose fibres*). The disturbance of these soils may give rise to airborne releases of fibres posing an inhalation risk to market workers, the general public, and construction operatives. It is incumbent on the developer / contractor to devise a Health and Safety Plan which takes account of the risks of human exposure to airborne fibres during excavation and similar works which may cause disturbance of the ground. Developers / contractors should refer to CIRIA C733: '*Asbestos in Soils and Made Ground: A Guide to Understanding and Managing Risks*'. Further guidance is contained in CL:aire document *'Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials – Industry Guidance.'* Where fully suspended precast concrete floors are to be adopted, the base of the subfloor void must receive a 50mm cover of blinding concrete
Controlled Waters	The above controlled waters risk assessment confirms that no contaminant exceeds its respective AA-EQS and/or WHO guideline criteria. Hence, no risk to controlled waters and/or human health is indicated.

Water Mains	The preliminary findings indicate that the soil concentrations of pertinent hydrocarbon contaminant species are above the permitted threshold concentrations as specified by the UKWIR for the adoption of normal polyethylene (PE) water mains and therefore new water mains for the proposed development should be specified as a PE-AL-PE type construction. Good practice requires that new water mains be laid in a remediated alignment comprising of clean granular fill extending to 600mm + pipe diameter and to 300mm below pipe underside. Pipes should be laid in accordance with BS EN 12201-2 '*Plastic piping systems for water supply and for drainage and sewerage under pressure'* as stated in UKWIR guidance. It should be noted that this recommendation is subject to the opinion of the water supplier, and in this instance the local water authority (**Yorkshire Water**) must be consulted to confirm that the proposals above accord with their interpretation of current guidance.
Preliminary Waste Classification	A waste classification exercise was undertaken in relation to potential offsite disposal of excavation arisings. The first stage entailed the assessment of the basic soil contamination data via the **Hazwaste** online program. The output data from this basic assessment is provided in Appendix H. This program generates the baseline '*Hazardous / Non-Hazardous*' classification of soils. Asbestos containing materials in the form of Chrysotile (loose fibres) were detected in soils recovered at 4nr sampling positions Quantification testing on the positive Asbestos detection confirm the presence of <0.001% - 0.002% ACM. Taking into account the above asbestos detection, with regards offsite disposal, current legislations, '*The Hazardous Waste (England and Wales*) Regulations 2005' and '*The Special Waste Amendment* (Scotland) Regulations 2004', state that any soil having an asbestos content greater than 0.1% weight/weight (w/w) is classified as '*Hazardous Waste'*, and any soil with an asbestos content of less than 0.1% w/w can be classified as '*Non-Hazardous'* waste, unless there are other contaminants present which would make the waste hazardous. Based on this assessment, it is concluded that the positive ACM detections classify as being 'Non-Hazardous'. The appended **Hazwaste** report confirms that all soils analysed classify as being '*Non-Hazardous'*, and therefore soils generated for off-site purposes may be disposed at a suability licenced '*Non-Hazardous'* landfill facility. It should be noted that the final decision on waste classification is at the discretion of the accepting landfill, and it is recommended that consultation with landfill operators be undertaken during the development of the waste management plan.
Concrete specification	Concrete in the ground should be specified to conform to the compositional requirements of **DC-2** as defined in BRE Special Digest 1: 2005
Gas Risk Assessment	After 4nr round of monitoring, a Gas Screening Value (GSV) of 0.0011l/hrs is calculated for CO_2, and <0.00001l/hr for CH_4. Using the above GSV values, the risk to the proposed development was assessed in line with Situation A as defined in CIRIA C665, and on this basis the site complies with Characteristic Situation 1 (CS1) and based on this classification gas protection measures are not required. Notwithstanding the above, it must be borne in mind that a further 1nr round of monitoring are required to complete the ongoing monitoring programme.
Surface instability	Using CIRIA guidance, the evidence of the investigation is that there is sufficient intact bedrock to prevent any upward migration of any future collapses below 41mbgl. This investigation has not detected any voided and/or broken ground within 41m of existing ground levels, and for void migration (Hv) to rockhead level from a theoretical collapse at >40 below rockhead level arising from a conical collapse mode, the required collapsible void thickness may be calculated by: N,bHv = nt / (B-1) *Where* n = 3 for a conical collapse mode t = extracted seam thickness B = bulking factor – assumed 1.3 for rock In this case, a collapse of a void of 4m thickness at depth 40mbgl would be required, and this is discounted as a conceivable possibility, hence it is therefore concluded that the site is safe for development in respect of coal mining related risks.
Foundation Design	See Section 15.0 for fuller discussion
Floor Slabs	See Section 15.0 for fuller discussion
Groundwater Control	All borehole positions were reported to be dry on completion of fieldworks with monitored standing water levels being in the order of 2.28m – 2.47mbgl during the initial rounds of gas – groundwater monitoring programme. Notwithstanding the above observations, a prudent contractor would allow for pumping to maintain dry working conditions during foundation construction and/or service installations, particularly during periods of heavy / prolonged periods of precipitation.
Excavations	Excavations in the observed made ground and natural drift soils may be undertaken by light hydraulic excavators. Excavations in excess of 1.2mbgl will require side support.
Further work	• Prepare Phase III Remediation Strategy Report • Prepare Phase IV Validation Report