PLANNING AND
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Worthington Properties Ltd

Proposed Student Accommodation at Moss Lane East, Manchester





Phase I and Phase II Desk Study and Geo–Environmental Site Investigation Report

85269/02

March 2011

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CLIENT: **Marcus Worthington Properties Ltd**

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Marcus Worthington Properties Ltd
Moss Lane East, Manchester
Executive Summary

Developer and Funder			Marcus Worthington Properties Ltd
Current Site Status			The site comprises • In the west - Footprint of a former factory building under a hardcore cover and currently in use as a car park • In the north east - Steel clad warehouse in use as a covered car park with an adjacent small tarmac car park
Development Proposals			The development proposal will comprise; • Multi Storey Student Accommodation with associated car parking, access road and localised landscape areas
Site	Location		The site is centred at NGR 384970 395630 at the corner of Moss Lane East and Heald Grove, Manchester
	History	Site	Historical records identify the following site history: • Carriage and Tramway depot with tramlines from 1893-1920's • Houses to 1922 • Handkerchief Factory from 1920's to 1970's • 'Factory' from 1979 to 2009 • Main factory building to the west was demolished in 2009 • The historical desk study and Envirocheck report identify a former PFS on the site. However, this is based on an incorrect location marker in the EnviroCheck report- the former PFS is clearly located to the west of the site at the junction of Moss lane east, Heald Place and Heald Grove. The Local Petroleum Officer confirmed that no fuel tanks have been present on site.
		Adjacent land	Historical records identify the following adjacent site history: • Laundry to the south from 1890's • Hospital to the north east from the 1920's • Depository immediately east from 1900's to 1920's • Coach works to the south from 1950's • Motor repair works to the north east from the 1950's • Petrol Filling station to the east from the 1960's • Petrol filling station to immediate west of site – now demolished and used as a car wash
	Geology		The following ground conditions have been identified during the Site Investigation: • Made Ground as a granular fill comprising fragments of limestone, brick concrete and ash to between 0.5m and 2.5m • Firm becoming stiff Clay to between 6.9m to 8.7m begl • Localised dense Gravel to between 7.5m – 8.8m begl • Sandstone bedrock encountered between 7.5 and 8.8mbegl
Controlled waters		Surface Water	The following information is provided on surface waters: • No surface water is present on site • The nearest surface water feature is the Platt Brook approximately 911m to the south-east of the site
		Ground Waters	The following groundwater conditions were identified during post site investigation monitoring: • Localised seepage within the made ground • No groundwater identified within the superficial deposits or the Sandstone Aquifer • Sandstone aquifer at depth is classified as a Major Aquifer • The nearest water abstraction is 1054m west of the site

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Moss Lane East, Manchester
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Flood Risk	• The Site is in Flood Zone I and is not an area identified as at risk to flooding by the Environment Agency
Radon	• BRE 211 indicates that Radon gas protection measures are not required
Landfill and soil gas	• A made ground cover has been identified by the site investigation generally as inert construction and reprofile fill • Localised Carbon Dioxide, up to 2.4%v/v with negligible flow rates were encountered during post site investigation monitoring. Therefore, the site is classified as Characteristic Situation 1 • There are no landfills on site or within 1km to the site
Mining	The Coal Authority indicates that the site is not within a zone of likely physical influence on the surface from past or present underground workings
Principle Contamination issues	The following contamination issues were identified during the site investigation; • Localised marginally elevated Benzo (a) Pyrene within the made ground. The elevated concentrations are likely to be due to the ash content within the made ground. Due to the presence of hardstanding and soft cover to the proposed development the risk to human health is considered to be **Low**. • Localised marginally elevated lead within the made ground (970mg/kg). Statistical analysis confirms that the elevated concentrations are not representative of the site. Therefore the risk to human health is considered to be **Low**. • Marginally elevated TPH within the perched waters in the made ground. However, due to the presence of up to 5m of clay beneath the site the risk to groundwaters is considered to be **Low**.
Asbestos	In order to review the potential risk associated with asbestos the following works have been undertaken; • Review of historical data; type II survey, disposal certificates and confirmation letter • Site Walkover inspection • Asbestos testing of soils from site investigation The following review is provided; • A Type III Asbestos Survey was undertaken by Tameside Environmental Consultants in February 2009 prior to the demolition of the main factory building • The survey identified the presence of localised asbestos in the built development. A consignment note has been provided relating to the removal and disposal of asbestos material. The Consignment Note states that removal was undertaken on the 8th June 2009 by Alsager Contractors Ltd. • Tameside Environmental Consultants undertook a further site visit, and in their letter dated 28th January 2011 state that all asbestos materials identified in their Type III Survey have been removed from the premises • A site walkover was undertaken by WA Fairhurst on the 29th January 2011. No visual evidence of asbestos debris was identified to the ground surface or within the made ground during the site investigation • 13 surface and near surface samples have been sent for Asbestos Analysis. In view of the above, which indicates the appropriate identification and removal of asbestos from the demolished historical building and no visual evidence of asbestos debris on the site the risk of there being significant asbestos debris is considered to be low. However, in view of the historical nature of the site the absence of asbestos cannot be fully discounted and, as such, an appropriate risk allowance should be included in construction budgets. We understand that an asbestos survey of the remaining building on site is in progress and will be reported in due course.

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Executive Summary

Contamination Statutory Liability	The site development would be expected to be subject to a contaminated land planning condition as part of future planning application.
Remediation Options	Based on the reviewed information the site represents a **Low** level of environmental risk, which would not preclude development or require significant remediation actions prior to development. However, specific mitigation measures may be required within the development to ensure and demonstrate that risks to receptors are maintained to a low level: • Visual inspection during earthworks to confirm the absence of significant contamination • Validate imported materials used for landscape cover • Construction workers to adopt appropriate PPE • No soil gas protection measures are required
Waste Management	• In view of the identified site conditions site excavated material would not require off site disposal to mitigate contamination risk to receptors and should be acceptable to remain on site. If near surface materials from foundation and drainage arisings are disposed of to landfill they are likely to comprise made ground materials with a provisional classification as 50% Inert and 50% Contaminated Non Hazardous.
Geotechnical Constraints	• Variable thickness of made ground 0.5m to a maximum depth of 2.5m • Historical foundations and substructures anticipated with potential tram lines and filled inspection pits – brickwork identified in TP03 and TP04. Natural obstruction encountered at 7.0m begl in BH04 • Main site is approximately 1.0-2.0m higher than Heald Grove along the western boundary with retention from the original warehouse wall at the site boundary. Any variation to this structure should be designed to avoid impact to the adopted highway or services. • Demolition to existing warehouse and slab
Foundation and Floor Slab Design	• Traditional pad foundations founded on firm clay at depths of between 1.2m and 2.0m bgl with a typical bearing capacity of 100 kN/m^2 • Trench fill to areas of deeper made ground will be required • In view of the variable made ground a suspended slab is likely to be the most simple and economic solution. Alternatively where made ground is thin or can be reengineered and validated a ground bearing floor slab would be acceptable. • For highly loaded structures the use of a piled foundation will be required. For piles driven to a set in the bedrock at a depth of around 10m a typical working load of around 350kN is achievable

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Earthworks	• The site is generally level and, as such, is unlikely to require significant earthworks re-levelling. • However, minor earthworks will be required to generate a suitable development platform and it is anticipated that levels would be set to generate a cut fill balance with materials re balanced on site. • Existing made ground is considered to be suitable for re use on site. However, reused materials should be subject to an appropriate earthworks specification and may require localised treatment/stabilisation if subject to weather degradation.
SUDS	The following information is provided on SUDS; • The use of infiltration drainage is not viable due to the presence of variable made ground and impermeable superficial deposits • Surface water discharge is likely to require appropriate attenuation with discharge to public sewer subject to approval from United Utilities and the Environment Agency
Concrete Class	• Concrete should be design in accordance with DS2 and ACEC AC2s
Pavement Design	• Design CBR value of 2% may be achievable for existing made ground with a typical pavement construction thickness of 450mm. An increased thickness may be required for adopted road. • All subgrades should be proof rolled and visually inspected. Any soft or loose material identified should be removed and replaced with a compacted granular fill
Services	Statutory service plans have been reviewed and do not identify any evidence of on site statutory services. It is assumed that service connections to the demolished unit would have been disconnected at the time of demolition though this needs to be confirmed. Service connections may still be present to the remaining unit and disconnections need to be confirmed prior to demolition. All main services are located adjacent to the site though capacity and connections will need to be approved by the statutory provider. There are a number of services within the footway immediately adjacent to the site and any works to the site boundary and access/egress will need to be reviewed for potential impact
Temporary Works	The following works may be required for any proposed development: • The use of traditional plant for excavation. • Excavation side support will be necessary where man access is required • Localised perched water within made ground; any seepages that do occur should be adequately controlled by pumping from sumps

1.0 INTRODUCTION

1.1 General

W. A. Fairhurst and Partners were requested by Marcus Worthington Properties Ltd to carry out a Phase I Geo-Environmental Risk Assessment and a Phase II Site Investigation on a site at Moss Lane East, Manchester. As part of these works an environmental and geotechnical desk study has been undertaken.

The aim of the Phase I desk study and Phase II site investigation was to provide Geotechnical and Environmental information to assist the Client in the assessment of abnormal costs associated with the development, and to provide supplementary information in support of the discharge of Planning Condition No 17 from Application Number 093074/FO/2010/S1.

The desk study includes a review of the available geological, historical and environmental information in order to establish the likely ground conditions at the site.

The aim of the site investigation was to confirm the geotechnical and environmental conditions identified by the desk study. This was carried out via intrusive ground investigation techniques and chemical and geotechnical testing.

This report provides the following information;

- A review of the desk study information and development of a preliminary conceptual model
- Summary of the Environmental and Geotechnical site conditions
- Qualitative Environmental Risk Assessment relating to the site conditions and proposed development
- Outline remediation strategy, which should be implemented during development to mitigate the Environmental risks identified by the Qualitative Risk Assessment
- Geotechnical engineering recommendations for the development; foundations, highway and car park pavement design, earthworks and temporary works design
- Revision of the preliminary conceptual model set out in the Phase I Desk Study
- Identification of the Geotechnical and Environmental constraints and abnormal works

1.2 Development Proposals

The development proposals are shown on Hodder Drawing No. 0538 L (-) 001 L, **in Appendix E,** and includes the following;

- Multi storey student accommodation with associated access road, car park and localised landscaped areas

1.3 Sources of Information

The following sources of information were utilised in the preparation of the Desk Study report and are presented in **Appendix A**:

- Historical desk study report by Scott Hughes design (**for information only**)

- Type III asbestos survey by Langham House Environmental Services (**for information only**); survey of the former factory demolished in 2009, together with asbestos removal certificates, and off site disposal transfer notes for asbestos disposal.
- TEC letter dated 28th January 2011 confirming that asbestos as identified in the above survey had been removed from site
- Ordnance Survey Historical Plans
- British Geological Survey geology map
- Landmark Envirocheck Report
- Statutory Services information
- In addition enquiries have been made to the following statutory authorities; Local Authority Environmental Health and Planning Departments.

2.0 SITE DESCRIPTION

2.1 Location and Topography

The site is centred at NGR 384970 395630 at Moss Lane East, Manchester as shown on Drawing No. 85269/9001, **Appendix E**. The site lay out is shown on Landmark Envirocheck Sensitivity Map in **Appendix E**.

The site is approximately 0.6 Ha and comprises the following

- In the west - Footprint of a former factory building under hardcore cover currently used as a car park
- In the north east – Steel clad warehouse in use as a covered car park with an adjacent small tarmac car park

The site is generally level with a steeply sloping access off Heald Grove in the south west. The main site is approximately 1.0m to 2.0m higher than Heald Grove along the western boundary with retention from the original warehouse wall at the site boundary.

The site is bound by Heald Grove to the west, Moss Lane East to the north, job centre to the south with a pub, car park and flats to the east.

2.2 Site History

Information about the historical development of the site and the adjacent land has been obtained from a review of the available Ordnance Survey maps, **Appendix A**. The existing and historical land use at the site is summarised in **Table 1** and **Table 2** below:

Table 1: Existing Development

Date	On Site	Adjacent Land
Present	• In the west - Footprint of a former factory building under a hardcore cover and currently in use as a car park • In the north east - Steel clad warehouse in use as a covered car park with an adjacent small tarmac car park	• Moss Lane East and Whitworth park to the north • Heald Grove and Residential to the west • Job Centre and residential to the south of the site • Commercial businesses to the east • Car wash to the west at the location of the former PFS

Table 2: Historical Land Use

Date	On Site	Adjacent Land
1850	• Housing to the north with the potential for basements • Undeveloped land to the south	• Largely undeveloped with sporadic housing and park land
1893	• Terrace housing to the north • Southern end of the site is part of a Tramway Depot with Tramlines with potential inspection pits	• Terrace housing to the south east and west • Laundry to the south • Whitworth Park to the north • Tramway lines to the east
1908	• Large unidentified building along the western end of the site	• Higher density of housing to the east and south • Depository immediately east
1922	• Whitworth Park Factory (Handkerchief) along the western end of the site	• Largely unchanged.

1950	• Factory has expanded up to the southern boundary • Chimney shown in the far south	• Coach works immediately south • Small garage to the west • Motor repair works and quilt works to the north east • Depository to the east has increased
1961-1986	• Terrace housing to the north east have been demolished • Factory expanded to the north east	• St Mary's Hospital and Laboratory to the north • Works and garage immediately south of the site • PFS to the west • Possible PFS immediately north west of the site at the corner of Heald Place and Moss Lane East
1992	• Whitworth Park Factory labelled as "Factory"	• Depository to the east has been demolished • Works to the south have been demolished
1995*	• Main factory occupies the entire western end of the site up to the southern boundary • Separate warehouse unit in the north west corner	• PFS present immediately north west of the site at the corner of Heald Place and Moss Lane • Car Park immediately east • Waste ground immediately south east and immediately west • Residential housing to the south west • Job centre with sub station immediately south • Whitworth Park to the north beyond Moss Lane East
2000-2009*	• Small section of the main factory in the far south of the site demolished circa 2000 • Waste ground with sparse vegetation present in far south	• PFS in the north west has been demolished and is now used for car storage • Halls of residence have been built on the waste ground to the south east and east
2009-2011*	• Demolition of the main factory in June 2009 • Site now used as a car park • Warehouse unit in the north east still present	• Waste ground at location of former PFS

* Description based on aerial photographs presented in **Appendix G**

2.3 Geology

2.3.1 Made Ground

Historical plans for the site show development on the site as a factory, houses and a tramway depot with tramlines and as such made ground cover is expected across the site to comprise of construction fill material. Deeper made ground deposits may be present associated with potential basements to the former terrace housing and inspection pits to the tramway depot.

2.3.3 Superficial Deposits

British Geological Survey, Map Sheet Number 35, 1:50,000 indicates that superficial deposits comprise a till which comprises clay with poorly sorted mix of sand and gravel.

2.3.4 Solid Geology

The solid geology beneath the site is shown on the BGS plan to comprise Sherwood Sandstone.

2.4 Mining and Mineral Extraction

Information from the Coal Authority is summarised below:

- The property is not within the zone of likely physical influence on the surface from past underground workings
- The property is not within an area for which the Coal Authority have granted or is determining whether to grant a license to remove coal using underground methods in the future
- The property is not within the likely zone of influence of any present underground coal workings
- There are no known coal mine entries within 20m of the boundary
- Within the area there are no known faults or other lines of weakness due to coal mining that have made the property unstable at the surface
- Not within/or 200m of an opencast mining site from which coal has been removed

2.5 Landfilling and Soil Gas

The site has been subject to historical development as a factory and housing as such made ground is anticipated to comprise inert reprofile materials and is likely to be a source of low concentration soil gas at low emission rate.

There are no recorded landfills on site or within 1Km of the site.

2.6 Radon

Based on information within the BGS Radon report no radon protection measures are required for the area

2.7 Controlled Waters

2.7.1 Surface Water

Information on surface waters obtained from the desk study enquiries is presented in **Appendix A** and summarised below;

- There are no surface water features on site
- The nearest water feature is the Platt Brook approximately 911m to the south east of the site

2.7.2 Groundwater

The site is expected to comprise made ground over clay with possible sand lenses over sandstone. The following information is provided on groundwaters;

- Localised seepages within the made ground are expected
- Perched waters within granular superficial deposits
- The sandstone aquifer is classified as a Major Aquifer

- The site is within a Source Protection Zone III
- The Landmark Envirocheck Report indicates that there are no groundwater abstraction licences within 500m of the site
- The nearest groundwater abstraction point is 1.1Km from the site

2.7.3 Flood Risk

Information on flood risk obtained from the desk study enquiries is presented in **Appendix A** and summarised below:

- The site is within a Flood Zone 1 and is not an area identified as at risk to fluvial flooding by the Environment Agency

2.8 Ecological Receptors

Information contained within the Landmark Envirocheck report is summarised below;

- The site is not located on any Environmentally Sensitive Areas including Areas of Outstanding Natural Beauty and Sites of Special Scientific Interest.

2.9 Invasive Species

No Japanese Knotweed was identified during the site walkover on the 29th January 2011. However a formal invasive plant survey is recommended due to the nature of the site during the plant growing season.

2.10 Regulatory Review

2.10.1 Permits Consents and Authorisations

The factors that could influence the environmental status of the site are described below in **Table 3 and 4**. A full listing of these factors including discharge consents, pollution incidences and other environmental information included in the Envirocheck® Report is presented in **Appendix A**.

Table 3 - Regulatory Review

Feature	No. within 1km of site boundary	Closest to site:	Comments
Local Authority PPC	6	26m NW	Whiteworth Park Service Station
Registered Radioactive Substances	39	510m N	Central Manchester Children's NHS Trust
Contemporary Trade Directory Entries	62	26m NW	Save Service Station
Registered Fuel Stations	7	0* (marked incorrectly as on site in Envirocheck	Save Service Station now obsolete and was located at 490 Moss Lane East at the corner of Moss Lane East and Heald Place

*Correspondence, shown in **Appendix A**, with the local petroleum Officer confirms that no petroleum or related products that legally require to be licensed were present on site.

2.10.2 Landfilling and Waste Management

Details of landfill sites and waste management facilities are summarised in **Table 4** below.

Table 4 – Landfill and Waste Management Sites

Feature	No. within 1 Km of site boundary	Closest to site	Comments
Historical Landfill	0	-	None within 2Km of the site
Registered Landfill Sites	0	-	None within 2Km of the site
Licensed Waste Management Facility	1	454m NE	Manchester Royal Infirmary – Clinical waste transfer station
Registered Waste Treatment or Disposal	1	435m NE	Manchester Royal Infirmary

2.11 Site Inspection

A Site inspection was undertaken by WAF on the 29th January 2011. The photographs taken during the site inspection can be found in **Appendix H**. A location plan of the photographs taken during the walk over is shown on drawing No 85269/9004 in **Appendix C**. The findings of the site inspection are summarised below:

- Site access is off Heald Grove in the south west. The access slopes steeply to the east from Heald Grove towards the site (**Photograph 1**)
- The main site to the west comprises the footprint of the former factory with a hardcore cover (**Photograph 2, 3, 4 and 5**). The site is used as a car park.
- The walls of the former factory still remain along the north, west and eastern boundary of the main site (**Photograph 3, 4 and 5**)
- The main site is between 1 and 2 m higher than Heald Grove to the west (**Photograph 6**)
- A steel clad warehouse is located in the north east corner of the site. The warehouse is empty and is used as a covered car park (**Photograph 7-9**)
- A small tarmac covered car park is located to the north of the warehouse facing Moss Lane East (**Photograph 8**)
- A brick structure was encountered at approximately 0.5m bgl within TP03 (**Photograph 10**)
- No visual or olfactory signs of contamination were identified during the site walkover

2.12 Demolition and Asbestos Survey

In order to review the potential risk associated with asbestos the following works have been undertaken;

- Review of historical data; type III survey, disposal certificates and confirmation letter
- Site Walkover inspection
- Asbestos testing of soils from site investigation

The following review is provided;

- A Type III Asbestos Survey was undertaken by Tameside Environmental Consultants in February 2009 prior to the demolition of the main factory building
- The survey identified the presence of localised asbestos in the built development. A consignment note has been provided relating to the removal and disposal of asbestos material. The Consignment Note states that removal was undertaken on the 8th June 2009 by Alsager Contractors Ltd.
- Tameside Environmental Consultants undertook a further site visit, and in their letter dated 28th January 2011 state that all asbestos materials identified in their Type III Survey have been removed from the premises
- A site walkover was undertaken by WA Fairhurst on the 29th January 2011. No visual evidence of asbestos debris was identified to the ground surface or within the made ground during the site investigation.
- 13 surface and near surface samples have been sent for Asbestos Analysis.

In view of the above, which indicates the appropriate identification and removal of asbestos from the demolished historical building and no visual evidence of asbestos debris on the site, the risk of there being significant asbestos debris is considered to be **Low**. However, in view of the historical nature of the site the absence of asbestos cannot be fully discounted and, as such, an appropriate risk allowance should be included in construction budgets.

We understand that an asbestos survey of the remaining building on site is in progress and will be reported in due course.

3.0 PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

3.1 Qualitative Risk Assessment Methodology

In accordance with the current UK Government policy of "suitable for use" approach to the remediation of contaminated land, a qualitative contamination risk assessment has been undertaken for the site. The assessment has been undertaken with regard to proposed student accommodation.

The following sections discuss all the identified potential on and off site sources, pathways and receptors in the context of the proposed development and plausible pollutant linkages which may represent a risk to identified receptors such as human health and/or controlled waters from the data gained from the desk study. At this stage the assessment is qualitative and aimed to determine all pollutant linkages, irrespective of significance or allowing for uncertainty.

Three impact potentials exist for any given site, these are:

- The site impacting upon itself;
- The site impacting on its surroundings;
- The surroundings impacting on the site.

All three impacts need to be considered in a risk assessment.

3.2 Potential Sources

The site has undergone historical development as a residential houses, tramway depot, factory and car park. The historical developments may be a source of contamination (Ref 4).

On site sources:

General Made Ground: metals, heavy metals, inorganics, asbestos, hydrocarbons

Historical Factory and tramway depot: Fuel/oil hydrocarbons, asbestos

Off site Sources:

Historical land use a PFS: Oil/fuel hydrocarbons, VOC's

Historical coach works and motor repair works: metals, heavy metals, inorganics and hydrocarbons

3.3 Pathways

A pathway is defined as a mechanism or route by which a contaminant comes into contact with, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the proposed development are identified as follows:

- Direct contact through ingestion, inhalation and absorption
- Soil gas migration and accumulation within confined spaces
- Surface run-off and infiltration
- Horizontal and lateral migration of contaminants
- Dust blow
- Direct contact by buried structures and services
- Development foundations

3.4 Receptors

Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by contaminants.

3.4.1 Human Health

Human receptors would be at risk from identified sources through the identified pathways. Groups at risk may include:

- Future site users as residential with no plant uptake
- Construction and maintenance workers
- Adjacent site users

3.4.2 Controlled Waters

The site is underlain by a Major Aquifer which means contaminants may have the potential to migrate and contaminate a controlled water source. Water sources that pose a potential risk include:

- Groundwater (Major Aquifer)

3.4.3 Construction Materials

Migration of contamination may represent a risk to construction materials including:

- Building
- Underground services and buried concrete structures

3.4.4 Ecological

No ecological receptors were identified

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

Based on the preliminary Conceptual Site Model (CSM) for the site, an Environmental Risk assessment (ERA) has been undertaken. This ERA has been carried out on the basis of a simple matrix taken from CIRIA C552 (Rudland et al., 2001) 'Contaminated Land Risk Assessment – A Guide To Good Practice' and provides a consistent basis for decision-making. The probability and consequences are defined according to parameters relevant to the situation and risk assessment.

The plausible Pollution Linkages (**Table 5 and 6)** indicate the level of risk associated with the identified source and is based on the combination of consequence and probability. **Tables 10, 11, 12** and **13** in **Appendix A** provide a Risk Matrix, Classification of Consequence, Probability and Classification of Risk and likely action required respectively.

Table 5 - Summary of plausible source-pathway-receptor pollutant linkage Onsite Sources:

Source	Pathway	Receptor	Con	Prob	Risk
General Made Ground associated with historical land as a factory and tramway depot	Ingestion, Inhalation, dermal contact	Future Site users	M	Lw	M/L
		Construction Workers	M	Li	M
	Leaching and migration of contaminants	Groundwaters	M	Li	M
	Direct Contact	Underground building structures/services	M	Li	M
	Direct contact and root uptake	Landscaped areas	M	Ul	L
Asbestos fibres within made ground	Ingestion, Inhalation, dermal contact	Future Site users	M	Lw	M/L
		Construction Workers	M	Li	M
Ground gases associated with general made ground	Migration into buildings and Inhalation pathways during earth works	Future site users	S	Ul	M/L
		Construction Workers	S	Lw	M
		Adjacent land users	S	Ul	M/L

Table 6 - Summary of plausible source-pathway-receptor pollutant linkage Offsite Sources

Source	Pathway	Receptor	Con	Prob	Risk
Contaminants associated with historical off site land use as PFS, motor repair shop and a coach works	Ingestion, Inhalation, dermal contact	Future site users	M	Ul	L
		Construction Workers	M	Ul	L
	Leaching and lateral and vertical migration of contaminants to control water receptors	Controlled waters	M	Li	M
	Direct contact	Underground services	M	Ul	L
Ground gases associated with off site land use	Migration of soil gases into the site building receptors	Future site users	M	Ul	L
		Construction Workers	M	Ul	L

KEY:

Consequence: Sv = Severe, Md = Medium, Mi = Mild, Mr = Minor

Probability: Hi = High likelihood, Li = Likely, Lw = Low Likelihood, Ul = Unlikely

Risk: VH = Very High, H = High, M = Moderate, M/L = Moderate/Low, L = Low, VL = Very Low

After CIRIA Report C665, Assessing risks posed by hazardous ground gases to building, 2007

Based the pollution linkage assessment combined with the historical and geological setting of the site the Environmental Risk Assessment has indicated the following:

- The site represents a **Low to Moderate** risk to human health from the potential pollution linkages
- The site represents a **Moderate** risk to onsite construction workers
- The site represents a **Moderate** risk to controlled waters

5.0 PHASE II GEO-ENVIRONMENTAL SITE INVESTIGATION

5.1 Objectives

A detailed Site Investigation was designed and implemented by W. A. Fairhurst & Partners in accordance with BS10175 (Ref. 3). The overall aim of the investigation was to:

- Identify and confirm the general soil profile.
- Identify suitable founding strata to assist in foundation design.
- To assess the potential presence of and extent of contamination in shallow soil and ground water beneath the site.
- To establish the significance and magnitude of the observed contamination through comparison of analytical data to appropriate published environmental screening criteria.
- To revise the Preliminary Conceptual Site Model set out within the Phase I Desk Study.
- To provide a report on the findings of the intrusive investigation together with conclusions and recommendations with respect to the observed contamination.
- Potential further actions that may be required and the likely associated costs.
- Establish any potential development abnormals prior to site development.
- Provide information to assist in the characterisation of the site in order to satisfy regulators that environmental risks have been adequately identified and mitigated.

5.2 Ground Investigations

The ground investigation for this site comprised the following works and is detailed in Ian Farmer Associates Factual Report dated August 2010 (Ref 1):

- Six cable percussion boreholes to depths of up to 10m bgl to investigate ground materials to depth and to install standpipes to monitor groundwater and soil gas conditions
- Excavation of 4.5 No trial pits to a maximum depth of 4m bgl.

The exploratory hole locations are shown on Drawing No.083928/9002 in **Appendix E.**

5.3 Soil Gas

The desk study identified the following potential source of soil-gas.

- Made Ground associated with historical development on the site
- Soil gas associated with natural deposits

Standpipes were installed across the site to target the made ground and the natural deposits. 4 complete monitoring events were carried out between 9th February 2011 and the 2nd March 2011.

The results of the Gas monitoring are presented in **Appendix D**, and the exploratory hole location plan are shown on Drawing No.083928/9002 in **Appendix E.**

5.4 Laboratory Testing

Chemical analysis was undertaken on representative soil and groundwater samples recovered from across the site.

9 No. soil samples were analysed for chemical content. The analysis included the general suite with additional determinants on selected samples. These are detailed within **Table 15, Appendix C.**

Chemical analysis was undertaken for the following determinants;

Soil Samples

General suite (GS)

- Metals and metalloids - arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc.
- Inorganic compounds - cyanide, sulphate, sulphide, pH.
- Organic compounds - phenols, total petroleum hydrocarbons screen (TPH), Polyaromatic hydrocarbons screen (PAH's).

The following additional determinants were also scheduled on selected samples; .

Asbestos (Asb), speciated TPH, speciated PAH and Total Organic Carbon (TOC)

Groundwater Samples

Groundwater samples were obtained and analysed on 2 No. occasions. These are detailed in Ian Farmer Associates Factual Report (Ref 1) and summarised below.

The following contaminants were tested for;

- Arsenic, cadmium, chromium, selenium, mercury, lead, copper, nickel, zinc, boron, polyaromatic hydrocarbons (PAH) screen and speciated, total petroleum hydrocarbons (TPH) screen and speciated, cyanides (total, free, complex), thiocyanate, total sulphate, soluble sulphate, sulphur, sulphide, pH and total phenols

Asbestos

Due to the recent demolition and the age of the demolished buildings an additional 13 surface samples were taken from across the site and analysed for Asbestos ID. The location of the surface samples is shown on Drawing No 86988/9002, in **Appendix E**. A total of 6 No additional near surface samples from the exploratory holes were also tested for Asbestos.

6.0 GROUND CONDITIONS

6.1 Soil Profile

Detailed descriptions of the materials encountered, together with groundwater observations and the results of in situ tests are given in Ian Farmers Factual Report (Ref. 1). A summary of the soil profile is detailed below;

Table 7– Summary of Soil Profile

Proposed Development	Details of Strata	Depth to base (m)
Student Accommodation	Made Ground as a mix of granular and cohesive fill with fragments of brick and concrete and ash	0.5-2.5
	Firm becoming stiff **Clay**	6.9 to 8.7
	Localised dense **Gravel**	7.5-8.8
	Weathered **Sandstone**	Proven to 10.1

6.2 Groundwater Profile

Based on the monitoring information and the Site Investigation the following groundwater regime has been identified and is summarised below.

Table 8 – Summary of Groundwater Profile

BH ID	Strikes during SI (mbgl)	Long term water levels (mbgl)	Response zone
BH01	Dry	Dry	7.5 – 9.1 - Main Water in Sandstone
BH03	Dry	0.6 - 1.32	0.5-2.0 Perched Water in Made Ground
BH05	Dry	Dry	7.2-9.2 Main Water in Sandstone
BH06	Dry	1.54 – 2.15	0.5-2.5 Perched Water in Made Ground

The following groundwater profile was encountered on site:

- Localised discontinuous perched water within made ground at between 1.32m and 1.68m bgl
- No groundwater encountered within superficial deposits
- No groundwater encountered within the sandstone bedrock (Major Aquifer)

6.3 Relic Structures

The site has been subject to historical development as shown on drawing No 86988/9003. Based on the historical land use of the site and anecdotal evidence infilled basements and historical foundations are likely to be present. The following obstructions were encountered during the site investigation;

- Natural obstruction at 7.0m bgl in BH04
- Brickwork identified in TP03 at 0.9m bgl
- Brickwork identified in TP04 at 1.0m bgl
- Drainage gullies run through the centre of the main site

In addition the following obstructions are expected associated with the sites historical development;

- Historical foundation associated with the former factory
- Historical foundations associated with former residential properties
- Infilled basements associated with former housing were not identified during the site investigation but cannot be discounted
- Infilled inspection pits associated with the historical tramway depot were not identified during the site investigation but cannot be discounted
- Foundations to existing warehouse

6.4 Geotechnical Properties

In the following sections a summary of the Geotechnical properties, based on physical description, in situ testing and empirical values is presented for each strata encountered.

6.4.1 Made Ground

Made ground has been identified over the entire site comprising a mix of granular and cohesive fill with fragments of brick, concrete, sandstone, coal and ash up to 2.5m bgl.

Standard penetration tests carried out in the Made Ground gave 'N' values of between 3 and 20 indicating an inconsistent fill.

In view of the variable nature of the made ground this material is expected to be of low bearing capacity and high compressibility.

6.4.2 Superficial Deposits (Clay)

Glacial clay was identified beneath the made ground at depths of between 0.5 and 2.6m in each of the exploratory hole and was proven to a maximum depth of 8.7m bgl.

The clay was described as being firm becoming stiff.

Standard Penetration Tests carried out within the clay deposits gave 'N' values of between 16 and 37, and consistently over 20 indicating a firm to stiff consistency.

Laboratory tests were carried out on samples of the Glacial Till to assess the moisture content, index properties and shear strength of the Till.

Moisture content were in the range of 11% to 22%. The index test results gave plastic limits of between 20%, liquid limit of 47% and plasticity indices of 27%.

Based on the soil descriptions, empirical correlation (SPT values) and published data the following typical design values are considered appropriate:

- Bearing capacity of 100kN/m^2

6.4.4 Bedrock

Bedrock was encountered as weathered sandstone recovered at between 7.5 and 8.7 and proven to a maximum depth of 10mbgl.

Standard penetration tests carried out in the bedrock gave 'N' values of >50

Based on the engineers field descriptions and published data (Ref 11) the following design parameters are considered appropriate;

- Bedrock strata from Rockhead -UCS of 500 kN/m^2

6.5 Evidence of Contamination

6.5.1 *Visual and Olfactory Evidence*

The entire site is underlain by made ground deposits typical of inert construction fill materials. The made ground comprised of brick, concrete, sandstone and ash.

The following visual and olfactory signs of contamination were identified during the site investigation:

- Ash encountered within the made ground across the site
- Slight hydrocarbon odours noted at between 0.7-1.2m in BH05

6.6 Soil Contamination Test Results

10 No. samples of made ground and 2 No sample of natural soils were analysed for contamination. The results are detailed in **Table 15** in **Appendix C**.

Made Ground

10 No. soil samples of the made ground were analysed for contamination and are summarised below:

- 1 No sample with elevated Total TPH (14,000mg/Kg in BH04 at 0.3m). However, speciated results were all below their respective assessment criteria
- 1 No samples with elevated Benzo (a) Pyrene of 120mg/kg in BH04 at 0.4m
- 3 No samples with elevated lead (970mg/kg in TP01 at 0.7m, 300mg/kg in BH04 at 0.3m and 250mg/kg in BH06 at 1.0m
- No elevated TPH identified in BH5 at 1.0m

Natural

2 No. soil sample of natural soil was analysed for contamination and is summarised below:

- No samples above their respective Assessment Criteria

Asbestos

A total of 19 samples were analysed for Asbestos ID. The lab results are present in **Appendix C** and are summarised in **Table 15**, **Appendix C** and is summarised below;

- No asbestos fibres were detected within the made ground

6.7 Groundwater Contamination Test Results

2 No. samples of groundwater perched in the made ground were analysed for contamination. The results are detailed in **Table 15** in **Appendix C**.

Perched Water within Made Ground

2 No. water samples of perched water within made ground were analysed for contamination and are summarised below:

- 2 No samples of elevated TPH at between 0.071 and 0.59mg/l

Superficial Waters and Main Waters within Sandstone bedrock

- No waters were encountered within the superficial deposits or within the sandstone aquifer

7.0 GEOTECHNICAL ASSESSMENT

7.1 Design Criteria

The following design criteria have been adopted for the proposed development as shown in Hodder Architects Drawing No. 0538 L (--) 001 Rev L, **in Appendix E**;

- Assumed structural load of up to 1000kN with a floor slab load of 30kN/m^2
- Line loads of 100kN/m
- Allowable foundation settlement of less than 25mm with a maximum differential movement of 1 in 750
- Allowable floor slab settlement of less than 20mm with a maximum differential of less than 1 in 500

7.2 Geotechnical Hazards/Constraints

The following geotechnical constraints have been identified on the site as shown on Drawing 86988/003 in **Appendix E**;

- Variable thickness of made ground 0.5m to a maximum depth of 2.5m
- Historical foundations and substructures anticipated with potential tram lines and filled inspection pits – brickwork identified in TP03 and TP04. Natural obstruction encountered at 7.0m begl in BH04
- Main site is approximately 1.0-2.0m higher than Heald Grove along the western boundary with retention from the original warehouse wall at the site boundary. Any variation to this structure should be designed to avoid impact to the adopted highway or services.
- Demolition to existing warehouse and slab

7.3 Demolitions

The following building will need to be demolished;

- Steel clad warehouse in the north east corner of the site
- Walls of former factory which form the site boundary
- An asbestos survey for the existing warehouse is underway

7.4 Foundation Design and Floor Slab Considerations

The following foundation design is recommended for the development:

- Traditional pad foundations founded on firm clay at depths of between 1.2m and 2.0m bgl with a typical bearing capacity of 100 kN/m^2
- Trench fill to areas of deeper made ground will be required
- In view of the variable made ground a suspended slab is likely to be the most simple and economic solution. Alternatively where made ground is thin or can be reengineered and validated a ground bearing floor slab would be acceptable.
- For highly loaded structures the use of a piled foundation will be required. For piles driven to a set in the bedrock at a depth of around 10m a typical working load of around 350kN is achievable. The advice of a specialist contractor should be obtained for detailed pile design.

7.5 Pavement Design

Based on the available information the following sub-grades and indicative design CBR values are considered appropriate:

Subgrade	Design CBR
Existing Made ground	2%

A typical pavement construction thickness of 450mm is likely to be required. An increased thickness may be required for adopted road.

Prior to construction the subgrades should be proof rolled and visually inspected. Any soft or loose material identified should be removed and replaced with a compacted granular fill to give a minimum subgrade CBR of 2.0%.

7.6 Earthworks

The site is generally level and, as such, is unlikely to require significant earthworks re-levelling.

However, minor earthworks will be required to generate a suitable development platform and it is anticipated that levels would be set to generate a cut fill balance with materials re balanced on site.

Existing made ground is considered to be suitable for re use on site. However, reused materials should be subject to an appropriate earthworks specification and may require localised treatment/stabilisation if subject to weather degradation.

7.7 Flood Risk

Information on flood risk obtained from the desk study enquiries is presented in **Appendix A** and summarised below:

- The site is within a Flood Zone 1 and is not in an area identified as at risk to fluvial flooding by the Environment Agency

7.8 SUDS

The site was formerly developed as a factory, tramway depot and houses. The site investigation identified variable made ground over superficial deposits comprising a mix of sand and clay.

In view of the localised soil and groundwater contamination and low infiltration associated with the made ground over clay the use of infiltration drainage is not viable on site.

Surface water discharge is likely to require appropriate attenuation with discharge to public sewer, subject to connection approvals.

7.9 Services

The following services may impact the development. The location of the services can be found on drawing No 86988/9003 in **Appendix E.**

Statutory service plans have been reviewed and do not identify any evidence of on site statutory services.

It is assumed that service connections to the demolished unit would have been disconnected at the time of demolition though this needs to be confirmed.

Service connections may still be present to the remaining unit and disconnections need to be confirmed prior to demolition.

All main services are located adjacent to the site though capacity and connections will need to be approved by the statutory provider.

There are a number of services within the footway immediately adjacent to the site and any works to the site boundary and access/egress will need to be reviewed for potential impact

7.10 Temporary Works

The following temporary works are anticipated for the proposed development;

- The use of traditional plant for excavation
- Excavation side support will be necessary where man access is required
- Localised perched water within the made ground. Any seepages that do occur should be adequately controlled by pumping from sumps

8.0 ENVIRONMENTAL RISK ASSESSMENT

8.1 General

Following the recent withdrawal of the guidance notes CLR7 to CLR10 inclusive and previous DEFRA/EA Contaminated Land Exposure Assessment (CLEA) model, and the associated Soil Guideline Values, the results of the chemical testing have been assessed against the recently published SGV's by the Environment Agency/DEFRA. In the absence of any specific published SGV's, Atkins ATRISK (soil) SSVs, assessment criteria for residential with no plant uptake have been used.

These Atkins SSVs have been derived using the updated science report, SC050021/SR2/SR3 by DEFRA and the Environmental Agency.

Groundwater samples have been compared to the UK Drinking Water Standards (2000) (UKDWS) and surface water samples to the UK Environmental Quality Standards for Fresh Water (EQS).

Gas protection measures are assessed against CIRIA 665 'Protecting Development for Methane' (Ref 5). This offers a series of "Characteristic Situations".

The results of soil, groundwater and ground gas testing are presented in Ian Farmer Associates Factual Report (Ref 1). The assessment criteria for the site, including the sources used for individual determinands, is included in Table 14 **Appendix C**. A summary comparison table of the results is also included in Table 15 **Appendix C** and is discussed in the following sections.

8.2 Statistical Analysis in the Assessment of Soil Contamination Data

8.2.1 General

The statistical analysis techniques have been jointly produced by CIEH and CL:AIRE and are drafted on the perspective of either the Planning System or Part 2A of the Environmental Protection Act 1990.

The following statistical approach is based on two Hypotheses, the Null Hypothesis and the Alternative Hypothesis. These hypotheses have been structured to show (with a defined level of confidence) which of the two hypotheses is most likely to be true in any particular case.

8.2.2 Null and Alternative Hypothesis- Under the Land Use Planning System

The Null Hypothesis is that the level of contamination (in the land of interest) is the same as, or higher than, the critical concentration.

If the statistical test shows that the Null Hypothesis should be rejected, the assessor can conclude that the Alternative Hypothesis is more likely to be true i.e. that contaminant concentrations are low relative to the critical concentration and that, potentially, the land is suitable for use.

If the test shows that the Null Hypothesis should not be rejected the assessor should conclude that contaminant concentration may be the same as, or higher than the critical concentration and further assessment may be needed.

8.2.3 Null and Alternative Hypothesis- Under the Part IIA

The Null Hypothesis is that the level of contamination in the land of interest is the same as or lower that the critical concentration and the Alternative Hypothesis is that the level of contamination is higher than the critical concentration.

In this case if the Null Hypothesis is rejected the assessor can conclude that contaminant concentrations are high relative to the critical concentration (and a basis for intervention under the regime potentially exists). If the Null Hypothesis is not rejected, contamination levels may be the same as, or lower than, the critical concentration and a basis for regulatory input is unlikely to be available.

8.3 Human Health Risk Assessment, Assessment Criteria: Residential No Plant Uptake

The results of the chemical analyses of the samples recovered from the investigatory works at the site have revealed the site to be generally free of significant soil contamination (based on soil samples analysed between 0.0 to 1.0m bgl). The majority of the chemical results were either below the levels of detection, or below their respective assessment criteria. The following sections summarise the categories of chemicals tested and the analysis results.

8.3.1 Inorganic Compounds, Metals, Non Metals- Assessment Criteria: Residential with No Plant Uptake

The assessment has been made against the Atkins Site Specific Values (SSV's) or Environment Agency's SGV where available.

Contaminants assessed in this way include;

- Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, Thiocyanate and cyanide

1 No sample with elevated lead (970mg/kg in TP01 at 0.7m) was identified. In order to establish if the elevated concentrations of lead are representative of the soil conditions on site statistical analysis was undertaken. The statistical analysis confirms that the elevated concentrations are not representative of the site and exist as an outlier (hotspots). However, as the proposed development will be under hardstanding and clean covers there is no pathway of contact and the risk to end users is considered to be **Low**.

8.3.2 Organic Compounds

The assessment has been made against the Atkins Site Specific Values (SSV's).

Contaminants assessed in this way are:

- Polycyclic Aromatic Hydrocarbons (PAH)

One sample with elevated Benzo (a) Pyrene was detected (120mg/kg in BH04 at 0.4m). The elevated reading may have been due to ash identified within the made ground. The proposed development will comprise hardcovers and clean covers throughout the site and in the absence of a pathway there is no risk of contact with the end user. Therefore the risk to human health is considered **Low**.

- Total Petroleum Hydrocarbons (TPH)

Analysis for Total Petroleum Hydrocarbons (TPH) was carried out on samples from across the site to delineate the site in terms of hydrocarbon contamination. Elevated Total TPH was identified in BH04 at 0.4m (1400mg/kg). However, speciated results were all below their respective SSV's. Therefore, the risk to human health is considered **Low**.

8.3.3 Asbestos

19 No samples were tested for asbestos. No asbestos fibres were identified therefore the risk to endusers is **Low**, whilst the risk to construction workers remains **Moderate**.

However, the localised presence of asbestos cannot be discounted.

8.4 Controlled Waters

The site is located in an area designated by the Environment Agency as being a Major Aquifer. Standpipes were installed within the made ground and weathered bedrock to a maximum depth of 10m. Two out of four rounds of groundwater monitoring including chemical analysis of samples has been carried out and the results are summarised below. The results can be found in Ian Farmers Associates Factual Report (Ref 1) and summarised in **Table 16** in **Appendix C**.

Perched Waters in Made Ground

- 2 No samples with marginally elevated TPH within localised perched water within the made ground at between 0.071mg/l and 0.59mg/l

Superficial Waters

- No superficial waters identified on site

Main Waters

- The Main Water within the sandstone aquifer was not encountered on site

The localised elevated concentrations of TPH were identified within discontinuous perched water in the made ground. Due to the presence of up to 5.0m of clay beneath the made ground, restricting the downward migration of contamination, the perched waters within the made ground are not considered to be in hydraulic continuity with the underlying Major Aquifer at depth. In addition the site will be under hardstanding and clean covers which will restrict infiltration. Therefore the risk to groundwaters within the Major Aquifer is considered to be **Low**.

8.5 Ground Gas

4 rounds of gas monitoring have been undertaken between 9th February 2011 and 20th February 2010. The results are shown in Table 17 in **Appendix D** and are summarised below.

CIRIA Report 665 "Assessing Risks Posed by Hazardous ground gases to Buildings" (Ref 5) presents current best practice on the assessment of ground gases. The report presents a risk based approach based on gas screening levels which depend on both the concentration and emission rate of gas from the ground. Gas screening levels are calculated as follows:

Gas screening value: (l/hr) = gas concentration (%) x measured borehole flow rate (l/h)

Maximum CO_2 recorded = 2.4

Maximum Gas flow rate	=	0.5
GSV	=	0.012

A Maximum gas screening level of 0.012 l/hr has been recorded giving "Characteristic Situation 1", in accordance with current guidance given in CIRIA C665 (Ref 5).

8.6 Refined Pollution Linkages and Conceptual Model

8.6.1 Introduction

Environmental liabilities and risks have been evaluated in terms of a source - pathway - target relationship in accordance with the approach set out in the 1995 Environment Act, The Contaminated Land (England) Regulations 2000 and the DETR circular 02/2000 Environmental Protection Act 1990: Part IIA Contaminated Land. Under Section 57 of the 1995 Act, it is the duty of Local Authorities to determine whether land is contaminated. Contaminated land is defined within the legislative framework as land which is in such condition by reason of substances in, on or under the land that:

a) Significant harm is being caused or there is a significant possibility of such harm being caused: or

b) Pollution of controlled waters is being caused or likely to be caused.

The potential for harm under item a) is based on the presence of three factors:

- **Source**: Substances that are potential contaminants or pollutants that may cause harm.
- **Pathway**: A potential route by which contaminants can move from the source to the receptor.
- **Receptor or target**: A receptor that may be harmed for example the water environment, humans, flora and fauna.

Where a source, pathway and target are all present a pollutant linkage exists and there is potential for harm to be caused. Therefore, the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm. It should be noted that under b) the pollution of controlled waters alone could cause a site to be designated as contaminated. The nature and importance of both pathways and receptors, which are relevant to a particular site, will vary according to the intended use of the site, its characteristics and its surroundings.

The key principle that underpins this approach is the suitable for use criterion. This requires remedial action only where contamination is considered to pose unacceptable risks to human health or the environment. Under this approach action is only required where a site poses unacceptable, actual or potential risks to health or the environment and appropriate and cost effective remediation techniques exist taking into account the actual or intended use of the site.

In order to assess the contamination risk at the subject site an assessment of pollutant linkages has been made and is discussed in the following sections.

The Site Investigation has identified a series of hazards, pathways and receptors, which are summarised in the following sections.

8.6.2 Sources

The following sources have been identified on site;

- Localised marginally elevated Benzo(a)pyrene and total TPH within made ground
- Localised marginally elevated lead within the made ground
- Marginally elevated TPH, compared with UK Drinking Water standards, within discontinuous perched water within made ground. The perched waters within made ground are not considered to be in hydraulic continuity with the main aquifer at depth.

8.6.3 Refined Pollution Linkages

Pollution linkages based on the identified soil, groundwater and soil gas hazards have been undertaken with respect to the pathways and receptors. A summary table of the expected level of risk from the identified hazards is presented in **Table 9**.

Table 9– Refined Pollution Linkages

Source	Pathway	Receptor	Cons.	Prob.	Risk	Are Mitigation Measures required?
Localised marginally elevated PAH and lead within the general made ground	Ingestion, Inhalation and Skin Contact	Future Site User	Mi	Lw	L	No, The application of hard cover and clean covers will inhibit the pathway to the future site users.
		Construction Worker	Mi	Lw	L	Yes, Construction workers should adopt appropriate health and safety measures and use of appropriate PPE during any earthworks operations.
		Adjacent Land Users	Mi	Lw	L	Yes, Dust suppression measures will be required to prevent fugitive dusts migrating to the adjacent land during construction phase.
	Direct Contact	Services/Buried Structures	Mi	Lw	L	Yes, Service and buried structures should be designed in accordance with BRE special publication (Ref. 6).
	Direct contact	Landscaping	Mi	Lw	L	Yes, Application of clean cover to areas of landscaping in accordance with AGS Guidance-Cover Systems.
Marginally elevated TPH within perched water within the made ground	Leaching and Lateral Migration	Major Aquifer	Mi	Lw	L	No, The localised perched water within the made ground is discontinuous and not considered to be in hydraulic continuity with the main aquifer at depth due to the presence of up to 5m of clay beneath the site. In addition the site will also be under hard cover thus reducing infiltration and there are no potable abstraction points within 1km of the site.
Ground gas – Marginally elevated	Migration of gases from made ground	Future Site User	Mi	Lw	L	No – No gas protection measures are required
		Construction Workers	Mi	Lw	L	Yes, Gas monitoring should be undertaken before man entry into void spaces.
		Adjacent Site Users	Mi	Lw	L	No
Offsite historical PFS now a car wash	Leaching and Lateral Migration	Major Aquifer	Mi	Lw	L	No

8.7 Recommendations for Site Remediation

8.7.1 General

Based on the results of the investigation localised pollution linkages have been identified on this site. The concentrations of contamination and hazard pathways generally only represent a **Low** level of risk which should not require any active remediation prior to development. However, specific mitigation measures will be required within the development to ensure that risks to receptors are maintained at a low level.

8.7.2 Site Wide Preparatory Earthworks

The following mitigation measures should be undertaken during the general preparatory earthworks.

General Measures Implemented During Construction

- Construction workers should undertake soil gas and VOC monitoring prior to and during man entry of below ground voids.
- Construction workers should adopt appropriate health and safety measures to prevent contact with contaminated soils and waters, as detailed in HSE guidance (Ref. 7).
- Surface water control measures should be adopted during construction to limit runoff and infiltration through exposed made ground horizons and to limit siltation of the surface drainage system and runoff entering surface drainage.
- Dust suppression measures should be adopted during all earthworks to mitigate associated risks

Minimum Measures to Remediate Pathways

The following measures are required to remediate pathways:

- Locate and seal site investigation borehole standpipes
- Locate and seal disused surface water runoff drainage connections to redundant sewerage system

Minimum Measures to Mitigate Risk to Human Health-End Users

The site investigation has indicated only localised low concentration contamination. As the development is mainly under hard cover and clean covers there is no viable pathway to end users. Therefore the risk of contaminants migration in soil will be **Low**. As such, no remedial measures are currently required during preparatory earthworks with respect to end users.

Minimum Measures to Mitigate Risk to Controlled Waters

Localised hotspots of TPH have been identified within the soil and perched water within the made ground. Although the concentrations are not considered to be a significant risk which requires removal the following precautionary minimum measures should be implemented during the preparatory earthworks to maintain a **Low** risk to controlled waters;

On completion of the site strip, a visual inspection and validation testing should be undertaken to identify evidence of any further areas of unknown contamination (hydrocarbon and asbestos).

- Additional contaminated materials if encountered during construction works should either be disposed of to the appropriated landfill or remediated onsite. After completion of these works validation testing and auditing should be undertaken to confirm the successful removal of contaminants.
- Validation testing to be carried out on existing stockpile of demolition waste, site won material, imported bulk fill and imported topsoil.

8.7.3 Mitigation Measures within the Built Development

It is recommended that the following mitigation measures should be incorporated into the built development;

- Buried concrete and services should be designed in accordance with the guidance given in BRE Special publication No. 1 (Ref. 6). Based on sulphate conditions the use of Design sulphate DS-2 and ACEC Class AC-2s is considered appropriate.
- The advice of service providers should be obtained to ensure that appropriate measures are taken to protect services from contamination and aggressive ground conditions.
- The site has been classified as "Characteristic Situation 1" with respect to soil gas; therefore no specific mitigation measures are required
- Where imported materials or site won and materials are to be utilised within the bulk fill construction works or as subsoil and topsoil covers these materials should be validated as acceptable for reuse on site.

8.7.4 Implementation of Outline Remediation Strategy

Where appropriate, a method statement identifying the method of implementation of the proposed remediation strategy will be prepared identifying the following:

- The method of implementation of the remedial strategy
- The method of validating the work
- The validation assessment criteria
- The supervision and audit requirements

8.7.5 Regulatory Approval

The remediation strategy will be subject to approval and control via planning conditions attached to the development.

8.7.6 Validation and Reporting

All Environmental works should be validated by suitable validation testing and reporting. The method of validation and reporting should be detailed within a method statement and approved with the regulatory authority prior to commencement of works.

REFERENCES

1. Ian Farmers Associates – Moss Lane East, Manchester– W11/4089 – February 2011
2. Langham House Environmental Services – Moss Lane East/Heald Grove, Rusholme, Manchester – Type III Asbestos Survey Report dated 19th February 2009 (**Information Only**)
3. BS10175 Investigation of Contaminated Land: Code of Practice
4. Contaminated Land Reports (CL7, 8, 9 and 10)
5. CIRIA 659, Assessing the risks posed by hazardous ground gases to buildings., 2009
6. Building Research Establishment. Concrete in Aggressive Ground Special Digest 1 (2001)
7. HSE Protection of Workers and the general public during the development of contaminated land recognisable
8. BRE Report BR211, Protecting new dwellings from Radon
9. AGS Guidance Cover Systems for Land Regeneration
10. Environment Agency Interim guidance on the disposal of contaminated soils
11. Foundation Design and Construction, M.J. Tomlinson

Appendix A

Desk Study Enquiries

- Landmark Envirocheck Report
- Radon Report
- The Coal Authority Report
- Petroleum Officer
- Statutory Services