



Phase 1 Desk Study Site Investigation Report

LOCATION	Proposed Development, Tetlow Street, Liverpool L4 4LE
ISSUE DATE	9 March 2015
FOR	LMH c/o BYA Architects
CLIENT REF.	
OUR REF.	G15029a

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1. Introduction

In accordance with the instructions of Mr K Dunn of BYA Architects Ltd, Geoinvestigate Ltd carried out a Phase 1 Desk Study Investigation of a plot of land adjacent to Tetlow Street, Liverpool.

The site currently comprises a roughly rectangular area of land adjacent and to the north of Tetlow Street, Liverpool. The study area currently comprises gently sloping plot of land with rough grassed surface and some trees and low vegetation.

It is understood that it is intended to redevelop the site with fifteen dwellings together with associated roads, parking and landscaping.

The purpose of the Phase 1 Desk Study investigation was to review the historical land use information on the site in order to provide an assessment of the potential geotechnical/foundation problems together with a qualitative contamination and ground gas risk assessment.

The location of the site is shown on the Groundsure EnviroInsight and GeoInsight environmental and geological reports provided in the appendices of this report.

2. Scope of Works

The investigation comprised a review of the following information;

- An extract from the 1:50,000 Solid & Drift geological map (BGS Sheet 96 – Liverpool).
- Observations from a walkover study carried out by Mr S Howe of Geoinvestigate Ltd.
- Historical OS maps of various scales dating back to 1847 (presented in Appendix 1).
- A GroundSure EnviroInsight Report and a Groundsure GeoInsight Report. These reports are included in Appendices 2 and 3 respectively.

3. Findings of Phase 1 Investigation

3.1 Anticipated Geology

The extract of the 1:50,000 Solid & Drift geological map (BGS Sheet 96 – Liverpool) indicates the site is underlain solid geology comprising the sandstone of the Chester Pebble Beds Formation of the Sythian, with no superficial deposits shown.

No faults are shown within 500m of the site.

3.2 Historical OS Maps and Historical Land Use

Copies of historical OS maps were obtained for the site covering the period 1847 to 2014. Historical land uses and major features located within the site boundary and externally but potentially within influencing distance are summarised in Table 1 overleaf.

The earliest OS map of 1847 shows the site and the majority of the surrounding land to the south to comprise open agricultural land on the northern outskirts of Kirkdale town centre, some 2 miles north of Liverpool City centre. A field boundary forms the northern boundary of the site, whilst terraced housing (Langham Street) is shown 200m to the north of the site. Springfield Mill (a windmill) is shown some 230m north west of the site. A sandstone quarry is shown some 200m south of the site. In the wider context, several other sandstone quarries are shown, together with a large nursery annotated as Walton Nursery some 400m north of the site.

Table 1: Summary of Historical OS Map Land Use & Potential Hazard Identification

Map Feature	Location	Appears	Absent	Notes
Sandstone Quarries	200m south (closest)	1858	1895	Possibly open cast based on map feature but a tunnel is also shown.
Nursery	400m North	1851	1890	
Cemetery	450m Northeast	1890	Remains present	
Ponds (within Stanley Park)	300m East	1890	Remains Present	
Railway	700m North	1895	Remains Present	Associated airshafts shown also
(Glass Cutting) Works	90m Northwest	-1949	Remains Present	Adjacent works also shown
General Municipal expansion	-On site -Surrounding Site	-1890 -1890	-1973 -Some absent 1973	Salop Street backing on Tetlow Street running East - West -Some replaced by new dwellings from 1973
Heather Court	-On Site	-1975	-2010	-Possible residential development (overhead photography on GroundSure Reports shows development absent by 2005)
Dye Mills (Kirkwood)	-20m Northwest	-1893		-Not annotated as such from 1908 although building still present.
Bakery	-20m Northwest	-1949	1969	-Marked as disused from 1958
Mill	-230m Northwest	-1851	1927	-Marked as disused from 1893
Public House	On site	-1890	-1973	.
Church	-10m south	-1890	-Remains Present	
Electricity Substation	Adjacent Southeast	-1979	Remains Present	Possible use of Polychlorinated biphenyl (PCB) coolants – correct period.

NB: Quotation marks indicate descriptions taken directly from historical maps

NB. Arbitrary potential hazard assessment: Higher (amber), Moderate (yellow), Lower (green) – typically adjacent or nearby activity, Very Low (uncoloured) – typically distant activity.

A review of the historical OS maps and the land uses shown has highlighted the land uses most likely to present a hazard or source of potentially harmful contamination to the study area. These are demolition activities and building activity within and adjacent to the site, together with the presence of an adjacent electrical sub station. Other identified features are generally situated too distant from the site to pose significant risk.

3.3 GroundSure Environmental Data Search (EnviroInsight) Report

The GroundSure EnviroInsight Report presented in Appendix 2 provides listings of potentially contaminative current and past land uses together with possible pathway and receptor information. It also covers other potential risks to the site including ground hazards associated with the area's natural geological setting and man-made hazards such as those arising from building activities. A summary of the relevant EnviroInsight Report findings is presented in Table 2 overleaf:

Table 2: GroundSure EnviroInsight Summary: Potential Contaminative Uses/Pathways/Receptors

Details	Feature	Location relative to site
Environmental Permits Incidents and Registers		
Two(2) Part A(2) and Part B Activities within 500m	-(1) Petrol Filling Station -(1) Dry Cleaners	-322m Northwest -480m North
Landfill and Other Waste Sites		
Four (4) Environment Agency Historic Landfill Sites within 1500m	Waste types inert, Industrial or Household; all licence surrendered.	1051m West (closest)
One (1) Local Authority Landfill site within 1500m	-Refuse Tip.	679m South
Thirty Three (33) Environment Agency licensed waste sites within 1500m	Non-Biodegradable Waste - Waste Transfer Station (WTS) (1), Household, Commercial and Industrial WTS (10), Metal recycling sites (4) Physio-Chemical Treatment Facility (12). Vehicle Depollution Facility (2), Non Specified (1); Five(5) listed as licence surrendered.	783m South (closest)
Current Land uses		
Seventeen (17) Potentially Contaminative Industrial Sites within 250m of the site	-Unspecified Works or Factories (3) -Vehicle Repair, Testing and Servicing (2) -Vehicle Parts and Accessories (1) -Curtains and Blinds (2) -Furniture (1) -Beds and Bedding (1) -Fireplaces and Mantelpieces (1) -Moorings and Unloading Facilities (1) -Electricity Substation (5)	-70m South -89m North -152m North -133m West -139m Northwest -162m Northwest -134m Northwest -244m East -On site (closest) (adjacent in reality)
Petrol and Fuel Sites	-Texaco PFS	-319m Northwest
Hydrogeology and Hydrology		
Unproductive Aquifer (2)	-Superficial geology	-74m East (closest)
Principle Aquifer (1)	-Bedrock geology	-On site (closest)
-Ground water Abstraction Licences.	-Make Up or Top Up Water (2)	-194m East (Closest)
-Surface water Abstraction Licences.	-Drinking, Cooking, Sanitary, Washing	-1876m North
-Potable water Abstraction Licences.	-None within 2000m	-N/A
-Source protection zones.	-Drinking, Cooking, Sanitary, Washing	-1876m North
	-None within 500m	
River network and Surface water features	-Surface Water Feature (Lake)	-117m East
Groundwater vulnerability and soil leaching potential	High leaching potential assumed – no quantitative data	On site
Flooding		
Zone 2 & Zone 3 floodplains and flood defences	None within 250m. No flood defences noted.	N/A
Groundwater flooding susceptibility	Limited potential – Underlying geology	On site
Designated Environmentally Sensitive Areas		
Nitrate Vulnerable Zones	Not named	289m East
World Heritage Sites within 2000m (2)	-Liverpool Maritime Mercantile City – Buffer Zone (1) - Liverpool Maritime Mercantile City (1)	-1666m Southwest (closest) -1916m West
No (0) other Designated Environmentally Sensitive Areas listed		

NB Arbitrary potential hazard assessment: potentially significant (yellow) or unlikely to be significant (uncoloured).

No additional significant potentially contaminative land uses or natural risks are listed in the EnviroInsight report beyond those already discussed in the review of the historical map record. Other identified features are considered to be too distant or historical to pose significant risk to the study site. Potential geotechnical hazards are discussed in more detail in the GeoInsight Report (see Section 3.4 overleaf).

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3.4 Groundsure GeolInsight Report

The Groundsure GeolInsight Report (Appendix 3) provides additional detailed information on potential geological hazards. A summary of the relevant GeolInsight Report findings is presented in Table 3 below:

Table 3: Groundsure GeolInsight Summary: Potential Geological Hazards

Details	Feature	Location relative to site
Geology		
Made ground	-Made Ground (Undivided) -Worked Ground (Undivided)	-99m East -118m East
Superficial geology (2 records)	-Till (Devensian) (1) – No Records of permeability -Till (Devensian) (1) – No Records of permeability	-74m East -211m West
Bedrock geology (1 record)	-Chester Pebble Beds Formation – Sandstone – Scythian (Moderate to High Permeability)	-On site
Landslip	No (0) records within 500m	N/A
Geology		
Faults	No (0) records within 500m	N/A
Radon risk	Area not affected	N/A
Mining and Ground Workings		
Historical surface ground workings	Ten(10) within 1000m: -Pond (5) -Boating Pond (4) -Fish Pond (1)	-114m East (Closest) -116m East (Closest) -114m East
Historical underground workings	-Forty Eight (48) within 1000m: -Tunnel (45) -Air Shafts (3) -Disused Tunnel	-684m North (Closest) -933m North (Closest) -841m North
Current ground workings	Five (5) within 1000m: -Sandstone (All marked as Ceased)	-143m South West (Closest)
Mining and Extraction	-Air Shafts (3) – Features most likely associated with Railway Tunnel. No Coal or Non Coal Mining Features shown within 100m of site	-933m West
Natural Ground Subsidence		
Shrink-swell clays	Negligible Risk	On site
Landslides	Very Low Risk	On site
Dissolution of soluble rocks	Negligible Risk	On site
Compressible deposits	Negligible Risk	On site
Collapsible deposits	Very Low Risk	On site
Running sands	Negligible Risk	On site
Railways and Tunnels		
Railway tunnels, Railway features, Historical railways and Active railways	No (0) records within 500m	N/A

NB Arbitrary potential hazard assessment: possibly a significant hazard (yellow) or unlikely to be hazardous (uncoloured)

A review of the GeolInsight report has highlighted no additional potential risks to the site or the intended development arising due to the geological setting.

3.5 Walkover Survey Observations

A site reconnaissance visit was undertaken on Monday 16 February 2015 by Stuart Howe of Geoinvestigate, an experienced geo-environmental engineer.

The site comprises a roughly rectangular parcel of land bounded to the south west and east by Tetlow Street, and properties thereon, The site in an essentially residential setting, although some light industrial and commercial are present >100m to the north west. An electricity sub-station is present just beyond the southeast boundary of the site.

The site is surfaced by rough grass with some sparse bushes. A number of trees (<6m tall) are present in the northeast and northwest corners of the site, the site also has a shallow slope from east to west, dropping by some 2m over the entire width of the site.

Although some evidence of bonfires and generally domestic rubbish tipping is present on the site, no visible surface evidence of physical or chemical contamination (including hydrocarbon substances) was noted on the site. Nor was any evidence of animal grazing or widespread fly tipping.

In summary, the inspection of the surface of the site found no obvious evidence of physical hazards or odours, staining, or residues that might be indicative of the presence of chemical (including hydrocarbon) contamination. On the basis of the walkover inspection only, the risk of a serious contamination hazard occurring at this site would be assessed to be Low to Moderate (as opposed to negligible) given the current condition of the site, its previous use, and the construction and demolition activity that has been carried out at the site (see Section 3.2 above). The hazardous gas risk at the site, based solely on the findings of the walkover survey, would be assessed to be Low to Moderate also (as opposed to negligible) reflecting the possible presence of made ground within the site and associated with the previous construction and demolition activity.

Photograph 1: Site looking north



Photograph 2: Southeast corner of the site.



4. Qualitative Risk Assessment

4.1 Method

In order to assess the potential risks to the site, information obtained on the potential sources of hazard identified in Section 3 have been reviewed and applied to a model of the site. This allows an assessment of the potential sources of contamination to be made by examining the potential pollutant linkages between these and the receptors at the site.

The risk assessment presented comprises a source-pathway-receptor model developed in the context of the intended end use of the site (domestic dwellings). It is noted that an alternative land use would present different pollutant linkages with more or less vulnerable receptors and differing pathways for exposure. Were the intended land use to be changed at the site a revised risk assessment would be required.

Identified potential sources of hazard or contamination, vulnerable receptors and possible pathways by which they may be exposed are presented in the Conceptual Ground Hazard Model (CGHM) presented in Figure 1, see Section 4.2.

In addition to risks to human health and controlled waters and aquifers posed by contamination and ground gas, the CGHM examines the potential risks to the construction of the development including its buildings from geological or geotechnical hazards. It allows an overall assessment to be made of the potential hazards and risks to the site and the proposed development with respect to “fitness for purpose”. The superficial and bedrock geology which is anticipated to underlie the site have been assumed to exhibit low and potentially high permeability respectively.

4.2 Risk Assessment

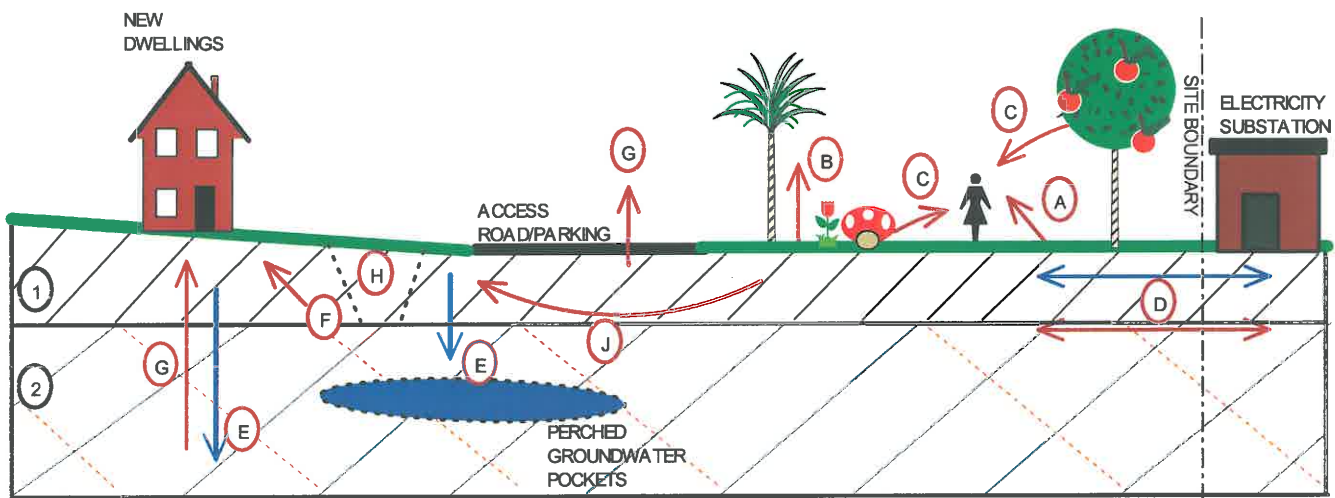
The desk study has highlighted the presence of limited sources of contamination potentially affecting the site primarily comprising development and demolition of initial 19th century terraced housing, the subsequent 1970s building (also possibly housing) within the site boundary with possible associated made ground. A nearby electricity substation is noted also which has been present since the 1970's when polychlorinated biphenyl (PCB) coolants were commonly used in such infrastructure. A possible ground gas hazard has also been identified associated with the presence of possible made ground within the study site and made ground associated with building demolition, and possible in-filled cellar features.

Contamination from external sources would require a favourable pathway for migration into the site; the majority of other external sources of contamination are likely to be too distant to pose any significant risk (save for the adjacent sub-station) although the sandstone rock beneath the site would be expected to give rise to a favourable pathway for contaminant migration.

The sources discussed above could potentially give rise to the presence of contaminants at the site including asbestos and PCBs particularly in the near surface soils.

Potential receptors at the site would include the end users of the site (residents of the dwellings), workers employed in the construction of the new development, the buildings themselves and their services, plants and vegetation, and ground water at depth. A representation of the potential hazards and pollutant linkages is shown in Figure 1 below:

Figure 1 – Conceptual Ground Hazard Model of site including a Source, Pathway and Receptor Model



- 1 POTENTIAL MADE GROUND HORIZON
 - 2 UNDERLYING GEOLOGY - CHESTER PEBBLE BEDS FORMATION (SANDSTONE) POTENTIALLY HIGH PERMEABILITY
- .NO DRIFT GEOLOGY REPORTED AT SITE

IDENTIFIED HAZARDS Including Potential CONTAMINATION SOURCES

Possible presence of made ground and potential historical contamination thereof by past land use.

IDENTIFIED RECEPTORS and ASSOCIATED PATHWAY

- A - Construction Workers & End Users through Direct Contact / Inhalation / Ingestion. Buildings and hard-standing will encompass some of the site, removing any pathway to end users through direct contact in these areas.
- B - Plants and Trees through uptake.
- C - End Users through cultivation and consumption of vegetables / fruit.
- D - Neighbouring Sites through lateral migration (in soil and water, including surface water run-off). Migration of PCBs *into* site from substation currently of more concern.
- E - Ground water through leaching of sub-soil.
- F - Building and services through direct contact.
- G - End users and buildings through ground gas migration.
- H - Site surface through potential instability arising from possible cellars in historical housing

The CGHM model and the summary table below (Table 4) show that past and current land uses located both within and near to the property could give rise / have given rise to contamination of the site.

These activities may have given rise to harmful and potentially mobile contamination of possible made ground and sandstone rock which likely underlie the site. As the rock is potentially high anticipated permeability it is likely that a plausible pathway for the migration of contaminants either into or out of the site exists.

Therefore assuming the worst case scenario the potential for harmful contamination to exist at the site from historical sources is assessed to be Low to Moderate (as opposed to negligible) owing to the small number of the potentially contaminative activities located within the study area.

The gas risk is assessed to be Low to Moderate, given the possible occurrence of; made ground and demolition waste including timber within the site boundary and the pathways presented by the underlying geology which likely underlie the site.

The actual current level of risk to the development and its users can only be ascertained through confirmation of the ground conditions by a Phase 2 intrusive investigation including a contamination and gas survey.

Table 4: Summary of Conceptual Ground Hazard Model

Potential Source	Nature of Hazard	Associated Contaminants	Pathway	Receptor	Preliminary Risk Rating
Construction/ Demolition activity and General made ground within the site	Inorganic and organic chemical contaminants within soil.	Contaminants linked to filled ground. -Asbestos -Trace metals -PAHs	-Direct contact -Ingestion of soil -Ingestion of dust -Inhalation of vapour -Leaching into ground water	-Site Operatives -End Users -Vegetation -Controlled waters -Structures and services	Low
	Contaminants from claddings, roofing materials, insulation and boilers	Hazardous Gas (CO ₂ , CH ₄)	-Inhalation -Explosion risk	-Site Operatives -End Users	Low
Nearby electricity substation	Potential migration of organic chemical contaminants into site.	PCB coolants	-Direct contact -Ingestion of soil -Ingestion of dust -Inhalation of vapour -Leaching into ground water	-Site Operatives -End Users -Vegetation -Controlled waters -Structures and services	Low

5. Conclusions

A summary of the anticipated conditions, risks and implications based on the findings of Sections 3 and 4 of this report is presented in Table 5 on the following page:

Table 5: Summary of Phase 1 Desk Study Findings

Concern	Desk Study Finding	Initial Risk Assessment	Action Required in Phase 2 Investigation
Radon Gas	N/A	Negligible	None
Normal Foundations	Competent sandstone rock at shallow depth expected to provide adequate support for moderate loadings Possible presence of in-filled cellars associated with previous housing and public house on site.	Potentially suitable *	Borehole investigation to confirm strength of ground with regard to supporting building loads.
Soakaways	Sub soils of High anticipated permeability.	Likely to be suitable	Borehole investigation to confirm soil type and whether ground is of high enough permeability to install soakaways.
Chemical Contamination	Possible presence of made ground arising from limited building demolition and associated with previous development of the site potentially containing a range of inorganic and organic contaminants including asbestos. Possible contamination of made ground or natural rock deposits by nearby electricity substation	Low - Moderate	Chemical analysis for potential contaminants in soil samples. Samples should be recovered both from made ground and underlying natural sub soils to check for potential leaching and migration into the site from potential external sources, particularly regarding PCBs near location of substation.
Hazardous Gas	Potential for hazardous gas to migrate from possible made ground beneath and adjacent to site and from underlying coal measures geology.	Low - Moderate	Installation of ground gas monitoring wells with appropriate monitoring.

The initial risk assessment provided above is tentative as it is based only on the Phase 1 desk study. The risks will need to be reassessed and may perhaps change significantly becoming higher or lower depending on the results of the Phase 2 intrusive investigation and contamination survey.

6. Recommendations

In light of the Phase 1 desk study findings it is recommended that a Phase 2 investigation including a ground investigation and contamination and gas testing is carried out at the site to establish the actual site conditions and to properly assess the risks from the geology of the site and its historical land use.

The Phase 2 investigation should be designed to focus on the potential contaminants highlighted in the CGHM (Figure 1 and Table 4). As the potential for hazardous gas to exist at the site is judged to be low to Moderate, a gas survey is necessary also.

The Phase 2 investigation should therefore need to include shallow boreholes, gas monitoring and contamination analyses to establish the ground conditions across the site. The proposed scope of the Phase 2 investigation is presented in Table 6 on the following page.

Table 6: Proposed Phase 2 Site Investigation Specification

Action	Quantities	Justification/Details
Window Sampling Boreholes	Up to 7 boreholes. (up to 3m in depth – or likely shallower if competent rock is encountered)	Establish actual ground conditions. Retrieve disturbed and undisturbed samples of made ground and natural soils for geotechnical testing and contamination analysis. Recover ground water samples if encountered. Installation of ground gas monitoring wells.
Gas Monitoring	6 No. visits over 3 months 1No preferably <1000mb and after sharp drop	Quantify risk posed by potential hazardous gas should significant made ground be encountered in boreholes.
Chemical Contamination Analysis of Soils and Leachate	Up to 8 No. samples from made ground at shallow depth (<1m) and deeper natural strata.	Quantify risk posed to receptors identified in CGHM (see Figure 1) for revised risk assessment. Determinands should include a range of metals and other inorganic chemicals, speciated PAH content, asbestos presence and soil organic matter content (to aid in revised risk assessment). Additionally, testing for PCBs in soils close to the nearby electricity substation should be carried out.
Geotechnical Testing	Up to 50 No. Up to 12 No.	Moisture content determination to classify nature of soils. Atterberg Limit determinations to assess the shrinkage and swelling characteristics of the ground should clay soils be encountered.
Provision of Factual and Interpretive Report	N/A	Presentation of findings and implications including: <ul style="list-style-type: none"> • Site plan • Borehole logs • Contamination analysis results • Ground gas measurements • Revised CGHM and chemical contamination risk assessment including site specific modelling and appropriate soil assessment criteria • Advice regarding any necessary remediation/validation • Advice regarding foundation design, roads etc.

It should be noted that the scope, extent and cost of the Phase 2 work may increase if hazardous gas, ground contamination, or extensive amounts of made ground were found to exist at the site and/or the Local Authority or the Environment Agency require additional information.

Before the Phase 2 investigation can proceed, the scope of the works proposed may need to be agreed with the Local Authority

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