

soiltechnics

environmental and geotechnical consultants

Proposed residential development
Land east of Chipping Lane
Longridge, Preston

Ground Investigation Report
(Phase 3)

Ivy Mill Business Centre, Crown Street, Failsworth, Manchester M35 9BG

t: 0161 9470270

e: mail@soiltechnics.net

w: www.soiltechnics.net

**Proposed residential development
Phase 3
Land East of Chipping Lane
Longridge
Preston
PR3 2NA**

GROUND INVESTIGATION REPORT

Soiltechnics Ltd. Ivy Mill Business Centre, Crown Street, Failsworth, Manchester, M35 9BG
Tel: (0161) 9470270 E-mail: mail@soiltechnics.net

Report originators

Prepared
by



Tomasz Opara B.Sc., M.Sc.

tomasz.opara@soiltechnics.net

Assistant geo-environmental Engineer, Soiltechnics
Limited

Supervised/
Reviewed
by



Sam Dean B.Sc. (Hons)., FGS., MIEEnvSc.

sam.dean@soiltechnics.net

Director, Soiltechnics Limited



Aerial photograph of site



Approximate Phase 3 site boundaries edged in pink

Report status and format

| Report section | Principal coverage | Report status | |
|----------------|------------------------|---------------|----------|
| | | Revision | Comments |
| 1 | Executive summary | | |
| 2 | Introduction | | |
| 3 | Desk study information | | |
| 4 | Chemical contamination | | |
| 5 | Gaseous contamination | | |
| 6 | Future investigations | | |
| 7 | Drawings | | |

List of drawings

| Drawing | Principal coverage | Status | |
|---------|---|----------|----------|
| | | Revision | Comments |
| 01 | Site location plan | | |
| 02 | Plan showing existing site features and location and extent of development phases | | |

List of appendices

| Appendix | Content |
|----------|--|
| A | Definitions of geo-environmental terms used in this report |
| B | Copies of Statutory Undertakers replies |
| C | Copy of Phase 1 Desk Study report undertaken by Curtins Consulting Ltd |
| D | Illustrative masterplan showing indicative development layout |
| E | Copy of correspondence received from Environmental Health |
| F | Conceptual site model |

1 Executive summary

We recommend the following executive summary is not read in isolation to the main report which follows.

| Topic | Summary | Abnormals | | | | | | |
|--|--|---|--|------------------------------|-----------------------------|---|-----------------|----------------------------|
| Site conditions | The site comprised three open grassed fields separated by mature hedgerows and sporadic trees, positioned on the north-western outskirts of Longridge, Preston. It is understood that the land is currently used by livestock for grazing. Higgin Brook is also recorded along part of the south-western boundary of the site. | | | | | | | |
| Proposals | We understand the scheme in its entirety will consist of redevelopment as areas of Public Open Space and recreational grounds. | | | | | | | |
| Investigations | Limited at this stage to collection, presentation and review of desk study information. | | | | | | | |
| History of the site | Historically the site has remained undeveloped farm land. | | | | | | | |
| Ground conditions | Soils (geological sequence) | Strata. | Typical Soil type | Approximate thickness | | | | |
| | | Alluvium (NW of site only) | Clays and silts | <3m | | | | |
| | | Devensian Till | Clay | >5m | | | | |
| | | Pendleside Sandstone Member | Sandstone with mudstone and siltstones | Up to 50m | | | | |
| | | Bowland Shale Formation | Mudstone, siltstone with sandstones | Up to 200m | | | | |
| Groundwater and Geohydrology | Strata. | Aquifer designation | Likely permeability | Groundwater | | | | |
| | | | | | Alluvium | Secondary A | Low-moderate | Possibly in basal deposits |
| | | | | | Devensian Till | Unproductive strata (r) | Low | Unlikely |
| | | | | | Pendleside Sandstone Member | Secondary A aquifer (r) | Low to moderate | Possibly at depth |
| | | | | | Bowland Shale Formation | Secondary A and secondary undifferentiated aquifers (r) | Low to moderate | Possibly at depth |
| | Site not recorded in a source protection zone (SPZ) | | | | | | | |
| Land stability | Site levels gently fall to the north-west and thus not considered to be at risk of instability. Site not affected by opencast workings or past mine workings | | | | | | | |
| Soil classification | N/A | | | | | | | |
| Possible foundation solution | N/A | | | | | | | |
| Soakaway feasibility | N/A | | | | | | | |
| Contamination | Chemical | Risks considered low on site and based on adjacent land uses. | | | | | | |
| | Gas | Alluvium present in the north-western part of the site may contain organic matter which would provide a source of gasses. Given the nature of the development, site considered at low risk. | | | | | | |
| Future investigations | Site considered to pose a low risk of causing harm to identified receptors. Intrusive investigations not considered necessary. As a precaution hardness of water in Higgin Brook should be determined, to enable a more detailed risk assessment to be completed in relation to water receptors | | | | | | | |
| Statement with respect to NPPF paragraphs 120 and 121 | Site not considered to present unacceptable risks from pollution and land instability. Remediation to render the site fit for purpose with respect to chemical/gaseous contamination considered unlikely. | | | | | | | |

2 Introduction

| | |
|-----|---|
| 2.1 | Objectives |
| 2.2 | Client instructions and confidentiality |
| 2.3 | Site location and scheme proposals |
| 2.4 | Report format and investigation standards |
| 2.5 | Status of this report |
| 2.6 | Report distribution |

2.1 Objectives

- 2.1.1 This report describes a ground investigation carried out for the Phase 3 area of a proposed residential development located on land east of Chipping Lane, Longridge, Preston PR3 2NA.
- 2.1.2 The Phase 3 development of the Chipping Lane site incorporates areas of Public Open Space (POS) and recreational grounds. This report addresses issues relating to the health of identified human receptors and risks to controlled waters from ground conditions at the site.
- 2.1.3 A Phase 1 Desk Study Assessment has been previously undertaken for the site by Curtins Consulting Ltd (ref EB1355/GL/3692 Revision A dated April 2014). A copy of their report is presented in Appendix L. We understand that we have the benefit of using such information and have provided a summary of the data in Section 3 of this report. This will also form a basis for our interpretative chemical and gaseous contamination assessments presented in Sections 4 and 5 respectively.
- 2.1.4 The investigation has also been produced to support a planning application for the site (ref 3/2014/0764) by satisfying National Planning Policies Framework sections 120 and 121.

2.2 Client instructions and confidentiality

- 2.2.1 This report was prepared in June 2016 acting on instructions received from our client Barratt Homes (Manchester).
- 2.2.2 This report has been prepared for the sole benefit of our above named instructing client, but this report, and its contents, remains the property of Soiltechnics Limited until payment in full of our invoices in connection with production of this report.
- 2.2.3 Our original investigation proposals were outlined in our correspondence to Barratt Homes of 20th January 2016. The investigation generally followed our original investigation proposals. The investigation process was also determined to maintain as far as possible the original investigation budget costs.

2.3 Site location and scheme proposals

- 2.3.1 The National Grid reference for the site is 360447, 437970. A plan showing the location of the site is presented on Drawing 01, with the extent of the development phases presented on Drawing 02.
- 2.3.2 We understand the scheme in its entirety will comprise the construction of up to 363 dwellings within what is termed Phases 1 and 2 (refer to Drawing 02 for details), with associated landscaping, gardens, hardstanding and access roads. This report refers to the Phase 3 area in which areas of POS and recreational grounds are proposed in the northern and eastern areas of the development site.
- 2.3.3 We have received layout drawings of the proposed scheme with the indicative layout presented in Appendix D.

2.4 Report format and investigation standards

- 2.4.1 Sections 2 to 3 of this report describe the factual aspects of the investigation with Section 4 providing a risk assessment of likely chemical contamination with section 5 describing a similar risk assessment in relation to gaseous contamination. Section 6 outlines a strategy for any future investigations required to progress the scheme to detailed design and construction.
- 2.4.2 This report describes both contamination and geotechnical aspects of the site. The desk study process followed the principles of BS10175: 2011 '*Investigation of potentially Contaminated Sites – Code of Practice*' and limited to a preliminary investigation as described in this document.
- 2.4.3 The extent and result of the preliminary investigation (desk study) undertaken by Curtins Consulting Ltd, in addition to site reconnaissance undertaken by Soiltechnics Ltd, is reported in Section 3.

2.5 Status of this report

- 2.5.1 This report is final based on our current instructions.
- 2.5.2 This investigation has been carried out and reported based on our understanding of best practice. Improved practices, technology, new information and changes in legislation may necessitate an alteration to the report in whole or part after publication. Hence, should the development commence after expiry of one year from the publication date of this report then we would recommend the report be referred back to Soiltechnics for reassessment. Equally, if the nature of the development changes, Soiltechnics should be advised and a reassessment carried out if considered appropriate.

2.6 Report distribution

2.6.1 This report has been prepared to assist in the design and planning process of the development and normally will require distribution to the following parties, although this list may not be exhaustive:

Table summarising parties likely to require information contained in this report

| Party | Reason |
|---|--|
| Client | For information/reference and cost planning. |
| Developer/Contractor/project manager | To ensure procedures are implemented, programmed and costed. |
| Planning department | Potentially to discharge planning conditions. |
| Environment Agency | If ground controlled waters are affected and obtain approvals to any remediation strategies. |
| Independent inspectors such as Building Control | To ensure procedures are implemented and compliance with building regulations. |
| Project design team | To progress the design. |
| Principal Designer (PD) | To advise in construction risk identification and management under the Construction (Design and Management) Regulations. |

Table 2.6

3 Desk study information and site observations

| | |
|------|---|
| 3.1 | General |
| 3.2 | Description of the site |
| 3.3 | Injurious and invasive weeds and asbestos |
| 3.4 | History of the site |
| 3.5 | Geology and geohydrology of the area |
| 3.6 | Landfill and infilled ground |
| 3.7 | Radon |
| 3.8 | Flood risk |
| 3.9 | Enquiries with Statutory Undertakers |
| 3.10 | Enquiries with Local Authority Building Control and Environmental Health Officers |

3.1 General

3.1.1 A Phase 1 Detailed Desk Top Study has been previously undertaken for the site by Curtins Consulting Ltd (reference EB1355/GL/3692, revision A, issue 01, dated 14th April 2014). A copy of their report is presented in Appendix C. We understand that we have the benefit of using such information and have provided a summary of the data in following paragraphs, together with our own site observations. It should be noted that we have tailored the information to suite the current site boundary for the Phase 3 development area, which is shown in a slightly different position in the Curtins report.

3.2 Description of the site

3.2.1 The site is positioned on the north-western outskirts of Longridge, Preston, at an elevation of between approximately 101m and 122m AOD and with the topography of the site falling in a north-westerly direction. The site comprised of three open grassed fields separated by hedgerows and trees between approximately 2m and 15m in height. Localised ponding of surface water was evident, with two small ponds present along the eastern boundary of the most north-westerly located parcel of land. Higgin Brook is also recorded along part of the south-western boundary of this parcel of land, flowing in a north-westerly direction and culverted beyond the location of the adjacent cricket pavilion.

3.2.2 The site was bound to the north and east by further open grassed fields. Chipping Lane, further fields and a cricket pitch were located to the west. The grassed fields which form the Phase 1 and Phase 2 development areas are present to the south, with residential housing and Willows Farm present to the south-east.

3.2.3 A plan showing existing site features and location of exploratory points is presented as Drawing 02.

3.3 Injurious and invasive weeds and asbestos

3.3.1 Injurious and invasive weeds

3.3.1.1 The following weeds are controlled under the Weeds Act 1959:

- Common ragwort
- Spear thistle
- Creeping (or field) thistle
- Broad-leaved dock
- Curled dock

3.3.1.2 Whilst it is not an offence to have the above weeds growing on your land, you must:

- Stop them spreading to agricultural land, particularly grazing areas or land used for forage, like silage and hay
- Choose the most appropriate control method for the your site
- Not plant them in the wild

3.3.1.3 Should you allow the spread of these weeds to another parties land, Natural England could serve you with an Enforcement Notice. You can also be prosecuted if you allow animals to suffer by eating these weeds.

3.3.1.4 In addition to the above, you must not plant in the wild or cause certain invasive and non-native plants to grow in the wild as outlined in the Wildlife and Countryside Act 1981. It is an offence under section 14(2) of the act to '*plant or otherwise cause to grow in the wild*' any plants listed in schedule 9, part II. This can include moving contaminated soil or plant cuttings. The offence carries a fine or custodial sentence of up to two years. The most commonly found invasive, non-native plants include:

- Japanese knotweed
- Giant hogweed
- Himalayan balsam
- Rhododendron ponticum
- New Zealand pigmyweed

3.3.1.5 You are not legally obliged to remove these plants or to control them. However, if you allow Japanese knotweed to spread to another party's land, you could be prosecuted for causing a private nuisance.

3.3.1.6 The presence of such weeds on site may have considerable effects on the cost/timescale in developing the site. Japanese knotweed can cause significant damage to buildings, roads and pavements following development, if untreated prior to development.

3.3.1.7 Our investigations exclude surveys to identify the presence of injurious and invasive weeds. We did not observe any obvious evidence the above species; however, we recommend specialists in the identification and procedures to deal with injurious and invasive weeds are appointed prior to commencement of any works on site.

3.3.2 Asbestos

3.3.2.1 Our investigations exclude surveys to identify the presence or absence of asbestos on site. It should be noted, however, that where intrusive investigations were undertaken we did not observe any obvious evidence of potential asbestos containing materials. This information does not constitute a site-specific risk assessment and we recommend specialists in the identification and control/disposal of asbestos are appointed prior to commencement of any works on site.

3.3.2.2 The presence of asbestos on site may have considerable effects on the cost/timescale in developing the site. There is good guidance in relation to asbestos available on the Health and Safety Executive (HSE) website.

3.4 History of the site

3.4.1 The recent pertinent history of the site, updated from the Curtins summary to reflect the current site boundary, is presented in the following table:

| Summary description of site history | | |
|-------------------------------------|---|---|
| Date | On site | Off site |
| 1847 | Open fields including a number of small ponds and marshy areas. | Surrounding land predominantly agricultural. Quarrying works recorded between 500m and 1000m east of the site. |
| 1893 to 1914 | No significant change | Pitt Street Mills (Corn & Bone) and a smithy are some 300m to the south. An iron and brass foundry present 350m to the south-west of the site. Victoria Mill and gasometer present 100m to south-eastern boundary. Tan Yard 500m to the south-east. |
| 1932 to 1956 | No significant change | The Pitt Street Mills (Corn & Bone) and smithy buildings recorded as a Bobbin works. Tank recorded at Willow Farm to the south-east of the site. |
| 1961 to 1967 | No significant change | The Bobbin works is no longer recorded and the site has been redeveloped as Ashley Dairy. Some residential development has also occurred to the south and west. |
| 1968 to 1975 | No significant change | The iron and brass foundry was labelled as a works. Significant development is occurring to the south of the site (Longridge). |
| 1975 to 1996 | No significant change | No significant changes |
| 2001 to 2013 | No significant change | Ashley Dairy has been redeveloped as a superstore. |

Table 3.4.1

3.5 Geology and geohydrology of the area

3.5.1 Geology of the area

3.5.1.1 The geology of the area, updated from the Curtins summary to reflect the current site boundary, is presented in the following table:

| Summary of geology and likely aquifer-containing strata | | | | | |
|--|-------------------------------|------------------------------|--|----------------------------|---|
| Stratum | Bedrock or superficial | Approximate thickness | Typical soil type | Likely permeability | Aquifer designation |
| Alluvium (north-western part of site) | Superficial | <3m | Clay, silt, sand | Low to moderate | Secondary A aquifer (r) |
| Devensian Till | Superficial | >5m | Clay with silt and sand | Low | Unproductive strata (r) |
| Pendleside Sandstone Member | Bedrock | Up to 50m | Sandstone with mudstone and siltstones | Low to moderate | Secondary A aquifer (r) |
| Bowland Shale Formation | Bedrock | Up to 200m | Mudstone, siltstone with sandstones | Low to moderate | Secondary A and secondary undifferentiated aquifers (r) |

Table 3.5.1

(r) recorded aquifer designation
(a) assumed aquifer designation

3.5.1.2 Unproductive strata are defined as deposits exhibiting low permeability with negligible significance for water supply or river base flow. Unproductive strata are generally regarded as not containing groundwater in exploitable quantities.

3.5.1.3 Secondary A aquifers are predominantly permeable layers capable of supporting water supplies at a local, rather than strategic, scale. In some cases, Secondary A aquifers can form an important source of base flow to rivers.

3.5.1.4 Secondary undifferentiated aquifer is a designation used when it is not possible to attribute fully one of either Secondary A or Secondary B, due to the variable nature of the soils. The unit will therefore be a mix of both, which are defined as follows:

- Secondary A can be defined as: Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- Secondary B can be defined as: layers which may store limited amounts of ground water. These groundwater stores are generally the water bearing parts of former aquifers.

3.5.2 Water abstractions

3.5.2.1 There are no potable groundwater abstraction licences within 2km of the site. The only surface water abstraction within a 2km radius of the site is associated with field drains located approximately 450m to the south of the site. Details of the water's use are not supplied.

3.5.2.2 There are two groundwater abstractions within a 2km radius of the site. They are both associated with Singletons Dairy (Mill Farm, Preston) and are located approximately 900m and 1km to the south of the site. The abstracted water is used for general purposes.

3.5.2.3 The site is not located within a zone protecting a potable water supply abstracting from a principal aquifer (i.e. a source protection zone).

3.5.3 Coal mining and brine extraction

3.5.3.1 The site is not recorded to be within an area affected by past or present coal mining, minerals worked in association with coal, or brine extraction (within the Cheshire Brine Compensation District). The site does not lie within a coal mining referral area and, as such, a Coal Authority report is not required.

3.5.4 Shallow mining and natural subsidence hazards

3.5.4.1 The British Geological Survey presents hazard ratings for shallow mining and natural subsidence hazards. The site has the following ratings:

| Table summarising mining and subsidence hazards | |
|--|----------------------|
| Hazard | Rating |
| Mining hazard in non-coal mining areas | Highly unlikely |
| Potential for collapsible ground stability hazard | Very low / no hazard |
| Potential for compressible ground stability hazard | Moderate / no hazard |
| Potential for ground dissolution stability hazard | Low / very low |
| Potential for landslide ground stability hazard | Very low |
| Potential for running sand ground stability hazard | Low / very low |
| Potential for shrinking or swelling clay ground stability hazard | Very low |

Table 3.5.4

3.5.4.2 The moderate potential for compressible ground stability hazards is likely to be associated with the deposits of Alluvium recorded in northern-western most parcel of land at the site.

3.5.5 Borehole records

3.5.5.1 The British Geological Survey (BGS) retains records of boreholes formed from ground investigations carried out on a nationwide basis. However, there are no BGS borehole records in the vicinity of the site.

3.6 Landfill and infilled ground

- 3.6.1 Within a 2km radius of the site, there are no BGS recorded or historical landfill sites; however, there are two registered landfill sites. Lords Delph (Forty Acre Lane, Longridge) is located approximately 500m to the east of the site and has been accepting non-biodegradable waste since at least 1982. Chapel Hill Quarry is located approximately 900m to the south of the site and accepted non-biodegradable waste; in 1992, the site was recorded as dormant.
- 3.6.2 In addition, we have reviewed old Ordnance Survey maps and there is no obvious evidence of significant quarrying in the area, other than a small number of BGS mineral sites, recorded between 250m and 700m of the subject site which exploited the underlying clays and grits. The geological map of the area indicates areas of infilled ground which approximately coincide with such areas.

3.7 Radon

- 3.7.1 Envirocheck uses the British Geological Survey database to review reported radon levels in the area in which the site is located, to establish recommended radon protection levels for new dwellings. The database presented in the Curtins report indicates that the site is located in an area where no protection is considered necessary.
- 3.7.2 Building Research Establishment (BRE) publication BR211 '*Radon: guidance on protective measures for new buildings*' (2007) applies to all new buildings, conversions and refurbishments, whether they be for domestic or non-domestic use.
- 3.7.3 It is noteworthy that the BRE information is based on statistical analysis of measurements made in dwellings, in combination with geological units which are known to emit radon. Therefore there is a risk that actual radon levels at the site will exceed the levels assessed by the BRE. Currently, the only true method of checking actual radon levels is by measurement within a building on the site over a period of several months. It should be noted that it is not currently a requirement of the Building Regulations to test new buildings for radon; however, the BRE recommends testing on completion or occupation of all new buildings (domestic and non-domestic), extensions and conversions. Should you wish to undertake radon monitoring following completion of the development, we can provide proposals.

3.8 Flood risk

- 3.8.1 Based on the information provided within the Curtins report, the site is not located within a fluvial or tidal flood plain. It should be noted that this information does not constitute a site-specific Flood Risk Assessment (FRA) and that a full FRA may be required for the development to support a planning application or to satisfy planning conditions.

3.9 Enquiries with Statutory Undertakers

3.9.1 We have been provided with the following Statutory Undertaker (SU) records in order to avoid damaging their apparatus during our fieldwork activities:

- a) BT Openreach
- b) Electricity North West
- c) ESP Utilities Group
- d) National Grid Gas
- e) United Utilities

3.9.2 Copies of these records are presented in Appendix B. These records have been obtained solely for the purposes described above.

3.9.3 Normally Statutory Undertakers' drawings record the approximate location of their services. We recommend further on-site investigations be undertaken to confirm the position of the apparatus and thus establish the effect on the proposed development and the necessity or otherwise for the permanent or temporary diversion of the service to allow the construction of the development to safely and successfully proceed.

3.9.4 It should be noted that Statutory Undertakers' records normally exclude private services.

3.10 Enquiries with Environmental Health Officers

3.10.1 We have contacted the Local Authority Environmental Health Officer, who has confirmed that no gas monitoring is required on this site, due to the limited number of sources and pathways in the area (refer to Section 5 for further details). A copy of their correspondence is presented in Appendix E.

4 Chemical contamination

| | |
|-----|--|
| 4.1 | Contaminated land, regulations and liabilities |
| 4.2 | Objectives and procedures |
| 4.3 | Development characterisation and identified receptors |
| 4.4 | Identification of pathways |
| 4.5 | Assessment of sources of contamination |
| 4.6 | Initial conceptual model |
| 4.7 | Actions |
| 4.8 | Risk assessment summary and recommendations |
| 4.9 | Statement with respect to National Planning Policy Framework |

4.1 Contaminated land, regulation and liabilities

4.1.1 Statute

4.1.1.1 Part IIA of the Environment Protection Act 1990 became statute in April 2000. The principal feature of this legislation is that the hazards associated with contaminated land should be evaluated in the context of a site-specific risk based framework. More specifically contaminated land is defined as:

“any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reasons 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 or is likely to be caused”.*

4.1.1.2 Central to the investigation of contaminated land and the assessment of risks posed by this land is that:

- i) There must be contaminant(s) at concentrations capable of causing health effects (*Sources*).
- ii) There must be a human or environmental receptor present, or one which makes use of the site periodically (*Receptor*); and
- iii) There must be an exposure pathway by which the receptor comes into contact with the environmental contaminant (*Pathway*).

4.1.1.3 In most cases the Act is regulated by Borough or District Councils and their role is as follows:

- i) Inspect their area to identify contaminated land
- ii) Establish responsibilities for remediation of the land
- iii) See that appropriate remediation takes place through agreement with those responsible, or if not possible:
 - by serving a remediation notice, or
 - in certain cases carrying out the works themselves, or
 - in certain cases by other powers
- iv) keep a public register detailing the regulatory action which they have taken

4.1.1.4 For “special” sites the Environment Agency will take over from the Council as regulator. Special sites typically include:

- Contaminated land which affects controlled water and their quality
- Oil refineries
- Nuclear sites
- Waste management sites

4.1.2 Liabilities under the Act

4.1.2.1 Liability for remediation of contaminated land would be assigned to persons, organisations or businesses if they caused, or knowingly permitted contamination, or if they own or occupy contaminated land in a case where no polluter can be found.

4.1.3 Relevance to predevelopment conditions

4.1.3.1 For current use, Part IIA of the Environmental Protection Act 1990 provides the regulatory regime. The presence of harmful chemicals could provide a ‘source’ in a ‘pollutant linkage’ allowing the regulator (Local Authority or Environment Agency) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as ‘contaminated’ under the provision of the Act requiring the remediation process to be implemented.

4.1.4 Relevance to planned development

4.1.4.1 The developer is responsible for determining whether land is suitable for a particular development or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:

- a) Whether the land in question is already affected by contamination through source – pathway – receptor pollutant linkages and how those linkages are represented in a conceptual model.
- b) Whether the development proposed will create new linkages e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors, and

- c) What action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable safe development and future occupancy of the site and neighbouring land?

4.1.4.2 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, '*Site preparation and resistance to contaminants and moisture*' which seeks to protect the health, safety and welfare of people in and around buildings, and includes requirements for protection against harm from chemical contaminants.

4.1.5 Pollution of controlled waters

4.1.5.1 Part IIA of the Environment Protection Act 1990, defines pollution of controlled waters as

'The entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter'

4.1.5.2 Paragraphs A36 and A39 of statutory guidance (DETR 2000) further define the basis on which land may be determined to be contaminated land on the basis of pollution of controlled waters.

'Before determining that pollution of controlled waters is being, or likely to be, caused, the Local Authority should be satisfied that a substance is continuing to enter controlled waters, or is likely to enter controlled waters. For this purpose, the local authority should regard something as being likely when they judge it more likely than not to occur'

'Land should not be designated as contaminated land where:

- a) *A substance is already present in controlled waters:*
- b) *Entry into controlled waters of that substance from the land has ceased, and*
- c) *It is not likely that further entry will take place.*

Substances should be regarded as having entered controlled waters where:

- a) *They are dissolved or suspended in those waters; or*
- b) *If they are immiscible with water, they have direct contact with those waters, or beneath the surface of the waters'*

4.1.5.3 Controlled waters are defined in statute to be:

'territorial waters which extend seawards for 3 miles, coastal waters, inland freshwaters, that is to say, the waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and groundwaters, that is to say, any waters contained in underground strata.'

4.1.6 Further information

- 4.1.6.1 The above provides a brief outline as regards current statute and planning controls. Further information can be obtained from the Department for the Environment, Food and Rural Affairs (DEFRA) and their website www.defra.gov.uk.

4.2 Objectives and procedures

4.2.1 Objectives

- 4.2.1.1 This report section discusses investigations carried out with respect to chemical contamination issues relating to the site. The investigations were carried out to determine if there are any liabilities with respect to Part IIA of the Environmental Protection Act. As stated in Section 2.4.2, the investigation process followed the principles of BS10175: 2011 '*Investigation of potentially contaminated sites – Code of Practice*', but limited to a desk study (preliminary investigation)
- 4.2.1.2 This section of the report produces '*Conceptual models*' based on investigatory data obtained to date. The conceptual model is constructed by identification of *contaminants* and establishment of feasible *pathways* and *receptors*. The conceptual model allows a *risk assessment* to be derived. Depending upon the outcome of the risk assessment it may be necessary to carry out remediation and/or further investigations with a view to eliminating, reducing or refining the risk of harm being caused to identified receptors. If appropriate, our report will provide recommendations in this respect.
- 4.2.1.3 Clearly we must consider the current pre-development condition, establishing risks which may require action to render the site safe to all relevant (current) receptors meeting the requirements of current legislation (Part IIA of the Environmental Protection Act 1990).
- 4.2.1.4 Definition of terms used in the preceding paragraph and subsequent parts of this section of the report are presented in Appendix A.

4.2.2 Procedure to assess risks of chemical contamination

4.2.2.1 For the purposes of presenting this section of this report, we have adopted the following sequence in assessing risks associated with chemical contamination.

| Table outlining sequence to assess risk associated with chemical contamination | | |
|---|--|--|
| Conceptual model element | Contributory information | Outcome |
| Receptor | Development categorisation | Identification of receptors at risk of being harmed Method of analysing test data Criteria for risk assessment modelling |
| Pathways | Geology and ground conditions Development proposals | Identification of critical pathways from source to receptor |
| Source | Previous site history Desk study information Site reconnaissance Fieldwork observations | Testing regime Identification of a chemical source Analysis of test data and other evidence |

Table 4.2.2

4.2.2.2 We have adopted, in general, the procedures described in CIRIA C552 '*Contaminated land risk assessment - a guide to good practice*' in deriving a risk assessment. Initially we have carried out a 'phase 1 assessment' based on desk study information and site reconnaissance, to produce an initial conceptual model and thus a preliminary risk assessment. This model / assessment is then used to target any future fieldwork activities and laboratory testing that is recommended, ultimately allowing the conceptual model to be updated and risk assessments to be refined.

4.3 Development characterisation and identified receptors

4.3.1 Site characterisation

4.3.1.1 The nature of the site has a significant influence the likely exposure pathways between potentially contaminated soils and potential receptors. The following table summarises elements which characterise the site based on site observations and desk study information.

| Summary of site characteristics | | |
|---------------------------------|------------------------|---|
| Element | Source/criteria | Characteristic |
| Current land use | Observations | Site currently in use as grazing land for livestock. Not accessible to the general public. |
| Future land use | Advice | Developed as POS and recreational grounds |
| Site history | Desk study | Recorded as fields from earliest maps. |
| Geology | Desk study | Alluvium overlying overlying >5m thickness of Devensian Till deposits with Bowland Shale Formation/Pendleside Sandstone Member at depth. |
| Ground water | Aquifer potential | Alluvium recorded as a Secondary A aquifer. Devensian Till deposits recorded as unproductive strata. Underlying Bowland Shale recorded as a Secondary A and secondary undifferentiated aquifers (r), with Pendleside Sandstone recorded as Secondary A. |
| | Abstractions | There are no potable water abstractions within 1000m of the site. There are two groundwater abstractions within 1000m of the site, the nearest associated with Mill Farm borehole located 900m south of the site. |
| | Source protection zone | Site not recorded in source protection zone (SPZ). |
| Surface waters | Location | The nearest surface water feature is a tertiary river (Higgin Brook) which flows in a north-westerly direction along the south-western boundary of the site. |
| | Abstractions | There is one surface water abstraction within 1000m of the site located 450m south-east associated with a field drain located in Lyndhurst, Longridge. |

Table 4.3.1

4.3.2 Identified receptors

4.3.2.1 The principal receptors subject to harm caused by any contamination of the proposed development site are as follows.

| Principle Receptor | Detail |
|--------------------|---|
| Humans | Users of the current site |
| | End user of the developed site |
| | Construction operatives and other site investigators |
| Vegetation | Plants and trees, both before and after development |
| Controlled waters | Surface waters (Rivers, streams, ponds and above ground reservoirs) |
| | Ground waters (used for abstraction or feeding rivers/streams etc.) |

Table 4.3.2

4.3.2.2 This section of the report assesses those receptors listed above.

4.3.3 Human receptors

4.3.3.1 The Contaminated Land Exposure Assessment (CLEA) model can be used to derive guideline values, against which land quality data can be compared to allow an assessment of the likely impacts of soil contamination on humans. The parameters used within the model can be chosen to allow guideline values to be derived for a variety of land uses and exposure pathways. For example, a construction worker is likely to be exposed in different ways and for different durations than an adult in a residential setting.

4.3.3.2 On the basis that the existing site is restricted to agricultural activities the adult is considered an appropriate current receptor. Following completion of the residential development the critical site user (receptor) is considered to be a child under the age of 6 years. These criteria have been used in the conceptual model for the current and future site use. Our assessment also considers construction operatives as adult receptors.

4.3.4 Vegetation receptors

4.3.4.1 Soil contaminants can have an adverse effect on plants if they are present at sufficient concentrations. The effects of phytotoxic contaminations include growth inhibition, interference with natural processes within the plant and nutrient deficiencies.

4.3.4.2 Vegetation is currently present at the site and will remain so following development, in addition to further vegetation proposed as part of the new development. We have therefore considered vegetation a viable receptor.

4.3.5 Water receptors

4.3.5.1 The near surface Alluvium deposits are recorded as a Secondary A aquifer. The underlying Devensian Till deposits are recorded as unproductive strata and are known to extend to depths beyond 3.2m within the Phase 1 and Phase 2 development areas. The underlying Bowland Shale Formation is recorded as a Secondary A aquifer. The site is not recorded in a source protection zone. Based on the above, given the relatively small and confined nature of the area of Alluvium recorded at the site and adjacent to the north, in addition to the thickness of Devensian Till, groundwater is not considered a viable receptor. The nearest watercourse to the site is Higgin Brook, which flows along the south-western site boundary. On this basis, surface water is considered to be a viable receptor.

4.3.6 Summary of identified receptors

4.3.6.1 Based on the above assessments, the following table summarises identified and critical receptors.

| Table summarising identified (viable) receptors | | | | |
|--|--|--------------------------------------|--------------------------------------|----------------|
| Principle Receptor | Detail | Viable and critical receptors | | |
| | | Viability and justification | Critical receptor | |
| Humans | Users of the current site | Yes | Grazing land | Adult |
| | End user of the developed site | Yes | POS and recreational land | Child |
| | Construction operatives and other site investigators | Yes | | Adult |
| Vegetation | Current site | Yes | Trees on site | Vegetation |
| | Developed site | Yes | Trees to remain | Vegetation |
| Controlled waters | Surface waters (Rivers, streams, ponds and above ground reservoirs) | Yes | Higgin Brook along site boundary | Surface waters |
| | Ground waters (used for abstraction or feeding rivers/ streams etc.) | No | Unlikely to be present (impermeable) | Groundwater |

Table 4.3.6

4.4 Identification of pathways

4.4.1 Pathways to human receptors

4.4.1.1 Guidance published by the Environment Agency in Science Report SC050021/SR3 'Updated technical background to the CLEA model' provides a detailed assessment of pathways and assessment and human exposure rates to source contaminants. In summary, there are three principal pathway groups for a human receptor:

| Table summarising likely pathways | |
|--|--|
| Principal pathways | Detail |
| Ingestion through the mouth | Ingestion of air-borne dusts |
| | Ingestion of soil |
| | Ingestion of soil attached to vegetables |
| | Ingestion of home grown vegetables |
| Inhalation through the nose and mouth. | Inhalation of air-borne dusts |
| | Inhalation of vapours |
| Absorption through the skin. | Dermal contact with dust |
| | Dermal contact with soil |

Table 4.4.1

4.4.1.2 The site currently comprises open fields surfaced in grass and used for grazing livestock. It is understood that this has been the principal site use for much of the sites history, if not all. Based on such we have considered all the above pathways would be present for current users with the exception of those associated with the consumption of vegetables.

4.4.1.3 Following redevelopment the site will comprise areas of POS and recreational grounds. Based on such, again all of the above pathways with the exception of those associated with the consumption of vegetables will be considered. A summary of our pathway assessment is presented in Section 4.4.4.

4.4.2 Pathways to vegetation

4.4.2.1 Guidance published by the Environment Agency in Science Report SC050021/SR (Evaluation of models for predicting plant uptake of chemicals from soil) provides a detailed assessment of plant uptake pathways. In summary, plants are exposed to contaminants in soils by the following pathways:

- Passive and active uptake by roots.
- Gaseous and particulate deposition to above ground shoots.
- Direct contact between soils and plant tissue.

4.4.2.2 All of the above routes of exposure are considered to be present for vegetation.

4.4.3 Pathways to controlled waters

4.4.3.1 A number of pathways exist for the transport of soil contamination to controlled waters. A summary of these pathways is presented below:

- Percolation of water through contaminated soils
- Near-surface water run-off through contaminated soils
- Saturation of contaminated soils by flood waters

4.4.3.2 Near surface soils in the Phase 1 and Phase 2 development areas comprised cohesive Devensian Till deposits which are considered impermeable and extend to depths beyond 3.2m at the sites. Whilst deposits of Alluvium are recorded in the north-western part of the site, which may exhibit a degree of permeability, they are not considered to be laterally extensive and unlikely to provide a source of groundwater worthy of abstraction. The clay soils of the Till will also severely restrict the percolation of surface water into the underlying aquifer of the Bowland Shale Formation, therefore, pathways associated with percolation of surface water will not be considered further.

4.4.3.3 Based on the permeability of near surface Devensian Till deposits, in our opinion such soils are considered amenable to promoting significant amounts of near surface water run off through contaminated soils.

4.4.3.4 The site is not recorded within a fluvial flood plain and as such saturation of contaminated soils by flood waters is unlikely to occur.

4.4.4 Summary of identified likely pathways

4.4.4.1 Based on the above assessments, the following table summarises likely pathways of potential chemical contaminants at the site to identified receptors.

| Table of likely pathways | | |
|--|--------------------------|---|
| Receptor group | Critical receptor | Pathway |
| Proposed site users | Child | Ingestion of air-borne dusts |
| | | Ingestion of soil |
| | | Inhalation air-borne dusts |
| | | Inhalation of vapours |
| | | Dermal contact with dust |
| | | Dermal contact with soil |
| Current site users and construction operatives | Adult | Ingestion of air-borne dusts |
| | | Ingestion of soil |
| | | Inhalation of air-borne dusts |
| | | Inhalation of vapours |
| | | Dermal contact with dust |
| | | Dermal contact with soil |
| Vegetation | | Root uptake, deposition to shoots and foliage contact |
| Groundwater | Surface water | Near-surface water run-off through contaminated soils |

Table 4.4.4

4.5 Assessment of sources of chemical contamination

4.5.1 Introduction

4.5.1.1 Initially, potential sources of contamination are assessed using the following elements of the investigation process.

- History of the site
- Desk study information
- Site reconnaissance
- Geology
- Fieldwork

4.5.1.2 These elements will dictate a relevant soil/water testing regime to quantify possible risks of any identified contaminative sources which may harm identified receptors.

4.5.2 Source assessment – History of the site

4.5.2.1 The history of the site and its immediate surroundings based on published Ordnance Survey maps is described in Section 3.

4.5.2.2 Based on published historical maps, there is no evidence to indicate the site has been subject to activities which could produce a source of chemical contamination. Records indicate that land uses in areas surrounding the site to the west, south and east consisted of mills, unclassified works, a garage, dairy and foundry. Due to the distance from the site and the relatively impermeable geology, in our opinion, there is unlikely to be a significant risk of contamination migrating from these potential sources to the subject site.

4.5.3 Source assessment – Desk study information

4.5.3.1 Envirocheck presents a detailed database of environmental information in relation to the site including;

- Pollution incidents
- Landfill sites
- Trading activities

4.5.3.2 *Pollution incidents*

4.5.3.2.1 Envirocheck report a number of pollution incidents to controlled waters within 2000m of the site, the closest of which are recorded some 200m to the north-west and 220m to the south-west. The incident to the north-west is dated 1994 and classified as a Category 3 minor incident, with silage liquor affecting Higgin Brook. The incident to the south-west is dated 1996 and associated with the release of inert materials and light oils and is classified as a Category 3 minor incident. Given the distances from the site and the type and severity of the incidents they are considered unlikely to have impacted the site.

4.5.3.3 *Landfill sites*

4.5.3.3.1 Envirocheck reports within 2km radius of the site, there are no BGS recorded or historical landfill sites; however, there are two registered landfill sites. Lords Delph (Forty Acre Lane, Longridge) is located approximately 500m to the east of the site and has been accepting non-biodegradable waste since at least 1982. Chapel Hill Quarry is located approximately 900m to the south of the site and accepted non-biodegradable waste; in 1992, the site was recorded as dormant.

4.5.3.3.2 In addition, we have reviewed old Ordnance Survey maps and there are a small number of quarries recorded between 250m and 700m from the subject site, predominantly to the east, exploiting the underlying clays and grits.

4.5.3.3.3 Based on the above, due to the distance, the risk of any chemical contamination associated with landfill sites and restored mineral sites in the area, migrating and impacting identified receptors at the site, is considered low.

4.5.4 Source assessment – Site reconnaissance

4.5.4.1 A full description of the site and observed adjacent land uses is provided in Section 3 of this report. A plan summarising observations made on site during our site reconnaissance visit is presented on Drawing 02.

4.5.4.2 We did not observe any obvious evidence of any current or recent activities on site which provide a potential source of chemical contamination.

4.5.5 Source assessment – Geology

4.5.5.1 The geological map of the area indicates the topography local to the site is formed in deposits of Alluvium, Devensian Till, Bowland Shale Formation and Pendleside Sandstone Formation. Typically, and in our experience, such deposits do not exhibit any abnormal concentrations of naturally occurring chemical contaminants.

4.5.7 Source assessment - summary

4.5.7.1 Based on the paragraphs above, we have identified the following potential sources of contamination:

| Table summarising results of source assessment | | | | |
|--|-----------------------|--|-------------------------------|--------------------------------|
| Source | Origin of information | Possible contaminant | Probability of risk occurring | Likely extent of contamination |
| On site | | | | |
| Historic land uses in local area | Desk study | Metals, PAHs, TPHs | Unlikely | N/A |
| Pollution incidents in local area | Desk study | Metals, PAHs, TPHs, organic pathogens/bacteria | Unlikely | N/A |
| Landfills/ restored quarries | Desk study | Metals, PAHs, TPHs | Unlikely | N/A |

Table reference 4.5.7

4.6 Initial Conceptual Model

4.6.1 Based on our assessment of potential contaminative sources, identified receptors and viable pathways to receptors described in preceding paragraphs, we have produced an initial conceptual model in the form of a table which is presented in Appendix F.

4.6.2 Based on the conceptual model the initial assessment of risk of chemical contamination causing harm to identified receptors does not exceed the low category, but this is solely based on desk study information. Clearly investigations are required to quantify and refine risks, but at this stage significant remediation is considered unlikely.

- 4.6.3 Based on laboratory testing of near surface soils within the areas of the Phase 1 and Phase 2 developments, concentrations of chemical contaminants tested were recorded below relevant guideline values for both current and proposed land uses. Typically Topsoil deposits were encountered, with very localised areas of Made Ground.
- 4.6.4 Near surface soils in the Phase 3 development area are highly likely to consist of Topsoil overlaying naturally deposited soils, and based on such, we consider it unlikely that such soils will be artificially contaminated in respect of human receptors.
- 4.6.5 Laboratory testing did, however, identify elevated concentrations of leachable copper in some samples of Topsoil tested, likely to be attributed to the use of copper based fertilisers in agriculture. The EQS values used in the assessment are largely dictated by the hardness of the receiving watercourse and fairly conservative values for hardness were adopted for the site based on readily available groundwater data. It is likely that if water was tested within Higgin Brook (receiving surface watercourse) that hardness values would be higher than those adopted (>200mg/l rather than <100mg/l) which would have the effect of increasing the EQS value of copper from 6µg/l to 28µg/l. If this were to be the case then the concentrations of leachable copper measured in Topsoil deposits in the development areas of Phase 1 and Phase 2 would fall below the guideline value for the site.
- 4.6.6 Based on the above, whilst there is the potential for leachable copper to also exist in Topsoil at the site, we are of the opinion that the concentrations are unlikely to have an adverse effect on surface waters in the area.
- 4.6.7 As a precaution, we recommended in the previous investigations that surface waters within Higgin Brook are tested to determine site specific values of hardness which will enable a more detailed risk assessment to be completed.

4.7 Actions

- 4.7.1 Based on the above our sole recommendations are as follows:-
- Hardness values within surface waters of Higgin Brook are determined, as recommended in our reports for the Phase 1 and Phase 2 redevelopment areas to the south, to enable a more detailed risk assessment to be completed in relation to water receptors
 - Construction operatives adopt adequate hygiene precautions
- 4.7.2 We also recommend that ground workers/construction operatives are vigilant during excavations onsite, and any noticeable change in ground conditions should be assessed and investigated if necessary.

4.8 Risk assessment summary and recommendations

4.8.1 Based on our assessments described above, we can provide the following summary and recommendations for each identified receptor.

4.8.2 Current and proposed site users

4.8.2.1 As no source of significant chemical contamination has been identified on site, we are of the opinion that the site represents a very low risk of causing harm to the health of identified current users of the site.

4.8.3 Construction operatives and other site investigators

4.8.3.1 The risk of damage to health of construction operatives and other site investigators is, in our opinion, low. As a precautionary approach, however, we recommend adequate hygiene precautions are adopted on site. Such precautions would be:-

- Wearing protective clothing particularly gloves to minimise ingestion from soil contaminated hands.
- Avoiding dust by dampening the soils during the works.
- Wearing masks if processing produce dust.

4.8.3.2 Guidance on safe working practices can be obtained from the following documents

- The Health and Safety Executive Publication *“Protection of Workers and the General Public during the Development of Contaminated Land”* (HMSO) and
- *“A Guide to Safer Working on Contaminated Sites”* (CIRIA Report 132).

4.8.3.3 In addition, reference should be made to the Health and Safety Executive. In all cases work shall be undertaken following the requirements of the Health and Safety at Work Act 1974 and regulations made under the Act including the COSHH regulations.

4.8.4 Controlled waters

4.8.4.1 Based on the above, and on laboratory results for Phases 1 and 2, we are of the opinion that the site potentially represents a low-moderate risk of causing harm to water receptors. As a precaution we recommend that values of hardness are determined in surface waters of Higgin Brook to enable a more detailed risk assessment to be undertaken in relation to concentrations of leachable copper.

4.8.5 Vegetation

4.8.5.1 As no source of significant chemical contamination has been identified on site, we are of the opinion that the site represents a low risk of causing harm to vegetation.

4.9 Statement with respect to National Planning Policy Framework

- 4.9.1 Based on investigations completed to date with respect to chemical contamination, providing the recommendations as outlined above are completed, we are of the opinion that the proposed development will be safe and suitable for use for the purpose for which it is intended, thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, *'Site preparation and resistance to contaminants and moisture'*.

5 Gaseous contamination

| | |
|-----|--|
| 5.1 | Legislative framework |
| 5.2 | General |
| 5.3 | Assessment of source of gases |
| 5.4 | Gas migration |
| 5.5 | Conclusion |
| 5.6 | Statement with respect to National Planning Policy Framework |

5.1 Legislative framework

- 5.1.1 There is currently a complex mix of documentation relating to legislative and regulatory procedures on the issue of contamination and it is not considered a purpose of this report to discuss the detail of these regulations. Essentially, Government Policy is based on *'suitable for use approach'*, which is relevant to both the current and proposed future use of land. For current use Part IIA of the Environmental Protection Act 1990 provides the regulatory regime (see Section 8.1). The presence of harmful soil gases could provide a 'source' in a 'pollutant linkage' allowing the regulator (Local Authority) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as 'contaminated' under the provision of the Act requiring the remediation process to be implemented with the Environment Agency responsible for enforcement.
- 5.1.2 The Town and Country Planning (General Development Procedure) Order 1995, requires the planning authority to consult with the Environment Agency before granting planning permission for development on land within 250 metres of land which is being used for deposit of waste, (or has been at any time in the last 30 years) or has been notified to the planning authority for the purposes of that provision.
- 5.1.3 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, *'Site preparation and resistance to contaminants and moisture'* which seeks to protect the health, safety and welfare of people in and around buildings and includes requirements for protection against harm from soil gas.

5.2 General

- 5.2.1 The following assessment relates to the potential for, and the effects of, gases generated by biodegradable matter. The potential for the development to be affected by radon gas is considered in Section 3. The principal ground gases are carbon dioxide (CO₂) and methane (CH₄). The following table provides a summary of the effects of these gases when mixed with air.

| Significant gas concentrations in air | | |
|---------------------------------------|-------------------------|---|
| Gas | Concentration by volume | Consequence |
| Methane | 0.25% | Ventilation required in confined spaces |
| | 5 - 15% | Potentially explosive when mixed with air |
| | 30% | Asphyxiation |
| | 75% | Death after 10 minutes |
| Carbon Dioxide | 0.5% | 8 hour long term exposure limit (LTEL) (HSE workplace limit) |
| | 1.5% | 15 min short term exposure limit (STEL) (HSE workplace limit) |
| | >3% | Breathing difficulties |
| | 6 – 11% | Visual distortion, headaches, loss of consciousness, possible death |
| | >22% | Death likely to occur |

Table 5.2.1

5.2.2 Following the current Building Regulations Approved Document C1, Section 2 'Resistance to Contaminants' (2004 incorporating 2010 and 2013 amendments) a risk assessment approach is required in relation to gaseous contamination based on the source-pathway-receptor conceptual model procedure. We have adopted procedures described in the following reference documents for investigation and assessments of risk of the development being affected by landfill type gases (permanent gases) and if appropriate the identification of mitigation measures.

- BS10175:2011 'Investigation of potentially contaminated sites- Code of Practice'
- BS8576:2013 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'
- BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'
- CIRIA Report C665 'Assessing risks posed by hazardous ground gases to buildings' (2007)
- NHBC report No 10627-R01(04) 'Guidance on development proposals on sites where methane and carbon dioxide are present' (January 2007)
- CL:AIRE Research Bulletin RB17 'A pragmatic approach to ground gas risk assessment' (November 2012)

5.2.3 Whilst we have followed the guidance and recommendations of BS8576, we have used BS8485:2015 to derive recommendations for protective works, and where considered necessary supplemented by NHBC report No 10627-R01(04).

5.2.4 An assessment of the risk of the site being affected by ground gases is based on the following aspects:

- a) Source of the gas
- b) Investigation information
- c) Migration feasibility
- d) Sensitivity of the development and its location relative to the source

5.3 Assessment of source of gases

5.3.1 General sources

5.3.1.1 The following table summarises the common sources of ground gases and parameters affecting the generation of ground gases:

| Source and control of gases | |
|---------------------------------|--|
| Type | Parameters affecting the rate of gassing |
| Landfills | Portion of biodegradable material, rate reduces with time |
| Mineworkings | Flooding reduces rate of gassing |
| Dock silt | Portion of organic matter |
| Carbonate deposits | Ground/rainwater (acidic) reacts with some carbonates to produce carbon dioxide. |
| Made Ground | Thickness of Made Ground and proportion of degradable organic matter. |
| Naturally deposited soils/rocks | Thickness of Made Ground and proportion of degradable organic matter. |

Table 5.3.1

5.3.1.2 The rate of decomposition in gas production is also related to atmospheric conditions, pH, temperature, and water content/infiltration.

5.3.1.3 As the site is not within a dockland environment or an area affected by mineworkings, and near surface soils do not exhibit high carbonate content, then potential gas sources are limited to landfills and/or soils with a high proportion of organic matter.

5.3.2 Landfill and infilled ground sources

5.3.2.1 Waste Management Paper 27 (1991) produced by the Department of the Environment '*Control of Landfill Gases*' contains the recommendation to avoid building within 50m of a landfill site actively producing large quantities of landfill type gases and to carry out site investigations within a zone 250m beyond the boundary of a landfill site. No distinction is made between sites of differing ground conditions, but the paper does not advocate the site is safe beyond the 250m zone, dependant, of course, upon the type of landfill and potential for migration of landfill gases.

5.3.2.2 Within a 2km radius of the site, there are no BGS recorded or historical landfill sites; however, there are two registered landfill sites. Lords Delph (Forty Acre Lane, Longridge) is located approximately 500m to the east of the site and has been accepting non-biodegradable waste since at least 1982. Chapel Hill Quarry is located approximately 900m to the south of the site and accepted non-biodegradable waste; in 1992, the site was recorded as dormant.

5.3.2.3 In addition, we have reviewed old Ordnance Survey maps there are a small number of quarries recorded between 500m and 1000m from the subject site, predominantly to the east. The geological map of the area indicates areas of infilled ground which approximately coincide with such areas.

5.3.2.4 Due to the distance of the sites from the subject site and the nature of the waste, in our opinion they are considered very unlikely to represent potential sources of ground gases which could affect the subject site. Furthermore, a series of small ponds are noted to have been recorded on adjacent sites and possibly filled in recent years. However, given the limited size of the water features it is considered unlikely that any gases associated with organic/putrescible material contained within would have the potential to affect identified receptors.

5.3.3 Soil conditions

5.3.3.1 None of the soils observed in exploratory excavations, in our opinion, exhibit significant concentrations of organic matter which are likely to produce elevated quantities of carbon dioxide and / or methane gas.

5.3.3.2 Based on an assessment of 'deep' geological conditions we are of the opinion that it is unlikely that the subject site would be affected by significant quantities of carbon dioxide and methane generated by soils/rocks at depth.

5.3.3.3 Based on the presence of extensive deposits of cohesive and impermeable Devensian Till in the local area, any potential migration of landfill type gases which may be generated at the sources outlined in Section 5.3.2 would also be severely restricted and unlikely to feasibly migrate to the subject site. We can confirm that we have consulted with Ribble Valley Borough Council with regards to this matter and they have agreed with such assessments. A copy of their correspondence is presented in Appendix E.

5.3.3.4 Deposits of Alluvium are also recorded at surface in the north-western part of the site. Such soils may have the potential to contain organic material which may have the potential to generate landfill type gases. Given that development of the Phase 3 area of the site will consist of POS and recreational areas, with no enclosed spaces, any gases generated are unlikely to pose a risk to human receptors.

5.3.4 Source assessment summary

5.3.4.1 The following table summarises the possibility of a source of landfill type gases.

| Source assessment summary | | |
|----------------------------------|----------------------------|--|
| Potential source origin | Viability of source | Evidence |
| Landfills | Unlikely | Desk study information |
| Mineworkings | Unlikely | Desk Study information Geological conditions not amenable |
| Dock silt | Unlikely | Site remote from dockland environment |
| Carbonate deposits | Unlikely | Recorded and observed soil conditions do not indicate high concentrations of carbonates |
| Made Ground | Unlikely | Based on Phase 1 and Phase 2 SI, unlikely to be present at thicknesses and compositions which would give cause for concern |
| Naturally deposited soils/rocks | Unlikely | Alluvium may generate some gasses if organic matter present, however, unlikely to harm human receptors in outdoor space. |

Table 5.3.4

5.4 Conclusion

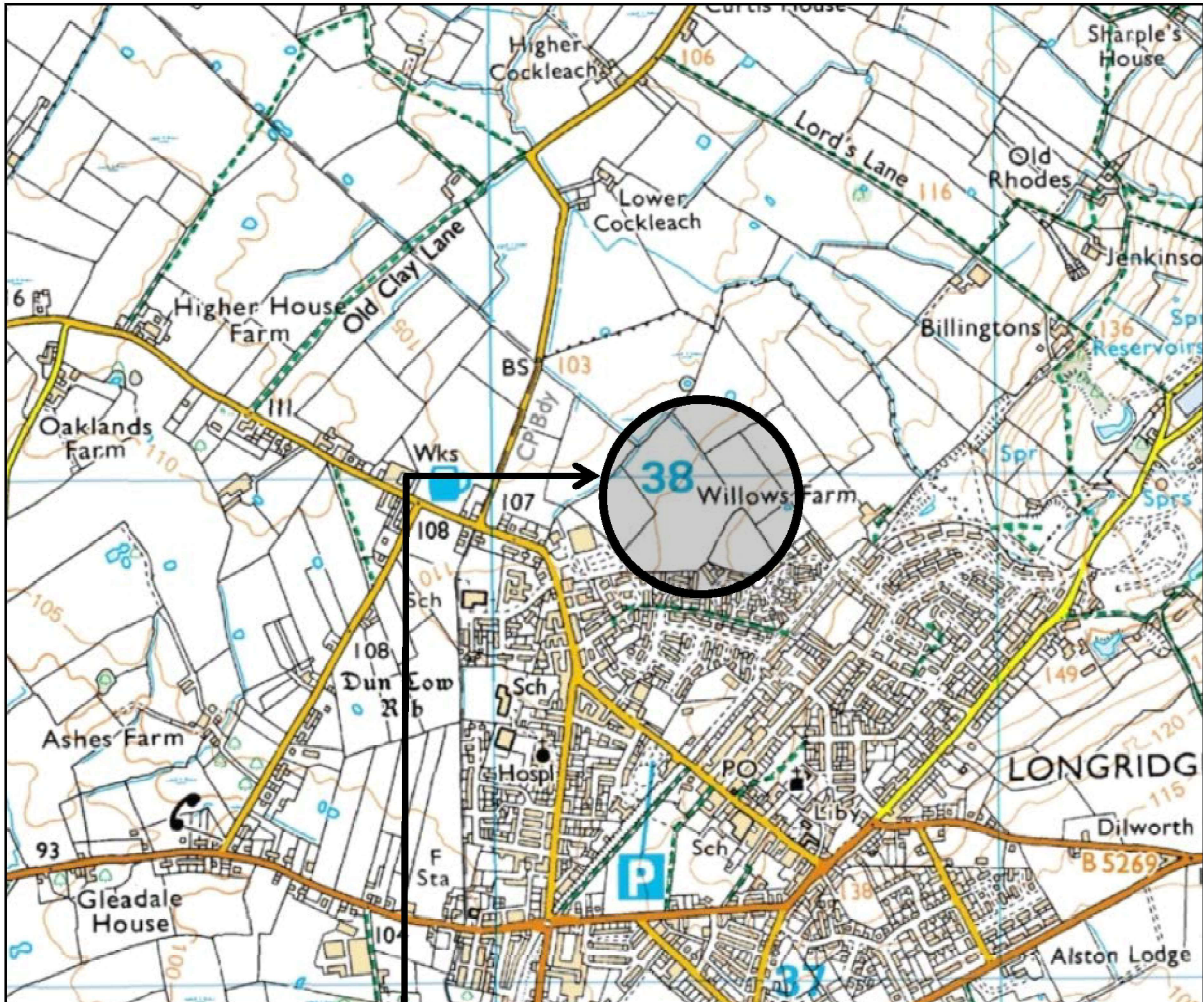
5.4.1 Based on the above there is no evidence to demonstrate that there is a potential source rendering the site at a significant risk of being affected by ground gases (carbon dioxide / methane) sufficient to cause significant harm to human end users of the site, construction operatives or indeed buildings. On this basis, it is not considered necessary to consider possible pathways for migration of ground gases, and indeed implementation of further investigations to measure concentrations of ground gases. Again on the basis of evidence provided above, mitigation measures against ingress of ground gases into the proposed development area are not considered necessary.

5.5 Statement with respect to National Planning Policy Framework

5.5.1 Based on investigations completed to date with respect to gaseous contamination, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended (without the need for any remedial action) thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, '*Site preparation and resistance to contaminants and moisture*'.

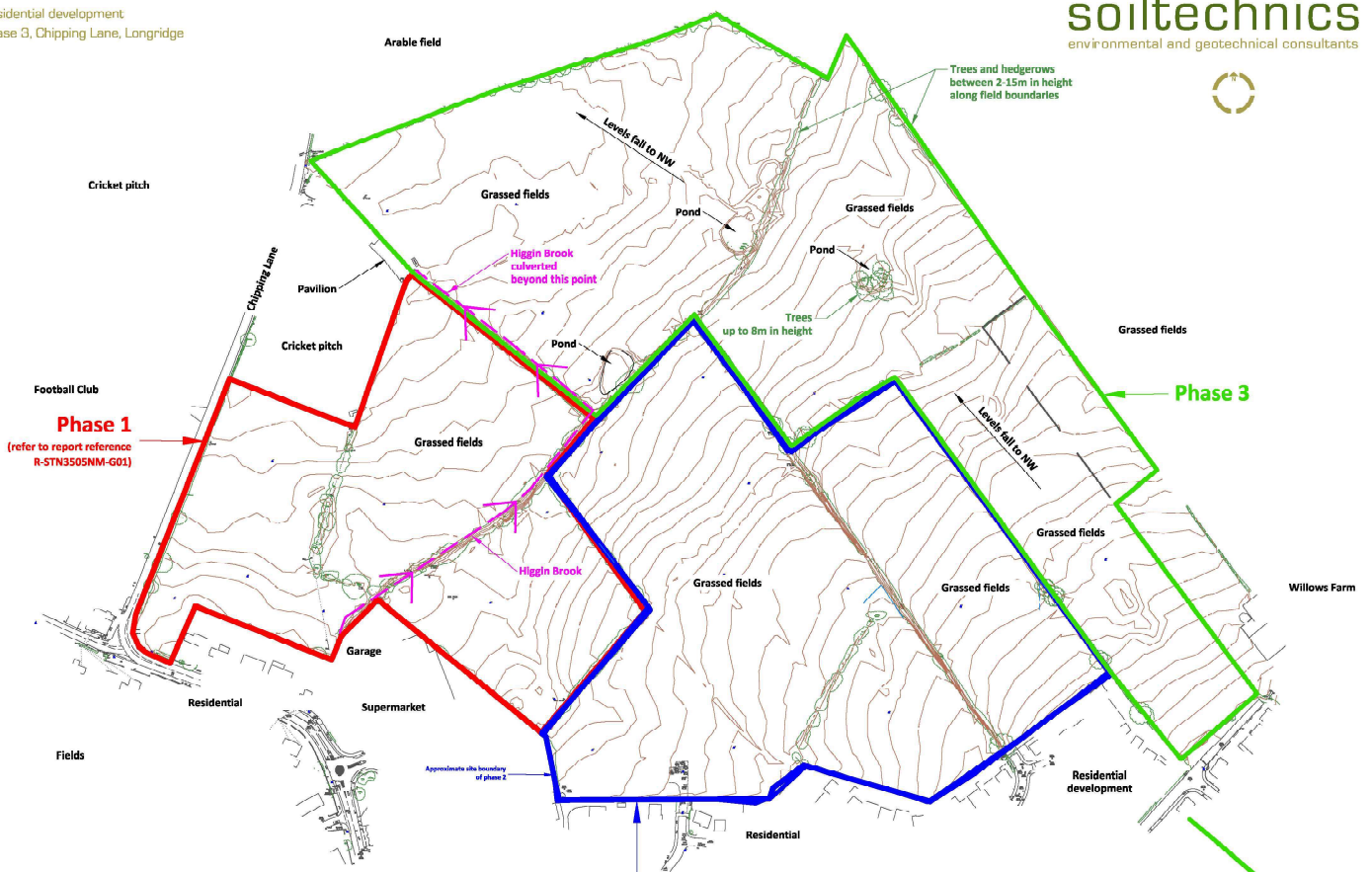
6 Further investigations

- 6.1 Although we have endeavoured to provide a comprehensive investigation for the proposed development within budgetary constraints there are areas, which we recommend further investigations be carried out. These are as follows: -
- Hardness values within surface waters of Higgin Brook are determined, as recommended in our reports for the Phase 1 and Phase 2 redevelopment areas to the south, to enable a more detailed risk assessment to be completed in relation to water receptors
- 6.2 We would be pleased to carry out any of the supplementary investigations described above and provide proposals with costings on further instructions.



Approximate area of investigation

| Title | Scale | Drawing number |
|--------------------|--------------|----------------|
| Site location plan | Not to scale | 01 |



Phase 1
(refer to report reference R-STN3505NM-G01)

Phase 2
(refer to report reference STN3505NM-G02)

Phase 3

Title
Plan showing existing site features and location and extent of development phases

Scale
1:2500 at A3

Drawing number
02

Definition of geo-environmental terms used in this report

Conceptual model

Textual and/or schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the basis of the information obtained from the investigatory process.

Contamination

Presence of a substance which is in, on or under land, and which has the potential to cause harm or to cause pollution of controlled water.

Controlled water

Inland freshwater (any lake, pond or watercourse above the freshwater limit), water contained in underground strata and any coastal water between the limit of highest tide or the freshwater line to the three mile limit of territorial waters.

Harm

Adverse effect on the health of living organisms, or other interference with ecological systems of which they form part, and, in the case of humans, including property.

Pathway

Mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor.

Receptor

Persons, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by the contaminant(s).

Risk

Probability of the occurrence of, and magnitude of the consequences of, an unwanted adverse effect on a receptor.

Risk Assessment

Process of establishing, to the extent possible, the existence, nature and significance of risk.

Definition of environmental risk/hazard terms used in this report.

Based on CIRIA report C552 '*Contaminated land risk assessment – A guide to good practice*'.

Potential hazard severity definition

| Category | Definition |
|---------------|--|
| Severe | Acute risks to human health, catastrophic damage to buildings/property, major pollution of controlled waters |
| Medium | Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures. |
| Mild | Pollution of non sensitive waters, minor damage to buildings or structures. |
| Minor | Requirement for protective equipment during site works to mitigate health effects, damage to non sensitive ecosystems or species. |

Probability of risk definition

| Category | Definition |
|------------------------|--|
| High likelihood | Pollutant linkage may be present, and risk is almost certain to occur in long term, or there is evidence of harm to the receptor. |
| Likely | Pollutant linkage may be present, and it is probable that the risk will occur over the long term |
| Low likelihood | Pollutant linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so. |
| Unlikely | Pollutant linkage may be present, but the circumstances under which harm would occur are improbable. |

Level of risk for potential hazard definition

| Probability of risk | Potential severity | | | |
|------------------------|--------------------|--------------|--------------|--------------|
| | Severe | Medium | Mild | Minor |
| High Likelihood | Very high | High | Moderate | Low/Moderate |
| Likely | High | Moderate | Low/Moderate | Low |
| Low Likelihood | Moderate | Low/Moderate | Low | Very low |
| Unlikely | Low/Moderate | Low | Very low | Very low |

Refer sheet 2 for definitions of 'very high' to 'low'