Report type:	Site Appraisal
Site:	Land off Manchester Road, Chapel-en-le-Frith.
Client's Agent:	John Rose Associates
Client:	Barratt Developments Ltd
Ref:	GRM/P5382/F.1
Date:	January 2011

Site Appraisal for
Manchester Road, Chapel-en-le-Frith

SUMMARY OF RECOMMENDATIONS

Where further assessment is required it is indicated with a "Y" in the right hand column		
Proposed Development	Residential housing (assumed up to 3-storey) and gardens.	
CONTAMINATION ASSESSMENT - REMEDIATION / WASTE DISPOSAL		
End Users	Localised removal of contaminated topsoil prior to site strip.	
Site Workers	No remediation required, suitable PPE is required though.	
Construction Materials	Upgraded water supply pipes and/or clean backfill around pipes may be required – considered unlikely. Appropriate concrete specification.	
Groundwater	No remediation required.	
Surface Water	No remediation required.	
Waste Disposal (may include soils, asbestos, oil drums, chemical containers, etc)	Client has a duty of care to ensure that all waste is disposed appropriately to a licensed landfill. The landfill receiving the waste may request additional WAC testing analysis. Waste characterisation can only be confirmed by the landfill site.	
GEOTECHNICAL ASSESSMENT – FOUNDATIONS		
Ground Treatment Required	Some treatment or reinforcement of the ground surface may be required to improve trafficability during development works.	
Main Bearing Strata	Clay	
Nett Allowable Bearing Pressure	110kN/m^2 (Clay);	
Tree Influence	Some. Trees present along field boundaries.	
Volume Change Potential	Low to medium. Assume medium throughout.	
Likely Foundation Types	Strip/Trench Fill	
Likely Foundation Depth Range	Locally greater than 2.5m due to tree influence. Generally 0.9m begl.	Y
Excavation Hazards	Shallow groundwater	
Floor Slab Types	Combination of ground bearing, insitu suspended, and voided suspended (e.g. beam and block).	Y
Gas Protection Requirements Radon and/or Landfill	None.	
GEOTECHNICAL ASSESSMENT - GENERAL		
Slope Stability Risk	Negligible.	
Soakaways Potential	Not suitable for soakaway drainage.	
New Access Roads	Between 2% and 3%	
Buried Concrete Class	DS - 1; AC- 1.	
Retaining Walls	Unlikely.	
Other Comments	Further investigation related to contamination issues required.	Y

This summary is based on the full report that provides the detailed assessment of the ground risks affecting the development and how to manage them. It should not be used in isolation.

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APPENDICES

1 INTRODUCTION

1.1 PREAMBLE

GRM Development Solutions Limited (GRM) has been appointed by John Rose Associates (Client's Agent) on behalf of Barratt Developments Ltd (Client) to update a previous Site Appraisal to current standards.

In 2009 GRM Development Solutions Limited (GRM) was appointed by John Rose Associates (Client's representative) on behalf of S. Robinson Developments and High Peak Land Ltd (Clients) to undertake a Site Appraisal. A desk study and site inspection formed Phase I of the assessment and allowed the geotechnical and geo-environmental setting of the site to be determined and the identification of areas of particular concern that required targeted investigation. The Phase II works comprised the intrusive ground investigation, geotechnical testing and chemical analysis. The information gained from the Phase II works was used to refine the conceptual model for the site and determine the most cost-effective development solutions for the site.

Although originally the desk study information was assessed prior to the intrusive investigation works, for ease of reading and efficiency, the Phase I and Phase II aspects of the appraisal are combined here within one document.

The Client proposes to develop the site with up to 2½-storey housing, and 3-storey apartments and associated infrastructure. The proposed end use includes gardens and soft landscaping. The outline development proposals provided by the Client are presented in Appendix A.

The Client did not inform GRM of any known potential development hazards, prior to the site works.

This site appraisal is intended to provide information that will assist decision making by identifying and recommending solutions to ground engineering and contamination issues.

GRM Standard Limitations of Reporting are provided on the back cover of this report.

Significant Features reported by the Client:
None

1.2 OBJECTIVES OF THE SITE APPRAISAL

The principal aims of the Site Appraisal are as follows:

a) Obtain information, from easily accessible sources, about the soil and groundwater conditions within the area of the site.

b) Determine the possible ground related geotechnical and contamination hazards within the site boundaries that may affect the proposed development.

c) Provide preliminary development recommendations.

d) Provide advice on further works required for the cost-effective reduction of risks to the development and procedures likely to satisfy regulators.

Whilst every effort has been made to pre-empt the likely requirements of the Local Authority and the Environment Agency, they are likely to have specific requirements that will need to be discussed and addressed at a later date.

2 PHASE I DESK STUDY AND SITE OBSERVATIONS

2.1 INFORMATION SOURCES

The following sources have been used for the identification and assessment of potential ground hazards:

- Relevant British Standards
- British Geological Survey (BGS) Geology Map Scale 1:10,000 SK08SW
- British Geological Survey (BGS) Geology Map Scale 1:50,000 Sheet 99 Chapel-en-le-Frith
- BGS Memoir
- BGS Borehole Records
- Environment Agency Groundwater Vulnerability Map 1:100,000 Sheet 17 Derbyshire
- Historical Ordnance Survey (OS) Maps
- Environmental report from Groundsure Ltd
- Environment Agency Website: http://www.environment-agency.gov.uk/
- DEFRA/Environment Agency R&D Publication CLR documents and DoE Industry Profiles
- BRE Guide BR211 (2007), 'Radon: Guidance on protective measures for new buildings'
- HPA-RPD-033 (2007), 'Indicative Atlas of Radon in England and Wales'
- NRPB Publication W26 (2002), 'Radon Atlas of England and Wales'
- Client supplied information including: the location of the site

Other technical references used throughout this document are detailed in the text.

2.2 SITE DESCRIPTION

2.2.1 Geographical Setting

The site is approximately 1.4km west of Chapel-en-le-Frith town centre. The National Grid Reference (NGR) for the approximate centre of the site is SK048804. A location plan is presented in Appendix B.

The site is presently used as grazing land and covers an area of approximately 3 hectares. The northern and western boundaries are formed by fields and private gardens. The southern boundary is formed by residential properties off Manchester Road. The eastern boundary is formed by Crossings Road and residential properties off it.

2.2.2 Site Inspection Observations

The diagram presented in Appendix C illustrates the salient observations made during a site inspection on 5th May 2009.

The site comprises two fields. A small bank runs along the eastern boundary of the northern field, which then slopes down by approximately 1m to the general site level. The entire site slopes very gently to the west. There is no evidence of instability either on the bank or across the rest of the site.

The surface of the northern field is covered by rough grassland and the southern field by grass which is grazed by horses.

Soft marshy ground and standing water was observed locally throughout site, but particularly in the north western corner of the southern field. Ruts in the ground suggest that the surface soils exhibit poor trafficability during wet conditions.

A small hole was noted close to the southern boundary of the northern field which surface run-off was draining down into. It is unclear whether this is a man-made or natural drainage feature.

Vegetation included hawthorn bushes and mature trees, which formed the site boundaries and a small clump in the western portion of the southern field. An arboricultural specialist should conduct a tree survey should cohesive strata be found on site.

Invasive plant species were not observed (see section on Invasive plant species/ ecology).

A chicken coop was noted in the south eastern corner of the southern field.

Significant Features identified during site inspection:
Marshy/soft ground – potentially high groundwater Mature trees/bushes – deepened foundations if cohesive strata present Drainage feature

2.3 HISTORICAL DEVELOPMENT OF THE SITE

A review of the available historical Ordnance Survey (OS) maps gives an insight into the development of the site and can highlight potential hazards. Extracts of the maps reviewed are provided in Appendix D. The relevant differences between each edition are highlighted below.

1879: The earliest map reviewed shows the site occupying two fields, in a similar configuration to the present day. Manchester Road is shown to the south, and Crossings Road to the east. Open fields form much of the surrounding area. A small hamlet, Lower Crossings, lies immediately to the east of the site at the junction of the two roads. Chapel-en-le-Frith Union Workhouse is shown approximately 200m to the east.

1897/98: Additional residential properties are shown adjacent to the site's southeastern corner. A pond or marshy area is shown in the northwestern corner of the site's southern field. A ditch/stream is shown approximately 40m to the north and 30m to the west of the site. A well is indicated approximately 130m to the north.

1922/24: Additional residential properties are shown along the site's southern boundary. The previous ditch/stream is shown to flow in a generally southeasterly direction. A ditch/stream is shown forming the site's northwestern boundary, flowing away to the southwest at the location of the previous pond/marshy area (no longer shown).

1938: No significant changes.

1949: Additional residential properties are shown along the southern part of the site's eastern boundary, and along Manchester Road.

1968: The southern boundary is now fully occupied by residential properties and a police station. A residential property (Nearwell) now forms the site's northern boundary. The stream/ditch forming the site's western boundary (now indicated as a drain) is suggested to "sink" at the location of the former pond, and re-emerge some 120m to the south east. The other stream is also indicated to "sink". The field forming the northern part of the site is shown to be divided into two parts. The area to the east of Crossings Road is shown to be fully built-up.

1974 to 2008: No significant changes.

The hazards identified are summarised in the table below.

Significant Features identified on OS Maps:
Pond/Marshy area – soft possibly organic ground and Made Ground.
Drain forming site's western boundary.
Other drains/streams locally; sinks.
Well – up hydraulic gradient from site so not considered to be at risk.

2.4 ANTICIPATED GEOLOGY

The BGS Geological Sheet for this area shows superficial deposits of Glacial Till (Boulder Clay) over a solid geology of Carboniferous Millstone Grit Series strata (including the Kinderscout Grit Group).

The geological memoir for the area describes Millstone Grit Series strata as sandstones with subsidiary mudstone and siltstone. The Kinderscout Grit Group that reportedly underlies the eastern part of the site is described locally as a massive, well-bedded fine to coarse grained sandstone. The Glacial Till deposits are described locally on the mapping as a "stiff red-brown clay with occasional pebbles".

The BGS holds no borehole records close to the site.

The geological sheet for the area provides no detailed dip information close to the site. However, a general dip to the west can be inferred from the information that is available. The site is not indicated to be directly affected by faulting; the nearest indicated fault being 200m to the west.

Significant Features identified from geological data:
Shrinkable strata – geotechnical hazard

2.5 HYDROGEOLOGICAL INFORMATION

No detailed information regarding the depths to groundwater is available, however, the groundwater level is likely to be subject to seasonal variations.

The presence of a pond or marshy area on the historical mapping suggests that groundwater may, at least locally, be shallow.

The underlying strata (Millstone Grit Series) have been classified by the Environment Agency as a Secondary A Aquifer, overlain by low permeability clays.

There are no recorded groundwater abstraction licenses within 500m of the site. The site is not recorded to be within a groundwater Source Protection Zone.

Significant Features identified from hydrogeological data:
Possible locally high groundwater table – geotechnical hazard Secondary A aquifer – potential receptor

2.6 HYDROLOGICAL INFORMATION

Local surface water features include:

- Drain forming part of the site's western boundary.
- Other streams/drains local to site area.
- Sinks.

The Environment Agency does not consider the site to be at risk from river flooding.

No significant pollution incidents are reported to have occurred which may affect the site.

There are no recorded surface water abstraction licences within 1km of the site.

Significant Features identified from hydrological data:
Drain/stream forming part of site's western boundary – possible shallow groundwater, potential receptor for contamination.

2.7 COAL MINERAL RESOURCES

The Coal Authority's Online Directory (www.coalminingreports.co.uk) provides immediate online confirmation on entering a property postcode as to whether a coal mining search is necessary or not. Such a search is not required for this site.

2.8 OTHER MINERAL RESOURCES

There is no evidence of any non-coal mineral extraction having taken place within, or close to, the site area.

Potential Other Mining Hazards:
None recorded

2.9 ENVIRONMENTAL INFORMATION

Environmental database information has been acquired from Groundsure Ltd. The full report is presented in Appendix E.

A summary of the relevant information not included elsewhere in this report is presented below:

- There are no BGS Recorded Landfill Sites within 1000m of the site.
- There are no Local Authority Recorded Landfill Sites within 1000m of the site.
- There are no Registered Landfill Sites within 1000m of the site.
- There are no Registered Waste Transfer Sites within 500m of the site.
- There are no Registered Waste Treatment or Disposal Sites within 500m of the site.
- There are no Integrated Pollution Control Registered Waste Sites within 500m of the site.
- There are no Control of Major Accident Hazards (COMAH) Sites within 500m of the site.
- There are no Notification of Installations Handling Hazardous Substances within 500m of the site.
- There are no Planning Hazardous Substance Consents within 500m of the site.
- There are no Contaminated Land Register Entries and Notices within 500m of the site.
- There are 6 Current Industrial Land Use sites within 500m of the site. None are likely to affect the site.
- There are no Fuel Station Entries within 500m of the site.

Significant Features identified from Environmental data:
None

2.10 ARCHAEOLOGY

Archaeological information has not been sought as part of this desk study and has not been identified as an issue by the Client. Some Local Authorities require at least an initial archaeological appraisal for development sites. GRM can undertake such appraisals if required.

Archaeological investigations occasionally reveal ground-related problems from ancient times (prior to the 1st Edition OS maps) and can occasionally cause foundation and contamination development hazards.

Archaeological Hazards:
Not researched

2.11 INVASIVE PLANT SPECIES/ECOLOGY

Ecological issues can have a significant effect on developments. GRM is not a specialist in this topic and has not conducted such a survey. However, GRM endeavour to report easily recognisable issues such as Japanese Knotweed, Giant Hogweed, badger sets etc, when seen on site. None were observed on this site during GRM's site works.

Invasive Plant Species/Ecological Hazards:
None observed

2.12 RADON ASSESSMENT

The site has been assessed following the guidelines in 'Radon: guidance on protective measures for new dwellings' (BR211 2007).

The site is not within an area recorded to require radon protection measures, as shown by map 14, 'Derbyshire, Leicestershire, Nottinghamshire', of the BR211 (2007) guidance.

According to latest available information from the Health Protection Agency (HPA-RPD-033, BGS Radon Atlas), between 0% & 1% of homes in this area are reported to have radon levels above the 'Action Level'.

The environmental report (Appendix E) indicates that based on information provided by the BGS, no radon protection measures will be required.

It is recommended that **radon protection measures are not required for this site**.

Radon Hazard:
None

2.13 CONTAMINANTS OF CONCERN

The DEFRA document CLR 8 and DoE Industry Profiles are normally used to assess likely contaminants from past land use and potential nearby industrial sources. For land uses such as this site's, where no profile is available likely contaminants of concern are selected by GRM based on past experience of similar sites, a general screening suite of contaminants covered by CLEA and common contaminants from the Industry Profiles.

There are contaminants that are generally tested for as a matter of course as their prevalence on brownfield sites is renowned. These include:

- Arsenic
- Cadmium
- Chromium
- Lead
- Mercury
- Selenium
- Copper
- Nickel
- Zinc
- Phenols
- Cyanide (total)
- pH
- Water soluble sulphate
- PAH (polycyclic aromatic hydrocarbons)

For sites with a recent agricultural land-use, such as this one, pesticides/herbicides should also be analysed.

These potential contaminants should be tested for to assess the risk posed to end users, controlled waters and construction materials.

Monitoring for methane and carbon dioxide should be undertaken in accordance with best practice guidance.

2.14 SUMMARY OF IDENTIFED SIGNIFICANT FEATURES

Potential hazards have been identified in earlier sections and are now summarised in tabular form, with their consequences and possible risk management actions.

Potential Hazard	Potential Consequence	Action
Locally soft ground	Poor trafficability	Possible need to improve near surface strata
Variable strata	Deepened foundations	Ground Investigation
Shrinkable clay/trees	Deepened foundations	Ground Investigation
High water table	Groundwater in excavations	Ground Investigation
Pesticides/ Herbicides	Potential risk to end users/site workers/water supply pipes/minor aquifer	See section 2.13
Agricultural land use	Potential risk end users/site workers/water supply pipes/minor aquifer	See section 2.13

3 PHASE I CONCEPTUAL MODEL

3.1 POTENTIAL SOURCE – PATHWAY – RECEPTOR

The consideration of contamination is based upon the principles of risk assessment, using the 'source-pathway-receptor' model in order to establish the presence, or potential presence, of a pollutant linkage. To create a risk, contamination must have the potential to cause harm to susceptible targets or receptors such as humans, the water environment or the built environment. The potential for harm to occur requires three conditions to be satisfied to form a pollutant linkage:

- The presence of substances that may cause harm (SOURCE).
- The presence of a target which may be harmed (RECEPTOR).
- The existence of a plausible migration route between the source and the receptor (PATHWAY).

In the absence of a plausible pollutant linkage there is no risk. Where a potential linkage is identified in order for it not to pose a risk to the identified receptor(s) it must be broken.

This site is considered to be "green-field", having comprised open-fields for at least the last 140 years, and probably before that. No potential sources of contamination have been identified, other than its agricultural land-use. Potential contaminants of concern for the whole site are pesticides/herbicides. In additions agricultural activities may have imported materials onto site, for example through "Muck-spreading". PAH, toxic metals (e.g. As, Ni, Cr, Pb), phenols and sulphate and contaminants of concern associated with a range of activities.

The development proposals are believed to incorporate residential housing with areas of hardstanding (e.g. car parking) and private gardens, and landscaping.

The primary human health receptors are residents of the completed development and construction workers. The primary pathways of concern include indoor and outdoor inhalation of ground gas and soil vapours, the ingestion of contaminated soil and soil dust, dermal contact with contaminated soil and soil dust and the ingestion of vegetables that have taken up contaminants from the soil.

For controlled waters, the primary receptor for the site is the underlying Minor Aquifer (Millstone Grit Series). The primary pathways of concern are leaching of contaminants and vertical migration to the groundwater. It is anticipated that the near surface deposits of Glacial Till (clays) will greatly reduce the risk of contaminants infiltrating into the aquifer.

For construction materials, the primary receptors are water pipes and buried concrete. The primary pathways of concern are the migration of contamination leading to degradation of pipe materials and sulphate/acid attack on buried concrete.

Based on the currently available information the risk to human health receptors on this site is considered low, the risk to controlled water is considered very low, and the risk to construction materials is considered low to moderate. The pollutant linkage model is illustrated in detail on the following page.

3.2 POLLUTANT LINKAGE MODEL

HUMAN HEALTH			
Potential Source	**Potential Pathway**	**Potential Receptor**	**Possible Solution**
Potentially contaminated soils due to agricultural land use. Contaminants of concern include pesticides/herbicides, toxic metals, organics, etc.	Ingestion of contaminated soil and soil dust, and dermal contact with contaminated soil and soil dust.	End users of the completed development and construction workers.	Soil capping or removal of contaminated soils.
Potential ground gases (methane/ carbon dioxide) from natural strata.	Indoor and outdoor inhalation of ground gas and soil vapours.	Indoor and outdoor inhalation of ground gas and soil vapours.	Gas protection.

CONTROLLED WATERS			
Potentially contaminated soils due to agricultural land use. Contaminants of concern include pesticides/herbicides, toxic metals, organics, etc.	Leaching of contaminants and vertical migration to the groundwater. Pathways anticipated to be greatly restricted by near surface low permeability cohesive strata.	Secondary A Aquifer.	Removal of locally contaminated soils. Assessment of groundwater quality and, if required, subsequent risk assessment and remediation.

CONSTRUCTION MATERIALS			
Potentially contaminated soils due to agricultural land use. Contaminants of concern include pesticides/herbicides, toxic metals, organics, etc.	Migration of contamination through leaks and joints, degradation of pipe materials.	Water supply pipes.	Upgraded water pipes/clean backfill material.
Natural soils with elevated sulphate content or pH.	Sulphate attack on buried concrete.	Buried concrete.	Appropriate concrete specification.

4 PHASE II GROUND INVESTIGATION

4.1 FIELDWORK

The ground investigation (including fieldwork, sampling, monitoring and laboratory analyses) has been designed to identify and assess potential ground-related problems and to allow cost effective solutions to be advised. It has been planned on the basis of the desk study and site inspection. All fieldwork and soil descriptions were carried out in general accordance with relevant British Standards.

The exploratory holes have been positioned and advanced to depths to determine the general ground/groundwater/gas conditions below the site. The hole spacing has been designed to provide adequate coverage of the whole site. The resultant exploratory hole density is commensurate with the anticipated complexity of the site conditions and detail of information required for this phase of the investigation.

The intrusive ground investigation fieldwork was conducted on 5th May 2009, with groundwater/gas monitoring continuing after this date.

The exploratory hole location plan and exploratory hole logs are presented in Appendix B and Appendix C respectively. Ten trial pits were excavated, to a maximum depth of 4.0m below existing ground level (begl), and three window sample holes were drilled to a maximum depth of 3.0m begl.

4.2 MONITORING INSTALLATIONS

The gas monitoring programme has been designed to broadly comply with the recommendations outlined in CIRIA Report C665 ‘Assessing risks posed by hazardous ground gas to buildings’ (2007).

Three 35mm diameter gas/groundwater monitoring standpipes have been installed across the site in the window sample boreholes (WS1, WS2 and WS3) with response zones targeted at the natural strata.

As the gas hazard is considered low (limited organic clay), the monitoring programme comprised six visits over three months. The results to date are presented in Appendix E.

4.3 PROVEN GROUND

The ground conditions revealed during the investigation are as follows:

- Topsoil
- Glacial Till
- Weathered Millstone Grit Series.

4.3.1 Topsoil

A layer of topsoil was observed across the whole site, to depths of between 0.2m and 0.6m begl, and typically comprised firm brown silty sandy clay with quartzite,

sandstone and brick fragments. It is considered that the rare inclusions of brick are due to ploughing of the site by the current or previous landowners.

4.3.2 Glacial Till

Glacial Till was observed in all the exploratory holes. The strata reported here as Glacial Till were variable, comprising;

- Firm and stiff, orange brown and grey, silty, sandy CLAY with occasional fine to coarse angular to subrounded gravel including sandstone and quartzite.
- Firm to stiff, brown and grey, sandy, silty CLAY. Encountered in the southern field
- Firm, grey and brown, clayey, locally sandy, SILT. Encountered in the northern field.

It is considered likely that at least some occurrences of the latter two soil types above, actually represent the underlying weathered Millstone Grit Series strata (see below).

4.3.3 Weathered Millstone Grit Series.

Strata considered to be weathered Millstone Grit Series mudstones were encountered in exploratory holes TP1, TP2, TP6, TP9, and WS1. These strata were typically:

- Stiff grey silty CLAY.
- Stiff grey silty CLAY with some fine to coarse angular to subrounded gravel of mudstone lithorelicts.

4.4 GROUNDWATER

4.4.1 Groundwater Initial Observations

Groundwater inflows/seepages were not observed in the trial pits, however the soils were found to be damp from surface in all exploratory holes.

4.4.2 Groundwater Monitoring Observations

The results of the groundwater monitoring to date are reported in Appendix H. In summary groundwater has been recorded at depths of between 0.30m begl and 0.90m begl.

4.4.3 Groundwater Regime

The recorded water levels are considered to represent the local groundwater table in the Glacial Till. However, it is considered that the recorded levels are not indicative of the regional groundwater table. Additionally, due to the presence of a significant thickness of predominantly cohesive near surface strata, it is considered that the recorded water is not likely to be in hydraulic continuity with the underlying Minor Aquifer (Millstone Grit Series).

4.5 CONTAMINATION OBSERVATIONS

No visual or olfactory evidence of contamination was observed in the exploratory holes.

4.6 GROUND GAS

4.6.1 Landfill Type Gases and Vapours

The potential sources of ground gas and the rationale for the number of gas standpipes and the length of the monitoring programme is reported in Section 2.2. The gas monitoring results are presented in Appendix H.

In summary:

- Methane was not detected;
- Carbon dioxide concentrations of up to 2.2%v/v were detected;
- Oxygen levels as low as 19.0%v/v were detected;
- No flow was detected during the monitoring.

The results suggest that small amounts of carbon dioxide are being generated by the underlying natural strata. See section 5.2.4 for an analysis of the results.

4.6.2 Radon Gas

The desk study risk assessment determined that no radon protection measures are required.

4.7 SUMMARY OF FIELDWORK OBSERVATIONS

The fieldwork has revealed/confirmed the following potential hazards, receptors and sources that were not identified during the desk study, but which should be included when assessing the site.

Significant Features identified during fieldwork
Locally soft ground – poor trafficability. Variable strata – deepened foundations. Trees in association with shrinkable clay – deepened foundations. High water table – groundwater in excavations. Drain/stream forming western site boundary.

4.8 LABORATORY ANALYSES AND MONITORING RATIONALE

4.8.1 Chemical Laboratory Analysis

Chemical laboratory analyses were selected to provide the parameters necessary to make an initial assessment of potentially contaminated soils and/or waters, for the budgetary design of the development. The choice of contamination testing was based on the contaminants of concern detailed in the desk study and site observations.

It was considered that the topsoil may be suitable for re-use in the proposed development and so six samples of this material have been analysed for a general suite of contaminants (including metals and PAHs) to assess its suitability for this purpose.

As the site has, in the past and present, had an agricultural use, testing for pesticides has been carried out.

pH and water soluble sulphate testing was also conducted to determine how aggressive the ground and/or waters are to buried concrete.

As there is considered not to be a significant risk to controlled waters (due to the lack of clear and consistent pathway), leachate and/or groundwater analysis has not been carried out as part of this investigation.

The chemical analysis results are presented in Appendix I.

4.8.2 Geotechnical Laboratory Testing

Geotechnical soils testing for Atterberg limits (PI) classification was undertaken to provide the parameters necessary for the budgetary design of foundations and infrastructure. The results of this testing are presented in Appendix J.

5 QUANTITATIVE RISK ASSESSMENT – HUMAN HEALTH

5.1 INTRODUCTION

It has been assumed that the Client will redevelop the site with residential housing with associated gardens and infrastructure.

Although various sources of contamination were put forward in the initial conceptual model of the previous Phase I Site Appraisal (Desk Study), observations on site determined that the material on site most likely to be contaminated is the topsoil.

Guidance contained in the Environment Agency's CLEA Report has been used to assess the risks posed to human health. For this assessment the default Tier 1 Assessment Criteria (TAC) for 'residential land with plant uptake' have been used, i.e. a female with a start age class of one and an end age class of six. All pathways have been considered including the consumption of home-grown vegetables. This has been carried out in order to provide a precautionary screening approach to assessing the risks posed to human health.

The TAC used by GRM include Soil Guideline Values (SGV) published by the EA, values calculated by GRM using the CLEA v1.06 risk assessment and values and chemical data developed by LQM/CIEH. The TAC used in the assessment of the site is presented in Appendix K.

Where soil chemical analysis results are found to exceed the TAC, Site-Specific Risk Assessments will be undertaken using the CLEA v1.06 risk assessment software.

To assess the risks posed by ground gases such as radon, carbon dioxide and methane, the relevant current guidance has been used. For radon the site has been assessed following the guidelines in 'Radon: guidance on protective measures for new dwellings (BR211: 2007)'. See Sections 2.12 and 4.6.2 of this report. For methane and carbon dioxide the primary guidance document used to determine if protection measures are required is CIRIA Report C665 'Assessing risks posed by hazardous ground gases to buildings' (2007). This uses Gas Screening Values (GSVs), which are gas concentrations multiplied by borehole flow rate, along with additional limiting factors (such as maximum methane concentrations) to classify the gas regime of a site.

The guidance document includes two methods of characterising a site. The main method 'Situation A' is based on work by Wilson and Card and is used for all types of development except low rise housing that meets the assumptions of 'Situation B'. The 'Situation B' method proposed by Boyle and Witherington for the NHBC assumes all properties have pre-cast suspended floors (beam and block) with ventilated underfloor voids.

For this site, as the method of ground floor construction is not yet known and is likely to include a number of different floor types, the risk from ground gases has been assessed using 'Situation A' and 'Situation B'.