Appendix 3: Site Investigation Report (provided on CD)

coopers

chartered consulting engineers

Our ref: 5883si

Site Investigation Report

for land at the

Trough Laithe Farm,

Barrowford Road, Barrowford

Lancashire

For : Peel Holdings
Peel Dome,
The Trafford Centre,
Manchester
M17 8PL

17 September 2014

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Site Investigation Report for land at Trough Laithe Farm,
Barrowford Road, Barrowford, Lancashire.

Document Verification

Project Title	Trough Laithe Farm, Barrowford Road, Barrowford, Lancashire
Project Number	5883
Document Title	Site Investigation Report for land at the Trough Laithe Farm, Barrowford Road, Barrowford, Lancashire.
Document Number	5883si
This document is not to be used for contractual or engineering purposes unless the document verification sheet is signed where indicated by the approver of the document.	

Prepared by: *N Reynolds* **BSc(Hons), MSc, CGeol, CSci, FGS, MIEnvSc, EurGeol**

Signature

THE GEOLOGICAL SOCIETY
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CHARTERED GEOLOGIST
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Approved by: *P R Sykes* **BSc(Hons), MSc(Eng), CGeol, FGS**

Signature

Document Revision

Report Reference	Date	Description	Prepared	Checked and Approved
5883si	16 September 2014	Site Investigation Report	N Reynolds	P R Sykes

This report has been prepared for and on behalf of our client, in accordance with the terms and conditions of their appointment agreements with Coopers. Other than where specifically allowed for in the said appointment agreements, any other party using this report for any purpose whatsoever does so at their own risk and any duty of care to that party is specifically excluded.

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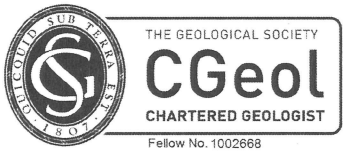

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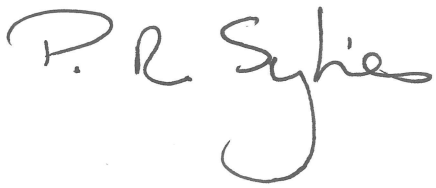

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1.0 Introduction

1.1 This site investigation report is an appraisal of the ground conditions, contamination aspects and anticipated foundation requirements for a proposed residential development on land at Trough Laithe Farm, Barrowford Road, Barrowford, Lancashire. This report was prepared on instructions received from our client, Peel Holding, Peel Dome, The Trafford Centre, Manchester M17 8PL.

1.2 The copyright of this report and the associated plans/documents prepared by Coopers is solely owned by Coopers. Consequently neither this report nor the associated plans/documents may be reproduced, published or adapted without the express written approval of Coopers. Complete copies of this report may, however, be made and distributed by our client as an expedient in dealing with matters directly related to its commission.

1.3 The accuracy of map extracts cannot be guaranteed and it should be recognised that different conditions on/adjacent the site may have existed between and subsequent to the various map surveys. Historical map extracts are produced within the report from maps held in-house. Coopers can reproduce and use these extracts in this report under their Ordnance Survey Licence No. AL100005579.

1.4 Where data supplied by others, including that from previous investigations, has been used it has been assumed that the information is correct. No responsibility can be accepted by Coopers for inaccuracies within the data supplied by others. We would advise that our clients makes their own detailed enquiries to the Local Authorities to determine any additional planning constraints which may be applied to this site and which have not been identified within this report.

1.5 The results of the trial pit and borehole explorations are based upon the facts established from observations and field tests. It should be recognised that strata may vary considerably from point to point and the groundwater regime may be influenced by seasonal or other factors. While every attempt is made to assess the likelihood and extent of such variations, conditions may nevertheless exist which are undisclosed by this investigation.

1.6 This report has been prepared in accordance with the NHBC Standards Chapter 4.1. The scope of this report complies with the criteria for certification under the Initial Assessment including the Desk Study (D1), the Walkover Survey (D2), and the Basic Investigation (D4), and complies with the requirements associated with the planning guidance. This report should address the conditions placed within the planning approval regarding the ground conditions and contamination. This report should be considered as a Phase 2 report in accordance with CLR 11.

1.7 The further actions deemed necessary to be completed prior to development of the proposed site for residential development have been listed in Section 22.0 of this report. The full extent of further actions may not be limited to those issues stated and, during the course of the development, additional further actions may be required.

1.8 **The report should be read in its entirety, including all associated drawings and appendices. Coopers cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.**

1.9 Arboricultural Survey and advice on arboricultural issues are considered to be outside the scope of this report except for their effect on the foundations to the proposed buildings. Where identification of any species is made, especially invasive plants such as Japanese Knotweed, Himalayan Balsam or Giant Hogweed, this should only be considered as a preliminary assessment and subject to confirmation by a professional Arboriculturist. Coopers takes no responsibility for failing to identify, or the incorrect identification, of any tree or plant species on site.

1.10 This report is prepared and written in the context of the purposes stated above and should not be used in a different context. Furthermore, new information, improved practices and legislation may necessitate an alteration to this report in whole or in part after its submission. Therefore with any change in circumstances or after the expiry of one year from the date of this report, the report should be referred to Coopers for re-appraisal.

2.0 Executive Summary

Grid Reference	SD 851 388 (refer to Drawing No. 5883/L1)
Approximate Areas	58.57 acres (23.7 hectares)
Site Investigation Data (Appendices 8 to 11)	69 No. trial pits excavated by Coopers between 28 April and 1 May 2014. 9 No. trial pits (TP1, TP2, TP4, TP11, TP16, TP17, TP19 and TP20) excavated by Capita Symonds on 14 and 18 October 2005. 2 No. cable percussive boreholes (BH1 and BH2) drilled for Capita Symonds during October 2005.
Proposed Development	The site is proposed to be developed for private residential dwellings with limited areas of dedicated public open space.
Site Location, Description and Boundaries (Sections 3.0 and 4.0)	The proposed site is located on the southwestern outskirts of the village of Barrowford, situated approximately 1.1km north west of Nelson Town City. The site predominantly comprised sloping pasture fields. Existing slope at a gradient of 1 in 11.5 (5 degrees). No obvious visible signs of slope instability in evidence from walkover survey.
Site History (Section 6.0)	The site was agricultural on the 1st edition map.
Hazardous Installations and Development Constraints (Section 7.0)	Not affected by hazardous installations. High voltage electricity pylons cross the site.
Landfill Sites & Ground Gases (Section 8.0)	Not affected by former or existing landfill sites. Not affected by Radon gas.
Geology, Hydrology & Hydrogeology (Section 9.0)	Drift – None present in the northwestern corner, Till (boulder clay) of Devensian age over the majority of the site with alluvium in the southern and southeastern area. Bedrock – Pennine Lower Coal Measure Formation of Carboniferous age. Faults – No faults noted on the geological maps. Groundwater – Secondary A aquifer for bedrock and alluvium. Hydrology – Pendle Water (river) situated beyond the southern boundary. With several field ditches running along field boundaries. Groundwater abstraction on site. Site not situated in a drinking water or groundwater safeguarding zones and water protection zones. Flood Risk – Not affected by risk of flooding from rivers, seas or reservoirs. Limited risk of surface water flooding along possible drainage runs. An area of flooding noted associated with a mitigation pond along the southeastern boundary. Several spring points noted in the northern areas of the site. Subsidence Hazards – No hazard to low risk according to Envirocheck.
Animal Burial Sites etc (Section 10.0)	Site unlikely to be affected by animal burial sites or archaeological interest.
Coal Mining and Brine Subsidence (Section 11.0)	Site is not situated in an area of known coal mining or brine abstraction.
Ground Conditions (Section 12.0)	Accessibility – Access was only restricted to two areas of the site due the land being used by the farmer. Buried Structures None encountered to date. Ground Conditions The typical soil profile for the site comprises: **Topsoil** – Typically 0.1 to 0.2m thick. Maximum depth 1.0m. **Natural Strata –** Alluvium along lower slope and flood plain with firm to very stiff clays and very loose to medium dense sands interbedded on higher slope. **Bedrock –** Highly to completely weathered mudstone at shallow depths of less than 1m to greater than 3m. **Groundwater** – Groundwater per se was not encountered during the course of the excavation of the trial pits with the seepages anticipated to comprise non-laterally extensive confined lenses of groundwater or localised perched water.

Contamination (Section 13.0)	**Topsoil –** Uncontaminated. **Madeground** – None encountered. **Drift Strata** – Uncontaminated. **Bedrock** – uncontaminated. **Groundwater** – None encountered. **Validation** – No validation for contamination anticipated. **Waste** – Non hazardous. WAC testing needed to determine if natural strata can be determined as inert. **Potable Water Supply** –PE pipelines considered suitable.
Sub-Soil Classification (Section 14.0)	Concrete Classification (Based on BRE Special Digest 1 (2005) – **DS-1,AC-1/1s, DC-1** Shrinkage Potential - Clay – Medium Frost Susceptibility – Sand Frost susceptible. Infiltration characteristics – Sand – Low, Clay – very low.
Trees (Section 15.0)	The site had a significant coverage of mature trees and hedgerows around the boundary and within the site. In areas underlain by shallow clays heave conditions may affect properties which are constructed in close proximity to trees.
Suitability of site to Residential Development (Section 16.0)	Development of site is recommended to utilise natural ground profiles where possible and minimise the use of cut/fill or retained measures. Maximum gradients of drives or gardens to be limited to 1 in 10. Terraces to gardens to be a maximum of 1.2m high. Split level properties maybe considered and larger retained measures to be limited to 3.m where possible. All cuttings or filled areas and retained measures need to be geotechnically investigated for their impact on the overall stability of the slope.
Ground Floor Slabs (Section 17.0)	Cast in situ for the majority of the site, with pre cast (or cast in situ with void formers) within areas which require heave around the perimeter of the site
Anticipated Foundations (Section 18.0)	General Site underlain by firm to very stiff clay, very loose to medium dense sand and mudstone over majority of the site, with soft alluvium at the base of the slope, along the southern and south eastern boundary. • For those plots underlain by natural clay, unaffected by trees, **traditional strip foundations** • For those plots underlain by natural clay, and affected by existing, **trenchfill foundations with and without heave mitigation**. • For those plots underlain by natural sand strata, nominally reinforced strip foundations or designed reinforced strip foundations or wide reinforced strip foundations. • For those plots situated in the southern and south eastern area of the site, **piled foundations** anticipated. Bearing Strata Bearing strata predominantly comprises firm to very stiff clay with very loose to medium dense sands. Bearing Capacity: Very Loose Sand - 50kN/m^2 Loose Sand - 75kN/m^2 Loose to Medium Dense Sand - 100kN/m^2 Firm Clay - 100kN/m^2 Stiff to Very Stiff Clay - 175kN/m^2 Consolidated Granular Fill (Rafts) - 50kN/m^2
Dewatering and Trench Side Stability (Section 19.0 and 20.0)	Dewatering anticipated due to seepages and overland flow. Site unsuitable for soakaways. Trenchside stability low and requires support if excavations are to remain open for long periods
Road Sub-Grade (Section 21.0)	Road formation anticipated to comprise natural sand or clay. CBR between 3 & 5% anticipated following processing.
Further Actions (Section 22.0)	**Further action which may be required to progress the investigation could include, but not necessarily be limited to: -** • Provide copy of Site Investigation Report to statutory bodies for approval. • Detail design of site levels for scheme layout. • Further ground investigation of specific locations of proposed cuttings or embankments or retained measures with geotechnical analysis of the affects on the overall slope stability of the proposals.

3.0 Site Location

(Refer to the Appendix 15)

3.1 The proposed site is located on the southwestern outskirts of the village of Barrowford, situated approximately 1.1km north west of Nelson town city centre, at National Grid Reference SD 851 388.

3.2 This site comprised an irregular shaped parcel of land, approximately 23.7 hectares (58.57 acres) in area, pasture land with hedgerows, dry stone walls, and several high voltage overhead cables. The site slopes from the northwest to the southeast, with a high voltage above ground cables on pylons crossing the site from northwest to southeast.

3.3 The surrounding area comprised residential housing to the east, the river, Pendle Waters and an industrial estate (offices) beyond the southern boundary, pasture to the west and north.

3.4 The location of the site is shown on Drawing No. 5883/L1.

4.0 Site Description and Boundaries

(Refer to the Appendix 15)

4.1 At the time of the ground investigation, the site comprised 7 No. fields actively grazed by sheep with dry stone walls, hedgerows and ditches forming field boundaries. In the south eastern area of the site, these comprised non grazed areas which comprised unmanaged fields. A timber post and barb wire fence formed the boundary of the grazed and non-grazed areas.

4.2 Within the southern central area of the site was a hollow within the profile of the field slope with several mounds at the base. The soils at the base of the hollow were saturated. To the east of the hollow was an electric pylon. A second pylon was situated in the northern area of the site.

4.3 Along the southern boundary was a road which had been constructed for a proposed industrial estate with offices. Only 5 No. 2 storey office buildings had been constructed on the eastern side of the access road. The access road was situated at a higher level to the ground to the west (within the proposed development site).

4.4 An area was inaccessible at the time of the ground investigation in the northern area of the site adjacent to the cottages on Lower Laithe Drive where an area had been fenced off using barbwire and chicken wire with orchard trees within.

4.5 The eastern area of the site had been designated as a flood area with 2 No. attenuation ponds and was constructed as part of the infrastructure works for the proposed industrial development. The bank of Pendle Waters was eroding with many concrete and brick structures being undercut, with many sheet piles situated within the river course.

4.6 The topographical levels of the site fall from 181m aOD in the northwest to 120.m aOD in the southeast over a distance of approximately 700m. This is an approximate gradient of 1 in 11.5 (5 degrees).

5.0 Proposed Development and Basis of Assessments

5.1 There is no proposed planning layout for this site to date; however we have been informed that the proposed land use will comprise standard 2 to 3 storey residential properties with private front and rear gardens.

5.2 It is also assumed that all materials and workmanship will comply with the Building Regulations and the NHBC Standards, and no significant regrading will be carried out.

5.3 Where private drainage is proposed to be laid between adjacent plots, careful consideration must be given to the relative levels of the foundations of the footings and drainage pipework. This information needs to be reviewed to ensure that no footings are being undermined by drainage pipework levels.

6.0 Site History

(Refer to Appendices 3 and 15)

Enquiries to : GroundSure Historical Maps
Reference : GS-1509640_LS
Dated : 18 June 2014

6.1 According to the historical maps obtained from Groundsure, the site has been agricultural land since the 1st edition historical maps. The site is extensive and many field boundaries are present within the site boundary several of which were noted as being watercourses with a direction of flow which follows the general topography of the site (flowing southeast). Few field boundaries had changed over the series of map editions.

6.2 A public footpath was noted to cross the site from the northern boundary which enters the site at the head of Mosman Place and exits immediately south of the property name Laund beyond the western boundary, and then extends further beyond the western boundary. The footpath which exits the site at Mosman Place also extent along the north eastern boundary to land between 65 and 67 Wheatley Lane Road. A public footpath was also noted along the western bank of the river Pendle Water, with a small extension of the footpath cutting through the eastern extent of the site.

6.3 A pond was noted along the south eastern boundary between 2 No. entrances pre-constructed along the access road.

6.4 The only variations have been field boundaries which are anticipated to comprise hedgerows, ditchlines and dry stone walls, as well as the construction of 2 No. pylons which carry high voltage electric cables over the site between 1938 and 1950.

6.5 Several wells and spring points were noted within the north western area of the site.

6.6 Relevant former features indicated on these maps have been reproduced on the Site Plan, Drawing No. 5883/01, in Appendix 15, with the historical maps included as Appendix 3.

7.0 Hazardous Installations and Development Constraints

(Refer to Appendices 2 and 15)

Enquiries to : GroundSure EnviroInsight
Reference : GS-1509617
Dated : 17 June 2014

7.1 Findings

7.1.1 The site is not affected by any potentially hazardous installation according to the GroundSure data base. 1 No. record of COMAH and NIHHS National Incidents Recording System List 2 had been made 36m southeast of the site boundary, however was noted as category 4 – no impact. There were 5 No. entries within the same list for oils and fuels (4 No.), inert materials and waste (1 No.) situated between 140m and 174m. 3 No. entries were noted to be category 3 (minor) for water, with other impacts noted to be category 4 (no impact). All entries were dated 2001 or 2002. We do not consider that the site is impacted by these entries.

7.1.2 There were 6 No. discharge consents within 250m of the site boundary. 2 No. consents were granted 8m southwest of the site boundary for sewage discharges which comprise final/treated effluent, for Laund Farm STW (sewerage treatment works) , Wheatley Lane. The effective dates for these discharges were 1991 and 1995. 2 No. consents had been granted for Barrowford CSO (Combined Sewer Outfall) for sewage discharge for sewer storm overflow dated 1996 (revoked) and 1997, with Pendle Water receiving the discharge. Both the consents situated 42m (Barrowford CSO) and 49m (Gisburn Rd/Lee Street CSO) beyond the south eastern boundary both comprised sewage discharges for storm overflow into Pendle Water. The Gisburn Rd consent started in 1995 (revoked 1997) and the Barrowford CSO commenced in 1997.

7.1.3 There were no groundwater abstraction licenses within 500m of the proposed site boundary.

7.2 Conclusions

7.2.1 The site is not considered to be impacted by hazardous installations.

8.0 Landfill Sites and Ground Gases

(Refer to Appendices 2 to 5, 7 to 9 and 15)

Enquiries to : GroundSure EnviroInsight
Reference : GS-1509617
Dated : 17 June 2014

And

Enquiries to : British Geological Survey - GeoReport
Reference : GR_208979/1
Dated : 17 June 2014

8.1 **General**

8.1.1 Coopers have appraised the potential ground gases to provide an initial conceptual model in terms of source-pathway-receptor in accordance with CIRIA C665: '*Assessing risks posed by hazardous ground gases to buildings.*', NHBC Report No. 10627-R01 (04) "*Guidance On Evaluation Of Development Proposals On Sites Where Methane And Carbon Dioxide Are Present,*" British Standards BS8485:2007: *'Code of Practice for the Characterization and Remediation from Ground Gas in Affected Developments,'* BS8576:2013 *'Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)'* and CL:AIRE Research Bulletin, RB17 (2012) *'A Pragmatic Approach to Ground Gas Risk Assessment*.'

8.1.2 All information and advice regarding requirements for gas precaution measures are considered to be provisional until approval from statutory bodies has been granted.

8.1.3 Coopers have provided a conceptual model for the site regarding the potential sources of ground gas which may impact uses both on and off the site for the proposed residential development, as well as the mechanisms (pathways) for the sources to impact receptors.

8.2 **Potential Sources**

8.2.1 ***General***

8.2.1.1 An appraisal of potential common sources of ground gas which may impact future receptors within the site are detailed below. It should be noted that Pendle Borough Council may not have shared their database of landfill sites with data providers such as GroundSure, and hence additional landfill sites may be recorded

8.2.2 ***Landfills (on site)***: -

8.2.2.1 None recorded.

8.2.3 ***Landfills (off site)***

8.2.3.1 None recorded within 250m of the site boundary.

8.2.4 ***Ponds (on and off site)***

8.2.4.1 The only pond situated on site was created as part of SuDS provision and will be part of the proposed development. This will not pose a potential ground gas risk.

8.2.5 ***Deep Madeground (excluding landfills)***

8.2.5.1 There is no madeground known on or near this site.

8.2.6 ***Organic Rich Strata and Peat***

8.2.6.1 Peat and organic silt was recorded along the southern area of the site along the former flood plain within the alluvial sediments. This form of organic material has the potential to generate and retain low concentrations of both carbon dioxide and methane, however the rate of generation is typically low. Should these strata be exposed through excavations/boreholes or piling, ground gas may be generated due to this material being oxidised, however the period of oxidation will be limited.

8.2.7 ***Coal and Mining Activity: -***

8.2.7.1 The site is not situated within an area which has been exploited for coal exploration.

8.2.8 ***Radon***

8.2.8.1 According to the BGS Radon Report, the site is not impacted by radon and no mitigation is required.

8.2.9 ***Petroleum Hydrocarbon or Volatile Products***

8.2.9.1 None encountered on site.

8.3 **Receptors**

8.3.1 Hazardous ground gases can provide a risk to human health when exposed within a confined space. The primary gases that provide risks are carbon dioxide through displacement of oxygen causing asphyxiation, methane via explosion, and vapours as carcinogens via inhalation. Radon is not considered a primary gas of concern for this site.

8.3.2 ***Future Occupants****:* The primary receptors are anticipated to be the future occupants of the residential properties via the build up and ingress of hazardous gases or vapours through the ground floor slabs of the properties.

8.3.3 ***Adjacent residents and workers****:* These receptors may be exposed to hazardous gas if sources are generated on site and migrate beyond the site boundary (such as the migration of fuel spillages which may release volatile compounds) or preferential pathways exist for the horizontal migration of gases beyond the site boundary from on site generated ground gas. We currently do not consider that adjacent residents or workers will be impacted by ground gases generated on site.

8.3.4 ***Construction/Maintenance Workers***: Other receptors include construction workers, primarily through work within trenches or excavations where preferential pathways for the migration and collection of gases could occur. HSE guidance on safe work in confined space details potential dangers from gases within trenches, assessments required and precautions to take prior to entering a confined space. The appointment of a supervisor to ensure the necessary procedures and precautions are in place where construction workers intend to enter a confined space is advisable in accordance with HSE guidance.

8.4 **Conceptual Model Summary.**

8.4.1 There were no significant sources of off site ground gas which may impact this site.

8.4.2 No significant depths of madeground were noted across the site, hence this is not anticipated to be a risk for ground gas. Alluvium may be a potential source of ground gas and was located in the southern and south eastern areas of the site. These typically may generate carbon dioxide and methane with very low generation rates (considered low risk). We would recommend limited ground gas monitoring within those areas where alluvium was encountered. We would recommend that 6 No. visits over a period of 3 months will be considered sufficient to assess the potential risk of ground gas within these areas,

8.5 **Ground Gas Risk Assessment**

8.5.1 No ground gas risk assessment is required for the majority of this site as no significant sources of ground gas are present. The only potential source of ground gas comprises alluvium within the southern and south eastern areas of the site. It would be recommended that nominal ground gas monitoring is undertaken within these areas to determine whether mitigation will be required. The risk associated with alluvium is considered low due to the limited generation rates and the low permeability of the alluvial (low diffusion rates), hence reducing the potential for oxidation of degraded organic matter within the generally cohesive strata, and the ability for fluctuations in ground which may release trapped gas within pockets. According to BRE RB17 (A pragmatic approach to ground gas risk assessment), assuming a robust risk assessment is provided, it may be assumed that in lieu of monitoring, the adoption of Characteristic Situation 2 mitigation measures may be adopted for properties overlying the alluvial stratum (refer to Figure 2 (p4) in RB17). An assessment on organic content will be required. Where buried peat is present, passive venting may be required as part of the mitigation.

9.0 Geology, Hydrology & Hydrogeology

(Refer to Appendices 2 and 15)

1:10,560 scale Geological Sheet – SD 83NE
British Geological Survey Geology of Britain Viewer.

Enquiries to : GroundSure GeoInsight
Reference : GS-1509618
Dated : 17 June 2014

9.1 Drift

9.1.1 The 1:10,560 geological map shows that the site is underlain by boulder clay over the majority of the site, with drift absent from the north western corner of the site. Alluvium was recorded in the southern and south eastern areas of the site at the base of the slope of the site.

9.2 Bedrock

9.2.1 The site was underlain by the Pennine Lower Coal Formation, of Carboniferous age. Coal seams were not shown to be present on site, however were indicated to be present 396m beyond the northern boundary (Noggarth Seam).

9.3 Geological Faults

9.3.1 According to the 1:10,560 scale geological map, there are no significant faults within the near vicinity of the site boundary. The closest fault according to the GeoInsight report was 160m beyond the north western site boundary.

9.4 Hydrology & Hydrogeology

9.4.1 The superficial deposits along the southern and south eastern areas of the site were noted to comprise alluvium consisting of silts and soft clay. The majority of the stratum encountered on the remainder of the site comprised sand, with belts of firm to stiff clay along the northern and central areas of the site. Within the streams, ribbons of silt were recorded underlying the sand stratum.

9.4.2 Surface water overland flow is anticipated to predominately govern the hydrology of the site with water channelled along incised with limited infiltration into surface topsoil and more granular stratum is anticipated under its current situation. The receiving water course is Pendle Water (river) located adjacent to the eastern boundary.

9.4.3 We anticipate that the permeability characteristics will be low for the alluvium and the boulder clay, however the sand stratum may have a low to moderate permeability, depending upon the silt content.

9.4.4 Permeability of mudstone was considered to be negligible/low with permeability through secondary permeability and within confined sandstone lenses which had relatively low permeability.

9.5 Flood Risk

9.5.1 According to the GroundSure EnviroInsight report, the site is not impacted by flooding from rivers, sea or reservoir. The Environment Agency have recently added surface water flooding to their online GIS databases but this has not been included within the GroundSure report. The mapping indicates that the site will be affected along the existing drainage channels and areas of former ponds by surface water flooding (refer to Figure 1 below).

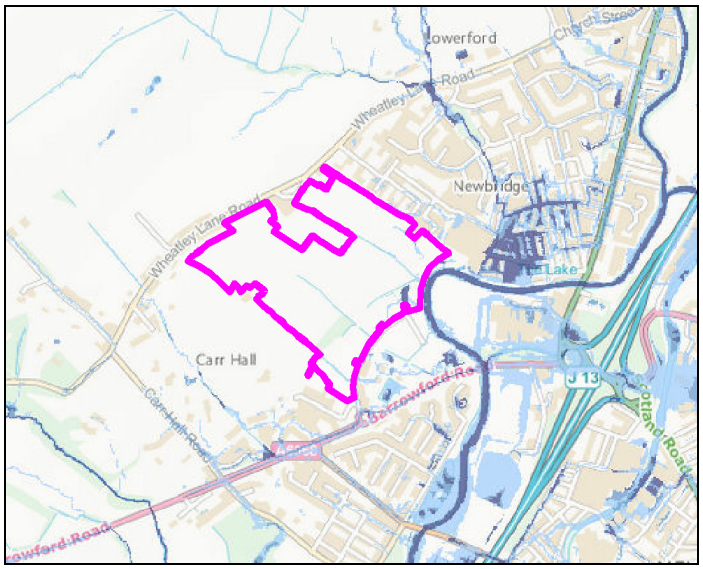

Figure 1: Surface water map of the area surrounding the proposed development site.

10.0 Animal Burial Sites and other Environmental, Archaeological, Ecological and Conservation Issues

(Refer to Appendices 2, 3 and 6)

Enquiries to : GroundSure Historical maps
Reference : GS-1509640_LS
Dated : 18 June 2014

And

Enquiries to : TEP
Report Reference : 2307.001
Dated : February 2010

10.1 Findings

10.1.1 Based on a review of the historical Ordnance Survey maps, we consider it unlikely that the site will be affected by animal burial sites.

10.1.2 The site is not situated within, or within 500m of a designated environmentally sensitive site.

10.1.3 To our knowledge the site is not a significant archaeological site, however this will require clarification from the appointed archaeological consultant for the Council. We do not anticipate that any of the existing structure on site will be considered of importance.

10.1.4 According to the Ecological Report completed by TEP in 2010 for the southern area of the site, there was no evidence for badgers and water voles. Bats may potentially utilise mature and semi-mature trees for roosting. The pond created in 2007/8 as part of the SuDs provision and replacement habitat for an infilled pond for the Riverside Business Park in the south eastern area of the site has been designed to have a suitable habitat for great crested newts, however there are no significant populations known in this area. Birds may potentially be nesting within trees and hedgerows on site. A shallow area of ponded water was noted south of the hollow situated adjacent to the southern electric pylon and was assessed as a potential habitat for great crested newts. No indication of a population was encountered.

10.1.5 The ecological report recommends that where possible, mature trees should be retained on site. Tree protection is required for all trees and hedgerows to be retained.

10.1.6 No Japanese knotweed had been noted within the ecological survey.

10.1.7 Coopers are not aware of whether the site is of archaeological importance. Consultation will be required with the County Archaeologist.

10.2 Conclusion

10.2.1 Although this site does have the potential for roosting sites for bats and nesting birds, the site is not significantly impacted by ecological constraints. The ecological report recommends that mature trees are retained where possible.

10.2.2 The site is not considered to be impacted by animal burial sites.

10.2.3 We do not anticipate that this site will be of archaeological importance; however this requires confirmation from the County Archaeologist.

11.0 Coal Mining and Brine Extraction

(Refer to Appendix 4)

The Law Society's Guidance Notes and Directory for Coal Mining Searches
DOE/ARUP Map of Mining Instability in the Northwest

Enquiries to: The Coal Authority
Reference: 51000556532001
Dated: 17 June 2014

11.1 Coal Mining

11.1.1 Based upon the Coal Mining Report, the site is not affected by coal mining.

11.2 Brine Abstraction, Mining and Natural Dissolution

11.2.1 The site is not within a brine compensation area or an area and no special precautions are likely to be required.

12.0 Ground Conditions

(Refer to Appendices 7 to 9 and 15)

12.1 General

12.1.1 Coopers have undertaken one phase of trial pitting (69 No. trial pits) across the site to determine the superficial and madeground content of the site, as well as the presence of bedrock between the 28 April and 1 May 2014. Capita Symonds drilled 3 No. cable percussive boreholes (BH1 to BH3) and excavated 10 No. trial pits (TP1, TP2, TP4, TP11 and TP15 to TP20). The investigation completed by Capita Symonds was undertaken over a larger area comprising the proposed business park beyond the south eastern.

12.1.2 There were 2 No. areas of the site which were inaccessible at the time of the Coopers ground investigation and comprised the central northern field which contained an electric pylon and the eastern most parcel of the site which had previously been investigated by Capita Symonds. The northern central area of the site was in use by the farmer who was residing at Trough Laithe Farm silage and hence works within this area was not possible. During the course of the investigation, the superficial geology and the depth to bedrock were noted to be similar on both sides of this inaccessible area, hence we consider that the geology is present as identified within the area currently inaccessible. This requires further investigation to confirm our assumptions.

12.1.3 Trial pit logs are contained in Appendices 7 and 8, with cable percussive borehole logs contained in Appendix 9. The positions of the exploratory holes are indicated on the Site Plan contained in Appendix 15.

12.2 **Hardstanding, Foundations and Services**

12.2.1 No hardstanding or foundations were encountered on site. High voltage overhead cables were present crossing the site on pylons, with an overhead BT cable also noted. A full service appraisal of the site must be undertaken by the developer.

12.3 **Topsoil**

12.3.1 Topsoil had been encountered in all trial pits varying in depth between 0.1m (TP101, TP122, TP126, TP127) and 1.0m, with the majority of trial pits encountering 0.2m of topsoil. Topsoil had been encountered to exceed 0.4m in 3 No. trial pits (TP106 - 1.0m, TP107 - 0.8m and TP108 - 0.6m). Peat was encountered at surface in trial pit TP153 to a depth of 0.5m.

12.4 **Madeground**

12.4.1 None encountered during the course of the investigation by either Coopers or Capita Symonds.

12.5 **Natural Stratum and Bedrock**

12.5.1 *Alluvium*

12.5.1.1 Alluvium was encountered within trial pits at the south eastern area of the site, at the foot of the slope within Coopers trial pits TP101 to TP107, TP120, TP127, TP130, TP153, TP154 and TP168, as well as Capita Symonds trial pits TP01, TP02, TP04, TP11, TP15, TP17, TP18 and TP20. This stratum was noted to comprise soft, dark grey/blue clayey silt and was often overlain by a firm clay or sand. The depth to the silt encountered varied between 0.9m (TP154) and 2.8m (TP103). No trial pit encountered the base of this stratum.

12.5.1.2 Borehole BH1 drilled by HB Boring & Company Ltd encountered firm to stiff clay in the southern corner of the site at a depth of 5.0m with no bedrock encountered at a depth of 10m when the borehole was terminated. Borehole BH2 situated midway along the south eastern boundary encountered firm clay at a depth of 4.7m, with bedrock encountered at a depth of 6.5m. Borehole BH3 was drilled in the eastern corner of the site and encountered medium dense mudstone gravel at 4.9m (possibly highly weathered bedrock), with bedrock encountered at a depth of 7.0m.

12.5.2 *Drift Stratum*

12.5.2.1 The drift strata was encountered as a mosaic across the site, with areas of sand, clay, clay overlying sand, and sand overlying clay.

12.5.2.2 Firm to stiff, to stiff clay had been encountered generally along the northern boundary on both sides of the site (extending approximately 40m to 125m into the site), whereupon a significant belt of very loose to medium dense sand had been recorded which extended between 90m to 240m into the central area of the site. Predominantly firm to stiff and stiff clay had also been encountered within the eastern and central south western boundary. Within the north eastern sand area and between the southern extent of the sand and the southern clay unit were interbedded sand and clay units. The majority of the interbedding related to sand overlying clay. The mosaic of strata has been illustrated in the 'Drift Strata Plan', Drawing No. 5883/DSP included within Appendix 15.

12.5.2.3 Bedrock had been encountered as either a highly to completely mudstone (predominantly recovered as a clay bound gravel), or a very weak, brown orange, thinly laminated, highly fractured mudstone.

12.6 **Groundwater**

12.6.1 Groundwater was recorded within the following trial pits:

Slight seepages - TP101(b), TP102(b), TP110 (b), TP117 (1.5 within sand), TP123(b), TP126(b), TP127(b), TP128(b), TP130 (1.5 in silt), TP135(b), TP139(b), TP143(b), TP150(b), TP151(b), TP154(b), TP163 (1.2m in completely weathered mudstone)

(b) denotes base of trial pit.

Standing water - TP153 (1.8) and TP166 (2.0m)

12.6.2 Groundwater per se was not encountered during the course of the excavation of the trial pits with the seepages anticipated to comprise non-laterally extensive confined lenses of groundwater or localised perched water.

13.0 Contamination

(Refer to Appendices 2 to 9, 11, 12 and 15)
Chemical Analysis: DETS (For Coopers)
Chemical Test Certificate Reference: 14-05756
Dated: 19 May 2014
Chemical Analysis: Casella (For Capita Symonds)
Chemical Test Certificate Reference: 05/5460/SO
Dated: 15 November 2005

13.1 General and Works Undertaken by others

13.1.1 This is a basic appraisal of the issues identified to date regarding contamination with respect to residents occupying the site, groundwork's contractors working on site, the surrounding residents, as well as the groundwater and the surrounding ecosystems.

13.1.2 The site will be developed for the purpose of residential dwellings with limited areas of public open space.

13.1.3 Coopers submitted the following samples for analysis to DETS for standard chemical analysis following the initial phase of ground investigation using trial pits

- Topsoil – 8 No. samples
- Natural Silt – 2 No. samples
- Natural Sand – 5 No. samples
- Natural Clay – 2 No. samples
- Mudstone – 2 No. samples.
- Peat – 1 No. sample.

13.1.4 Capita Symonds submitted 17 No. samples of soil, and 3 No. samples of groundwater from the proposed industrial estate which partially includes the area within the southern boundary. The samples within the proposed development area comprise:

- Topsoil – 4 No. samples
- Natural Clay – 4 No. samples
- Natural Silt – 2 No. samples
- Groundwater – 2 No. samples

13.1.5 The standard suite of analysis undertaken by DETS comprised the standard CLR metals, cyanide, phenols, sulphate/sulphide and speciated US EPA 16 suite of PAH compound concentration. A reduced analysis suite was undertaken by Capita Symonds, excluding PAH compounds.

13.1.6 There was no indication of hydrocarbon contamination on site; hence there was no requirement for temperature controlled sampling.

13.2 Ground Investigation Methodology

13.2.1 The majority of the site was accessible for investigation using trial pits with only limited areas which were inaccessible due to a request from the farmer not to enter certain areas, or areas having no access.

13.2.2 These inaccessible areas were pasture grazing areas with other former use. One area which was inaccessible to Coopers (eastern most field) had previously been investigated by Capita Symonds,

13.3 Conceptual Model

13.3.1 In accordance with the plethora of CLR publications, produced by the Environment Agency, this risk assessment has been assessed in the form of sources of contamination and the pathways with which they may affect potential targets/receptors. The targets/receptors have been assessed to determine how they are likely to use the land and hence consider what actual risk is likely to be present associated with identified contamination on site. Remedial measures have been assessed in light of the land use and the form of contamination encountered.

13.3.2 General Strata

13.3.2.1 No madeground was encountered on site, with silt and clay encountered at the base of the slope in the southern and south eastern area of the site, with clay and sand overlying mudstone (shallow in the northern area of the site). Topsoil was encountered within all exploratory holes.

13.3.3 Groundwater

13.3.3.1 Groundwater was not encountered during the course of the Coopers investigation, however samples from the base of the slope were analysed by Capita Symonds from borehole wells.

13.3.3.2 The bedrock was classified by the Environment Agency as a Secondary A Aquifer.

13.4 Justification for Risk Assessment

13.4.1 As of 12 August 2008, the Environment Agency withdraw all CLEA documents associated with the CLEA 2002 and CLEA UK risk assessment packages, and replaced them with the following guidance documents:-

SC050021/Technical Report 1	–	A review of body weight and height data used within the (2009)Contaminated Land Exposure Assessment model (CLEA).
SC050021/SR2 (2009)	–	Human health toxicological assessment of contaminants in soil.
SC050021/SR3 (2009)	–	Updated technical background to the CLEA model.
SC050021/SR4 (2009)	–	CLEA Software (Version 1.05) Handbook.
SC050021/SR7 (2008)	–	Compilation of data for priority organic pollutants for derivation of soil guideline values

13.4.2 At the time of this report being compiled, the CLEA software had been advanced to version 1.06 due to changes with methodology of risk assessment, additional preloaded data and compromise to the security of the software. The technical guidance documents noted above have also been updated. Significant advances regarding the datasets required to populate the risk assessment model have also been made by Land Quality Management (LQM) in conjunction with the Chartered Institute for Environmental Health (CIEH) (commercial publication 2nd Edition) and the recently issued document from CL:aire in association with the Environmental Industries Commission (EIC) and the Association of Geotechnical and Geoenvironmental Specialists (AGS) (free publication). All human health risk assessment have been completed utilising this form of modelling. The modelling undertaken by LQM and CIEH utilised CLEA version 1.04, with the CL:aire modelling using CLEA version 1.06.

13.4.3 The difference between CLEA version 1.04 and version 1.05 was the addition of preloaded data, modifications of the soil organic matter concentration (standard changed from 1% to 6%). CLEA version 1.05 was updated to version 1.06 as a consultant published the password for the security settings of the workbook on a contaminated land forum. Minor amendments were made to the model, however these were not sufficient to require the GAC thresholds to be amended from either publication.

13.4.4 Although the Environment Agency have stated that a typical soil has a soil organic matter concentration of 6%, we have adopted 1% soil organic matter for the purpose of determining Tier 1 Generic Assessment Criteria (GAC). This is the most conservative value for organic compounds which are susceptible to this parameter. Should the concentration of the samples exceed the GAC threshold, the soil organic matter will be assessed, depending upon the magnitude of the exceedance. The 1% soil organic matter GAC has been published for all elements and compounds analysed to date (for human health risk assessment) within the publications noted, however we have also included the Tier 1 threshold values relevant for this report within Appendix 12.

13.4.5 LQM and CIEH GAC threshold values have been calculated for copper and zinc using CLEA 1.04 software. The threshold values for copper and zinc were 2330mg/kg (524mg/kg for allotments) and 3,750mg/kg (618mg/kg for allotments) respectfully.

13.4.6 According to BS3882:2007, "Specification for topsoil and requirement for use", the phytotoxic assessment for copper and zinc has been revised and has thresholds based upon a pH basis as illustrated below:

Table 1: Phytotoxic threshold values.

Elements/Soil pH Range	***<6.0***	***6.0-7.0***	***>7.0***
Zinc	*<200mg/kg*	*<200mg/kg*	*<300mg/kg*
Copper	*<100mg/kg*	*<135mg/kg*	*<200mg/kg*
Nickel	*<60mg/kg*	*<75mg/kg*	*<110mg/kg*

13.4.7 As copper and zinc phytotoxic threshold values according to BS3882 are significantly less than human health thresholds, these will be adopted for topsoil strata as well as near surface fill (within landscaped areas). Although the human health risk assessment thresholds are significantly higher than the phytotoxic thresholds, there may be the potential for statutory nuisance claims to be made should plants and trees not thrive within the garden areas for properties.

13.4.8 Bioavailability analysis may be undertaken on samples where elevated copper and zinc have been encountered to determine whether the form of these elements are likely to pose a risk to proposed planting, and again should be considered as supplementary analysis during further risk assessment.

13.4.9 Additional bioaccessibility risk assessments may be made regarding arsenic and lead which aim to determine the potential risk associated with the arsenic form and content within the sample analysed. This is a costly form of analysis and should be undertaken as part of the specific risk assessment of the site by the developer who purchases this site.

13.4.10 DEFRA recently published Category 4 Screening Levels (C4SLs) in accordance with the revised Statutory Guidance on the contaminated land regime under Part 2A of the Environmental Protection Act 1990, for arsenic, cadmium, chromium (VI), lead, benzene and benzo(a)pyrene.

13.4.11 The National Planning policy Framework states that as a minimum land should not be in such a state as to be determined as contaminated land under the contaminated land regime. It should be noted that these levels have only been published based on 6% soil organic matter. To be consistent Coopers have derived a C4SL for benzo(a)pyrene in soil with 1%, while the remaining C4SLs would not be affected by the change in soil organic matter. The use of these threshold values are principally for use for Part IIa assessment ensuring that sites are not considered to be to have the significant potential of significant harm for chemicals of concern. Coopers have utilised CLEA GAC and SGV as Tier 1 threshold values.

13.5 **Potential Point Sources of Contamination**

13.5.1 The source types listed below detail the potential on site contamination that could affect the receptors. A brief description of the potential pathways and receptors is included (where applicable) with each source type as these are intrinsically linked within the conceptual model. A more detailed assessment of the method of pathway migration and receptors is listed in Section 13.6 and 13.7 respectively.

13.5.2 *Former Site Use*

13.5.2.1 There are no potential sources of contamination on this site other than the application of a fertiliser to improve the grass stock for grazing.

13.5.5 *Natural Strata*

13.5.5.1 There was no indication of natural contamination in the natural strata.

13.5.6 *Groundwater*

13.5.6.1 There was no groundwater per se encountered on site. There was a significant amount of refuse in the course of Pendle Water, and generally comprised shopping trolleys and old relic scour defence and drainage headwalls.

13.5.7 *Proposed Temporary Above Ground Fuel Storage Tank*

13.5.7.1 During the construction phases of the development of this site, an above ground fuel storage tank will be present on site to fuel plant. Mitigation measures should be detailed within a risk assessment by the approved contractor to ensure fuel spillages do not occur and confirmatory investigation and analysis should be undertaken on the site of the tank. The tank location should be recorded and forwarded to the Council for their information. Validation should always be undertaken following the decommissioning or moving of the above ground fuel tank.

13.5.7.2 Plant should be checked and maintained regularly to ensure fuel/oil leakages do not occur. All staff on the development site must be warned of the potential consequences that a fuel spillage will have for both the development and the surrounding environment.

13.5.8 *Adjacent landuse*

13.5.8.1 The site was bounded to the west and north by pasture land which is situated at a lower level to the proposed development site, and hence is not considered to pose a risk to the proposed development. Beyond the eastern and southern boundary was residential housing, the course of Pendle Water and the recently constructed industrial estate, none of which are considered to pose a risk to the proposed development site regarding contamination.

13.5.9 *Imported fill/topsoil's*

13.5.9.1 Imported fill/topsoil requires validating to ensure that contaminated soils are not brought onto site. Refer to section 13.8.5 and 13.8.6 for further information regarding imported soils.

13.6 **Pathways**

13.6.1 Below is a specific list of pathway migrations for contaminants. The potential pathways for source types (where appropriate), have been described within Section 13.5 above.

13.6.2 *General Madeground*

13.6.2.1 The granular madeground predominantly allows infiltrated water to flow with least resistance with little potential for perching, however areas of hardstanding may retain groundwater. Mobile contamination is likely to be flushed relatively easily through this stratum, however a limited degree of sorbsion is anticipated within siltier zones.

13.6.3 *Natural Strata*

13.6.3.1 The natural stratum comprises sand and clay stratum overlying mudstone over the majority of the site, with the southern area of the site underlain by alluvium. Groundwater (infiltrated through flow) will be prevalent within the sand stratum, however may be retarded by the silt content. Water will perch over the clay and mudstone stratum.

13.6.4 *Drains*

13.6.4.1 These provide pathways for leachable elements and compounds to flow, if breakages of the pipeline occur this may cause a secondary point source for contamination.

13.6.5 *Dusts*

13.6.5.1 If the turf/hardstanding is removed from the site, the soiled surface may dry sufficiently to be blown in the prevailing wind during dry days and during reprofiling. We advise during dry periods that any exposed madeground be damped down. During occupation, open ground will be covered by turf or topsoil (within border areas), however near surface soil may be carried into the house by normal gardening works, by sitting on exposed ground and having soil adhering to clothing as well as soil adhered to the sole of shoes brought into the house. These soils dry, desiccate, flake and form dust within the property. It should be noted that open ground is normally only present within areas of bedding (with the remaining area covered by lawn), however soils from turf may be brought into the property on the soles of shoes.

13.6.6 *Sewer/Service Excavations*

13.6.6.1 Pathway for leachable elements and compounds within groundwater to migrate from contaminated to uncontaminated areas. Coopers are aware that many live drains are present across the site, however the contents of the drains have not been assessed. This pathway may be important if a contamination event occurs on site (i.e. leakage of fuel).

13.6.6.2 All existing services/drains require surveying and purging prior to decommissioning to ensure that no contaminants are present.

13.6.7 *Direct contact with soils*

13.6.7.1 Hand to mouth contact, or direct ingestion from soil or soil adhered to home grown vegetation/objects with soil adhered (i.e. toys).

13.7 **Targets/Receptors**

13.7.1 The proposed planning layout will comprise the standard landuse for residential developments as discussed within the CLEA documents. According to the CLEA classification for land use, front gardens (where vegetables are not traditionally grown) may be considered suitable for classification as residential without plant uptake, depending on the size and nature of the soft landscaping within this area (i.e. landscaped borders). The rear gardens are considered to be classified as residential with (vegetable) plant uptake. It is assumed that all asbestos has been removed prior to site works commencing.

13.7.2 *Future Residents* (Domestic dwelling with plant uptake)

13.7.2.1 It has to be considered that the use of the garden area has to be reasonable. It is not feasible to carry out risk assessments regarding extreme land use; therefore it has been assumed that the majority of domestic gardening occurs within the upper 0.6m of soil. The predominant depth of regular excavation will be up to 0.2m due to the planting of annual and biannual bedding plants with shallow weeding. It is anticipated that the deeper planting will be associated with the planting of deep potted shrubs, and is generally restricted to few occasions over several years.

13.7.2.2 It is anticipated that the majority of the gardens will comprise lawn and ornamental bedding. Residents may utilise their rear garden as allotments and grow vegetables. It is anticipated that the deepest cropping vegetable will be the potato and generally crops to depths of up to 0.5m (it should be noted that potatoes are generally over dug where by during the growth of the crop soil is piled onto the plant). It is therefore considered that the initial 0.6m depth of garden will be the threshold zone for risk to the resident for non-mobile contaminants. This assessment concurs with the findings of BRE Report 465, Cover Systems for Land Regeneration. It is highly unlikely that the resident will excavate to depths in excess of 0.6m. If this does occur, it will be on the basis of once or possibly twice a year for a very small period of time. We generally consider 2 No. paving slabs will be required adjacent to the rear of the property for maintenance requirements and will not require remediation as this will be considered hardstanding. The requirement for 2 No. paving slabs allows ladder access to the first storey and roof. Refer to Figure 2 below for a typical cross section for inert cover should this be required following the contamination appraisal.

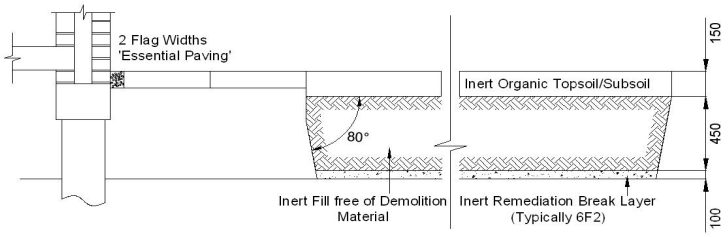

Figure 2: Inert cover requirement for rear garden.

13.7.2.3 It is highly unlikely that the residents will be planting vegetables for consumption within the front gardens of the houses. It should be noted that it is unlikely that clauses will be present within the deeds to restrict this practice; however we have to assume reasonable practices within these areas of the site. It is traditional to plant lawn and bedding plants, or pave the entire area of the front garden depending upon resident's proficiency regarding gardening. It is generally assumed that the aesthetic value of having a vegetable patch in the front garden is significantly low, and produce may be lost by theft from passers-by. The potential for human health risk regarding the consumption of vegetables grown in these areas is hence negligible and should not be considered.

13.7.2.4 The transporting of soils into the property also poses a risk to the residents. The soils caked on shoes and adhered to clothing due to contact with soils will dry, desiccate and form dust in the houses.

13.7.2.5 Any excavations associated with the constructing of extensions to the property should only be completed after consulting the Planning Department of Pendle Borough Council.

13.7.2.6 Children may come into contact with soils during unsupervised playtime through direct ingestion and during supervised playtime through inadvertent consumption of soils from toys which have come into contact with soils. When very young children excavate in soils, it is anticipated the maximum depth will be in the order of 0.2m to 0.3m. It is anticipated that parents will not leave young children unsupervised in garden areas for any significant period of time.

13.7.3 *Groundwork's contractor*

13.7.3.1 Affected by near surface fill. During construction works, groundwork's contractors will come into contact with site soils prior to, during and after re-profiling. Soils adhered to boots and clothing may be taken off site and be taken into the groundwork's contractor's house. Groundwork's contractors should wear a minimum degree of personal protective equipment on a working building site, comprising hard hat, steel toe capped boots and high visibility vest. Vapours or hazardous gases may affect groundwork's contractors within confined spaces. Any works identified to be within a confined space (including excavations) should be completed in accordance with HSE guidance. Further information on the potential hazard from gases or vapours will be detailed following a full period of in situ monitoring and subsequent reporting.

13.7.3.2 During the site induction process, the Site Manager must state that no food or drink is to be consumed on site, and smoking is prohibited. Hand washing facilities must be provided at all stages of the development with running warm water and dispensed soap. The Site Manager during the site induction, must state that groundwork's contractors must wash their hands before eating and drinking within designated areas on the site. This is not enforceable, however if the facilities are provided by the developer, any breach of this requirement will be undertaken at the risk of the groundwork's contractor.

13.7.3.3 Responsibility for using the on site facilities must be explained during the induction. Gloves may be worn to reduce the risk of soil adhering to hands during works within soils, however it is recognised that many trades cannot wear gloves as this would impede their service. Therefore, gloves are considered to be a recommendation rather than a requirement. The groundwork's contractor employed on this site will require setting the level of personal protective equipment for their employees in consideration of the contents of this report.

13.7.3.4 No site burning may be permitted and must be strictly enforced on this site.

13.7.3.5 If suspected asbestos is encountered (excluding that previously noted) during the course of the groundwork's contract, the Site Manager must immediately inform the Engineers Office for the developer and a specialist contractor will be required to remove and validate the remediation of these areas in accordance with statutory guidance.

13.7.4 *Groundwater*

13.7.4.1 The site is not currently considered to be a potential risk to controlled watercourses. Site practices must be such that contaminants (including silt) do not impact this water feature.

13.7.4.2 The bedrock is noted to be a Secondary A Aquifer and is not considered a significant source for groundwater abstraction, however through flow is likely to contribute to the base load of Pendle Water located adjacent to the eastern boundary. Contamination of this aquifer has already occurred due to historical practices associated with the storage of timber preservation products. This will require remediation and will be discussed below in Section 13.8.5. The approach for mitigation is not anticipated to comprise fully removing the impacted sandstone, rather removal of a sufficient volume of grossly impacted material, treatment of bedrock below that which is economical to remove and treat, with the philosophy of source removal and betterment.

13.7.4.3 The security of fuel during the course of development will be imperative to prevent any further damage to the aquifer.

13.7.5 *Adjacent Landowners*

13.7.5.1 The agricultural land may be impacted by run off of surface water from the site. This will require mitigation.

13.7.5.2 During dry periods on site when soils are exposed, contaminated dusts (including asbestos, where present) may be created by the development and be carried with the prevailing wind. We would advise that during dry periods, the site is damped down/misted to suppress the dust.

13.8 Contamination Results and Remediation Strategy

13.8.1 The extent of contamination within the samples analysed from the Coopers trial pits and boreholes have been discussed below.

13.8.2 Topsoil, Natural Sand, Clay and Silt and Bedrock (Mudstone)

13.8.2.1 All samples were uncontaminated. No remediation will be required for this site.

13.8.2.2 Should during the course of the development, suspected contamination be encountered, the developer/groundwork's contractor must contact the developers consultant to investigate the area of concern.

13.8.3 Groundwater

13.8.3.1 The groundwater samples analysed by Capita Symonds were uncontaminated in accordance with UK Drinking Water Standards.

13.8.4 Remediation Strategy

13.8.4.1 None required for either ground gas or soil contamination.

13.8.5 *Imported Topsoil*

13.8.5.1 We anticipate do not anticipate that imported topsoil will be required for this site and that the topsoil will be retained for reuse as topsoil in garden areas

13.8.5.2 It is recommended that prior to accepting imported sources of topsoil, samples should be analysed by the material provider, proving the topsoil inert, preferable with provenance to aid the certification of the site. Topsoil must not be accepted from areas where Japanese Knotweed or other invasive or injurious plants, as specified by the Environment Agency, are suspected to have been growing. We would advise that the suitable imported material should be sampled by an independent, suitably qualified Environmental Geologist, to confirm the initial assessment that the material is inert.

13.8.5.3 Currently, the NHBC are requesting certification from developers that all imported topsoil to sites is suitable for use. Clause 9.2 M3 (g) states "Topsoil quality should be such that it will not present a hazard to users of the garden areas." BS3882 (2007) and the Contaminated Land Exposure Assessment (CLEA) guidelines provide advice on determining the "suitability of topsoil". Clause 3.2 S6 also states "Garden areas should be provided with topsoil to a minimum thickness of not less than 0.1m. The topsoil should not contain contaminants which are likely to present a hazard to users of the garden area". The Tier 1 parameters to be adopted by hauliers of inert topsoil are included in Appendix 12.

13.8.5.4 Pendle Borough Council may have guidelines on the certification of imported topsoil which will need to be agreed prior to placement. The developer should maintain the integrity and quality of any topsoil brought onto site, ensuring that it does not become cross contaminated through poor site practice.

13.8.6 *Imported Fill*

13.8.6.1 All imported inert fill required for backfilling or regrading should comprise a good quality fill, free of demolition detritus (such as bricks, brick ties, etc) as well as deleterious materials (such as timber, glass and asbestos). These should have provenance and chemical analysis to prove the strata to be imported as inert prior to acceptance on site. The analysis from the provider of the inert fill must be current and relevant for the material being imported. Additional independent analysis should be completed to confirm the source documents. The Tier 1 parameters to be adopted for all imported material to this site are included in Appendix 12.

13.9 Disposal and Control of Excavated Materials

13.9.1 Waste Management Plans require the identification of the classification of materials intended for disposal offsite (inert, non-hazardous, stable non-reactive, or hazardous) and volume targets for disposal of each type. Currently no approved planning layout or proposed finished levels have been provided for this site; hence calculating the volumes of materials intended for disposal is not possible.

13.9.2 Environment Agency Technical Guidance WM2 - Hazardous Waste, details the requirements for classifications of materials as hazardous waste. The soils will typically be classified as:

17 05 03 soil (including excavated soil from contaminated sites), stones and dredging spoil [soil and stones containing dangerous substances], (WAC analysis required for disposal) or

17 05 04 soil and stones other than mentioned in 17 05 03 – not containing dangerous substances. (WAC analysis not required).

13.9.3 The hazard rating 'H' classifications for compounds and elements have been obtained in accordance with Appendix C (of WM2), from Occupational Health Safety datasheets and Table 3.1 within Annex VI to Directive 67/548/EEC (the EU classification and labelling system prior the implementation of GHS). Based upon the chemical analysis of the samples taken to date, **Coopers have assessed the waste characteristics of the natural strata analysed from the site and anticipate that this strata will be non-hazardous and potentially inert (however WAC analysis would be required to confirm this).**

13.9.4 Where materials are excavated for construction purposes these should be retained on site for engineering purposes where considered suitable for use. There are 2 No. paths for developers to pursue regarding the control of materials on site. The initial pathway which is currently being phased out is by utilising Waste Management Exemptions from the Environment Agency with the second path being the CL:aire Code of Practice.

13.9.5 The developer is therefore advised to complete all works under the CL:aire Development Industry Code of Practice for the Definition of Waste, Version 2 (or superseding versions if relevant). This guidance expects a Remediation Strategy to be produced for the site (assuming it to be potentially contaminated) to determine which strata or areas of the site are considered to be contaminated with regard to the proposed land use (Route A). A Design Statement maybe utilised for those sites which have no contamination (Route B). As no contamination has been encountered on this site to date, we anticipate that a design statement will be required (Route B). This strategy has been included above, however is likely to be revised following further investigation following clearance of the remaining building.

13.9.6 When applying for approval of the Code of Practice for this site, all engineering works on site have to be known. As part of the requirements, a full material management plan will be required. This will designate what material (including volumes) will be excavated, the likely positioning of stockpiles on site, as well as the fate of the soils. All aspects associated with site management and excavation works should be completed by the groundwork's contractor, or an engineer supervising the groundwork's contractor.

13.9.7 Tracking systems of materials, stockpiles and remediation processes will be required to be robust within the site management systems. Should the process of material tracking be considered non-robust, this may fail the test whether excavated materials may be considered non-waste. It should be noted that it must be proved the volume of soils to be transferred will be utilised on the receiving site, otherwise this material may be considered waste.

13.9.8 Direct transfer of naturally occurring soils may be undertaken, however a robust assessment of the materials have to be undertaken to confirm this material is suitable for use and uncontaminated. It should be noted that all materials on this site encountered to date may be subject to direct transfer.

13.9.9 The Code of Practice requires 4 No. factors to be addressed within the Material Management Plan:

(1) Protection of human health and protection of the environment

(2) Suitability of use, without further treatment

(3) Certainty of use

(4) Quantity of material

13.9.10 With regard to Box A within the Code of Practice (c.3.7, p.13), the material types encountered have been classified to determine the 'Categorisation of materials within the ground'. Should areas and volumes of strata be noted below, these are approximate values and require assessment by a qualified quantity surveyor. These volumes do not represent the volumes of soils likely to be excavated through any part of the demolition/construction phase of the site redevelopment, rather the anticipated total volume of that stratum. Additional investigation may be required to obtain more accurate detailed quantities:

Table 2: Categorisation of materials within the ground in accordance with CL:aire Code of Practice.

(1)	Material that is capable of being used in another place on the same site without treatment*;
(2)	Material that is capable of being used in another place on the same site following ex-situ treatment on site*;
(3)	Material that is capable of being used in another development site without treatment (Direct Transfer);
(4)	Material that is capable of being used in another development site following ex-situ treatment on another site e.g. Hub site*;
(5)	Material that is not capable of being used on the site or elsewhere and requires recovery or disposal off site as waste; or
(6)	Material that will be surplus to requirements and requires recovery or disposal off site as waste.
*	Having regard to the conceptual model (receptors and pathways) and appropriate risk assessment of the location where materials are to be used. We do not consider damping down to be treatment.

13.9.10.1 Topsoil and Natural Strata

13.9.10.1.1 All topsoil and natural strata (sand, clay, peat, silt and mudstone) were suitable for use on site due to chemical analysis. It should be noted that geotechnically, silt, soft to firm clay and peat are not suitable bearing strata and may require improvement depending upon the areas of excavation and the method of founding properties. (1) (2 – for strata with poor geotechnical characteristics), (3) (6).

13.10 Risks to Groundwork's Contractors

13.10.1 We do not anticipate that groundwork's contractors will be detrimentally affected by the materials present on site assuming basic site hygiene is followed; comprising wearing gloves, overalls, steel toe capped boots and hard hat on site, warm/hot water is available for washing hands and eating and smoking is prohibited on site.

13.11 Water Supply Pipes (Preliminary Risk Assessment)

13.11.1 Coopers have undertaken United Utilities risk assessment forms for this site and determined that the site will not require specialist pipelines (based on information to date), and standard PE pipeline should be sufficient.

13.11.2 Refer to Appendix 13 for the United Utilities risk assessment document.

13.11.3 There were no requirements for the analysis of ethers, nitrobenzene, ketones, aldehydes, or amines due to the former landuse.

13.11.4 Should any suspicious material be encountered after site clearance or during the course of construction, samples should be tested. These tests should determine the materials true chemical characteristics and classification for possible disposal.

13.12 Conclusion

13.12.1 This site is to be developed in a sustainable manner for residential development with as little volume of material disposed to landfill as possible.

13.12.2 No contamination was encountered on site, hence no remediation/mitigation will be required.

13.12.3 Radon mitigation will not be required within all of the ground floor slab design.

13.12.4 Potable water supply pipelines are anticipated to comprise standard PE pipeline across the site.

13.12.5 This assessment will require approval by Pendle Borough Council prior to commencing with site works.

14.0 Geotechnical Data and Sub Soil Classification

(Refer to Appendices 10 and 11)

14.1 General

14.1.1 Samples of the natural strata from the trial pits excavated by Coopers were submitted to DETS for chemical laboratory analysis, which included sulphate concentrations and acidity levels.

14.1.2 Atterberg Limits, particle size distribution and dry density/moisture content relationship analysis using a 4.5kg rammer had been undertaken by Murray Rix and the laboratory test reports are contained in Appendix 11. Analysis by DETS is included in Appendix 10.

Table 3: Summary of Chemical Analysis for Concrete Assessment

	No. Samples	pH	SO_4 (2:1) g/l (water soluble)	SO_4 % (acid soluble)	PI (%)	Mobile/ Static
Sand	6	5.6 to 6.9	<0.01 to 0.02	<0.01 to 0.17	-	Mobile
Silt	3	6.9 to 8.2	0.01 to 0.08	0.02 to 0.06	-	Static
Clay	6	6.0 & 6.9	<0.01 & 0.04	<0.01	14 - 32	Static
Mudstone	1	5.9	0.02	0.04	-	Static

14.2 Interpretation

14.2.1 Shrinkage Potential : **Medium**

14.2.2 Frost Susceptibility : **Sand** – Frost Susceptible

14.2.3 Soil Classification : Based upon BRE Special Digest 1 (2005), the Design Sulphate (DS) class, Aggressive Chemical Environment for Concrete (AC) class, and Design Concrete (DC) class for each of the strata types is given below: -

Sand – **DS-1, AC-1, DC-1**

Silt – **DS-1, AC-1, DC-1s**

Clay – **DS-1, AC-1, DC-1s**

Mudstone – **DS-1, AC-1, DC-1s**

Site Wide Concrete Classification **DS-1, AC-1, DC-1**

14.2.4 Topsoil is not typically in contact with subsurface concrete and mortar for this site.

14.2.5 The permeability (k) which has been included within Table 4 has been assessed using the Kozeny Carman equation based on percentage of material passing the 10% and 60% sieves during a particle size distribution assessment. As the 10% passing point was within the area which requires sedimentation as the particle sizes were less than 0.06mm, an extrapolation of the data was undertaken. Using the extrapolation, the 10% was noted to be consistently within the 0.015mm grading. Using this information, the results of the assessment resulted in permeability rates (k) ranging between 2.3×10^{-12} and 8.6×10^{-12}. The sand stratum was generally noted to be silty and occasionally clayey, hence the permeability characteristics are anticipated to be poor.

14.2.6 To improve permeability, the sand may be washed sand, however we anticipate that this would be prohibitively expensive. If this stratum is to be used as a permeable material, we would recommend that sedimentation is undertaken to determine the D10 amount of sediment passing. Additionally, stockpiled granular strata may be analysed specifically to determine permeability. We do not anticipate that soakaway tests will be viable on the site to determine the potential for infiltration.

Table 4: Geotechnical Properties of strata

	Moisture content (%)	% passing 63µm sieve	Bulk density (Mg/m^3)	Max. Dry Density	Optimum MC (%)	K_v m/s	Max. Dry Density	Cohesion (kPa)
Sand	20 to 23	22 – 39		1.73-1.75	13 & 14	$2.3x10^{-12}$	1.73-1.75	
Silt	21 to 36	-	1.43 & 1.8	-	-	-	-	32
Clay	16 to 33	-	1.87 & 2.06	1.79-1.8	16	-	1.79-1.8	43 & 60
Mudstone	-	-	-	-	-	-	-	-

14.2.7 Coopers submitted 5 No. samples of sand and 2 No. samples of clay for compaction analysis. Due to the significant volumes of samples required for this form of assessment, both the sand and clay samples were composite. The composite samples were taken from specific areas of the site, and samples were not combined site wide. It was noted that the sand appeared consistent within the analysis with an optimum moisture content of 13% to 14%, with the maximum dry density varying between $1.73Mg/m^3$ and $1.75Mg/m^3$. The clay analysis was completed on combined samples from trial pits TP130 to TP139, and trial pit TP106 and TP107. The optimum moisture content was 16%, with a maximum dry density of $1.79Mg/m^3$ and $1.8mg/m^3$. The moisture content required to achieve 95% of the maximum dry density will range between 13.3% and 16.5% for clay, 13.1% and 14.5% for silt and 12.5% and 13.7% for sand.

14.2.8 The natural moisture content measured by both PSL and Murray Rix was significantly greater than the optimum/95% moisture content and will require drying out/dewatering to achieve a material which may achieve adequate engineering compaction. To achieve this, the materials may be naturally dried in stockpile, or by chemical methods such as the application of lime to stabilise the stratum. The lime stabilisation has a longer term affect of increasing the strength of the material. Should the stratum be unsuitable for either natural drying or stabilisation (due to material characteristics or cost), these may be utilised as general non-engineered bulk fill, and assuming those stratum with significant organic content are removed.

14.2.9 The assessment of the plasticity of the clay strata reported within the Atterburg Limit analysis, indicated plasticity index values ranging from 15% to 32% and were relatively consistent for both the analysis undertaken by Coopers and Capita Symonds. All samples were considered plastic, with no failures recorded due to low clay content. In accordance with the Casagrande Classification for plasticity, the majority of the clay was considered as intermediate plasticity (CI), with shallow clay (overlying silt) within trial pits TP02 and TP03 by Capita Symonds considered as high (CH). The plasticity classification in accordance with the NHBC Table 1 Volume change potential for clay will assume the majority of the clay strata encountered on site to be medium (20% to less than 40%). The majority of the samples were noted to have in excess of 95% of the samples passing a 63µm sieve, hence there will be negligible change to that recorded for the modified indices.

14.2.10 The analysis undertaken by Capita Symonds was principally completed on the alluvial strata situated along the southern area of the site, as well as the glacial strata underlying.

14.2.11 Particle size distribution had been completed on 3 No. samples of sand/sandy clay/organic sand. The percentage of sample passing through a 63µm sieve ranged between 27% and 35%. This corresponded with the analysis undertaken by Coopers for the remainder of the site.

14.2.12 Undrained shear strength analysis in triaxial compression had been completed on 5 No. samples from the boreholes drilled by Capita Symonds of which 3 No. were within the proposed development area. Borehole BH1 tested a sample of firm to stiff clay (situated beneath silt), recorded cohesion on 60kPa, with a moisture content of 25%. Borehole BH2 analysed a sample of soft/soft to firm clay/silt, and recorded cohesion of 49kPa, with a moisture content of 29%. Borehole BH4 did not encounter any discernable silt content and recorded cohesion of 43kPa with a moisture content of 16%.

14.2.13 Shear box analysis had been completed on a sample of gravel from TP14 (1.5m), of silt from TP15 (2.0m) and firm clay from TP17 (0.5m). TP14 and TP15 were situated within close proximity to the river course on the alluvial plain, with TP17 being situated mid slope within the eastern area of the site. The angle of shearing resistance was 36, 36 and 35.5 degrees respectively.

14.3 Settlement

14.3.1 3 No. samples of firm to stiff clay from boreholes BH1 (8.0m), BH4 (4.0m) and BH5 (1.2m) were analysed by PSL for one dimension consolidation (oedometer). The shallow clay was loaded to 200kPa for the clay sample obtained at 1.2m with the deeper clay (4.0m and 8.0m) loaded to 400kPa; then both were returned to 50kPa. This assessment considers the potential settlement associated with 10 times overburden for BH4 and BH5, however is considered approximately 2.5 times for BH1. 1 No. sample of clay/silt had been analysed from BH2 at a depth of 2m. Mv and Cv values have been obtained for these strata and may be utilised in the assessment of settlement on this site, however the assessment of the degree of settlement will be dependant on the types of foundations and structures proposed on the site.

14.3.2 We would recommend more targeted analysis of strata within the alluvial plain depending upon the proposed structures, assuming it is not considered more economical to pile these structures, thereby bypassing the requirement for an assessment on settlement.

14.4 Concrete Specification

14.4.1 Any fill material to be imported onto the site should be tested and should not exceed the classifications given above.

Table 5: Sub-structure ready mix concrete designations by end use over the entire site

Use as substructure and ground floors		Ready-mixed concrete (designated mix)
General Use:		
• Rough blinding (non-structural)	-	GEN1
• Infill	-	GEN1
• Unreinforced oversite concrete below timber floors	-	GEN1
• Structural blinding and overbreak	-	GEN1
• In situ external concrete for drives and paths	-	PAV1
• In situ external concrete foundations for precast concrete paving slabs	-	GEN1
• Fill to wall cavity	-	GEN1
• Solid filling under steps	-	GEN1
Floor Slabs:		
• House or garage with reinforced concrete floor slab, either suspended or precast.	-	RC35
• House with non-reinforced slab (ground bearing) with either:		
a) Permanent finish to be added, e.g. screed or floating floor.	-	GEN1
b) No permanent finish to be added, e.g. carpet.	-	GEN2
• Garage with non-reinforced slab (ground bearing)	-	GEN3
Foundations:		
• Strip foundations	-	GEN1
• Trench fill	-	GEN1
• Other mass concrete foundations	-	GEN1
• Reinforced concrete footing	-	RC35

Notes:
1) Worst case sulphate conditions over the entire site are ACEC Class AC-1/AC-1s, and Design Chemical Class DC-1.
2) Classification and designation in accordance with NHBC guidance, Section 2.1 – Table 1, and BS8500-1, 2006.
3) The above conditions represent the worst case conditions identified within the testing of soils on the site.
4) Any fill material to be imported onto the site should be tested and should not exceed the classifications given above.

15.0 Trees

(Refer to Appendix 1, 14 and Site Plan in Appendix 15)

Tree Solutions
Report Title: Arboricultural Impact Assessment
Report Reference: 13/AIA1CHE(w)/118 (Rev C)
Dated: 29 January 2014

15.1 The site had a significant coverage of mature trees and hedgerows around the boundary and within the site. As the site was underlain by shallow sand and mudstone bedrock, the only impact to proposed development will comprise the removal of stump and rootballs from the footprint of plots. It should also be noted that although tree roots are likely to have followed the surface of the bedrock, however roots may also have opened up lines of weakness within the bedrock. We anticipate that significant reprofiling will be required on this site and a significant volume of clay will require removal and stockpiling.

15.2 Any proposed felling or removal of trees or hedgerows should be agreed with the Local Authority as part of the pre-planning discussions for development.

15.3 Care must be taken to ensure that any existing trees scheduled for retention beyond the site boundary are not adversely affected by construction operations. Further guidance on this aspect of site works is given in the British Standards "Guidance for Trees in Relation to Constructions", BS5837.

16.0 Suitability of Site for Proposed Residential Development

16.1 The topographical survey of the site indicates that the existing slope has naturally formed at a gradient of 1 in 11.5 or approximately 5 degrees. The walkover survey of the slope has not indicated any obvious landforms which are indicative of any ongoing slope failures. There is no obvious evidence of mass solifluction failure on the slope. The limited laboratory testing of the natural strata would indicate that a conjectured value for the residual angle of shearing for the glacial clays could conservatively be assumed to be 18 degrees (based upon a peak value of 36 degrees) and in the case of the glacial sands 21 degrees. Therefore the slope in its present condition is preliminary assessed from a visual inspection to be stable. Some minor instability of the ground conditions maybe in evidence in the two small gully features which are present on the site but these are not extensive or considered detrimental to the overall site.

16.2 The implication of this assessment is that there is no obvious impediment to the future development of this site for residential housing provided that certain precautions that would recommend are taken during the formulation of the scheme design. The basic precautions we would recommend are outlined below.

16.3 Where possible regrading of the slope should not exceed a gradient of 1 in 3 (18 degrees) for all natural drift strata and not exceed 1.2m in overall height without a detail slope stability assessment being undertaken. Above a height of 1.2m retaining measures should be designed but limited to less than 3m retained height and their affect on local and overall slope stability assessed in each and every case. Driveways and gardens should be limited to a maximum gradient of 1 in 10 and terraces limited to 1.2m in height.

16.4 It is likely that each housing developer potentially tendering would have their own ideas for the most suitable planning layout and scheme for the site which may or may not adhere to the above recommendations. It will be the responsibility of the successful developer to design their scheme safely with due consideration for the long term overall stability of the slope to the satisfaction of the regulatory authorities.

17.0 Ground Floor Slabs

(Refer to Appendix 15)

17.1 Cast in situ concrete suspended ground floor slabs are anticipated for the majority of plots proposed for this site as it is the preferred construction method for most housing developers. Cast in situ ground bearing concrete floor slabs could be considered as an alternative provided the depth to natural strata is less than 600mm from the underside of the floor slab.

17.2 For those parts of the site that are underlain by cohesive strata at shallow depths and affected by existing trees likely to be subject to heave, precast concrete suspended ground floor slabs with a 250mm void must be adopted. Alternatively it may be possible to adopt a cast in situ concrete floor slab with a void forming material placed beneath which will compress during heave conditions.

18.0 Foundations

(Refer to Appendices 7 to 9, 14 and 15)

18.1 General

18.1.1 The locations of the exploratory holes are shown on the Site Plan, Drawing No. 5883/01 in Appendix 15. Copies of the trial pit and borehole logs excavated/drilled by/for Coopers are contained in Appendices 7 and 8.

18.1.2 It is assumed that all materials and workmanship will comply with the Building Regulations and the NHBC Standards, and no significant regrading will be carried out.

18.2 Bearing Strata

18.2.1 Based upon the findings of the trial pit and borehole investigation, we would anticipate that the glacial clays and sands would be suitable to form the predominant bearing stratum for the proposed buildings. Soft alluvial deposits are considered unsuitable as bearing strata for two storey dwellings.

18.3 Anticipated Bearing Capacities

Very loose Sand	-	50kN/m^2
Loose Sand	-	75kN/m^2
Loose to medium dense Sand	-	100kN/m^2
Firm Clay	-	100kN/m^2
Firm to stiff Clay	-	125kN/m^2
Stiff Clay	-	150kN/m^2
Very stiff Clay	-	150kN/m^2
Mudstone Bedrock	-	150kN/m^2

18.4 Minimum Depth (relative to proposed ground level)

Clay Strata	-	0.9m
Sand Strata	-	0.6m
Mudstone Bedrock	-	0.45m

18.5 Foundation Recommendations

18.5.1 All foundations and floor slabs for the plots should be specifically designed by a Structural Engineer once the planning layout and slab level requirements have been finalised. The foundation options presented below have been assessed by interpolation between trial pits and boreholes without any consideration of external changes in ground level. It should be noted that the anticipated regrading operation may have a significant impact on the depth to bearing strata across the site and influence the proportion of foundation types described below.

18.5.2 For properties in the northern and mid western part of the slope, which are anticipated to be founded in firm, and firm to stiff to very stiff clay, and not affected by existing trees or hedgerows, where the depth to the bearing strata from finished ground level is less than 1.25m we would recommend the adoption of the following:-

Traditional Strip Foundations

Maximum safe bearing pressure limited to 100kN/m^2 in firm clay up to 150kN/m^2 in very stiff clay.

Minimum foundation depth of 0.9m below finished ground level.

The strength of the clay sub-grade is critically dependant on its moisture content, and is likely to deteriorate and soften quickly if allowed to become wet, with a resultant reduction in shear strength and safe bearing pressure.

For further details refer to Drawing No. 5883/Ts/01 in Appendix 15.

For those properties in this zone which are **affected by trees and hedgerows and require heave precautions,** where the depth to a moisture stable bearing strata from finished ground level is in excess of 1.25m we would recommend the adoption of the following:-

Trenchfill Foundations with Heave Precautions

For further details refer to Drawing No. 5883/TfH/01 in Appendix 15.

Or,

Semi-Stiff Raft Foundations on a Consolidated Stone Blanket

Bearing capacity limited to 50kN/m^2 on consolidated stone blanket. The thickness of the stone blanket should be calculated in accordance with NHBC guidance, Chapter 4.2. The assumed average thickness of stone blanket is 1.0m.

For further details refer to Drawing No. 5883/RfH/01 in Appendix 15.

18.5.3 For those properties in the central northern third of the slope which are anticipated to be **founded on very loose to medium dense sand,** where the depth to the bearing strata from finished ground level is less than 1.25m, we would recommend the adoption of the following:

Nominally Reinforced Strip Foundation

Maximum safe bearing pressure limited to 100kN/m^2 in loose to medium dense sand.

For further details refer to Drawing No. 5883/Rn/01 in Appendix 15.

Or

Designed Reinforced Strip Foundation

Maximum safe bearing pressure limited to 75kN/m^2 in loose sand.

For further details refer to Drawing No. 5883/Rs/01 in Appendix 15.

Or

Wide Reinforced Strip Foundation

Maximum safe bearing pressure limited to 50kN/m^2 in very loose sand.

For further details refer to Drawing No. 5883/WRs/01 in Appendix 15.

18.5.4 For those properties on the southern third of the slope which are anticipated to be underlain by weak bearing strata (alluvium) where the depth to a founding level from finished ground levels is anticipated to be greater than 2.5m to 3.0m, we would recommend adopting the following:

Piled Foundations with associated ground beams

Driven concrete piles with loads in the range 100kN to 500kN. Pile lengths subject to specialist contractor design but anticipated to be in the order of 8-10m long.

19.0 Trench Side Stability

(Refer to Appendices 7 and 8)

19.1 Generally good stability of side walls had been noted during excavation of trial pits on site within the natural strata. It is anticipated that the sides of all excavations will require to be fully supported or be battered to the angle of repose of the soil, especially for deep excavations for service and sewerage trenches.

19.2 Battering of excavations should be avoided in the proximity of existing trees and boundary structures without assessment from experienced engineering personnel.

19.3 Excavations through the natural superficial strata should be within the capacity of conventional hydraulic plant. It should be noted that the mechanical excavator had only moderate difficulty excavating through the very weak mudstone bedrock and hence it is recommended that any potential developer should assess the rippability of this strata using larger plant.

19.4 It should be noted that seasonal groundwater variations, construction activity or other factors may further affect the stability of the trench sides.

19.5 Trench excavations for foundations/services must be adequately supported at all times and should be in accordance with the recommendations of CIRIA Report 97: Trenching Practice.

19.6 Further guidance on this aspect of site works is given in the British Standards for "Workmanship on Building Sites", BS 8000, Parts 1 and 14, and in the Construction Industry Training Board's Site Safety Note 10.

20.0 Dewatering

(Refer to Appendices 7 and 8)

Foundation excavations and service/drainage trenches are likely to require dewatering due to seepages and overland flow during periods of inclement weather.

20.2 As silt and suspended solids are considered to be contaminants within controlled water bodies, all potential surface water runoff will require either bunding and diverting or filtering to prevent this material from leaving the site.

20.3 Where former/existing drainage runs are encountered during the excavation of either foundations or service/drainage trenches these will need to be immediately diverted around the excavation and building footprint, and the excavations are likely to require localised dewatering where breached.

20.4 It is anticipated that surface runoff from the site itself may accumulate in open excavations and trenches, and may require dewatering. Standing water should not be allowed to develop within the base of excavations as this will be detrimental to the stability of the excavation.

20.5 Groundwater should not be discharged into the existing river or land drainage system without prior agreement from the Environment Agency and Local Authority and hence may need to be tankered off site for disposal.

20.6 It should be noted that seasonal factors may affect changes in groundwater levels at the site. Consequently, dewatering may even be necessary in the winter or at times of prolonged rainfall for shallow foundations or drainage trenches.

20.7 We consider it unlikely that the surface water drainage design can utilise soakaways on this site as part of SUDS due to the prevalence of low permeability cohesive strata and the lack of large expanses of deep, clean granular strata. The granular stratum contains high proportions of silt which result in a low conjectured permeability of 10^{-12} m/s, as outlined in Section 14.2.5.

20.8 Further guidance can be obtained from the CIRIA Report 113 entitled "Control of Groundwater for Temporary Works".

21.0 Road Sub-Grade

(Refer to Appendices 7 and 8)

21.1 We anticipate that the likely sub grade materials for the site will predominantly comprise a mosaic across the site, with areas of sand, clay, clay overlying sand, and sand overlying clay over the higher two thirds of the slope and alluvium over the bottom third of the slope.

21.2 Estimating California Bearing Ratio (CBR) values for in situ natural strata is dependent upon the relative density of the granular material and the consistency of the cohesive material. In accordance with Volume 7, Section 2 of the Department of Transport, Departmental Standard Interim Advice Note 73/06 Revision 1 – Design Manual for Roads and Bridges, and Plasticity Index values of clay on this site. The clay subgrade is estimated to have a CBR of between 2.5% to 5% or greater after proof rolling and soft spot removal. However, we would anticipate that an improvement in the in situ CBR value of the granular strata may be obtained if proof rolling of the formation level was undertaken. In this instance we would anticipate a minimum CBR value of 5% for design could be achieved for existing granular strata subject to in situ testing. It should be noted that the maximum depth of capping will be required with a CBR value of 5% in strict accordance with guidelines, however the requirement for capping may be modified depending upon individual standard practices of Council Highway Departments.

21.3 Due to the high fines content of the granular strata and the low permeability of the cohesive strata, the site infiltration characteristics are likely to be slow. After prolonged periods of rainfall, ponding of surface water is likely to occur if adequate crossfalls are not maintained to suitable surface water outlets. Under these conditions construction traffic is likely to rapidly deteriorate road sub-grade and site formation layers. It is also assumed that any natural granular subgrades are frost susceptible. It is recommended that if initial roads and sewer construction is proposed to commence during the winter months then a longer period should be allowed for construction due to the potential for weather disruptions to the site.

21.4 Proposals are subject to the review of Pendle Borough Council – Highways Department. However, we would recommend that all sub-grade materials are in situ CBR tested at proposed road formation level prior to final pavement design.

22.0 Further Actions

Further action which may be required to progress the contract could include, but not necessarily be limited to: -

22.1 Provide copy of Site Investigation Report to statutory bodies for approval.

22.2 Detail design of site levels for scheme layout.

22.3 Further ground investigation of specific locations of proposed cuttings or embankments or retained measures with geotechnical analysis of the affects on the overall slope stability of the proposals.

22.0 References

- A study of the published geological maps, and enquiries to the British Geological Survey website.
- A review of data held in the Coopers archives.
- A review of data provided by Peel Holdings.
- A review of desk study data obtained from internet sources.
- The Law Society's Guidance Notes and Directory for Coal Mining Searches.
- DOE/ARUP Map of Mining Instability in the Northwest.
- Enquiries to The Coal Authority regarding coal mining and brine subsidence.
- Enquiries to the British Geological Survey regarding radon levels underlying the site.
- A review of borehole records held by the British Geological Survey.
- Enquiries to the Environment Agency and Environment Agency website
- The findings of a trial pit investigation carried out by Coopers between April and May 2014.
- The results of contamination testing carried out by DETS.
- The results of geotechnical testing carried out by Murray Rix.
- BS 5930 - Code of Practice for Site Investigations.
- BS 8000 - Code of Practice for Workmanship on Building Sites.
- BS 8004 - Code of Practice for Foundations.
- BS 8485 - Code of Practice for the Characterisation and Remediation from Ground Gas in affected Developments
- BS8576 - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)
- C.I.T.B. Site Safety Note No 10.
- NHBC Standards.
- BRE Special Publication 1 (2005) – Concrete in Aggressive Ground.
- TRRL Laboratory Report 1132 - The Structural Design of Bituminous Roads.
- CIRIA Report 97 – Trenching Practice.
- CIRIA Report 113 - Control of Groundwater for Temporary Works.
- CL:aire Definition of Waste: Code of Practice Version 2, 2011.
- BRE Report 211 (2007) Radon: Guidance on Protective Measures for New Dwellings.
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Site Investigation for land at
Trough Laithe Farm, Barrowford Road, Lancashire

Appendix 1

Site Description

Coopers

Dated: 28 April 2014

Site Description

Project:	Trough Laithe, Barrowford	Project No: 5883
Prepared by:	M Ollier	Date: 28 April 2014
Weather:	Hot, Sunny	Time on site: 08:00
Engineer:	M Ollier	Time off site: 09:00

Site Description

During the walkover survey, the site comprised of six fields separated by post and wire fences and dry sandstone walls, several of which had barbed wire along them, with sections being lined with mature trees. Photograph 1 shows the steel gate that secures the southern access road from the recently constructed business park beyond the south western corner of the site. There were several stubs of access road to link into a proposed development as shown in Photograph 2. .

Photograph 1: *Site Entrance from business park*

Photograph 2: *Access road to site*

The southern area of the site comprised a parcel of land with a shallow slope from north to south with small hummocks and hollows with the surface comprising poor quality reed and marshy grassland (refer to Photographs 3, 4 & 17). Several copses of trees and bushes/shrubs were noted along field boundaries and occasionally within the parcels. Several deep ditchlines crossed this area of the site running from north to south, and northwest to southeast, both of which were noted to contain flowing water (refer to Photograph 5).

Photograph 3: *View of site from near secondary access point*

Photograph 4: *View of overhead cables running up site.*

There was a small circular cylindrical hole, covered by a section of plastic sheeting, noted at the central northern area of this southern area of the site and was formerly used as a socket point for a telecom pole which had been redirected (Photograph 6). The northern boundary of the southern parcel of the site comprised a wooden post and wire/barb wire fence. It is uncertain whether the underground cables had been removed from this position.

Photograph 5: *Northwest southeast running ditch/watercourse.*

Photograph 6: *Former post hole from a telegraph post.*

The remainder of the site was regularly utilised as pasture and hence comprised a good quality of grass, with a steeper gradient than the southern section. There were 2 No. significant features within the remainder of the site and comprised National Grid electric cables and a significant basin feature within the central area of the site.

The general topography of the central area of the site comprised a moderate slope with small scale hummocks and hollows, with the gradient shallowing at the northern area/crest of the site. This can be seen on Photograph 7 as well as the landscaped panoramic Photographs 18 to 24.

Photograph 7: *View of the site looking from south to north within the central field. Electric cables noted on telegraph posts as well as on pylons. Basin area in left to centre of the midground in the photograph.*

The main electric cables which crossed the site from north to south were supported on 2 No. pylons located in the northernmost parcel and within the southern extent of the central area of the site. These have been included on many of the photographs within this description. The southern pylon was situated immediately to the east of the basin feature. A smaller set of cables were noted to be supported on telegraph poles running roughly parallel with the main run of cables.

The basin feature appeared to comprise a shallow bowl feature with several shallow drainage channels which had been formed around hummocky areas as seen in Photograph 8 below. The lower section of the feature was heavily waterlogged and covered by reeds (Photograph 9). There was no water within the channels. The land to the east of the basin feature is shown in Photograph 19. A view from the north of this feature is shown in the landscape photograph 20.

Photograph 8: *Shallow basin feature in the central field.*

Photograph 9: *Water logged ground at the southern area of the basin feature.*

The eastern area of the site was noted to be relatively steeply sloped with a narrow dry valley feature running from north to south (refer to Photographs 23 & 24). This area was inaccessible to the plant on site due to a tree lined ditch/stream with the adjacent central southern parcel and a double post and wire fence with orchard trees within along the northern boundary of this field. The stream which formed the western boundary of this parcel was the only section of watercourse to have a dry stone wall retaining wall along its course. The southern area of this parcel had its post and wire mesh boundary fence which had been breached and the compensation pond which had been created for the business park beyond the south eastern boundary.

The orchard trees are anticipated to have been planted by the owners of Lower Laithe Cottages (cottages situated outside of the site boundary), and are situated at the northern crest of the eastern field. The orchard was within the proposed development area. A ditchline which runs along the north eastern boundary of the site had been diverted southwest along the northern boundary of the cottages and discharges into the narrow dry valley feature. The ditchline was noted to be holding a low level of water and was marshy at the base. An earth berm was present between the south western ditchline and the cottages. During the ground investigation works, Peel Holdings requested that Coopers further open the ditch and where possible raise the berm as the cottages had been noted to be susceptible to flooding (refer to Photograph 10).

Site Description

Project: Trough Laithe, Barrowford

Project No: 5883

Prepared by: M Ollier

Date: 28 April 2014

Photograph 10: Ditch along southern margin of eastern field

Photograph 11: Stone trough

Photographs 12 and 13 illustrate a boundary wall for 69 Wheatley Lane Road. This structure was situated in the northern corner of the site and was in a very poor condition with collapse evident along the north western section of the wall. A hollow section had undergone complete collapse of the outer south western wall with a bridging slab still intact.

Photograph 12: Stone wall at the north eastern corner of the eastern field.

Photograph 13: Second image of wall shown in Photograph 12

Site Description

Project: Trough Laithe, Barrowford

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Photographs 14 & 15: *Course of Pendle Water looking west and east. Erosion of the riverbank had broken concrete headwalls and sheet piles.*

Photographs 16: *Erosion of the riverbank had broken concrete headwalls and sheet piles.*

Site Description

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Photograph 17: *Panorama showing extent of site from access road and land in the southern area of the site.*

Photograph 18: *Panorama showing extent of the eastern field from its southern boundary.*

Photograph 19: *Panorama showing the land to the east of the shallow basin within the central area of the site.*

Photograph 20: *Panorama showing the basin area within the central area of the site, taken from the north.*

Photograph 21: *Panorama showing the extents of the northern field from its western edge*

Photograph 22: *Panorama of the western field from its northern edge*

Site Description

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Photograph 23: 270° *panoramic view showing the southeastern field. The northern area of the site is to the centre of the photograph, with west and east to the left and right of the photograph. Lower Laithe Cottages to the right of the central high ground.*

Photograph 24: *View from the southeastern corner of the site looking west and north with the compensation pond either side of the timber walkway.*

Site Description

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Photograph 25: *Panorama showing the contours of the hollow in the central field from its northern edge*

Site Boundaries

North western - This boundary predominantly comprised mature hedgerow along Wheatley Lane Road, with the grounds of Trough Laithe Farm, 67, 69 and 107 to 135 Wheatley Lane Road which had been delineated by hedgerows, concrete post and timber board, post and wire mesh fencing, and sandstone retaining walls.

North eastern - This boundary was formed by a ditchline, beyond which were the tree lined hedgerows for residential properties fronting Warren Drive, Mosman Place, Cottesloe Place, Maylands Place and Lower Laithe Drive. The eastern most section of this boundary was noted to comprise a tree lined/wooded area with a public footpath beyond which was a large engineering works (Aztec Engineering, Merc Engineering and Peter Reeves).

South eastern - The eastern area of this boundary was open with a compensation pond and associated pipework for the proposed Business Park proposed beyond the western boundary. The residential development boundary has been taken to the kerb of the access road which had been constructed for the Business Park. Beyond the compensation pond was the erosional meander of the Pendle Waters, with sections of sheet piles and compromised headwalls for outfalls (refer to Photographs 14 to 16).

South western - This site boundary comprised timber panel fencing in the western most area by the roundabout for the Business Park, with a footpath that ran northwest beyond the boundary dogleg. The remainder of the boundary was made up of hedgerows and post and wire fences that backed onto adjacent fields, the residential property called Laund centrally along this boundary, and the access road for Laund to the western boundary when the track follows the boundary of 135 Wheatley Lane Road.