Eastwood & Partners
CONSULTING ENGINEERS

E P

PHASE 1 GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION

NETHER MILL FARM, PENISTONE

FOR

CHRIS CARR ARCHITECTS

ISSUE 1



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Eastwood & Partners, St Andrew's House, 23 Kingfield Road, Sheffield, S11 9AS
Tel: 0114 255 4554 Fax: 0114 255 4330 mail@eastwoodandpartners.com www.eastwoodandpartners.com

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Approved	:	M J Yates

Also at: Pearson Court, 3 Kings Road, Fleet, GU51 3DL Tel: 01252 360 580 Fax: 01252 360581

Directors: **G M Seaman** BSc, CEng, FICE, FIStructE **S D Preston** BEng, CEng, FICE, FIStructE **N J Baines** BSc, CEng, MICE, MCIWEM
P Richardson BSc, CEng, MICE, MIStructE **J M Wood** BSc, CEng, MICE, FIStructE **M J Yates** BSc(Eng), ACGI, CEng, MICE, FIStructE
S R Ellis, BEng, CEng, MIStructE, AMICE **K R Pursall** BEng, CEng, MIStructE
Senior Associates: **K Newsome** BSc, CEng, MICE, MIStructE **S J Mitchell** BSc, MSc, CEng, MEI, MCIBSE, MASHRAE
Associates: **A Jones** BEng, CEng, MICE, MIStructE **M Young** MA, CEng, MICE, MIStructE **C A Wood** BSc, CEng, MIStructE, AMICE
A ALLISON B.ENG **C A TOPLISS** BSC, CENV, CSCI, CGEOL, SILC, AMICE, FGS
S J English BEng, CEng, MIStructE **A R Priest** B.Eng

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EXECUTIVE SUMMARY

1 This desktop study has been carried out for Chris Carr Architects on approximately 4.5 hectares of land at national grid reference 424520 403820. The site is currently occupied by farmhouses, farm buildings and open land. The surrounding land is residential and agricultural riparian in nature.

2 The site was already occupied by the farmhouse Nether Mill House, a corn mill, mill dam and a mill race by 1851. The mill race and dam were infilled in the 1960s.

3 The geology beneath the site is the Lower Coal Measures. Sandstone or mudstone is expected. Alluvium and river terrace deposits are indicated above the bedrock beneath most of the site.

4 The site is not expected to be at risk from the effects of shallow underground coal mining.

5 At this stage, traditional strip or trench fill footings may be suitable for any new development, at a minimum depth of 900 mm in clay soils and deeper near to trees. If significantly deep or soft alluvium is encountered, piling or raft foundations may have to be considered.

6 Precast concrete floors are expected to be suitable over areas of deep made ground or areas at risk from ground gas. Ground bearing floor slabs should be suitable where the footing depth due to trees is less than 1500 mm and where the depth of made ground is less than 600 mm.

7 An infilled historical mill race and mill dam are present on the site, which could be a potential source of ground gas. It may be necessary to undertake some gas monitoring if these features are found to be of significant depth, or if they contain biodegradable or organic materials.

8 No radon precautions are required.

9 Parts of the site lie within flood zones associated with the Rover Don. A full flood risk assessment will be required prior to development.

10 Soakaways will probably not be viable as the site overlies alluvium and the groundwater level is expected to be shallow. However, it may be prudent to undertake some infiltration testing if suitable areas are present on the site. There appears to be an existing piped drainage system serving the existing buildings on the site. It is possible that the proposed development could be joined to this.

11 Some contamination is expected, from the infilled mill race and mill dam. There are also above ground fuel storage tanks in the farm yard in the north east of the site, with some signs of localised spillage around them. At this stage, a 600 mm deep capping layer of clean soil should be assumed for the areas currently occupied by agricultural buildings and yards.

12 Before more definite information regarding the properties of the ground and any contamination present can be given, an intrusive ground investigation will be required.

13 The conclusions made within this report should be agreed with the Local Authorities and other regulators prior to commencement of the development works.

1.0 INTRODUCTION

1.1 Terms of Reference

This report presents the findings of a phase 1 geotechnical and geo-environmental site investigation carried out by Eastwood and Partners (Consulting Engineers) Ltd for, and on the instructions of, Chris Carr Architects for use in a potential redevelopment of the site with residential properties. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

1.2 Context

No previous investigations are known to have been undertaken on the site in the past.

1.3 Aims and Objectives

The aims and objectives of this investigation were as follows.

- Assimilate Phase 1 data to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;
- Detail the expected ground conditions and their geotechnical properties enabling outline foundation proposals to be made for the proposed residential development;
- Carry out preliminary risk assessment to establish the likely risks to future receptors,
- Identify likely feasible remediation options if risks are highlighted;

1.4 Scope of Investigation

It is proposed to redevelop the site for residential use. This will constitute a mixture of converting some of the existing buildings to dwellings, where practical, and some new build development. It is assumes that all dwellings will be of traditional construction and will be no more than three storeys in height.

This document constitutes the findings of the Phase 1 investigation. This involved a review of information extracted from published documentation as well as that obtained from a site reconnaissance. Information regarding the current and former land uses both on and surrounding the site, as well as the environmental sensitivity of the site location as determined by factors including geology, hydrogeology and hydrology have been examined.

Information analysed in this section of the report has been obtained from a variety of sources and included the following:

- A Landmark Envirocheck report. This includes historical Ordnance Survey maps, as well as information regarding environmental issues. It compiles information obtained from amongst others, the Environment Agency and the Local Authority.
- Geological Maps and Associated Geological Memoirs
- Coal Authority Mining Report

This report does not include any structural inspection of any existing buildings which are to be retained or demolished. Such an inspection is to be undertaken by Eastwood & Partners and will be reported on under separate cover. During the walkover survey carried out for this report, no access was gained into any of the residential buildings currently on the site. Access was gained into the open agricultural storage barns however. Risks to ecological receptors, such as bats, have not been considered.

2.0 THE SITE

2.1 Description

The site roughly consists of two irregularly shaped parts ("Site A" and "Site B") to either side of Barnsley Road in Penistone, South Yorkshire. This is approximately 7 miles west of Barnsley town centre. The site has a total area of approximately 4.5 hectares, and is centred around Ordnance Survey national grid reference 424520 403820.

Site A

Site A is located to the north of Barnsley Road. The site can be divided into two areas, "A" and "A2".

'Area A'

Area A forms the eastern and southern parts of Site A, and is currently occupied by residential and agricultural buildings with associated yards. In the north east, Nether Mill House is present. This is a detached two storey house, probably of stone construction although it is rendered externally. The rear of the house is dug into the ground, with a stone retaining wall of around 1 m height separating the house from the rear garden which is at the higher level. The garden is most laid to lawn, with some mature trees, including chestnuts.

To the east of the house, a stone built barn is present. This is two storeys in height with a pitched roof. The western gable is buttressed, and shows signs of bowing and cracking, with a section possibly having been rebuilt previously in blockwork. A cobbled yard is located to the south of the barn, which is around 1.5 m lower than Barnsley Road. An access ramp into the yard from the road is provided. Immediately north of the barn is located a two storey farmhouse. This is also of stone construction. A number of small out-buildings are located around a concrete covered farm yard to the west of this farmhouse. At the time of the site visit, various farm machinery was being stored in the buildings.

A second two storey stone built barn is located in the east of Area A. A single storey shed is attached to this building. The barn is open fronted at ground level. The barn appears unused at present, but the attached shed appears to be used as dog kennels. Further kennels are located to the rear of this building, along with a cement bound asbestos sheet lean-to. Also located to the rear of the barn are two above ground fuel storage tanks. These are metal tanks, supported on wooden beams. The area below the tanks is not bunded, and is surfaced partly with concrete and partly with stone cobbles. Dispenser nozzles are present on both tanks for the refuelling of vehicles. It is therefore presumed that the tanks will contain diesel fuel for agricultural machinery. One tank

possibly contains red-diesel, the other white diesel, based on the colour of the tanks themselves. Some evidence of spillage on the ground was noted, with black stained patches directly below the nozzles, which were free hanging. It is likely that small amounts of fuel drip from the nozzles when they are hung after refuelling. A concrete covered yard is located east of the barn. A blockwork retaining wall runs along the northern side of the yard, forming the site boundary. A further yard is present beyond the boundary with access to a fishing pond. A water course, Scout Dike, runs southwards along the eastern boundary of the site, before passing beneath Barnsley Road and joining the River Don on the south side of the road. Drainage is provided within the farm complex, with manholes evident across the various yards. It is not known to where these drains outfall. It may be that surface water is discharged to the river, or to public sewers within Barnsley Road.

In the south west of Area A, further buildings are present. Two large barns are present. The largest of these is around three storeys in height and consists of asbestos bound cement panels fixed around a steel frame. The barn is currently used for storing hay and a number of tractors and other equipment. The rear section of the building is divided into pens for animals. The smaller barn, to the west, is also a steel framed building but with timber cladding to the walls, and an asbestos bound cement panel roof. Further hay bales and farm machinery were stored within this barn. Additional animal pens are also located between the two barns. A concrete covered yard is present to the north of the barns, with a small blockwork retaining wall along the northern side. Various building materials were stored in this yard, along with a number of vehicles. To the front of the barn, a cobbled track runs, with a gated entrance from Barnsley Road at the western end of the barns.

To the south of the barns, derelict buildings are present. These appear to be old brick built barns or garage type buildings, currently used for storing timber, bricks and other materials. A raised area, supported on stone walls is present, although no evidence of there having been a tank on this feature in the past was noted. Clay land drain sections were stockpiled on this area at the time of the walkover. A two storey stone built barn with attached cottage is present to the south of the derelict buildings, facing onto Barnsley Road. The western end of Area A comprises a gravel surface yard. The gravel included lumps of concrete as well as bricks. At the time of the visit, the yard was empty. The yard is raised around 500 mm to 1 m above the road.

'Area A2'

Area A2 is located to the north west of Area A. Area A2 predominantly comprises a grassed paddock used for grazing. The land rises towards the north by several metres. The southern part of this area also comprises a gravel surfaced yard, used for the storage of hay bales and several trailers.

Site B

Site B is located to the south of Barnsley Road, and is disected by the river Don. Site B is also divided into two areas.

'Area B'

'Area B' is located in the west and comprises a farm yard with three barns. The first of these is located in the east and is two storeys in height. No access into this building was available at the time of the visit, but the barn appeared unused. The building is a combination of block and brick walls, with cement bound asbestos sheet roofing and gutters. Some animal pens were evident at the rear of the building, which were partially filled with rubble. The second barn, to the west of the first, is an open fronted structure. The rear and side walls are of blockwork, whilst the roof is of cement bound asbestos sheets supported on a steel frame. Various farm machinery was being stored within this barn at the time of the walkover visit. The third barn is a timber framed structure, which is in a state of some disrepair. The roof consists of corrugated panels, possibly tin rather than cement bound asbestos. Hay bales were being stored within the barn at the time of the site visit.

The south eastern corner of this area is a gravel surfaced yard. The gravel appears to comprise assorted rubble including brick and concrete fragments. Several areas of the yard are overgrown with grass. To the north of the buildings, further open space is present. This is very overgrown, with mature trees of various species along the eastern boundary and river bank. A number of small derelict animal shelters are present in this area. A number of small soil heaps are also present amongst the undergrowth. A number of manhole covers were also noted.

'Area B2'

Area B2 is located to the west of Area B, with a small triangular section being segregated by the River Don. At the time of the walkover visit, the water level within the river was around 2 m below the general ground level of Site B.

The main part of Area B2 is on the south side of the river. This comprises a relatively level field. Mature trees are present along the river bank on the northern side, with some also being present around the eastern, western and southern boundaries. At the time of the site visit, the field contained short grass. Recent aerial photographs do indicate crops to be present, however. A manhole is present in the north of the field, along with a concrete headwall on the river bank. A pipe was noted discharging from the headwall into the river. The pipe appeared to be around 250 mm in diameter, but the source of this discharge was not verified.

The small area on the northern side of the river is currently used for animal grazing. This area is around 1.5 m to 2 m below the level of Barnsley Road. A concrete slab is present in the north of this area which appears to be the remains of a small shed. Two wooden animal sheds are also located in the east. The field is covered by grass.

The area surrounding the site is predominantly residential, with Penistone Grammar school located to the north of Site A. A garage and fuel filling station is located around 50 m to the west.

The main features of the site described above are indicated on Drawing Number 35223/001, which is included in Appendix 1.

2.2 History

Historical Ordnance Survey maps have been reviewed in order to assess the previous land usage at and within the vicinity of the site. Copies of the maps used are presented in Appendix 1 within the Envirocheck report.

2.2.1 The Site

Areas A and A2

The earliest map reviewed, dated 1851, showed the north eastern section of the site to be occupied by Nether Mill House. Several other buildings are indicated around the house, which match the general footprint of the larger barns which remain to the present day. Nether Mill, a corn mill, with associated out buildings and a mill dam, is shown in the south western part. A mill race crosses the site approximately from north to south and a track runs from west to east past a mill dam. The rest of the land appears to be agricultural or open land.

By 1931, in the western section of the site, a building was developed in the centre. Nether Mill House remained in the north, with additional out-buildings added around the original buildings. The mill race and mill dam were removed between 1967 and 1968. Between 1981 and 1983, the building in the western section of the site was extended over the previous position of the mill race. Ancillary extensions and changes were also made to the buildings surrounding Nether Mill House at this time.

Little change is shown on any of the subsequent maps up to the present day.

Areas B and B2

The earliest map shows the River Don to cross from the west to the north east corner. Scout Dike joins the Don immediately east of the site after running south along the eastern boundary of both Site A and Site B. Trees are shown lining the course of the river. The rest of the land appears to be agricultural or open land.

By 1931, a rectangular shaped building is shown in the south western corner of Area B. This is in the location of the timber barn. By 1960, the other two barns are also shown, although the open fronted barn is indicated to be L-shaped, with a section running along the western boundary. This section of the building appears to have been removed between 1983 and 1985. No other significant changes are indicated by subsequent maps.

2.2.2 The Surrounding Area

The earliest existing Ordnance Survey map, from 1851, showed the area surrounding the site to predominantly be agricultural land, with a few quarries and farmhouses in the surrounding area. A well is shown around 40 m north east of the site and Water Hall is present adjacent to the eastern boundary of the site section B. Scout Dam is present between 250 and 500 m to the north of the site. Broad Hill Quarry, a sandstone quarry, was present approximately 250 m to the north east of the site in 1851. More sandstone quarries were present between 250 and 500 m to the south of the site. Railways were present around 250 m to the south and east. Springs were also present in the surrounding area.

By 1893, escarpments can be seen around 50 m to the east and 150 m to the north of the site. The Penistone Union Workhouse was built adjacent to the north western boundary of Site A, with a pump indicated on the boundary between the site and the workhouse. A gas works was present around 200 m south west of the site. By 1894 the sandstone quarries are no longer labelled, and the ones to the south of the site are replaced by a school and its grounds.

Another escarpment was labelled by 1907, adjacent to the southern boundary of the southern section of the site, and a sewage farm was present around 450 m to the west of the site. Residential development around the site increased between the 1900s to the 1930s, including the development of two houses adjacent to the western boundary of the northern site. The escarpment adjacent to the southern boundary became a recreation ground although the slope was still present. The Union Workhouse was changed to the Poor Law Institution.

By 1960 the Poor Law Institution had changed its use to Netherfield Home for the Aged. An electricity substation and Bridge Mill Joinery Works are shown adjacent to the western boundary of section B of the site by 1968, and a garage around 50 m to the south west of the site. During the 1970s and 1980s residential development in the area intensified, particularly around 100 m south west of the site.

The surrounding area then stays much the same to the present day. Netherfield Home for the Aged was converted into Penistone Grammar School Sixth Form Annex.

2.3 Geology

The Geological Map of the area, sheet 273 SE (1:10,560 scale) indicates the solid geology beneath the site to be undifferentiated mudstone, sandstone or siltstone of the Lower Coal Measures. The exact strata type is not indicated, as the area is covered by drift deposits. The maps indicate the drift beneath the northern section of the site (Areas A and A2) to be river terrace deposits. Alluvium is indicated beneath the southern side of the river (Areas B and B2).

No faults or other lines of weakness are indicated to cross the site, although the surrounding area is quite heavily faulted. The dip of the strata is generally indicated to be to the north east at angles of between 3° and 6°.

2.4 Hydrogeology

2.4.1 Groundwater Vulnerability

The Environment Agency groundwater vulnerability maps identify the site to overlie a Secondary A aquifer. Both the drift deposits and the bedrock are given this classification. Secondary A aquifers are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

The site does not lie within a Groundwater Source Protection Zone.

2.5 Hydrology

The nearest surface water feature is the River Don running through the site oin the southern side of Barnsley Road. The Scout Dike also runs along the eastern boundary, joining the Don on the eastern most point of the site. Both of these watercourses are potential receptors if contaminated materials were to be found on the site.

2.6 Mining

2.6.1 Coal Mining

The geological maps indicate several seams of coal to outcrop in the area surrounding the site. The named coal seams outcropping nearest to the site are the Grenoside Sandstone Coal, which outcrops approximately 750 m to the south west, the Lower Penistone Coal, which outcrops approximately 540 m to the south, and the Penistone Green Coal, which outcrops approximately 750 m to the south. The Lower Penistone Coal and the Penistone Green Coal outcrop approximately 150 feet (45.7 m) higher than the site, on the southern side of the large valley in which Penistone sits. The area is heavily faulted, but several seams of coal are indicated to outcrop in corresponding positions in the northern side of the valley. It is therefore considered that these seams of coal are stratigraphically 'above' the site, and are therefore not expected to be present below the site.

Therefore the shallowest coal expected beneath the site is the Grenoside Sandstone Coal, although its outcrop thins and discontinues towards the north. Because of this, it is doubtful if this seam continues beneath the site. If it is present, it is estimated to be around 35 m beneath the south westernmost corner of the site and around 50 m beneath the north easternmost corner of the site, based on the strata dipping at 3° towards the north east.

The seam is recorded as being around 4 inches (0.1 m) thick in the local area. The geological memoir states that the coals in the area have locally been worked where thick enough, but only usually at outcrop or occasionally from shallow shafts.

A Coal Authority mining report has been obtained for the site and is enclosed in Appendix 2. This states that the site is not within the likely zone of influence from past underground workings. There are no recorded mine entries within the site or within 20 m of the site boundary.

The site is not within the likely zone of influence from any present or currently proposed future underground coal workings. However, reserves of coal exist in the locality which could be worked at some time in the future subject to feasibility, licences and planning consents. Future workings of the coal reserves below the site are considered unlikely due to the demise of the coal mining industry in this area.

There are no records of any mine gas emission which required action by The Coal Authority having taken place on the site, and no claims for mining related subsidence have been made on the site.

Given the thin nature of the shallowest seam of coal expected below the site, if it is present at all, it is not expected that the site is at risk from the effects of shallow mine workings.

2.6.2 Quarrying

Broad Hill Quarry, a sandstone quarry, was present approximately 250 m to the north east of the site in 1851. More sandstone quarries were present between 250 and 500 m to the south of the site. By 1894 these quarries are no longer labelled, and the ones to the south of the site are replaced by a school and its grounds.

Quarrying activities are not expected to have taken place on the site in the past due to the presence of alluvium and river terrace deposits associated with the River Don. The expected shallow water table will also have deterred any potential surface workings.

2.7 Ground Gas

2.7.1 Landfill Gas

A mill race, mill dam and overflow were present in the northern section of the site and were infilled between 1967 and 1968. It is possible that organic materials remain in the bed of the former race or dam. It is also possible that biodegradable materials were used to infill these features, although neither are expected to be of significant depth.

The Envirocheck Report lists one historical landfill site within 250 m of the site. This was named "T.A. Centre" and was situated 230 m to the west of the site. It operated between 1982 and 1994 and accepted commercial and inert wastes, demolition waste, excavation waste and subsoil and topsoil. Reference to historical maps suggests that the landfill may have operated to allow the redevelopment of an old TA centre into a new sports centre including sports pitches. It is therefore likely that limited amounts of waste were imported to level the site as part of the redevelopment. As such, a significant risk of ground gas generation is not anticipated, and the risk of migration to the current development site is not expected to be a significant risk.

Potentially infilled sandstone quarries have been identified around 250 m to the north east and south of the site. However, at this distance, a significant risk of gas migration towards the site, should any of these quarries have been infilled, is not anticipated.

Generally, based on the review of the available desktop information, there is considered to be a low risk of gas generation and migration which could affect the proposed development. The risk is presented from the former mill race and mill dam on the site, rather than from any former feature in

the surrounding area. The level of risk will be dependent on what materials are present within the infilled mill race. If biodegradable or putrescible wastes are included, some gas monitoring may be required, or gas resisting measures incorporated into the proposed dwellings. The contents of the former mill race and mill dam will need to be confirmed by way of intrusive investigation.

2.7.2 Radon Gas

According to information included within the Envirocheck Report, which has been provided by the BRE, no radon protective measures are required in new dwellings at this site.

2.8 Flooding

According to the Environment Agency flood maps, the area south of Barnsley Road (Areas B and B2) lies within an area at risk of flooding from river waters. The most southerly part of the northern section of the site (A and A2) is also included in this area at risk of flooding. As the development area is greater than 1 hectare, a full flood risk assessment will be required prior to development in any case.

3.0 EXPECTED GROUND CONDITIONS

On the basis of information presented on the historical Ordnance Survey Maps and geological and hydrogeological maps, it is anticipated that the natural ground at the site will comprise alluvium of clay, sand or gravel, or river terrace deposits of sand and gravel , over sandstone or mudstone. The alluvial and river deposits are expected to be several metres thick, but may be reasonably competent.

Some made ground is expected be encountered on the site, given its historical use as a mill and farm, although this is not expected to be of significant depth across most of the site. Some slightly deeper made ground may be encountered within the former mill race and mill dam. Within Area B2, topsoil is expected overlying the natural ground. This may be of greater depth than normally expected due past farming of the site.

Groundwater is likely be encountered at relatively shallow depth due to the proximity to the River Don and Scout Dike. Water level at the time of the site walkover was around 2 m below the general site level, and therefore it could be expected that water will sit at a similar level within the soils along the river banks.

4.0 GEOTECHNICAL APPRAISAL

4.1 General

The natural ground beneath the site is expected to comprise alluvial clay, sand and gravel or river sands and gravels over the majority of the site. These may be several metres thick. The underlying bedrock is expected to be sandstone or mudstone.

4.2 Foundations

For a low rise residential development, the most suitable foundations are likely to be traditional strip or trench fill footings, taken through any made ground or loose or soft material and founded within the alluvial soils or the river terrace deposits at a likely minimum depth of 900 mm bgl. This, however assumes that these soils are reasonably competent, and significantly deeper foundations may be required in some areas of the site.

Foundations may need to be deepened locally where clay soils are present and existing or proposed trees will have an effect. There are a number of mature trees lining the course of the River Don, which crosses site section B2, and more sporadic planting around other areas of the site.

If significantly deep and soft alluvium is encountered, for example in the infilled mill race and mill dam, piling or raft foundations may have to be considered. A ground investigation will be required to assess the presence, nature and thickness of any made ground and also the underlying drift deposits. If the drift deposits are found to be soft or weak, the ground investigation may need to be extended to assess the depth at which the bedrock is encountered.

4.3 Superstructure Precautions

From the information obtained during the desktop phase of this investigation, superstructure precautions are unlikely to be required for detached low rise dwellings.

4.4 Ground Slabs

Precast concrete floors are expected to be suitable over areas of deep made ground, or areas at risk from ground gas. Ground bearing concrete floor slabs should be suitable for use where the footing depth is less than 1500 mm. Where the footing depth due to trees is greater than 1500 mm, a precast or reinforced suspended floor slab should be used.

4.5 Roadworks

At this stage, a minimum CBR value of 2%, probably greater, is expected to be provided by the soils on the site.

4.6 Problems Due To Past Development

A historical mill race and mill dam were present on the site until the 1960s, when they were infilled. These features may have solid walls or floors remaining in-site.

4.7 Excavation Problems

It is not expected that there will be significant excavation problems. The stability of trenches at the site is currently unknown. Where excavations which workers are required to enter are over 1.2 m deep, or less where there is a risk of harm from collapse of the sides of the excavation, the sides should be supported or battered back to make them safe.

4.8 Surface Water Drainage

Soakaways may not be viable as the site overlies alluvium, and the groundwater table is expected to be quite high. However, it may be possible to use soakaways in some areas, dependant on the ground conditions encountered. It is considered prudent to allow for some infiltration testing to indicate whether soakaway drainage could be considered within the proposed development if a trial pit investigation were to indicate suitable ground conditions exist on the site.

The existing buildings appear to be served by piped drainage systems, although it is not known where these may discharge to. It should be acceptable to retain these, subject to survey, and approval from the regulators. Some attenuation may be required if additional dwellings are to be connected into this system.

4.9 Sulphate Attack of Buried Concrete

At this stage, it is likely that any sulphate resisting precautions will be required in some of the foundations or other sub-structure, particularly in made ground. Therefore DS-2 AC-2 concrete should be allowed for at this stage. This is subject to confirmation by chemical testing, however.

5.0 CONTAMINATION APPRAISAL

5.1 Outline Conceptual Model

The development proposals for this site will include the construction of new residential properties, with associated gardens and areas of hard landscaping.

Historically, the site has been occupied by farm and mill buildings since the earliest historical maps in 1851. A mill race and mill dam were present crossing the northern section of the site until the 1960s when they were infilled. Contaminants could arise from the infilling of the mill race and mill dam on site. These could include metals/metalloids, sulphates and hydrocarbons.

During the site walkover, above ground tanks were noted in the northern area of the site which showed some spillage of fuel onto the ground beneath the tanks. It is therefore expected that some localised hydrocarbon contamination will be encountered. Fuel spillages or leakages may also have occurred around the existing farm buildings where vehicles have been stored. A petrol station is also located around 50 m south west of the site which could result in hydrocarbon contamination of the ground due to groundwater flow, although this is generally considered unlikely.

The site and surrounding land is has been predominantly agricultural or residential in nature for the past 100 years at least. It is possible that some naturally occurring slightly elevated concentrations of heavy metals such as lead, arsenic or nickel may be present. It is also possible that elevated concentrations of PAHs such as benzo(a)pyrene may also be present in near surface soils due to atmospheric fallout. Such contaminants may pose a potential risk to human health.

The groundwater table is expected to be at shallow depth. The site overlies a Secondary A aquifer, and does not lie within a groundwater source protection zone. A potential risk to the aquifer is unlikely to be presented. However, a potential risk to surface water may be presented if contaminated materials are present and if those contaminants are found to be potentially mobile, where they could enter the River Don or the Scout Dike.

The site may be at risk of ground gases such as methane or carbon dioxide if significant volumes of biodegradable wastes or organic materials are present within the former mill dam or mill race, or if these features are of significant depth.

No radon precautions are required.

5.2 Possible Pollutant Linkages

Contaminant	Pathways	Receptor
• Elevated concentrations of hydrocarbons or PAHs in the area surrounding the above ground fuel tanks. • Localised fuel spillages around existing buildings where farm machinery has been stored. • Elevated concentrations of heavy metals and PAHs within any made ground present. • Naturally elevated concentrations of heavy metals and PAHs in the natural soils.	• Ingestion, inhalation, direct contact.	• Future residents and visitors. • Construction workers.
	• Leaching and migration	• River Don • Scout Dike
	• Root uptake	• Plants
• Sulphates within soils.	• Direct contact.	• Below ground concrete.
• Ground gases including methane or carbon dioxide from historical mill race and mill dam on site if biodegradable or organic materials are included within the infill	• Migration through ground	• Future residents and buildings.

6.0 RATIONALE FOR FURTHER INVESTIGATION

Before more definite information regarding the properties of the ground and any contamination present can be given, an intrusive ground investigation will be required. The excavation of trial pits will be the most suitable method of investigation. This would allow both investigation of the ground conditions and soil sampling. A borehole investigation may be required should the near-surface soils be found to be soft or loose, and incapable of supporting foundations at shallow depth.

It may also be prudent to undertake soil infiltration testing in some areas of the site to determine the suitability of the ground for soakaway testing.

The potential pollutant linkages presented in the Outline Conceptual Model will need to be investigated by means of soil analysis. The chemical testing suite should be chosen to cover the range of potential contaminants indicated above.

If any elevated levels of contamination are identified the risks to receptors would need to be assessed and remediation considered. Should significant depths of made ground, or materials containing significant amounts of biodegradable waste or organic matter be encountered, a program of gas monitoring may also be required.

At this stage, it is expected that remediation measures will be limited to the placement of an inert capping layer in some areas of the site, probably consisting of the areas currently serving as farm yards. A 600 mm thick capping layer should be allowed for at this stage across these areas. For the areas which are presently fields, it is unlikely that a capping layer will be required.