Phase 1 Geoenvironmental Risk Assessment and
Phase 2 Ground Investigation

LADY ANN ROAD
SOOTHILL, BATLEY

for

D. Noble Limited

Report Number 3663

September 2016

Michael D Joyce Associates LLP
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1 INTRODUCTION

1.1 At the request of D. Noble Limited a Phase I Geoenvironmental and Geotechnical Assessment (Desk Study) and a Phase II Intrusive Investigation have been carried out at Lady Ann Road in Batley. It is proposed to develop the site with residential properties.

1.2 The intrusive investigation has comprised trial pitting with associated in-situ and laboratory testing. Recommendations are made for the safe and economic development of the site.

1.3 The study has not included checks on services on or adjacent to the site, and no structural or asbestos surveys have been carried out.

2 THE SITE

2.1 The site covers an area of approximately 3.3 hectares and is located approximately 3km north of the centre of Dewsbury. The Ordnance Survey grid reference is SE 250 246. Figure 1 shows the general site location, whilst figure 2 shows the site in more detail.

2.2 The site is a large plot of land situated between Lady Ann Road to the east and Primrose Hill to the west. Access to the site was in the south east corner across a railway sleeper along a footpath, or from the northwest corner of the site over a wooden fence.

2.3 The site is an irregular shape, with the northern site boundary marked by a 1.0m high wooden fence with trees and bushes. The western site boundary is marked by back gardens of terraced houses on Primrose Hill, with the actual boundary marked by a typical wooden garden fence. The north eastern site boundary is marked mainly by dense bushes/trees, with the rest of the eastern boundary marked by a small beck and Lady Ann Road.

2.4 The site slopes down steeply from the west towards the east and south. The site is surfaced by overgrown weeds, reeds, bushes, trees and grass.

2.5 In the central eastern corner of the site, a depressed area of reeds exists, which is very soft underfoot and according to locals is prone to regular flooding. The same is noted in the northeast corner of the site, and to a lesser extent adjacent to southeast boundary.

2.6 A row of mature trees cuts the site in roughly half across the centre from the east to the west. It is understood that the trees have Tree Protection Orders (TPO) placed on them.

2.7 Fly-tipped material was identified in west and centre of site, typically household waste. Fly tipped material also encountered in northeast corner of site and northwest corner of site, again typically household waste. Although asbestos was not identified, it is possible that it may exist within some of the fly tipped material.

2.8 Manholes/Drainage is situated along eastern site boundary. Overhead electricity pylons are situated in the north of the site, running east to west.

3 SITE HISTORY

3.1 The following archival Ordnance Survey maps have been examined to trace the past development of the site. These are reproduced in Appendix 5 with the current site boundary superimposed on them. The apparent displacement on the older maps is due to a change in Ordnance Survey co-ordinates.

Scale and Year of Publication			
6" to 1 mile	1854	1:2500	1894
	1892		1907
	1906		1922
	1932		1933
	1938		1939
	1948		1955
	1957		1969
	1967		
1:10,000	1975	1:1250	1955
	1985		1969
	1992		1970
	1995		1977
	2002		1992
	2010		1995
	2014		

3.2 The earliest map of 1854 shows the site and surrounding area to be essentially agricultural. However by 1894, Lady Ann Mills had been built to the east of the site. This was a large woollen mill. A smaller Culvert Mills (Flock) lay to the south on Lady

Ann Road, with Farfield Nursery to the north of the site. Railway lines had been built to the west and to the southeast. A quarry is also shown to the south of the site.

3.3 By 1907 Primrose Hill had been constructed with most of the terraced housing adjoining it. The terraced housing on Lady Ann Road was also begun around this time and by 1972 extended much of the way along Lady Ann Road, both to the north and south of Culvert Mills.

3.4 Further development surrounding the site continued and by 1933 part of the site itself had become allotments. Over the subsequent years most of the site became allotment gardens. There were a number of small sheds and greenhouses but no obvious large structures.

3.5 The site continued to be used as allotments over the following years, and according to the historical maps the site has never been used for any other purpose. Lady Ann Mills became a business park during the 1990s and Culvert Mills was used as warehousing. The former quarry appears to have had housing built within it.

3.6 Due to time and cost constraints, it has not been possible to consult with local history journals and newspapers. This can be carried out if requested, but is unlikely to provide any significant additional information.

3.7 It is not believed that the study site is of archaeological interest but it would be prudent to make enquiries with West Yorkshire Archaeology Service (tel: 01924 306797).

4 GEOLOGY AND MINING

4.1 Geology

4.1.1 Maps of the British Geological Survey (BGS), in particular 1:10,560 scale sheet 232SE and 1:50,000 scale sheet 77 show the site to be underlain by mudstones, siltstones, shales and sandstone of the Carboniferous Middle Coal Measures.

4.1.2 The geological amps show two faults crossing the site. The main fault trends in a northeast-southwest direction through the northern part of the site, whilst a sub-ordinate fault runs a northwest-southeast direction and abuts the main fault.

4.1.3 The result of this faulting is that undifferentiated mudstones, siltstones and shales underlie the northern part of the site, and the Thornhill Rock sandstone underlies the southern part of the site.

4.1.4 There is a small area of Alluvial Deposits overlying the bedrock in the northeast corner of the site, adjacent to Howley Beck and Lady Ann Mills.

4.2 Mining

4.2.1 A mining report has been obtained from the Coal Authority, and is reproduced in full in Appendix 6. It states that there has been mining in three seams of coal between 50m and 300m depth, with the last date of working being 1907. Under normal circumstances, any subsidence should have ceased by now.

4.2.2 The report makes no mention of shallow workings being present or that shallow unrecorded workings might be present. The Coal Authority holds no record of any notice or subsidence claim having been made.

4.2.3 No shaft or adits are reported on, or within 20m of the site boundary. Although old unrecorded mine entries might be present on the site, these are considered relatively unlikely. No past, present or future opencasts are reported within the vicinity of the site.

4.3 GroundSure Geo-Insight

4.3.1 A GroundSure Geo-Insight Report has been obtained for the site and is reproduced in Appendix 4. The report is based on the British Geological Survey (BGS) geological maps, GroundSure data and miscellaneous other geological sources.

4.3.2 None of the following are recorded beneath the site.

Geology
Records of Landslip within 500m of site boundary Records relating to permeability of Landslips within the site boundary

Ground Workings
Historical Surface Ground Working Features from Small Scale Mapping Historical Underground Working Features from Small Scale Mapping Current Ground Workings

Mining, Extraction and Natural Cavities
Historical Mining
Johnson Poole and Bloomer Mining Area
Non-Coal Mining
Non-Coal Mining Cavities
Natural Cavities
Brine Extraction
Gypsym Extraction
Tin Mining
Clay Mining

Railways and Tunnels
Tunnels
Historical Railway and Tunnel Features
Historical Railways
Active Railways
Railway Projects

In respect of natural ground subsidence, the BGS reports the following risk ratings.

Hazard	Risk
Shrink-Swell Clay	Very Low
Landslide	Moderately
Ground Dissolution of Soluble Rocks	Negligible
Compressible Deposits	Moderately
Collapsible Deposits	Very Low
Running Sand	Low

5 HYDROGEOLOGY AND FLOODING

Hydrogeology

5.1 The Coal Measures occur throughout the heavily industrialised areas of West and South Yorkshire. They comprise a thick sequence of faulted rocks characterised by the repeated sequence of mudstone, siltstone, sandstone, seatearth and coal.

5.2 The Coal Measures, though classed as a minor aquifer, may provide good borehole yields from sandstones and many industrial supplies rely on them. However, groundwater flow is extensively affected by the faulting and fissuring of the rocks, and also by the results of coal mining and associated dewatering activities. Due to the complex, and often poorly understood hydrogeology, it is impossible to subdivide the Coal Measures into aquifers and non-aquifers except on a very detailed level and the whole sequence must therefore be considered in general terms as an aquifer.

5.3 Since April 2010, the Environment Agency's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive.

5.4 The aquifer within the superficial and bedrock deposits is designated as Secondary A. This is described 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.

5.5 Details provided by the Environment Agency in the GroundSure Enviro-Insight report, indicate there to be no licensed surface water or groundwater abstraction points within at least 900m of the site.

Flooding

5.6 The eastern part of the site is shown to lie within a Zone 3 floodplain according to data supplied by the Environment Agency within the GroundSure Report. This estimates the annual probability of flooding as one in one hundred (1%) or greater.

5.7 The Environment Agency Risk of Flooding from Rivers and the Sea (RoFRaS) database provides an indication of river and coastal flood risk at a national level on a 50m grid as used by many of the insurance companies. RoFRaS data is based on a 50m grid system, with the flood rating at the centre of the grid calculated and given below. The data considers the probability that the flood defences will overtop or breach, and the distance from the river or the sea. RoFRaS data for the study site indicates the site or an area within 25m has a High (1 in 30 or greater) and Medium (less than 1 in 30 and more than 1 in 100) chance of flooding in any given year.

6 GROUNDSURE ENVIRO-INSIGHT REPORT

6.1 A GroundSure Enviro-Insight Report has also been commissioned for this site. The following features are recorded within 250m of the site and full details are given in Appendix 4.

6.2 Records of Licensed Discharge Consents

There is a sewage discharge consent for the discharge of sewage at time of flood at a point recorded as being 34m to the south of the site, presumably to Howley Beck.

6.3 Environment Agency Landfill Sites

Bridge Street in Batley, some 126m to the west is listed as a historical landfill site for "*liquid waste*". Soothill Tip is also recorded to be 201m to the east at its nearest point. However there are no details given other than it was a historical refuse tip on the Ordnance Survey mapping of 1968 and 1988.

6.4 Environment Agency Recorded Pollution Incidents

There has been one recorded pollution incident. The event had a "significant" water impact and comprised 'diesel'. The location is identified as 156m to the southwest of the site.

6.5 Contemporary Trade Entries

The GroundSure Enviro-Insight Report lists various trade entries in the vicinity of the site. It should be noted that these lists are rarely complete.

6.6 Others

None of the following are recorded within 250m of the centre of the study site.

Environmental Permits, Incidents and Registers
Historic IPC Authorisations
Part A(1) and IPPC Authorised Activities
Red List Discharge Consents
List 1 Dangerous Substances Inventory sites
List 2 Dangerous Substances Inventory sites
Part A(2) and Part B Activities and Enforcements
Category 3 or 4 Radioactive Substances Authorisations
Water Industry Referrals
Planning Hazardous Substance Consents and Enforcements (within 500m)
COMAH and NIHHS sites
Sites Determined as Contaminated Land under Part 2A EPA 1990

Landfill and Other Waste Sites
Environment Agency Registered Landfill Sites
BGS/DoE Landfill Site Survey
Operational and Non-Operational Waste Treatment, Transfer and Disposal Sites
Environment Agency Licensed Waste Sites

Current Land Uses
Current Industrial Sites Data
Records of Petrol and Fuel Sites
National Grid Underground Electricity Cables
National Grid Gas Transmission Pipelines

Hydrogeology and Hydrology
Groundwater Abstraction Licences
Surface Water Abstraction Licences
Potable Water Abstraction Licences
Source Protection Zones
Source Protection Zones within Confined Aquifer
Environment Agency information on river quality
Groundwater Vulnerability and Soil Leaching Potential
Environment Agency information on River quality
River Network entries
Surface Water Features

Flooding
Flood Defences Areas benefiting from Flood Defences Areas used for Flood Storage BGS Groundwater Flooding susceptibility (within 50m) BGS confidence rating for the Groundwater Flooding susceptibility areas

Designated Environmentally Sensitive Sites
Sites of Special Scientific Interest (SSSI) National Nature Reserves (NNR) Special Areas of Conservation (SAC) Special Protection Areas (SPA) Ramsar Sites Ancient Woodlands Local Nature Reserves (LNR) World Heritage Sites Environmentally Sensitive Areas Outstanding Natural Beauty (AONB) National Parks Nitrate Sensitive Areas Nitrate Vulnerable Zones

6.7 The GroundSure Enviro-Insight Report is based upon known, published information and may not comprise a complete record of all features of relevance. An explanation of the datasets used is available on request.

6.8 It should be noted that due to time constraints the Local Authority has not been contacted, nor has the Petroleum Licensing Officer as former fuel tanks are not suspected.

7 CONTAMINATED LAND

7.1 There is no significantly visible contaminated material on the surface of the site, nor is there any distressed vegetation suggestive of significant or serious contamination. There is some fly-tipping across the site, and pieces of asbestos cement sheeting can be seen scattered across the site in places.

8 RADON

8.1 According to the GroundSure Geo-Insight report the site lies in an area where between 3% and 5% of homes are above the action level recommended by the Health Protection Agency. Basic Radon Protective Measures are therefore necessary according to the BGS data provided in the GroundSure report and as described in Building Research Publication BR 211.

9 THE INVESTIGATION

9.1 The investigation was designed to provide preliminary information on ground and groundwater conditions on the site, together with identifying potential areas of contamination. The investigation was undertaken in accordance with the principles of BS EN 1997-1: 2004 "Eurocode 7 - Geotechnical Design - Part 1: General Rules", BS EN 1997-2: 2007 "Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and Testing", BS5930: 1999 and BS10175: 2001 and under the full-time supervision of a Fellow of the Geological Society from Michael D Joyce Associates LLP.

9.2 The ground investigation was carried out on the 15th, 19th and 22nd August 2016 and comprised 29 No. trial pits. The trial pitting consisted of excavating a number of trial holes using a mechanical excavator. On completion, the excavations were backfilled with the arisings. The exploratory trial pit positions are shown on figure 2. It should be noted that areas adjacent to Howley Beck were inaccessible due to the very soft ground. In addition, the northwest corner of the site was inaccessible due to slipping on soft side long ground.

10 STRATA PROFILE

10.1 The full exploratory trial pit records are presented in Appendix 1. These give full strata descriptions based on visual examination and are in accordance with the requirements of BS EN ISO 14688-1:2002 "Geotechnical Investigation and Testing - Identification and Classification of Soil - Part 1", BS EN ISO 14688-2:2004 "Geotechnical Investigation and Testing - Identification and Classification of Soil - Part 2", and BS EN ISO 14689-1:2003 "Geotechnical Investigation and Testing - Identification and Classification of Rock - Part 1".

10.2 Trial pits TP1 to TP9 were excavated on the lower-lying southeastern part of the site. Several trial pits indicated a thin covering of Made Ground over Alluvial Deposits in the near surface. The Alluvial Deposits were encountered as slightly clayey sands in trial pits TP1 and TP2.

10.3 This Alluvium was underlain by yellow-brown moderately weathered fine to medium grained sandstone. This became less weathered with depth, such that these two trial pits terminated at around 3m depth on competent bedrock.

10.4 In trial pits TP3 and TP9 the Alluvium was absent. In places there was a thin covering of topsoil and/or Made Ground, below which there was completely weathered sandstone bedrock. This occurred as light brown and orange gravelly sand, which was clayey in places. The degree of weathering decreased with depth, such that below this there was the same moderately weathered sandstone which was encountered in trial pits TP1 and TP2. These trial pits terminated at between 2.6m and 4.0m depth, depending on the degree of weathering. Trial pit TP22 was located towards the top of the slope and this encountered a thin covering of Made Ground over weathered sandstone.

10.5 There appears to be a fault which runs roughly east-west between trial pits TP10, TP11 and TP23 to the south and trial pits TP12 and TP24 to the north. This resulted in the sandstone being replaced by mudstone bedrock to the north of the fault. The mudstone comprises a light brown slightly sandy clayey gravel of mudstone at the surface. With depth the degree of weathering decreases and a highly weathered mudstone becomes moderately weathered. These trial pits generally extended to the maximum reach of the excavator at around 4m depth.

10.6 This mudstone forms the higher ground in the west of the site. However towards the base of the slope there is a change in the geology. Trial pits TP18, TP19, TP20 and TP21 encountered stiff to firm orange-brown sandy clay to around 1.5m to 1.7m depth, which overlies the weathered mudstone. This material may possibly be a Head Deposit. It was also notable that this area was also very soft and boggy. There was also some standing water around trial pit TP20, particularly in areas where there has been some previous localised shallow excavations of the ground surface.

10.7 Trial pit TP17 encountered a little Made Ground overlying a firm to stiff brown and grey sandy clay to 2.3m depth. To the south of this, trial pit TP16 encountered Made Ground to 1.3m depth. This comprised a black and grey sandy gravel of fine to coarse ash, clinker, brick and tile. This in turn overlies orange-grey-brown silty clayey sand to 2.3m and underlain by the weathered mudstone.

10.8 The trial pits in the area to the south of Lady Ann Business Park encountered Alluvial Deposits. Trial pit TP13 encountered very soft brown-grey sandy clayey gravelly clay to 2.9m depth. This had a strong natural organic odour throughout. There was also a thin covering of Made Ground at the surface. Trial pit TP14 encountered very soft

organic clay to 1.6m depth overlying clayey gravelly sand. Mudstone bedrock was encountered at 2.9m depth and 2.2m depth respectively in these two trial pits.

10.9 Trial pit TP19 encountered soft to firm clay to 2.0m depth overlying clayey gravel, with shaly mudstone bedrock at 3.0m depth.

10.10 The same Alluvial Deposits were encountered in trial pit TP11 to 2.1m depth, with very soft organic clay at the surface. Trial pit TP10 was further up the slope and encountered weathered mudstone bedrock below the topsoil.

10.11 Groundwater was encountered as seepages in the following trial pits.

Trial Pit No.	Seepage Depth (mbegl)
TP1	2.1
TP3	2.7
TP7	2.1
TP11	1.0
TP13	1.9
TP14	1.5
TP15	3.0
TP16	3.0
TP17	3.60

10.12 There was no unusual colouration or odours to any of the soils encountered during the investigation and no obvious visual evidence of contamination, such as asbestos, was found during the investigation. This does not mean that asbestos containing materials or asbestos fibres are not present, particularly since they were observed on the surface.

10.13 It should be noted that lateral and vertical changes can occur between exploratory points and care is needed when extrapolation is used. This is particularly true of the Made Ground which, by its nature, can be very variable in its physical and chemical composition.

11 IN-SITU AND LABORATORY TESTING

11.1 In-Situ Gas Monitoring

11.1.1 Methane is the dominant constituent of landfill gas, and can form an explosive mixture in air at concentrations of between 5% and 15%. Thus 5% methane in air is known as the Lower Explosive Limit (LEL). Concentrations less than this do not normally ignite. Carbon dioxide can also be a potential problem, especially where it occurs in concentrations greater than 1.5%.

11.1.2 In-situ gas tests were carried out in probe holes made in the sides of the trial pits. Testing was with a portable meter, which measures the methane content as its percentage volume in air. The corresponding oxygen and carbon dioxide concentrations are also measured.

11.1.3 No methane, carbon monoxide or hydrogen sulphide gases were detected in any of the boreholes. Carbon dioxide ranged from zero to 1.2% by volume.

11.1.4 The risks associated with the gases have been considered in accordance with British Standard BS 8485:2007 “Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments”, CIRIA report C665, “Assessing Risks Posed by Hazardous Ground Gases to Buildings” and NHBC Report No. 4 “Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present”.

11.2 Geotechnical Laboratory Testing

The soil testing was carried out to BS1377:1990 Methods of Test for Soils for Civil Engineering Purposes. Testing was carried out by Envirolab of Cheshire and Geo-Site Testing Services Limited (GSTL) of Llanelli to UKAS accredited procedures. The full results are presented in Appendix 2.

11.2.1 Plasticity Tests

Atterberg Limits Classification tests were carried out on eleven samples of the clay.

Trial Pit No.	Depth (m)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
TP1	1.10	23	42	20	22
TP2	0.80	22	40	19	21
TP4	0.90	14	34	13	21
TP7	1.10	20	42	20	22
TP12	1.30	19	37	19	18
TP14	1.00	30	44	24	20
TP17	2.40	20	37	18	19
TP20	1.00	23	41	22	19
TP24	1.30	15	37	14	23
TP26	1.00	17	53	19	34
TP29	1.60	21	39	18	21

The clays are of a low to high plasticity. They can be expected to exhibit medium swelling and shrinkage properties, but are not potentially frost susceptible.

11.2.2 Sulphate and Acidity Tests

Chemical tests were carried out on representative samples of the sub-soils in order to determine their water soluble content and acidity.

Borehole No.	Depth (m)	Water Soluble Sulphate Content (g/l)	pH
Natural Clay			
TP1	1.10	0.05	7.86
TP4	0.90	0.03	6.87
TP7	1.10	0.03	7.30
TP14	1.00	0.05	6.58
TP17	2.40	0.03	6.69
TP20	1.00	0.02	7.57
TP24	1.30	0.04	7.95
TP26	1.00	0.06	7.16
TP29	1.60	0.06	6.43
Made Ground			
TP1	0.05	0.03	6.29
TP2	0.20	<0.01	6.04
TP3	0.30	<0.01	5.28
TP5	0.20	<0.01	5.37
TP6	0.05	<0.01	6.06
TP13	0.10	0.04	6.76
TP16	0.50	0.04	6.45
TP18	0.05	0.17	6.41
TP20	0.10	<0.01	7.10
TP22	0.05	<0.01	4.61
TP23	0.40	0.04	7.14
Topsoil			
TP4	0.05	<0.01	5.49
TP8	0.05	<0.01	4.68
TP9	0.05	0.01	7.17
TP10	0.05	<0.01	6.87
TP11	0.10	0.06	6.77
TP29	0.05	<0.01	5.19

Contamination testing recorded negligible to low water soluble sulphate contents and acidic to slightly alkaline pH values.

11.3 Contamination Testing

Rationale

11.3.1 The investigation and sampling was under the full time direction of a Fellow of the Geological Society. All the recovered soil samples were screened on site for any visual or olfactory evidence of contamination including the presence of VOCs. Samples were selected from the trial pits on the basis of those which were most likely to be contaminated and those which gave the most appropriate indication of the spread of any contaminants. The samples were stored in both glass and plastic containers and kept in cooled conditions. Testing was carried out by Envirolab of Cheshire to UKAS accredited procedures in accordance with MCERTS performance standards.

11.3.2 The aim of this was to make a preliminarily assessment of the level of any contamination on the site in order to determine if there was any significant risk associated with contaminants in respect of both human health and the environment, including controlled waters.

11.3.3 Standard Appendix B attached to this report discusses the methodology for the assessment of contamination and should be read in conjunction with the comments overleaf.

11.3.4 The Contaminated Land Report (CLR) series of documents have been produced by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency, to provide regulators with "relevant, appropriate, authoritative and scientifically based information and advice on the assessment of risk from contamination in soils".

11.3.5 The Environment Agency has issued a number of Soil Guideline Values (SGVs) which, whilst non-binding, may be used as guidance in the assessment of land and in setting remediation targets. They should only be applied to human health assessments.

11.3.6 The SGVs have been derived using the Contaminated Land Exposure Assessment Model (CLEA) and are based on assumptions relating to soil conditions, pollutant type and behaviour, land use patterns and the availability of receptors. SGVs are also subject to statistical assessment. The CLR documentation requires that the results of laboratory testing are subject to statistical analysis to remove uncertainty over a so-called 'averaging area'.

11.3.7 To date selective SGVs have been issued for the following land-uses as follows;

- Residential with and without plant uptake (SGVres)
- Allotments
- Commercial/Industrial (SGVcomm)

11.3.8 DEFRA previously issued "Outcome of the Way Forward Exercise on Soil Guideline Values". This document was intended to provide guidance to determine if there is a Significant Possibility of Significant Harm (SPOSH) i.e. whether land meets the legal trigger of being contaminated land.

11.3.9 In the context of Part 2A, a risk assessor using an SGV would conclude the following (DEFRA, 2008).

- At a representative average soil concentration at or below an SGV, it is very unlikely that there will be a *significant possibility of significant harm (SPOSH)*.

- At a representative average soil concentration above an SGV, there *might* be a *significant possibility of significant harm* with the significance linked to the margin of exceedance, the duration and frequency of exposure, and other site-specific factors that the enforcing authority may wish to take into account. Further investigation and/or detailed evaluation will usually be required.

11.3.10 It should be stressed that where there is any uncertainty as to whether or not there is a SPOSH, it was the policy of this practice to adopt a conservative approach, particularly in the adoption of clean cover systems.

11.3.11 In April 2012, Defra published new Statutory Guidance which forms a major part of their contaminated land regimes under Part 2A of the Environment Protection Act 1990. The regime provides a means of dealing with contaminated land which poses a significant risk to human health or the environment where there is no alternative solution. It also works alongside planning rules and building regulations to help ensure that affected land is made suitable for use when it is redeveloped.

11.3.12 Since the regime was first introduced in 2000 there has been considerable uncertainty over how to decide when land is, and is not, contaminated land on grounds of the legal test of *significant possibility of significant harm to human health or the environment*.

11.3.13 To help address this, one of the main changes set out in the new Statutory Guidance, is the introduction of a new four category test to help decide when land is, and is not, contaminated land on grounds of *significant possibility of significant harm to human health*. Under the new four category test:

- Category 1 describes land that is clearly contaminated land, for example because similar land is known to have caused significant harm in the past.

- Categories 2 and 3 cover less straightforward land where more detailed consideration is needed before the regulator can decide either: (a) that there is a strong case for regulatory action, in which case the land would be in Category 2 and be classified as contaminated land under Part 2A; or (b) that such a case does not exist, in which case the land would be in Category 3 and not be classified as contaminated land under Part 2A.

- Category 4 describes land that is clearly not contaminated land, as discussed below.

11.3.14 One of the main purposes of including the Categories in the Statutory Guidance is to provide a legal framework against which new technical tools can be developed by the land contamination sector to describe the Categories in more detail with regard to specific substances and/or situations.

11.3.15 The new Category 4 test is particularly important in terms of reducing uncertainty over when land is definitely not caught by the regime.

11.3.16 The new Statutory Guidance makes clear what land should be placed into Category 4, for example:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil (as explained in Section 3 of the guidance), unless there is a particular reason to consider otherwise. In other words land with normal background concentrations in the soil.

(c) Land that has been excluded from the need for further inspection and assessment under Part 2A because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of the guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of the guidance, e.g. Category 4 Screening Levels.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed to in the normal course of their lives).

11.3.17 The guidance clarifies how generic assessment criteria (including the currently available SGVs/GACs) should and should not be used. It states that:

3.27 It is common practice in contaminated land risk assessment to use "generic assessment criteria" (GACs) as screening tools in generic quantitative human health risk assessment to help assessors decide when land can be excluded from the need for further inspection and assessment, or when further work may be warranted.

3.28 Local authorities may use GACs and other technical tools to inform certain decisions under the Part 2A regime, provided: (i) they understand how they were derived and how they can be used appropriately; (ii) they have been produced in an objective, scientifically robust and expert manner by reputable organisations; and (iii) they are only used in a manner that is in accordance with Part 2A and this Guidance.

3.29 GACs relating to human health risk assessment represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health. With regard to such GACs:

(a) They may be used to indicate when land is very unlikely to pose a significant possibility of significant harm to human health. This is on the basis that they are designed to estimate levels of contamination at which risks are likely to be negligible or minimal and far from posing a significant possibility of significant harm to human health.

(b) They should not be used as direct indicators of whether a significant possibility of significant harm to human health may exist. Also, the local authority should not view the degree by which GACs are exceeded (in itself) as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.

(c) They should not be seen as screening levels which describe the boundary between Categories 3 and 4 in terms of Section 4 (i.e. the two Categories in which land would not be contaminated land on grounds of risks to human health). In the very large majority of cases, these SGVs/GACs describe levels of contamination from which risks should be considered to be comfortably within Category 4.

(d) They should not be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part 2A.

(e) They should not be used as generic remediation targets under the Part 2A regime. Nor should they be used in this way under the planning system, for example in relation to ensuring that land affected by contamination does not meet the Part 2A definition of contaminated land after it has been developed.

11.3.18 The way in which the new four category system is intended to operate and the place of the C4SLs within that system, was explained in detail in the Impact Assessment which accompanied the Statutory Guidance. Please note that although the detail of the Impact Assessment is included here to provide clarity on the job expected of C4SLs, the Statutory Guidance, itself, sets out the regime that needs to be delivered under Part 2A.

11.3.19 The C4SLs are intended as "*relevant technical tools*" (in relation to Paragraph 4.2.1(c)) provides to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

11.3.20 The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

> *"The new statutory guidance with bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land".*

11.3.21 A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

> *"SGVs are guidelines on the level of long-term human exposure to individual chemicals in soils that, unless stated otherwise, are tolerable or pose a minimal risk to human health".*

11.3.22 C4SLs, therefore, should not be viewed as "SPOSH levels" and they should not be used as a legal trigger for the determination of land under Part 2A.

11.3.23 In 2014 CL:AIRE (Contaminated Land: Application in Real Environments) published "*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*". In it a series of C4SLs were proposed as follows;

Analyte	Residential (with home grown produce) (mg/kg)	Residential (without home grown produce) (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)	POS (mg/kg)
Arsenic	37	40	49	640	79
Benzene	0.87	3.3	0.18	98	140
Benzo(a)Pyrene	5.0	5.3	5.7	77	10
Cadmium	22	150	3.9	410	880
Chromium (vi)	21	21	170	49	21
Lead	200	310	80	2300	630

Results

11.3.24 Five samples of topsoil and twelve samples of Made Ground were tested. The following range of results was obtained and the full results are presented in Appendix 3.

Topsoil

Analyte	Concentration Range (mg/kg)		SGV/C4SL Concentration for Residential Use (mg/kg)
Arsenic	4	31	32 (2) / 37 (3)
Cadmium	<0.05	<0.05	10 (2) / 22 (3)
Chromium (vi)	<1	<1	21 (3)
Copper	5	700	2330 (1)
Mercury	<0.17	<0.17	170 (2)
Nickel	14	46	130 (2)
Selenium	<1	<1	350 (2)
Lead	11	154	200 (3)
Zinc	54	348	3750 (1)
Phenol	<1	<1	420 (2)
Benzo(a)pyrene	<0.04	1.45	5.0 (3)
Dibenzo(a,h)anthracene	<0.04	0.24	0.9 (1)
Naphthalene	<0.03	0.19	8.7 (1)
Fluorene	<0.01	0.21	780 (1)
Asbestos	None	None	None

(1) *Values derived by LQM/CIEH "Generic Assessment Criteria for Human Health Risk Assessment" 2009. For organics a SOM of 2.5% assumed.*

(2) *Latest SGV published in 2009.*
< indicates below the limit of detection.

(3) *C4SL published 2014.*

11.3.25 All the results for topsoil fell below their respective C4SLs and SGVs for a residential end-use.

Made Ground

Analyte	Concentration Range (mg/kg)		SGV/C4SL Concentration for Residential Use (mg/kg)
Arsenic	15	136	32 (2) / 37 (3)
Cadmium	<0.05	0.08	10 (2) / 22 (3)
Chromium (vi)	<1	<1	21 (3)
Copper	44	436	2330 (1)
Mercury	<0.17	1.86	170 (2)
Nickel	21	39	130 (2)
Selenium	<1	<1	350 (2)
Lead	47	432	200 (3)
Zinc	66	1060	3750 (1)
Phenol	<1	<1	420 (2)
Benzo(a)pyrene	0.17	3.13	5.0 (3)
Dibenzo(a,h)anthracene	<0.04	0.44	0.9 (1)
Naphthalene	<0.03	1.71	8.7 (1)
Fluorene	0.03	0.76	780 (1)
Asbestos	Amosite	Amosite	None

(1) *Values derived by LQM/CIEH "Generic Assessment Criteria for Human Health Risk Assessment" 2009. For organics a SOM of 2.5% assumed.*

(2) *Latest SGV published in 2009.*
< indicates below the limit of detection.

(3) *C4SL published 2014.*

11.3.26 The Made Ground was found to contain some areas with elevated Arsenic and Lead. Of the twelve samples tested, six exceeded the C4SL of 32mg/kg. Six samples also exceeded the C4SL for Lead of 200mg/kg. In addition, Amosite (Brown Asbestos) board was found in two of the samples.

Waste Acceptance Criteria

11.3.27 The Landfill Directive sets out procedures for waste acceptance at landfills and the types of waste for each class of landfill as specified by Waste Acceptance Criteria (WAC). The WAC are predominantly lists of "limit values" for certain parameters obtained from standard leaching tests of wastes going to landfills. WAC are set out in the Landfill Directive itself. Full details can be found in the Environment Agency document "Guidance for waste destined for disposal in landfills" Version 2, June 2006.

11.3.28 At this stage no samples of Made Ground have been WAC tested. If at a later date materials from the site were to be excavated and removed to landfill this testing would be necessary in addition to that already undertaken.

12 GEOENVIRONMENTAL RISK ASSESSMENT

Conceptual Site Model

12.1 A quantitative health and environmental risk assessment has been carried out as part of this assessment. The process of risk assessment is set out in Part IIA of the Environment Protection Act 1990 and amended in part by The Water Act 2003. This defines contaminated land as *"any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that there is a significant possibility of significant harm being caused, or that significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused".*

12.2 The Act introduces the concept of a pollution linkage. This linkage consists of a pollution (contaminative) source or hazard and a receptor, together with an established pathway between the two. For land to be contaminated, a pollution linkage (hazard-pathway-receptor) must exist. This forms a so-called 'conceptual model' of the site.

12.3 Examples of pathways and effects from land contamination (after PPS 23) are given below, and these are illustrated on figure 3.

12.4 Human Health (Pathways 1-5, Receptors A – C)

Uptake of contaminants by food plants grown in contaminated soil - Uptake will depend on the concentration of a contaminant in soil, its chemical form, soil pH, plant species and prominence in diet.

Ingestion and inhalation - Substances may be ingested directly by young children playing on contaminated soil, or by eating plants which have absorbed metals or are contaminated with soil or dust. Ingestion may also occur via contaminated water supplies. Metals and some organic material substances may be inhaled from dusts and soils. Land gas, radon and volatile organic compounds can be inhaled directly.

Skin contact - Soil containing tars, oils and corrosive substances may cause irritation to the skin through direct contact. Some substances (e.g. phenols) may be absorbed into the body through the skin or through cuts and abrasions.

Irradiation - As well as being inhaled and absorbed through the skin, radioactive materials emitting gamma rays can cause a radiation response.

Fire and explosion - Materials such as coal, coke particles, oil, tar, pitch, rubber, plastic and domestic waste are all combustible. Both underground fires and biodegradation of organic materials may produce toxic or flammable gases. Methane and other gases may explode if allowed to accumulate in confined spaces.

12.5 Buildings (Pathways 7 and 8)

Fire and explosion - Underground fires may cause ground subsidence and cause structural damage. Accumulations of flammable gases in confined space leads to a risk of explosion. Underground fires may damage services.

Chemical attack on building materials and services - Sulphates may attack concrete structures. Acids, oils and tarry substances may accelerate corrosion of metals or attack plastics, rubber and other polymeric materials used in pipework and service conduits or as jointing seals and protective coatings to concrete and metals.

Physical - Blast-furnace and steel-making slag (and some natural materials) may expand. Degradation of fills may cause settlement and voids in buried tanks and drums may collapse as corrosion occurs or under loading.

12.6 Natural Environment (Pathway 6, Receptors D - E)

Phytotoxicity (prevention/inhibition of plant growth) - Some metals essential for plant growth at low levels are phytotoxic at higher concentrations. Methane and other gases may give rise to phytotoxic effects.

Contamination of water resources - Soil has a limited capacity to absorb, degrade or attenuate the effects of pollutants. When this is exceeded, polluting substances may enter into surface and groundwaters.

Ecotoxological effects - Contaminants in soil may affect microbial, animal and plant populations. Ecosystems or individual species on the site, in surface waters or areas affected by migration from the site may be affected.

12.7 For any contaminant source identified, judgement is used regarding the probability of a pollution linkage occurring and the potential consequences of that linkage. Based on the probability and likely consequences, the overall risk (significance) can be established. The definitions that have been used for this purpose are given in Standard Appendix B. The probability of a hazard, combined with its consequences, can be used to assess risk. This forms the so-called Conceptual Site Model.

Sources

12.8 The site has been used in the past as allotments. As such heavy metals, especially lead, zinc, copper and arsenic can be present. In addition, asbestos cement sheeting will have been used in part in former buildings, such as sheds, as evidenced by observations on site.

Risk Assessment based on Conceptual Site Model
Summary of Hazards, Pathways and Receptors

Source	Potential Pollutant	Pathways	Receptor	Risk (1)
Potential contaminated Made Ground. **Possible past minor spillages and metals.**	Oils, fuels, grease, hydraulic fluid, metals, asbestos.	1 - 5	A. Present Occupants.	Site Unoccupied.
			B. Groundworkers.	**Low Risk** involved with excavation work, providing personnel adopt suitable precautions, together with washing facilities.
			C. Future Occupants.	**Low Risk** for residential use, providing Made Ground is capped by clean sub soil and topsoil.
		6	D. Controlled Waters.	**Low Risk at present.** Provided on-site monitoring is undertaken throughout, and ground work phases of development shows no adverse effects, the risk will be **low**.
			E. Ecosystems.	**Low Risk** as leaching is not considered likely.
		7	F. Building Materials and Services.	**Low Risk.** Install pipes in clean bedding materials. Adequate precautions to be taken in respect of buried concrete.
Organic Material.	Landfill Gases, Radon, VOCs, SVOCs.	8	A - F	**Moderate Risk.** Low values of ground gases present during the investigation. However Basic Radon Gas Protection Measures are required.
Waste materials.	Fly-tipping.			Any waste materials to be removed from site.

(1) See Standard Appendix B. *The risk ratings are based on the results of the investigation, assumes that the remedial measures proposed in Section 13 are applied.*

Pathways and Receptors

12.9 The principal receptors are groundworkers, future residents and controlled waters (Receptors B, C and D). However based on the past history of the site and the laboratory testing to date, the probability of contamination being present sufficient to affect the identified receptors is considered to be a low risk.

12.10 The overall risk is assessed to be low. At this stage it is not considered that there is likely to be any significant risk and further intrusive investigation in respect of contamination is not considered to be necessary.

12.11 With any site, the possibility of contaminants being present, sufficient to cause significant harm cannot be entirely precluded without extensive intrusive investigation, sampling and testing since it is not always possible to determine if contaminants have been tipped on the site, or have seeped into the ground, or have migrated below the ground onto the site from adjacent pieces of land. However, based on the investigation carried out to date, this is considered unlikely.

12.12 It is recommended that if during construction any suspicious or unusual odours, colours, liquids or soils are uncovered, these should be brought to the attention of Michael D Joyce Associates LLP and appropriate advice sought.

13 RECOMMENDATIONS

13.1 It is proposed to redevelop the site for residential purposes. At present there do not appear to be any major geotechnical constraints to developing this site. However, there are a number of aspects that need to be taken into consideration when assessing the feasibility and design of this scheme.

13.2 Foundation Criteria

Normal Strip Footings

13.2.1 Normal to deep strip footings will be suitable for most of the new buildings. They will have to be sited below any Made Ground and original topsoil still remaining after site clearance, and founded upon the underlying firm clay. This clay can be expected to exhibit moderate swelling and shrinkage properties. In order to allow for seasonal variations in the moisture content of this clay, foundation levels should be at least 0.9m below groundlevel. At this depth, for foundations sited upon the firm clay, allowable bearing pressures of up to 80kN/m^2 can be adopted. It would also be prudent to lightly reinforce the footings. Since the eastern part of the site lies in a Zone 3 Floodplain, a flood risk assessment will be required in this respect. This will make recommendations in respect of minimum flood levels and other precautions to be taken into consideration with respect of potential flooding.

13.2.2 In all cases the foundation excavations must be inspected to ensure that no footings are sited upon any weak Made Ground, softer clays or other such weak materials that would be incapable of safely sustaining the applied foundation loads. This will be particularly important wherever any appreciable amounts of Made Ground occur.

Wherever any suspect ground is encountered at proposed foundation level, then that footing must be deepened until a satisfactory bearing medium is obtained.

13.2.3 It is normal practice to avoid building directly over faults. It is recommended that for houses within 10m either side of the fault, that these properties are constructed on raft foundations. This will mitigate against potential future movement.

Piling

13.2.4 The Alluvial Deposits are not suitable for founding upon, and it is recommended that piled foundations are used for those properties along the eastern boundary. It is likely that ground levels will have to be raised in this area, such that floor levels are sited above predicted future flood levels. Recommendations are made in Section 13.13 with respect to further investigation to better delineate between strip/trench footings and piled foundations.

13.2.5 In order to provide a satisfactory bearing medium, especially in view of the variable depth and density of fill across this area, all piles will have to be sited within the underlying mudstone or sandstone bedrock. The piling will also have to overcome difficulties expected with shallow groundwater levels along the eastern part of the site adjacent to Howley Beck.

13.2.6 Piling may be inhibited by the presence of denser fill or large sandstone boulders. Where these occur they would either have to be dug out if shallow or additional piles installed if any individual pile terminates above bedrock level.

13.2.7 If piling is adopted in this area, it is recommended that either driven pre-cast concrete or steel tubular piles are used. Steel tubular piles can then be infilled with concrete. Driven piles are preferable to bored piles, as they will be better able to overcome the presence of larger obstructions. A 275mm square pre-cast concrete pile, founded upon competent mudstone or sandstone bedrock, can be expected to have a safe working load of 20 tonnes.

13.2.8 In order to achieve their full working load, each pile must be driven to a `set'. In view of the nature of the backfill, it would be advisable to site all the piles on the underlying bedrock, in order to take full advantage of their maximum carrying capacity. In this respect they should be designed as essentially end bearing.

13.2.9 For piles sited upon bedrock, it is normally recommended that they penetrate into rock at least 5 times their diameter in order to achieve the maximum working load. However this may not always be possible where hard resistant bedrock is encountered. It is recommended therefore that a sufficient number of pile load tests are carried out to ensure that the piles can carry the required working loads without giving rise to any unacceptable settlements. This will be particularly important should piling terminate at shallower levels on suspected fill.

13.2.10 Negative skin friction is not expected to be a major problem especially if no appreciable loads are exerted on the ground at surface level. However, there may be some settlement of the fill around the piles, but as they will be essentially end bearing, this is not expected to affect their performance.

13.2.11 The houses can then be founded upon ring beams designed to span between the piles. In order to bond them to the piles, the tops of the piles must be broken out to expose the reinforcement, which can then be tied into that of the beams.

13.2.12 It is recommended that a specialist piling contractor is used for any detailed design. Any solution must also take into account vibration and the effect on adjacent properties.

13.3 Building Near Trees

13.3.1 Wherever any houses are located near existing or proposed new trees, their foundations must be sited below the potential root growth zone. Reference should therefore be made to the NHBC Standards Chapter 4.2 "Building Near Trees", which gives guidance on foundation criteria, depths and construction. All services will also have to be similarly protected.

13.4 Landfill and Radon Gas

13.4.1 The site is in an area where Basic Radon Protection Measures are required for new properties.

13.4.2 British Standard BR211 (2015) “Radon: Guidance on Protective Measures for New Buildings” all give construction advice for preventing gases entering buildings, the principles of which are incorporated in these recommendations. Advice is also given in respect of sealing services where they pass through impermeable membranes.

13.4.3 The supervision of the installation will need to be undertaken by a suitably qualified consultant. Detailed records and photographs of the installations should be made.

13.5 Existing Drains and Services

13.5.1 Wherever any redundant drains and other services channels are likely to underlie building foundations, they must be dug out and replaced by lean mix concrete, or compacted hardcore. Alternatively, long drainage runs can be grouted up, particularly where their alignments are uncertain but care is needed to ensure that no grout enters any live services. In the case of roads, they should be dug out and the areas infilled by properly compacted fill.

13.6 Road Construction

13.6.1 The new road should conform to the specifications of a Type A1 Road, up to 5.5m wide, in accordance with the former West Yorkshire County Council "Highways Design Guide", which continues to be implemented by the district council. It should also conform to "The Specifications of Highway Works" and "The Notes for Guidance on the Specification for Highway Works".

13.6.2 For most of the site the subgrade will comprise weathered mudstone or sandstone bedrock. In some places Made Ground will underlie the new carriageway. This should be dug out to a depth of 0.75m and replaced by suitable, non-frost susceptible materials, laid in properly compacted layers to formation level.

13.6.3 It is recommended that a design CBR of 2% be adopted for some of the new roads. This will allow for a reasonable construction thickness on top of the subgrade, as well as for any isolated weaker areas of the clays. For the road along the east part of the site, Alluvial Deposits are likely to comprise the subgrade, and as such a lower CBR of 1% should be assumed for this material.

13.6.4 The design of trafficked pavements must take account of the ground conditions and likely traffic loads during the life of the development. Designs meeting the following requirements will normally be acceptable. At sites where particular poor ground conditions are encountered or where it is anticipated that there will be a particularly high frequency of commercial vehicle or abnormal load movements, further analysis is accordance with the "Design Manual for Roads and Bridges" will be required to demonstrate integrity of the design.

13.6.5 A preliminary design can be prepared using an "Equilibrium CBR" value based on the appropriate type of sub-grade material as set out in the table below. However, if this method of CBR estimation is used, testing by an approved laboratory will be required prior to construction in order to verify the CBR value used for design.

Equilibrium CBR Value to be used for Design Purposes		
Type of Soil	**Plasticity Index**	**Equilibrium CBR (%)**
Heavy Clay	50 or greater	Less than 2
Heavy Clay	40 to 49	2
Heavy Clay	30 to 39	2
Silty Clay	20 to 29	3
Sandy Clay	10 to 19	4
Silt	Less than 10	1
Sand (Poorly graded)	Non-plastic	20
Sand (well graded)	Non-plastic	40
Gravel (poorly graded)	Non-plastic	40
Sandy Gravel (well graded)	Non-plastic	60

(*Based on Design Manual for Roads and Bridges)*

13.6.6 A granular foundation comprising sub-base or a combination of sub-base and a capping layer can be provided in accordance with the table below.

Pavement Foundation Design					
CBR (%)	**Capping (mm)**	**+**	**Sub-Base (mm)**	**OR**	**Sub-Base (mm)**
Less than 2	600	+	150		--
2	450	+	150		--
3	350	+	150	OR	300
4	300	+	150	OR	275
5 to 15	250	+	150	OR	225
> than 15	--	+	--		150

13.6.7 Sub-grades that have CBR values significantly less than 2% and deform under construction traffic may be unsuitable to support the pavement. In this case, special measures will be required. No material within 450mm of the finished road surface should be frost susceptible.

13.6.8 Prior to the application of any sub-base, all subgrades must be checked by proof rolling to ensure that an adequate CBR exists. Where any loose granular or soft clayey areas remain, these must be either dug out and replaced by compacted material or an additional 150mm of sub-base added. This will be especially important wherever trench works for drains, sewers and other services have been carried out. Old foundations should be removed to a depth of 1m below subgrade level to prevent hardspots occurring. It will also be necessary to prevent the deterioration of the subgrade due to the effects of wet weather and the site traffic.

13.7 Sustainable Surface Water Drainage

13.7.1 As the southern third of the site is underlain by sandstone bedrock, soakaways for carriageway and/or house roof surface water drainage should be feasible in this area. Each soakaway will have to be sited in the clean, unweathered zone of the sandstone bedrock, which should be at a reasonable depth. If soakaways are proposed, it will be necessary to carry out some further representative tests in order to establish the permeabilities of the sandstone bedrock, and depths of clean unweathered zones at the actual locations of the proposed soakaways. Soakaways should be designed in accordance with BRE Digest 365: *Soakaway Design* and sized so that they discharge the design storm within 24 hours.

13.7.2 The positioning of the soakaways should also take into account potential downslope discharge of the surface water. In addition, no soakaways should be placed within 5m of building foundations, nor should they discharge directly into Made Ground.

13.7.3 Soakaways will not be suitable in the mudstone bedrock underlying the northern two-thirds of the site. As an alternative it may be possible to discharge directly to the watercourse.

13.8 Excavations and Groundwater

13.8.1 Soft ground plant should prove suitable for most of the excavations.

13.8.2 For all deep excavations in excess of 1.2m where vertical sides are necessary, trench supports should be provided as the soils will not be self-supporting for any appreciable length of time. It would also be prudent to monitor excavations for the presence of explosive or asphyxiating gases.

13.8.3 Groundwater seepages were noted in places in the near surface. It should also be remembered that trapped groundwater can be released from areas of Made Ground when they are excavated. In addition seasonal variation in groundwater levels will occur and groundwater will be shallower during the winter months. In this respect it is considered good practice for ground staff to be equipped with pumping apparatus as a precaution. Along the eastern boundary of the site this standing groundwater level is expected to lie very close the level of Howley Beck.

13.9 Re-use of Materials

13.9.1 In England, the SWMP Regulations 2008 came into force on 6th April 2008. They apply to 'construction projects', and to the whole life of a construction project, from design all the way through to completion. As well as including actual construction works, they include renovation projects, site preparation works, the installation of services, and all kinds of demolition. If you carry out a construction project where the value of the materials plus labour exceeds £300,000, it becomes a criminal offence (for both the project manager and the main contractor) not to produce a SWMP.

13.9.2 The Plans must include basic elements such as who prepared it, who's in charge of the project, who's the main contractor, what's the location, and what's the estimated value. But it must also include details of the decisions taken at the outset on (1) the design of the project, (2) the methods employed and (3) the materials employed in order to minimise the quantity of waste produced on site. It will therefore be necessary to have evidence of that thought process. The SWMP must describe each type of waste that will be produced, and estimate the volume.

13.10 Contamination

13.10.1 Laboratory testing to date has recorded contamination in the Made Ground but not in the topsoil. It is therefore recommended that in the first instance any asbestos cement sheeting is removed from the topsoil. This should be done by hand-picking of pieces from the surface, bagging and disposal at a licensed facility.

13.10.2 The topsoil should then be separated from the Made Ground during the site strip. It should be possible to remove the topsoil, but the Made Ground should be reused only below hardstanding areas. Providing the asbestos cement sheeting has been removed, it should be possible to reuse the topsoil subject to the approval of the regulators.

13.10.3 As a precautionary measure and to provide a growing medium for plants, it is recommended that a clean cover system is applied to garden areas only where Made Ground forms the subsoils. The clean cover system should consist of a minimum of 600mm of clean topsoil and sub-soil. This is in accordance with the recommendations in the joint NHBC, Environment Agency and Chartered Institute of Environmental Health publication "Guidance for the Safe Development of Housing on Land Affected by Contamination" published in 2008.

13.10.4 According to the Environment Agency's Remediation Position Statements, the placement of a cover system using "clean" material is not treatment of waste. Consequently, no licensing/permitting position statements are applicable to this type of remediation. If the cover system uses 'waste materials' in its construction, waste management licensing exemption paragraph 9A may be applicable to its installation. If the installation of the proposed cover system does not meet the criteria for

registration of this exemption, the activity may be regulated through a waste management site licence.

13.10.5 The clean cover system should be validated in accordance with the "Verification Requirements for Cover Systems – Technical Guidance for Developers, Landowners and Consultants". This document has recently been issued by the Yorkshire and Humberside Pollution Advisory Council and adopted by Local Authorities in Yorkshire, Humberside and Lincolnshire. Where applicable, it should also be in accordance with the requirements of the NHBC as set out in Standards Extra 47 (June 2010) "Contaminated Land – Cover System Validation".

13.10.6 Material can be sourced from clean site won. In the interest of sustainability, Local Authorities promote the use of such site-won materials providing that they are suitable for the intended end use of the site. Alternatively, materials can be sourced from other developments and commercial companies. It may be possible to reuse the topsoil. However there is a practical difficulty in that care will be necessary to exclude Made Ground materials and also to ensure that asbestos cement sheeting is not included. If it is intended to be reuse the topsoil, the stockpile should be inspected for any asbestos and Made Ground materials. Some further testing will be necessary to confirm this.

13.11 Cement and Buried Concrete

13.11.1 The Made Ground has generally been found to contain low levels of water soluble sulphates.

13.11.2 In accordance therefore with the Building Research Establishment Special Digest No. 1 "Concrete in Aggressive Ground", a normal Portland cement in accordance with Group DS-1 Specifications should be used for all buried concrete, mortar, concrete piles, and pre-cast concrete pipes. In local areas Made Ground is present and a sulphate resisting cement (DS-2) would be prudent in these areas.

13.12 Services

13.12.1 Flexible service connections will be necessary on this site, especially in the areas of deeper fill. In addition, adequate gradients should be provided for all drains and sewers so as not to create backfalls should any future ground movements take place in the deeper backfill. Compacting the bases of all such trenches will reduce settlement.

13.12.2 Wherever drains and mains services pass from natural to Made Ground strata, adequate flexibility should be provided so that breakages do not occur due to adverse settlements between materials of differing compressibility.

13.12.3 The results of the chemical testing should be provided to the utilities companies so that any specific requirements they may have can be provided for.

13.13 Further Monitoring and Inspection

13.13.1 It is strongly recommended that the extent of the very soft and soft Alluvial Deposits along the eastern boundary of the site, are better defined. This should be with a series or window sampling boreholes, during which Standard Penetration Tests (SPTs) should be carried out to determine the bearing capacity of the soils. It is also

recommended that a series of combined gas and groundwater monitoring standpipes are installed as part of this work. In order to confirm a suitable material for possible piles, this work should be supplemented by a few deeper cable percussive boreholes.

13.13.2 As discussed in Section 13.1, it is normal practice not to construct across fault lines. It is recommended that the position of the fault is better identified.

13.13.3 Should any geotechnical or geoenvironmental problems arise on site or if ground conditions are different from those that we predicted, they should be referred back to Michael D Joyce Associates LLP.

REDACTED

A D Joyce

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September 2016

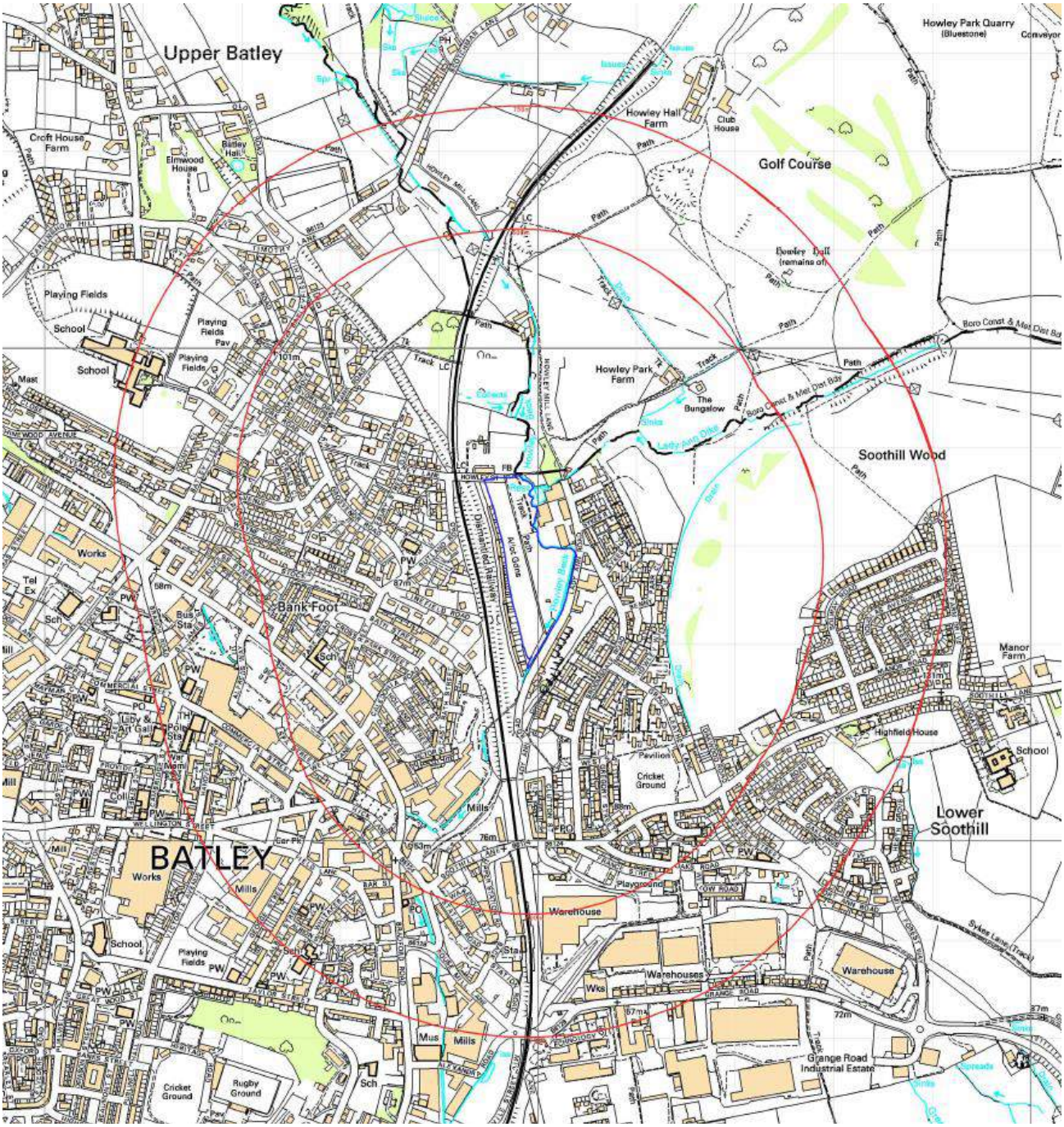
Procedure Notes

The desk study and ground investigation have been carried out in accordance with the principles of BS EN 1997-1: 2004 "Eurocode 7 - Geotechnical Design - Part 1: General Rules", BS EN 1997-2: 2007 "Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and Testing", BS5930: 1999 and BS10175: 2001, and the terms of the client's brief. By its very nature any ground investigation only samples a small percentage of the ground. Consequently changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimize such risks. Conclusions and recommendations are based on the information presented in this report, but unforeseen features may exist. Therefore, actual ground conditions should be noted during construction and further advice sought if they differ significantly from those predicted.

Further investigation can be carried out to further reduce uncertainty and risk but ultimately these risks cannot be eliminated. Similarly a desk study normally only considers readily available information and further information could be held by other sources. In commissioning further research or investigation the cost/benefit of doing so must be considered.

Where buildings are present on a site, structural and asbestos surveys have not been carried out, unless specifically stated. An unexploded ordnance survey has not been carried out. In relevant situations it would be prudent to commission such surveys.

Where information has been obtained from Third Parties, no liability can be accepted for the accuracy or completeness of this information. Where anecdotal evidence or speculations are presented, they must be treated as such and cannot be relied upon.



Lady Ann Road, Batley

Site Location

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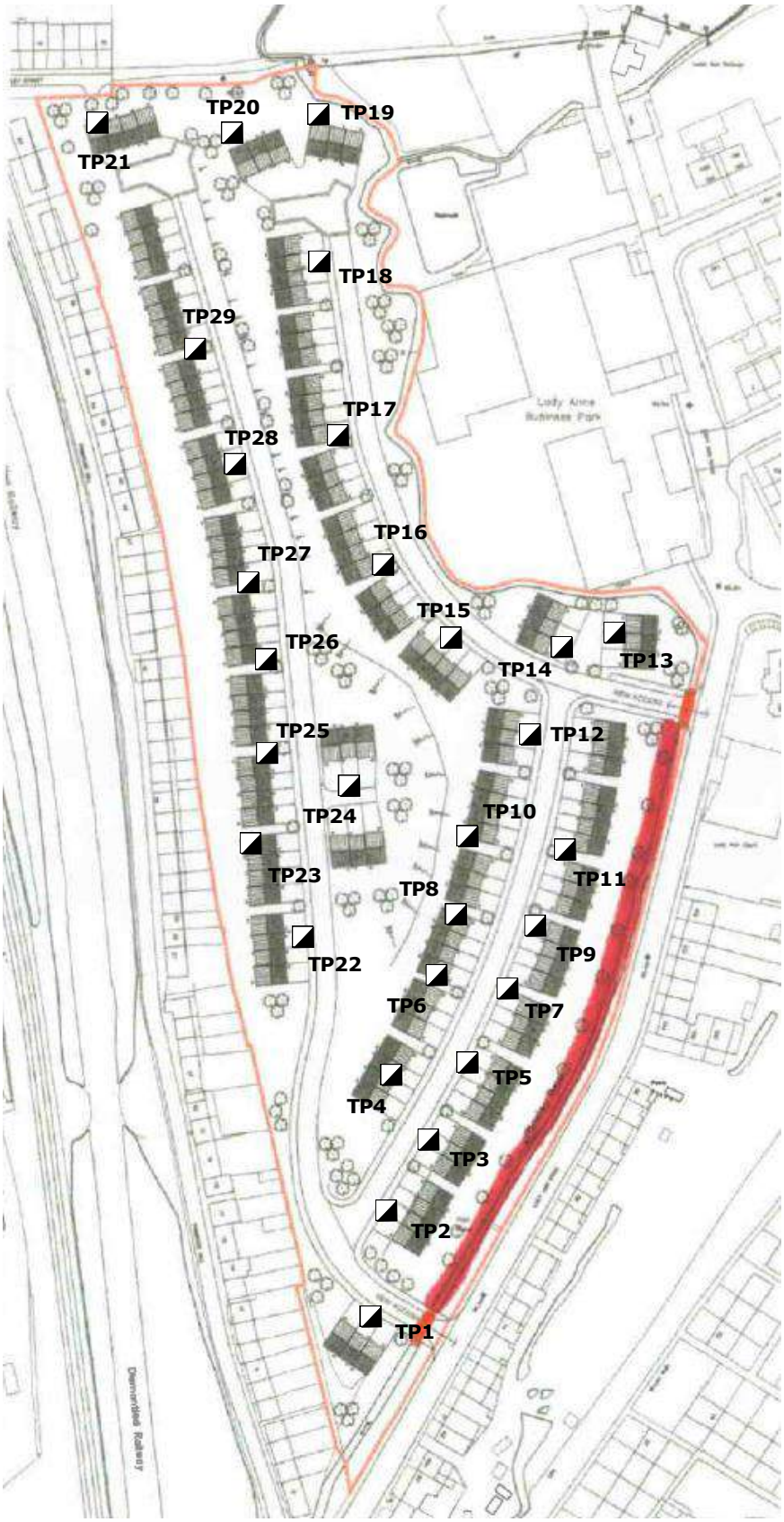
Scale: NTS

Figure: 1



Lady Ann Road, Batley

Site Plan with Development Proposals and Exploratory Trial Pit Positions

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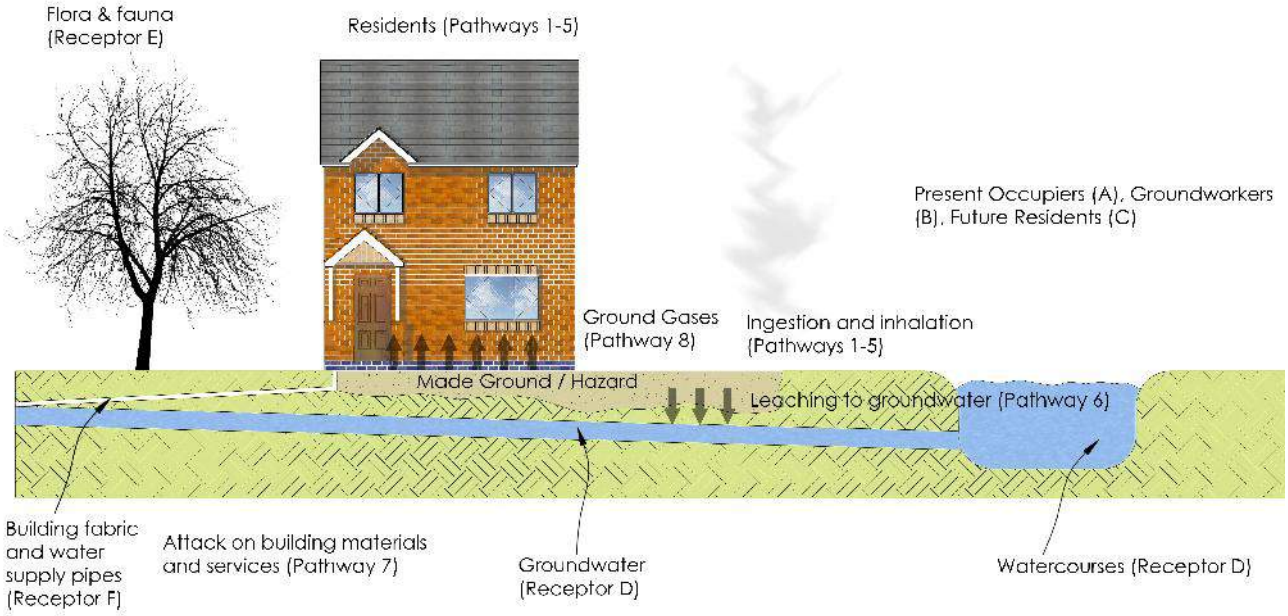
Scale: NTS

Figure: 2



Pathways

1. Ingestion of contaminated soil/dust
2. Ingestion of contaminated food
3. Ingestion of contaminated water
4. Inhalation of contaminated vapours
5. Dermal contact with contaminated soil/dust or water
6. Pollution of controlled water and off site migration
7. Attack on building materials and services
8. Migration of landfill gases and radon

Receptors

A. Present site occupiers
B. Site development personnel
C. Future residents
D. Controlled waters
E. Flora and fauna
F. Building and services

Schematic Representation of Conceptual Site Model

Schematic Representation of Conceptual Site Model

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Figure: 3