Land East of Penistone Road, Fenay Bridge, Huddersfield

Summary Report on Previous Site Investigation

ENGIE Regeneration Ltd

Report prepared by:
Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW
0114 266 9292

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Ecus Ltd

Report to: **Engie Regeneration Ltd**
Callflex Business Park
Golden Smithies Lane
Wath upon Dearne
Rotherham
S63 7ER

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Originated By: REDACTED

M A McDowell BSc (Hons) CGeol EurGeol FGS
Principal Geoscience Consultant Date: 19 December 2018

Reviewed and Approved By: REDACTED

K Hawkins BSc (Hons) MSc DIC CBiol
CSci FRSB MIoD
Regional Director Date: 3 January 2019

Prepared by:
Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW

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Executive Summary

Site Location	The Site is situated on land east of Penistone Road, Fenay Bridge, Huddersfield and is approximately 2.3 hectares in area. The National Grid Reference for the Site is E: 418600, N: 414820.
Current Site Use	The Site comprises a single undeveloped parcel of agricultural land (presumed to be open pasture land).
Proposed Site Use	The Site is anticipated to be developed with residential housing and associated private gardens.
Previous Site Uses	The Site has remained undeveloped throughout its history.
Geological Setting	No superficial drift deposits or artificial made ground are recorded across the Site or immediate vicinity. The Site is recorded to be underlain by the Grenoside Sandstone, part of the Lower Pennine Coal Measures, dating to the Carboniferous period. No geological faults are shown to affect the Site.
Environmental Considerations	No pollution incidents have been highlighted within 250 m that could affect the Site. The Site is not located within a groundwater Source Protection Zone and the underlying bedrock is recorded to be a Secondary (A) aquifer. No recorded landfill sites have been identified within 250 m of the Site. The Better Bed coal seam could present a ground gas risk. No radon protection measures are required for the new buildings.
Preliminary Contamination Assessment	No historical or potential sources of contamination have been identified on site. Soil testing indicated elevated arsenic with subsequent statistical analysis confirming a UCL below the screening value. An exceedance of mercury is considered to be an outlier and not representative of the wider site environment. The risk to human health is overall considered to be low. The risk of pollution to controlled waters is very low. The risk from hazardous ground gases is considered to be low.
Geotechnical Considerations	The Site is not deemed to be at risk from unrecorded shallow mine workings or quarrying. Based on the anticipated ground conditions consideration could be given to founding the new dwelling on strip footings seated into stiff / residual soils or weathered bedrock. At this stage full construction thickness should be assumed for a stratum with 2.5% CBR for any highway or pavement areas. Concrete design conditions of DS-1 and AC-2z for slightly acidic ground have been determined. Soakaways are not recommended.
Recommendations	Remediation measures for contaminated land are not considered necessary. An Earthworks Method Statement is recommended to address re-profiling of the Site. This may require additional geotechnical testing to obtain design data (e.g. compaction tests).

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1 Introduction

1.1 Terms of Reference

1.1.1 Ecus Ltd (hereafter Ecus) was commissioned by ENGIE Regeneration Ltd (the 'Client') to undertake a desk-based review of existing site investigation data for land at Fenay Bridge, Huddersfield (hereafter referred to as 'the Site') The Site location is shown on Figure 1.

1.1.2 The report follows the general format of a Phase 1 geo-environmental desk study but uses existing WSP report 'Land At Fenay Bridge: Combined Phase I and Phase II Ground Risk Appraisal' (Report Reference. 70035780-001, dated October 2017) as the primary source of information. The WSP report, while containing a significant amount of useful data, was found to be lacking in its conclusions on some issues; Ecus were asked to review and update WSP's findings and to provide firmer conclusions where possible, or to identify limitations and further work requirements where necessary.

1.2 Objectives

1.2.1 The assessment has been carried out in general accordance with the requirements of British Standards BS5930 (2015) – *Code of Practice for Ground Investigations* and BS10175 (2011+A2:2017) – *Investigation of Potentially Contaminated Sites*. *Code of Practice.*

1.2.2 The general objectives of the assessment are as follows:

- Review existing site investigation data covering both geo-environmental and geotechnical issues;
- Review the geological, hydrogeological and hydrological conditions identified under the Site;
- Confirm that the Conceptual Site Model (CSM) of potential linkages between potential sources of contamination and receptors through likely pathways is still valid and update where appropriate;
- Review potential geotechnical constraints or hazards from the ground conditions and confirm geotechnical recommendations for foundations, pavements and drainage where appropriate;
- Confirm the status of any coal mining risk to the Site; and
- Provide any recommendation for further investigations or remedial actions as may be necessary.

1.3 Future Site Use

1.3.1 It is proposed to develop the site with approximately eighty residential properties with private gardens as shown on Figure 2.

1.3.2 This report has been written in relation to this site end-use; should the proposed Site use change then the conclusions and recommendations of the report will require reassessment.

1.3.3 Any changes in the development layout within the red-line boundary are not considered likely to be significant in terms of the findings of this report.

1.4 Sources of Information

1.4.1 Table 1 presents sources of information that have been consulted during this assessment.

Table 1: Sources of Information

Source	Details
Client	The Client provided information in relation to the proposed future use of the Site.
Site Walkover	Information about the Site was gained from visual inspection during a site walkover.
Previous Site Investigation Reports	WSP report 'Land At Fenay Bridge: Combined Phase I and Phase II Ground Risk Appraisal' (Report Reference. 70035780-001, dated October 2017) is included as Appendix B. The report looks at three sites in the Fenay Bridge area. The information for 'Plot D' is relevant to this review.
British Geological Survey (BGS)	The BGS Geoindex website[1] was consulted for geological information relating to the site and surrounding area.

1.5 Limitations

1.5.1 The recommendations presented in this report are based on the findings of the available information reviewed when compiling the report. Published information has been rechecked using publically available online resources where possible.

1.5.2 Ecus cannot be held responsible for any recommendations or conclusions based on the published information if it is later proven to be inaccurate.

1.5.3 It should also be noted that there may be other conditions prevailing on the site which are not disclosed by the available information and therefore could not be taken into account when writing this report. Ecus cannot be responsible for unrecorded information.

1.5.4 The conclusions and recommendations of this report cannot be guaranteed to gain regulatory approval. This report should be passed to the relevant regulatory authorities for their comment and approval prior to undertaking any works on site if it is required as part of a Planning Application.

[1] http://www.bgs.ac.uk/geoindex/. Accessed 14th November 2018.

2 The Site

2.1 Location

2.1.1 The Site is approximately 2.3 hectares in area, and is situated on land east of Penistone Road, Fenay Bridge, Huddersfield. Figure 1 shows the location of the Site which centres on National Grid Reference E: 418600, N: 414820.

2.1.2 A Site walkover survey was carried out by Ecus on 19th December 2018. Figure 2 shows the proposed layout of the Site. Photographs of the Site are presented in Appendix 1.

2.2 Site Description

2.2.1 At the time of the walkover survey the Site comprised an undeveloped agricultural field (open pasture land), as shown in photo 1.

2.2.2 The western site boundary was formed by Penistone Road. The eastern site boundary was formed by a disused railway embankment. Whitegates grove bounded the Site to the north, and the southern boundary was marked by existing residential development to the south.

2.2.3 Mature trees were located at the northern end of the Site, with a single oak tree standing alone in the middle of the Site. Further mature trees were present along the eastern boundary. Sparsely planted young trees were present along the western roadside boundary.

2.2.4 No obvious visual or olfactory signs of potential contamination were identified on the Site during the walkover survey. Limited littering was observed by the site entrance, and also included some discarded scaffold boards and organic garden waste (photos 2 and 3).

2.3 Topography

2.3.1 The Site slopes from east to west, the south-east corner is the highest point at c. 97.4 m Above Ordnance Datum (AOD), and the north-west corner is the lowest point at 85.7 m AOD.

2.4 Access

2.4.1 Access to the Site is via Whitegates Grove in the north-west corner of the Site.

2.5 Underground Structures and Services

2.5.1 A formal underground services search has not been undertaken at this stage.

2.6 Surrounding Land Use

2.6.1 The Site is situated at the western side of the village of Fenay Bridge, and is surrounded by residential property to the north, east and south. The land to the west comprises of undeveloped fields.

3 Historical Setting

3.1 Historical Land Use

3.1.1 Historical Ordnance Survey mapping was included in the WSP report (Appendix 2), and has also been verified using online resources such as Old Maps[2].

3.1.2 A description of the historical use of the Site is presented in Table 2, along with a summary of surrounding land uses considered to have the potential to influence the contamination potential of the Site.

Table 2: Summary of Historical Land Use (all distances are approximate)

Map Date	Land Use within the Site Boundary	Potentially Significant Surrounding Land Use
1854	The Site comprised undeveloped agricultural land.	Rowley Bottom is approximately 400 m south-east of the Site. Rowley Mill (Woollen) is approximately 450 m south of the Site. A small gravel pit is located 250 m south. A sandstone quarry lies 200 m east,
1894	No changes shown.	There is a railway embankment (Kirkburton Ranch) that runs along the eastern boundary of the Site in a north-south orientation. The gravel pit is no longer depicted and has potentially been infilled. A fireworks manufactory is shown 300 m east.
1908	No changes shown.	No significant changes shown.
1933	No changes shown.	Railway sidings are shown 50 m south of the Site. Victoria Colliery is shown 200 m south-east of the Site, with Woodsome Colliery located 300 m south-east. Several shafts are also depicted, the closest being an old shaft 200 m north-east. Woodsome Brick Works is located 400 m south-east of the Site.
1938-1948	No changes shown.	No significant changes shown.
1955-1956	No changes shown.	Woodsome Colliery has reduced in size and there are no longer any railway sidings shown.
1965-1968	No changes shown.	Circular structures, potentially brick kilns, are shown to the north and east of the brick works. Several buildings labelled 'Works' are shown in the village of Rowley Hill, 200 m to the east of the Site.
1976-1979	No changes shown.	The railway to the east of the Site is no longer shown. The colliery is no longer shown.
1984	No changes shown.	The potential brick kilns have been cleared.

[2] www.old-maps.co.uk. Accessed 14th November 2018.

Map Date	Land Use within the Site Boundary	Potentially Significant Surrounding Land Use
1992-2017	No changes shown.	No significant changes shown.

3.2 Summary of Historical Land Use

3.2.1 The Site is shown to have remained undeveloped since the earliest available map, dated to 1854. No significant potential sources of contamination on Site identified.

3.2.2 The surrounding area has remained largely rural to the west and residential to the east, with a few industrial works in the vicinity including a brick works and a colliery, which have now become disused.

4 Environmental Searches

4.1 Pollution Incidents

4.1.1 There is one recorded pollution incident within 500 m of the Site. The incident was recorded 30 m north-west of the Site, it occurred as a result of sewage released to an unnamed freshwater stream, dated January 1994. The incident was classified by the Environment Agency (EA) as being Category 2 – Significant.

4.1.2 There are no recorded Part 2(a) sites within 500 m of the Site.

4.2 Discharge Consents

4.2.1 One licensed discharge consents to surface water or groundwater has been identified within 500 m of the Site.

4.2.2 The Consent is held by Woodsome Hall Golf Club for the discharge of treated sewage to Springwood Beck approximately 400 m south-west of the Site. The consent was issued in June 2004.

4.2.3 Within 250 m of the Site, no records for any Water Industry Referrals (potential harmful discharges to the public sewer) have been highlighted.

4.3 Landfill Sites and Waste Management Licences

4.3.1 There are no recorded active or historical landfill Sites, or other waste management facilities located within 250 m of the Site.

4.3.2 There are no recorded licensed waste management facilities within 250 m of the Site.

4.4 Potentially Infilled Land

4.4.1 Ten entries for potentially infilled land relating to three locations are highlighted within 500 m of the Site. The nearest location is shown 125 m south-east of the Site and relates to an unknown filled ground (pit, quarry etc.) dating to 1992.

4.5 Part A and B Authorised Activities

4.5.1 No Part A(1), Part A(2), Part B or Historic IPC Authorisations have been identified within 500 m of the Site.

4.6 Dangerous Substances

4.6.1 Within the Groundsure report, there are no records of any List 1 or List 2 Dangerous Substances within 500 m of the Site.

4.6.2 No records for registered Category 3 or 4 Radioactive substances sites have been identified within 500 m of the Site.

4.6.3 The Groundsure report does not recorded any Control of Major Accident Hazards (COMAH) or Notification of Installations Handling Hazardous Substances (NIHHS) sites within 500 m of the Site.

4.7 Industrial Land Uses

4.7.1 There are six records for industrial land uses relating to three locations within 500 m of the Site. The closest are 360 m south of the Site and cover manufacturing and light engineering services.

4.7.2 No active petrol stations / fuel sites are recorded within 500 m of the Site.

4.7.3 There are no recorded high voltage underground electricity cables or high pressure gas pipelines within 500 m of the Site.

4.8 Environmentally Sensitive Land Uses

4.8.1 The Site is not located within a groundwater Source Protection Zone (SPZ), as set by the EA for the protection of potable groundwater resources.

4.8.2 There are seven records for two registered groundwater abstractions located within a 500 m radius of the Site. The closest lies 400 m south of the Site and is for textile and leather processes at Reliance Gear Co Ltd. The abstractions appear to be live.

4.8.3 No other potential environmentally sensitive receptors have been recorded across the surrounding area in the Enviro Insight report.

4.9 Radon

4.9.1 The Site is located within an intermediate probability radon area (1 to 3 % of homes are estimated to be at or above the Action Level). Protection measures are not normally required in the construction of new dwellings or extensions at this probability level.

4.10 Flood Risk

4.10.1 The Site is not shown to lie within an area deemed to be at risk of flooding from rivers or seas.

4.10.2 According to the British Geological Survey (BGS), the Site is indicated to be at limited risk potential for groundwater flooding at the site.

5 Geology and Mining

5.1 Artificial Deposits and Superficial

5.1.1 The geological map for the area, 1:50,000 scale BGS Sheet 77 (Huddersfield), and BGS sheet SE12SE, scale 1:10,000, have been studied to infer the likely geology of the Site and surrounding area.

5.1.2 No superficial deposits are shown to overlie the solid geological unit in proximity to the Site.

5.1.3 No artificial made ground deposits are recorded to underlie the Site or within the surrounding area.

5.1.4 Shallow soils would therefore be anticipated in the form of residual soils, weathered down from the parent bedrock.

5.2 Solid Geology

5.2.1 The solid strata shown underlying the Site is the Grenoside Sandstone as part of the Pennine Lower Coal Measures Formation, dating to the Carboniferous period. This formation comprises interbedded mudstone, siltstone and sandstone, with more numerous and thicker coal seams in its upper horizon.

5.2.2 The geological maps indicates the Better Bed coal seam is present, trending north to south along the eastern boundary of the Site. The seam is indicated on the 1:10,000 scale geological map to be dipping 2 degrees to the east. The thickness of the Better Bed coal seam is recorded as 0.10m to 0.90 m.

5.2.3 No geological faults are shown to affect the Site.

5.3 Hydrogeology

5.3.1 The bedrock geology (Pennine Lower Coal Measures Formation and the Grenoside Sandstone) is classified by the EA as Secondary A aquifers. These are described as permeable layers capable of supporting water supplies at a local rather than strategic scale.

5.3.2 The Site is not located within a SPZ.

5.4 Hydrology

5.4.1 The Site is located within the EA's defined Humber River Basin District and the Aire and Calder Catchment area.

5.4.2 The nearest named surface watercourse is Fenay Beck, located approximately 80 m west of the Site, which runs in a westerly direction.

5.4.3 Fenay Beck is classified by the EA as having moderate ecological potential and a good chemical water quality.

6 Phase 2 Ground Investigation Summary

6.1 Introduction

6.1.1 The WSP report included the findings of a site specific Phase 2 ground investigation. The investigation appears to have been undertaken broadly in accordance with British Standards BS5930:2015 – *Code of Practice for Ground Investigations* and BS10175:2011+A1:2013 – *Investigation of Potentially Contaminated Sites. Code of Practice.*

6.2 Intrusive Investigation Works

6.2.1 Fieldwork was undertaken at the Site between 15th and 23rd August 2017.

6.2.2 Three rotary boreholes, designated BHD01 to BHD03, were formed by open-hole techniques using a Commachio Geo 205 rig to depths of between 21 m and 24 m below ground level (bgl). The boreholes were positioned along the eastern edge of the Site where the Better Bed coal seam was projected to outcrop to assess the potential for shallow abandoned mine workings.

6.2.3 50 mm diameter ground gas and groundwater monitoring standpipes were installed in the boreholes on completion. Subsequent ground gas and groundwater monitoring was undertaken on two occasions in September 2017. Groundwater samples were also taken for laboratory testing.

6.2.4 Six mechanically excavated trial pits, designated TPD01 to TPD06, were formed using a JCB 3CX to inform the general ground profile across the Site. The pits reached maximum depths of 2.40 m bgl and were sampled to assess background contaminant concentrations and to determine the geotechnical properties of the ground.

6.2.5 Standard penetration testing (SPT) was undertaken in the boreholes in the near surface strata.

6.2.6 A photo-ionisation detector (PID) was used to screen samples for volatile organic compounds during sampling. Results are reported to have been limited to 1 ppm or less.

6.3 Geo-environmental Laboratory Testing

6.3.1 Samples were sent to ALS Laboratories for testing. Determinands included heavy metals, polycyclic aromatic hydrocarbons (PAH) and asbestos.

6.4 Geotechnical Laboratory Testing

6.4.1 Four samples were tested by Geotechnical Engineering Ltd (via ALS) for moisture content and Atterberg Limits (plasticity) testing. The WSP report states that testing for particle size distribution and compaction was undertaken, however no results are included or discussed within the report.

6.5 Ground Conditions

Made Ground

6.5.1 Made Ground was not reported to have been encountered during the ground investigation.

Superficial Deposits

6.5.2 Topsoil was recorded in all trial pit locations as a sandy clay. The topsoil thickness varied between 0.15 m and 0.35 m and the soil was generally described as having a soft consistency.

6.5.3 No superficial deposits other than topsoil were recorded.

Solid Geology

6.5.4 Solid geology consistent with the Pennine Lower Coal Measures Formation was encountered in all locations.

6.5.5 The main detail is provided within the trial pit logs due to the boreholes using an open-hole method that resulted in limited recovery.

6.5.6 The logs indicate the underlying bedrock to have been weathered to a stiff to very stiff (locally firm, locally hard) clay. The clay is frequently slightly sandy or sandy, often containing gravel of mudstone or sandstone lithorelics. The depth of weathered strata was up to 2.00 m bgl.

6.5.7 The underlying bedrock was encountered as a mudstone, typically recovered as gravel indicated a highly fractured or 'non intact' state.

6.5.8 In the boreholes, the bedrock was predominantly recorded as mudstone. Occasional bands of siltstone, 2.40 m to 5.00 m thick, and sandstone, 0.10 m to 1.00 m thick, were recorded at depth.

Groundwater

6.5.9 Groundwater was not encountered during the drilling of boreholes or excavation of trial pits.

6.5.10 Post-fieldwork monitoring indicates two groundwater horizons may exist. The shallowest groundwater was recorded in borehole BHD01 between 7.30 m and 7.41 m bgl.

6.5.11 The deeper groundwater was recorded in boreholes BHD02 and BHD03 between 15.89 m and 16.75 m bgl and appears likely to correspond to sandstone and siltstone bands generally encountered between 10 m and 20 m depth.

7 Geotechnical Considerations

7.1 General

7.1.1 The recommendations given below are based on the available geological information and the anticipated ground conditions at the Site as demonstrated by the existing WSP Phase 2 ground investigation.

7.1.2 These recommendations are based on the proposed development for residential properties. If there are changes to these proposals then modification to the recommendations provided may be required.

7.2 Foundations

7.2.1 It is anticipated that conventional strip footings will be suitable based on the reported stiff to very clays across the Site. These should provide an allowable bearing capacity of up to 125 kN/m^2 based on a 1 m wide strip footing at 1 m depth, more than sufficient for low-rise housing development.

7.2.2 Settlements are anticipated to be less than 25 mm.

7.2.3 Soil volume change potential is indicated to be medium to high based on the available plasticity results. This is not unexpected since the shallow soils are derived from shallow mudstone bedrock which typically has a high plasticity and a minimum foundation depth of 1 m should be sufficient to accommodate this.

7.3 Floor Slabs

7.3.1 The information available is relatively limited but the residual soils have some potential for volume change and suspended floor slabs in line with NHBC guidance for potentially high volume change material are recommended.

7.3.2 If the formation level is on the mudstone bedrock, ground bearing floor slabs may be used.

7.4 Excavations & Earthworks

7.4.1 Based on the desk study information and ground investigation results, significant made ground and granular soils are not currently anticipated.

7.4.2 Temporary support is not anticipated to be necessary for excavations in the clay soils or mudstone bedrock.

7.4.3 Care should be taken where excavations remain open for an extended period since instability can develop over time.

7.4.4 Excavations should be avoided in periods of inclement weather to avoid softening of the clay formation level. Soft spots should be excavated and replaced with a material of similar properties to the surrounding soils.

7.4.5 It is anticipated that some earthwork cut and fill construction will be necessary to achieve the desired construction levels due to the slope of the Site. Compaction testing is understood to have been done as part of the WSP Phase 2 ground investigation but was not included within the information provided. If this can be made available for review, it should be used to prepare an Earthworks Method Statement (EMS) detailing the construction methodology for the cut and fill works. Where the compaction testing is not available, further ground investigation for this purpose would be necessary prior to preparation of the EMS.

7.5 Highways and Hard Standing

7.5.1 Highways Agency Interim Advice Note 73/06 (2009): 'Design Guidance For Road Pavement Foundations' provides a method for estimating the California Bearing Ratio (CBR) of soils based on soil type and plasticity. Based on the results of the WSP Phase 2 ground investigation, a CBR value of 2.5 % should be achievable

across the Site. Based on this, a sub base thickness of 450 mm would be appropriate based on restricted design methodology. It may be possible to reduce this thickness through site specific CBR testing (advisable where materials are to be reworked as fill) or sub grade reinforcement.

7.6 Concrete Protection

7.6.1 A limited number of water soluble sulphate and pH tests were undertaken as part of the chemical testing on samples obtained from the WSP ground investigation. The results indicated water soluble sulphate concentrations of <4.0 mg/l and 49 mg/l, with corresponding pH levels between 5.47 and 7.32.

7.6.2 The results have been assessed in line with BRE Special Digest 1 (2005): 'Concrete in Aggressive Ground' to determine the risk to buried concrete such as foundations. The sulphate results indicate a Design Sulphate Class of DS-1 is appropriate for the Site. It is noted that the pH levels are slightly acidic and the corresponding ACEC classification is therefore proposed as AC-2z, primarily to provide some protection against acidic conditions.

7.7 Soakaways and Site Drainage

7.7.1 The ground investigation results have demonstrated clay soils and shallow mudstone bedrock across the Site. The materials have a low permeability and would not be expected to accommodate rapid soil infiltration of surface waters. On this basis, soakaway drainage is not recommended for the Site.

7.7.2 It is noted that the Site levels vary by as much as 12.00 m, representing a significant fall in ground level that will naturally direct surface water flows to the west towards Penistone Road. Surface water run-off entering the highway drainage system on Penistone Road may not be allowed depending on the local authority drainage strategy, and it may therefore be necessary to incorporate a surface water attenuation pond or similar feature.

8 Coal Mining Risk Assessment

8.1 General

8.1.1 The Site is understood to lie within a Coal Mining Report Area, and partially lies within a Development High Risk Area. This means that the Coal Authority is likely to be a statutory consultee for any planning applications associated with the Site.

8.1.2 The WSP report included a Preliminary Coal Mining Risk Assessment (see Appendix 2). The findings of that assessment are reappraised here alongside a further review of available information to present a more definitive conclusion of the mining risks to the Site.

8.2 Published Geology

8.2.1 The solid strata shown underlying the Site is the Grenoside Sandstone as part of the Pennine Lower Coal Measures Formation, dating to the Carboniferous period. This formation comprises interbedded mudstone, siltstone and sandstone, with more numerous and thicker coal seams in its upper horizon.

8.2.2 The geological maps indicates the Better Bed coal seam is present, trending north to south along the eastern boundary of the Site. The seam is indicated on the 1:10,000 scale geological map to be dipping 2 degrees to the east. The thickness of the Better Bed coal seam is recorded as 0.10m to 0.90 m.

8.2.3 No geological faults are shown to affect the Site.

8.3 Historical Mapping

8.3.1 The closest mapped mining features comprise an old mine shaft approximately 200 m north-west of the Site, and Victoria Colliery located approximately 200 m to the south-east.

8.3.2 The position of the old shaft does not correspond with the Better Bed coal seam and may have been used to target much deeper coal seams, possibly acting as an air shaft. The Victoria Colliery does lie in proximity to the Better Bed coal seam.

8.3.3 Mining appears to have ceased by the 1960s.

8.4 Coal Authority Data

8.4.1 A Coal Authority report was obtained for the Site, but is only summarised within the WSP report. The details summarised are as follows:

- The Site is in a surface area that could be affected by underground mining in three seams of coal at shallow to 230 m depth, last worked in 1931.
- The Site is not within a surface area that could be affected by present underground mining.
- The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 m since 31 October 1994. There is no current Stop Notice delaying the start of remedial works or repairs to the property.

8.4.2 The Coal Authority's online Interactive Map Viewer[3] shows that the eastern edge of the Site is located within a Development High Risk Area, with the remainder of the Site being within a Coal Mining Reporting Area.

8.4.3 The Development High Risk Area along the eastern edge of the Site coincides with the mapped outcrop of the Better Bed coal seam. The line of the outcrop is recorded as having probable shallow coal mine workings, while an area approximately 30 m to

[3] http://mapapps2.bgs.ac.uk/coalauthority/home.html. Accessed 16th November 2018.

the east (beyond the former railway line) is shown as having past shallow coal mine workings.

8.4.4 A mine abandonment plan obtained from the Coal Authority was included in the WSP report. The plan was for Woodsome Outcrop, Huddersfield Collieries Ltd and covers workings in the 'Better Bed Clay' which underlies the Better Bed coal seam. The Better Bed Clay is not highlighted specifically on the geological maps but its position beneath the coal seam indicates it probably represents a thick fireclay that would have been used in local brick manufacture.

8.5 Ground Investigation

8.5.1 Three rotary boreholes were formed using open-hole techniques to depths of up to 24 m bgl. The boreholes were located along the eastern edge of the Site to determine whether the Better Bed coal seam was present and whether there was any evidence of abandoned mine workings.

8.5.2 None of the boreholes encountered coal, and trial pits across the Site similarly did not record any coal within the shallow strata. This does not mean the Better Bed coal seam is absent in the area, but more likely means that it lies along the eastern boundary of the Site, probably beneath the railway embankment.

8.5.3 It is possible that the Better Bed Clay could have been worked but the main mining activity in the area commenced after the railway was constructed. It would therefore not have been possible to extract clay (or coal) such close proximity to the railway without risking the removal of ground support to the railway. Based on this, and the absence of mining features within the boreholes, it is unlikely that clay workings are present beneath the Site.

8.6 Potential Coal Mining Risks

8.6.1 The Coal Authority present several questions that are to be addressed as part of any Coal Mining Risk Assessment. These are presented in Table 3.

Table 3: Coal Mining Risks

Potential Coal Mining Risk	Relevant to Site?	Comments
Underground coal mining (recorded at shallow depths)?	No	Coal Authority data does not identify any known shallow mine workings at shallow depth beneath the Site, the closest being some 30 m to the east.
Underground coal mining (probable at shallow depths)?	No	Coal Authority data identifies probable shallow coal mine workings based on Better Bed outcrop position. This only encroaches on the eastern edge of the Site however, and boreholes have demonstrated the coal to be absent indicating the outcrop is likely to be further east and therefore off site.
Mine entries (shafts and adits)?	No	None identified on site from Coal Authority, BGS and historical OS data. Presence of former railway makes it highly unlikely mine entries such as adits have been driven into the sloping ground.

Potential Coal Mining Risk	Relevant to Site?	Comments
Coal mining geology (fissures)?	No	None identified from Coal Authority or BGS data.
Record of past mine gas emissions or potential?	No	None identified from Coal Authority data.
Recorded coal mining surface hazard?	No	None identified from Coal Authority data.
Surface mining (opencast workings)?	No	None identified from Coal Authority data.

8.7 Conclusions

8.7.1 The Coal Authority data indicates a potential risk of shallow coal mine workings relating to the Better Bed coal seam which outcrops along the eastern edge of the Site. Boreholes and trial pits have not identified the presence of any coal seams and it is therefore considered likely that the coal seam outcrops immediately east of the Site beneath the former railway embankment. On this basis, the risk posed to the Site by shallow abandoned mine workings and mine entries is considered to be low and no further assessments are considered necessary at this time.

9 Revised Conceptual Model and Risk Assessment

9.1 General

9.1.1 The following geo-environmental assessment uses the WSP Phase 2 ground investigation results but comprises an independent analysis of the data by Ecus.

9.1.2 The development proposals provide the potential for future residents to come into contact with any contaminated soils that may be present on site in proposed private garden and soft landscaped areas.

9.1.3 Made Ground was not proved in any of the exploratory holes at the Site, and chemical testing was therefore undertaken on the shallow natural soils to verify that the Site was otherwise uncontaminated.

9.1.4 In light of the development proposals for residential houses with private garden areas, chemical levels recorded in the laboratory test results have been compared against available published human health guideline values for an end-use scenario of "residential with homegrown produce".

9.2 Risks to Site End Users – Selection of Human Health Risk Screening Criteria

Category 4 Screening Levels

9.2.1 The Department for Environment, Food and Rural Affairs (Defra) published Category 4 Screening Levels[4,5] (C4SLs) in 2014. These were developed to be used in the inspection of potentially contaminated land under Part 2A of the Environmental Protection Act (1990) (hereafter referred to as 'Part 2A') to define land that is suitable for use and definitely not contaminated land.

9.2.2 Defra has explicitly stated that the C4SL values are suitable for use for soil contamination assessments within the development planning regime; the Policy Companion Document published by Defra to be read alongside the main document states that:

"The Part 2A regime and the planning regime are inter-linked such that the National Planning Policy Framework states that "after development, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990" and that "Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner." The Part 2A Statutory Guidance and accompanying Impact Assessment were developed on the basis that Category 4 Screening Levels could be used under the planning regime, as they would be in Part 2A investigations directly".

9.2.3 Hence a site where all shallow soils contain concentrations of contaminants that are equal to or less than the applicable C4SLs is suitable for use, as defined within the National Planning Policy Framework (NPPF). Therefore, the C4SLs are appropriate for use as a human health risk screening tool in this assessment. However, where the concentration of a contaminant is greater than the C4SL value, this is not necessarily indicative that there is an unacceptable risk or that remediation is required; other lines of evidence should also be taken into consideration.

9.2.4 The land use assumptions for the residential, allotments and commercial land use scenarios within the C4SL assessment system are based on the EA's Contaminated

[4] CL:AIRE, 2014. *Development of Category 4 Screening Levels for Assessment of Land affected by Contamination*. *Final Project Report (Revision 2).* Defra, London.
[5] Defra, 2014. *Development of Category 4 Screening Levels for Assessment of Land affected by Contamination – Policy Companion Document*. Defra, London.

Land Exposure Assessment (CLEA) model[6,7,8], with amendments to the exposure assumptions within the standard land use models and exchanging the health criteria values (HCVs) used to calculate the previously published soil guideline values (SGVs) for updated low levels of toxicological concern (LLTC).

9.2.5 At the time of writing, C4SL values have been published for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead.

Suitable 4 Use Levels

9.2.6 Land Quality Management Ltd (LQM) and the Chartered Institute of Environmental Health (CIEH) published Suitable 4 Use Levels (S4ULs) in 2015[9]. These were calculated based on the same assumptions on exposure as those used to calculate the C4SL values, and LLTC values that are of an equivalent level of protection as the C4SLs.

9.2.7 Accordingly, the S4UL have been used as human health risk screening criteria in this assessment for those heavy metals, PAH compounds and petroleum hydrocarbon fractions not covered by the C4SLs.

Asbestos

9.2.8 For the assessment of the risk from asbestos in soils, guidance contained within CIRIA Report C733[10] has been taken into consideration, although it should be noted that this document does not include any UK-based SGVs for the assessment of risk from asbestos in soils.

9.3 Risks to Human Health – Conceptual Exposure Model

9.3.1 C4SLs and S4ULs have been produced for the following standardised land use scenarios:

- Residential (with and without home-grown produce);
- Allotments;
- Commercial;
- Public open space near to housing; and
- Public open space distant from housing.

9.3.2 In the CLEA model, the residential land use with home-grown produce scenario is assumed to consist of a small two-storey house built on a ground-bearing floor slab with access to a private garden. The standard critical receptor is assumed to be a young female child (aged zero to six years old) with a duration of exposure of six years.

9.3.3 It is understood that the site is proposed for redevelopment with residential houses, with private gardens and public amenity areas. Therefore, C4SL and S4UL values for the 'residential with home-grown produce' land use scenario have been chosen

[6] Environment Agency, 2009. Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil.*
[7] Environment Agency, 2009. Science Report SC050021/SR4: *CLEA Software (Version 1.05) Handbook.*
[8] Environment Agency, 2009. Science Report SC050021/SR3: *Updated technical background to the CLEA model.*
[9] Nathanail, C.P., et al., 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, Nottingham.

[10] Nathanail, P., et al., 2014. CIRIA Report C733. *Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks*. CIRIA, London.

as the initial risk screening criteria for the site for the potential redevelopment of the site for residential use.

Soil Organic Matter

9.3.4 The soil organic matter (SOM) from made ground soil samples analysed varies between 1.11 % and 7.05 %. S4UL values based on an assumed 1 % SOM have been used in this assessment. The C4SL values are calculated assuming a SOM concentration of 6 %.

9.4 Human Health – Generic Quantitative Risk Assessment (GQRA)

Initial Screening

9.4.1 The results of the WSP Phase 2 ground investigation do not record any evidence of Made Ground on the Site. No visual or olfactory evidence of contamination was recorded.

9.4.2 The original chemical testing data (including WSP's previous assessment) is included in Appendix 2. Appendix 3, Tables A and B present the chemical data in a summary format showing the minimum and maximum values achieved, and highlighting any exceedances against the human health screening values for a residential with home-grown produce end-use.

9.4.3 Appendix 3, Table A shows the results summary for heavy metals and asbestos. No asbestos was detected in any of the samples. Two samples showed exceedances for arsenic (TPD04 at 0.10 m bgl, and BHD03 at 0.30 m bgl). A third sample showed an exceedance for mercury (TPD05 at 0.20 m bgl). Each exceedance was clearly above its respective screening value and a further statistical analysis is therefore required.

9.4.4 Appendix 3, Table B shows the results summary for PAH. No exceedances are evident and further analysis is not required for PAH.

Statistical Analysis Summary

9.4.5 The statistical analysis for arsenic and mercury is presented in Appendix 3. The results indicate that the upper confidence limit (UCL) for arsenic is 31.1 mg/kg at an evidence level of 99 %. When compared against the original screening value of 37 mg/kg, this means that the risk posed by elevated arsenic at the Site is not considered to be statistically significant no further actions are required.

9.4.6 The statistical analysis for mercury indicated that the single exceedance – TPD05 at 0.20 m bgl, located in the south-west corner of the Site – was an outlier that resulted in a UCL value that exceeded the original screening value of 1.2 mg/kg. Identification and subsequent separation of said outlier demonstrated that the UCL for the remaining results is 1.0 mg/kg and an evidence level of 98 %.

9.4.7 It is noted that the outlier was not identified in the WSP Phase 2 appraisal, and a review of the screening criteria in that assessment indicates a much higher value for inorganic mercury was used, rather than the lower elemental mercury screening value used by Ecus.

9.4.8 Given the local geology with a recorded presence of a coal seam on the edge of the Site, the otherwise 'greenfield' condition of the Site, and the absence of other heavy metal exceedances, it seems probable that the outlier for mercury reflects a localised feature that is probably natural in origin. The result is not therefore considered representative of the wider site environment.

Asbestos

9.4.9 No evidence of asbestos was reported in any of the samples tested. This does not preclude the possibility that asbestos may be present in some form given its prevalence in the modern urban environment, however the lack of previous site development the risk is considered to be very low.

9.5 Controlled Waters

9.5.1 No significantly potentially mobile contamination was identified during the site investigation and no shallow groundwater was identified. The Site is also underlain by several metres of low permeability mudstone. The resultant risk to groundwater or any adjacent controlled waters is considered to be low.

9.6 Ground Gases

9.6.1 Guidance within BS8485:2015[11] advocates a risk assessment approach based on calculated Hazardous Gas Borehole Flow Rates (Qhg) using the maximum recorded flow rate and concentrations of methane (CH_4) and carbon dioxide (CO_2) from all monitoring locations on each individual monitoring visit.

9.6.2 Where no flow is recorded BS8485:2015 stipulates using a nominal flow rate based on the limit of detection of the monitoring equipment used; taken as 0.1 l/h.

9.6.3 Where gas concentrations have been detected, the Qhg values are calculated for both methane (CH_4) and carbon dioxide (CO_2).

9.6.4 A design Gas Screening Value (GSV) is then used for risk assessment purposes, typically taken from the highest calculated Qhg, but a site wide GSV can also be calculated using the highest recorded gas concentration and peak flow rate from all the monitoring locations, as a worst-case scenario.

9.6.5 Monitoring for ground gas emissions was undertaken as part of the WSP ground investigation on two occasions in September 2017. The first visit was carried out under rising pressure conditions, and the second under falling pressure conditions.

9.6.6 Table 4 presents the maximum recorded methane and carbon dioxide concentrations and borehole flow rate results for each monitoring location, and, where applicable, summarises the maximum Qhg for the borehole during the monitoring programme.

Table 4: Calculation of Borehole Hazardous Gas Flow Rates (Qhg)

Reference	Max. CH_4 (%)	Max. CO_2 (%)	Max. Flow (l/hr)	Max. CH_4 Qhg (l/h)	Max. CO_2 Qhg (l/h)
BHD01	0.0	2.5	0.2	0.0	0.005
BHD02	0.0	0.5	0.0	0.0	0.0
BHD03	0.0	2.1	0.0	0.0	0.0
SITE	**0.0**	**2.5**	**0.2**	**0.0**	**0.005**

9.6.7 From Table 3 it can be seen that methane was not recorded in any of the boreholes, but low levels of carbon dioxide were recorded in all three locations.

9.6.8 Based on the monitoring data, a site-wide design GSV of 0.0 l/h for methane and 0.005 l/h for carbon dioxide have been derived. Both GSVs are within the prescribed range for Characteristic Situation CS1 indicating a very low hazard potential.

9.6.9 The ground gas risk at the Site is therefore considered to be low.

9.7 Invasive Plants

9.7.1 No evidence of any invasive plant species was identified during the site walkover. However, the visual absence of invasive plants on site cannot be a guarantee that they are not present.

[11] British Standard 8485:2015, Code of Practise for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

9.7.2 If any areas of potential invasive plants are suspected during construction works an ecological consultant should be contacted for identification of any invasive plants and further advice.

9.8 Revised Conceptual Site Model

9.8.1 A CSM was presented as part of the WSP Phase 2 site investigation report. The CSM has been replicated and reassessed here. The original risk ratings have been reassessed by Ecus and additional risks added where considered relevant.

9.8.2 The proposed development includes houses with private gardens and public amenity spaces. The following assessment is based upon this end-use.

9.8.3 Definitions of each element of the Source-Pathway-Receptor model are outlined in Table 5 for ease of reference. Where all three elements are deemed to be present, the risk is a function of the probability of the event occurring and the potential consequence, should the event occur.

Table 5: Source-Pathway-Receptor Definitions

Source	A substance that is above, on or under land and could pose potential harm or adversely affect an identified receptor, or cause pollution to controlled waters.
Pathway	The physical means by which the potential contaminants may reach the receptor.
Receptor	The identified element (either animate or inanimate) that could be adversely affected by the contaminant.

9.8.4 The risk classifications assigned to the CSM are based on the terminology for consequence and probability outlined in CIRIA C552, with a summary of the resultant risk classifications summarised in Table 6.

Table 6: Summary of risk classification

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High likelihood	Very High risk	High risk	Moderate risk	Moderate/low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

9.8.5 In accordance with best practise guidance the CSM should be treated as a live document and updated as necessary throughout the development process. The revised CSM is provided in Table 7.

9.8.6 If any unrecorded conditions are encountered throughout the development works the CSM should be reviewed and, where necessary, the potential risks to the identified receptors reassessed and updated accordingly.

Table 7: Revised Conceptual Site Model

Source	Hazard	Critical Pathway	Most Sensitive Receptor	Comments	Current Anticipated Risk
Contaminated soils	Asbestos	Inhalation of fibres	Future site users and construction Workers	No asbestos fibres reported, Site has remained undeveloped.	Very low
	Metals, TPH and PAH	Direct contact and ingestion of soil, inhalation of soil derived dust.	Future site users and construction Workers	Some elevated heavy metals detected but are not considered statistically significant.	Low
		Ingestion of home-grown produce	Future site users	Some elevated heavy metals detected but are not considered statistically significant.	Low
	Leachable metals, TPH and PAH	Leaching from soil and migration through porous strata or overland flow.	Fenay Brook and Secondary (A) bedrock aquifer	No potentially mobile contaminants observed and soil contaminant concentrations are generally low. Porous strata in the bedrock aquifer protected by overlying mudstone acting as an aquitard.	Very low
Coal seams & mine workings	Ground gases & VOCs	Upward migration of ground gas and accumulation within confined spaces	Future site users and buildings	No mine workings have been proven at the Site. Ground gas monitoring to date has demonstrated CS1 conditions.	Low

9.8.7 The overall risks to human health and the local environment appear to be very low to low, and the Site is considered to be suitable for its intended residential use.

10 Conclusions

10.1 Geo-environmental Assessment

10.1.1 The Site is shown to have remained undeveloped and no visual or olfactory signs of potential contamination were highlighted during the walkover survey.

10.1.2 The risk to human health from soil contamination is considered to be generally low. Elevated arsenic concentrations in two locations were statistically analysed and the overall site UCL determined to be below the human health screening value. A single elevated mercury result appears to be an outlier and is thought to be a natural occurrence given the presence of coal bearing strata in the area. No further soil testing or remediation measures are proposed at this time.

10.1.1 The potential for unforeseen ground conditions is always a risk during construction. Should any potential contamination hotspots be encountered during construction works a suitably qualified geo-environmental consultant should be informed and an appropriate environmental assessment carried out to determine the presence and extent of any contamination.

10.1.2 If off-site disposal of soils is likely to be required, chemical testing of the soils should be undertaken to assess the likely waste classification of the soils. However based on the likely requirement for reprofiling of the Site, it is anticipated that off-site disposal of soil will be minimal.

10.1.3 No risks to controlled waters have been identified in relation to Site or the proposed development.

10.1.4 Coal bearing strata present a risk of mine gas generation, however no properties will be built directly over shallow coal seams and ground gas monitoring has not indicated any significant concern. The Site is deemed to fit Characteristic Situation CS1 and no gas protection measures are necessary.

10.1.5 Radon protection measures are not required to be installed in the proposed new properties.

10.2 Geotechnical Analysis

10.2.1 Geotechnical testing has been limited to date but the boreholes and trials indicate suitable founding conditions for development, with allowable bearing capacities of 125 kN/m^2 and settlements below 25 mm calculated.

10.2.2 Highway pavements based on a CBR of 2.5 % will require 450 mm of sub base, but this may be refined through further testing or reduced through the incorporation of sub grade reinforcement.

10.2.3 Compaction testing is understood to have been carried out but was not provided for review. An Earthworks Method Statement should be prepared to cover the anticipated site re-profiling. If existing compaction data remains unavailable, further site testing will be required in order to obtain additional design data.

10.2.4 Concrete design should be based on DS-1 and AC-2z conditions.

10.2.5 The Site is not considered suitable for soakaways.

10.2.6 The Site has been shown to have no shallow coal seams or mine workings beneath it. While a coal outcrop is anticipated along the eastern edge of the Site, this is assumed to lie beneath the adjacent former railway embankment. The risks from abandoned mine workings is considered to be low.

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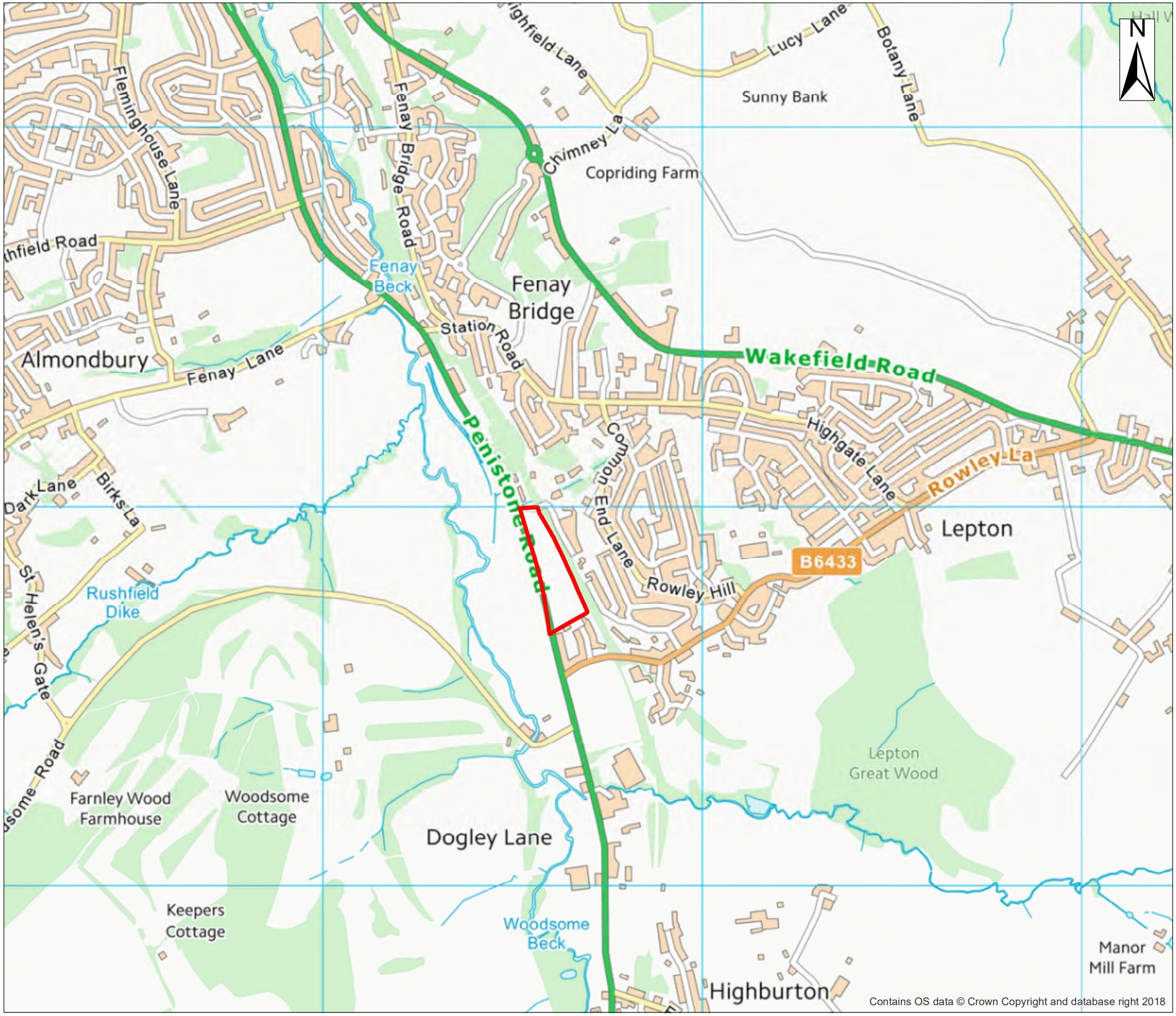
Figures



ecus
ENVIRONMENTAL CONSULTANTS

Legend

Site Boundary

0 250 500
Meters

ENGIE Regeneration Ltd

Penistone Road, Fenay Bridge, Huddersfield

Figure 1
Location Map

Brook Holt 3 Blackburn Road Sheffield S61 2DW
T: 0114 2669292 www.ecusltd.co.uk

Date: January 2019 | Scale: 1:10,000 @A3 | Drg.Ref: OS/12358/1.0

Legend

- Site Boundary
- Borehole - WSP (2017)
- Trial Pit - WSP (2017)

N

0 50 100

Meters

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ENGIE Regeneration Ltd

Penistone Road, Fenay Bridge, Huddersfield

Figure 2
Site Plan

Brook Holt 3 Blackburn Road Sheffield S61 2DW
T: 0114 2669292 www.ecusltd.co.uk

Scale: 1:1,200 @A3 | Drg.Ref: OS/12358/2.0 Date: January 2019

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Appendix 1: Site Walkover Photographs

Job: Summary Report on Previous Site Investigation **Site:** Land East of Penistone Road, Fenay Bridge **Ref:** 12358	**P1: View of Site from north-west corner access point.**

Job: Summary Report on Previous Site Investigation **Site:** Land East of Penistone Road, Fenay Bridge **Ref:** 12358	**P2: Discarded rubbish by access point in north-west corner of Site, including garden waste.**

Ecus Ltd
3 Blackburn Rd
Sheffield
S61 2DW

Tel : 0114 266 9292

www.ecusltd.co.uk

ecus
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Job: Summary Report on Previous Site Investigation **Site:** Land East of Penistone Road, Fenay Bridge **Ref:** 12358	**P3: Discarded rubbish by access point in north-west corner of Site, including scaffold boards.**

Ecus Ltd
3 Blackburn Rd
Sheffield
S61 2DW

Tel : 0114 266 9292

www.ecusltd.co.uk

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Appendix 2: WSP Combined Phase 1 & 2 Ground Risk Appraisal

Farnley Estates Ltd & John Radcliffe and Sons (Holdings) Ltd

LAND AT FENAY BRIDGE &

Combined Phase I and Phase II Ground Risk Appraisal

70035780-01
OCTOBER 2017

PUBLIC

Farnley Estates Ltd

LAND AT FENAY BRIDGE

Combined Phase I and Phase II Ground Risk Appraisal

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70035780
OUR REF. NO. 70035780-01

DATE: OCTOBER 2017

WSP
Three White Rose Office Park
Millshaw Park Lane
Leeds
LS11 0DL
Phone: +44 113 395 6200
Fax: +44 113 395 6201
WSP.com

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Version 1			
Date	October 2017			
Prepared by	C. Wainwright / R Jacobs			
Signature				
Checked by	G. Meynell / A Hallas			
Signature				
Authorised by	A McCusker			
Signature				
Project number	70035780			
Report number	70035780-001			

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EXECUTIVE SUMMARY

GVA, supporting John Radcliffe and Sons (Holdings) Ltd and Farnley Estates Ltd (the 'Client'), commissioned WSP to undertake a Preliminary Ground Risk Appraisal at Fenay Bridge in Huddersfield, West Yorkshire (the 'site'). The site comprises three individual parcels of land referred to as Plot A, D and E all of which have been allocated for residential development as part of the local authority's latest Local Plan.

Given the land's designation the Client now wishes to sell the land for residential development and requires information to understand potential ground related development constraints. The primary aim of the appraisal was therefore to identify potential land quality and ground engineering constraints to outline potential development issues/risks and opportunities in the context of a residential development.

The appraisal included a Phase 1 desk based element collating information on the environmental site setting, history and potential sources of contamination. The desk based element identified that the wider site area had been subject to shallow mining activities which may be present at shallow depth beneath all three plots of land and also that a large brick works and small refuse tip were located on Plot A historically. A Phase 2 ground investigation was subsequently scoped to target potential areas of shallow mine workings and potential source areas of contamination associated with the former brick works.

The ground investigation was completed in August 2017, and included ten boreholes across the three plots of land, advanced to depths of between 21 and 24mbgl, and 23 trial pits advanced to depths up to 3.4mbgl. The intrusive investigation confirmed a ground model sequence comprising topsoil predominantly underlain by Pennine Lower Coal Measures within Plots D & E and topsoil underlain by Made Ground and Pennine Lower Coal Measures within Plot A.

Groundwater was encountered within all but one borehole (BHE1) installed within the Pennine Lower Coal Measures at depths varying between 4.02mbgl in BHA2 and 17.9mbgl in BHE3. Soil sampling and subsequent laboratory analysis observed concentrations unlikely to pose an unacceptable risk to human health assuming a residential redevelopment on plots D and E. Trace asbestos fibres were recorded in Made Ground on plot A; given the potential associated risks a capping layer is likely to be required over contaminated soils to mitigate the risks.

Ground gas monitored was undertaken on two occasions during September 2017. A preliminary ground gas risk assessment concluded a classification of Characteristic Situation 1, which indicates that no specialist gas protection measures would be required in new buildings.

No worked or unworked coal seams were encountered in Plot D and E. Coal Authority records identified localised mine workings in the east and west of the plot associated with clay extraction for the brick works. Where identified shafts, adits and mine workings have been identified they may require treatment if development is to be undertaken above / in the vicinity of them.

The uncertainties in the variation, depth and geotechnical characteristics of the Made Ground within Plot A indicates that the ground conditions may not suitable to support a traditional foundation option generally across the site, however, this would be subject to review following confirmation of the layout and plot loadings. The weathered and unweathered Pennine Lower Coal Measures encountered across Plot D and E is likely be suitable for traditional spread foundations and ground bearing floor slabs. The majority of the earthworks are likely to be achievable with standard earth moving plant.

Contact name Gareth Meynell

Contact details 01133956463 | gareth.meynell@wsp.com

1 INTRODUCTION 1

1.1 AUTHORISATION

GVA, supporting John Radcliffe and Sons (Holdings) Ltd and Farnley Estates Ltd (henceforth referred to as the 'Client'), commissioned WSP to undertake a combined Phase 1 and Phase 2 Preliminary Ground Risk Appraisal for three parcels of undeveloped land in Fenay Bridge, Huddersfield, West Yorkshire henceforth referred to as the 'site'. A site location plan is included as **Figure 1.**

These works have been instructed and delivered in accord with our proposal and associated terms, reference 70035780-P01 dated 16 June 2017.

1.2 PROJECT CONTEXT

The site has been allocated for housing as part of Kirklees Council's Local Plan. Given this status the client is seeking to sell the land for residential development. Although the site is currently undeveloped it is located in an area which has been extensively mined, which can potentially pose ground stability issues, and parts of the site have been occupied by industrial premises which may have impacted the ground. Given these potential ground risk related issues WSP was commissioned to undertake a combined Phase 1 and 2 Preliminary Ground Risk Appraisal to assess potential contaminated land and ground engineering development constraints and opportunities to support the sale of the land.

The site is split into three separate parcels of land referred to as:

- Plot A (4.8 ha);
- Plot D (2.3 ha); and,
- Plot E (3.6 ha).

A site layout plan showing each individual plot is included as **Figure 2.**

1.3 AIM & OBJECTIVES

The aim of this appraisal is to obtain information to allow potential ground related development constraints to be better understood by both the client and prospective purchasers.

The specific objectives of the appraisal were to:

- Review the history and publically available information regarding the environmental setting of the site, to inform potential historical sources of contamination/ground type;
- Review publically available documentation, and site specific Envirocheck Report (Appendix A) to set out the environmental sensitivity of the site;
- Present an initial understanding of ground conditions including the depth to natural ground / thickness of fill materials;
- Investigate for the presence of potential contamination associated with the site;
- Identify (where possible) the probability of shallow mining, approximate seam depth (where present) and whether they may have been worked;
- Assess the presence of a shallow groundwater table;
- Provide an initial assessment of ground gas concentrations to inform the likelihood of potential ground gas protection measures; and,
- Provide commentary on the potential ground engineering related issues.

1.4 LIMITATIONS

This investigation has been undertaken with due consideration to the guidance in '*Model Procedures for the Management of Land Contamination*', Contaminated Land Report 11(CLR 11), (Environment Agency, 2004), and in general accordance with the British Standard '*Investigation of potentially contaminated sites - Code of practice*' BS EN 10175 2011, in the context of a preliminary investigation only.

Given the size of the site, further ground investigation works will be required to satisfy future planning.

The location of a number of suspected mine shafts have been provided by the Coal Authority only. Their location and integrity are yet to be proven by intrusive investigation.

Furthermore, not all areas of the site were accessible during our ground investigation for example due to:

- Dense tree growth with Plot A and badger set restrictions; and
- Health and safety concerns around areas of steep slope in Plots D and E.

A copy of our general limitations are included in **Appendix B**.

1.5 RELIANCE

This report is addressed to and may be relied upon by the following parties:

- John Radcliffe and Sons (Holdings) Ltd: and
- Farnley Estates Ltd.

This assessment has been prepared for the sole use of the above named parties. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used either in its entirety or in part, by any other party. This report has been prepared to support the sale of Land at Fenay Bridge (the site) and not for planning or detailed geotechnical design purposes.

2 SITE INFORMATION

2.1 SITE DETAILS

A summary of pertinent site information is provided in **Table 1**.

Table 1 - Summary of Site Details

ASPECT	DESCRIPTION
Site address	Land at Fenay Bridge, Fenay Bridge, Huddersfield, HD8 0JS.
National Grid Reference	418870, 414330 (approximate site centre).
Site location	The site is located approximately 750m south-west of the centre of Fenay Bridge and 5km south-east of Huddersfield. A site location plan is included as Figure 1. A site layout plan showing the current site boundary is included as Figure 2.
Approximate surface area	Total site area is approximately 10.7ha, broken down into the following three separate plots of land: • Plot A (4.8ha); • Plot D (2.3ha); and, • Plot E (3.6ha).
Topography	**Plot A** – the central area of the site comprises a relatively flat plateau (102.6mAOD to 99.4mAOD). There is a steep decline in plot levels in the west towards the western and southern boundary (c.93m AOD) and also an incline in the north of north-east (c.110m AOD), which follows the natural surrounding topography. **Plot D** – the plot is located on a slope which generally falls from east to west, the most elevated point is in the south-east corner (97.4mAOD) with the lowest point being on the western boundary (85.7m AOD). **Plot E** – the plot generally slopes from east to west, the most elevated point is in the south-east corner (98.8mAOD) with the lowest point being on the western boundary (88.8m AOD). Topographical survey plans are included in **Appendix H**.
Current site use	**Plot A** - is currently rough grassland, there are wooded areas around the majority of the boundaries of the plot as well as a dense area within the centre of the area. In the north-west are some overhead power lines. Access to the plot is from a gate in the north-west, through Woodsome Park. **Plot D** - is undeveloped arable farmland. Access to the plot is via Whitegates Grove to the north-west. **Plot E** - is undeveloped arable farmland. Access to the plot is off Rowley Lane to the north-west.
Proposed end use	All three plots are anticipated residential end use with gardens.
Surrounding land uses	**Plot A** – undeveloped to the south and east, residential buildings to the north and Reliance Precision Limited (engineering) to the west. A large disused viaduct is located to the west of the plot and a pond is located to the southeast. **Plot D** – residential to the north, south and east and undeveloped to the west. **Plot E** – residential to north, commercial and residential to the east, Reliance Precision Limited to the south and undeveloped to west.
Radon	All three plots are located within an intermediate probability radon area (1 to 3% of homes are estimated to be at or above the Action Level). Reportedly there is not a necessity for protection measures in the construction of mew dwellings or extensions.

2.2 SITE HISTORY

Historical Ordnance Survey (OS) maps have been obtained (**Appendix A**) and reviewed to provide a summary of historical activates at each plot. **Table 2** summarises pertinent historical information for each plot.

Table 2 - Site History

MAP DATE	PLOT A	PLOT D	PLOT E	SURROUNDINGS
1854	The plot is shown to be undeveloped agricultural land.	The plot is shown to be undeveloped agricultural land.	The plot is shown to be undeveloped agricultural land. A small gravel pit is shown on the western boundary.	Rowley Bottom is approximately 150m east of Plot E and 100m north of Plot A. Rowley Mill (Woollen) is 100m south of Plot E.
1894	No significant changes noted.	No significant changes noted in the plot.	The gravel pit is no longer depicted on-site and has potentially been infilled.	There is a railway embankment (Kirkburton Ranch) that runs along the eastern boundary of Plot D and Plot E and on the western boundary of Plot A in a north / south orientation.
1908			No significant changes noted.	No significant changes noted within the vicinity.
1933	The centre of the plot is occupied by Woodsome Brick Works. Railway sidings are shown in the north of the plotand extend off-site to the Kirkburton Branch.			Woodsome Colliery is adjacent to the north of Plot A, several shafts are depicted.
1938	No significant changes noted.			No significant changes noted within the vicinity.
1948				
1955-1956	The railway sidings are no longer shown.			Woodsome Colliery has reduced in size and there are no longer railway sidings extending off-site to the north-west of Plot A.
1965-1968	Circular structures (potentially brick kilns) relating to the brick works are shown in the north and east of the plot. The north, east and south-east of the site have been profiled with mounds depicted in the south and west.			Immediately north of Plot A a refuse heap is shown.
1976-1979	Many of structures are no longer depicted in the east of the plot, and are assumed to have been demolished. A thin strip of land in the south east is shown to be a refuse tip.			The railway to the east of Plot D and E and to the west of Plot A is no longer shown. The colliery to the north of Plot A is no longer shown.
1984	All structures have been cleared from the site with the exception of a			No significant changes noted in the vicinity.

Map Date	Plot A	Plot D	Plot E	Surroundings
	rectangular building in the north-west of the plot. The refuse tip is no longer shown.			
1992	The plot has been cleared of all structures.			
2000	No significant changes noted in the plot.			
2006				
2017				

2.3 HISTORICAL SOURCES OF CONTAMINATION SUMMARY

2.3.1 PLOT A

Between 1930s and 1980s the plot was developed with a clay and brick works. Potential contamination associated with the former industrial land use could include ash from on-site furnaces, process waste as well as asbestos and heavy metals associated with demolished buildings.

A refuse tip was shown in the south of the plot between 1976 and 1984, it is likely that this refuse tip was associated with the clay and brick works and therefore potential contaminants are likely to be a similar to that associated with the works.

2.3.2 PLOT D

No significant potential sources of contamination identified.

2.3.3 PLOT E

A small gravel pit on the western boundary was present between 1854 and 1894, the pit is presumed to have been backfilled with material of unknown origin, therefore potential contaminants would be dependent on the nature of the fill, and contaminant concentrations are likely to have diminished with time.

2.3.4 OFF-SITE

Adjacent to all three plots (east of Plots D & E and west of Plot A) was a former railway line and embankment, potential contaminants associated with the railway include metals, pesticides, hydrocarbons, including PAHs and asbestos.

Woodsome Colliery was located adjacent to the north of Plot A, present in 1933 with a refuse heap depicted in 1965, it was no longer present by 1976. Potential contaminants from the colliery may include metals, hydrocarbons (including PAHs) and asbestos. However, hazardous mine gas could be present beneath the site, subject to geology and the presence of workings.

2.4 REGULATORY INFORMATION

Table 3 - Regulatory Information Summary

ASPECT	ON-SITE	WITHIN 500M	DETAILS
Discharge Consents	0	2	The Consent is held by Reliance Precision Limited for the trade discharge of cooling water to Beldon Brook via Old Mill Pond approximately 20m south-east of Plot A. The consent was issued in July 2006. The second discharge is held by Woodsome Hall Golf Club for the discharge of treated sewage to Springwood Beck approximately 380m west of Plot E, the consent was issued in June 2004.
Pollution Incidents to controlled waters	0	13	The nearest pollution incident recorded was a result of released sewage to an unnamed freshwater stream approximately 30m north-west of Plot D, the incident occurred in January 1994 and was classified by the Environment Agency as being Category 2 – Significant. 50m south of Plot E, an incident occurred in August 1995, relating to the release of sewage to the Calder tributaries, the incident was classified by the EA as Category 2 – Significant.
Landfills/infilled land	0	1	One historical landfill is recorded approximately 90m south-east of Plot A, referred to as Netheroyd Hill Tip. There are no further records regarding the landfill. Historical plan show a refuse tip in the southeast of the site.

2.5 SITE SETTING

2.5.1 GEOLOGY

British Geological Survey (BGS) Sheet 77, Huddersfield scale 1:50,000, Solid and Drift edition, dated 2003 and BGS Sheet SE12SE, scale 1:10,000, Solid and Drift edition, dated 1999 indicate the solid geology beneath the site to be of the Pennine Lower Coal Measures. This comprises interbedded mudstone, siltstone and sandstone, with more numerous and thicker coal seams in its upper horizons.

Plot A is shown to have superficial deposits comprising alluvial on the southern boundary of the plot, the underlying solid geology comprises Pennine Lower Coal Measures in the north-eastern 70% of the site and the Grenoside Sandstone outcrop in the south-western 30% of the site.

Plot D is underlain by Grenoside Sandstone. No superficial deposits are recorded.

Plot E is shown to have superficial alluvial deposits present in the northwest corner of the plot only. The underlying bedrock comprises Grenoside Sandstone covering circa 80% of the west of the plot, with the remainder of the east of the plot underlain by Pennine Lower Coal Measures.

The geological maps indicates two coal seams, the Better Bed, and the Black Bed Coal seam, outcrop on and in the vicinity of the site, trending approximately northwest-southeast. Further details relating to the underlying coal seams are discussed in Section 3 below.

Figures 3A to 3C and 4A to 4C show the drift and solid geology of the site.

2.5.2 HYDROGEOLOGY

The bedrock geology (Pennine Lower Coal Measures Formation & Grenoside Sandstone) is classified by the Environment Agency (EA) as Secondary A aquifers. These are described as permeable layers capable of supporting water supplies at a local rather than strategic scale.

The site is not located within a Source Protection Zone (SPZ). Two publically registered groundwater abstractions are located within a 500m radius of the site boundary. The nearest are located approximately 40m and 70m to the southwest of Plot A, abstracted groundwater is recorded as being used for general use in textiles and leather, including process water and non-evaporative cooling water for Reliance Gear Co Ltd. There is no information regarding daily abstraction rates.

2.5.3 HYDROLOGY

The site is located within the Environment Agency (EA) defined Humber River Basin District and the Aire and Calder Catchment area. The nearest named surface watercourse is Beldon Brook, which runs in a westerly direction along the southern boundary of Plot A. the Brook joins with Fenay Beck, located approximately 80m west of Plots D & E. Fenay Beck is classified by the EA as having a moderate ecological potential and a good chemical water quality.

3 PRELIMINARY COAL MINING RISK ASSESSMENT

3.1 MINING RELATED GEOLOGY

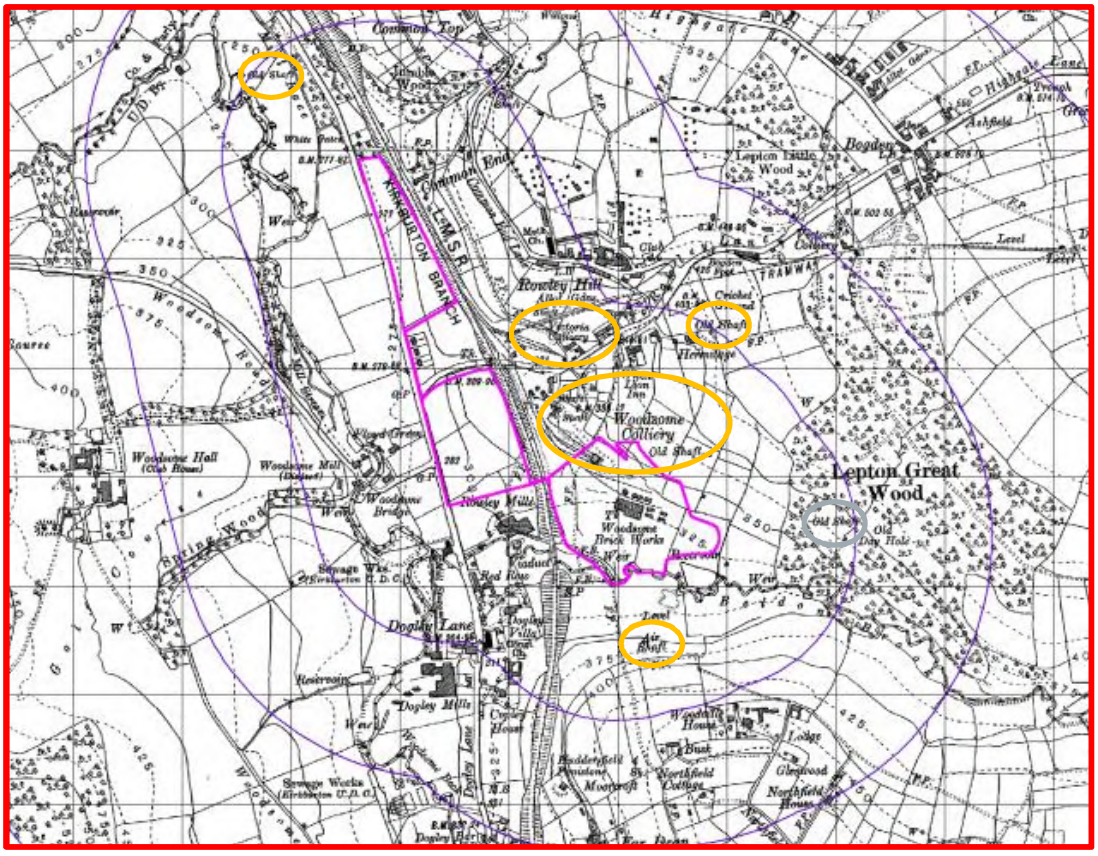
The BGS mapping indicates all three plots are underlain by bedrock comprising the Pennine Lower Coal Measures.

The Better Bed coal seam is indicated to outcrop in an approximately south east to north west direction across the centre of Plot A and in a broadly north to south direction along the eastern boundary of Plots D and E. The seam is indicated on the 1:10,000 geological map to be dipping 2^{o} to the east.

3.2 HISTORICAL OS MAPS

The 1933 OS maps (Drawing. 1) shows Woodsome Colliery located approximately 95m to the east of Plot D and 80m northwest of Plot A. Two shafts are shown at the centre of the colliery, as are railway sidings which encroach onto the north-eastern boundary of Plot A. Victoria Colliery is shown immediately to the north of Woodsome Colliery, located approximately 180m to the northeast of Plot D and 200m southeast of Plot D. An 'Old Shaft' and an 'Air Shaft' are also shown approximately 150m and 200m east and south of Plot A respectively. By the mid-1960s the collieries are no longer shown, and the sites were developed with housing by the 1990s.

DRAWING 1. 1933 OS map, with coal mining related features highlighted.



3.3 COAL AUTHORITY INFORMATION

A Coal Authority report was obtained for the site. Pertinent details are summarised below:

- The site is in a surface area that could be affected by underground mining in three seams of coal at shallow to 230m depth, last worked in 1931.
- The site is not within a surface area that could be affected by present underground mining.

- The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres, since 31 October 1994. There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority Interactive Viewer and GIS data indicates that:

- The easternmost parts of Plots D and E are located within a Development High Risk Area, relating to the outcrop of the Better Bed coal seam and are associated with areas of 'probable shallow coal mine workings'. No recorded shallow workings are recorded within Plots D and E.
- The north-eastern part of Plot A is located within a Development High Risk Area, linked to the outcrop of the Better Bed coal seam and associated with areas of 'probable shallow coal workings' and two areas of 'past shallow coal mine workings'.

Extracts from the Coal Authority GIS data is presented on figures **5A, 5B** and **5C**.

A series of Coal Authority Shaft Plan and Data Sheets (referenced 51001620532001) were obtained (**Appendix I),** which provide limited information on the shafts present on site. No treatment details were provided for any of the shafts/adits.

3.4 MINE ABANDONMENT PLANS

A mine abandonment plan (referenced 11127, entitled 'Woodsome Outcrop, Huddersfield Collieries Limited, Better Bed Clay Workings', dated 1933) was obtained from the Coal Authority. This indicates two areas of shallow workings within Plot A.

The abandonment plan indicates that the Better Bed coal seam was encountered at a depth of approximately 1.2m bgl and approximately 0.45m thick. However, the plan indicates that rather than the coal being worked, a 0.9m thick clay seam was worked using pillar and stall techniques at a depth of 3.0m bgl. It is considered likely that the clay workings were associated with the Woodsome Brick Works which is shown to be located on site on the 1933 historical map.

The plan indicates the strata beneath Plot A is dipping at approximately 2˚ to the northeast.

3.4.1 IDENTIFICATION AND ASSESSMENT OF SITE SPECIFIC COAL MINING RISKS

Based on the information reviewed in the above sections, site specific coal mining risks have been identified and assessed for each plot, and these are presented in Table 4 to 6.

Table 4 - Plot A - Identification and assessment of site specific coal mining risks

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
Is the proposed development in the likely zone of influence of past underground coal mining?	Yes	The site is in an area that could be affected by past underground mining within three seams (shallow to 230 m depth).
Is the proposed development in the likely zone of influence of any present underground coal workings?	No	-
Is the proposed development within the likely zone of influence of underground coal workings at shallow depth (depths of less than 30m)?	Yes	Areas of recorded and probable shallow workings are identified.
Is there a possibility of unrecorded shallow mine workings and/or mine entries?	Yes	A coal seams outcrops on site and the potential exists for unrecorded workings associated with this seam. In addition, there are recorded workings within a seam of clay beneath the coal seams and further unrecorded workings associated with this clay may be present.

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
		clay may be present.
Is there a record of mine gas emissions within the site boundary?	No	The potential for shallow mine workings within the vicinity of the site suggests that ground gas monitoring would be warranted.
Is the proposed development in an area for which the Coal Authority is determining or has granted a license to remove coal by underground methods?	No	-
Are there recorded coal mine entries within the site or within 20m of the site boundary?	Yes	The Coal Authority indicates that there are ten mine entries on site, or within 20 m of the site boundary. There is no record of what steps, if any, have been taken to treat the eight adits and two shafts recorded.
Has the site been subject to remedial works by, or on behalf of, the Coal Authority under its surface hazard call out procedures?	No	-
Is the proposed development within the boundary of a surface mining/opencast site from which coal has been removed by surface mining/opencast methods?	No	-
Is the proposed development within 200 metres of a surface mining/opencast site from which coal is being removed?	No	-

Table 5 - Plot D- Identification and assessment of site specific coal mining risks

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
Is the proposed development in the likely zone of influence of past underground coal mining?	Yes	The plot is in an area that could be affected by past underground mining within three seams (shallow to 230 m depth).
Is the proposed development in the likely zone of influence of any present underground coal workings?	No	-
Is the proposed development within the likely zone of influence of underground coal workings at shallow depth (depths of less than 30m)?	Yes	The outcrop of the Better Bed Coal seam is shown on or close to the plot's eastern boundary.
Is there a possibility of unrecorded shallow mine workings and/or mine entries?	Yes	The Better Bed Coal Seam outcrops on or close to the plot's eastern boundary and could be associated with shallow workings and/or mine entries.
Is there a record of mine gas emissions within the site boundary?	No	The potential for shallow mine workings within the vicinity of the site suggests that ground gas monitoring would be warranted.
Is the proposed development in an area for which the Coal Authority is determining or has granted a license to remove coal by	No	-

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
underground methods?		
Are there recorded coal mine entries within the site or within 20m of the site boundary?	No	
Has the site been subject to remedial works by, or on behalf of, the Coal Authority under its surface hazard call out procedures?	No	-
Is the proposed development within the boundary of a surface mining/opencast site from which coal has been removed by surface mining/opencast methods?	No	-
Is the proposed development within 200 metres of a surface mining/opencast site from which coal is being removed?	No	-

Table 6 - Plot E – Identification and assessment of site specific coal mining risks

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
Is the proposed development in the likely zone of influence of past underground coal mining?	Yes	The plot is in an area that could be affected by past underground mining within three seams (shallow to 230 m depth).
Is the proposed development in the likely zone of influence of any present underground coal workings?	No	-
Is the proposed development within the likely zone of influence of underground coal workings at shallow depth (depths of less than 30m)?	Yes	The outcrop of the Better Bed Coal seam is shown on or close to the plot's eastern boundary.
Is there a possibility of unrecorded shallow mine workings and/or mine entries?	Yes	The Better Bed Coal Seam outcrops on or close to the plot's eastern boundary and could be associated with shallow workings and/or mine entries.
Is there a record of mine gas emissions within the site boundary?	No	The potential for shallow mine workings within the vicinity of the site suggests that ground gas monitoring would be warranted.
Is the proposed development in an area for which the Coal Authority is determining or has granted a license to remove coal by underground methods?	No	-
Are there recorded coal mine entries within the site or within 20m of the site boundary?	No	
Has the site been subject to remedial works by, or on behalf of, the Coal Authority under its surface hazard call out procedures?	No	-
Is the proposed development within the boundary of a surface mining/opencast site from which coal has been removed by	No	-

COAL MINING ISSUE	APPLICABLE TO SITE	RISK ASSESSMENT / COMMENTS
surface mining/opencast methods?		
Is the proposed development within 200 metres of a surface mining/opencast site from which coal is being removed?	No	-

4 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 CONCEPTUAL SITE MODEL

A preliminary conceptual site model (CSM) was initially formulated utilising the available information to determine the potential for plausible contaminant linkages and to assist in targeting this preliminary site investigation. For a significant or identifiable risk to exist an exposure pathway must be present which requires each of the following to be identified:

- The presence of substances that may cause harm (source);
- The presence of a receptor which may be harmed at an exposure point (receptor); and
- The existence of means of exposing a receptor to the source (the exposure pathway).

4.2 POTENTIAL SOURCES OF CONTAMINATION

Based on the sites historical use together with site walkover, potential sources of contamination identified have included:

Plot A

- Made Ground associated with demolished buildings from the brick works (which could include asbestos containing materials (ACM), heavy metals, total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs));
- Made Ground/waste associated with infilling of the ground associated with a former refuse heap; and
- The potential for ground gases associated with shallow and deeper mine workings (hazardous ground gases).

Plot D

- The potential for ground gases associated with shallow and deeper mine workings as well as from backfill within the former opencast areas (permanent ground gases).

Plot E

- Known infilled land associated with a former sandstone extraction pit. Potential contamination would be dependent on the nature of the fill material used but could be a source of contaminated leachate as well as ground gas.
- The potential for ground gases associated with shallow and deeper mine workings as well as from backfill within the former opencast areas (hazardous ground gases).

Potential off-site sources of contamination furthermore include a former landfill located ~90m to the south-east presenting a potential for the generation and migration of landfill leachate and ground gases towards the site.

4.3 POTENTIAL RECEPTORS

Based on the sites proposed future residential redevelopment and potential receiving environment, potential receptors are considered to include the following:

- Future on-site residents;
- Construction/maintenance workers conducting subsurface works;
- Controlled waters: underlying Secondary A Aquifer, Beldon Brook and Fenay Beck.
- Build Environment - subsurface concrete, susceptible to sulphate erosion and water supply pipes.

4.4 EXPOSURE PATHWAYS

Transport mechanisms and exposure routes could include the following:

- Direct contact with impacted soils (dermal contact and incidental ingestion);
- Dermal contact, incidental ingestion and inhalation of soil particulates (dust);
- Direct ingestion of contaminants via home grown produce;
- Volatilisation of vapours from impacted soil and/or groundwater and subsequent vapour intrusion into buildings leading to vapour inhalation;
- Accumulation of gases resulting in potentially explosive / asphyxiating atmosphere;
- Leaching of contamination into groundwater followed by migration of groundwater to the wider groundwater environment and down gradient surface waters; and

- Direct contact of buried concrete with aggressive (acidic) ground.

4.5 SUMMARY OF PLAUSIBLE POLLUTION LINKAGES

Pre investigation plausible pollutant linkages are summarised in Table 7. Potentially active linkages are to be assessed herein by way of preliminary assessment.

Table 7 - Potential pollutant linkages

EXPOSURE LINKAGE	POTENTIALLY ACTIVE (✓) / INACTIVE (×)	PLOT A	PLOT D	PLOT E
HUMAN HEALTH				
Exposure to contaminated soils via ingestion/dermal contact/inhalation (site users, maintenance and construction workers)		✓	✓	✓
Vapour inhalation (outdoor and indoor)		✓	×	×
BUILT ENVIRONMENT				
Migration of ground gas & potentially vapours into buildings		✓	✓	✓
Permeation of contaminants through water pipework leading to contamination of drinking water supply		✓	×	×
Direct contact of aggressive ground with buried concrete		✓	✓	✓
CONTROLLED WATERS				
Contamination of groundwater and surface waters		✓	×	×
Contamination of abstraction wells		✓	×	×

5 INTRUSIVE GROUND INVESTIGATION

5.1 RATIONALE

The desk based assessment identified a number of potential ground risk related issues which can broadly summarised as follows:

Land Quality

- Potential for contaminated ground associated with former brick works and from a former refuse tip (Plot A) and small infilled pit (Plot E) presenting potential risks sensitive environmental receptors;
- Potential for hazardous ground gas to migrate to the surface and impact future buildings (site wide) presenting unacceptable risks to future site users and buildings.

Geotechnical

- Potential for shallow mine (coal and clay) workings presenting ground stability risks;
- Potential for Made Ground across Plot A and associated with an infilled pit (Plot D), potential for differential settlement.
- Potential for below ground obstructions, which may impact ground engineering works.
- Potential for shallow groundwater which could impact excavations and other below ground infrastructure.
- Potential for aggressive ground conditions that could impact below ground concrete.

Given the desk based issues this investigation was subsequently undertaken to assess potential land quality issues and also to gain a preliminary understanding of geotechnical related issues.

5.2 EXPLORATORY HOLES AND INSTALLATIONS

The intrusive investigation was overseen by WSP staff between 14 and 22 August 2017. Prior to breaking ground underground utility plans were studied prior to a specialist underground utility avoidance engineer assessing all proposed exploratory locations, this was delivered on 10 August 2017.

5.2.1 PLOT A

Four boreholes (BHA01 to BHA04) were advanced using rotary open hole drilling techniques to depths of between 21mbgl (BHA01 & BHA03) and 22.5 (BHA04). Boreholes were located to target coal seams / potential historical shallow workings in the north of the plot. Eleven trial pits (TPA01 to TPA11) excavated to a maximum depth of 3.4mbgl were located on-site for general coverage as well as investigating the former on-site brick works and the area depicted as being a refuse heap.

5.2.2 PLOT D

Three boreholes (BHD01 to BHD03) were advanced using rotary open hole drilling techniques to depths of between 21mbgl (BHD01 & BHD02) and 24mbgl (BHD03). Boreholes were located to target coal seams / potential historical shallow workings in the east of the plot. Six trial pits (TPD01 to TPD06) were excavated to a maximum depth of 2.4mbgl across the plot for general coverage as well as investigating shallow contamination.

5.2.3 PLOT E

Three boreholes (BHE01 to BHE03) were advanced using rotary open hole drilling techniques to a depths of 21mbgl. Boreholes were located to target coal seams / potential historical shallow workings in the east of the plot. Seven trial pits (TPE01 to TPE07) were excavated to a maximum depth of 1.6mbgl across the plot for general coverage as well as investigating shallow contamination.

On completion of drilling, groundwater / ground gas monitoring wells were installed in all of the boreholes.

A borehole location plan is included as **Figure 6**. Exploratory hole logs are included in **Appendix C.**

Table 8 - Summary of monitoring well installations

BOREHOLE ID	GROUND ELEVATION (MAOD)	PIEZOMETER DIAMETER (MM)	SCREEN TOP AND BASE DEPTH (MBGL)	SCREEN TOP AND BASE ELEVATION (MAOD)	STRATA TARGETED
Plot A					
BHA1	102.318	50	10.00 to 15.00	92.32 to 87.32	Pennine Lower Coal Measures
BHA2	100.732	50	2.50 to 5.00	98.23 to 95.73	Pennine Lower Coal Measures
BHA3	99.990	50	4.00 to 9.00	95.99 to 90.99	Pennine Lower Coal Measures
BHA4	101.298	50	6.00 to 11.00	95.30 to 90.30	Pennine Lower Coal Measures
Plot D					
BHD1	92.983	50	1.00 to 10.00	91.98 to 82.98	Pennine Lower Coal Measures
BHD2	94.974	50	16.00 to 21.00	78.97 to 73.97	Pennine Lower Coal Measures
BHD3	95.251	50	18.00 to 24.00	77.25 to 71.25	Pennine Lower Coal Measures
Plot E					
BHE1	96.823	50	1.00 to 6.00	95.82 to 90.82	Pennine Lower Coal Measures
BHE2	96.351	50	11.00 to 21.00	85.35 to 75.35	Pennine Lower Coal Measures
BHE3	96.876	50	15.00 to 21.00	81.88 to 75.88	Pennine Lower Coal Measures

5.3 IN-SITU AND FIELD TESTING

A hand held Photo-Ionisation Detector (PID) (fitted with a 10.6eV lamp) was used to provide an indication of the presence of volatile compounds within the soil profile. The PID readings are presented on the borehole logs (**Appendix C**), there were no reading above 1ppm recorded across any of the three plots.

5.4 GROUNDWATER AND GROUND GAS MONITORING

Groundwater level monitoring (using an interface probe) and ground gas monitoring meter was undertaken on two occasions (05 & 25 September 2017).

Ground gas monitoring included the measurement of methane, carbon dioxide, hydrogen sulphide, carbon monoxide and oxygen along with peak and steady gas flows plus barometric pressures.

Groundwater was sampled from BHA02, BHA03 and BHA04 using low-flow techniques, comprising a YSi Pro Plus and peristaltic pump.

5.5 LABORATORY ANALYSIS AND TESTING

Selected soil samples were submitted for analysis to ALS Laboratories which uses United Kingdom Accreditation Service (UKAS) and Environment Agency of England & Wales (EA) Monitoring Certification Scheme (MCERTS) accredited methods, where applicable. A total of 33 samples were analysed for the identified contaminants of concern, including:

- Asbestos screen;
- Metals suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Total petroleum hydrocarbons Criteria Working Group (TPH CWG);
- Benzene, toluene, ethylbenzene, xylenes (BTEX) compounds;
- Methyl tertiary butyl ether (MTBE) and tert-amyl methyl ether (TAME); and,

A selection of samples were also analysed for moisture content and % Soil Organic Matter (SOM).

Laboratory analytical reports are included in **Appendix D**.

The three groundwater samples were analysed for the following contaminants:

- Metals suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Total petroleum hydrocarbons Criteria Working Group (TPH CWG);
- Benzene, toluene, ethylbenzene, xylenes (BTEX) compounds; and
- Methyl tertiary butyl ether (MTBE) and tert-amyl methyl ether (TAME)

Bulk and disturbed samples were sent for geotechnical testing (Plasticity Index, moisture content, particle site distribution and compaction) at Geo Site & Testing Services Ltd (GSTL) laboratory. Results are included within **Appendix E.**

6 GROUND CONDITIONS

6.1 SUMMARY OF ENCOUNTERED GROUND CONDITIONS

6.1.1 PLOT A

All intrusive locations identified grass and topsoil (of between 0.1m and 0.3m thick) within their uppermost horizons.

Made Ground was encountered in all trial pits and boreholes beneath the topsoil with the exception of TPA10 located in the south-west of the plot, where topsoil was underlain by weathered bedrock. The thickness of the Made Ground is variable across the plot and its thickness was not proven (>3m death) in the south of the plot (TPA07 and TPA08) where a historical refuse tip had been recorded. The Made Ground encountered generally comprised clayey gravel or gravelly clay compiled of mudstone, burnt shale, crushed brick, ash and crushed clay pipes. The edge of the refuse area was identified in TPA09 where a layer (2.95m thick) of Made Ground was identified and underlain by weathered bedrock. In the centre and east of the plot Made Ground was identified to between 1mbgl and 1.8mbgl. In the west of the site, trial pits were not able to be extended to beyond 0.8m bgl due to underground obstructions in the form of concrete or brick foundations; however the boreholes identified Made Ground to a maximum depth of 1.8mbgl in the area.

Underlying the Made Ground in all instances was weathered bedrock comprising clay and then interbedded mudstone, siltstone, sandstone and coal of the Pennine Lower Coal Measures, encountered between 0.8m and 3.1m bgl.

Coal was encountered in a number of the exploratory holes carried out within Plot A. Table 9 below summarises the coal seam encountered during the ground investigation

Table 9 - Summary of encountered coal seams

Borehole	Elevation m AOD	Depth m BGL	Seam Thickness	Interpreted Coal Seam
BHA1	96.22	6.10	0.9	Better Bed Coal
BHA2	96.83	3.90	0.7	Better Bed Coal
BHA3	97.79	2.60	0.6	Better Bed Coal
TPA05	97.03	2.70	0.1	Better Bed Coal
TPA10	99.26	0.70	0.5	Better Bed Coal

The available data indicates that the strata dips at an angle of circa 2° towards the north. No evidence of mining was recorded within Plot A during the ground investigation.

6.1.2 PLOT D

All intrusive locations identified topsoil (of between 0.15m and 0.35m thickness) within their uppermost regions.

Made Ground was not encountered within any of the exploratory locations.

Topsoil was underlain by weathered rock comprising clay and then interbedded mudstone, siltstone, sandstone and coal of the Pennine Lower Coal Measures. The depth of the bedrock was not proven in any of the exploratory locations. Coal was not recorded in any of the exploratory locations.

6.1.3 PLOT E

All intrusive locations identified topsoil (of between 0.2m and 0.35m thickness) within their uppermost regions.

Made Ground was not encountered within any of the exploratory locations.

Topsoil was underlain by weathered rock comprising clay in the south-east (BHE04 & BHE04) and sand in the remainder of the plot. The underlying bedrock was a sandstone outcrop (Grenoside), part of the Pennine Lower Coal Measures comprising interbedded mudstone, siltstone, sandstone and coal. The depth of the bedrock was not proven in any of the exploratory locations

A summary of the strata encountered during our investigation is presented in **Table 10**. Exploratory hole logs are provided within **Appendix C**.

Table 10 - Summary of Strata Encountered

STRATUM NAME	DEPTH TO BASE OF STRATA (MGBL)	ELEVATION OF BASE OF STRATA (MAOD)	THICKNESS (M)
Plot A			
Topsoil	0.10 to 0.20	102.37 to 99.68	0.10 to 0.20
Made Ground Granular	0.40 to 3.10	102.17 to 96.49	0.20 to 2.45
Made Ground Cohesive	0.80 to 3.10	100.52 to 97.89	0.60 to 2.90
Pennine Lower Coal Measures Formation	Not proven (22.50)	Not proven (78.80)	Not proven (22.50)
Plot D			
Topsoil	0.15 to 0.35	97.07 to 85.47	0.15 to 0.35
Pennine Lower Coal Measures Formation	Not proven (24.00)	73.97 to 71.25	Not proven (24.00)
Plot E			
Topsoil	0.2 to 0.35	98.45 to 88.51	0.2 to 0.35
Pennine Lower Coal Measures Formation	Not proven (21.50)	75.82 to 75.38	Not proven (21.50)

6.2 EVIDENCE OF CONTAMINATION

The PID screening of soil samples collected during the advancement of the boreholes, trial pits and hand dug pits all reported readings below 1ppm. Furthermore no visual or olfactory evidence of contamination was reported during the advancement of the exploratory holes.

6.3 GROUNDWATER CONDITIONS

Groundwater strikes were recorded in multiple boreholes; depths of the strikes are recorded within borehole logs within **Appendix C.**

Groundwater levels were subsequently recorded during the groundwater and ground gas monitoring rounds. A summary of the groundwater depths and elevations recorded post site investigation is provided **Table 11**. Field records are provided in **Appendix F**.

Table 11 - Summary of groundwater levels recorded post site investigation

BOREHOLE ID	GROUND ELEVATION (MAOD)	GROUNDWATER DEPTH (MBGL)		GROUNDWATER ELEVATION (MAOD)	
		Min	Max	Min	Max
Plot A					
BHA1	102.32	9.45	9.88	92.44	92.87
BHA2	100.73	4.02	4.14	96.59	96.71
BHA3	99.99	5.92	6.36	93.63	94.07
BHA4	101.30	8.68	8.94	92.36	92.62
Plot D					
BHD1	92.98	7.30	7.41	85.57	85.68
BHD2	94.97	15.89	16.11	78.86	79.08
BHD3	95.25	16.11	16.75	78.50	79.14
Plot E					
BHE1	96.82	Dry	Dry	N/A	N/A
BHE2	96.35	17.23	17.61	78.74	79.12
BHE3	96.88	17.89	17.90	78.98	78.99

Groundwater was identified at elevations between 78.50 mAOD (BHD3) and 96.71 mAOD (BHA2) within the Pennine Lower Coal Measures.

Plot A – Groundwater depths were recorded to be variable across the plot, likely a result of purchased water associated with low permeability stratum and potentially disruption of groundwater flow from relict below ground infrastructure.

Plot D - Groundwater depths are in keeping with the local topography with the exception of BHD1, where there is a more elevated response zone compared to BHD2 & BHD3. This has resulted in a higher groundwater elevation, indicating that there is likely to be a perched water body in the shallow subsurface.

Plot E – Groundwater depths are broadly in keeping with the local topography.

7 GENERIC QUANTITATIVE RISK ASSESSMENT

7.1 METHODOLOGY

Legislation and guidance on the assessment of contaminated sites acknowledges the need for a proportionate and consequently tiered risk based approach. Our assessment herein represents a Generic Quantitative Risk Assessment (GQRA), being a comparison of site contaminant levels against generic assessment criteria, including a qualitative assessment of risk using the source-pathway-receptor model. These criteria may be considered as delivering a conservative assessment of the available data. Our Generic Assessment Criteria (GAC) have been calculated using the Environment Agency's Contaminated Land Exposure Assessment (CLEA) Workbook v1.071 to assess potential health risks associated with contaminants in soil. Our methodology for the derivation of GAC is presented in **Appendix G**.

7.2 HUMAN HEALTH GQRA

Based on the sites' proposed residential end use with the potential for home grown produce in gardens, the soil chemical data has been compared against GACs derived for residential end use. Site specific Soil Organic Matter (SOM) content was obtained from 12 out of 32 soil samples, with values ranging between 1.11% (TPD05 at 0.7-0.8mbgl) and 37.1% (TPA06 at 0.5-0.6mbgl). Given the variability of organic content across the site, GACs for 1% SOM were adopted as the selection of the percentage of SOM can have an influence upon the screening criteria, use of 1% may be considered as conservative. Screened results are included as a table in **Appendix D**.

7.2.1 PLOT A

A total of 13 soil samples were analysed, comprising 12 samples taken from Made Ground and one topsoil sample.

A trace of chrysotile (white) asbestos was identified within TPA01 at between 0.3m and 0.4m bgl, it is currently being quantified and results are awaited.

When compared to appropriate GACs it was determined that there was one exceedance of the GAC threshold. This was for arsenic, which was identified as having a concentration of 52.6mg/kg in TPA10 at 0.1-0.2m bgl, exceeding the GAC of 32.0mg/kg.

7.2.2 PLOT B

A total of nine soil samples were analysed, comprising five samples taken from the topsoil and four from the underlying natural strata (Pennine Lower Coal Measures).

When compared to appropriate GACs it was determined that there were two exceedances of the GAC threshold. These were both for arsenic, which were identified as having concentrations of 42.4mg/kg (BHD3 at 0.3m bgl) and 41.9mg/kg (TPD04 at 0.1-0.2m bgl) both exceeding the GAC of 32.0mg/kg.

7.2.3 PLOT E

A total of ten soil samples were analysed, comprising three samples taken from topsoil and seven from the Pennine Lower Coal Measures. There were no exceedances recorded on this plot.

7.3 CONTROLLED WATERS ASSESSMENT

Three groundwater samples (BHA2 – BHA4) were collected on 25 September 2017. Legislation and guidance on the assessment of contaminated sites acknowledges the need for a tiered risk based approach. This assessment represents a GQRA: a comparison of site contaminant levels against GAC, including a qualitative assessment of risk using the source-pathway-receptor model.

Based on the preliminary conceptual site model and the identified receptors, the following water quality standards (WQS) have been adopted primarily in consideration of the underlying Secondary A Aquifer, and the nearby surface water (Beldon Brook).

- UK Drinking Water Standards
- WHO Drinking Water Guidelines 2008 & 2011
- EC Drinking Water Directive 1998
- Scotland Private Water Supply Regulations 2006

- Environmental Quality Standards 2015

The following exceedances were identified from groundwater testing in Table 13 below:

Table 13 – Groundwater Exceedances

Determinand	Number of samples analysed	Environmental Quality Standards (EQS) Inland Surface Water Receptor	Min	Max	Location of Exceedance
PAHs					
Benzo(a)pyrene	3	0.0002	0.00275	0.0196	BHA2, BHA3, BHA4

Benzo(a)pyrene was also idenfied as exceeding the UK DWS (0.01 µg/l) in BHA3 and BHA4.

All exceedances are noted to be marginal.

WSP has also derived a set of groundwater GACs to evaluate the potential indoor inhalation health risks associated with vapours derived from volatile contaminants within groundwater. When compared to thresholds for a residential end use, there were no exceedances.

Groundwater results and screening are included within **Appendix D.**

8 GROUND GAS ASSESSMENT

8.1 POTENTIAL GROUND GAS SOURCES

The site is located in an areas which is understood to have been extensively mined for coal therefore former coal mining activities are considered to represent a moderate generation potential of ground gas source at the site.

Plot A and E have also been subject to historical infilling (refuse tip and gravel pit).However, the investigation backfill was noted to be of brick and burnt shale as well as clay and not degradable material were recorded. The infilled areas are therefore considered to present a low risk of gas generation.

8.2 GROUND GAS MONITORING RESULTS

Two ground gas monitoring visits have been undertaken on 05 and 25 September 2017. These have been delivered as an initial assessment of gas risk only and not for compliance against CIRA 665 and planning regulations. Barometric pressure was recorded to be relatively stable during the first visit and a slight increase during the second sampling visit. This is constant with regional barometric pressure data measured at Linton-On-Ouse Air Base (65km north-west). Monitoring results are summarised in **Table 12** below.

Table 12 - Summary of ground gas monitoring results (steady concentrations)

Monitoring Point	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Flow (l/hr)	
	Min	Max	Min	Max	Min	Max	Min	Max
Plot A								
BHA1	0.00	0.00	1.20	3.00	12.70	17.80	0.00	0.00
BHA2	0.00	0.00	1.40	2.70	17.10	17.80	0.00	0.00
BHA3	0.00	0.00	3.50	3.90	9.40	11.30	0.00	0.00
BHA4	0.00	0.00	0.40	0.80	18.60	19.60	0.00	0.00
Plot D								
BHD1	0.00	0.00	2.50	2.90	15.70	17.60	0.00	0.20
BHD2	0.00	0.00	0.00	0.50	20.00	20.70	0.00	0.00
BHD3	0.00	0.00	1.90	2.10	17.20	18.00	0.00	0.00
Plot E								
BHE1	0.00	0.00	0.40	1.90	18.70	19.80	0.00	0.00
BHE2	0.00	2.50	0.00	2.30	1.00	20.50	0.00	0.00
BHE3	0.00	0.00	2.20	4.20	14.40	16.00	0.00	0.00

Steady methane levels were all 0% with the exception of BHE2 where a maximum concentration of 2.5% was recorded during the first monitoring round, it was not recorded during the second round.

The maximum initial carbon dioxide concentration of 4.2%v/v was recorded in BHE3, a concentration that remained at this steady level. Carbon dioxide levels were also generally low and below 5% v/v in all instances.

Flow was recorded at <0.1l/hr in all boreholes with the exception of BHD1 which recorded an initial flow rate of 0.2lhr which reduced to 0lhr steady flow.

The ground gas data is presented in **Appendix F**.

A preliminary ground gas risk assessment has been carried out as part of this investigation in line with CIRIA Report C665, "*Assessing risk posed by hazardous ground gases to buildings*" (CIRIA, 2007). This publication details the methods for assessing the ground gas regime at a site; it is reliant on the calculation of a Gas Screening Value (GSV) calculated as shown below:

- GSV = Maximum steady carbon dioxide or methane concentration (%) / 100 x maximum steady flow rate (l/hr)

Based on the maximum carbon dioxide concentration and flow rate recorded during the limited monitoring in 2017, the GSV for the site is 0.0084 l/hr. On this basis, the site classification corresponds to Characteristic Situation 1 with no need for ground gas protection measures to be installed in buildings.

9 REVISED CONCEPTUAL SITE MODEL

9.1 PLOT A

The ground investigation data generally indicates that the majority of the plot comprises grass and topsoil over Made Ground. The Made Ground encountered it described as clayey gravel and gravelly clay, comprising mudstone, ash, burnt shale, crushed brick and crushed terracotta pipe. No gross contamination was identified associated with the Made Ground. This was further supported by the volatile field screening where no samples recorded above the PID's level of detection (1ppm). However, one sample recorded trace asbestos fibres, likely to be associated with demolition rubble.

Risks to controlled waters are considered be minimal from a plot wide risk assessment perspective. However, it is noted that localised areas of leachable contamination cannot discounted based on the available information. Groundwater testing has been undertaken and the results indicate the plot is not impacting the underlying groundwater. The ground investigation data also suggests there are limited to no sources of vapours; again further investigation would be required to confirm this across the site.

Based on the preliminary CSM developed for the site, the ground investigation field observations and the outcome of the GQRA, an initial assessment of the potential contaminant linkages identified are summarised in **Table 14** below.

Table 14 - Contaminant linkage summary Plot A

SOURCE	PATHWAYS	RECEPTOR	PROBABILITY OF EXPOSURE	POTENTIAL CONSEQUENCE	RISK RATING
Made Ground associated with demolished buildings (inc. trace asbestos fibres) as well as the infilling of ground associated with a former refuse heap	▪ Ingestion of soil; ▪ Dermal contact with soil; and, ▪ Inhalation of soil-derived dust. Associated with any proposed garden/landscaped areas where fill is present at the surface.	Construction workers	Low likelihood	Medium	Moderate
		Future site residents	Low likelihood	Medium	Moderate
	▪ Ingestion of contaminants via uptake from homegrown vegetables	Future site residents	Low likelihood	Mild	Low
	▪ Inhalation of vapours in confined spaces. Associated with future buildings areas of Made Ground	Future site residents	Unlikely	Mild	Very Low
	▪ Controlled waters	Surface water / aquifers and groundwater abstraction wells.	Unlikley	Mild	Very low
Underlying mine workings – Ground gas generation	▪ Upward migration and accumulation of ground gases Associated with upward migration of ground gas and accumulation within enclosed spaces	Buildings & future site residents	Unlikely	Severe	Moderate / low

9.2 PLOT D

The ground investigation has generally indicates that the plot comprises topsoil over weathered bedrock (clay) of the Pennine Lower Coal Measures Formation. The topsoil and weathered bedrock did not exhibit any

notable sources of contamination. This was further supported by the volatile field screening where no samples recorded above the PID's level of detection (1ppm).

Risks to controlled waters are considered be minimal from a plot wide risk assessment perspective. The ground investigation data also suggests there are limited to no sources of vapours; again further investigation would be required to confirm this across the site.

Based on the preliminary CSM developed for the site, the ground investigation field observations and the outcome of the GQRA, an initial assessment of the potential contaminant linkages identified are summarised in **Table 15** below.

Table 15 - Contaminant linkage summary Plot D

SOURCE	PATHWAYS	RECEPTOR	PROBABILITY OF EXPOSURE	POTENTIAL CONSEQUENCE	RISK RATING
Made Ground associated with demolished buildings as well as the infilling of ground associated with a former refuse heap	▪ Ingestion of soil; ▪ Dermal contact with soil; and, ▪ Inhalation of soil-derived dust. Associated with any proposed landscaped/garden areas where fill is present at the surface.	Construction workers	Low likelihood	Mild	Low
		Future site residents	Low likelihood	Mild	Low
	▪ Ingestion of contaminants via uptake from homegrown vegetables	Future site residents	Low likelihood	Mild	Low
	▪ Inhalation of vapours in confined spaces. Associated with future buildings areas of Made Ground	Future site residents	Unlikely	Mild	Very Low
	▪ Controlled waters	Surface water / aquifers and groundwater abstraction wells.	Unlikely	Mild	Very low
Underlying mine workings – Ground gas generation	▪ Upward migration and accumulation of ground gases Associated with upward migration of ground gas and accumulation within enclosed spaces	Buildings & future site residents	Unlikely	Severe	Moderate / low

9.3 PLOT E

The ground investigation has generally indicates that the plot comprises topsoil over weathered bedrock (Clay and Sand) of a sandstone outcrop (Grenoside) of the Pennine Lower Coal Measures Formation. The topsoil and weathered bedrock did not exhibit any notable sources of contamination. This was further supported by the volatile field screening where no samples recorded above the PID's level of detection (1ppm).

Risks to controlled waters are considered be minimal from a plot wide risk assessment perspective. The ground investigation data also suggests there are limited to no sources of vapours; again further investigation would be required to confirm this across the site.

Based on the preliminary CSM developed for the site, the ground investigation field observations and the outcome of the GQRA, an initial assessment of the potential contaminant linkages identified are summarised in **Table 16** below.

Table 16 - Contaminant linkage summary Plot E

SOURCE	PATHWAYS	RECEPTOR	PROBABILITY OF EXPOSURE	POTENTIAL CONSEQUENCE	RISK RATING
Made Ground associated with demolished buildings as well as the infilling of ground associated with a former refuse heap	▪ Ingestion of soil; ▪ Dermal contact with soil; and, ▪ Inhalation of soil-derived dust. Associated with any proposed landscaped/garden areas where fill is present at the surface.	Construction workers	Low likelihood	Mild	Low
		Future site residents	Low likelihood	Mild	Low
	▪ Ingestion of contaminants via uptake from homegrown vegetables	Future site residents	Low likelihood	Mild	Low
	▪ Inhalation of vapours in confined spaces. Associated with future buildings areas of Made Ground	Future site residents	Unlikely	Mild	Very Low
	▪ Controlled waters	Surface water / aquifers and groundwater abstraction wells.	Unlikley	Mild	Very low
Underlying mine workings – Ground gas generation	▪ Upward migration and accumulation of ground gases Associated with upward migration of ground gas and accumulation within enclosed spaces	Buildings & future site residents	Unlikely	Severe	Moderate / low

10 GEOTECHNICAL ASSESSMENT

10.1 GROUND MODEL

PLOT A

The ground conditions encountered beneath Plot A (with the exception of TPA10) can be summarised as topsoil over Made Ground, which is in turn underlain by weathered Pennine Lower Coal Measures comprising clay, sandstone, mudstone, siltstone and coal.

The recorded Made Ground generally increases in thickness to the south and southwest and comprised reworked natural material, with the addition of burnt shale, crushed brick, ash and crushed terracotta pipes.

Coal seams were recorded in a number of the exploratory holes within Plot A. The coal was encountered at depths of between 0.7 and 6.1 m BGL (99.26 and 96.22 m AOD), with the thickness of coal encountered ranging between 0.1 and 0.9 m. The recorded elevations show the coal seam to have an easterly dip.

No voids or broken ground were recorded as part of the ground investigation, although no boreholes were located within the two areas of known shallow mine workings. Voids and/or broken ground are anticipated within the two areas of known shallow mine workings.

TPA10 in the south west of the plot did not encounter Made Ground.

PLOTS D AND E

The ground conditions encountered beneath Plots D and E can be summarised as topsoil over weathered Pennine Lower Coal Measures comprising clay, sandstone, mudstone and siltstone. No coal, voids or broken ground were recorded during the ground investigation.

10.2 FOUNDATIONS AND FLOOR SLABS

PLOT A

The ground investigation recorded a variable thickness of Made Ground across the site, typically increasing in depth to the south. The depth of Made Ground may prohibit the use of traditional shallow spread foundations and ground bearing floor slabs and alternative foundation solutions are likely to be required.

PLOTS D AND E

Based on the ground conditions encountered, it is anticipated that shallow spread foundations bearing within the weathered Pennine Lower Coal Measures would likely be suitable for traditional low rise housing. Likewise, ground bearing floor slabs are also anticipated to be suitable.

At present it is unclear whether site levels will be altered significantly to create development platforms. In areas of up-fill, the type of foundation and floor slab will be dependent on the quality and performance of the placed fill.

10.3 EARTHWORKS

No development masterplans are currently available and the nature and extent of earthworks required to establish development platforms for the plots are unknown.

If significant earthworks are required, an earthworks specification should be prepared to manage excavations and the placement of fill. This should detail the compaction or performance requirements for each fill type.

10.4 EXCAVATIONS / OBSTRUCTIONS

It is anticipated that the majority of excavations should be achievable with standard earth moving plant. However, excavations within the Pennine Lower Coal Measures may require ripping or hydraulic breakers if hard strata are encountered.

Man-made obstructions were encountered in the Made Ground on Plot A during the ground investigation.

Trial pits across the site were generally stable. However, instability was recorded within two trial pits in Plot A.

10.5 GROUNDWATER

The results from the preliminary groundwater monitoring suggest that the main groundwater table is present at depth within the Pennine Lower Coal Measures strata.

Groundwater strikes closer to the ground surface were recorded during the investigation in exploratory holes BHA2 (2.7m bgl) and TPD01 (2.4m bgl).

10.6 COAL MINING

PLOT A

No evidence of shallow mining (coal or clay) was encountered within any of the exploratory holes formed, with intact coal being encountered within four exploratory holes. Given the geology it is highly unlikely that coal workings exist to the south of the coal seam.

Abandonment plans obtained from the Coal Authority show recorded shallow underground workings in two isolated locations within the site. No evidence that the extent of the workings is greater than that recorded was encountered, although it should be noted that the number of exploratory holes is limited.

Where present, the underground workings and the identified shafts and adits may require treatment if built development is to be undertaken above / in the vicinity of them.

PLOTS D AND E

The eastern extents of Plots D and E are recorded as being within a Coal Authority *Development High Risk Area*, relating to *probable shallow coal mine workings* associated with the Better Bed coal seam outcrop.

No coal or evidence of mining was recorded on these plots during the ground investigation.

10.7 CONCRETE CLASSIFICATION

Results from the limited laboratory testing conducted indicates a Design Sulphate Class of DS-1 for the three Plots and Aggressive Chemical Environment for Concrete (ACEC) classes as follows:

- Plot A: between AC-1 and AC-2z;
- Plot D: between AC-1 and AC-3z; and,
- Plot A: between AC-1 and AC-2z.

11 CONCLUSIONS

11.1 GROUND INVESTIGATION

A preliminary ground investigation has been carried out at Fenay Bridge in Huddersfield to support the delivery of initial site due diligence. Plots D & E comprised primarily 'Greenfield' land. Plot A has historically been a brick / clay works and has been subject to infilling and reprofiling activities. Plots D & E are currently undeveloped farm land used for pasture and Plot A is undeveloped grassland.

This preliminary ground investigation has confirmed a ground model sequence In Plot A comprising topsoil, underlain by Made Ground associated with the former brick and clay works including the on-site refuse heap, underlain by Pennine Lower Coal Measures. In Plots D & E, the ground model comprised topsoil over weathered bedrock of the Pennine Middle Coal Measures Formation. Groundwater has been identified in all but one of the boreholes across the site, in Plots D & E groundwater depths follow the general trend of the topography, whereas in Plot A the depth is variable and therefore likely influenced by the variable thickness of Made Ground and potential below ground infrastructure.

11.2 LAND QUALITY ASSESSMENT

Soil characterisation has been undertaken for potential contaminants of concern. A conservative and generic risk assessment has been undertaken to assess potential health risks to site users, based on its proposed residential end use. The GQRA has identified soil concentrations predominantly below their respective GACs and an absence of asbestos in the majority of soil samples retained. Marginally elevated concentrations of arsenic was identified in three of the 32 samples analysed. A maximum concentration encountered was 52.6mg/kg within Plot A against a GAC of 32mg/kg. As the three exceedances are marginal, they are not generally considered to pose a significant risk to construction workers and future site users. However, further ground investigation would be required to confirm this. In particular the presence of made ground materials is indicative of the potential presence of asbestos (even though only one sample has to date contained asbestos). Consequently, appropriate health and safety measures (including PPE/RPE) should be planned to assist in mitigating the risks associated with the made ground materials encountered.

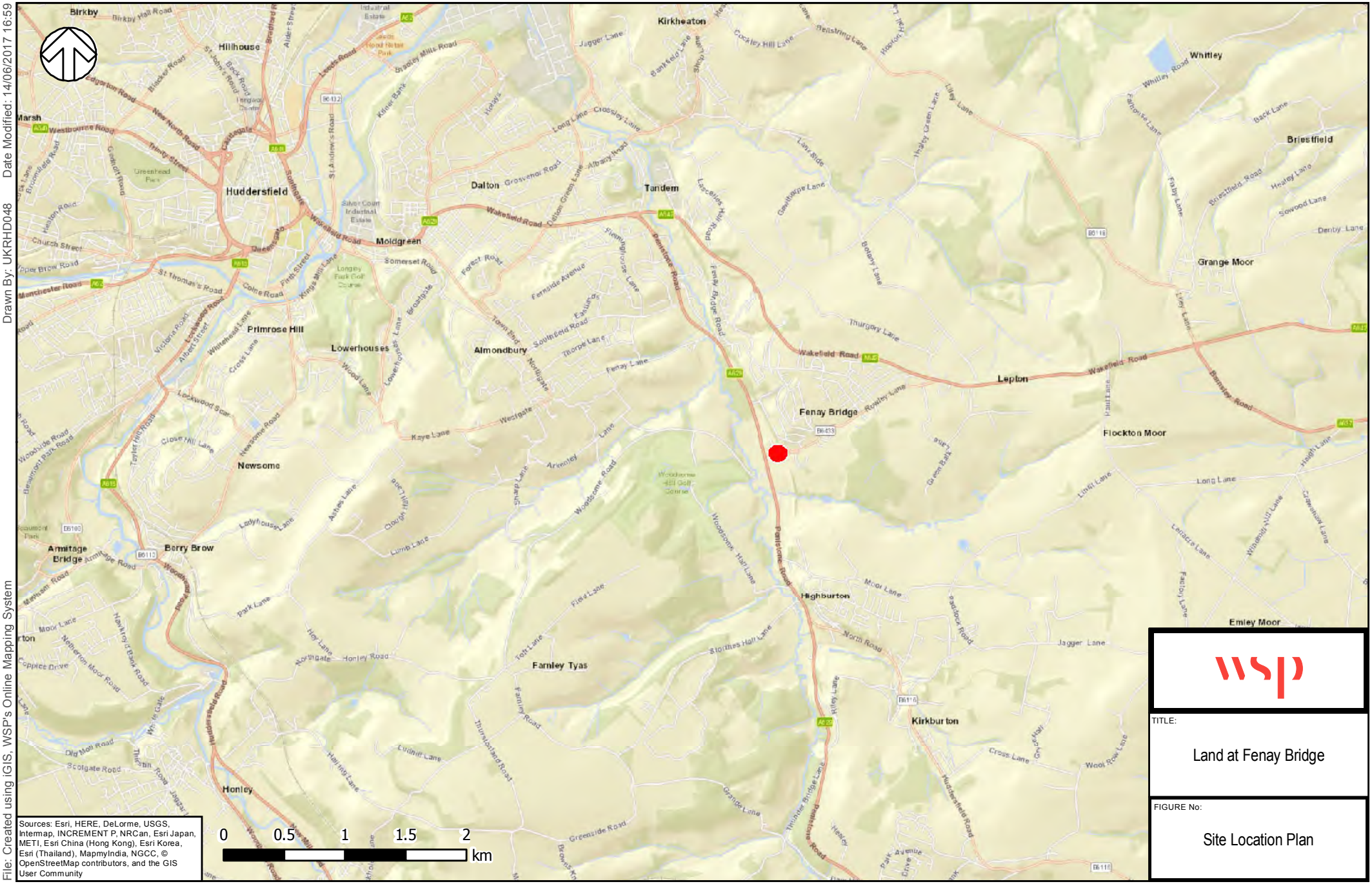
Of the three groundwater samples there were several marginal exceedances of PAHs, however these are considered to not be significant due to their low concentrations. Impacts from groundwater receptors from all three plots are considered to me minimal based on the ground investigation data obtained to date.

A preliminary ground gas risk assessment limited to two monitoring rounds suggests the site classification corresponds to Characteristic Situation 1 with no need to incorporate basic gas protection measures within new buildings. However, a full gas assessment is recommended in the consideration of development proposals and it is noted that grouting works may alter the ground gas regime.

11.3 GEOTECHNICAL ASSESSMENT

The following geotechnical related constraints and opportunities have been identified from the investigation:

- The weathered and unweathered Pennine Lower Coal Measures should be suitable for the support of spread foundations and ground bearing floor slabs for traditional low rise residential properties across plot D and E.
- The depth of Made Ground within Plot A may prohibit the use of shallow spread foundations and ground bearing floor slabs.
- Changes in site levels are likely to be achievable with standard earth moving plant. However, excavations within the Pennine Lower Coal Measures may require ripping or hydraulic breakers if hard strata are encountered.
- Shallow groundwater may be present locally, particularly within the Made Ground on Plot A.
- Areas of Plot A have been identified to be at risk of potential shallow underground workings and a number of mine entries are present on the plot. Pre-development mitigation measures are therefore likely to be required in plot A. No coal seams or potential workings were recorded on Plots D and E.
- Testing indicates a Design Sulphate Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class between AC-1 and AC-3z for below ground concrete.



File: Created using iGIS, WSP's Online Mapping System Drawn By: UKRHD048 Date Modified: 14/06/2017 16:59

TITLE:

Land at Fenay Bridge

FIGURE No:

Site Location Plan


Key
Site Boundary
Plot D
Plot E
Plot A
0 50 100 150 200
m
Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
wsp
TITLE:
Land at Fenay Bridge
FIGURE No:
Site Layout Plan
File: Created using iGIS, WSP's Online Mapping System
Drawn By: UKCDW004
Date Modified: 09/10/2017 10:13

Date Modified: 29/4/17

Drawn By: UKRHD048

File:\\uk.wspgroup.com\Central Data\Projects\700173xx\70017314 - Bassingthorpe Farm\E Models and Drawings\Drawings\PDF

Legend

- Site Boundary
- Alluvium - Clay, Silt, Sand and Gravel
- Indicative Made Ground from BGS - Artificial Deposit

0 0.0125 025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Drift Geology Plan Plot A

FIGURE No:

Figure 3A

Date Modified: 29/4/17

Drawn By: UKRHD048

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Legend

- Site Boundary
- Made_Ground
- Alluvium - Clay, Silt, Sand and Gravel
- Made Ground - Artificial Deposit

0 0.0125 025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Drift Geology Plan Plot E

FIGURE No:

Figure 3B

Date Modified: 29/4/17

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Legend

- Site Boundary
- Alluvium - Clay, Silt, Sand and Gravel
- Made Ground - Artificial Deposit

0 0.0125 025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Drift Geology Plan Plot D

FIGURE No:

Figure 3C

Date Modified: 29/4/17

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Legend

- Site Boundary
- Sandstone
- Penine Lower Coal Measures
- Coal Seam
- Fault

BETTER BED

BLACK BED

BETTER BED

0 0.0125 025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Solid Geology Plan Plot A
BGS Infomation

FIGURE No:

Figure 4A

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TITLE:

Land at Fenay Bridge
Solid Geology Plan Plot E
BGS Infomation

FIGURE No:

Figure 4B

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Date Modified: 29/4/17

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Legend

- Site Boundary
- Sandstone
- Penine Lower Coal Measures
- Coal Seam
- Fault

BLACK BED

BETTER BED

BLACK BED

0 0.0125 025 0.05 0.075 0.1

Kilometres

wsp

TITLE:

Land at Fenay Bridge
Solid Geology Plan Plot D
BGS Infomation

FIGURE No:

Figure 4C

Date Modified: 29/4/17

Drawn By: UKRHD048

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TPE01
TPE02
BHE01
BHE02
TPE07
BHE03
TPE03
TPE06
TPE04
TPE05
TPA01
BHA01
TPA02
TPA11
BHA04
TPA03
TPA10
BHA02
TPA09
TPA05
BHA03
TPA06
TPA07
TPA08

Legend

- Site Boundary
- Shaft from Coal Authority Report
- Adit from Coal Authority Report
- Mine Entry
- Pillar and Stall Mining
- Past Shallow Coal Workings
- Coal Outcrops
- Probable Shallow Coal Workings
- Dynamic sample boreholes (with rotary fololow on)
- Trial Pit/trench

0 0.0125 025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Coal Mining Plan Plot A

FIGURE No:

Figure 5A

Date Modified: 29/4/17

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TPD04

TPD06

TPD05

TPE02

TPE01

BHE01

BHE02

TPE07

BHE03

TPE03

TPE06

TPE04

TPE05

TPA01

BHA01

TPA02

TPA11

BHA04

TPA03

TPA10

TPA09

Legend

- Site Boundary
- Shaft from Coal Authority Report
- Adit from Coal Authority Report
- Mine Entry
- Pillar and Stall Mining
- Past Shallow Coal Workings
- Coal Outcrops
- Probable Shallow Coal Workings
- Dynamic sample boreholes (with rotary fololow on)
- Trial Pit/trench

0 0.0125 0.025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Coal Mining Plan Plot E

FIGURE No:

Figure 5B

Date Modified: 29/4/17

Drawn By: UKRHD048

File:\\uk.wspgroup.com\Central Data\Projects\700173xx\70017314 - Bassingthorpe Farm\E Models and Drawings\Drawings\PDF

TPD01

TPD02

BHD01

BHD02

TPD03

BHD03

TPD04

TPD06

TPD05

TPE02

TPE01

BHE01

Legend

- Site Boundary
- Shaft from Coal Authority Report
- Adit from Coal Authority Report
- Mine Entry
- Pillar and Stall Mining
- Past Shallow Coal Workings
- Coal Outcrops
- Probable Shallow Coal Workings
- Dynamic sample boreholes (with rotary fololow on)
- Trial Pit/trench

0 0.0125 0.025 0.05 0.075 0.1 Kilometres

wsp

TITLE:

Land at Fenay Bridge
Coal Mining Plan Plot D

FIGURE No:

Figure 5C

Date Modified: 29/4/17

Drawn By: UKRHD048

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Legend

- Site Boundary
- Dynamic sample boreholes (with rotary fololow on)
- Trial Pit/trench

TPD01
TPD02
BHD01
BHD02
TPD03
BHD03
TPD04
TPD06
TPD05

TPE02
TPE01
BHE01
BHE02
TPE07
BHE03
TPE03
TPE06
TPE04
TPE05

TPA01
BHA01
TPA02
TPA11
BHA04
TPA03
BHA02
TPA10
TPA09
TPA05
BHA03
TPA06
TPA07
TPA08

0 0.025 0.05 0.1 0.15 0.2 Kilometres

wsp

TITLE:

Land at Fenay Bridge

FIGURE No:

Exploratory Hole Location Plan

Appendix A

ENVIROCHECK

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
·285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Mud
Sand
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

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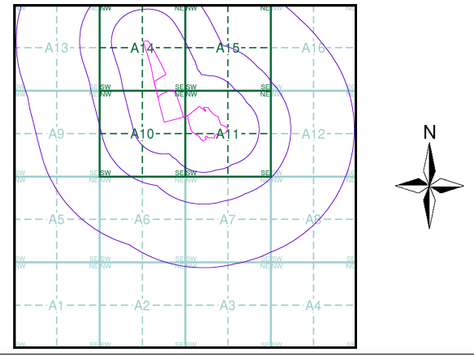
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Yorkshire	1:10,560	1854	3
Yorkshire	1:10,560	1894	4
Yorkshire	1:10,560	1908	5
Yorkshire	1:10,560	1930	6
Yorkshire	1:10,560	1933	7
Yorkshire	1:10,560	1938	8
Yorkshire	1:10,560	1948	9
Ordnance Survey Plan	1:10,000	1955 - 1956	10
Ordnance Survey Plan	1:10,000	1965 - 1968	11
Ordnance Survey Plan	1:10,000	1976 - 1979	12
Ordnance Survey Plan	1:10,000	1980 - 1989	13
Batley	1:10,000	1983	14
Huddersfield	1:10,000	1984	15
Ordnance Survey Plan	1:10,000	1992 - 1993	16
10K Raster Mapping	1:10,000	2000	17
10K Raster Mapping	1:10,000	2006	18
VectorMap Local	1:10,000	2017	19

Historical Map - Slice A



Order Details

Order Number: 132631275_1_1
Customer Ref: 70035780
National Grid Reference: 418870, 414330
Slice: A
Site Area (Ha): 10.7
Search Buffer (m): 1000

Site Details

Land at Fenay Bridge, Fenay Bridge, HUDDERSFIELD, HD8 0JS

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Web: www.envirocheck.co.uk

Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Fireproof Building
- Prominent Fireproof Building
- Non-fireproof Building
- Non-fireproof Building (non-dwelling)
- Factory, mill, and flour mill, with chimneys
- Factory, mill, and flour mill, without chimneys
- Power Station, drawn to scale
- Hydroelectric Power Station
- Radio Station, drawn to scale
- Telephone Station, drawn to scale
- Abandoned Open-pit Mine or Quarry
- Open-pit Salt Mine
- Pit
- Oil Deposit or Well
- Oil Seepage
- Tailings Pile
- Fuel Storage Tanks
- Natural Gas Tank
- Bench Mark
- Drill Hole
- Burial Mound
- Triangulation Point on Burial Mound
- Single-track Railroad
- Double-track Railroad and Station Building
- Coniferous Forest
- Deciduous Forest
- Mixed Forest
- Lawns
- Citrus Orchard
- Wet Ground
- Scattered Vegetation

243,8 — Values for prominent elevations

186.0 — Numbers for spot elevations, depth soundings, contour lines, etc.

0,2 — Velocity of the current, width of river bed, depth of river

Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	ъ (–)
Д д (D)	Л л (L)	У у (U)	ы (Y)
Е е (E)	М м (M)	Ф ф (F)	ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Partly Demolished Buildings
- Demolished Buildings
- Built-Up Area with Fireproof Buildings Predominant
- Built-Up Area with Non-Fireproof Buildings Predominant
- Individual Fireproof Building
- Prominent Industrial Building
- Individual Dwelling, Fireproof
- Ruins of an Individual Dwelling
- Factory or Mill Chimney
- Factory or Mill with Chimney
- Factory or Mill without Chimney
- Mine or Open Pit Mine
- Operating Shaft or Mine
- Non-Operating Shaft or Mine
- Salt Mine
- Tailings Pile
- Pit
- Stone Quarry
- Gas Pump or Service Station
- Fuel Storage or Natural Gas Tank
- Oil or Natural Gas Derrick
- Small Hydroelectric Power Station
- Power Station
- Transformer Station
- Cemetery
- Burial Mound (height in metres)
- Triangulation Point on Burial Mound
- Triangulation Point
- Bench Mark
- Bench Mark (monumented)
- Telegraph Office
- Telephone Station
- Radio Station
- Radio Tower
- Airfield or Seaplane Base
- Landing Strip
- Main Highway
- Highway under Construction
- Improved Dirt Road (former truck road)
- Double-track Railroad with First Class Station
- Dismantled Railroad
- Railroad Under Construction
- Shore Embankment
- River or Ditch with Embankment
- Direction and velocity of current
- Well
- Water Reservoir or Rain Water Pit
- Spring
- Isobath with value
- Heavy (Index) Contour Line
- Contour Line and Value
- Half Contour Line
- Spot Elevation Value
- Coniferous
- Deciduous
- Mixed
- Scrub

Key to Numbers on Mapping

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Yorkshire	1:10,560	1854	3
Yorkshire	1:10,560	1894	4
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Ordnance Survey Plan	1:10,000	1965 - 1968	11
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Ordnance Survey Plan	1:10,000	1980 - 1989	13
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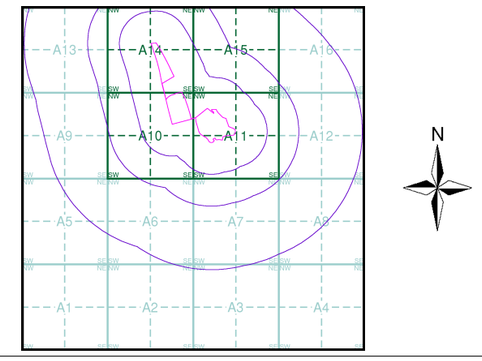
Russian Map - Slice A



Order Details

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Site Area (Ha): 10.7
Search Buffer (m): 1000

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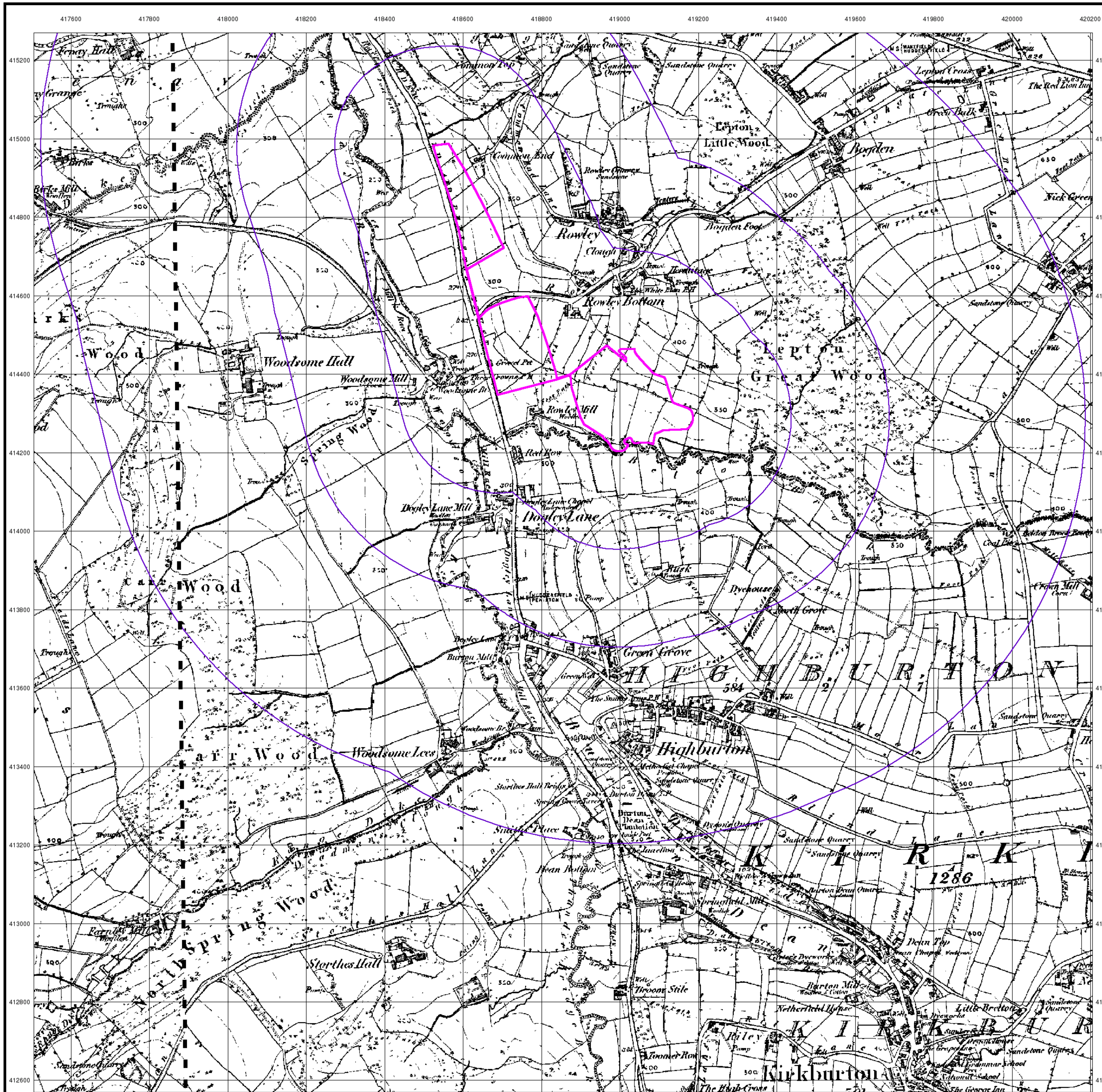

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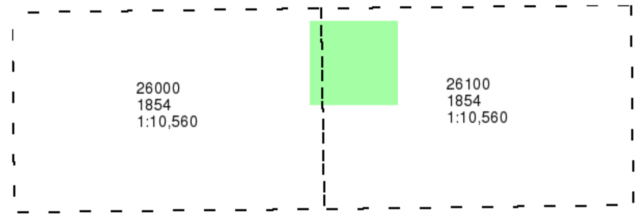
Yorkshire

Published 1854

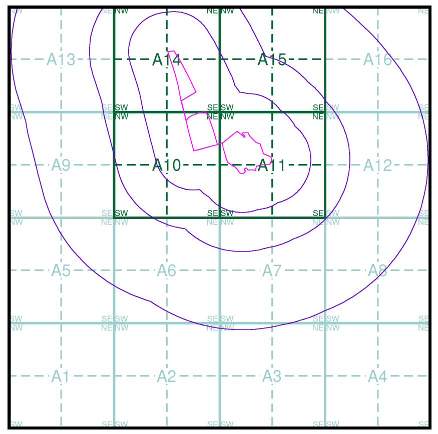
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



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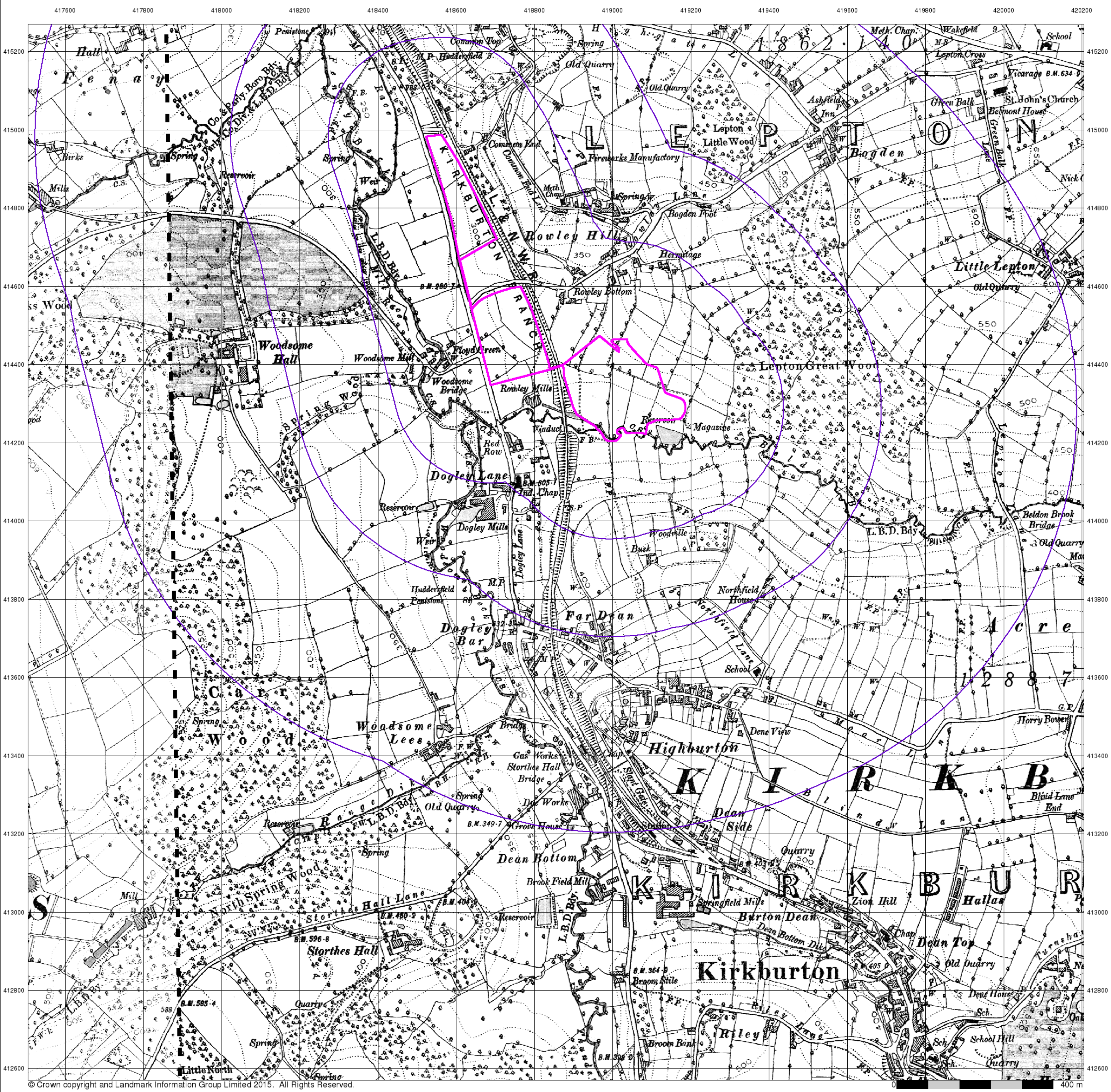

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Yorkshire

Published 1894

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

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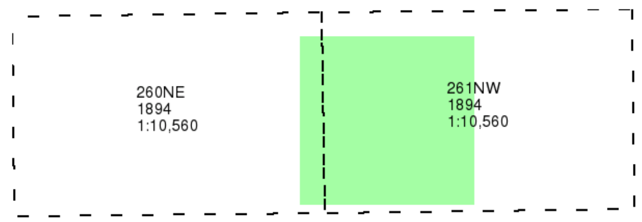
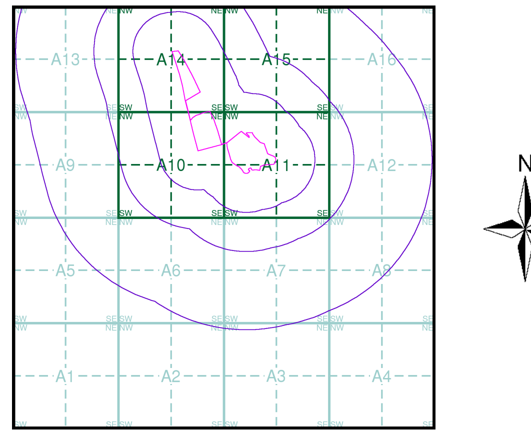


Historical Map - Slice A



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