Eastwood&Partners
CONSULTING ENGINEERS

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PHASE 1
GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION

KERESFORTH ROAD, DODWORTH, BARNSLEY

FOR

KEEPMOAT HOMES LTD

ISSUE 1

46631-001 **3 December 2021**

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Kate Edwards

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1.0 EXECUTIVE SUMMARY

1. The approximately 7.84-hectare site is located immediately south of Junction 37 of the M1 carriageway, to the east of Dodworth, Barnsley. The site currently comprises three open fields, including two small fields to the south and centre, and one large field to the north. Each field is separated by a line of dense woodland, through which a stream passes through, in the woodland between the northern and centre fields.

2. Ground levels generally slope towards the south and south east in the northern half of the site, and to the west and south west in the southern half of the site. Average gradients in the north are around 1 in 30, increasing to around 1 in 7 to 1 in 10 in the centre and south. In the southern half of the site, ground levels slope down from east to west. Average gradients typically range between 1 in 10 and 1 in 12. Localised steeper slopes exist across the site, notably in the vicinity of dense wooded areas. Regrading of site levels will be required as part of any future development.

3. An approximately 1 in 6 embankment is present beyond the southern half of the eastern boundary for the motorway, whilst a roughly 1 in 2 embankment is present along the southern edge of the southern-most field. It is recommended that plots are kept at least 10 m from these slopes.

4. The solid geology below the site comprises the Pennine Middle Coal Measures Formation. Multiple fault lines trending south west to north east cross the site in the north and south. No superficial deposits are shown to be present on site.

5. The Lidgett Coal outcrops in the north and south of the site. Associated opencast workings are recorded in the north (up to around 12 m deep) and south east (around 3 m deep), and immediately beyond the eastern boundary. Underground workings in the seam cannot be ruled out at this stage. The next deepest seams (the Joan and Flockton Thick coals) are not expected to impact surface stability. A rotary drilling investigation is required.

6. An old sandstone quarry is recorded adjacent to the south east of the site, but is not expected to have been infilled. No evidence of any quarrying activity was observed on the site during the walkover.

7. The site does not lie within a flood zone. Localised areas at risk of surface water flooding are shown close to the stream and along the eastern boundary. The majority of the site is shown to have no or limited potential for groundwater flooding. Around 20% of the site in the north has a potential for groundwater flooding at the surface or of property below the surface.

8. A discharge consent relating to a pumping station is recorded where the stream crosses the site, but is expected to be present off-site adjacent to the motorway.

9. Topsoil is expected to be present at the surface of the site. Opencast backfill (colliery spoil) is expected in the north and south east of the site, and up to around 12 m and 3 m deep respectively. The natural ground is generally expected to comprise firm or stiff clay overlying mudstone, siltstone or sandstone bedrock. Shallow coal may be locally encountered along the outcrop of the Lidgett Coal seam.

10. Groundwater is expected to be present from around 3 m depth.

11. Traditional strip or trench fill footings are expected to be suitable for the majority of plots after a regrade in levels. An alternative foundation solution such as piles or rafts could be considered where plots overlie the opencast backfill. Where possible, plots should not be positioned directly overlying the opencast highwall.

12. If drilling and grouting of mine workings is necessary, reinforced spread footings may be utilised for overlying plots.

13. Where spread foundations are within influence of trees, the footing depth will need to be increased in accordance with NHBC Standards Chapter 4.2. Precautions against soil heave due to the influence of past or existing trees are likely to be required.

14. Soakaway drainage is not expected to be viable.

15. No radon precautions are required. At this stage, Amber 1 gas precautions should be allowed for plots in the vicinity of the opencast backfill. This will need to be confirmed through a programme of gas monitoring.

16. Significant contamination is generally not expected. Subject to chemical testing, the site won topsoil, natural ground and colliery spoil are likely to be suitable for re-use, assuming the colliery spoil does not pose a combustion risk.

17. Where coal or coal-rich strata is encountered, a 1 m thick clean capping layer (including at least 100 mm topsoil) will need to be provided. In addition, DS-2, AC-2 sulphate precautions should be allowed for below ground concrete in contact with the made ground and coal, and protective water supply pipes, at this stage.

18. Before more definite information regarding the properties of the ground and any contamination present can be given an intrusive investigation comprising trial pits, boreholes and gas monitoring will be required.

2.0 INTRODUCTION

2.1 Terms of Reference

This report presents the findings of a Phase 1 Geotechnical and Geo-environmental Site Investigation carried out by Eastwood & Partners (Consulting Engineers) Ltd. for and on the instructions of Keepmoat Homes Ltd. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

2.2 Context

Eastwood & Partners previously completed a Phase 1 Geotechnical & Geo-Environmental Site Investigation (38633-001) and Phase 2 Geotechnical & Geo-Environmental Site Investigation (38633-002) for the site on behalf of others in June 2015 and July 2017 respectively. However, we understand that Keepmoat Homes do not have reliance on these reports.

We are not aware of any other investigations having previously been undertaken at this site.

2.3 Aims and Objectives

The aims and objectives of this investigation were as follows:

- To assimilate and review information extracted from published documentation and a site walkover to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;
- To detail the expected ground conditions and their geotechnical properties enabling outline foundation proposals to be made for the proposed residential development; and
- To outline proposals for a Phase 2 intrusive investigation, the purpose of which would be to obtain information to test the conceptual model and assess the risks to receptors as well as to confirm the foundation proposals.

2.4 Scope of Investigation

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

Information analysed has been obtained from a variety of sources and included the following:

- A Landmark Envirocheck;

- A Consultants Coal Mining Report;
- British Geological Survey maps and memoirs; and
- A site walkover.

2.5 Limitations of Investigation

This report is based on the assumption that the site will be developed with low rise housing of conventional construction, with associated private gardens and areas of soft landscaping. Regrading of site levels is expected to required. If this is not the case, further advice may be needed.

Where assessments of site areas affected in particular ways are given, these are approximate. All information, comments and opinions given in this report are based on the documentary information examined. This report considers the ground and groundwater and does not cover any buildings or their fabric or the constituents of any existing hardstanding. Risks to ecological receptors, such as bats, have not been considered.

3.0 THE SITE

3.1 Description

The approximately 7.84-hectare site is located immediately south of Junction 37 of the M1 carriageway, to the east of Dodworth, Barnsley. The site is centred around grid reference 432390, 404990.

The site currently comprises four open fields, including three small fields to the south and centre, and one large field to the north. The far southern field is currently used as a grazing paddock for horses and contains a temporary building in use as horse-stables. The remaining fields are unoccupied.

The fields are typically separated by trees / woodland. A stream crosses the centre of the site, between the northern and southern fields. The stream lies within an approximately 3 m deep natural cutting; an embankment has been constructed across the stream which provides a foot access between the fields. The stream has been culverted below the embankment, and also beneath the M1 carriageway to the east. To the west, the stream continues to flow towards the south just beyond the western boundary.

The site is bordered by the M1 carriageway to the east and private residential dwellings backed onto a line of dense woodland to the west. Keresford Road comprises the site's southernmost boundary, and a public playing field lies immediately north of the site.

A public footpath passes from Keresford Road in the south west corner of the site, connects across the southern end of the site to Lambert Fold on the site's western boundary, and over to the bridge crossing the M1 carriageway in the south east corner of the site. A number of private (non-public) footpaths cross the remainder of the site, through which access to the northern field can be gained from the playing fields, and via Bark Meadows.

Ground levels generally slope towards the south and south east in the northern half of the site, and to the west and south west in the southern half of the site. In the northern field, the northern end lies at approximately 127 to 130 m AOD, and southern end lies at approximately 105 m AOD. Average gradients in the north are around 1 in 30, increasing to around 1 in 7 to 1 in 10 in the centre and south.

In the southern half of the site, ground levels range between 115 m AOD along in the south east to around 93 m AOD at the southern boundary. Average gradients typically range between 1 in 10 and 1 in 12. Localised steeper slopes exist across the site, notably in the vicinity of dense wooded areas. An approximately 4 m high embankment with a gradient of around 1 in 2 to 1 in 3 is located along the southern edge of the southern-most field.

Two additional notable slopes exist past the eastern site boundary with the M1 carriageway, where the ground slopes down steeply at a gradient of roughly 1 in 6 to the north east at the southern end of the site into the road cutting. At the northern end of the site however, the northbound slip road at Junction 37 is built up to be topographically higher than the site, which at its maximum, slopes at approximately 1 in 3 to the south west.

Photographs from the walkover are included in the Appendix.

3.2 History

Historical Ordnance Survey maps obtained as part of the Envirocheck have been reviewed to assess the previous use of the site and surrounding area. Copies of the maps are presented in the Appendix.

3.2.1 The Site

The earliest historical map, dated 1855, shows the majority of the site to comprise agricultural fields. A stream flowing from north to south crosses the centre of the site at the site's narrowest point; a localised area of woodland is present to the south of the stream. A track (labelled as a public footpath on subsequent maps) also runs through the southern quarter of the site, leading from Keresforth Road which forms the southern boundary.

The 1960 historical map indicates shows an embankment to be constructed across the stream in the centre of the site, providing access between the north and south of the site.

By 1979, a structure is indicated in the south of the site, possibly comprising a shed or barn associated with Keresforth Road Farm located adjacent to the south of the site. This structure appears to have been removed from the 1999 historical aerial imagery.

No further significant changes or developments are shown to the present day.

3.2.2 The Surrounding Area

The earliest historical map indicates the surrounding area to mostly comprise agricultural fields. Keresforth Road Farm is located adjacent to the south of the site, and further structures (possible farm houses) are located opposite Keresforth Road to the south. A well is also labelled around 110 m to the south. Two significant areas of woodland are located to the east and south east of the site. A sandstone quarry (Dodworth Bottom Quarry) is located around 25 m to the south east of the site, whilst another old quarry is labelled around 200 m to the north. Dodworth village is located approximately 500 m to the west of the site.

By 1894, a school is constructed on the location of the former Dodworth Bottom Quarry to the south east of the site – an embankment extends up to the site boundary, suggesting the quarry has not been infilled. Terraced housing forming the village of Gilroyd is developed around 200 m to the south. Two large collieries, Strafford Collieries and Church Lane Colliery (later known as Old Silkstone Collieries) are shown around 700 m and 900 m to the south and west of the site respectively.

By 1906, Rose Hill Colliery is located around 80 to 120 m to the south west of the site, and a shaft is labelled within the colliery buildings. By 1931 the colliery is no longer labelled, and a school and church are shown around 170 m to the west of the site. Another colliery, Needlewood Colliery, is labelled around 300 m to the south east of the site on the 1932 map; the colliery is labelled as disused by 1956, and the structures are no longer shown. Strafford Collieries is labelled as disused by this time.

By 1962, further farm buildings are added to Keresforth Road Farm, and the school to the south east is replaced with housing.

By 1970, the M1 motorway has been constructed adjacent to the eastern boundary of the site, including slip-roads for the junction located around 180 m to the north. The highway is located within a cutting below the level of the site, although the slip road adjacent to the northern half of the site is raised on an embankment. A footbridge crosses the motorway leading from the south east corner of the site. Only small sections of the woodland to the south east remain following the motorway construction, whilst the woodland to the east has also been deforested to create farmland. Significant residential development is shown around 100 m to the south of the site, including a care home which has been constructed on the former colliery. Further extensions are added to the school to the west. A recreation ground is also labelled adjacent to the north of the site.

The Old Silkstone Collieries appear to be disused by 1983.

Between 1990 and 2000, further residential development is undertaken on land to the west of the site, separated from the site by a 20 to 30 m wide strip of woodland. No further significant changes are shown.

3.3 Geology

The geological map sheets SE30 NW and SW (1:10,000), the British Geological Survey (BGS) Online Viewer and the Coal Authority Interactive Viewer have been reviewed.

The solid geology below the site is shown to comprise the Pennine Middle Coal Measures Formation; across the majority of the site, the geology comprises undifferentiated sandstone, siltstone and mudstone, although frequent sandstone bands are indicated.

The Lidgett Coal seam is shown to outcrop on the site. The seam outcrops roughly 100 m to the north of the stream, and is orientated roughly approximately north west to south east. The outcrop roughly follows the eastern site boundary, before crossing the southern third of the site orientated approximately north-south.

No superficial deposits are shown to underlie the site.

The geological maps show an area of backfilled opencast workings in the northern half of the site, north of the outcrop of the Lidgett Coal. Further backfilled workings are shown to extend into the south east corner, and immediately beyond the eastern boundary.

Two fault lines are shown to cross the site in the south, whilst another crosses the north of the site. Another fault is indicated just beyond the northern corner. The faults are all orientated roughly south west to north east, and the geology is downthrown to the south east.

The solid geology is indicated to dip down roughly towards the north east at approximately 3 to 5°.

Numerous boreholes have been completed in the residential development to the west of the site, the logs of which are available to view on the BGS Online Viewer. These typically recorded the natural ground to comprise stiff clay depths of between 0.5 and at least 2.5 m, overlying mudstone, shale and sandstone. These ground conditions are relatively consistent with findings from Eastwood & Partners' previous investigation at the site.

Three boreholes were also completed in the opencast backfill immediately east of the site; these recorded between 2.5 and 6.5 m of made ground overlying stiff clay, with mudstone or siltstone bedrock encountered from around 7 m depth.

3.4 Hydrogeology

The underlying bedrock is identified by the Envirocheck as a Secondary A Aquifer, which are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The site is not located within a Groundwater Source Protection Zone.

There are no groundwater or surface water abstractions within 500 m of the site.

3.5 Hydrology

The Envirocheck records the nearest surface water feature to the stream which crosses the centre of the site. The stream runs just beyond the southern half of the western boundary and converges with another stream close to the south west corner; the watercourse continues to the south east as

Dodworth Dike. Beyond the eastern boundary, the upstream portion of the stream is indicated to have been culverted below the motorway.

3.6 Extractive Industries

Coal Mining

The geological maps show the Lidgett Coal to outcrop in the north of the site as well as along the eastern boundary and crossing the site again in the southern third. The seam dips towards the north east, and is expected to deepen to around 30 m in the far north of the site and around 5 m depth below the south east corner.

The next deepest seam below the site is expected to be the Joan Coal, which outcrops offsite to the south west. At its closest point, the outcrop is located around 25 m from the site boundary close to the entrance to the site from Keresforth Road; the seam is generally expected to lie at least 8 m below the site in the south, deepening to over 60 m in the north.

The geological map shows backfilled opencast workings to extend across a significant area in the north of the site as well as extending onto site from the east.

Geological Memoirs

According to the geological memoir for Barnsley, the Lidgett Coal was proven at outcrop in the Dodworth area; to the west and north of Barnsley (north of Dodworth) the seam is recorded to become irregular and untraceable at the surface. The memoirs note that the seam was worked from day-eyes at Needlewood (around 300 m south east of the site) where the seam was recorded to be 0.56 m thick.

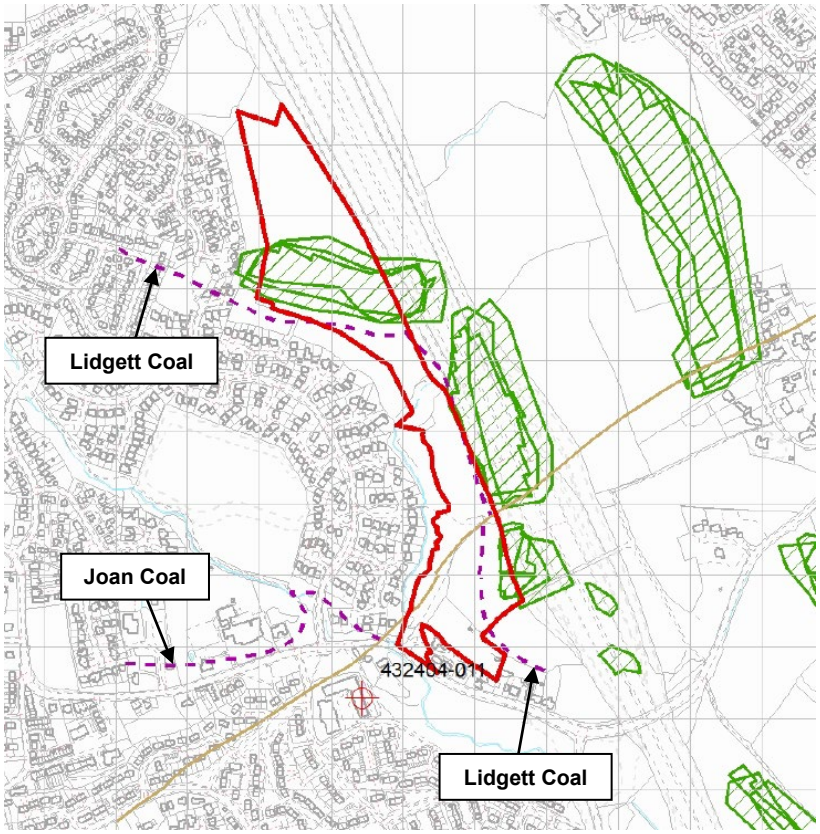
The next deepest seam below the Lidgett Coal is the Joan Coal. The intervening measures are noted to be around 33 to 46 m thick and contain one or two thin coal seams, although at Needlewood a seam attributed to the Joan Coal was recorded in a stream bed just 15 m below the Lidgett Coal. According to the memoirs the seam is persistent in thickness, varying between 0.3 and 0.6 m; it is recorded to have been worked locally at Dodworth, although no further details are provided. A borehole log for the Old Silkstone Collieries around 900 m west of the site (available on the BGS website) records the seam to be 0.61 m thick; the borehole also records a thin coal (0.25 m thickness) around 22.5 m above the Joan Coal.

The next deepest named seam is the Flockton Thick Coal. The borehole at Old Silkstone Collieries records the seam to lie 19 m below the Joan Coal, and has a thickness of 2.16 m. The memoirs note that the Flockton Thick Coal has been worked almost everywhere, often in connection with the

overlying Tankersley Ironstone which typically occurs around 4.5 to 15 m above the coal; at Old Silkstone Collieries the ironstone occurs around 7 m above the coal.

Consultants Coal Mining Report

A Consultants Coal Mining Report has been obtained and is included in the Appendix. The report records the Lidgett and Joan coal seams to outcrop in roughly the same location as the geological maps, and there is also broad correlation between the location of the opencast sites. An extract of the plan included in the CCMR is provided below.



Extract of plan from Consultants Coal Mining Report showing location of coal outcrops (purple dashed lines), fault lines (yellow solid line) and historical opencast sites (green hatched areas).

The Coal Authority (CA) report states that the site is affected by past underground mining in five coal seams:

Seam	Depth (m)	Extraction Thickness (m)	Year Last Mined
Flockton Thick	29 to 64	0.7	1930
Top Fenton	80 to 108	0.89 to 0.91	1923
Parkgate	96 to 135	1.37 to 1.78	1934
Silkstone	183 to 216	1.47 to 1.67	1935
Whinmoor	255 to 257	1.07	1968

The site is also recorded to lie within an area of probable unrecorded shallow workings.

One mine entry is recorded within 100 m of the site. This is the shaft located at Rosehill Colliery offsite to the south west of the site. The shaft was investigated in 2003 and found to be filled; it was subsequently remediated by drilling and grouting to its full depth in August 2003. The CA's records may be incomplete and therefore further mine entries could exist of which the CA has no knowledge.

The CA record backfilled opencast workings to be present in the north and south east of the site, and also immediately beyond the eastern boundary. There is broad correlation between the recorded extent of the opencast workings and the mapped extent on the geological map. Numerous abandonment plans are noted to be available. During the previous site investigation, Eastwood & Partners reviewed abandonment plan NE277 for the opencast areas which extend onto the site. This plan detailed opencast workings for the Lidgett coal which took place in 1949, backfilled in 1950. The Lidgett coal was recorded to be 0.6 m thick, and no underground workings were recorded during opencast, which extended up to around 12 m below original ground level. The seam was noted to dip to the north east and east at around 1 in 10 to 1 in 13.

Abandonment plan NE584 was also obtained which details underground workings in the Flockton Thick coal seam.

No notices have been given under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

There are no records of mine gas or mine water treatment schemes within 500 m of the site.

The Coal Authority have not received a damage notice or claim for coal mining subsidence for the site, or any properties within 50 m of the site, since 31 October 1994. The property is not within 200 m of an area where the CA has plans to grant a license to remove coal by underground methods. No future mining is proposed, and is considered unlikely due to the decline of the UK coal industry.

Previous Investigation

During the previous investigation undertaken by Eastwood & Partners, the Lidgett Coal was recorded to be between 0.3 and 0.7 m thick in the exploratory holes. The opencast backfill in the north of the site was recorded to be around 5 to 9 m deep, whilst the backfill in the south east is around 3 m deep. One borehole in the south of the site recorded 0.5 m of broken ground, although this was considered to relate to fractured sandstone rather than underground coal workings. No evidence of underground workings was recorded in the remaining boreholes.

Where encountered, coal seams attributed to the Joan Coal were recorded around 11 to 25 m below the Lidgett with a thickness of around 0.5 to 0.8 m, although these could comprise other unnamed thin seams. No evidence of workings was encountered.

Conclusion

The Lidgett Coal outcrops in the north of the site trending roughly north west to south east around 100 m to the north of the stream. The coal is known to have been worked by opencast methods up to around 110 m north of the outcrop; the opencast backfill is expected to be up to around 12 m thick. The coal also outcrops in the south of the site trending north to south. Another opencast area expected to be around 3 m deep extends into the south east of the site, whilst opencast sites are also recorded immediately beyond the eastern boundary.

The Lidgett Coal is recorded to have been worked at day-eyes (adits) around 300 m to the south east of the site. The Coal Authority do not record the seam to have been worked by underground methods below the site, although the presence of workings should not be ruled out at this stage. A rotary drilling investigation will be required to determine the depth and condition of the coal, and remedial works such as drilling and grouting may be required if shallow workings encountered at depths less that the minimum required thickness of competent cover (around 9 m based on the general rule that ten times the seam thickness of overlying competent cover is required).

The Joan Coal is generally expected to lie around 33 to 46 m below the Lidgett Coal, and is expected to be no greater than around 0.6 m thick. In the south of the site (but north of the southern fault lines) the coal is expected to be present from as shallow as around 8 m; the seam is therefore generally anticipated to be sufficiently deep to influence surface stability. However, it would be prudent to confirm this during the drilling investigation.

The Flockton Coal (around 2 m thick) is expected a further 19 m below the Joan Coal. Any workings in this seam are expected to be sufficiently deep to impact surface stability.

Sandstone Quarrying

The Envirocheck and the historical maps record a former sandstone quarry, Dodworth Bottom Quarry, to be present around 25 m to the south east of the site. The quarry is recorded on the earliest historical map dated 1855, although has been developed with a church by 1893.

Another old sandstone quarry is recorded on the historical maps around 200 m to the north on the 1855 map. No quarries are recorded to be present on the site, and no evidence of any quarrying activity was noted during the walkover.

3.7 Ground Gas

According to the Envirocheck, the site straddles a lower probability radon area (i.e. <1% of homes are estimated to be at or above the Action Level) and an intermediate probability radon area (1 to 3% of homes at or above the Action Level). No radon protective measures are therefore necessary in the construction of new dwellings or extensions.

Opencast backfill is recorded in the north and south east of the site, as well as immediately to the east of the site. The backfill in the north is expected to be up to around 12 m deep, and around 3 m deep (on site) in the south east. To the east of the site, the opencast was previously recorded to be around 12 m deep, although the backfill thickness is expected to be less than this following the construction of the motorway. Furthermore, underground mine workings may be present below and in the immediate vicinity of the site, which could present a risk of mine gas.

Limited made ground is expected to be present elsewhere on the site; two temporary stables are located in the south of the site, a possible shed was previously also located in the south, although a significant thickness of made ground associated with these structures is not anticipated.

According to the Envirocheck, there are three potentially infilled land features within 250 m of the site. The closest of these is located 35 m to the south east of the site, and is considered to relate to Dodworth Bottom Quarry, a former sandstone quarry recorded on the historical maps in 1855. The quarry was developed with a school by 1894, which was subsequently replaced by housing by 1962. However, the quarry does not appear to have been infilled from the historical maps, and ground levels were noted to be below that of the surrounding area during the site walkover, and therefore any backfill present is expected to be of limited thickness. The next closest feature is located 60 m to the south west, and is considered to relate to the former Rose Hill Colliery which became disused by 1931. Another infilled quarry is recorded 204 m to the north of the site; this is expected to have been infilled by 1893.

The Envirocheck also records a potentially infilled water feature 77 m to the south of the site; this is considered to relate to an infilled stream (Dodworth Dike) which was culverted during the construction of the motorway to the east.

According to the Envirocheck there are no active or historical landfills within 250 m of the site.

Due to the backfilled opencast sites located in the north and south east of the site and adjacent to the eastern boundary, and also due to the potential for underground mine workings to be present below and in the vicinity of the site, a gas monitoring programme is considered to be required.

3.8 Pollution Incidents to Controlled Waters

According to the Envirocheck, there have been five pollution incidents to controlled waters within 250 m of the site. Two of these refer to the same incident, which occurred adjacent to the southern boundary of the site along Keresforth Road; the incident occurred in April 1994 and was classed as a Category 3 Minor Incident. No further details are provided. Since the incident occurred at the lowest point of the site, it is not considered to have had a significant impact on the site.

The next closest incidents are recorded 61 m to the south east and 149 m to the east, and downstream of the site. The final incident occurred 152 m to the north, although the Envirocheck states that no pollution occurred. Each of these was classed as a Category 3 Minor Incident, and are not considered to have impacted the site.

3.9 Discharge Consents

According to the Envirocheck, there are five discharge consents within 250 m of the site. One of these consents is positioned where the stream crosses the centre of the site and relates to a pumping station operated by Yorkshire Water Services. The address for the consent is given as Dodworth Road (located around 320 m north of the site), and no evidence of the station was identified during the site walkover. Google Earth imagery indicates that the pumping station may be located just off-site adjacent to the slip-road for the motorway. The licence relates to sewage discharges and the receiving water is given as Dodworth Dike, and was granted in February 2003. No revocation date is provided.

Three of the consents relate to a Yorkshire Water storm tank located along a culverted stream around 91 m to the south west of the site. The consents included re-issued versions of the same licence, originally granted in January 1997. No revocation date is provided for the most recent licence.

The remaining consent relates to another Yorkshire Water pumping station located 213 m to the north of the site. The discharge type is given as sewage discharges, and the receiving water as Brough Green Brook. The licence was granted in November 1989 and revoked in February 2003.

3.10 Flooding

The site does not lie within an area at risk of flooding from rivers or seas.

Localised areas close to where the stream crosses the centre of the site, and also adjacent to the northern half of the eastern boundary, are shown to have a low (1,000 year return flooding event) to high (30 year return) risk of surface water flooding.

The majority of the site (around 80%) either has no or limited potential for groundwater flooding to occur. A localised band in the north of the site is shown to have a potential for groundwater flooding of property below ground level (~5% of the site) or groundwater flooding at the surface (~15%).

3.11 Soil Geochemistry

The Envirocheck estimates the following concentrations of arsenic, cadmium, chromium, nickel and lead to be present in the natural soil at the site. These are compared to an assessment value for residential gardens with homegrown produce.

Contaminant	Estimated Concentration (mg/kg)	Assessment Value (mg/kg)
Arsenic	<15 to 35	37
Cadmium	<1.8	11
Chromium	60 to 120	910
Lead	<100 to 200	200
Nickel	15 to 45	180

The concentrations of these contaminants are therefore not expected to be elevated within the natural ground.

3.12 Contemporary Trade Directory Entries, Fuel Station Entries and Waste Management Facilities

There are three contemporary trade directory entries recorded within 100 m of the site, although each of these are noted to be inactive.

The closest active entry is located 132 m to the north west of the site, and relates to a pest management company.

There are no fuel station entries or licenced waste management facilities recorded within 1 km of the site.

4.0 EXPECTED GROUND CONDITIONS

4.1 Surface Covering

Topsoil is expected to be present at the surface across the site.

4.2 Made Ground

Backfilled opencast workings are expected to be present in the north and south east of the site. The opencast in the north of the site is expected to be up to around 12 m thick, and in the south is expected to be around 3 m thick. The backfill is generally expected to comprise colliery spoil (i.e. reworked mudstone).

Made ground may be locally encountered below the existing and former structures (stables and sheds), but is expected to be of limited thickness.

4.3 Natural Ground

The natural ground is expected to comprise residual weathered strata (i.e. firm to stiff clay) overlying Coal Measures mudstone, siltstone or sandstone bedrock.

Shallow coal may be locally encountered close to the outcrop of the Lidgett Coal seam.

4.4 Groundwater

A stream crosses the centre of the site, and flows adjacent to the southern half of the western boundary. It lies within a natural cutting which is at least 3 m below the level of the site. Wells and other streams are shown on historical maps in the vicinity of the site. Groundwater is therefore expected to be present at shallow depth below the site.

5.0 OUTLINE CONCEPTUAL MODEL

The site is being considered for housing with associated private gardens and areas of soft landscaping.

5.1 Potential Sources of Contamination

The topsoil is expected to be suitable for re-use.

Opencast backfill is expected to be present in the north and south east of the site. However, the backfill is expected to comprise colliery spoil (i.e. reworked clay and mudstone) and is therefore not generally expected to contain elevated concentrations of contaminants which could pose a risk to human health. The colliery spoil may contain elevated sulphate concentrations which could impact sub-surface concrete.

A limited thickness of made ground may be encountered below the existing and former structures in the south of the site. Any made ground could contain elevated concentrations of heavy metals, polycyclic aromatic hydrocarbons (PAHs), sulphates and asbestos fragments / fibres.

5.2 Ground Gas

No radon protective measures are necessary in the construction of new dwellings or extensions.

Historical opencast sites are present in the north and south east of the site, and also immediately beyond the eastern boundary. The backfill thickness could be up to around 12 m, and they could present a risk of ground gas to the proposed development. It is also considered that there is a potential for underground coal workings to be present below or in the vicinity of the site, which could present a risk of mine gas.

A sandstone quarry was previously located adjacent to the south east corner of the site, although this is not expected to have been infilled. Further infilled features include a former colliery site and a stream to the south west, and a backfilled quarry to the north. However, due to size of these features and/or the length of time since backfilling took place, these are not considered to present a significant source of ground gas.

A gas monitoring programme is considered to be required to assess the gas risk presented by the on-site and off-site opencast backfill to confirm the gassing regime.

5.3 Potential Pollutant Linkages

The following table details the possible sources and associated contaminants of concern, pathways and receptors:

Source	Potential Contaminants	Potential Pathways	Potential Receptors
Made ground	Heavy metals/metalloids PAHs Asbestos fragments/fibres	Ingestion Inhalation Direct contact Biological uptake Migration through ground	Site residents and visitors to the site Site construction workers Secondary A Aquifer Plants Water supply pipes
Made or natural ground	Sulphates Low pH	Direct contact	Below ground concrete
On-site and off-site opencast backfill Underground coal workings	Ground gas / mine gas	Inhalation Migration through ground	Residents and future visitors to the site Site construction workers

5.4 Remedial Measures

Significant contamination is generally not expected. Subject to chemical testing, the site won topsoil, natural ground and colliery spoil are likely to be suitable for re-use, assuming the colliery spoil does not pose a combustion risk.

At this stage it is considered that allowance is made for the following:

- Where coal or coal-rich strata is encountered within 1 m of the surface within gardens and landscaped areas, a 1 m thick clean capping layer will need to be provided. This will likely affect <10% of the site;
- Any potential heat sources, such as electricity cables, should not be installed in potentially combustible material;
- A minimum DS-2 AC-2 level of sulphate precautions for below ground concrete structures in contact with made ground and coal;
- Protective water supply pipes in made ground; and
- Amber 1 gas protective measures, comprising a minimum 150 mm ventilated void and fully lapped and sealed gas membrane, in plots overlying or in close proximity to opencast areas (~25% of the site).

6.0 GEOTECHNICAL APPRAISAL

6.1 General

Ground Conditions

Topsoil is expected to be present at the surface of the site. Opencast backfill (comprising colliery spoil) is expected in the north and south east of the site, and is expected to be up to around 12 m and 3 m deep respectively. The natural ground is generally expected to comprise firm or stiff clay overlying mudstone, siltstone or sandstone bedrock. Shallow coal may be locally encountered along the outcrop of the Lidgett Coal seam.

Groundwater is expected to be present from around 3 m depth.

Underground workings in the Lidgett Coal are generally not expected to be present, but should not be ruled out at this stage. If present, these could impact surface stability. The depth and condition of the seam should be confirmed by a rotary drilling investigation. The underlying Joan Coal and Flockton Thick Coal are expected to be sufficiently deep to impact the surface, although the depth of the Joan Coal in the south of the site should also be confirmed by drilling.

Slopes

Ground levels generally slope towards the south and south east in the northern half of the site, and to the west and south west in the southern half of the site. Average gradients in the north are around 1 in 30, increasing to around 1 in 7 to 1 in 10 in the centre and south.

In the southern half of the site, ground levels slope down from east to west. Average gradients typically range between 1 in 10 and 1 in 12. Localised steeper slopes exist across the site, notably in the vicinity of dense wooded areas. An approximately 4 m high embankment with a gradient of around 1 in 2 to 1 in 3 is located along the southern edge of the southern-most field.

Two additional notable slopes exist past the eastern site boundary with the M1 carriageway, where the ground slopes down steeply at a gradient of roughly 1 in 6 to the north east at the southern end of the site into the road cutting. At the northern end of the site however, the northbound slip road at Junction 37 is built up to be topographically higher than the site, which at its maximum, slopes at approximately 1 in 3 to the south west.

Regrading of site levels will be required as part of any future development.

At this stage, it is recommended that plots are kept at least 10 m from these steeper slopes.

6.2 Foundations

At this stage, traditional strip or trench fill foundations are expected to be suitable for the majority of plots depending on how levels are regraded. Footings should be constructed at a minimum depth of 900 mm in natural clay or mudstone bedrock (assuming cohesive soils are of medium volume change potential) below existing or finished ground level (whichever is lower). This is dependent on the volume change potential of the soil, which would need to be assessed as part of an intrusive investigation. Where weathered sandstone is encountered, a minimum footing depth of 600 mm will be required.

Where opencast backfill is encountered (below around 25% of the site), an alternative foundation solution such as piles or rafts will need to be considered. We recommend that plots are positioned away from the highwall where possible. However, where this cannot be accommodated, piled foundations will be required socketed into the highwall.

If underground mine workings are encountered below the site, drilling and grouting may be required beneath the proposed plot and road positions. Reinforced strip or trench fill footings could then be used within the natural ground.

Where spread foundations are within influence of trees, the footing depth will need to be increased in accordance with the NHBC Standards Chapter 4.2. Precautions against soil heave due to the influence of past or existing trees are likely to be required wherever the footing depth is increased to a depth greater than 1500 mm and for piled foundations.

Where different materials are encountered within the same footing (e.g. clay or sandstone), it would be prudent to deepen the footing onto the same ground type to prevent differential settlement. Alternatively, reinforced footings could be utilised.

If coal is encountered in foundation trenches, this should be blinded using a lean mix of concrete. The footing should be deepened to bear onto the competent ground below.

Multiple faults are inferred to cross the site, however future movement of the fault is considered to be unlikely. Therefore, additional measures in spread foundations are not considered to be necessary.

6.3 Ground Slabs

At this stage, we recommend allowing for Amber 1 gas precautions within plots overlying or in close proximity to opencast backfill. This requires a precast concrete floor with an underlying ventilated void, in addition to a fully lapped and sealed gas resistant membrane.

Elsewhere, a reinforced suspended or precast concrete floors with a minimum 150 mm ventilated void are expected to be suitable.

A precast concrete floor with a void beneath would also be required for all piled plots and where footings require heave precautions due to trees. The void height would be dependent on the volume change potential of the clay.

6.4 Superstructure Precautions

In the event that mine workings are encountered, additional superstructure precautions such as masonry reinforcement would be required in overlying plots.

6.5 Excavation Problems and Obstructions

The stability of trenches may be poor in the opencast backfill, which may also contain boulders. Strong bedrock may be present at shallow depth, particularly where ground levels are to be reduced significantly.

Temporary support will be required in accordance with current Health & Safety Regulations wherever access is required to trenches deeper than 1.2 m or less where there is risk of collapse.

6.6 Roads

A CBR value of at least 2% is expected to be appropriate for road design. It is recommended that CBR tests are undertaken along any proposed roads prior to construction so that accurate CBR values can be obtained. The ground should be assumed to be frost susceptible at this stage and a minimum construction thickness of 450 mm will therefore apply.

6.7 Surface Water Drainage

Given the expected ground conditions, it is not expected that soakaway drainage will be viable for the site.

7.0 RECOMMENDATIONS FOR FURTHER WORK

Before more definite information regarding the properties of the ground and any contamination present can be given, an intrusive investigation will be required. Investigation by mechanically dug trial pits would be the preferred method of investigating the soils on site, as this allows a larger volume of soil to be viewed. This will also allow trenches to be excavated to determine the extent of the opencast backfill.

Rotary open-hole drilling will be required to determine the depth and condition of the Lidgett Coal seam below the site. These boreholes will also allow for the installation of gas and groundwater monitoring standpipes.

Cable percussive boreholes will be required to confirm the depth of the opencast backfill.

Cone Penetration Testing may be required should the backfill potentially be suitable as a bearing stratum for foundations.

The potential pollutant linkages presented in Section 5.3 will need to be investigated by means of soil and water analysis. The chemical testing suite should be chosen to cover the range of potential contaminants indicated. Geotechnical testing should be carried out on clay soils to determine their volume change potential.

APPENDIX

Site Walkover Photographs

Envirocheck

Consultants Coal Mining Report

Footpath access to site via Keresforth Road
(view east along Keresforth Road)

Footpath access from Keresforth Road
(view north along footpath)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	1 & 2

Eastwood & Partners
CONSULTING ENGINEERS

St Andrew's House
23 Kingfield Road
Sheffield S11 9AS
Tel: (0114) 2554554 Fax: (0114) 2554330

KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Footpath access to site via Keresforth Road
(view north along footpath, leading towards centre of site)

Field in centre of site
(view south towards southern end of site, from eastern boundary (left) with M1)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	3 & 4

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Field leading to southern field
(view south along eastern boundary, M1 to left)

Southern field
(view north along eastern site boundary, M1 to right)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	5 & 6

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Site access via bridge over M1 motorway
(view east along bridge from southern field)

View across centre of site from Eastern boundary
(view north along eastern site boundary, M1 to right)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	7 & 8

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Footpath access to site via Lambert Road
(south west towards Lambert Road, from site)

Footpath access to site via Lambert Road
(view east from Lambert Road)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	9 & 10

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Wooded area with Culverted stream between centre and northern fields
(view south from northern field into woodland)

Culverted stream beneath M1 carriageway
(view east towards M1 from wooded area)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	11 & 12

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Culverted stream beneath footpath in wooded area between centre and northern fields
(view west from wooded area towards footpath)

Northern field
(view north across northern field from edge of wooded area to rear)

Prepared	ACR	Checked		Date	12/11/2021	Photograph No	13 & 14

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Footpath access to northern field via Bark Meadows
(view south from site towards Bark meadows)

Footpath access to northern field via Bark Meadows
(view north from Bark Meadows towards site)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	15 & 16

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Northern field
(view south back towards wooded area)

Northern field
(view east from western boundary of northern field, towards M1 carriageway)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	17 & 18

Eastwood & Partners
CONSULTING ENGINEERS
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Sheffield S11 9AS
Tel: (0114) 2554554 Fax: (0114) 2554330

KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Footpath access to northern field from public playing fields
(view north across northern site boundary towards public playing fields)

Northern field
(view south along western boundary of northern field, from boundary with public playing fields, M1 carriageway to left)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	19 & 20

E P Eastwood & Partners CONSULTING ENGINEERS

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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

Northern field
(view south along eastern footpath, M1 carriageway visible to left (east))

Junction between Wood End Court and Keresforth Road, proposed site access route.
(view east from Keresforth Road)

Prepared	ACR	**Checked**		**Date**	12/11/2021	**Photograph No**	21 & 22

E P
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CONSULTING ENGINEERS
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KERESFORTH ROAD, DODWORTH

KEEPMOAT HOMES LIMITED

WALKOVER SITE PHOTOGRAPHS

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
Sloping Masonry
Pylon
Electricity Transmission Line
Pole
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

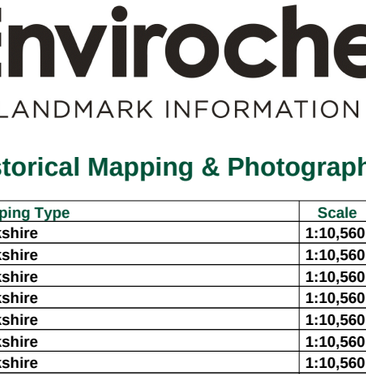
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community 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

Envirocheck®
LANDMARK INFORMATION GROUP®

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Yorkshire	1:10,560	1855	2
Yorkshire	1:10,560	1894	3
Yorkshire	1:10,560	1907	4
Yorkshire	1:10,560	1932 - 1933	5
Yorkshire	1:10,560	1938	6
Yorkshire	1:10,560	1938 - 1948	7
Yorkshire	1:10,560	1948	8
Ordnance Survey Plan	1:10,000	1956	9
Ordnance Survey Plan	1:10,000	1965 - 1966	10
Ordnance Survey Plan	1:10,000	1973 - 1978	11
Ordnance Survey Plan	1:10,000	1983	12
Ordnance Survey Plan	1:10,000	1993	13
10K Raster Mapping	1:10,000	2000	14
10K Raster Mapping	1:10,000	2006	15
VectorMap Local	1:10,000	2021	16

Historical Map - Slice A



Order Details

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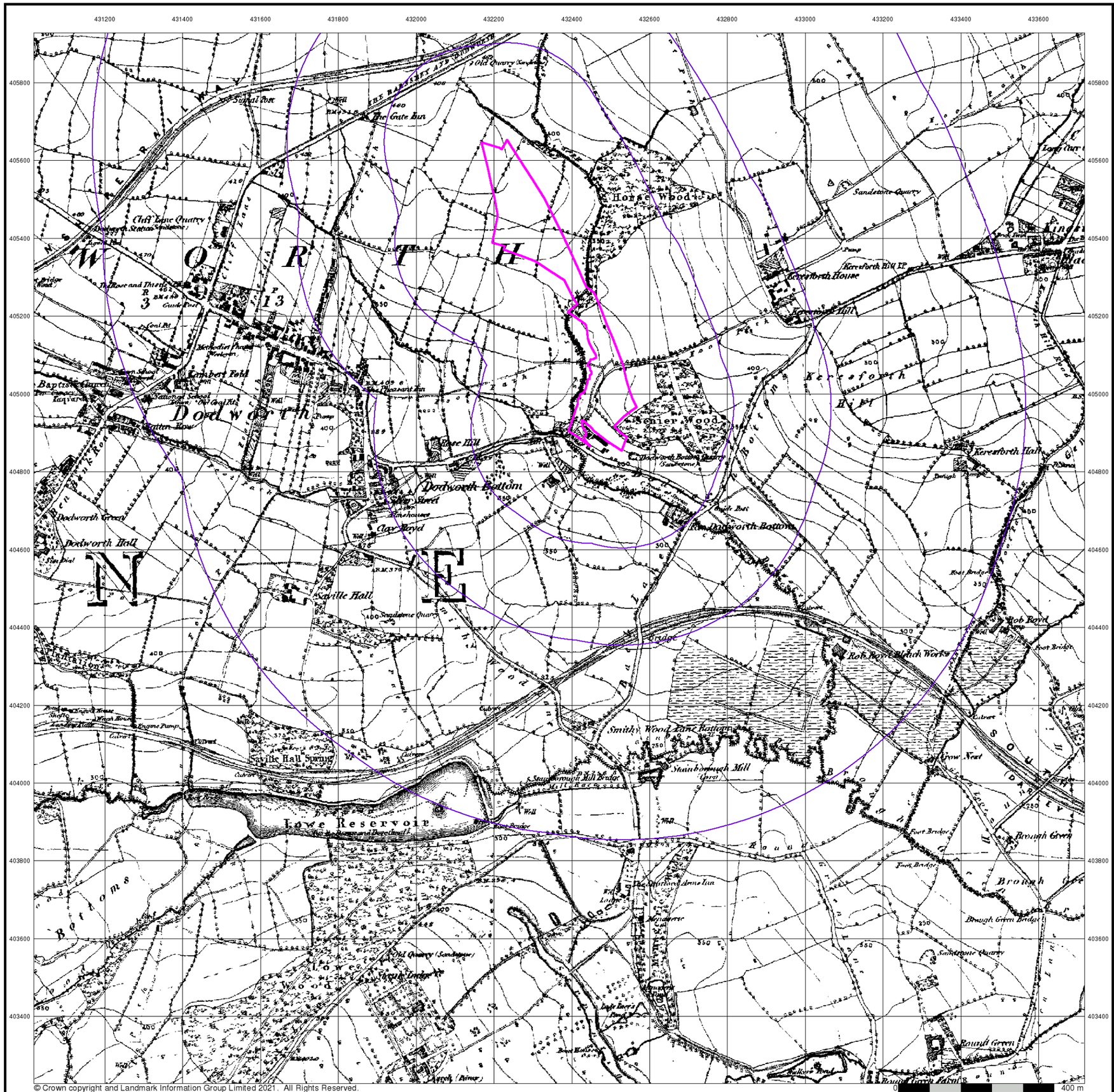
Customer Ref: 46631
National Grid Reference: 432390, 404990
Slice: A
Site Area (Ha): 7.84
Search Buffer (m): 1000

Site Details

Site at 432420, 405250

Landmark® INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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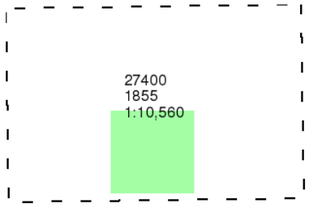
Yorkshire

Published 1855

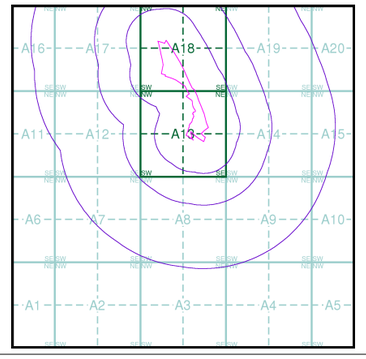
Source map scale - 1:10,560

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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