Technical Note

Project:	P17-176 Athersley RLE		
Subject:	Technical Note – Coal Mining Investigation		
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1 Introduction

1.1 Terms of Reference

In August 2019, Harworth Estates commissioned Rodgers Leask Environmental Ltd (RLE) to undertake a targeted investigation into coal mining legacy issues on land off Wakefield Road, Athersley, Barnsley, henceforth referred to as "the Site". The Site is proposed to be re-developed for a residential end use.

1.2 Limitations and confidentiality

All conclusions and recommendations made within this report are based upon and limited to the factual information obtained as part of this investigation. No responsibility can be taken by RLE Ltd for information obtained by third parties and it has been assumed that all third party information provided is true and correct.

No liability can be accepted for conditions not revealed within the exploratory holes or pits undertaken by this investigation. The exploratory points cover only a small proportion of the total site area. RLE Ltd has where necessary undertaken extrapolation between locations and no responsibility can be taken for different conditions which may occur between locations.

RLE Ltd has undertaken the work in accordance with our understanding of current best practice at the time of undertaking the report. Further assessment and revision of the report may be required should new information come to light or legislation/changes to best practice be introduced after the date of issue of the report.

RLE Ltd has prepared the report for the sole use and reliance of the Client. The report may not be used or relied upon by any unauthorised third party without the explicit written agreement of RLE Ltd.

2 Reference Documents

RLE has previously produced the following documents which should be referred to in conjunction with this technical note:

- Phase 1 Desk Study, May 2017, ref: 17176-RLE-17-00-RP-O-001
- Coal Mining Risk Assessment, May 2017, ref: 17176-RLE-17-00-RP-O-002
- Phase 2 Geo-Environmental Report January 2018, ref: 17176-RLE-17-00-RP-O-003

3 Background Information

3.1 Site History and Setting

The northwest of the Site was formerly occupied in part by the East Gawber Hall Colliery between c.1856 and 1922, with the remainder of the colliery being situated off-site to the north and west. This colliery included several shafts, adits and railway sidings located in the north of the Site, and numerous additional buildings including some coke ovens situated off-site to the northwest. Additional collieries were present in the wider surrounding area including Primrose Main and Wharncliffe Carlton to the south.

A former railway embankment (now public footpath) is present along the southern Site boundary.

Since closure of the colliery on Site, land north of the Site was redeveloped as an engineering works. The remainder of the Site appears to have been restored to the present condition of grass pasture. Anecdotal evidence provided to RLE by a local resident indicated that the east of the Site was formerly used as an excavator training ground.

3.2 Coal Mining Geology

The Site is underlain by solid geology of the Pennine Lower Coal Measures formation. No superficial deposits are recorded.

The following coal seams (listed in stratigraphical order) are anticipated to outcrop on Site or exist at shallow depth beneath the Site:

- Two Foot – up to 0.6m thick, expected at outcrop to shallow across the north of the Site only.
- Abdy (Winter) – up to 1.4m thick, expected at outcrop to ~16m depth across the centre and north of the Site only.
- Top Beamshaw – up to 1.8m thick, expected at outcrop to ~28m depth.

- Low Beamshaw – up to 0.6m thick, expected at outcrop to ~36m depth.
- Kent's Thin – up to 0.8m thick, expected between 24m to 52m depth.

Recorded shallow working has occurred within the Abdy seam in a small area in the northwest of the Site, worked from East Gawber Hall Colliery. However unrecorded working may have occurred in any of the above seams. Deeper recorded working has occurred in the Kent's Thick (Mapplewell) and Barnsley Seams, which are considered to present a low risk to the Site due to their depth (c.50m and c. 150m respectively).

The Coal Authority (CA) indicates that 9 No recorded and untreated mine entries are located on or within 20m of the Site. Of these, 6 No are located either on-site or are adits which are located off-site and inferred to exist beneath the site at depth. All mine entries are indicated in the northwest.

The north of the Site has been subjected to significant faulting, which renders the exact sequence of strata and coal seams uncertain.

3.3 Previously Identified Ground Conditions and Geology

Previous investigation works undertaken by RLE in July 2017 included machine excavated trial pits and window sample boreholes. Ground conditions were found to comprise the following:

- Made ground associated with the former colliery was present across the northern Site extents to a maximum depth of 2.5m. Made ground typically comprised gravels of coal, brick, concrete, sandstone, slag and red shale.
- Additional areas of made ground (mostly reworked natural materials) were identified in the east (former excavator training ground) and southwest (former track), to a maximum depth of 1.7m.
- Natural ground conditions comprised stiff to very stiff clays becoming extremely weak to very weak mudstone, siltstone and sandstone at depth. Depths to rockhead varied between 2.0m and 4.0m.
- Shallow coal was identified in numerous positions across the Site relating to the seams identified above.

A small area of visual and olfactory contamination was identified in the northwest of the Site comprising red shale containing pockets of black treacle-like coal tar.

4 Objectives and Scope of Works

The objectives of this targeted assessment are to investigate for the previously identified coal mining legacy issues on the Site. Specifically, the investigation has the following objectives:

- To identify and confirm the location and depth to each of the 5 No named coal seams across the Site, and to investigate for the presence of unrecorded workings in any of the above seams.
- To investigate for recorded shallow working in the Abdy (Winter) seam in the northwest of the Site.
- To investigate the location of 6 No recorded mine entries (4 No adits and 2 No shafts) in the northwest of the Site.
- To evaluate the risk to the proposed development from the above mining legacy issues.

Three additional mine entries to those investigated herein are indicated close to the north western Site boundary. The location of these mine entries has not been investigated in this assessment, however it may be prudent to undertake this in the future to confirm that these do not impact the Site.

5 Site Works

Investigation works were undertaken between 23rd September and 11th October 2019, under the direction and supervision of an RLE engineer. Works were undertaken in accordance with Coal Authority Permit 18771. A total of 104 No rotary open-hole boreholes were drilled under the following rationale:

- 30 No boreholes drilled to up to 38m depth to investigate shallow coal seams across the Site.
- 6 No boreholes drilled to up to 12m depth to investigate for Adit 434408-018
- 9 No boreholes drilled to up to 12m depth to investigate for Adit 434408-017
- 10 No boreholes drilled to up to 32m depth to investigate for Adit 434408-021
- 6 No boreholes drilled to up to 22m depth to investigate for Adit 434408-022
- 23 No boreholes drilled to up to 12m depth to investigate for Shaft 434408-007
- 20 No boreholes drilled to up to 12m depth to investigate for Shaft 434408-023

The boreholes drilled to investigate for the 6 No mine entries above all intercepted shallow coal and have therefore provided additional information to the depth and

condition of the various seams present across the Site. The rationale for the end borehole depths was to confirm competent rock for shafts, or to reach the anticipated worked seams for each of the adits.

All rotary boreholes were drilled utilising a rotary percussive (top hammer) drilling rig and water flush. Boreholes were backfilled with sand and cement.

Ground gasses (carbon dioxide, oxygen, methane, carbon monoxide and hydrogen sulphide) were continuously monitored at the drilling rig. No elevated concentrations of ground gas or mine gas were recorded.

A Borehole Location Plan (17176-RLE-19-XX-DR-O-007) and Mine Entry Investigation Plan (17176-RLE-19-XX-DR-O-008) are included in Appendix A and B respectively. Both drillers factual logs and engineers' interpretative logs are included within Appendix C. Cross sections indicating the interpreted geological model of the Site have been produced, and are included within Appendix D (drawing number 17176-RLE-19-XX-DR-O-009).

6 Ground Conditions and Discussion

6.1 Strata and Coal Seams Identified

The following reference material has been utilised to assist production of a geological model for the Site:

- BGS 1:50,000 Geological Map England and Wales Sheet 87 Barnsley District
- BGS 1:10,000 Geology Series SE30NW (Barnsley)
- Green, A.H. and Holmes T.V., 1870, Vertical Sections Sheet 36, Section of the Measures above the Barnsley Coal in the district of Barnsley and Wakefield
- Lake, R.D. and Hough, E. (Editor), 2006, The Pennine Lower and Middle Coal Measures Formations of the Barnsley District, British Geological Survey Internal Report: IR/06/135.

Geological interpretation has been used to infer the names of coal seams identified, informed by drillers logs, site engineer's observations and the above information sources. Given the complexity of the Site, the interpretation contained herein is merely one possible geological model for the Site, and any additional future investigation work may further refine the model. Plans, logs and cross sections included in Appendix A to D should be referred to in addition to the interpretation undertake herein.

Table 1 (below) summarises the coal seams encountered and the parting between seams, presented in stratigraphical order.

Table 1. Summary of Coal Seams Encountered.					
Seam Name	**Average Thickness [range]**	**Depth to top of seam**	**Typical Description**	**No of BHs into seam**	**Condition**
Probable Maltby (Two Foot) Marine Band	0.2m	4.0 – 4.4m	Black shale.	2	Non-coal, intact. Marine Band fossil marker horizon
Typical parting of 2m – MUDSTONE					
Two Foot	0.5m [0.1-1.0]	3.5 – 7.9m	Dull black shaley COAL. Becoming hard black semi-bright COAL in north.	12	Intact – 12 No boreholes
Typical parting of 8m-10m – MUDSTONE. Becoming a 15m SANDSTONE parting in the north of Site,					
Abdy (Winter)	0.7m [0.2-1.4]	2.0 – 19.1m	Hard black semi-bright COAL. Hard black bright sub-anthracite COAL	73	Intact – 72 No boreholes VOID at 5.4m to 6.8m – 1 No borehole (RBH06A)
Typical parting of 10m to 13m – MUDSTONE. Becoming 4m in east of Site.					
Top Beamshaw	0.8m [0.2-1.3]	5.0 – 32.8m	Hard black semi-bright to bright COAL. Splits into two leaves in the north and east of Site.	30	Intact – 30 No boreholes
Typical parting of 10m-12m – MUDSTONE					
Low Beamshaw	0.75m [0.5-1.0]	4.0 – 35.8m	Hard black semi-bright COAL	13	Intact – 12 No boreholes Possible broken ground at 7.6m to 12.6m – 1No borehole (RBH18A)
Typical parting of 16m-26m – MUDSTONE.					
Kent's Thin	0.6m [0.3-1.0]	26.6m – 35.5m	Soft black dull to semi bright COAL	4	Intact – 3 No boreholes Possible broken ground at 26.6m to 28.3m – 1No borehole (RBH17)

6.2 Structure

Strata on Site dip to the north / northeast at a generally shallow rate. However, the dip was found to be steeper and more variable in the east of the Site. Numerous faults in the north and east of the Site also impact the apparent dip of strata, as indicated on the cross sections included within Appendix D.

The Site is heavily affected by faulting, as indicated on RLE Drawing 17176-RLE-19-XX-DR-O-007 (Appendix B). Three normal faults are inferred to cross the Site, and the depth, thickness and quality of coal seams vary across the fault zones.

Two faults are shown on geological maps to strike approximately east to west through the north of the Site. These have been inferred on Site by plotting the off-set of coal seams on cross sections, and are indicated to downthrow strata to the north and south respectively by up to 6m. The influence of these two faults is best observed in Cross Sections 1, 2 and 3. A third fault (not shown on geological maps) is inferred to strike approximately north to south through the east of the Site, and manifests on Site as a marked topographical gully with a steam. This fault downthrows strata to the south by 6m-8m.

Additionally, probable fractured rock (intermittently encountered as soft strata and poor flush returns at varying depths) was encountered in boreholes in the far north of the Site, which possibly relates to the influence of a fourth off-site fault (inferred to exist along Wakefield Road to the northeast).

Significant faulting on Site is likely to be one contributing factor for the observed general absence of coal workings, despite the presence of numerous seams of shallow coal. In areas of significant shallow working or contemporary longwall workings, faults can act as a focus for subsidence. This is not considered to be a significant issue on this Site.

6.3 Two Foot Coal

The Two Foot seam was encountered across the north of the Site as a generally thin and poor quality seam of black shale and coal. In two boreholes in the north of the Site (RBH11 and RBH03A), a second thin bed of black shale was encountered above this seam, which is interpreted to be the Maltby Marine Band.

The parting between the Two Foot Coal and the underlying Abdy Seam typically comprises between ~8m and ~10m of mudstone. However, in the north of the Site the two seams are separated by a thick sandstone bed (the Abdy Rock), up to ~15m thick.

No evidence was encountered for working of this seam within the 12 No boreholes which intercepted it. Working is also considered unlikely given the generally poor quality of this seam.

6.4 Abdy (Winter) Coal

The Abdy seam was encountered across the centre and north of the Site as a generally good quality bright to sub-anthracite grade coal seam. The thickness and quality of this seam varies considerably either side of the faults identified in the north of the Site.

In the northwest of the Site, this seam was found to comprise hard black bright sub-anthracite quality coal of between 1.0m and 1.4m thick. Here the seam was encountered at shallow depths of between ~2.0m and 6.0m, and dips shallowly to the north.

In the north and east of the Site, this seam generally becomes thinner (0.3m to 1.0m) and poorer quality (soft, and semi-bright to bright).

Limited evidence of working was identified in this seam, with the seam being found intact in 72 No of 73 No borehole which intercepted this seam.

One borehole (RBH06A) in the northwest of the Site (where this seam is thickest and highest quality) encountered a VOID at the depth where this seam was anticipated at between 5.4m and 6.8m. This void was encountered roughly in the vicinity of recorded workings in this seam, shown on Coal Authority Abandonment Plan 7431. Additional boreholes drilled close to RBH06A identified solid coal only, however it is likely that further areas of workings exist in the northwest area of the Site. Further investigation of this area of shallow working was prevented by the presence of an overhead power line, underground sewer and known coal tar contamination.

6.5 Top Beamshaw Coal

The Top Beamshaw seam was encountered across the south, centre and north of the Site as a generally good quality seam of hard black semi-bright to bright coal.

In the north and east of the Site, this seam is observed to split into two leaves separated by a mudstone parting of between 0.2m to 1.0m. In this area, the upper leaf comprises soft dull coal and the lower leaf comprises hard black semi-bright coal.

No evidence was encountered for working of this seam in the 30 No boreholes that intercepted it. Working is also considered unlikely given the notable split in this seam across much of the Site.

6.6 Low Beamshaw Coal

The Low Beamshaw seam was encountered across the south and centre of the Site as a reasonable quality seam of hard black semi-bright coal.

Limited evidence of working was identified in this seam, with the seam being found intact in 12 No of 13 No borehole which intercepted this seam.

One borehole (RBH18A) encountered possible broken ground where this seam is anticipated at between 7.6m and 12.6m. It is possible that additional areas of shallow working exist in this seam where it is expected at shallow depth.

6.7 Kent's Thin

The Kent's Thin seam was encountered in the south of the Site as a generally thin poor quality seam of soft dull coal.

Evidence of possible working in this seam was encountered as broken ground between 26.6m and 28.3m in RBH17. Given the poor quality and thin nature of this seam it is unlikely that any workings are extensive. Additionally, at a maximum recorded thickness of 1m and a minimum shallowest depth of 26.6m, it is considered that any workings in this seam would have sufficient rockhead cover to mitigate the risk of void migration.

6.8 Mine Entry Investigation

Of the 9 No recorded mine entries on or within 20m of the site, 6 No (2 No shafts and 4 No adits) have been investigated during this investigation. Table 2 below provides details of the works undertaken to attempt to identify each mining feature. The Mine Entry Investigation Plan (drawing number 17176-RLE-19-XX-DR-O-008) included within Appendix B also provides detail on the investigation works undertaken.

Table 2. Summary of findings relating to shafts and adits.

Mine entry reference:	Investigation Undertaken	Coordinates	Detail / Observations
Adit 434408-017 **ADIT NOT IDENTIFIED**	6 No BHs to 12m bgl along line of adit	434695, 408822 (CA Coordinates)	Boreholes drilled along and perpendicular to the line of the adit encountered intact coal only (Abdy and Top Beamshaw Seams, likely seams which were worked). Further investigation required. Unable to drill close to the adit mouth for environmental reasons, due to the presence of known coal tar contamination (free product) within made ground in this area.
Adit 434408-018 **POSSIBLE ADIT OR WORKINGS IDENTIFIED** **SEE DRAWING 008 FOR DETAIL**	9 No BHs to 12m bgl along line of adit	434629, 408802 (CA Coordinates)	Boreholes drilled along and perpendicular to the line of the adit (close to the supposed position of the adit mouth) identified a linear area of voids and backfilled ground at shallow depth. However, the line of these workings trends to the northeast, which is perpendicular to the anticipated line of the adit. Additionally, no coal has been identified at the level of these workings, indicating this may be an adit or possible unrecorded shallow workings for another mineral such as clay or ironstone. Additional investigation may be able to constrain this feature more accurately.

Table 2. Summary of findings relating to shafts and adits.			
Mine entry reference:	**Investigation Undertaken**	**Coordinates**	**Detail / Observations**
Adit 434408-021 **ADIT NOT IDENTIFIED**	10 No BHs to 32m bgl along line of adit	434662, 408874 (CA Coordinates)	Boreholes drilled along and perpendicular to the line of the adit identified solid coal only (Abdy and Top Beamshaw seams), and no evidence of a possible adit or workings. This adit is shown on CA Abandonment Record 7431 associated with shallow workings in the Abdy seam at ~5m depth. This adit is anticipated to be present further south of the expected location for the following reasons: • No workings were identified in the Abdy seam along the supposed line of this adit, • The depth to this seam ranged from 9.5m to 11.5m here, (workings and adit expected where the seam is shallower at ~5m depth) • Workings (void) were only identified further south in RBH06A, hence this adit is likely to be closely associated with this. Further investigation is recommended, however this was not possible during this investigation due to the presence of buried and overhead services and known land contamination.
Adit 434408-022 **ADIT NOT IDENTIFIED**	6 No BHs to 22m bgl along line of adit	434666, 408847 (CA Coordinates)	Boreholes drilled along and perpendicular to the line of the adit identified solid coal only (Abdy and Top Beamshaw seams), and no evidence of a possible adit or workings. This adit is shown on CA Abandonment Record 7431 associated with shallow workings in the Abdy seam at ~5m depth. This adit is anticipated to be present further south of the expected location for the reasons stated above. Further investigation is recommended, however this was not possible during this investigation due to the presence of buried and overhead services and known land contamination.

Table 2. Summary of findings relating to shafts and adits.			
Mine entry reference:	**Investigation Undertaken**	**Coordinates**	**Detail / Observations**
Shaft 434408-007 **POSSIBLE SHAFT IDENTIFIED** **SEE DRAWING 008 FOR DETAIL**	23 No BHs to 12m bgl at 1m centres around shaft coordinates	434707, 408848 Estimated shaft centre	Boreholes drilled on 1m centres in a grid around the anticipated shaft location identified a possible shaft 5m south of the coordinates provided by the Coal Authority. The depth to rockhead was found at 4m surrounding the shaft – soft backfill was encountered to at least 10.5m (base not encountered) in 4 No adjacent BHs, which is interpreted to be a possible shaft of ~3m diameter. This shaft was not probed to full depth as it is expected to be c. 145m deep, descending to the Barnsley Seam which was worked at depth beneath the Site. This shaft will require treatment prior to development.
Shaft 434408-023 **SHAFT NOT IDENTIFIED**	20 No BHs to 20m bgl at 1m centres around shaft coordinates	434693, 408837 (CA Coordinates)	Boreholes drilled on 1m centres in a grid around the anticipated shaft location did not encounter a possible shaft, and identified intact coal only (Abdy Seam). This adit is shown on CA Abandonment Record 7431 associated with shallow workings in the Abdy seam, and is indicated to be ~4.6m deep. Further investigation is recommended, however this was not possible during this investigation due to the presence of buried and overhead services and known land contamination.

7 Summary and Conclusions

In summary a typical sequence of Coal Measures strata was identified through this investigation, generally comprising made ground or topsoil overlying clay onto bedrock (mudstone and sandstone) and coal seams. Due to the limitations of open-hole drilling, more detailed strata descriptions were not possible.

A number of shallow coal seams were encountered across the Site, some of which were of workable thickness and quality. However, limited evidence for shallow working was encountered on Site. This is likely due in part to the influence of faulting in the north of the Site, the somewhat variable thickness and quality of coal and the presence of more attractive coal seams to work in the local area (i.e. the Barnsley Seam, and the Abdy seam to the north where the influence of faulting is greatly reduced).

However, this investigation has identified that a number of coal mining legacy issues remain on Site which will require either further investigation or remediation prior to development.

Table 3 below lists the coal mining legacy issues which have been identified on Site, their likely risk rating and any further works or remediation considered necessary.

Table 3. Summary of coal mining legacy issues.

Coal Mining Issue	Risk Assessment	Remediation / further works
Shallow working in Two Foot Seam	**LOW**	None considered necessary. No evidence of recorded or unrecorded working was encountered. Working is considered unlikely as this coal seam was generally found to be thin and poor quality.
Shallow working in the Abdy Seam	**HIGH (hatched area in NW)**	Drill and grout areas of shallow working in this seam, in vicinity of RBH06A – approximate extent of working indicated as hatched area on RLE Drawing 17176-RLE-19-XX-DR-O-007.
	LOW / MODERATE (rest of Site)	Seam found intact across the rest of the north and east of Site. Extensive working is considered unlikely due to significant faulting. However, given the high quality of the coal and known working in this area, additional site investigation or a trial drill and grout exercise may be prudent where this seam is present at shallow depth in the north and east of Site.
Possible unrecorded shallow working near Adit 434408-018	**HIGH (hatched area in NW)**	Further investigation is recommended, drilling and grouting is likely to be required in hatched area shown on RLE Drawing 17176-RLE-19-XX-DR-007. Voids and backfilled ground were identified at shallow depth close to Adit 434408-018, at depths between the Abdy and Top Beamshaw seams – no coal was encountered at this depth hence this may either be the adit or unrecorded working for another mineral such as fireclay or ironstone.
Shallow working in the Top Beamshaw Seam	**LOW**	Seam found intact in all boreholes which intercepted it. Extensive working is considered unlikely due to significant faulting in the north and east of Site, and the presence of a split within this seam which separates and reduces the quality of this coal. However, some areas of good quality workable coal were identified at shallow depth, hence small-scale unrecorded working (bell pits) cannot entirely be discounted.
Shallow working in the Low	**HIGH (hatched area in SW)**	Drill and grout areas of possible shallow working in this seam, identified in RBH18A – approximate extent of working indicated as hatched area on RLE Drawing 17176-RLE-19-XX-DR-O-007. Further drilling investigation may further constrain this area.

Table 3. Summary of coal mining legacy issues.		
Coal Mining Issue	**Risk Assessment**	**Remediation / further works**
Beamshaw Seam	**LOW / MODERATE (rest of Site)**	Seam found intact across the rest of the Site. Additional site investigation or a trial drill and grout exercise may be prudent where this seam is present at shallow depth across the south and centre of the Site.
Shallow working in the Kent's Thin Seams	**LOW**	Possible unrecorded workings were identified in a single borehole (RBH17) in the west of the Site. However, this seam has a maximum thickness of 1m and was found at a shallowest depth of 26.6m. Therefore any workings in this seam are considered likely to present a low risk to the Site.
Mine Entries (recorded)	**HIGH**	Of the 9 No mine entries on or within 20m of the Site, 6 No have been investigated and 2 No have been possibly identified. Full treatment of shafts and adits is recommended by drilling, grouting and capping. Mine entry remediation should be designed and undertaken by a competent contractor and should be approved be the Coal Authority. Additional investigation is recommended into the mine entries that are recorded on site and have not been located. The location of recorded mine entries provided by the Coal Authority are approximate at best, and therefore investigation may also be required into the location of the 3 No nearby off-site mine entries.
Mine Entries (unrecorded)	**MODERATE**	Given the presence of 5 No seams of shallow workable coal across the Site, the possibility of small-scale unrecorded working (i.e. bell pits) cannot be entirely discounted. Whilst bell pits are difficult to investigate for, vigilance should be maintained for any evidence of unrecorded mine entries and associated shallow working during all future works on Site.
Mine gas emissions	**LOW**	No mine gas was encountered during drilling works, and no significant areas of workings were encountered (which could give rise to gas). Nevertheless, basic ground gas protection measures are recommended as per the conclusions of the RLE Phase 2 Geo-Environmental Report.
Coal Mining Geology (fissures)	**LOW**	The north and east of Site is heavily affected by faulting, however the risk of ground instability or fissures relating to these is considered low. Additional drilling (rotary coring) may be prudent to confirm ground conditions in some areas in the north of the Site, where soft ground (probable fractured rock) was encountered close to faults.
Recorded coal mining surface hazard	**NEGLIGIBLE**	No hazard recorded or identified on Site, no action required.

Table 3. Summary of coal mining legacy issues.		
Coal Mining Issue	**Risk Assessment**	**Remediation / further works**
Surface mining (opencast)	**NEGLIGIBLE**	No hazard recorded or identified on Site, no action required.

8 Recommendations

Based on the above table of risks, the following further works or remediation is recommended. Proposed remediation works are also indicated on RLE Drawing 17176-RLE-19-XX-DR-O-010 (Mining Remedial Works Plan) included within Appendix E.

- Treatment of shallow mine workings will be required where identified in the Abdy Seam, Low Beamshaw Seam and an unidentified seam/mineral near Adit 434408-018. These are indicated as hatched areas on RLE Drawing 17176-RLE-19-XX-DR-O-007. Further investigation works and/or a trial drill and grout exercise should be undertaken close to areas of identified working to more accurately constrain the area which requires treatment.
- It is considered that widescale drilling and grouting outside of the above areas is not required as no evidence of working of the coal has been identified in a significant number of boreholes outside of the above areas. The absence of working is likely to be due to the significant faulting. Nevertheless, there is less than ten times rock cover present across much of the Site and further boreholes and inspection post-strip would add further confidence of the absence of working.
- Further investigation should be undertaken into mine entries 434408-017, 434408-021, 434408-022, and 434408-023. These are recorded in the northwest of the Site, however these were unable to be identified during the present investigation due to site constraints.
- Treatment of all mine entries will be required prior to development, typically comprising drilling, grouting and capping onto suitable rockhead.
- Diversion or isolation of the overhead power line and underground sewer, and removal/remediation of coal tar contamination will be required to facilitate the above works in the northwest of the Site. Currently these present a health and safety or environmental constraint to drilling in this area.
- Vigilance should be maintained during all future site works for the presence of possible bell pits or small scale near surface working, which could give rise to localised difficult ground conditions. Due to the size of the Site and the typical small scale of these features, investigation is typically difficult but could comprise an extensive trial pit or topsoil strip exercise under the supervision of a suitably qualified Engineer.

- A small number of rotary cored boreholes could provide further information on ground conditions in the north of the Site, where soft ground and loss of flush were encountered in some boreholes at varying depth. This is most likely attributable to faulting, however coring would be able to confirm this.
- A significant amount of shallow coal remains on Site, and consideration should be given to extraction of minerals prior to development and sterilisation of the resource. However, such extraction by opencast methods could create more challenges for development (i.e. need for piled foundations), may not be socially or environmentally acceptable and may not be economically viable given the current reduced role of coal in the UK energy mix.

Approval of the above conclusions and recommendations should be sought from regulators and the Coal Authority.

Appendix A: Borehole Location Plan

Drawing No: 17176-RLE-19-XX-DR-O-007

A3

SEE DRAWING 17176-RLE-19-XX-DR-O-008 FOR DETAILS OF INVESTIGATION INTO MINE ENTRIES IN THESE AREAS

434408-010 (150m deep)
434408-001
434408-021
434408-006 (144.7m deep)
434408-022
434408-007 (144.5m deep)
434408-023 (4.6m deep)
434408-017
434408-018

RBH01A
RBH01B
RBH02A
RBH02B
RBH03A
RBH3B
RBH04
RBH05
RBH06A
RBH06B
RBH06C
RBH07
RBH08A&B
RBH08C
RBH09
RBH10
RBH11
RBH12A
RBH12B
RBH13
RBH14A
RBH14C
RBH15
RBH16
RBH17
RBH18A
RBH18B
RBH19
RBH20
RBH21

PH1/1
PH1/2
PH1/3
PH2/1
PH2/2
PH3/1
PH3/2
PH4/1

TWO FOOT SEAM (0.1 - 1.0M)
ABDY SEAM (0.2 - 1.4M)
TOP BEAMSHAW SEAM (0.2 - 1.3M)
LOW BEAMSHAW SEAM (0.5 - 1.0M)
DIP OF STRATA

GENERAL NOTES

NO DIMENSIONS TO BE SCALED OFF THIS DRAWING.

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ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.

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KEY

- SITE BOUNDARY
- COAL SEAM (NAMED) WITH THICKNESS
- FAULT (INFERRED) WITH TICK ON DOWNTROWN SIDE
- APPROXIMATE LOCATION OF MINESHAFT ON OR WITHIN 20M OF THE SITE (POSITION PROVIDED BY COAL AUTHORITY) NOT IDENTIFIED BY ROTARY DRILLING
- LOCATION OF MINESHAFT IDENTIFIED ON SITE BY ROTARY DRILLING
- APPROXIMATE LOCATION OF ADIT ON OR WITHIN 20M OF THE SITE (POSITION PROVIDED BY COAL AUTHORITY) NOT IDENTIFIED BY ROTARY DRILLING
- LOCATION OF POSSIBLE ADIT IDENTIFIED ON SITE BY ROTARY DRILLING
- ESTIMATED EXTENT OF IDENTIFIED POSSIBLE SHALLOW WORKINGS REQUIRING TREATMENT
- RBH02 — LOCATION AND REFERENCE OF ROTARY OPEN-HOLE BOREHOLE TO INVESTIGATE FOR SHALLOW WORKINGS
- APPROXIMATE AREA OF KNOWN COAL TAR CONTAMINATION - NO DRILLING FOR ENVIRONMENTAL REASONS
- APPROXIMATE LINE OF RECORDED ADIT, AND LOCATION OF ROTARY BOREHOLES TO INVESTIGATE THEIR LOCATION

Rev	Date	Amendments	By	Chk

Client
HARWORTH ESTATES

Project
ATHERSLEY

Drawing Title
ROTARY BOREHOLE INVESTIGATION PLAN

Status
INFORMATION

Scale	Drawn	Checked	Date
NTS	AT	IPB	05/11/19

Drawing No. — Rev.
17176-RLE-19-XX-DR-0-007-P01

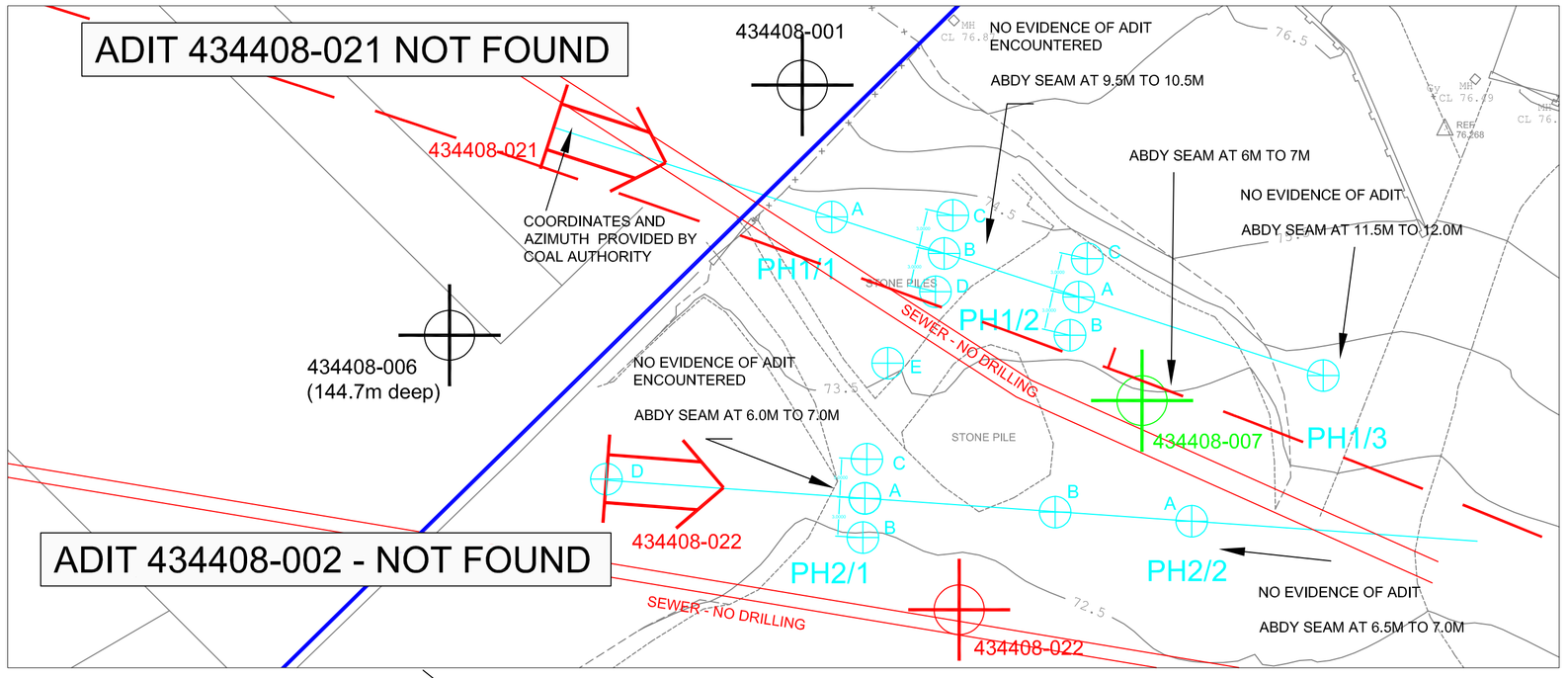
St James House ● Mansfield Road ● Derby ● DE1 3TQ ● Tel: 01332 285000 ● Fax: 01332 291728 ● www.rodgersleask.co.uk

Appendix B: Mine Entry Investigation Plan

Drawing No: 17176-RLE-19-XX-DR-O-008

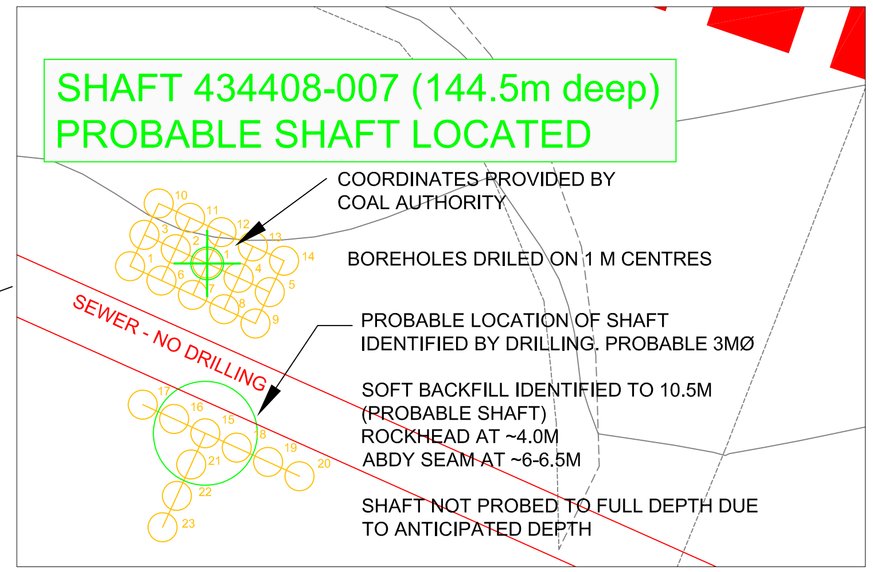
A1

ADIT 434408-021 NOT FOUND

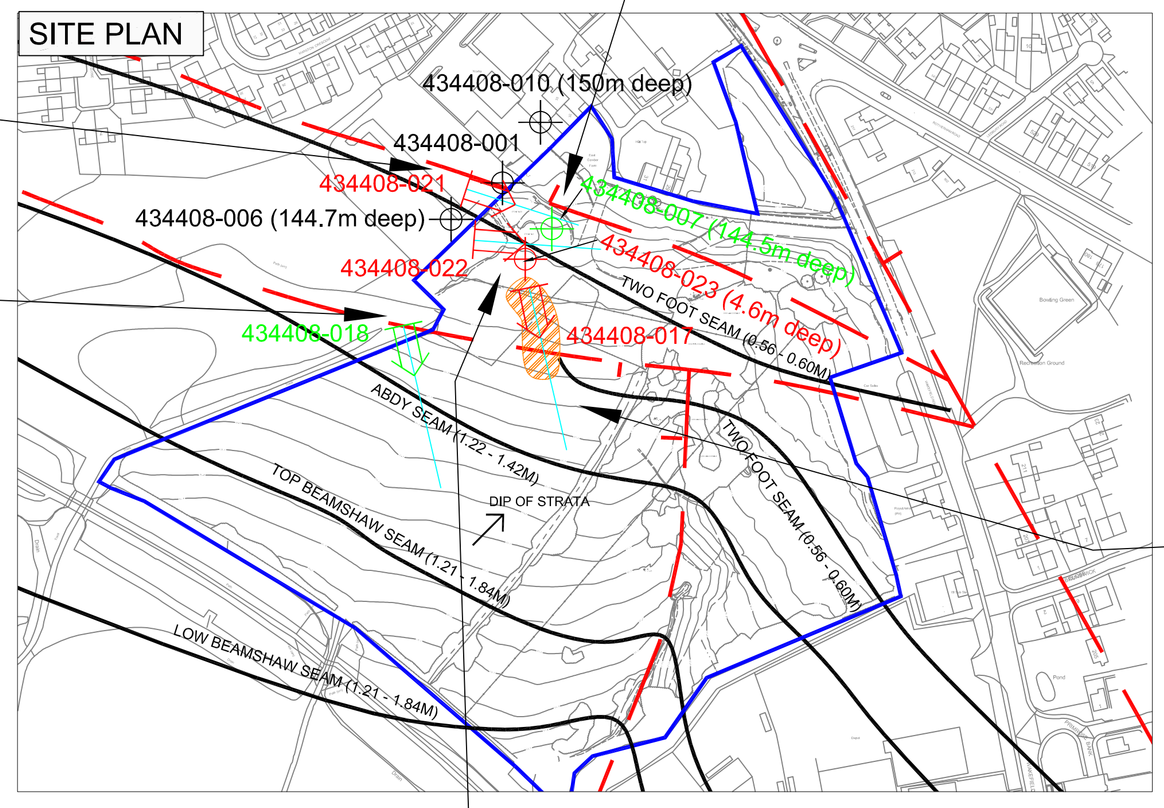


ADIT 434408-002 - NOT FOUND

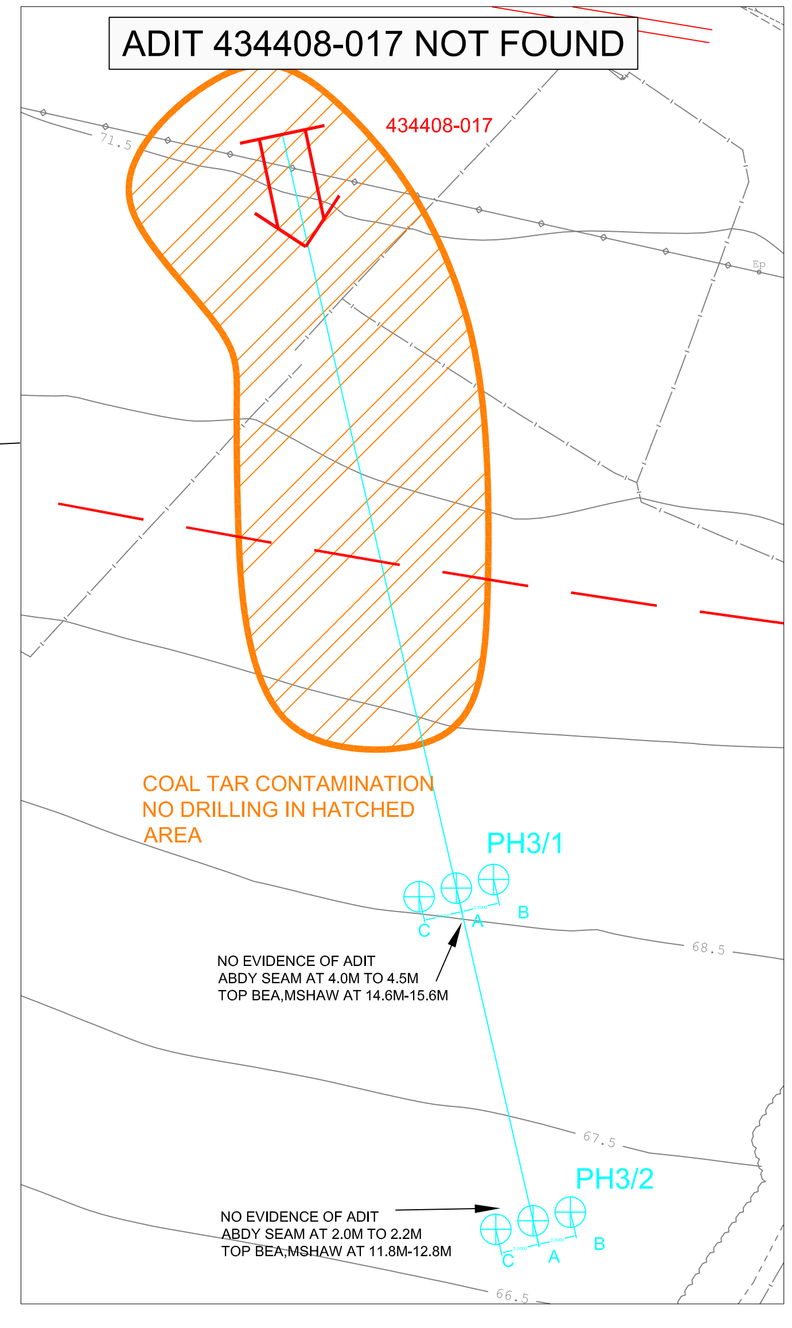
SHAFT 434408-007 (144.5m deep) PROBABLE SHAFT LOCATED



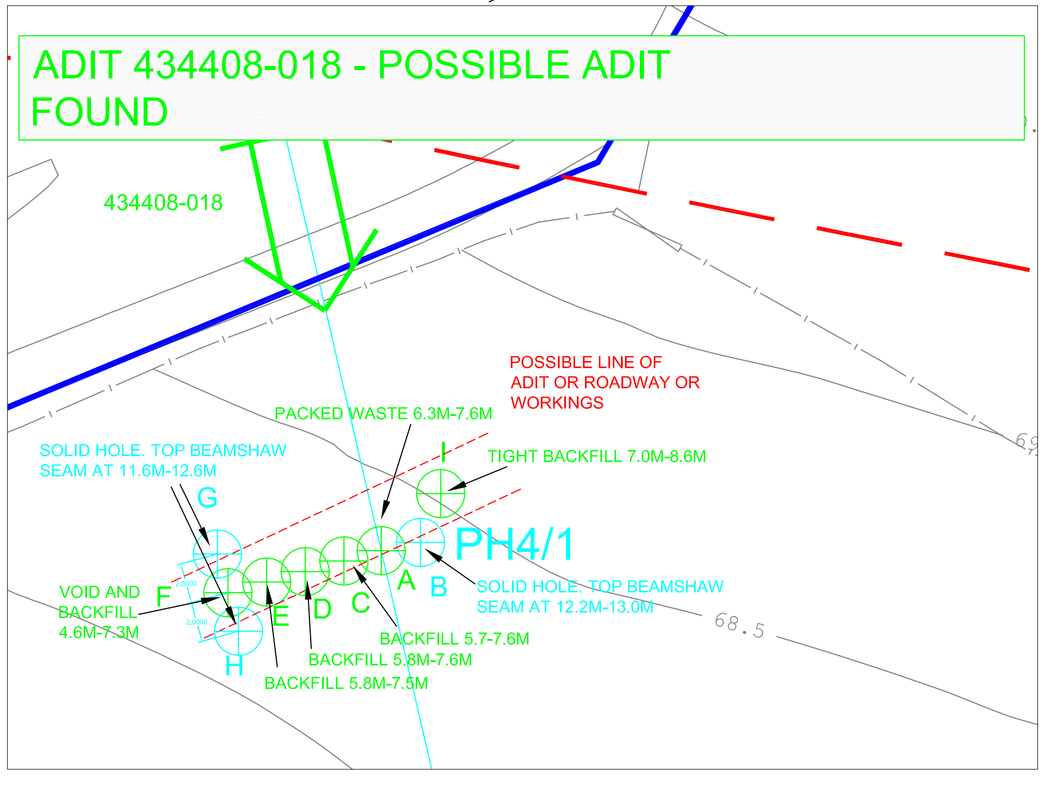
SITE PLAN



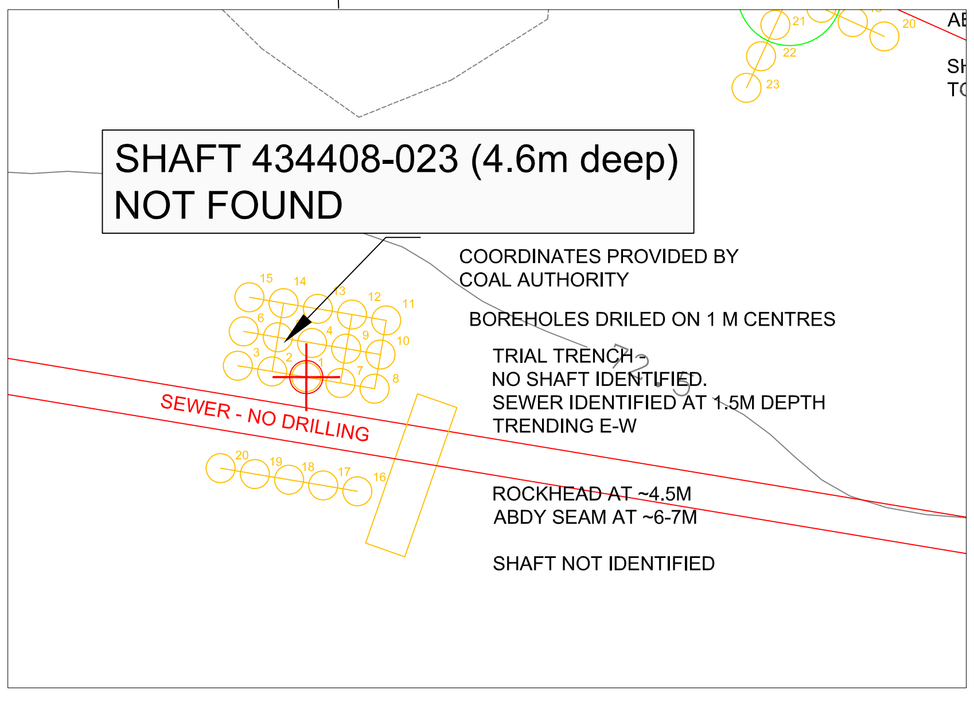
ADIT 434408-017 NOT FOUND



ADIT 434408-018 - POSSIBLE ADIT FOUND



SHAFT 434408-023 (4.6m deep) NOT FOUND



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KEY

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- APPROXIMATE LOCATION OF SHAFT ON SITE (POSITION PROVIDED BY COAL AUTHORITY) **NOT IDENTIFIED BY ROTARY DRILLIN**G
- LOCATION OF MINESHAFT **IDENTIFIED** ON SITE BY ROTARY DRILLING
- LOCATION OF POSSIBLE ADIT **IDENTIFIED** ON SITE BY ROTARY DRILLING
- APPROXIMATE LOCATION OF ADIT ON SITE **NOT IDENTIFIED BY ROTARY DRILLING**
- ROTARY PROBEHOLE DRILLED TO INVESTIGATE SHAFT LOCATIONS
- ROTARY PROBEHOLE DRILLED TO INVESTIGATE ADIT LOCATIONS - **ADIT NOT IDENTIFIED**
- ROTARY PROBEHOLE DRILLED TO INVESTIGATE ADIT LOCATIONS - **POSSIBLE ADIT IDENTIFIED**
- APPROXIMATE LINE OF ADIT BASED ON COAL AUTHORITY RECORDS
- APPROXIMATE AREA OF KNOWN COAL TAR CONTAMINATION - NO DRILLING FOR ENVIRONMENTAL REASONS

Rev	Date	Amendments	By	Chk

Client

HARWORTH ESTATES

Project

WAKEFIELD ROAD
ATHERSLEY

Drawing Title

MIINE ENTRY
INVESTIGATION PLAN

Status

INFORMATION

Scale	Drawn	Checked	Date
A1@A1@ NTS	AT	IPB	08/11/19

Drawing No. — Rev.

17176-RLE-19-XX-DR-0-008 — P01

Scale Bar: 1:250 0 2 4 6 8 10 12 14 16 18

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