



Coal Mining Risk Assessment &
Specification for the Consolidation of
Abandoned Mine Workings

Manox, Miles Platting



COAL MINING RISK ASSESSMENT & PERFORMANCE SPECIFICATION FOR CONSOLIDATION OF ABANDONED MINE WORKINGS

Former Manox Site
Miles Platting

Prepared for:

Landcare (East Manchester)

**Report Ref: 13-887-R7-revC
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EXECUTIVE SUMMARY

Site Address	Former Manox Site, West of Hulme Hall Lane, Miles Platting, M40 7LD
National Grid Reference	E 395990, N 404200.
Site Area	7.2 Ha.
Background	<p>E3P has been instructed by Landcare (East Manchester) to prepare a Coal Mining Risk Assessment and Performance Specification for the Consolidation of Abandoned Mine Workings that will facilitate a safe residential development at the site located at Manox in Miles Platting.</p> <p>This E3P specification has been produced in due consideration of the site assessment of ground stability risk associated with abandoned mine workings undertaken by E3P.</p>
Proposed Development	<p>The subject site is currently disused open land, following demolition of the previous industrial chemical production facilities. It is proposed to construct 410 domestic dwellings, associated gardens, public open space (POS) areas and adoptable roads and sewers.</p>
Coal Mining	<p>In accordance with industry best practice as detailed within CIRIA 758, E3P has completed intrusive investigation works and concluded that unrecorded shallow mine workings are present below the central and southern sectors of the site.</p> <p>The assessment has concluded that there is insufficient rock cover to provide the required degree of stability in the event of successive collapses (cavitation) within the known workings in three seams of coal, which could ultimately result in a “crown hole” subsidence event at the surface. However, sufficient rock cover is confirmed above the Yard seam in the north.</p> <p>Proof drilling on close centres is required to identify the location of the inferred sub-crop within all three seams of coal, this will be completed by drilling linear probe lines under the supervision of the site engineer. When the sub-crop position is confirmed, close centred primary probes will be advanced on a 6m primary grid beneath structures and infrastructure across the sub-crop where <10xT is confirmed, again this will be under the supervision of the site engineer.</p> <p>Where mine stabilisation works are required within the Bradford Four Feet, Bradford three Quarter and Charlotte coal seams sub-cropping beneath the site. Works are required to be completed in accordance with The Coal Authority permission process and detailed geotechnical design to be prepared in accordance with CIRIA 758. It is possible that the central and southern sector of the site will require some stabilisation by drill and grouting due to the void and rock cover ratio across the central/central-western sector.</p> <p>A historical mine entry (386399-007) has been identified in the central sector. This feature will require stabilisation by pressure grouting and capping by a grout plug cap.</p> <p>Given the known mining legacy and proven shallow mine workings, it is possible that other unrecorded mine entries exist within the curtilage of the site and immediate surrounding area.</p>

	It will therefore be necessary to allow for a watching brief during earthworks and ensure inclusion of a suitable mechanism for grouting and plugging of any such features and subsequent amendment to a development layout in the event that an unrecorded mine entry underlies a residential structure.
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SUMMARY OF CONSOLIDATION & STABILISATION WORKS

Consolidation of shallow workings in coal seam	<p>Once the position of the sub-crop position is confirmed, boreholes will be drilled on a primary staggered 6 m × 6 m grid across the building footprint, with treatment extending up to 3 m beyond with secondary boreholes to then be drilled at 4.5 m² infill centres across the area of stabilisation where workings are identified with less than 10xT rock cover.</p> <p>The boreholes will serve as injection points where grout will be pumped under pressure into the workings to consolidate the voids in accordance with the specification herein.</p> <p>Where necessary, tertiary boreholes will be drilled on a 3 m grid where grout take is high and completion pressure cannot be achieved within a grout hole.</p> <p>Boreholes will be drilled on a staggered 10m grid within areas of adopted highway, estate road and private driveway. Again, these boreholes will be used to pump and pressure grout voids within workings in the coal seam.</p> <p>Drill and grout boreholes are not proposed to garden and landscaped areas unless an adjacent position within a plot, highway or driveway indicates significant grout take (>10T).</p> <p>Works will be considered to be completed when the required borehole grid and pressure grouting has achieved the performance specification.</p> <p>Validation test boreholes will be drilled to confirm consolidation at locations and centres to be dictated by the supervising engineer.</p>
Consolidation & stabilisation of mine shaft	<p>Mine entry 386399-007 will be stabilised by a process of drilling a borehole to the base (or the agreed depth) prior to the pumping of grout to the agreed pressure and stages. A secondary borehole will be drilled and pressure grouted within each and every shaft.</p>
Construction of Grout Plug	<p>Give the known depth of Made Ground / superficial drift deposits, it is not technically possible to place a reinforced concrete cap on suitable stratum. It is therefore proposed to construct a 'grout plug' as the capping solution. Nominally this will comprise drilling of boreholes at 1.0m centres that will penetrate 1.0m into bedrock, each location will be pressure grouted in stages back to surface with a near Ordinary Portland Cement Grout (OPC).</p> <p>The grout plug constructed at 1.0m centres within 3.0m from the centre point of the shaft increasing to 3.0m centres will be formed across the conjectured extent of radial departure assuming a 60° angle of repose from bedrock. Boreholes within the inner 3.0m radius will be extended 1.0m into bedrock with boreholes in the 3.0m grid extended 1.0m below the conjectured zone of influence (full collapse).</p>

	The pressure grout plug will form a stiffened block that will mitigate the influence associated with any future consolidation within the stabilised shaft.
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1. INTRODUCTION

1.1. BACKGROUND

E3P has been instructed by Landcare (East Manchester) to develop a Performance Specification for the Consolidation of Abandoned Mine Workings to facilitate the safe and regulatory compliant stabilisation of the land to facilitate the proposed residential development at the site.

This report has been prepared to address Condition 18a and 19a within the Manchester City Council Planning Approval (ref: 125596/FO/2019) items specifically pertaining to Ground Conditions, as duplicated below:

Condition 18a – *Before the development hereby approved commences, a scheme for the investigation of all the shallow mine workings on the site and identification of remediation measures (the Site Investigation Proposal) shall be submitted to and approved in writing by the City Council as local planning authority.*

The measures for investigating the site identified in the Site Investigation Proposal shall be carried out, before development commences, and a report prepared outlining what measures, if any, are required to remediate the areas of shallow mine workings (the Site Investigation Report and/or the Remediation Strategy) shall be submitted to and approved in writing by the City Council as local planning authority.

Condition 19a – *Before the development hereby approved commences, a report outlining what measures (remedial works), if any, that are required to be undertaken to the mine entry (including foundation), together with any specific designs which may be required for any buildings within influencing distance of the mine entry (the Site Investigation Report and/or Remediation Strategy) shall be submitted to and approved in writing by the City Council as local planning authority.*

Following the initial issue of this Coal Mining Risk Assessment and Performance Specification for the Consolidation of Abandoned Mine Workings, the Coal Authority has provided acceptance and Condition 18a has since been discharged (29/06/2022).

At the time of the submission, foundation designs were not available to satisfy the requirements of Condition 19a, therefore this report is being reissued to allow the discharge of 19a now in receipt of foundation details.

For the avoidance of doubt, Conditions 18b and 19b are related to the validation of remedial measures with respect to coal mining and will therefore only be satisfied following completion of the works.

1.2. REPORT OBJECTIVES

The objectives of this report are as follows.

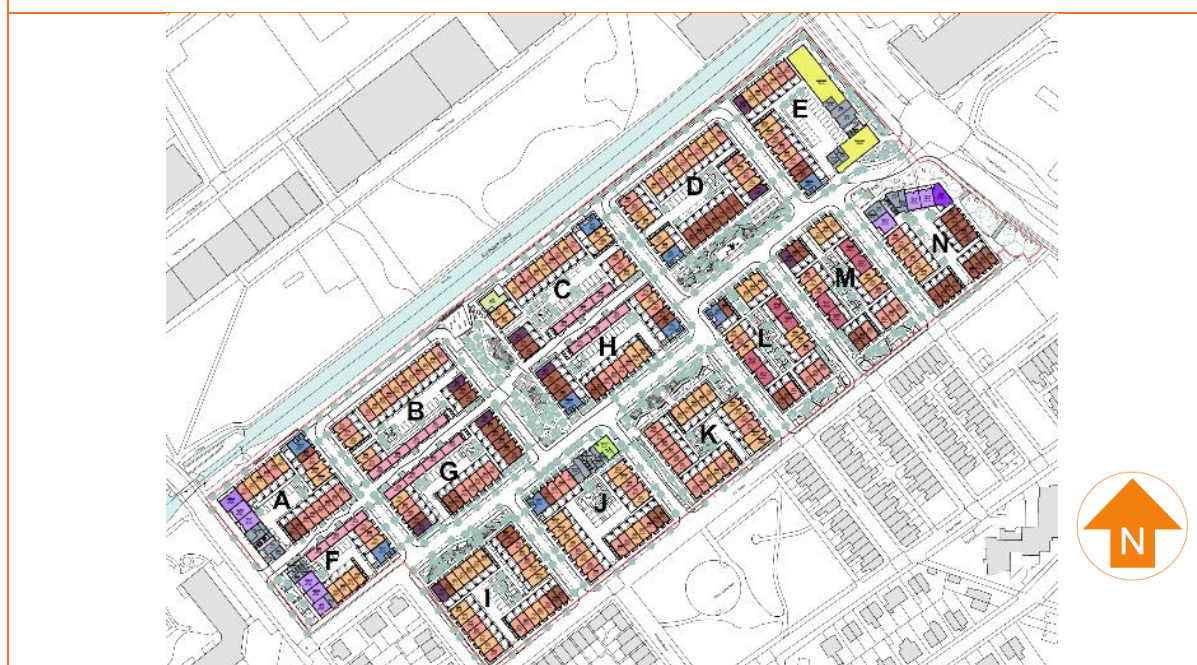
- ✦ Prepare an overview of identified issues associated with abandoned mine workings;
- ✦ Detailed Ground Investigation works undertaken to assess the potential presence of coal seams and potential workings;
- ✦ Evaluate feasible consolidation and stabilisation options.
- ✦ Define the proposed scope of works for the stabilisation of abandoned mine workings within the sectors of the site that have been determined to be at risk from a future subsidence event.
- ✦ Set out the validation criteria and protocols required to demonstrate the successful implementation of the mine stabilisation works with sufficient supporting information, test data and independent quality control to demonstrate successful implementation of the works.

1.3. REDEVELOPMENT PLAN

It is intended to construct a residential development comprising 410 low rise residential dwellings with associated gardens, public open space, estate roads and infrastructure. Drawing 13-887-002 (Appendix III) identifies the proposed development layout and Figure 1.1 provides a snapshot of this.

Manchester City Council has granted planning permission for housing-led mixed use redevelopment comprising: a maximum of 410 new dwellings (Class C3); and comprising Class E (maximum floorspace 744 sq. m GIA in total); recreation open space and landscaping; and associated access off Hulme Hall Lane, Varley Street and Iron Street, infrastructure provision and car parking.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.4. SITE SUMMARY

TABLE 1.1 SITE DETAILS

Site Address	Former Manox Site, West of Hulme Hall Lane, Miles Platting, M40 7LD
National Grid Reference	E 395990, N 404200.
Site Area	7.2 Ha.

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location plan is presented in Appendix III as Drawing 13-887-001.

1.5. CURRENT SITE USE

TABLE 1.2 SITE DESCRIPTION

<p>Occupancy/Use</p>	<p>The subject site is a large vacant area of land with the relict slabs and foundations of the former Manox industrial facility in the northern sector of the site and rough vegetated land to the south.</p> <p>The western sector is densely populated by semi-mature self-seeded vegetation and saplings as presented in Figure 1.2.</p> <p>Figure 1.2 Vegetation in West</p>  <p>An aerial photograph from ~2000 shows the former Manox industrial facility in the northern sector and formal playing fields to the east.</p> <p>Figure 1.3 Aerial Photograph ~2000</p> 
<p>Structures</p>	<p>The site is now clear of all above ground structures with only relict slabs and foundations remaining.</p> <p>There is no photographic evidence of any features that could be indicative of historical mining activities within the site or immediate surrounding area.</p>
<p>Mine Water egress</p>	<p>No evidence of acidic metalliferous mine drainage is noted, however given the site topography this is not unexpected.</p>
<p>Access</p>	<p>Access can be gained from the site periphery.</p> <p>It is understood that the southern sector is currently utilised as open storage land which restricts free and unrestricted access across the development site.</p>
<p>Slope</p>	<p>The site is relatively flat with not readily identifiable slopes of changes in topography. A brick retaining wall in various states of disrepair is present to the northern site boundary.</p>

Retaining Structures	The northern boundary is retained by a masonry wall to the adjacent canal tow path at a lower level to the subject site.	
Surface Cover (%)	Buildings:	0%
	Hardstand:	50%
	Soft cover:	50%

1.6. SURROUNDING AREA

The surrounding area land uses are summarised in Table 1.3.

TABLE 1.3 SURROUNDING LAND USES

DIRECTION	LAND USE
North	Canal with industrial buildings beyond.
East	Industrial buildings.
South	Residential development.
West	School & Residential units.

2. SYNOPSIS OF COAL MINING ISSUES

2.1. BACKGROUND

E3P has completed a desk based interpretive assessment and investigation to determine the potential for unrecorded abandoned mine workings at a shallow depth beneath the site and the subsequent potential for these workings to represent a ground instability risk associated with collapse and consolidation of the substratum.

2.2. PREVIOUS REPORTS

J Everett prepared a report titled Desk Study of Mine Shafts (April 2019) for Landcare Ltd and Engie.

The pertinent conclusion from the afore mentioned report resulted in the removal of a previously inaccurate shaft reference which was confirmed to be a duplication of the same record. The Coal Authority has since provided written confirmation that their database records are updated.

The Everett report concludes that Abandoned Mine Plans (AMP) for the site confirm the presence of workings in the Bradford Four Feet mine. It is concluded that these workings are well over 100 years old and as such subsidence caused by extraction of coal should have taken place decades ago.

E3P recognise that there is a reasonable probability that where the support from the mine was withdrawn, the workings will have collapsed. However, for pillar and stall workings there is no mechanism whereby the time for successive calculation of a void can be determined.

E3P can also confirm that there is no mechanism to assess the extent to which support by pillars or stalling has been withdrawn, therefore parts of the mine are potentially still open with the significant and unquantifiable risk of future collapse inducing successive cavitation of a void resulting in subsidence at the surface.

E3P prepared a letter report dated 1st June 2020 (ref: 13-887-L1), report specifically pertained to the investigation and assessment of mine entry 386399-007 located in the south west sector of the subject site. The salient conclusions from this report are summarised below:

The shaft condition has been appraised in accordance with the broad principals as outlined within CIRIA 758 Chapter 14 (Treatment of abandoned mine entries).

Given the shaft extends through 25m of glacial till, it is almost certain that this is a lined feature, which given the age is likely to be constructed from brick.

The exploratory drilling confirmed that the shaft is filled with unknown material to its base with no staging or voids identified.

Considering the site history, the shaft must have been infilled in the early 20th century, therefore any consolidation and settlement of the backfill would have been expected to occur, there is no surface distortion indicating consolidation of subsidence of the backfill.

Within Table 14.3 (CIRIA 758 Chapter 14), the minimum requirement for treatment related to situational risk for located features, the shaft will be located within an area deemed to be 'High Risk'. A high situational risk is deemed to be urban spaces, major roads, railway infrastructure, multiple dwellings and areas of high concentrations of people directly affected by the mine entry. The proposed development will include highways and dwellings with a high concentration of people.

The shaft is classified as 'filled with no evidence of movement'. The risk-based assessment therefore determined that the following action is required:

- 1) Investigate to assess condition;*
- 2) Drill and grout and consider installation of reinforced concrete cap.*
- 3) Install reinforced concrete cap at rockhead or piled reinforced concrete cap.*

Shaft 386399-007 has been successfully located with its base proven and will be subject to pressure grouting in accordance with the requirements of CIRIA 758 and a pertinent Coal Authority Permission.

It will not be possible to construct a reinforced concrete cap at bedrock due to the depth of superficial drift deposits extending to ~25m.

The shaft is believed to have possibly been used to access workings in the Bradford Four Feet Coal, this is a thick viable seam which may have been worked in the past, therefore the transferal of structural loads to rockhead is not considered a technically viable solution given the potential for the collapse of workings to instigate pile failure.

In light of the above, it is suggested that a Grout Plug capping solution is utilised by drilling and injecting concrete at close centred positions to form an solidified block over the shaft and this mitigate any risk in the highly unlikely event of a future failure in the pressure grouted shaft of shaft lining.

The maximum radial zone of influence is calculated in accordance with the guidance and principals as set out within CIRIA 758. If a conservative angle of repose at 45° is applied the maximum radial extent of influence in the highly unlikely event of total collapse would be 26m from the centre of the proven shaft position.

The detailed geotechnical investigations confirm stiff high strength clay to >13m with a $C_u > 100$ KPa, within the deeper stratum granular horizons are recorded intermittently, with further glacial till overlying the weathered bedrock.

In due consideration of the proven ground conditions, it has been determined that a 60° safe angle of repose can applied in this situation, therefore in the event of total shaft collapse the maximum extent of radial influence would be 15.4m.

In due consideration of the shallow depth of the shaft, proven competent backfill and absence of staging of voiding in the feature and propose to pressure grout the shaft and construct a grout plug, it is considered that the post treated state of the shaft will pose little or no viable potential for future collapse that would result in distortion or subsidence to the surface.

It is therefore recommended that all structures within the 15.4m zone of potential influence in the event of total collapse (which is not considered possible) be constructed using a raft semi-stiffened raft foundation capable of spanning a 3.0m area of ground subsidence.

The geotechnical design risk assessment has concluded that once treated the shaft represents no viable subsidence hazard, therefore when considered within the context of a specialist raft foundation to structure all perceived risk will be mitigated by design.

The E3P letter report (13-887-L1) dated June 2020 has been submitted to the Coal Authority as part of the planning process, the findings of which have been agreed subject to the design and specification for the pressure grouting to the shaft and the subsequent construction of a grout capping system.

The calculated maximum extent of radial influence in the event of a future subsidence event is indicated within the E3P Drawing 13887-004 (Appendix III) and Figure 2.1 and 2.2(overleaf).

FIGURE 2.1 – MAXIMUM EXTENT OF RADIAL INFLUENCE – SHAFT COLLAPSE.

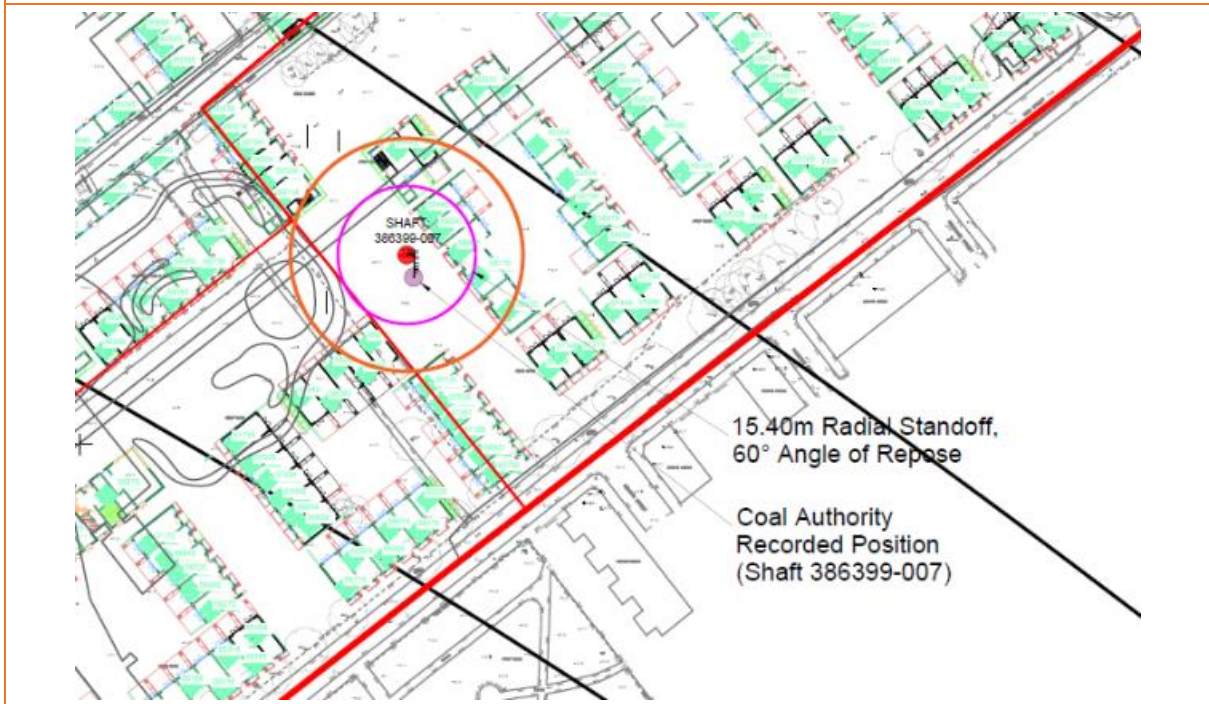
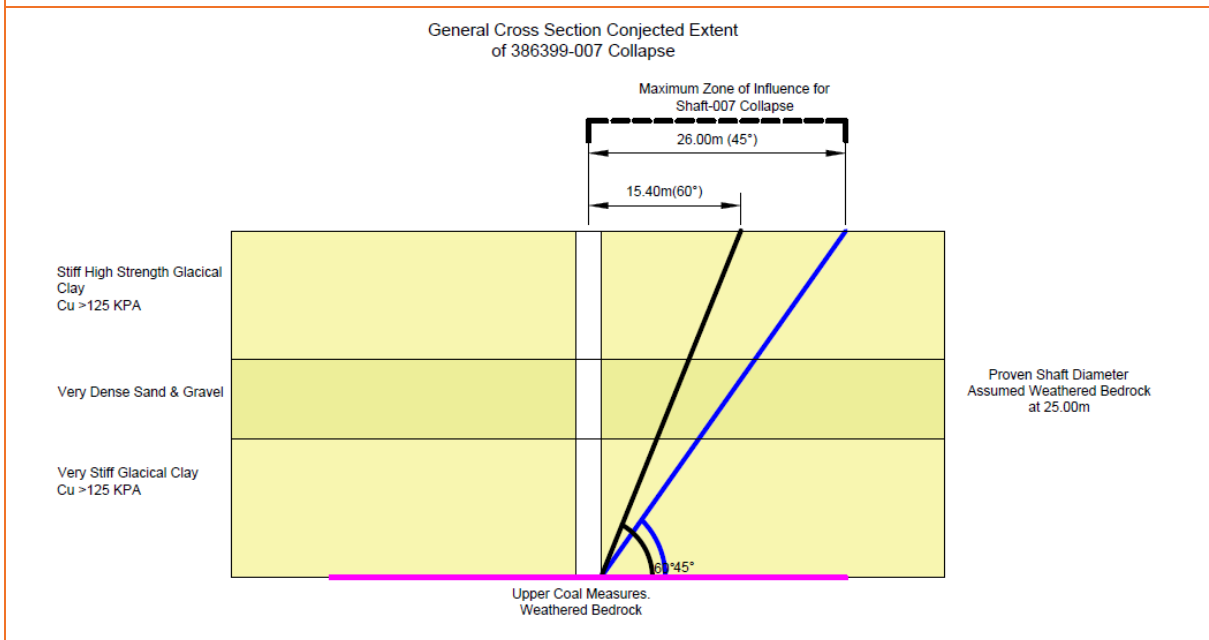


FIGURE 2.2 – CROSS SECTION OF CONJECTURED EXTENT



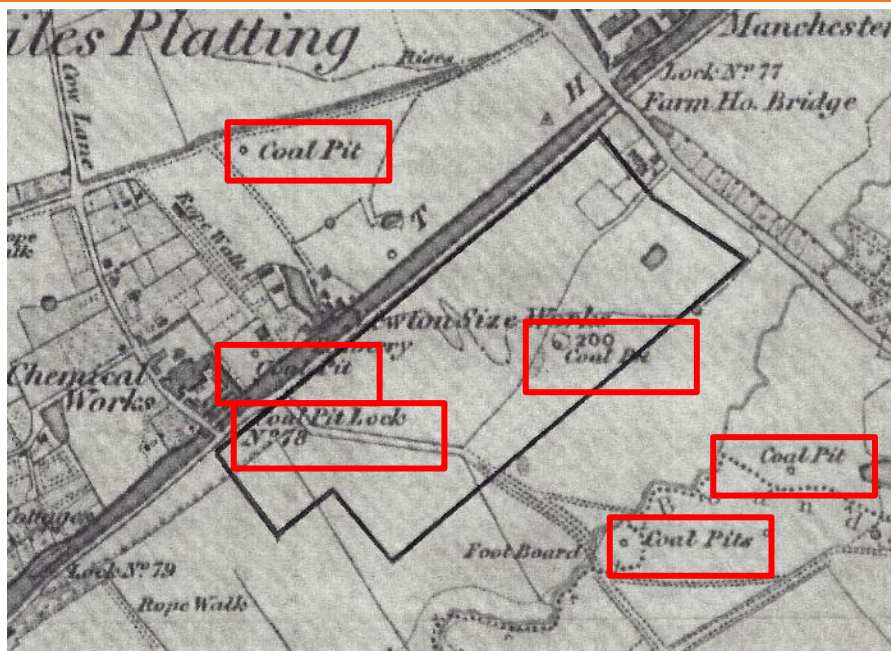
2.3. HISTORICAL DEVELOPMENT – MINING RELATED FEATURES

E3P has undertaken a review of the available historical mapping to identify the potential presence of any features on site or within the immediate proximity that would be associated with historical mining activity. A synopsis of this review along with pertinent extracts of the relevant historical mapping are presented below.

The Ordnance Survey Plan dated 1848 (included as Figure 2.3) confirms the presence of the following features;

- ✧ Coal Pit in the central / east sector;
- ✧ Coal Pit Locks indicated adjacent to the southwest boundary confirming the presence of mining in the area;
- ✧ Coal pit ~30m to the north of the western boundary;
- ✧ Coal Pit ~200m north of the site; and,
- ✧ 2 No. Coal Pits to the South / South East.

FIGURE 2.3 1848 ORDNANCE SURVEY MAP



2.4 GEOLOGY

The British Geological Survey (BGS) map for the site, (1:50,000, Solid and Drift edition) and online records indicate that the site is underlain by the geological sequence presented in Table 2.1 and BGS boreholes in Table 2.2.

TABLE 2.1 SUMMARY OF UNDERLYING GEOLOGY

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Drift	Glacial till.	SAND, CLAY and GRAVEL	Secondary undifferentiated
Solid	Pennine Upper Coal Measures Formation and South Wales	MUDSTONE, SILTSTONE, SANDSTONE	Secondary A aquifer

FIGURE 2.4 – EXTRACT OF 1:10,000 BGS MAPPING

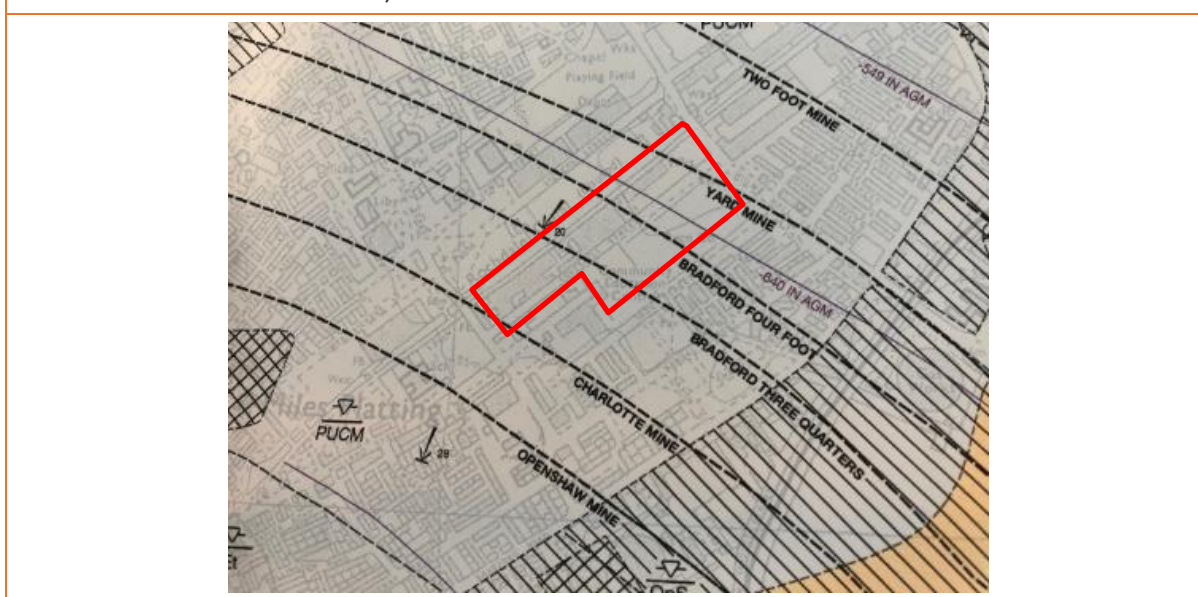


TABLE 2.2 SUMMARY OF BGS BOREHOLE RECORDS

LOCATION	DEPTH	MADE GROUND	DRIFT	SOLID
SJ89NE-673	31m	3.15m	>31m	Not encountered
SJ89NE-510	36m	2.70m	>36m	Not encountered
SJ89NE1936-1945	~6.0m	~3.0m	>6.0m	Not encountered

A historical phase of intrusive ground investigation by Parsons Brinckerhoff Ltd. (ref: SE96661A.1933) dated December, 2007 included the drilling of 2 No. Rotary Boreholes to 50m. E3P has not been provided with the exploratory logs for these boreholes.

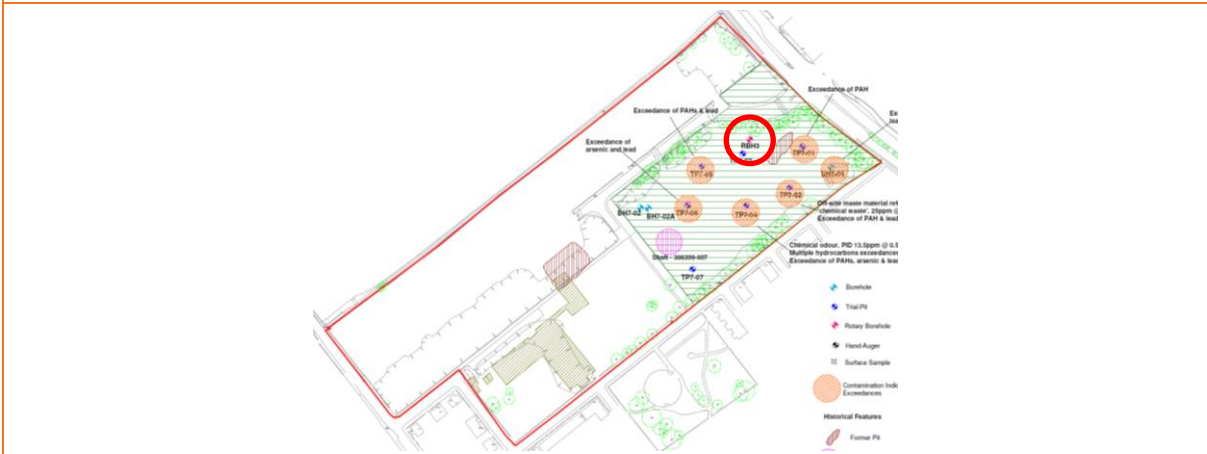
Three rotary boreholes were advanced to a depth of 50m between the 29th and 31st October 2007. Two of these holes were in Zones discussed in this report (Z4 and Z5W) and the last borehole RBH3 was within Zone 7.

Figure 2.5 and 2.6 indicate the location of the historical Parsons Brinckerhoff rotary boreholes.

FIGURE 2.5 – RBH2



FIGURE 2.6 – RBH3



The report confirms that the boreholes did not encounter any coal seams or evidence of potential mine workings to their completion depth.

There are no recorded faults within influencing distance of the subject site.

2.5 DESK STUDY REVIEW OF COAL MINING

A Coal Authority Mining Report was obtained (Ref: 51002224407001) dated 13th January 2020 by E3P (Appendix IV).

The Coal Authority operates a risk-based approach to the assessment of potential instability issues associated with future development of land located within the predefined Coal Authority Consultation Areas. This risk-based approach subdivides the potential risk into “Low” and “High” risk categories.

The risk categories can be defined as:

Low-Risk Sites – Deemed to be land where coal mining has taken place, however it was at such depth not to pose a risk to new development and it therefore contains no known recorded risks and as such no further assessment is required.

For low-risk sites, the CA categorically states:

*If your proposed development is within the Development Low Risk Area **there is no need for you to submit any coal mining information with your planning application** and The Coal Authority will not be consulted by the LPA. The LPA will include our Standing Advice as an informative note within the decision notice.*

High-Risk Sites – Deemed to be landholdings located within an area known to contain legacy risks that include:

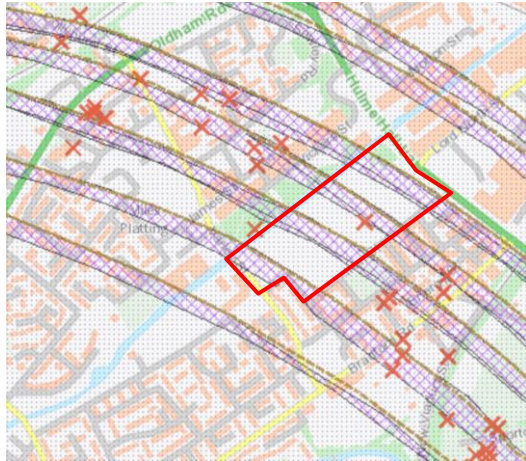
-  Mine entries (shaft or adit);
-  Shallow coal workings (recorded and probable);
-  Workable coal seam outcrops;
-  Mine gas sites and areas;
-  Recorded coal-mining-related hazards;
-  Geological features (fissures and break lines); and
-  Former surface mining sites (sometimes using historic opencast extraction methods).

2.5.1 COAL MINING INFORMATION

Prior to the enactment of the Coal Mines Regulation Act (1872), which came into force on the 1st January 1883, there was no statutory requirement to record the extent of abandoned mine workings and as such the Coal Authority has no knowledge of extensive workings throughout the UK Coal Fields where shallow workings are present at a depth which could result in a subsidence event in the future (through successive cavitation) associated with failure of support mechanism.

To determine if a site may have unrecorded or recorded coal mine workings requires a consideration of a wide range of information and E3P has completed a review of relevant information in relation to potential coal mining activities. Table 2.3 provides a summary of pertinent coal mining information.

TABLE 2.3 COAL MINING INFORMATION

SOURCES OF INFORMATION	SUMMARY
Coal Authority Mining Report	<p>The Coal Authority Mining Report (Ref: 51002224407001) dated January 2020 has been obtained for the subject site by E3P. This report confirmed that:</p> <ul style="list-style-type: none"> The property is located within a surface area that could be affected by past underground mining; There are recorded coal mine entries on site and within 20 metres of, the site boundary; The site is in an area where the Coal Authority believe there is coal at or close to the surface that may have been worked in the past; There may, however, be mine entries in the local area for which the Coal Authority has no knowledge; There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property; The Coal Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining; and The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.
Coal Authority Interactive Map	
British Geological Survey Mapping	<p>The 1:10,000 geological mapping for the area notes the presence the following seams outcropping within the curtilage of the subject site:</p> <p>Yard – Dipping 18.4° SW (Bearing 120) Bradford Four Feet Coal – Dipping 18.4° SW (Bearing 120); Bradford Three Quarters – Dipping 18.3 SW (Bearing 126) Charlotte – Dipping 18° SW (Bearing 120)</p> <p>The 1:10,000 BGS mapping confirms the presence of 4 coal seams outcropping beneath the subject site dipping in a south westerly direction.</p>

SOURCES OF INFORMATION	SUMMARY
Review of Coal Authority Archive	<p>The Coal Authority Archives record the following mine abandonment plans: AMP NW 1171</p> <p>This plan records the presence of shaft 386399-07 which is recorded within the Coal Authority Mining Report (see appendices).</p> <p>AMP 2655/1</p> <p>This plan records workings in the Bradford Four Feet Mine. This plan includes a memorandum 'with regard to the four feet mine' which states that the Four Foot Mine has been more or less worked since at least the late 16th century. The plan reportedly confirms that the Four Feet mine is worked from the outcrop under the northern and central sector of the site.</p> <p>It is clear that the Four Feet mine is worked to outcrop beneath the entire site from the available mine abandonment plans.</p> <p>The extent of known workings is indicated below, however it is believed that the Bradford Four Feet coal is extensively worked further south from sub-crop across the coal field.</p> 
Historical Ordnance Survey Mapping	<p>A review of the 1:10,000 Ordnance Survey mapping from circa 1850, which has records of mine workings that predated the Mining and Regulation Act of 1872, identified the following features, indicative of historical mine workings in proximity to the application site:</p> <ul style="list-style-type: none">✳ Coal Pit on-site (shaft (386399-07))✳ Shafts to the north and south of the site.✳ Coal pit locks indicated at canal confirming mining activities. <p>In consideration of the historical mining features in proximity to the site and potential for coal close to the surface, it is considered highly probable that coal extraction has occurred underlying the site at relatively shallow depths although further investigation would be required to determine the extent and depth of any worked seams.</p>
Historical Site Investigations	<p>A historical phase of intrusive ground investigation by Parsons Brinckerhoff Ltd. (ref: SE96661A.1933) dated December, 2007 included the drilling of 2 No. Rotary Boreholes to 50m. E3P has not been provided with the exploratory logs for these boreholes.</p>

SOURCES OF INFORMATION	SUMMARY
	<p>Three rotary boreholes were driven to a depth of 50m between the 29th and 31st October 2007. Two of these holes were in Zones discussed in this report (Z4 and Z5W) and the last borehole RBH3 was within Zone 7.</p> <p>The PB report indicates that no evidence of any coal seams or workings was encountered within either of these boreholes, however given the sparsity of the information this is not deemed a robust line of evidence to inform the assessment for the potential of shallow mine workings.</p>

2.5.2 COAL MINING GEOLOGY

A review of the mining geology confirmed the presence of four coal seams outcropping within the subject site dipping southwest at ~18° towards the site boundary. The seam thicknesses are as defined by the coal authority within the attached Consultants Report (Appendix IV).

The data is summarised in Table 2.4.

TABLE 2.4 SUMMARY OF COAL MINING GEOLOGY

COAL SEAM	THICKNESS	OUTCROP	DEPTH
Yard	1.0m	On-site	Sub-crop
Bradford Four Feet	1.20m	On-site	Sub-crop
Bradford Three Quarters	1.20m	On-site	Sub-crop
Charlotte	N/A	On-site	Sub-crop

2.5.3 RECORDED COAL AUTHORITY WORKINGS

The known recorded Coal Authority workings are summarised in Table 2.5.

TABLE 2.5 SUMMARY OF COAL AUTHORITY WORKINGS

FEATURE	LOCATION	REFERENCE	COMMENT
Shaft	386058E 399354N	386399-004	<i>Located immediately west of the site.</i>
Shaft	386298E 399369N	386399-007	<i>Located in the central / central south east sector.</i>
Recorded Workings	On site	Bradford Four Feet	<i>The Coal Authority records workings in the Bradford Four Feet Coal, the last year mined was 1900 with an extraction thickness at 1.20m.</i>

FEATURE	LOCATION	REFERENCE	COMMENT
Recorded Workings	On site	Bradford Three Quarters	<i>The Coal Authority records workings in the Bradford Three Quarters Coal, the last year mined was 1900 with an extraction thickness at 1.20m.</i>
Recorded Workings	South East	Yard	<i>The Coal Authority records workings in the Yard Coal, the last year mined was 1900 with an extraction thickness at 1.0m.</i> <i>The Yard coal outcrops beneath the southwest sector, therefore if the workings extent to the outcrop, it is highly probable shallow unrecorded workings are present beneath the subject site.</i>

2.5.4 COAL MINING RISK ASSESSMENT

This risk assessment comprises a desk-based review of all available information on the coal mining issues that are relevant to the application site, deemed to be located within a “High Risk” area. This includes:

- ⚙ Interpretation of information to identify and assess the risks to the proposed development from coal mining legacy, including the cumulative impact of issues;
- ⚙ Setting out appropriate mitigation measures to address the coal mining legacy issues affecting the site, including any necessary remedial works and/or demonstrate how coal mining issues have influenced the proposed development; and
- ⚙ Demonstrating to the local planning authority that the application site is, or can be made, safe and stable to meet the requirements of national planning policy with regard to development on unstable land.

The coal mining risk assessment is summarised in Table 2.6.

TABLE 2.6 SUMMARY OF COAL MINING RISK ASSESSMENT

Coal Mining Risk Assessment	Yes/No	Risk Assessment
Recorded Underground Coal Mining at Shallow Depth (< 30 m)	Yes	High
Recorded Underground Coal Mining at Shallow Depth (> 30 m)	Yes	High
Unrecorded Underground Coal Mining at Shallow Depth (< 30 m)	Yes	High
Mine Entries (Shaft/Adits)	Yes	High
Coal Mining Geology – Fractures/Fissures	No	Low
Recorded Gas Emissions	No	Low
Recorded Mining Surface Hazard	No	Low
Surface Mining (Opencast)	No	Very low/low

Based on the above, a high risk of shallow coal mine workings that have the potential to cause ground instability have been identified.

It is concluded that the mine entry (shaft 386399-007) accessed workings in the Bradford Four Feet sub-crop which transects NW/SE through the centre of the site. Workings are recorded in the Bradford Four Feet and Braford Three Feet Coal by CA mine abandonment plans confirming workings dating back to the 16th century.

The Coal Authority, as a statutory consultee, required a series of rotary open holes across the site to determine the presence of any coal on site and to understand the nature of known coal workings.

The proposed development layout must make due consideration of the fact that the recorded mine entry could be located at the site boundary and therefore no structures can be positioned within the conjectured zone of potential influence in the event of a future collapse. It will be necessary to install mitigation measures within the calculated zone of influence in the form of geogrids to ensure stability of the land within the theoretical zone of influence.

Based on the above, a high risk of shallow coal mine workings that have the potential to cause ground instability has been identified requiring extensive Ground Investigation works and in all likelihood future stabilisation by drilling and grouting in multiple seams of coal and the stabilisation of the mine entry.

3 INTRUSIVE COAL MINING INVESTIGATION

A detailed coal mining risk assessment has been undertaken due to the identified presence of shallow coal mining (recorded shaft and potential shallow workings) on site and in the immediate surrounding area.

3.1. SCOPE OF E3P INTRUSIVE GROUND INVESTIGATION

In due consideration of the potential presence of a potentially worked seams sub-cropping on-site dipping in a south westerly direction, a series of rotary boreholes have been advanced in accordance with Coal Authority Permission Ref: 19640 to assess the potential presence of shallow workings within this seam and the potential for ground instability to induce a future subsidence event within the proposed development.

It should be noted that the recorded mine entry was previously investigated by rotary probe drilling, the findings of this investigation are documented within the E3P Letter Report 13-887-L1 dated June 2020 included as Appendix VI. This letter also includes detailed analysis of the shaft stability and settlement calculations to model surface distortion in the event of future collapse of this feature (post treatment).

3.1.1 SUMMARY OF E3P INTRUSIVE GROUND INVESTIGATION WORKS

Sixteen rotary boreholes have been advanced at the locations detailed within the E3P Exploratory Borehole Location Plan (Drawing 13-887-040 in Appendix III) at positions to interject the recorded sub-crop of coal seams and assess the potential for any workings.

TABLE 3.1 ROTARY BOREHOLE SUMMARY

ROTARY BOREHOLE	DEPTH TO ROCKHEAD (m bgl)	DEPTH TO TOP/ (THICKNESS) OF COAL (m bgl)	EVIDENCE OF MINING ACTIVITY/SEAM	REMARKS
RB101	23.00	35.00 (0.40)	None	Coal inferred Yard sub-crop. 10xseam
RB102	24.00	45.50 (0.50)	None	Coal inferred Yard sub-crop. 10xseam. BH north of Braford Four feet sub-crop.
RB103	23.00	33.00 (0.50)	None	Coal inferred Yard sub-crop. 10xseam
RB104	27.00	39.00 (0.5)	None	Coal inferred Yard sub-crop. 10xseam.
RB105	27.00	31.00 (2.0)	None	Bradford Four Feet sub-crop. Thick coal and known to be worked. Insufficient rock cover.

Manox, Miles Platting

CMRA & Performance Specification for Consolidation of Abandoned Mine Workings

March 2024

ROTARY BOREHOLE	DEPTH TO ROCKHEAD (m bgl)	DEPTH TO TOP/ (THICKNESS) OF COAL (m bgl)	EVIDENCE OF MINING ACTIVITY/SEAM	REMARKS
RB106	26.00	34.00 (0.50)	None	Bradford Four Feet sub-crop. Thick coal and known to be worked. Possibly extracted and mine roof fallen. Insufficient rock cover.
RB107	31.90	41.90 (0.60)	None	Bradford Four Feet sub-crop. Thick coal and known to be worked. Possibly extracted and mine roof fallen. CA record Bradford Four Feet at 1.20m. Insufficient rock cover at this position.
RB108	31.00	Barren	None	Assume Bradford Four Feet dipping to greater depth or missing. Rock cover achieved. Bradford Three Quarter missing.
RB109	24.00	45.50 (0.50)	None	Possible Bradford Three Quarter. Sufficient Rock cover achieved. Charlotte sub-crop not identified. Possibly to north of inferred sub-crop.
RB110	31.50	33.50 (0.60) 45.00 (0.30)	None	Charlotte sub-crop. Bradford Three Quarter at 45m with sufficient rock cover.
RB111	25.30	27.70 (0.70)	None	Bradford Three Quarter. Insufficient rock cover.
RB112	26.00	Barren	None	Bradford Four Feet Missing. Assumed to be extracted.
RB113	29.90	41.30 (0.50)	None	Bradford three Quarter. 10xseam thickness achieved.
RB114	24.0	40.1 (0.60)	None	Bradford Four Feet. Sufficient rock cover.
RB115	22.80	40.00 (0.50)	None	Bradford Four Feet. Sufficient rock cover.
RB116	22.10	Barren	None	Bradford Four Feet either missing and extracted of BH north of sub crop.

For the purposes of this assessment, the names of the coal seams are inferred as best as possible. As for the purposes of assessing the risk from mine workings, the names of the seams are not critical.

3.2 SUMMARY OF COAL MINING ISSUES

E3P has reviewed the historical E3P Desk Study Coal Workings Risk Assessment, British Geological Survey (BGS) Geological Mapping and Coal Authority information, in addition to completing 16 No. 50m rotary boreholes to investigate shallow mine workings. A summary of the findings follows.

- ✿ The Coal Authority and BGS highlight the presence of known workings within the Bradford Four Feet and Bradford Three Quarter coal sub-crops beneath the site. All coal in the area dips in a south-westerly direction beneath the site.
- ✿ A recorded mine shaft is located to the east of the site.
- ✿ The intrusive ground investigations completed during this phase of works, comprising fifteen deep rotary boreholes has not identified any voids or evidence of shallow mine workings. However due to the age of the workings and effective pressure of the overburden, partial collapse is considered highly probable.
- ✿ The Yard coal sub-crop appears to be further north than the CA conjectured position, possibly beyond the site boundary with sufficient rock (10 x seam thickness) cover achieved in the boreholes drilled by E3P.
- ✿ Workings are known to be present in the Bradford Four Feet coal sub-crop dating to the 16th century. Rotary boreholes identify a thick seam of coal in places, with the seam being reduced or missing within other boreholes. It is likely that the reduced thickness is indicative of coal that could not be fully extracted from the mine with subsequent roof collapse, with other areas where it is removed almost in its entirety.
- ✿ The Bradford Three Quarter Coal sub-crop is also recorded to have been worked beneath the site and while no losses in flush or voids are identified within the limited number of site investigation boreholes, the variable thickness and absence of the seam in locations infers historical workings.
- ✿ The Charlotte coal sub-crop is identified in the south west, again this seam appears to have a reasonable (workable) thickness and therefore proof drilling and grouting is required.
- ✿ Mine stabilisation works are required across the three identified coal sub-crops where insufficient rock cover is present overlying the known workings to mitigate perceived ground stability risk in accordance with The Coal Authority permission process and detailed geotechnical design to be prepared in accordance with CIRIA 758.
- ✿ The use of a load transfer pile foundation will require detailed design consideration within the area of workings across the site, which requires stabilisation by drill and grout in accordance with industry best practice guidance CIRIA 758. It will be necessary to ensure the point load from a pile foundation does not stress treated mine workings.
- ✿ Where a greater degree of rock cover is present, the potential for foundation loadings to influence consolidated mine workings is reduced and as such piled foundations are potentially viable.
- ✿ Given the known mining legacy and proven shallow mine workings in historical investigation works, it is highly likely that other unrecorded mine entries exist within the curtilage of the site and immediate surrounding area. It will therefore be necessary to allow for a watching brief during earthworks and ensure inclusion of a suitable mechanism for grouting and capping of any such feature and subsequent amendment to a development layout in the event that an unrecorded mine entry underlies a residential structure.
- ✿ Mine entry 386399-007 will require stabilisation by pressure grouting and the construction of specialist grout capping solution.

4 GENERAL SPECIFICATION FOR MINE STABILISATION WORKS

4.1 OVERARCHING SCOPE OF WORKS

The location of the coal sub-crops will be determined by drilling of boreholes across the pre-defined grid in a linear sequence to establish the position of the sub-crop. Under the guidance of the supervising engineer the proof drilling grid will be amended to ensure it accurately targets the sub-crop position.

The linear boreholes will then be extended down crop to determine the position where sufficient rock cover is established for the relevant coal seam under the supervision of the geotechnical engineer.

Boreholes will be drilled on a primary staggered 6 m × 6m grid across the building footprint with treatment extending up to 3 m beyond the plot line.

Where voids or evidence of workings is identified within the primary drill grid, secondary boreholes will then be drilled at 4.5 m infill centres across the drill and grout grid to plot footprints and the off-set.

Where necessary, tertiary boreholes will be drilled on a 3 m grid where grout take is high (>5T per hole in 24 hr period) and completion pressure cannot be achieved within a grout hole.

Drilling and Grouting workings will be extended across areas of proposed estate roads, adopted highway and infrastructure.

One mine entry has been identified within the curtilage of the development site, the shaft will be subject to pressure grouting in accordance with the specification set out herein prior to the construction of a grout plug cap.

The stabilisation works will be undertaken by injecting a PFA/cement grout into the workings via the boreholes.

4.2 SUPERVISION AND VALIDATION

The client will appoint a resident supervising engineer, who will be in attendance at the outset of the works and on a part-time basis thereafter to monitor the completion of the project to ensure compliance with the performance specification and criteria documented herein.

The mine stabilisation contractor will appoint a site manager or suitably qualified foreman of the works, subject to agreement with the supervising engineer prior to instigation.

4.3 CONSTITUENT MATERIALS FOR GROUTING

Water shall be from the mains supply or other source approved by the resident engineer (RE) and supplied by the client.

Cement shall be Portland cement complying with BS 12.

PFA complying with BS EN 12715:2000 shall be conditioned hopper ash, or dry powder ash, or a type suitable as a constituent for grout and obtained from an approved supplier.

Sand shall generally comply with BS 882 and be of a grading suitable for use in the contractor's plant and approved by the RE.

Pea gravel shall comply with BS 882, and be of grading approved by the RE. Thixotropic admixtures shall be bentonite or another admixture approved by the RE.

4.3.1 STORAGE AND USE OF MATERIALS

Storage of materials shall be such as to prevent contamination and deterioration. Cement shall be kept in a dry location, and the sequence of deliveries recorded so that cement can be used in rotation.

PFA shall be stored within a predefined area and will be kept dampened to mitigate against fugitive dust.

4.3.2 GROUTING PLANT

The contractor shall submit to the RE, for approval, details of the proposed method of mixing, and pumping of grout to the injection points, together with the means of monitoring grouting pressures and the quantities injected.

The materials shall be introduced into the mixer via approved methods (volume batching).

The grout mixer shall be capable of producing a homogenous grout mix, with all particles being thoroughly wetted without segregation and suitably viscous to ensure the required flow and subsequent consolidation.

4.3.3 GROUT MIXES

In due consideration to the proposed residential development of the site, the filling material (grout) shall generally consist of a PFA: cement grout, which should be mixed in the proportions of up to 10:1 where water is present.

Representative cubes will be formed from grout mixes with crushing strengths of not less than 1 MN/m² at 28 days.

Note: the 7-day test is performed to indicate that the 28-day strength is achievable, i.e. a 7-day value of about 0.4-0.45MN/m² is considered to be on target to achieve the required 28 strength criteria.

Where excessive lateral flow of grout is anticipated or when voids greater than 500 mm are encountered, the RE may order or agree to the addition of sand or pea gravel to the mix in accordance with CIRIA SP32.

The specified grout mix shall have the minimum water content consistent with effective pumping.

The actual proportions to be used initially for the various grouts shall be agreed with the RE, paying due regard to the conditions met in drilling and the results of any trial grouting carried out before work commences.

4.3.4 GROUT PROPERTIES AND TESTING

With water/(cement and PFA) ratios generally in the range of 0.4 to 0.45, (including the moisture in the aggregates), the mixes proposed should produce "pumpable grout" with flowability readings of between 300 to 600 mm, when measured in a meter of the "Colcrete" type.

The sample for the flowability test shall be obtained by the grouting contractor at the point of injection, i.e. from the end of the tremie pipe.

A minimum of two flowability tests per week shall be performed by the contractor, as directed by the RE, with results to be provided in a timely manner to ensure appropriate review.

A minimum of two bleed capacity tests shall be performed by the contractor per shift or as directed the RE. The sample of grout for the test shall be taken from the point of injection, i.e. the end of the tremie pipe.

Bleed capacity shall be measured in a clear plastic or glass graduated cylinder which has an internal diameter not less than 75 mm and with a volume of approximately 1000 ml. After placing the grout, a cover shall be placed over the cylinder to avoid evaporation. Bleed capacity shall be read at hourly intervals for neat cement grout, and readings should continue for not less than 3 hours. For PFA: cement grouts, readings should continue for not less than 6 hours.

The contractor shall prepare two sets of test cubes of grout per week, or as directed by the Resident Engineer (RE), with all testing to be commenced within 48 hours of samples/cubes being obtained.

Each cube shall be of 100 mm side, or as agreed with the RE, and shall be taken from the grout at the point of injection, i.e. the end of the tremie pipe.

At the instruction of the RE, the contractor shall arrange for them to be tested by crushing at 7 and 28 days in accordance with BS 1881.

The testing shall be carried out by an independent UKAS-Accredited laboratory or as agreed with the RE.

As stated previously, mixes shall produce cubes with crushing strengths of not less than 1 MN/m² at 28 days.

If the RE considers that the results of the test indicate that a change of mix proportions is required, then the contractor shall make such modifications as the RE may direct.

4.4 TREATMENT OF WORKINGS IN SHALLOW COAL SEAM

4.4.1 DRILLING PROCEDURES FOR SHALLOW WORKINGS IN COAL SEAM

All boreholes to be used for the injection of grout, including those which strike coal pillars, shall be drilled by rotary or rotary percussive techniques down to a minimum of 0.5 m beyond the base of the old workings in the seam, or the floor of the seam itself, whichever is greater.

The drilling and Grouting grid will be as follows:

- ✚ **Plots (+3.0m offset):** 6m Primary grid.
- ✚ **Plots (+3.0m offset)** Secondary holes to be drilled and grouted where workings identified in primary 6m grid (equates to grouting at 4.50m²);
- ✚ **Highways, estate road, private drives and Hardstanding:** 10m staggered grid;
- ✚ **Gardens & Landscaping:** No drill and grout unless grout take is >10T per hole on the adjacent primary grid which will then trigger 10m staggered grid across area of concern.

The drilling system and flushing medium to be used shall be as instructed on The Coal Authority licence, and approved by the RE. The contractor shall allow for the provision of appropriate dust suppression for those holes that are to be drilled near sensitive receptors (e.g. nearby houses, highways, active commercial properties, car parks and public footpaths).

Boreholes drilled for the treatment of the plots will ensure that treatment extends up to 3 m out-with the building footprint, based upon anticipated grout flows.

The minimum diameter of the holes shall be 75 mm, unless otherwise specified by the RE. When it is impracticable to drill at the minimum diameter for the full depth, the diameter of the boreholes shall be increased in the upper lengths.

Boreholes shall be temporarily cased through superficial deposits down to the rockhead and, if directed by the RE, down through the rock strata. The boreholes shall be kept open until grout injection into the workings and rock is complete.

Where a borehole proves abortive because it becomes obstructed, it shall be re-drilled in a suitable location as directed by the RE, at a large diameter, and re-cased.

Any deviation from this proposed layout, including the drilling of additional secondary and tertiary holes, shall be recorded by the contractor and a revised borehole location plan provided to the RE.

4.4.2 GROUTING PROCEDURES FOR SHALLOW WORKINGS IN COAL SEAM

The aim of the stabilisation work is to substantially fill any old workings within the Bradford Four Feet, Bradford Three Quarter and the Charlotte Coal as well as any voids or broken ground found within the overlying strata in order to prevent the development of crown holes at the surface\foundation level.

Perimeter grout walls, if required, shall be formed by filling boreholes with a viscous grout comprising appropriate proportions of cement, PFA, sand or pea gravel and water. The mix, proportions and method must be agreed with the RE.

Pressure need not be applied to the grout in affected boreholes unless required by the RE.

Unless specified otherwise, the section of the perimeter wall at the deepest part of the seam shall be constructed first.

Immediately prior to grouting each borehole, the contractor shall check that it is unobstructed to the required depth to receive the tubing or tremie pipes for grout injection. Obstructions shall be dealt with as described in the drilling procedures in Section 4.4.

Grout shall be injected into each hole via an approved flexible tube, or series of steel tubes, placed to the base of the hole or to such other depth to receive the tubing or pipes for grout.

Grouting shall proceed upwards from the base of each borehole to the base of the surface deposits. It is not intended that, as a general rule, significant quantities of grout shall be injected into the surface deposits unless specified otherwise. This requirement will be subject to review by the RE.

The grout shall be injected at the approved rates until grout appears near the point of injection, when the borehole shall be deemed complete. If this criteria is reached quickly, the grout tubes shall be lifted to check that a local obstruction is not preventing the flow of the grout into the strata.

Pressure shall be applied to the grout in every borehole. If grout has not appeared at the point of injection after 5 tonnes of grouting materials have been introduced, then sand and/or pea gravel (gravel which passes through a 6.33 mm sieve and is retained on a 2.36 mm sieve) may be added to the mix or placed down the borehole.

Treatment of adoptable highways will generally be undertaken as per the plots although, should a borehole within the highway accept more than 6 tonnes of grout, then treatment within the hole will be suspended for 12 hours. Thereafter, further grout will be injected in 2 tonne batches. If pressure has not been achieved, or grout appeared, after a total of 10 tonnes of grout has been placed, then a review of the borehole grid spacing, grout mix and materials used will be undertaken.

All boreholes within the highway will be filled under hydrostatic pressure and, once complete, will be pressurised utilising a pneumatic packer to the appropriate pressure.

The contractor shall take all necessary precautions, including making all reasonable liaison with the client, to ascertain the positions and depths of underground services and drains passing through the site, making full allowance for working around and protecting live services and drains.

The contractor shall be responsible for maintaining close liaison with the local authority and the public utility authorities to avoid any disruption of the existing services.

When introducing grout into any borehole, the contractor shall ensure, by regular inspections throughout the day, that the grout is not entering adjacent drains, services, culverts and ducts.

In the event that any such leakage is detected, the contractor shall immediately suspend the grouting operations and commence to remove any accumulated grout.

4.4.3 IN-SITU TESTING

When directed by the RE, the contractor shall test the consolidated ground for permeability and strength.

Permeability by grout acceptance testing shall be checked by drilling test holes in positions to be selected by the RE and injecting grout at pressures appropriate to the depth, all in accordance with the requirements for infilling grouting. If the RE considers that the quantities of grout accepted are excessive, then further holes shall be drilled and grouted at the rates and prices agreed.

After testing, boreholes shall be completed in accordance with the requirements for grouting infill holes.

In general, test holes will be undertaken along the adoptable highways adjacent to boreholes exhibiting grout taken in excess of 6 tonnes.

4.5 DRILLING & GROUTING PROCEDURES FOR TREATMENT OF MINE SHAFT

4.5.1 SHAFT BOREHOLES

The boreholes shall be drilled by rotary methods employing water flush techniques unless otherwise agreed to by the CA / Project Manager / Supervisor. Initially, a vertical borehole of minimum 72mm diameter will be drilled commencing at the centre of the shaft. Drilling will then continue until solid strata are reached at the base of the shaft.

It is required that the subsequent grouting of the shaft is to be carried out via the drill string. The minimum internal diameter of the drill string shall be not less than 35mm and external casing will not be necessary unless it is required to insert pea gravel.

If a cavity is located within the shaft the Project Manager/Supervisor may require it to be in-filled with pea gravel. The Contractor will, in this case, be required to insert casing of minimum 100mm diameter to the upper limit of the cavity to facilitate the placing of pea gravel into the cavity. The casing must remain in place until the base of the shaft is proved.

During the drilling the Contractor shall carry out regular checks and any necessary adjustment to the drilling rig to ensure that the drill is vertical. When the drilling encounters solid strata at the presumed base of the shaft, boring will continue into rock for a distance of at least 5 metres or as specified by the Project Manager/Supervisor.

4.5.2 GROUTING TUBES

Grouting can then proceed via the drill string. Any casing may, at this stage, be withdrawn but the drill string must remain at the borehole base. A triple outlet, T- connection pipe will be attached to the top of the drill string, via a coupling of approved design. The connection pipe will be of such design that a free outlet is available to check the flow of grout and that a pressure meter, calibrated up to at least 1,725 kN/m² (250 p.s.i.) is permanently attached at the inlet location. It is anticipated that pressures in the region of 690 kN/m² (100 p.s.i.) to 1,035 kN/m² (150 p.s.i.) will be required.

Grouting will be injected via the drill string, previously placed to the base of the borehole until a pressure to be stipulated by the Project Manager/Supervisor has been recorded and maintained at the pressure meter attached to the T- connection pipe, or until grout overflow at the surface occurs. The drill string will be of such design that up to 3 metres (10 feet) lengths can be withdrawn, disconnected and the T-connection reconnected at the top of the borehole. When the stipulated pressure has been maintained and further grouting at that level is not possible without generating greater pressure, the Contractor will withdraw the drill string up by 3 metres. Further grouting will then proceed and further withdrawal up the shaft shall not be carried out at this or any subsequent stage or level until the stipulated pressure has been recorded and maintained at that stage or level. This procedure will continue until the shaft has been pressure grouted to the surface or near surface, to the satisfaction of the Project Manager/Supervisor.

On completion of the grouting via the shaft centre borehole, an additional borehole is to be drilled within the shaft area, no less than 1.0m from the shaft centre and the sequence repeated. If/where grout takes in the secondary borehole are high (i.e. exceeding 5 tonnes), and/or at the Project Manager/Supervisor's discretion, a third grouting borehole may be instructed.

4.5.3 RECOVERY OF MATERIALS

The Contractor is expected to recover from each borehole, metal rods, connections and casings used in the operations, and it will be necessary for the Contractor to indemnify the Employer against any claims for loss of such items.

4.5.4 DRILLING PLATFORM

The Contractor's particular attention is drawn to the possibility of the collapse of fill material into the shaft, or of the shaft itself whilst drilling and/or grouting operations are being carried out. During the drilling and treatment of the shaft, the drilling equipment shall be supported on and secured to a suitable platform such that, in the event of a collapse, the drilling rig remains supported over the shaft. When assessing the platform requirements, the Contractor shall consider whether the platform itself could become dislodged by a collapse and in such a case shall make provision for the platform to be secured to suitable anchorages so as to prevent such an occurrence. The dimensions of the platform/staging/scaffolding and any anchoring device must be provided to the Project Manager/Supervisor, prior to its transport and erection at the site. Subsequent to the shaft being located no drilling is to take place at any suspected old mine shaft until the Project Manager/Supervisor is satisfied that the appropriate platform and anchoring system has been established. It is recommended that all personnel involved in the drilling and treatment of a shaft should wear appropriate safety harnesses secured at a safe distance from the shaft. No claims will be entertained for any damage to plant and equipment caused by settlement or collapse of the internal filling of the shaft.

4.6 DRILLING AND PRESSURE GROUTING PROCEDURES TO CONSTRUCT GROUTED SHAFT CAP

4.6.1 METHOD OF DRILLING

The boreholes shall be drilled by rotary or rotary percussive methods employing water flush techniques unless otherwise agreed to by the Project Manager/ Supervisor.

It is proposed to construct the Grout Plug Cap by drilling boreholes on a staggered grid across the maximum extent of subsidence in the event of any future consolidation within the mine entry.

Boreholes to form the grout plug will be drilled at the following centres with a decrease in spacing across the calculated radial extent of influence in the event of total collapse.

-  **Shaft centre to 3.0m – 1.0m centres to 27m (1.0m into rock)**
-  **3.0m to 15m – 3.0 centres to be advanced to 1.0m below the calculated cone of influence in the event of total collapse.**

It is suggested that the approach will be adapted on-site to reflect ground conditions encountered, where grout takes are considered to be excessive, the centres will be reduced, similarly if grout takes are equal to or marginally greater than the borehole volume centres will be reduced.

4.6.2 DIAMETER OF BOREHOLES

The minimum diameter of borings shall be 50 mm. Where an exploratory hole is to be of such depth that boring to the full depth at the minimum diameter is likely to be impossible, or where obstructions are expected, the Contractor shall begin boring at such greater diameter as he may choose. Should any boring prove abortive because of the Contractor's failure to begin with a sufficiently large diameter boring, the Contractor shall carry out any necessary re-drilling and provide and install any necessary casing at his own expense.

4.6.3 PLUMBING OF BOREHOLES

Immediately prior to grouting any borehole the Contractor shall check by plumbing or by other approved techniques that no collapse has occurred within the borehole after the drill rods have been withdrawn and that the hole is open to the depth specified by the Project Manager/Supervisor.

4.6.4 RE-DRILLING OF BOREHOLES

Grouting shall commence via flexible tubing or a series of metal rods having a minimum internal diameter of 25 mm placed to the base of the borehole or at such other depth specified by the Project Manager/Supervisor. Where it is realised that the tubing or rods cannot be placed to the specified depth, the tubing or rods must be withdrawn and the obstruction removed by re-drilling to the specified depth with casing, if necessary. The costs of any such extra drilling shall be borne by the Contractor, who shall indemnify the Employer against any such claims.

4.6.5 GROUTING TUBES

When the tubing or rods have been placed to the depth specified, and checked for blockages by a water test, a T-connection pipe of approved design shall be attached to the top of the tubing or rods. The connection pipe shall have a free outlet available in order that grout flow may be checked and a pressure

meter calibrated up to at least 1,050 kN/m² (150 p.s.i.) but not exceeding 2,100 kN/m² (300 p.s.i.) must be permanently attached at the inlet during the grouting operations. There must be an adequate seal between the tubing/rods and borehole wall to ensure that grout is pumped into the formation. If grout cannot be satisfactorily pumped into the foundation, alternative methods shall be employed, such as grouting through casing, to pump grout into the superficial deposits.

4.6.6 GROUTING EQUIPMENT AND PRESSURE

The operating pressures shall be kept to a minimum and shall not exceed 104 kN/m² (15 p.s.i.) unless otherwise instructed by the Project Manager/Supervisor. Grout shall be mixed in approved plant and continuously agitated, until injected into the boreholes by a double acting long stroke reciprocating pump or other approved pump. When submitting the completed tender documents the Contractor must specify in writing the method of controlling, metering and pumping the materials to be used.

4.6.7 BACKFILLING BOREHOLES

Upon completion of the pressure grouting procedure, the Contractor shall ensure that each borehole is backfilled to the surface with grout. In the event that settlement of such backfill grout subsequently occurs, the Contractor shall return to these borehole locations to top up the grout level. Only in exceptional circumstances - for example where unacceptably high quantities of grout might flow into loosely filled ground – will this requirement be relaxed by the Project Manager/Supervisor.

4.6.8 ABANDONED CASING

The Contractor shall make every attempt to recover all casing used in the drilling operations. However, if this becomes impractical then any abandoned casings must be filled with P.F.A./cement grout and cut at least 2 metres below ground level. The positions of such abandoned casings must be recorded and the information relating to them passed to the Project Manager/Supervisor.

4.6.9 DRILLING AND GROUTING SEQUENCE

The boreholes shall be drilled in a sequence and to depths agreed in advance with the Project Manager/Supervisor. Grout will be injected into the boreholes in an order and with grout mixes as agreed with the Project Manager/Supervisor. Other than the possibility of the Project Manager/Supervisor requiring a series of initial or final random test holes the majority of the boreholes will be drilled and grouted in a systematic manner. However, if deemed necessary by the Project Manager/ Supervisor the Contractor may be required to return to specific areas intermittently to drill secondary injection boreholes or to continue grouting primary or secondary boreholes. No claim will be entertained for any inconvenience to the Contractor by such moving of drilling and/or grouting plant and it shall be necessary to indemnify the Employer against any such claims.

4.6.10 BOREHOLES TO BE GROUTED

Unless otherwise directed by the Project Manager/Supervisor the Contractor shall attempt to inject grout into each borehole. Care shall be taken to ensure that the grout is not injected into pipes, drains, cable ducts, etc.

4.7 RECORDS – COAL SEAM, SHAFTS & PLUGS

The contractor shall prepare and keep available for inspection on site, plans showing the positions of all boreholes, daily drilling records, and the total amounts of grout injected.

The plans shall be updated daily in conformity with the records detailed herein. On completion of the works, the contractor shall give fair copies of the plans and sections to the RE within one week of completion of the programme of grouting.

As works proceed, the contractor shall maintain separate daily records for drilling, for grouting and for materials and plant received in a form to be approved by the RE. The daily records signed by the contractor's agent shall be submitted each day to the RE for their agreement.

The contractor shall provide one copy of the agreed record for the RE's retention and keep a further copy available for inspection on site.

Daily drilling records shall be provided for each borehole and contain the following information:

- ✳ Job title and location;
- ✳ Borehole reference number;
- ✳ Date;
- ✳ Contractor's name;
- ✳ Plant in use, crew members and hours worked;
- ✳ Method of boring or drilling;
- ✳ Type, diameter and depth of casing used;
- ✳ Diameter and depth of hole at the beginning and end of each working day or shift;
- ✳ Loss of any flushing medium during drilling;
- ✳ Standing time, with reason, or time lost overcoming obstructions;
- ✳ Details of underground services located;
- ✳ Details of any settlement or ground heave;
- ✳ Daily and cumulative length drilled;
- ✳ Depth to each major change of stratum;
- ✳ Description, with identification, of the stratum and whether it is intact or broken;
- ✳ Each depth at which groundwater is encountered (if apparent), the depth to which it rose and any steps taken to stop the flow;
- ✳ Depths at which any samples are taken;
- ✳ Details and results of any permeability tests instructed by the RE;
- ✳ Details of any voids or suspected workings;
- ✳ Details of any emissions of gas, water, etc.; and
- ✳ Depth of completed borehole.

Daily grouting records shall be provided for each borehole and contain the following information:

- ✳ Job title and location;
- ✳ Borehole reference number;
- ✳ Date;
- ✳ Contractor's name;
- ✳ Plant in use, crew members and hours worked;
- ✳ Details of type of injection, grout-line dimensions and length of standpipes inserted;
- ✳ Type of grout mix and volumetric quantity injected, including total quantity by weight of each type of grouting material introduced;
- ✳ Grout pressures recorded, with the corresponding depths;
- ✳ The results of all flow and bleed tests;
- ✳ Details of casing abandoned;
- ✳ Details of grouting materials delivered to the site and a running total of each of the materials delivered;

- ✚ The nature, frequency and results of all inspections of services to check for grout penetration; and
- ✚ Details of all stoppages or delays and any other relevant information.

The daily records of materials and plant received shall show in particular that day's quantities by weight of each type of material and cumulative quantities. With the daily records, the contractor shall submit to the RE copies of receipts or invoices for all materials delivered and shall keep them on site until the works are complete.

Notwithstanding the information listed above, the contractor shall provide any other information required by the RE.

On completion of the drill and grout programme, the RE shall prepare a validation report containing copies of borehole records, a borehole location plan, procedures followed during the works, the results of validation boreholes and pressure tests, and a record of any deviation from this specification.

3.2. FOUNDATION DETAILS

Curtins have been instructed to create the detail for foundations in the zone of the mineshaft, with detailed drawings and calculations provided in Appendix VII.

The proposal for the entire site is to remediate due to contamination purposes and install vibro stone columns to improve the ground to provide the necessary allowable bearing capacity for the strip footings. The allowable bearing capacity of the ground after vibro improvement is 100kN/m² if the vibro stone columns are spaced at 1m centres. If the vibro stone columns are spaced at 2m centres, then the allowable bearing capacity reduces to 50kN/m². Taking this into account, the vibro stone columns are spaced at 2m centres where the line loads on the strip footings are low. The spacing of the vibro columns is reduced to 1m centres where the line loads are high and cannot be accommodated by the lower allowable bearing capacity provided by 2m spaced vibro columns.

As the ground bearing strip footings are within the conjectures zone of the mine shaft, they have been designed to span 3m and cantilever 1.5m in the case of any differential settlement.

END OF REPORT

APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the client as indicated in Section 1.2.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information, it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	WTE	Water table elevation

Manox, Miles Platting

CMRA & Performance Specification for Consolidation of Abandoned Mine Workings

March 2024

m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)		

APPENDIX III

DRAWINGS