

Trinity Academy, Barnsley

Strategy for Grout Stabilisation of Shallow Coal Mine Workings and Mine Entries

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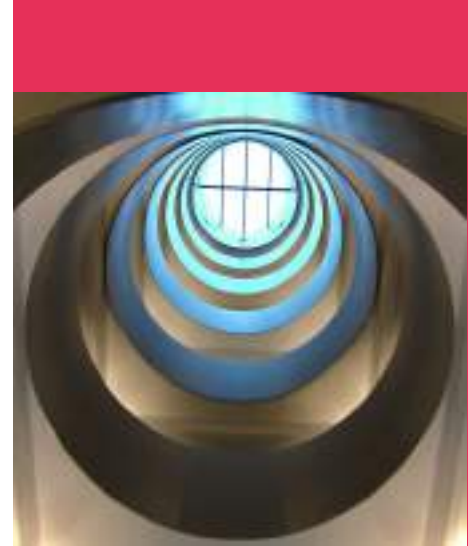
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1.0 Background

It is proposed to redevelop the former NHS Keresforth Centre site in Barnsley for an educational facility to be known as the Trinity Academy. The existing site comprises the former Keresforth Centre NHS facility in the east and a playing field adjacent to the A6133 Broadway in the west.

In the east of the site, the proposed works consist of the demolition of the eight NHS facilities buildings, with the subsequent construction of a three-storey teaching block, adjoining sports hall, associated hard landscaping, soft landscaping and MUGA. In the west the proposed works comprise the construction of grass and synthetic sports pitches.

This strategy for mining treatment works relates to the playing fields in the west which includes the mine shaft and potential shallow mine workings and eastern lower lying land that will be developed for the teaching block, sports hall, MUGA and soft and hard landscaping which is known and has further potential for shallow mine workings.

A Coal Mining Risk Assessment (CMRA) was undertaken by Waterman in 2020. This CMRA concluded that the risk presented by shallow coal mine workings necessitated mitigation or treatment for the site to be brought up to a condition that would be deemed suitable for development.

Ground investigation works undertaken by Waterman in 2020 also identified the presence of ground conditions that correlated with published information. Specifically, this included identifying voids that were considered to be associated with worked coal seams present within the shallow ground beneath the site.

In compiling this strategy, the following documents have been referred to.

- 1) Waterman Infrastructure & Environment (2020) Geo-Environmental Assessment Report for Trinity Academy, Barnsley (report no. WIE7125-100-R-8.1.3-Geoenv)
- 2) Waterman Infrastructure & Environment (2020) Coal Mining Risk Assessment for Trinity Academy, Barnsley (report no. WIE7125-100-R-7.1.3-CMRA)
- 3) Curtins (2022) Phase 2 Ground Investigation (Report no. 079532-CUR-XX-XX-T-GE-00002-P01_Phase 2 GI)
- 4) Curtins (2022) Coal Mining Ground Movement Assessment (Report no. 079532.301-CUR-XX-XX-T-GE-00003-P01).
- 5) Trinity Academy, Barnsley, Supplemental Ground Investigation, reference 079532-CUR-XX-XX-T-GE-00005, revision C01 dated 19 October 2022.
- 6) CIRIA document C758D "Abandoned Mine Workings Manual" has been referred to.

This strategy is to be read with Curtins document, Trinity Academy, Barnsley, Specification for Stabilisation of Shallow Coal Mine Workings, reference 079532-CUR-XX-XX-T-GE-00002 rev C02

dated 14 November 2022. The strategy and the specification are intended to provide guidance for the appointed specialist contractor with respect to the treatment of shallow coal mine workings as well as treatment and capping measures for the recorded mine shaft in the playing fields.

2.0 Site Setting

2.1 Site Location

The proposed development site is located off Keresforth Close, Barnsley S70 6RS and is located approximately 2km west of Barnsley town centre. The wider development covers an area of 7.2ha and is approximately centred on National Grid Reference 433423, 405601, as illustrated in Figure 2.1 below.

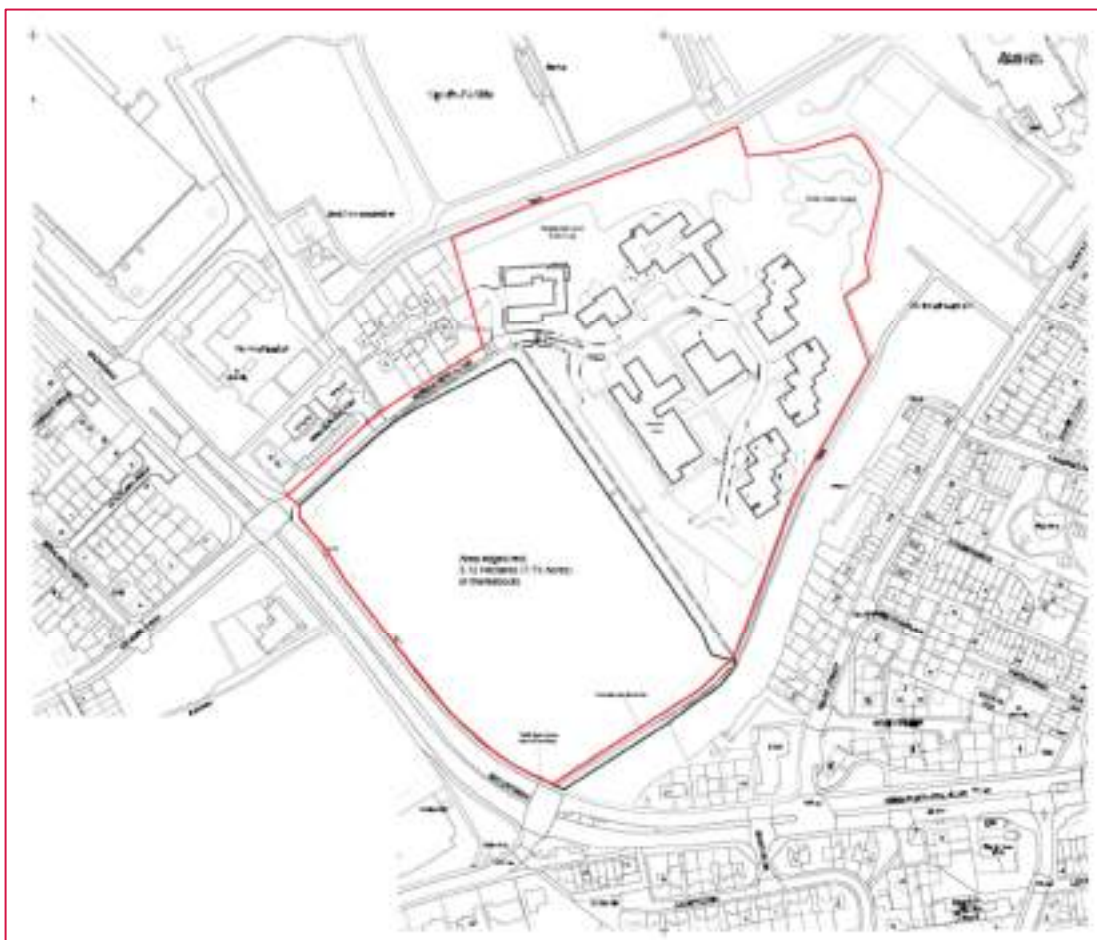


Figure 2.1 Site boundary plan

The site is currently identified as two distinct parcels of land: Keresforth Medical Centre, now disused in the north-east comprising of low-rise buildings with access roads, parking areas and soft landscaping and a public open space in the south-west. The area of public open space is predominately flat and is grass covered whilst the Keresforth Medical Centre (pre-demolition) is utilised by a mix of buildings, hardstanding, and soft landscaping. The site is bounded to the north by Keresforth Close comprising residential dwellings and sports fields, to the east by Joseph Locke Primary School, to the south by the A6133 Broadway, residential property, and allotments and to the west by the A6133.

The topography of the site varies and has an eastern area, where the NHS centre is located, at lower elevation at approximately 137m to 141m AOD sloping down to the north of the site and a western area, where the playing fields are located, at approximately 145m to 150m AOD sloping down to the south of the site.

2.2 Ground Conditions

The recorded geology of the development site is shown in Figure 2.2 below along with ground conditions for the eastern area as obtained from Reference 1.



Figure 2.2 Site geology

Made Ground

Made ground deposits were encountered in all the exploratory hole positions proven to maximum depths ranging between 0.15m and 1.90m bgl (141.25m – 138.83m AOD). The made ground was encountered as topsoil in the locations of RC07, RC08 and RC09 to maximum depths between 0.15m – 0.20m: described as grass over brown clayey topsoil. In the positions of RC10 and RC11 the made ground is encountered as asphalt up to maximum depths of 0.10m bgl. The made ground soils were proven to maximum depths ranging between 1.00m and 1.90m bgl (139.81 – 138.83m AOD). This was

described as a light yellow to cream compact sandy very angular GRAVEL of limestone with the location of RC10 also recorded to have a firm light brown gravelly CLAY made ground soil. The gravel is fine to coarse grained and very angular of coal, mudstone, and sandstone lithorelicts.

Residual Soil

The residual soil was encountered in all rotary borehole locations directly beneath the made ground deposits. The deposits were encountered at depths ranging between 0.15m and 1.90m bgl (141.25m AOD in RC09 – 138.83m AOD in RC11). The residual soils were proven to maximum depths ranging between 1.55m and 2.00m bgl (139.90m AOD in RC09 – 137.60m AOD in RC08). The shallow residual soils were primarily encountered as a CLAY deposit and are interpreted to be the weathered surface zone of the Pennine Middle Coal Measures Formation (PMCM). The deposit was typically described as a stiff to very stiff yellowish brown, brown and orange mottled grey slightly gravelly CLAY. Gravel is fine to coarse grained and very angular of coal and mudstone lithorelicts or as a stiff to very stiff brown CLAY. This residual soil deposit thickness is likely to vary laterally across the site, particularly where the site slopes in a south-east direction.

Bedrock (Pennine Middle Coal Measures Formation)

The bedrock deposits were encountered directly beneath the residual soils. The bedrock was encountered at depths ranging between 1.55m and 2.00m bgl (139.40m AOD in RC09 – 137.60m AOD in RC08). The base of the PMCM was not proven but the base of the boreholes were advanced up to 30.50m bgl (110.90m – 108.90m AOD). The deposits that were encountered were of interbedded mudstone, siltstone sandstone and coal of varying weathering grades and fracture states.

The mudstone is generally the most common of the interbedded deposits, generally the weakest and has a higher degree of weathering compared to the siltstone and sandstone. The mudstone is typically described as an extremely weak progressing to moderately weak, grey to dark grey MUDSTONE. Initially completely to highly weathered, becoming slightly weathered with extremely closely becoming closely spaced discontinuities. Fractures are generally iron stained dark purple, dark orange and orange with the orientation of the fractures generally horizontal to sub-horizontal with rare vertical fractures. Rare black plant fossil remains were present.

The siltstones are the second most common of the interbedded deposits and is generally described as a weak to medium strong light and dark grey lenticular bedded SILTSTONE. Highly weathered to slightly weathered with very closely to medium spaced discontinuities. Fractures are generally iron oxide-stained light to dark orange with largely horizontal to sub-horizontal with rare vertical fractures.

The sandstones are the third most common of the interbedded deposits and are generally described as a medium strong to strong rarely very strong light grey, rarely dark grey cross bedded fine grained SANDSTONE. Slightly weathered to fresh with closely to widely spaced discontinuities. Rarely fracture planes have possible calcite minerals deposited on the fracture planes. Some of the fracture planes are also iron oxide stained.

Coal deposits were encountered throughout with distinct layers encountered that are interpreted to be the Barnsley coal seam (recorded in historical records as a 2.68m thick split seam). At the position of RC09 between 8.00 and 9.50m bgl a zone of worked ground (possible void) was identified. At the positions of RC07, RC08, RC10 and RC11 intact coal was encountered possibly representing coal pillars in worked seams. In RC11 between 13.25m and 15.50m bgl a residual soil / extremely weak deposit of material was encountered above the coal seam; this was not encountered in other boreholes.

Geological Faults

BGS mapping identifies a geological fault series within the underlying bedrock associated with coal seams, with geological faults running broadly north-east to south-west within and surrounding the site boundary.

2.3 Mining

The Coal Authority Interactive Map shows that the site is within a “Coal Mining Reporting Area”, with the western area and encroachment on to the eastern area of the development site, identified as a “Development High Risk Area”.

The Coal Authority also advise that the property is in an area with probable unrecorded mine workings.

There are no mine entries recorded on the eastern development area, but three shafts are shown in its vicinity, two to the south east of the site boundary and one to the west within the site boundary on the playing fields development which is part of the overall scheme. In coal mining areas such as these there is always the potential for unrecorded mine entries to be present.

Abandonment plans are available within this report appended within Appendix B.

A Coal Mining Risk Assessment (CMRA) was undertaken by Watermans in 2020. This summarised that the Barnsley Coal is potentially present at shallow depths beneath the site, with the presence of shallow mine workings (both development areas) and a mine shaft (western development area).

Suspected mine workings and intact coal (thought to be associated with the Barnsley Coal seam) were identified during ground investigation works, with the maximum recorded no recovery / void thickness at 3m (from 7.5m to 10.5m bgl). Due to the lack of rock cover to arrest the upward migration of voids from this coal seam, workings are considered to constitute a risk of surface instability.

Based on the published geological information and information provided within the CMRA, it is assessed that there are potentially two coal seams that lie beneath the site with the potential impact the stability of the site surface. Ironstone mine workings are also likely to be present based on the available information; these workings may have been mined through bell-pits.

A summary of the named coal seams beneath the site as recorded on Coal Authority report and presented by Waterman is given in Table 2.1 below.

Table 2.1 Summary of Named Coal Seams beneath the property (Coal Authority information)

Colliery	Seam	Depth (m)	Dipping rate of seam worked (degrees) and direction	Extraction thickness (cm)	Year last mined
Unnamed	Barnsley	10	5.9 East	274	1924
Unnamed	Barnsley	21	7.4 East	274	1925
Dodworth	Top Fenton	186	4.4 North East	91	1956
Dodworth	Parkgate	207	3.8 North East	137	1942
Rob Royd	Silkstone	278	4.2 North East	167	1910
Rob Royd	Silkstone	293	6.7 East	167	1904

A summary of the named coal seams within the surrounding area of the site, as recorded on Coal Authority report and as presented by Waterman, is given in Table 2.2 below.

Table 2.2 Summary of Named Coal Seams surrounding the property (Coal Authority information)

Colliery	Seam	Depth (m)	Direction to working	Dipping rate of seam worked (degrees) and direction	Extraction thickness (cm)	Year last mined
Unnamed	Barnsley	14	North	5.0 East	274	1870
Dodworth	Flockton Thick	140	West	3.6 North East	70	1942
Dodworth	Flockton Thick	176	South	6.4 East	66	1949
Dodworth	Parkgate	218	South East	6.9 East	86	1958
Dodworth	Top Fenton	218	South West	6.5 East	86	1945
Dodworth	Middleton Main	244	West	4.9 North East	150	1961

Colliery	Seam	Depth (m)	Direction to working	Dipping rate of seam worked (degrees) and direction	Extraction thickness (cm)	Year last mined
Dodworth	Middleton Main	253	South West	7.2 East	122	1958

2.4 Previous Ground Investigation - Watermans

Ground investigation works were undertaken by Waterman in 2020 where the presence of the Barnsley Coal seam was identified as follows:

- RC101 records zones of no recovery at 1.5m to 1.98m, 3m to 3.53m, and at 4.5m to 4.96m. These are interpreted to be the result of weathered or weak rock being further weakened by the drilling resulting in no core being obtained. Zones of no recovery at 7.5m to 8.4m and 9m to 10.26m are interpreted as suspected mine workings, as they are associated with a loss of drilling flush at 8m. Intact coal was encountered at 10.5m to 10.9m. Terminated at 25m bgl.
- RC102 records zones of no recovery at 1.5m to 2.19m, 4.5m to 5.36m, and 6.0m to 7.02m. These are interpreted to indicate the presence of weathered or weak rock. Zones of no recovery at 7.5m to 8.4m and a void noted at 9.0m to 10.5m are interpreted as suspected mine workings, as they are associated with a loss of drilling flush from 8m. Terminated at 20m bgl.
- RC103 records intact coal at 19.5m to 22.0m. Terminated at 30m bgl.
- RC104 records zones of no recovery at 3.0m to 3.72m, 4.5m to 4.84m, 6m to 6.6m, and 7.5m to 7.69m. These are interpreted to indicate the presence of weathered or weak rock. A void is identified at 15.4m to 16.8m and is interpreted as suspected mine workings Terminated at 30m bgl.

All the suspected mine workings and intact coal are thought to be associated with the Barnsley Coal Seam.

The greatest thickness of no recovery or void associated with the Barnsley Coal seam was 3.0m beneath the site in RC102, from 7.5m to 10.5m bgl. Based on a likely propagation of voids to 10 times worked seam thickness through rock, as per CIRIA C758D, voids could migrate upwards by 30m. There is an insufficient thickness of rock cover to arrest the upward migration of voids from the Barnsley Coal seam and therefore workings are considered to constitute a risk of surface instability. On this basis, it is considered that the Barnsley Coal seam workings will require grout treatment within the development area.

Further information can be obtained from Watermans Ground Investigation Report (Ref WIE17125-100-R-8.1.3-Geoenvironment) a copy of which is appended to this strategy.

2.5 Curtins Ground Investigation (2022) – Playing Fields

The following information presents a summary of mining observations and findings reported in Curtins document, Trinity Academy, Barnsley, Phase 2 Ground Investigation, reference 079532-CUR-XX-XX-T-GE-00002 revision P01 dated 07 March 2022.

Table 2.3 below provides a summary of the coal, ironstone seams and potentially worked ground that was encountered during the ground investigation works.

Table 2.3: Summary of the coal encountered during the ground investigation on site

Exploratory Hole	Depth Encountered (m bgl)	Thickness (m)	Description of Strata
RC01	10.05 – 12.40	2.35	Extremely weak, dull black coal zones of no recovery - presence of weak or weathered rock
RC02	4.00 – 4.10	0.10	Coal recovered as gravel paste
	10.80 – 12.50	1.70	Loose fragmented coal – Zone of no to very little recovery. Coal likely to have fallen out of core.
	13.90 – 14.05	0.15	Fragmented sub-bituminous coal
	14.35 – 14.85	0.50	Coal recovered as gravel
	26.40 – 26.45	0.05	Moderately weak COAL
	34.00 – 34.15	0.15	Vitrinite rich, very light COAL
	34.25 – 34.45	0.20	Black COAL
	35.80 – 36.00	0.20	Black coal that is not fractured
RC03	15.30 – 15.60	0.30	Coal recovered as gravel
RC04	16.80 – 18.00	1.20*	Drillers Description (open hole) – COAL
RC05	17.00 – 18.20	1.20*	Drillers Description (open hole) – COAL – flush colour turned black
RC06	9.50 – 17.00	7.50	Potential broken ground – suspected mine workings due to poor core recovery
	15.50 – 17.00	1.50	Zone of no recovery - COAL

Exploratory Hole	Depth Encountered (m bgl)	Thickness (m)	Description of Strata
	17.85 – 18.05	0.20	Extremely weak and fragmented COAL

*Thickness based on open hole drilling

During the ground investigation works loss of water flush was recorded within all boreholes where mudstones and siltstones were encountered due to the fractured nature of the bedrock strata as well as where there was a presence of coal. The loss of flush was observed during the coring and subsequent open holing techniques. Coal seams were not encountered within the window sample boreholes. Where coal was encountered, during the coring portion of the drilling works, the coal was recorded to be fractured and retrieved as loose gravel. Within RC02, at depths beyond 34.00m bgl, coal encountered was recorded as intact, with no loose ground or voids being recorded at this depth. There was a notable change in the colour of flush from light grey to black during the open hole drilling within exploratory borehole RC05 indicative of coal encountered between depths of 17.00 – 18.20m bgl.

Possible broken ground may have been encountered within exploratory borehole position RC06 between depths of 9.50 – 17.00m bgl which was situated north-east of the mine shaft located by TP01. Several core runs between 9.50 – 17.00m bgl encountered a zone of core loss as well as the time for the core run was significantly reduced in comparison to previous boreholes. It is difficult to ascertain at this time if the coal seams encountered within RC01 and RC02, if the loss of the flush during the drilling was due to the natural fracture state of the bedrock that has occurred over hundreds of millions of years. Or, whether this is due to potential voids or broken ground in the immediate vicinity in the process of collapsing or they have already collapsed. If this is the likely scenario, the voiding is likely to be present along the northern extent of the proposed sports field only.

A geological fault runs along the northern boundary of the public open field that forms part of the site area and across the access road, aligned generally east-west through the proposed development position. The geological fault that runs NE-SW north of the open field and links the Champany Hill Fault (SW of fault) and the Barebones Fault (NE of the fault). This fault splay is dipping southeast with the bedrock recorded to dip to the east or north-east. Given the age of historic mining activities at shallow depths (1924/1925 or earlier) it is anticipated that any surface subsidence associated with faulting may have already occurred.

There is one record of a coal authority mine shaft (433405-008) present within the public open field and the proposed development footprint. The shaft is recorded to have no known treatment at the time of writing. This mine shaft was identified by TP01 during the ground investigation. TP01 identified the location of the coal authority mine shaft. The trial pit was excavated by 5.6m by 5.4m and found the shaft had a diameter of approximately 3.50m and was situated 0.60m bgl below the residual clays. The shaft was backfilled with old colliery spoils to include broken fine-grained sandstones, coal, pottery, and slag. As part of any future works the location of the mine shaft should be drilled to determine depth of

the mine shaft and remediation is required to undergo appropriate treatment of the shaft and construct the cap of the mine shaft. The risk assigned in the CMRA is Moderate. The risk rating has not changed after the completion of this set of ground investigation works.

Previous remedial works are recorded on site based on a surface hazard incident report completed by the Coal Authority in 2014. The treatment works included opening out a small crown hole situated very close to the northern boundary of the site adjacent to the entrance of the field, by 2.20m by 1.50m and excavating to a depth of 4.50m below the surface to the base of a void. It was also reported that there were three separate roadways heading in north-east, south-east and south-west directions. The area was filled and compacted in layers with 12 tonnes of clean 75-150mm limestones not exceeding 300mm to within 1.5m to the surface. Geo-textile was placed across the fill and around the exposed sides with the as-dug sandy clay spoil placed and compacted in layers not exceeding a thickness of 150mm to the underside of the existing turf. This was overlaid by the topsoil to reinstate the surface of the pre-existing field. No remediation of the visual 'roadways' was undertaken by the Coal Authority.

It has been assessed that the sports field is likely to have localised mine workings along the southern boundary as identified on the available abandonment plans and towards the northern boundary as unrecorded workings. A separate ground movement assessment report has been produced as part of the overall reporting for the proposed sports field and recommends the use of geogrid across the playing field area to mitigate against any potential crown hole collapses, rather than grout treating the entire field.

2.6 Curtins Ground Investigation (October 2022) – Main School Area

The following information presents a summary of mining observations and findings reported in Curtins document, Trinity Academy, Barnsley, Supplemental Ground Investigation, reference 079532-CUR-XX-XX-T-GE-00005, revision C01 dated 19 October 2022.

Table 2.4 below provides a summary of the coal, ironstone seams and potentially worked ground that was encountered during the ground investigation works.

Table 2.4 – Coal, ironstone seams and potential worked ground encountered as part of the rotary borehole works.

Exploratory Hole Location	Depth of Coal Encountered (m bgl) (m AOD)	Thickness (m)	Material Description
RC07	8.98 – 9.50 (131.29m – 130.77m AOD)	2.02 (Assumed)	Extremely weak black vitreous COAL . Highly weathered with extremely closely spaced discontinuities. <i>Water flush lost completely between 9.00m and 10.00m bgl (131.27m AOD and 130.27m AOD)</i>

Exploratory Hole Location	Depth of Coal Encountered (m bgl) (m AOD)	Thickness (m)	Material Description
	9.50 – 10.00 (130.77m – 130.27m AOD)		AZCL – No recovery. SPT undertaken first which confirmed coal deposits.
	10.00 – 11.00 (130.27m – 129.27m AOD)		Extremely weak to very weak black COAL with rare yellow sulphur present. Highly weathered with extremely closely spaced discontinuities. Partly recovered as a gravel.
	29.87 – 30.07	0.20	Very weak black COAL . Moderately weathered with extremely closely spaced discontinuities.
RC08	2.30 – 2.50 (137.10m – 136.90m AOD)	0.20	Moderately weak orange and dark purple IRONSTONE . Highly weathered with extremely closely spaced discontinuities. Recovered as a gravel.
	17.25 – 19.30 (122.15m – 120.10m AOD)	2.05	Very weak to weak black COAL . Extremely closely spaced discontinuities. Water flush lost completely around 19.10m bgl (119.90m AOD).
RC09	8.00 – 9.60 (133.40m – 131.80m AOD)	1.60 (Assumed)	Water flush lost completely around 7.20m bgl (134.20m AOD) No recovery - soft drilling with fragments of coal and mudstone, possible workings / VOID . Complete loss of flush from this point onwards.
	9.60 – 10.65 (131.80m – 130.75m AOD)	1.05	Black very angular GRAVEL of COAL into an extremely weak black COAL . Completely to highly weathered with extremely closely spaced discontinuities. Fractures are iron oxide-stained orange and coal has multi-coloured sheen on the fracture surfaces.
	29.00 – 29.10 (112.40m – 112.30m AOD)	0.10	Extremely weak black pyritic COAL . Highly weathered with extremely closely spaced discontinuities.
	30.20 – 30.50 (111.20m – 110.90m AOD)	0.30 (Thickness not proven)	Weak to moderately weak black COAL . Moderately weathered with closely spaced discontinuities. Recovered as a gravel.

Exploratory Hole Location	Depth of Coal Encountered (m bgl) (m AOD)	Thickness (m)	Material Description
RC10	13.40 – 15.40 (127.41m – 125.41m AOD)	2.50 (Excluding the 0.10m thick interbed of mudstone)	13.40 – 14.00m – Very limited recovery of extremely weak black COAL . Recovered as very angular gravels. Water flush lost completely around 14.00m bgl (126.81m AOD). 14.00 – 15.40m - Weak to moderately weak black COAL . Moderately weathered with closely spaced discontinuities. Some fractures contain iron oxide staining. Recovered as a gravel.
	15.50 – 16.00 (125.31m – 124.81m AOD)		Weak to moderately weak black COAL . Moderately weathered with closely spaced discontinuities. Some fractures contain iron oxide staining. Recovered as a gravel.
RC11	13.25 – 15.50 (127.48m – 125.23m AOD)	2.25	Zone of residual soil to extremely weak crumbly material, completely to highly weathered. Material was much weaker than the above and below rock deposits. Possible fault zone? Or worked zone nearby? Water flush lost completely around 14.00m bgl (126.73m AOD).
	15.50 – 15.80 (125.23m – 124.93m AOD)	0.30	AZCL – No recovery resistance while drilling. SPT test confirmed clay onto coal from 15.50 – 15.95m bgl.
	15.80 – 16.50 (124.93m – 124.23m AOD)	0.70	Medium dense GRAVEL of very angular COAL . Gravels are extremely weak.

The positions of RC07 and RC09 are likely to be situated north of the recorded geological fault with the possible void / worked ground in RC09 encountered at 8.00m bgl (133.40m AOD) and coal seam in RC07 at 8.98m bgl (131.29m AOD). This indicates that the seam is likely to dip to the east, north of the geological fault.

South of the geological fault the coal seams were encountered in RC08 at 17.25m bgl (122.15m AOD) in RC10 at 13.40m bgl (127.41m AOD) and RC11 at 15.50m bgl (125.23m AOD). Although in the location of RC11 an approximately 2.00m thick completely weathered residual soil to extremely weak crumbly material between 13.25m and 15.50m bgl (127.48m and 125.23m AOD) was recorded above

the coal seam. This shows that the coal seam to the south of the fault is likely dipping to the east and south.

To safely found building structures above abandoned mine workings, a generally accepted guide is for a minimum thickness rock cover, equivalent to $10 \times$ seam or void thickness (T), is required. Based on the findings of the ground investigation there is not sufficient rock cover overlying the worked ground or coal seams, given that the possible recorded worked thickness ranges from 2.00m and 2.50m thickness and historically recorded seam thickness of c2.7m for the Barnsley coal seam. Therefore, the risk from unrecorded shallow mine workings is assessed to be High for the areas both north and south of the geological fault. Without treatment of the shallow seams foundations for the proposed buildings could be impacted by:

- Excess settlement.
- Movement in the bedrock strata overlying the old workings due to their rearrangement.
- On the assumption that the mining extraction was by pillar and stall, the strata could eventually sag and collapse.
- On the assumption that the mining extraction was by pillar and stall, the pillars could punch into soft floor measures; and
- Overstressing of pillars leading to eventual collapse.

Coal seams were also encountered in RC07 at 29.87m bgl (110.40m AOD) with a thickness of 0.20m and in RC09 at 29.00m bgl (112.40m AOD) with a thickness of 0.10m and at 30.20m bgl (111.20m AOD) with a thickness of 0.30m. However, this is unlikely to be the full thickness of this seam as this corresponded with the finished depth of the rotary borehole. The location of RC08 encountered a shallow seam of Ironstone at 2.30m bgl (137.10m AOD) with a thickness of 0.20m. It is unlikely that these 4 No. seams would have been targeted for extraction and are assessed to be a Low risk to the proposed development.

At this stage of the development, both the main school building and the sports block are either positioned to cross this geological fault line or be positioned very close to the geological fault line. The previous CMRA assessed this geological fault as a Low risk due to no proposed structures present. However, given that the buildings are now to be situated on or close to the geological fault line this risk is assessed as Moderate. The ground conditions immediately surrounding the fault are likely to be weaker than the surrounding rock material resulting in reduced bearing support and potential fissures. Historically there doesn't appear to have been any reported movements of geological faults either for this site specifically or in the surrounding area. It is anticipated that any surface subsidence associated with faulting may have already occurred. Future grouting works are likely to find that the grout takes could increase towards the zone of the geological fault. The foundations will require additional reinforcement and potentially movement joints incorporating into the structure.

2.7 Additional Considerations

Given the extensive mining legacy within the area of the site, there is the potential for unrecorded workings to be present within influencing distance / depth of the proposed school development. Existing ground investigation works extended to between 20m and 30m below the existing ground level. The Coal Authority information identifies workings of the Barnsley Coal seam at two possible depths within the upper 30m of the site.

Localised anomalies were identified during a geophysical electromagnetic and resistivity survey of the entire field in the west of the site. This is in report reference: BGC1303 Curtins Keresforth Close RPT 1710a22_COMP with the survey undertaken between the 3rd and 5th October 2022. Recommendations included trial pitting to expose the identified anomalies across the playing field and confirm what is present. Along with an additional geophysical technique called electrical resistivity tomography in the north of the site only.

The features of C4, C5, M1, M2, M3, M5, M6 and M7 are under the synthetic pitch which will require machine excavated trial pitting to determine the nature of the anomalies identified as determined in the above BGC1303 report reference. This will also apply to feature C1 in the remaining field area which is interpreted to be a possible shaft and would need confirmation by machine excavated trial pitting.

The UXO risk assessment recommended that a UXO Risk Management Plan is prepared for the site. "Site-specific UXO Awareness Briefings" should be provided to all personnel conducting intrusive works.

3.0 Grouting Strategy

3.1 General Items

The contractor is to submit a site-specific Health and Safety Plan, Risk Assessments and Operation Method Statements for the Grouting Operations, including all temporary works details for approval by the Principal Designer, Principal Contractor and Curtins if appointed in a Technical Advisory capacity.

No works are to commence on site unless email instruction to do so from the supervising engineer has been received by the Contractor.

This instruction will not be given until a permit for the works is obtained from the Coal Authority.

The grouting operations are to be undertaken in accordance with the Grouting Specification document "Trinity Academy, Barnsley", Specification for Stabilisation of Shallow Coal Mine Workings, reference 079532-CUR-XX-XX-T-GE-00002 rev C02 dated 14 November 2022.

At this stage it is envisaged that the Grouting Programme will broadly comprise,

- a) Mobilisation to site.
- b) Installation of safety measures.
- c) Grouting operations.
- d) Validation of grouting operations.
- e) Demobilisation from site.

3.2 Proposed Grouting Strategy

Based on the findings of Waterman's Coal Mining Risk Assessment and ground investigation report and Curtins ground investigation reports, all referenced previously, it is proposed to grout structures and infrastructure in the eastern development area. This is defined as all proposed buildings, specific infrastructure (e.g., electrical substations, substantial utilities etc.) and external hardstanding areas (including adoptable highway, the site roads, MUGA and car parking areas). This will include the synthetic pitch on the playing field. It is considered that this external hardstanding requires grouting due to the identified and expected presence of significant shallow workings in the Barnsley Coal seam and the risk it presents.

Where adoptable highways are present on the development site, this strategy should be reviewed by the Local Authority Highways Department.

The Grouting Strategy is summarised below:

Stage 1: Primary Grid of Holes

The purpose of these boreholes is to positively identify the location and extent of the geological fault line and confirm that the shallow workings identified in the northern area of the site are coincidental with the Barnsley Coal and are not underlain by secondary leaves or other unrecorded workings:

- a) All buildings - 6m primary grid.
- b) Hard Standing (MUGA, Car Parking, Service Yard etc.) this will include the synthetic pitch on the playing field – 6 m primary grid.
- c) Highways, Roads, linear significant service runs - 12m primary central alignment spacing.

Boreholes are to be terminated at 30m depth; grouting undertaken at locations of workings (Barnsley Coal Seam) observed during the primary drilling.

Stage 2: Secondary Holes

Dependent on grout take secondary holes maybe required at the following spacing:

- a) All buildings - 6m overlapping secondary grid giving 'diagonal' spacing Primary to Secondary to Primary of 4.24m.
- b) Hard Standing (MUGA, Car Parking, Service Yard etc.) this will include the synthetic pitch on the playing field - 12m overlapping secondary grid giving 'diagonal' spacing Primary to Secondary to Primary of 8.48m.
- c) Highways, Roads, linear significant service runs - 12m overlapping secondary holes giving 6m central alignment spacing.

Boreholes are to be terminated 1.0 m below the workings (Barnsley Coal Seam) as confirmed in the Stage A grids. Note this level is expected to vary to the north and south of the geological fault.

Tertiary holes maybe required if significant workings are determined. Drilling and grouting hole spacing is to be agreed with the Engineer.

NOTE: The above strategy has been derived from currently available information. The intention of the strategy is to mitigate the risk to the proposed development from shallow underground workings. The appointed Contractor and their Engineer shall satisfy themselves that they have sufficient information, prior to, during and on completion to achieve that aim.

3.3 Proposed Grouting Extent

The proposed grouting extent is to cover the proposed buildings footprints, hardstanding, infrastructure and MUGA which will include the synthetic pitch on the playing fields.

Extent of grouting outside the grouted feature footprint should be a minimum of 4.5m for level or shallow dipping seams up to 20m depth below ground level.

3.4 Proposed Treatment of Mine Entry

One mine shaft has been recorded and identified within the playing field area of the site. It is possible that this mine shaft sits within the treatment grid for the synthetic pitch: Coal Authority Shaft ref. 433405-008. The Grouting Specification presented under separate cover Curtins (2022) ref. 079532-CUR-XX-XX-T-GE-00002 rev C02 dated 14 November 2022. At this stage, it is envisaged that the Grouting Programme will broadly comprise,

- a) Mobilisation to site.
- b) Installation of safety measures.
- c) Validation of grouting operations.
- d) Demobilisation from site.

The mine shaft will be treated independently of the proof drilling and stabilisation works. It is recommended that the shaft is drilled with three treatment boreholes (all within plan area of the shaft) which are drilled to the base of the shaft (current depth to base is unknown) and are pressure grout treated. The grout take in each borehole, which would be expected to reduce as treatment progresses, will be recorded. On completion of the treatment a fourth borehole will be drilled to the base of the shaft in the centre of the treatment boreholes, which must record significantly reduced grout-takes to demonstrate the treatment is complete.

Residual soil was encountered at 0.60m bgl during the investigation works to locate the shafts. This was stiff clay material.

The contractor is to confirm the exact treatment requirements with the Coal Authority. On confirmation of the treatment requirements submission to the Coal Authority of a scope of works, specification calculation sheets and slab design will be required to obtain approval and permits for the treatment works proposed prior to commencing works on site.

No further mine entries have been recorded on the site. However, if a suspected mine entry is encountered, the Engineer should be consulted to fully appraise the Health and Safety risk.

Actions required if and where a mine entry is identified are included within the specification, however if and where evidence of a mine entry is encountered, e.g., voiding, or loose ground from shallow depths, the Contractor shall cease operations and inform the Engineer immediately.

4.0 Risk Assessments, Method Statements, and Insurance Details

4.1 RAMS and Permits

The grouting contractor will be required to supply site specific risk assessments, method statement and insurance details.

It is the responsibility of the grouting subcontractor to gain the necessary permits from the Coal Authority and any other regulatory bodies.

With respect to the method statement, the treatment of shallow coal and probable ironstone mine workings is required.

Recommendations and supporting information provided herein are indicative and the contractor should satisfy themselves of the provision of suitable health and safety measures within their method statement.

4.2 Mine Gases

The mining of coal deposits and subsequent abandoning of the workings may have given rise to the accumulation of carbon dioxide, carbon monoxide, methane and hydrogen sulphide because of the anoxic conditions predominating at these depths.

Notwithstanding the potential presence of mine gases within the workings, the use of water flush within the probe holes and subsequent grout injection will result in only limited displacement of these gases and therefore; the risk presented to surrounding properties is assessed to be low and no specific, off-site mitigation measures recommended.

The monitoring of mine gases at the drill site should be undertaken as a matter of course and in accordance with the Coal Authority Permit requirements and contractor Health and Safety Plan, Risk Assessments and Method Statements.

4.3 Utility Mapping

The client is to provide relevant public utility suppliers service plans and or a scan of the site utilities prior to commencement of any intrusive works.

Thereafter the Contractor is to allow for confirming that the site is free from live services in the location of the exploratory holes or otherwise by use of appropriate equipment; CatScan and generator for example and or other appropriate surveys.

5.0 Reporting

Once completed, the contractor is to submit a Completion Report for the grouting works including copies of all records detailed in Section 8.0 of the Grouting Specification.

All records of mine working treatment should be provided to the supervising engineer in both paper and electronic format (.XLSX).

Following receipt of the Completion Report the supervising engineer shall be responsible for compiling an interpretive summary of the Completion Report for submission to the local planning authority and, through the planning process, the Coal Authority. Subject to the satisfactory completion of the grouting operations, this engineer's Completion Report shall confirm that the site is 'safe and stable'.

6.0 Appendices

Appendix A Development Layout

Appendix B Historical Reports

Appendix A Development Layout & Grouting Plan



Note
1. Do not scale from this drawing
2. To be read in conjunction with Project Risk Register REF: XXX
3. To be read in conjunction with all other Landscape Architect's drawings

KEY

- Site Boundary
- Proposed Building
- Proposed Tree
- Proposed Multi-Stem Tree
- Grass Seed
- Synthetic Turf Pitch
- MUGA
- Planting Area
- Planting Hedge
- Pedestrian Macadam Paving
- Vehicular Macadam Paving
- Resinbound Gravel
- Proposed Steps
- Cycle Shelter
- Bench seating
- Picnic bench seating
- Proposed Fencing
- Proposed Gate

ID	RISK	MITIGATION	DATE MITIGATED
RESIDUAL PROJECT RISKS			

DATE	REV	DESCRIPTION OF REVISION	DRAWN BY	APPROVED BY
REVISIONS				

STATUS
- PRELIMINARY

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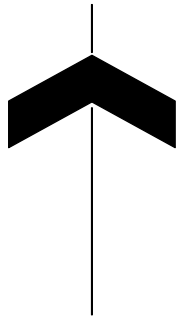
PROJECT TITLE:
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P01



Note
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2. To be read in conjunction with Project Risk Register REF: XXX
3. To be read in conjunction with all other Landscape Architect's drawings

- KEY**
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STATUS
- PRELIMINARY

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