

REPORT ON COAL MINING INVESTIGATIVE WORKS
UNDERTAKEN ON LAND OFF
SMITHY BRIDGE ROAD, LITTLEBOROUGH OL16 2RY

Prepared for:-

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On behalf of

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**Project Quality Assurance
Information Sheet**

***Report on Coal Mining Investigative Works undertaken on Land off Smithy Bridge Road,
Littleborough OL16 2RY.***

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Report Issue Record		
Revision	Date of Issue	Comments
0	02/10/2018	First Issue
A	14/12/2018	Drawing No. TLC1004/03 updated.
B	26/05/2019	Results of additional mine shaft investigative works included. Several typos amended.
C	29/05/2019	Concrete strength testing results added.
D	02/07/2019	Proposed development Drawing No. TLC1004/03 updated to reflect latest layout. Drawing No. TLC1004/10 added. Text amended slightly.
E	24/07/2019	Proposed development Drawing No. TLC1004/03 updated to reflect latest layout. Drawing No. TLC1004/10 also updated.
F	28/07/2019	Proposed development Drawing No. TLC1004/03 updated to reflect latest layout. Drawing No. TLC1004/10 also updated.
G	08/10/2019	Drawing No. TLC1004/10 updated – now shows potential zone of influence of the mine shaft; text amended accordingly (paragraphs 5.4.10 & 6.8).

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1.0 INTRODUCTION

- 1.1 LK Consult Limited (LK Consult) has been appointed to support a planning application made by Taylor Wimpey Strategic Land (North), for the development of a large site situated to the west of Smithy Bridge Road, Littleborough OL16 2RY; the site currently comprises predominantly of open farmland.
- 1.2 The property is intended to be developed out with residential housing incorporating private gardens. Areas of public open space and a new access road from Smithy Bridge Road into the residential development area are also scheduled. A proposed development plan is presented in Drawing No. TLC1004/03 in Appendix A.
- 1.3 Desk study type researches undertaken by LK Consult, indicated that some areas of the site were at risk from future ground subsidence associated with potential shallow coal workings, and from a mine shaft located close to the proposed entrance into the site from Smithy Bridge Road.
- 1.4 TLC was subsequently approached by LK Consult to review the potential for the site to be affected by the mine shaft and shallow coal seams/workings, and to provide advice related to investigating the site using rotary drill holes and trial trenches.
- 1.5 In summary, LK Consult's remit to TLC included:
 - Scoping the amount of site investigation work required to investigate the property for shallow coal seams/workings and the mine entry;
 - Obtaining permission from The Coal Authority to carry out the site investigation work; and,
 - Producing a factual and interpretive report on the findings of the site investigation work. This report would indicate whether the site is actually affected by shallow coal seams/workings, and whether the consolidation of shallow mining related voids is necessary prior to development works proceeding. The report would also provide advice related to whether treatment and capping of the on-site mine shaft was necessary prior to development works proceeding.

1.6 Limitations

- 1.6.1 The assessment and interpretation of the factual data obtained as part of this investigation has been undertaken in accordance with generally accepted consulting practice, and in line with currently accepted national and international guidelines.
- 1.6.2 The conclusions and recommendations made in this report are limited to those which can be made based on the findings of this survey and information provided by third parties. TLC assumes all third-party data to be true and correct. No responsibility can be accepted by TLC for inaccuracies in the information supplied by any other party.
- 1.6.3 Ground conditions can change rapidly, especially in areas of Made Ground; however, it is assumed that the ground conditions observed are typical and representative of the site as a whole. The ground conditions have been determined from a limited number of exploratory holes, therefore only a small percentage of the total area of the property has been investigated. Conclusions drawn from the ground investigation should be read in this context. TLC cannot accept responsibility for any situations resulting from locally unforeseen ground conditions occurring between exploratory holes.

- 1.6.4 This report is written in the context of an agreed scope of works and should not be used in a different context. Furthermore, new information, improved practices and changes in legislation may require a re-interpretation of the report in whole or in part after its original submission. TLC reserves the right to alter its conclusions and recommendations in the light of further information which may become available. This report is provided for the sole use of the Client and is confidential to them and their professional advisors.

2.0 SITE LOCATION AND DESCRIPTION

- 2.1 The site is located within a predominantly a mixed residential/semi-rural setting within the Greengate district of the town of Littleborough. The site can be centred approximately at the following coordinates: 392054E, 415367N. Site location plans are presented in Drawing Nos. TLC1004/01a and 01b in Appendix A; a more detailed site boundary plan is presented in Drawing No. TLC1004/02.
- 2.2 Access into the majority of the site is from the end of Old Road (postcode is OL16 2SP) via a farm gate. Access into the far NE of the site is from Smithy Bridge Road (postcode OL16 2RY). Several public rights of way cross/border the site.
- 2.3 The site as a whole has an area of ≈ 35 acres and is irregular in shape (orientated NE-SW). However, only approximately the north-western half of the property (17 acres) is scheduled to be redeveloped out with housing and the access road. The site is situated at an altitude of between ≈ 131 m AOD in the south and ≈ 155 m AOD in the north.
- 2.4 The majority of development area slopes gently down to the SE towards the River Roch, a moderately steep slope is then encountered before a relatively flat flood plain area is found around the river. The vast majority of this area comprises of grassed fields (separated by overgrown hedges or damaged stone walls) which are grazed by cattle; some marshy ground/heavily reeded areas are present adjacent to the river. The River Roch forms the site's SE boundary.
- 2.5 The far NE of the site (adjacent to Smithy Bridge Road) comprises of overgrown land which slopes very gently down towards to the SE (i.e. towards the River Roch). Buried infrastructure (United Utilities owned assets including a large detention tank, associated pipework and surface hardstanding (concrete)) - are present beneath the SE of this area.
- 2.6 Farmland is found beyond the River Roch to the SE. Farmland and residential new development is situated to the SW. Residential development is found to the NW, and farmland is found beyond Smithy Bridge Road to the NE.

3.0 PUBLISHED GEOLOGY AND MINING SUMMARY

3.1 The likely site geology, as determined from British Geological Survey (BGS) mapping is summarised in the table below.

MADE GROUND	None indicated.
DRIFT	Devensian Glacial Till (diamicton) is shown to be present at the surface across the majority of the site. Deposits of Alluvium are indicated to be present adjacent to the River Roch. Landslip deposits are depicted in the centre of the site adjacent to the southern boundary.
ROCK	Carboniferous rock strata of the Pennine Lower Coal Measures underlie the drift across the site. Milnrow Sandstone will be present beneath the drift across the majority of the site. Undifferentiated strata and Darwen Flags (sandstone) are depicted in the far NE of the site. Undifferentiated strata comprise of often cyclical sequences of sandstone, siltstone, mudstone, coal seams and seat earths.
ROCK DIP	No on-site dip information is available. However, rock dips in the general vicinity of the site of 7° SW (≈650m NE) and 5° SE (≈575m SW) are given. It is likely that the rock dip is very shallow and down to the SW in the far NE of the site, and very shallow and down to the S or SE beneath the majority of the site. Dips in the far NE of the site are likely to be caused by a SW plunging anticline.
FAULTING	2no. faults (both trending NW-SE and down-throwing to NE) pass through the approx. centre of the site.
COAL SEAMS	The Upper Mountain (Hogards) coal seam sub-crops beneath the drift at the far NE site boundary with Smithy Bridge Road. The Upper Foot coal seam sub-crops ≈38m to the NE. The Lower Mountain coal seam sub-crops ≈285m to the NE. The Lower Foot coal seam sub-crops ≈455m to the NE. The Bassy coal seam sub-crops ≈575m to the NE. With a SW rock dip beneath the far E of the site, it is considered that the Upper Mountain and Upper Foot coal seams could be present at shallow depth (<40m). The other coal seams are unlikely to pose a risk to the proposed development.

3.2 A Coal Authority (CA) CON29M non-residential mining report was obtained for the site by LK Consult Ltd and this is present in Appendix C. The main points are summarised below:

- The property is located in a surface area that could be affected by underground mining in two seams of coal at 30m and 190m depth, and last worked in 1891. The CA state that any movement in the ground due to coal mining activity should have stopped.
- A mine shaft is present within the site boundary in the far north-east of the site. The CA have no records of what steps, if any, have been taken to treat the mine entry.

3.3 The CA's online interactive map viewer provides the following additional information:

- The CA recorded mine shaft is referenced 392415-005, has an assumed diameter of 3m, has a depth of 78m and was associated with the former Dearnley Colliery.
- The departure distance of the shaft is given as ±5m

- The shaft and immediate surrounding area are shown to be located within a development high risk area.
 - Recorded underground coal workings are depicted beneath the sections of the north-eastern third of the site and also beneath the far north-western corner of the site.
- 3.4 The 1:10,560 scale geology plan covering the site indicates that the Lower Mountain coal seam was encountered at a depth of $\approx 74\text{m}$ within the shaft sunk in the far north-east of the site. A mine shaft located $\approx 120\text{m}$ to the south-west of the site encountered the Upper Mountain coal seam was encountered at $\approx 58.5\text{m}$ depth.

3.5 Previous Work - Geotechnics

- 3.5.1 Site investigation works have previously been carried out by Geotechnics¹ in the far north-east of the site and these were reported on in August 2013. The works carried out were in relation to the construction of a large new detention tank and involved the sinking of a number of sonic drilled open-holed boreholes, falling head permeability tests and packer tests. The report refers to previous site investigation works which were completed in 2012. The Geotechnics report also contains useful desk-based information.
- 3.5.2 The mine shaft in the far north-east of the site was investigated for using a mechanical excavator. The boreholes were all sunk in the immediate vicinity of the proposed detention tank located $\approx 90\text{m}$ to the south-east.
- 3.5.3 The report indicates that the coal pit on site was closed on 24th March 1886. The mine shaft was subsequently used for drawing water to serve locomotives of the nearby London and Yorkshire Railway company and a pumping station was established. The water table was $\approx 1.83\text{m}$ bgl within the shaft. Pumping from the shaft ceased in 1956.
- 3.5.4 Geotechnics exposed what they thought to be the concrete cap covering mine shaft and its position was surveyed by them. Drawing No. TLC1004/05 in Appendix A, which is reproduced from the Geotechnics report, displays the extent of shaft cap and also indicates the presence of a large sandstone block on top of the concrete. The coordinates of the edges of the concrete cap and sandstone block are also given on this drawing.
- 3.5.5 Geotechnics estimated that the depth to the Upper Mountain coal seam to be between 8.1m and 16.3m below the rockhead surface at the proposed detention tank location.
- 3.5.6 In the immediate vicinity of the tank, the drift deposits were penetrated at depths of between 15.0-18.5m and were observed to comprise of alluvium overlying fluvio-glacial and Glacial Till. The granular horizons were water bearing.
- 3.5.7 Sandstone was then reported beneath the Glacial Till to depths of between 21-31m. The sandstone was then underlain by horizons of mudstone and siltstone which were proven to a maximum depth of 43m.
- 3.5.8 The Upper Mountain coal seam was thought to have been present at depths of between $\approx 36.5\text{m}$ and 38m bgl in the tank area. Potentially grouted up workings were identified at two locations between (37.6-39.0m and 36.6-38.0m).

¹ Geotechnics Limited interpretive report entitled 'Additional Ground Investigation for ROC0122 – Smithy Bridge Road' dated August 2013 and referenced PN132935.

3.6 Previous Work – LK Consult Ltd

- 3.6.1 LK Consult Ltd have recently issued a factual and interpretive report² on Phase 2 geo-environmental site investigation works completed at the site.
- 3.6.2 The site investigation works included the sinking of:
- 24no. windowless sampling boreholes to depths of between 1.39-5.45m bgl;
 - 4no. follow on dynamic probe holes to depths of between 8.95-10.00m bgl;
 - 27no. machine excavated trial pits to depths of between 1.20-3.30m bgl; and,
 - 15no. dynamic cone penetration tests to depths of 1m bgl.
- 3.6.3 Topsoil (typically ≤0.30m thick) or Made Ground (typically ≤0.50m thick and rarely >1m thick) overlay cohesive or granular drift deposits (predominantly of glacial origin).
- 3.6.4 Rock (mudstone or sandstone) was encountered at 4no. locations only at depths of between ≈2.20-4.65m bgl.
- 3.6.5 Groundwater strikes were made during the fieldworks at depths of between 0.90-4.10m bgl. Standing water levels within borehole standpipe installations ranged between 0.02 to 4.06m bgl. Groundwater was not encountered in a number of the exploratory holes formed.
- 3.6.6 LK Consult Ltd also carried out mechanical excavation works in an attempt to confirm the location of the shaft cap. Although a large slab of concrete was encountered at depths of 0.40-1.30m bgl, it was 'L' shaped with a stepped surface. Therefore, this concrete may not represent the same area of concrete exposed by Geotechnics in 2013.

3.7 Anecdotal Evidence

- 3.7.1 The far north-east of the site is currently owned by John and Stephanie Mills. Both indicated to TLC that their father remembers the mine shaft being filled with stone and capped with concrete. They also indicated that large sandstone blocks had been placed over the shaft cap; this observation concurs with Geotechnics's findings (see paragraph 3.5.4). Backfilling and treatment of the shaft is likely to have taken place >40 years ago.

² LK Consult Ltd report entitled 'Smithy Bridge Road, Littleborough', 'Final Phase 2 Geo-Environmental Investigation, Risk Assessment and Remediation Strategy' dated July 2018 and referenced LKC 18 1005.

4.0 FIELDWORKS

4.1 Open Hole Rotary Drilling

- 4.1.1 Open hole rotary drilling, to determine whether the site is affected by shallow coal seams/workings, has been undertaken at 8no. locations (RH1-RH8) across the site.
- 4.1.2 The drilling works were undertaken by Taylor Drilling Services Ltd (TDS) between the 12th and 17th September 2018, using a Commachio 305 rotary drilling rig fitted with a claw or pdc drill bit. RH1-RH8 were all sunk using an air mist flush.
- 4.1.3 The drill holes were sunk at the locations indicated on Drawing No. TLC1005/04 in Appendix A. All drill holes were terminated at a depth of 40.00mbgl. The drill hole logs are presented in Appendix B.
- 4.1.4 The rotary holes were sited away from known service runs (as determined from service plans obtained by LK Consult). Hole locations were then cleared with a cable avoidance tool. As a final check for services, hand pits were excavated to 1.20m depth. Rotary drilling commenced from the base of each hand pit.

4.2 Mine Shaft Investigation

- 4.2.1 The mine shaft was investigated for on 29th August 2018 using a JCB 3CX Sitemaster under the close supervision of TLC.
- 4.2.2 After encountering what was thought to be a section of the concrete shaft cap, careful measurement of the shaft cap's position was made and then all excavations were backfilled with excavated arisings. An annotated plan which summarises the findings of the mine shaft investigation is presented in Drawing No. TLC1004/06 in Appendix A.
- 4.2.3 The shaft cap was subsequently investigated by rotary drilling (RHA) on 18th September 2018 by TDS. Drilling was carried out over a robust steel framed and wooden railway covered safety platform (see Drawing Nos. TLC1004/07a and 07b A for pictures). A water flushing medium was utilised. The drill hole log is presented in Appendix B.
- 4.2.4 Unfortunately, the position drilled was not located directly over the shaft, and drilling was terminated at 15.00m bgl upon encountering rockhead.
- 4.2.5 The mine shaft was searched for again on 18th and 19th February 2019 using a larger 14tonne tracked excavator (with dumper truck support), under the supervision of TLC. The concrete shaft cap was fully exposed. The centre of the shaft appeared to be defined by 4no. large blocks of sandstone which had been incorporated into the shaft cap. The position of RHA was clearly visible on the shaft cap - it was apparent that RHA had been sunk just off the shaft's position, as defined by the sandstone blocks. Photographs of the exposed shaft cap are presented in Drawing Nos. TLC1004/09a and 09b.
- 4.2.6 An attempt was made to prove the dimensions of the shaft using concrete coring techniques with follow on windowless sampling (D & I Drilling Ltd on 22nd February 2019); the intension was to sink a hole at the centre of shaft and work outwards at 0.50m centres. An earth ramp down to the shaft cap from the top of the excavation had previously been emplaced to facilitate coring/windowless sampling rig access.
- 4.2.7 It was only possible to core the shaft cap and carry out follow on windowless sampling at 2no. locations (WS201 and WS202), as steel reinforcement bar within the shaft cap damaged the core barrel. Both hole locations refused at 1.00m depth on sandstone fill material.

- 4.2.8 TLC was subsequently instructed by LK Consult Ltd to survey the shaft cap and excavation; the surveying works were completed by TLC on 1st March 2019. CAD drawings of the mine shaft and excavation are presented in Drawing Nos. TLC1004/08a and 08b in Appendix A.
- 4.2.9 Following completion of the surveying works, the excavation was backfilled with excavated soils material, and the layout of the shaft cap was re-surveyed out on the ground surface by TLC.
- 4.2.10 TDS was then remobilised to site to sink a further rotary drill hole (RHB), directly over the centre of the shaft cap. The drilling works were completed between 17th and 19th April 2019 and were again carried out over a robust steel framed and wooden railway covered safety platform. A water flushing medium was utilised. The drill hole was advanced to 80.00m bgl. The drill hole log is presented in Appendix B.

4.3 General

- 4.3.1 Prior to drilling, permission to intersect shallow coal seams beneath the site was first obtained by TLC from the Coal Authority. The permission certificate is presented in Appendix C. The permissions certificate also covers the investigation of the on-site mine shaft.
- 4.3.2 During drilling operations, gas readings were taken at regular intervals from around the mouth of the drill hole and from around the rig. Gas monitoring was undertaken using a GA2000.
- 4.3.3 Upon reaching completion depth, all boreholes were backfilled with a mixture of arisings and bentonite.

5.0 GROUND CONDITIONS AND LABORATORY TESTING

5.1 Topsoil and Made Ground

- 5.1.1 Topsoil (0.30m thick) was encountered at the surface of all of the drill holes formed, with the exception RHA and RHB, which was sunk in the far north-east of the site. No description of the topsoil was provided by the lead driller.
- 5.1.2 Made Ground was encountered beneath the topsoil in RH8 and was penetrated at 1.70m depth.
- 5.1.3 The excavation works, carried out to expose the mine shaft, encountered Made Ground to depths of between $\approx 0.90\text{m}$ and $\approx 2.40\text{m}$. The Made Ground typically comprised of dark grey or greyish brown gravelly sand with a high cobble and boulder content. The Made Ground is likely to have contained some topsoil type material, and contained ash and cinder rich in parts. Gravels typically comprised of brick, concrete, sandstone, glass, pottery and coal. Scrap iron, cables, timber fragments were recovered. Buried walls, concrete structures and extremely large sandstone blocks were also noted. Very organic rich clay containing timber fragments were recovered from one location between $\approx 1.70\text{m}$ - 2.30m depth.

5.2 Drift - Glacial Materials

- 5.2.1 Drift soils materials which are considered to be of glacial origin (Glacial Till and/or Glaciofluvial) were recovered from below the Made Ground and/or topsoil at all locations (with the exception of WS201, WS202 and RHB). These soils were penetrated at depths of between 1.00m (RH1) and 15.50m (RH6). The glacial soil was generally $\leq 4\text{m}$ thick; however, significant thicknesses of this material were recorded in RH6 (13.20m), RH8 (11.30m) and RHA (11.50m).
- 5.2.2 With the exception of RH4, RH6 and RHA, the glacial soil initially comprised of an orange brown CLAY which was noted to contain sandstone cobbles at several locations. This layer was penetrated at depths of between 1.00m (RH1) and 5.00m (RH8). No further glacial soil was encountered within RH1, RH2, RH3, RH5 or RH7. However, in RH8 an orange brown SAND and GRAVEL deposit containing cobbles was subsequently recorded between 5.00-13.00m bgl; coal gravel was also recovered from this hole.
- 5.2.3 Orange brown SAND and GRAVEL deposits were encountered beneath the topsoil in RH4 (0.30-4.00m bgl) and similar strata (plus some cobbles) were recorded beneath the Made Ground in RHA (2.20-7.50m bgl).
- 5.2.4 A red brown fine SAND was recorded below the topsoil in RH6 (0.30-15.50m bgl).
- 5.2.5 With the exception of RHA, 100% air mist flush returns were estimated by the lead driller whilst penetrating this deposit. A total loss of flush was experienced whilst drilling between 7.50-13.70m bgl in RHA; however, the driller recorded 'firm drilling' whilst penetrating this zone. The loss of flush could be due to drilling through coarse granular strata and/or the loss of flush could have been caused by drilling adjacent to the mine shaft.

5.3 Coal Measures Strata (CMS)

- 5.3.1 CMS was encountered below the glacial soils within all of the holes formed at depths of between 1.00m (RH1) and 15.50m (RH6). The CMS typically comprised of dark grey (and rarely light grey) SILTSTONE which often contained sandstone and gritstone bands.

- 5.3.2 The siltstone was overlain by a thin (2.10-4.00m thick) horizon of orange brown SANDSTONE containing clay bands in RH1, RH2, RH3 and RH7.
- 5.3.3 In RH8, the CMS comprised of orange brown SANDSTONE.
- 5.3.4 With the exception of RHA, 100% flush returns were recorded whilst penetrating the CMS. No flush returns were recorded whilst penetration the CMS between 13.70-15.00m bgl in RHA; however, as driller recorded 'very solid' drilling whilst penetrating this zone, intact rock was most likely to have been encountered.
- 5.3.5 No coal seams or evidence for coal workings were recorded whilst sinking RH1-RH8; such evidence can include some or all of the following: loss of flush, fast or broken drilling and a dropping of the drill string without rotation (indicating the presence of voids).

5.4 Mine Shaft Investigation

- 5.4.1 Excavation works were carried out to locate the mine shaft in two phases. A summary drawing displaying the results of an initial trial trenching exercise carried out in August 2018 is presented in Drawing No. TLC1004/06 in Appendix A. The August 2018 works only partially exposed the shaft cap. The cap was subsequently fully exposed by TLC on 18th and 19th February 2019 after carrying out bulk excavation works; Drawing Nos. TLC1004/08a and 08b display the findings of this work. The shaft cap appeared to be founded on a mixture of Made Ground and natural glacial strata.
- 5.4.2 4no. large sandstone blocks appear to be arranged around the shaft and these have been incorporated into the shaft cap. Due to the size of the sandstone blocks, it is considered that they may form part of the original above ground structure associated with the shaft.
- 5.4.3 An initial attempt (RHA) in September 2018 to test drill the shaft failed to intersect it. Despite penetrating an apparent layer of concrete between 1.00-2.20m depth, soils of Glacial origin were then encountered to a probable depth of 13.70m, below which, rockhead is likely to have been encountered and proven to 15.00m bgl. As indicated above, the total loss of flush recorded within the glacial soil could be due to either drilling through coarse grained glacial soil and/or be due to drilling adjacent to the shaft.
- 5.4.4 The RHA position was visible following the February 2019 bulk excavation works and is indicated in the shaft cap photograph displayed on Drawing No. TLC1004/09a in Appendix A. The thickness of the concrete cap was measured by TLC to be 0.40m thick. The concrete was in good condition and was not cracked.
- 5.4.5 Concrete coring of the shaft cap at 2no. locations (WS201 and WS202) in February 2019 proved that the cap was 0.40m thick and contained ≈12mm diameter steel reinforcement bars. Follow on windowless sampling subsequently proved sandstone fill to 1.00m bgl.
- 5.4.6 Rotary drilling (RHB) at the likely centre of the shaft to 80.00m bgl took place in April 2019. The RHB findings are summarised below:
- G.I. to 0.50m - MADE GROUND.
 - 0.50 to 1.00m - Shaft Cap.
 - 1.00 to 4.80m - Broken drilling.
 - 4.80 to 7.20m - Void (2.40m thick)
 - 7.20 to 40.60m - Steady drilling with broken bands.
 - 40.60 to 42.70m - Void (2.10m thick)
 - 42.70 to 52.90m - Steady drilling with frequent broken bands.

- 52.90 to 53.90m - Void (1.00m thick)
- 53.90 to 76.50m - Very loose fast drilling with frequent voids.
- 76.50 to 80.00m - Hard steady drilling. No broken drilling or voids. Probable Mudstone.

5.4.7 Therefore, the shaft has been proven to be 76.50m deep, and it appears that although the shaft has been loosely backfilled, the backfill contains significant voids.

5.4.8 It is noted that the drilling foreman recorded the shaft cap to comprise of sandstone. However, as the driller was set up directly over/adjacent to the WS201 position, the material encountered between 0.50-1.00m bgl will have comprised of concrete.

5.4.9 TLC considers, given then findings of WS201, WS202 and RHA, that the diameter of the shaft is likely to be in the order of 3m. The size of the shaft cap (including sandstone blocks) is approximately 8m x 11m, although the cap does not appear to be centred directly over the shaft. Despite this, there will typically >2m of shaft cap resting on Made Ground/Glacial soil located beyond the shaft boundary, with the exception of a small section of the eastern portion of the cap, where there this distance was only ≈1m.

5.4.10 The centre of the shaft is defined by the following NGR coordinates: 392399.32, 415459.54. The elevation of the top of the shaft cap at this point was 135.19m AOD. The position of the shaft in relation to the proposed access road is displayed on Drawing No. TLC1004/10 in Appendix A; the potential zone of influence of the shaft has also been plotted on this drawing. The potential zone of influence of the shaft has been determined in accordance with CIRIA SP32³.

5.5 Groundwater

5.5.1 With the exception of RH6 and RHA, groundwater strikes were noted by the lead driller in all of the remaining holes at depths of between 16m and 21m bgl. Rates of ingress were noted to be 'heavy'.

5.6 Ground Gas

5.6.1 No detectable concentrations of methane, carbon dioxide, carbon monoxide or hydrogen sulphide, or any oxygen depletions were measured during drilling operations.

5.7 Laboratory Testing

5.7.1 Three core samples of the concrete shaft cap were subjected to concrete strength testing at a geotechnical testing laboratory (Murray Rix) to BS EN 12504-1 2009 and BS EN 12390-7 2009. The testing results are presented in Appendix E and are summarised below.

Sample 1 – compressive strength = 40.8N/mm², in-situ strength = 41.5N/m² and density = 2360kg/m³;

Sample 2 – compressive strength = 54.4N/mm², in-situ strength = 55.0N/m² and density = 2400kg/m³; and

Sample 3 – compressive strength = 50.7N/mm²; in-situ strength = 51.6N/m² and density = 2400kg/m³.

5.7.2 The test results indicate that the concrete is medium strong to strong.

³ Figure 33 of CIRIA SPECIAL PUBLICATION 32, dated 1984 and entitled 'Construction over abandoned mine workings'.

6.0 CONCLUSIONS AND RECOMMENDATIONS

- 6.1 Desk study researches indicated that the proposed development areas were underlain by drift deposits of Devensian Glacial Till overlying Pennine Lower Coal Measures strata (CMS). The CMS was likely to comprise principally of Milnrow Sandstone with undifferentiated strata and a thin sandstone unit (Darwen Sandstone) present in the far north-east. The site was considered to be at risk from shallow workings within the Upper Mountain and possibly the Upper Foot coal seams, which are thought to sub-crop beneath the drift approximately at, and just beyond the north-eastern site boundary with Smithy Bridge Road. The site is affected by two north-west to south-east trending faults which pass roughly through the centre of the site. Rock dips are likely to be very shallow and down to the south-west in the east of the site, and down to the south-east in the west of the site.
- 6.2 A mine shaft (recorded by The Coal Authority to be 78m deep) is present in the far north-east of the site close to the route of the new access road into the proposed housing estate. The Coal Authority have no records of this shaft having had been treated and capped. The proprietors of the land within which the shaft is located, indicated to TLC that the shaft was previously backfilled with stone and capped with concrete (probably >40 years ago). Geotechnics Limited searched for and apparently found the shaft in 2013.
- 6.3 The shaft was also searched by LK Consult Ltd in February 2018. Although buried concrete structures were encountered, the presence of the shaft cap positively identified by Geotechnics Limited was not confirmed.
- 6.4 Geotechnics Limited sunk a number of exploratory holes $\approx 90\text{m}$ to the south-east of the shaft as part of investigatory works prior to the construction of a large underground detention tank. Drift deposits of alluvial and glacial origin (15.0-18.5m thick) overlay sandstone, mudstone and siltstone which were proven to 43m bgl. The Upper Mountain coal seam was thought to have been present at depths of between $\approx 36.5\text{m}$ and 38m bgl in the tank area. Potentially grouted up workings were identified at two locations between (37.6-39.0m and 36.6-38.0m).
- 6.5 To investigate the shallow coal mining risk, 8no. rotary drill holes (RH1-8) were sunk across the site to 40.00m bgl.
- 6.6 Made Ground and/or topsoil (0.30m thick) was encountered at the surface across the site. The Made Ground was encountered in the far north-east of the site only to depths of between 0.90-2.40m bgl. Soils of glacial origin were encountered beneath the Made Ground and topsoil which were penetrated at depths of between 1.00-15.50m bgl. The glacial soils comprised of clay, sand and gravel; cobbles were sometimes recorded.
- 6.7 CMS (sandstone, siltstone and gritstone) was encountered below the glacial soils and proven to 40.00m depth. No coal seams or potential evidence for the presence of shallow workings were recorded.
- 6.8 Machine excavation works, carried out under the supervision of TLC, successfully exposed the concrete shaft cap which is roughly 8m x 11m in plan area. The cap contains 4no. large sandstone blocks and these appear to have been arranged around the shaft; TLC considers that the sandstone blocks may have comprised some part of the original structure associated with the shaft. The cap has been proved to be 0.40m thick and in good condition (i.e. uncracked), reinforced with $\approx 12\text{mm}$ diameter steel bars, and appears to be founded on a mixture of Made Ground and soils of glacial origin; sandstone infill is present directly beneath the cap over the shaft. The diameter of the shaft is estimated by TLC to be $\approx 3\text{m}$; this concurs with The Coal Authorities assumed diameter for the shaft. The position of the shaft in relation to the proposed access road into the development is indicated on Drawing

No. TLC1004/10 in Appendix A; the potential zone of influence of the shaft has been plotted on this drawing.

- 6.9 Laboratory testing of three core samples of the shaft cap indicated that the in-situ compressive strength of the concrete ranged from 41.5N/mm² to 55.0N/mm² (indicating that the concrete is medium strong to strong), and that the density of the concrete ranged from 2360kg/m³ to 2400kg/m³.
- 6.10 The centre of the shaft is defined by the following NGR coordinates: 392399.32, 415459.54. The elevation of the top of the shaft cap at this point was 135.19m AOD.
- 6.11 Test drilling of the shaft has proven it to be 76.50m deep. The shaft is loosely backfilled and is voided in parts. Voids within the fill were recorded at the following depths (void thickness is indicated in brackets): 4.80m bgl (2.40m), 40.60m (2.10m) and 52.90 (1.00m). Very loose fast drilling and frequent voids were also recorded between 53.90-76.50m bgl.
- 6.12 In summary, the development is considered to be at very low risk of being affected by historical shallow mining activities. The consolidation of shallow mine workings by drilling and grouting is therefore not considered necessary prior to development works proceeding.
- 6.13 The mine shaft does present a ground subsidence risk to the proposed access road into the site, and consequently, it is advised that drilling and grouting up of the mine shaft will need to take place to stabilize the fill material within it and to infill the voids.
- 6.14 The following general advice with respect to treating the shaft is provided and is taken from CIRIA SP32:
- As the shaft is likely to be large, it is advised that several drill and grout holes are used to treat the shaft.
 - The holes should be cased down to the base of the shaft. The holes should be grouted up as the drill string is withdrawn, using a cement/flyash mixture as the casing is withdrawn, in stages of 2-3m, up to the surface.
 - All holes should be grouted up simultaneously and the casing withdrawn systematically.
- 6.15 CIRIA SP32 advises that ideally, shaft caps should be placed at or below rockhead, and where this is not feasible, the cap may be located near the ground surface provided that any necessary additional measures are taken to ensure security. Such measures could include plugging, grouting (inside and outside the shaft circle), piling, diaphragm walling etc., depending on the situation. As the drift thickness in the immediate vicinity of the mine shaft has been proven to be 13.70m, founding the shaft cap at or below rockhead is not feasible; indeed, TLC has proven that the existing cap is founded at shallow depth on a mixture of glacial soil and Made Ground. TLC advises that the mine shaft drilling and grouting works should extend beneath and to several metres beyond the existing shaft cap, so as to ensure the future stability of the ground beneath and immediately beyond the shaft cap.
- 6.16 The existing shaft cap is 0.40m thick and is reinforced. The cap (including sandstone blocks) is approximately 8m x 11m in plan area and typically extends >2m beyond the shaft boundary. TLC considers that the existing cap can remain in-situ once the shaft related drilling and grouting works have taken place.
- 6.17 If possible, TLC advises that the proposed access road into the estate should be located outside of the area of the shaft cap. The position of the shaft should be indicated at the

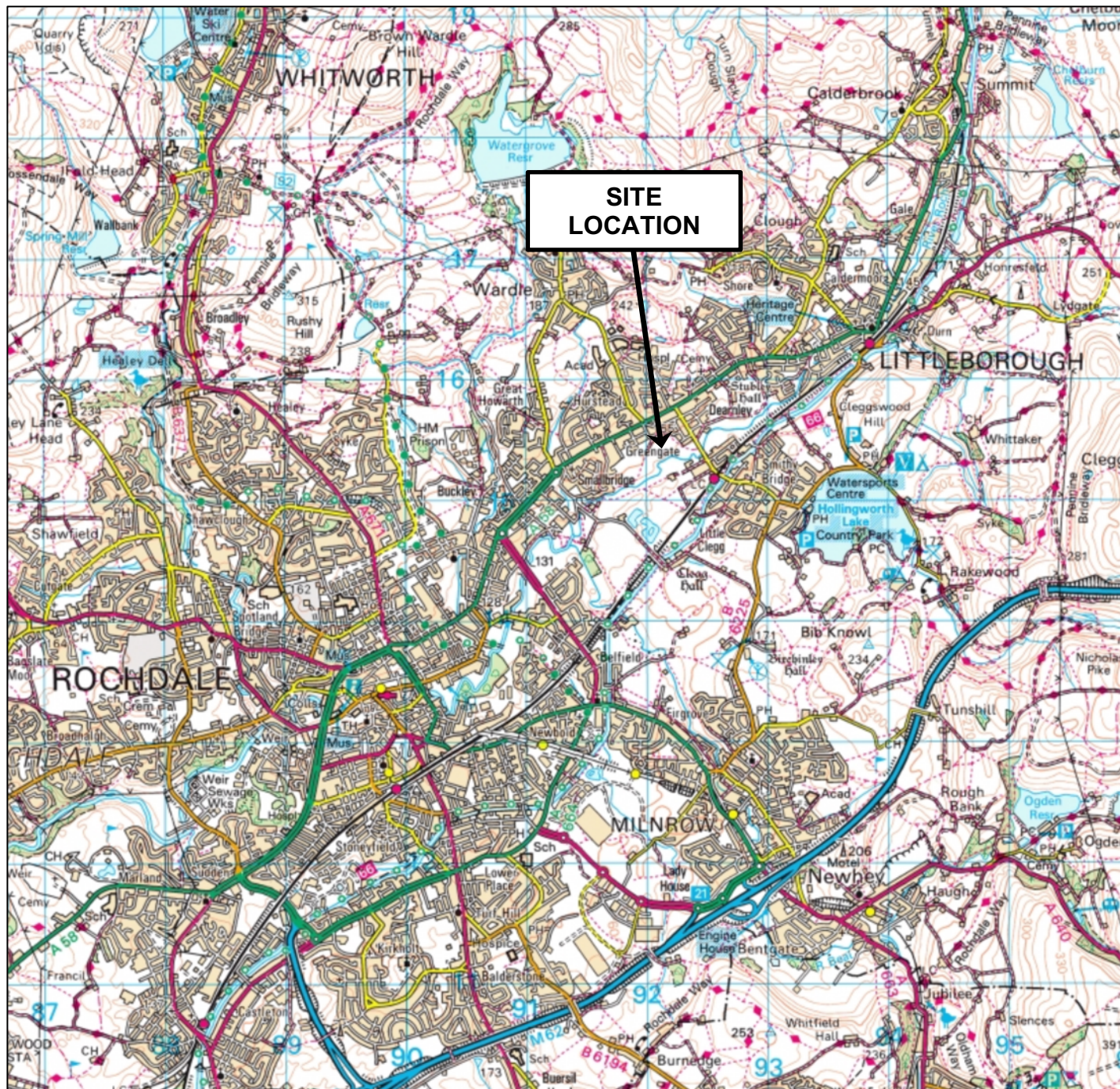
surface by a permanent marker so that it can be readily located and identified in the future.

- 6.18 Permission to carry out the above treatment works will need to be obtained from The Coal Authority. The shaft treatment works outlined above and TLC's opinion as to the suitability of the existing shaft cap will need to be agreed with The Coal Authorities engineering team prior to any further works being undertaken.
- 6.19 There is a low risk of encountering unrecorded mine entries during the redevelopment of the site. Mine entries are likely to manifest as potentially square, rectangular or circular areas of dark deep Made Ground (which may or may not be brick lined and could potentially be capped – e.g. with a large block of concrete) surrounded by natural soils/weathered rock. It is advised that a soil strip should take place beneath/adjacent to proposed dwellings to the south-west of the conjectured fault to check for the presence of unrecorded mine entries. If the presence of mine entries is suspected, the affected area should be cordoned off immediately and the advice of a coal mining engineer sought.

APPENDICES

APPENDIX A

DRAWINGS



THE LAND CONSULTANCY LIMITED

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Tel: 01772 610609; M: 07771 800859

email: sfknot@thelandconsultancy.co.uk; www.thelandconsultancy.co.uk

Project:

Land off Smithy Bridge Road, Littleborough,
Rochdale

Title:

Site Location Plan

Scale:

NTS

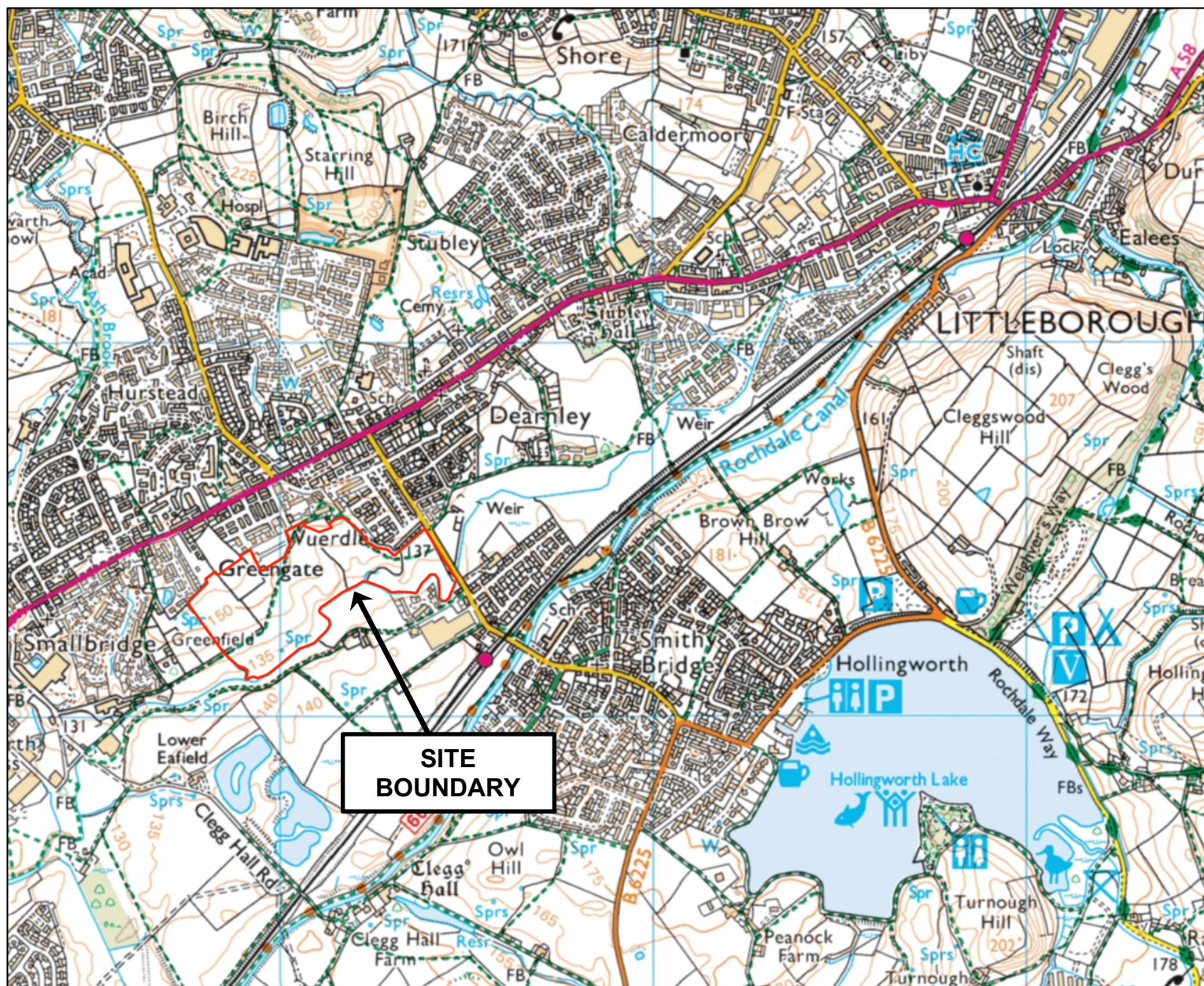
Drawn by:

SFK

Date:

01/10/2018

Drawing No.: TLC1004/01a



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Project:
Land off Smithy Bridge Road, Littleborough,
Rochdale

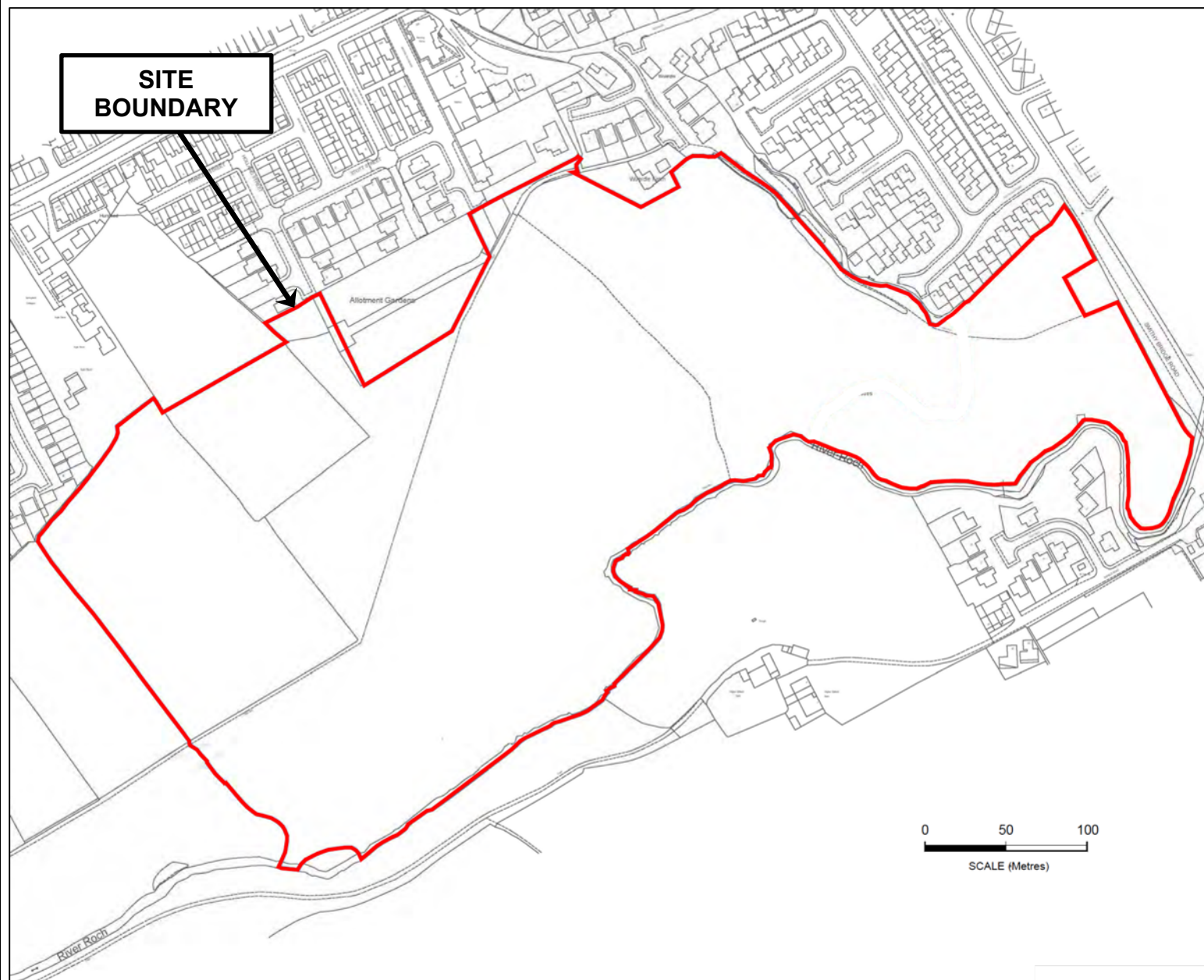
Title:
Site Location Plan

Scale:
NTS

Drawn by:
SFK

Date:
01/10/2018

Drawing No.: TLC1004/01b



THE LAND CONSULTANCY LIMITED

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Project:

Land off Smithy Bridge Road, Littleborough,
Rochdale

Title:

Site Boundary Plan

Scale:

As shown

Drawn by:

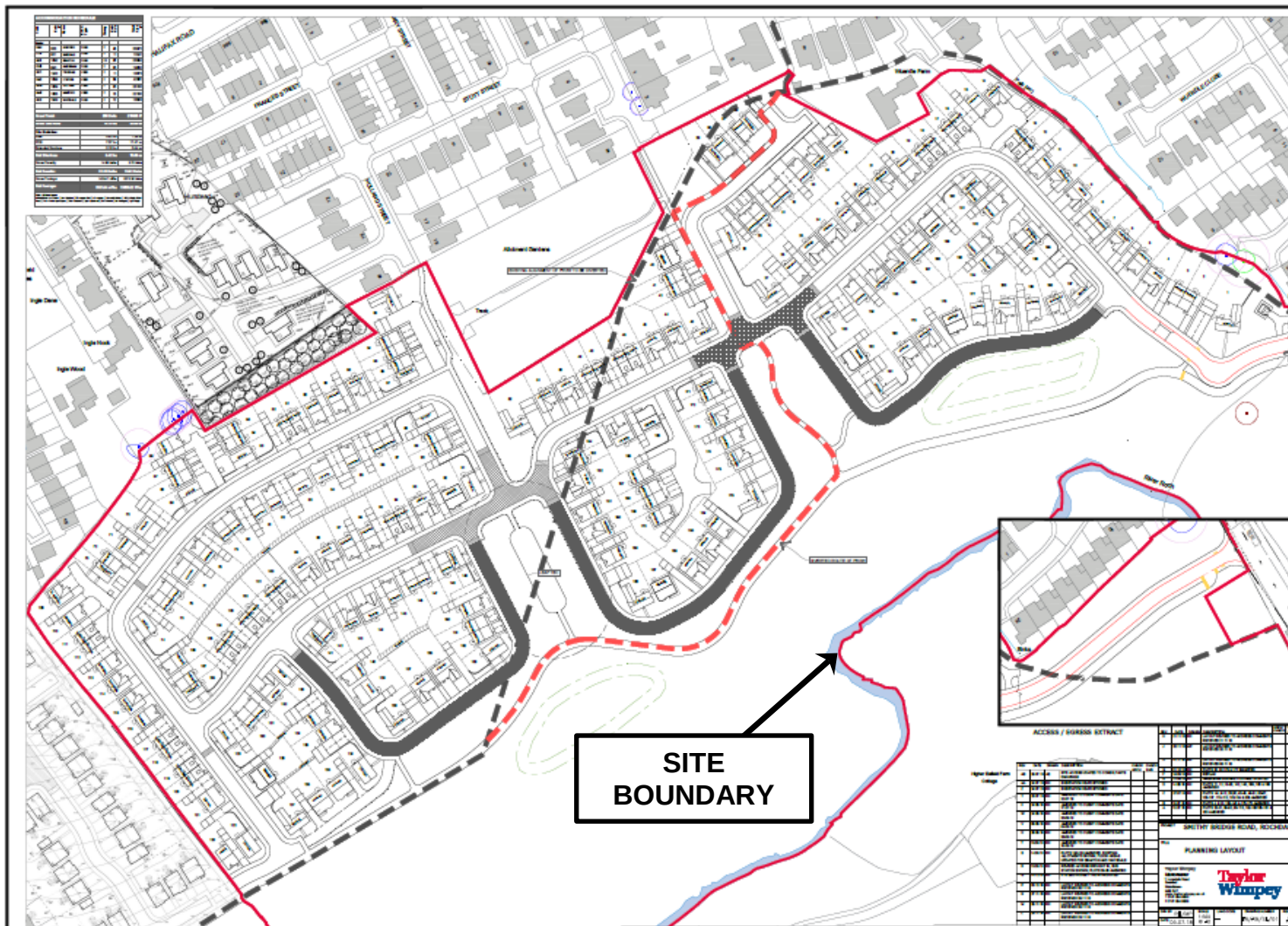
SFK

Date:

01/10/2018

Drawing No.: TLC1004/02

Extract from the following drawing supplied to LK Consult Ltd by Taylor Wimpey Strategic Land (North):
Contract Plan, No 2 (June 2017)



THE LAND CONSULTANCY LIMITED

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Project:

Land off Smithy Bridge Road, Littleborough,
Rochdale

Title:

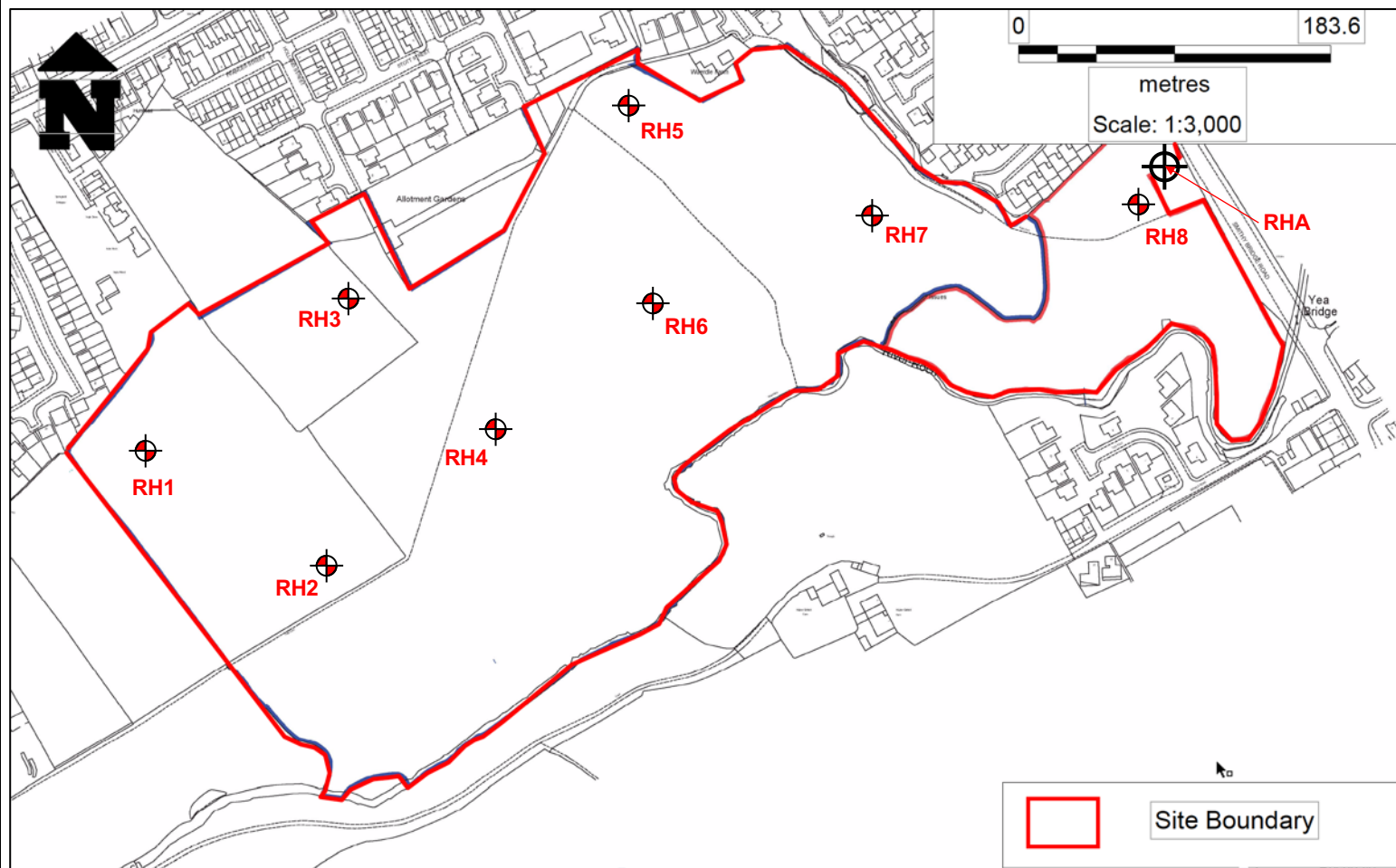
Site Boundary Plan showing Proposed Development

Scale:
NTS

Drawn by:
SFK

Date:
28/07/2019

Drawing No.: TLC1004/03




Mine Shaft Ref: 392415-005 (no treatment records). Investigated by trial trenching and rotary drilling.


Rotary Drill Hole Locations

THE LAND CONSULTANCY LIMITED

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Project:

Smithy Bridge Road, Littleborough OL16 2RY

Title:

Site Boundary Plan showing Rotary Drill Hole and Mine Shaft Locations

Scale:

As Shown

Drawn by:

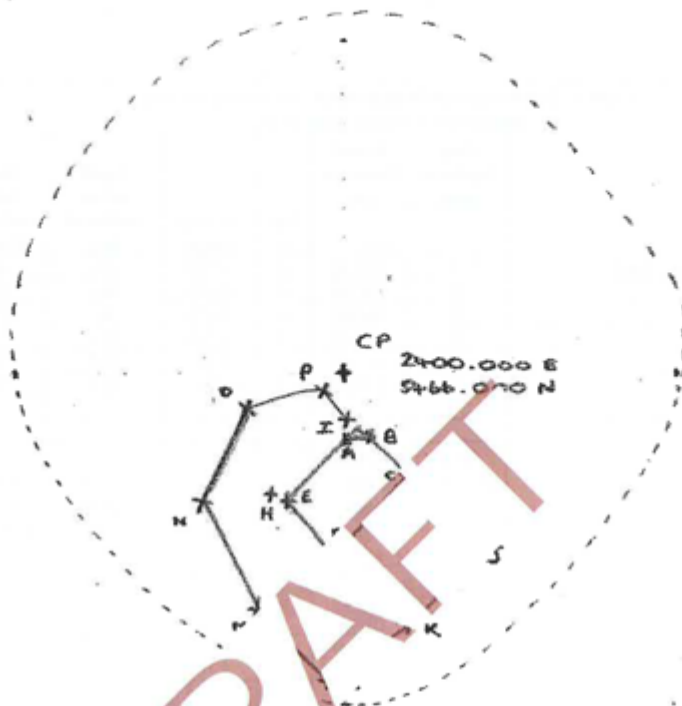
SFK

Date:

01/10/2018

Drawing No.: TLC1004/04

EXISTING MINE SHAFT SURVEY. 4/3/2013



	EASTING	NORTHING	LEV.	
A	2400.62	5462.358	135.578	} Sandstone Rock
B	2401.135	5462.358	135.583	
C	2401.62	5462.358	135.590	
D	2399.275	5461.148	135.580	
E	2398.580	5462.485	135.578	
F	2401.733	5462.090	135.137	} CONCRETE SLAB PERIMETER
G	2399.217	5460.852	135.161	
H	2398.260	5462.841	135.320	
I	2400.423	5463.821	135.214	
J	2402.631	5460.744	135.082	
K	2401.135	5459.648	135.146	
L	2398.262	5458.416	135.145	
M	2397.604	5460.130	135.169	
N	2396.104	5463.021	135.293	
O	2397.593	5465.102	135.364	
P	2399.579	5464.614	135.294	

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Project:

Smithy Bridge Road, Littleborough OL16 2RY

Title:

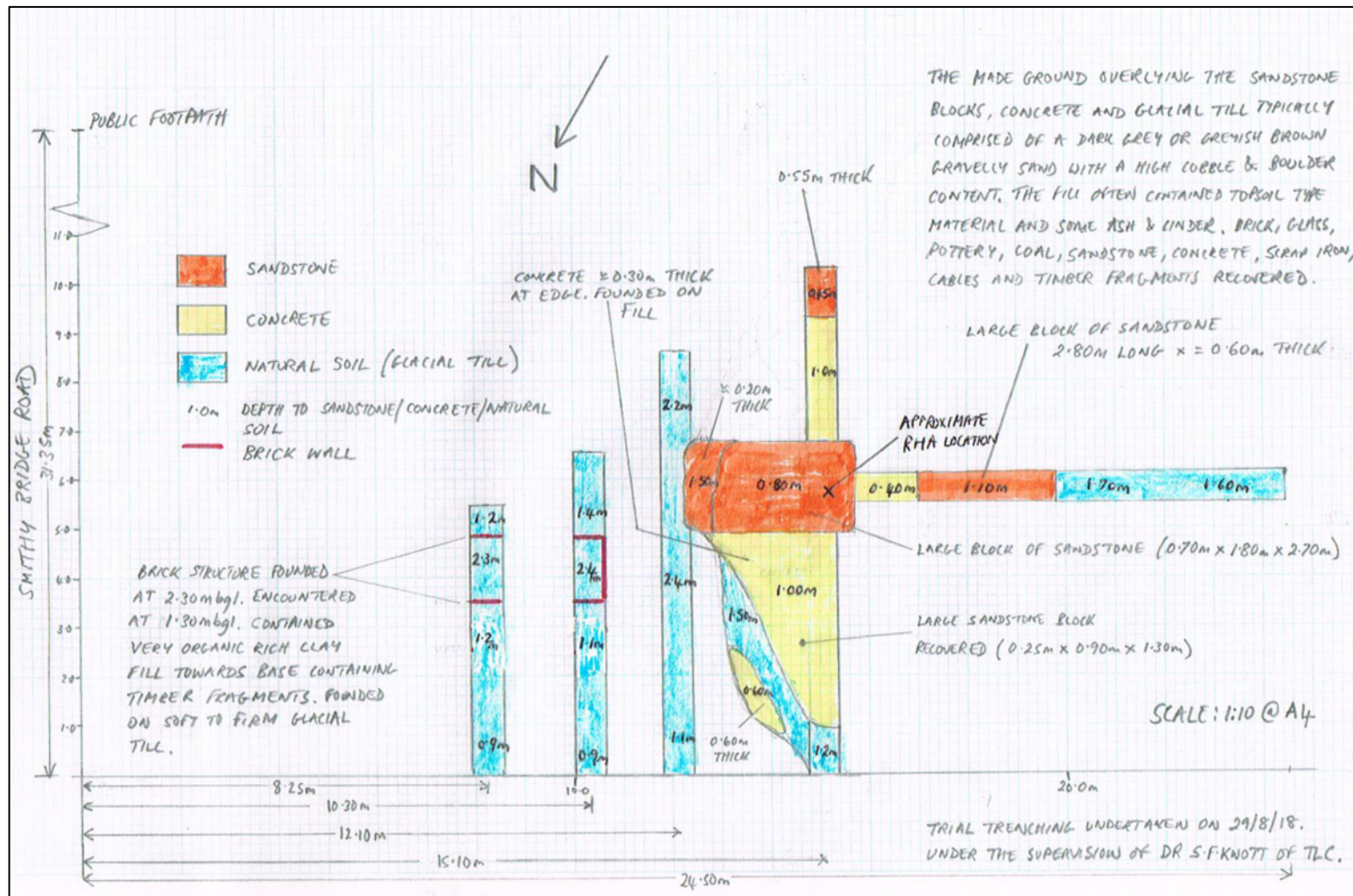
Geotechnics Limited's August 2013 Exposed Shaft Cap Drawing and Coordinates

Scale:
NTS

Drawn by:
SFK

Date:
01/10/2018

Drawing No.: TLC1004/05



THE LAND CONSULTANCY LIMITED

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Project:

Smithy Bridge Road, Littleborough OL16 2RY

Title:

TLC Mine Shaft Trial Trenching Summary Drawing

Scale:

As Shown

Drawn by:

SFK

Date:

02/10/2018

Drawing No.: TLC1004/06