Land at Barnsley West, Land Transfer One For Strata Homes Ltd

Report no: 3104/2b

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EARTHWORKS SPECIFICATION
for land at
BARNSLEY WEST, LAND TRANSFER ONE

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited have been commissioned by Strata Homes Ltd to prepare an Earthworks Specification for land at Barnsley West, Land Transfer One.

1.1.2 Lithos have already issued the following report for the above site:

- Geoenvironmental Appraisal (Report Ref: 3014/1, dated March 2022)

1.1.3 This document is a revision of the Earthworks Specification (Report 3104/2a) issued by Lithos in March 2023; Report 3104/2a is now superseded. This document now includes reference to the revised cut and fill levels produced by Queensbury Design (Drawing Number QD2088-00-302). The only significant revisions to 3104/3b having been made in Sections 3.1.

1.1.4 The appointed Earthworks Contractor will need to familiarise themselves with the above Report and comply with **all** relevant recommendations contained therein.

1.1.5 This Specification is intended to be used in connection with the construction of c. 366 residential dwellings which **will** derive direct support from the engineered fill, where not located over opencast highwalls.

1.1.6 It is emphasised that clay fills can be at least as susceptible to settlement or heave due to climatic, vegetation or other effects, as naturally occurring cohesive soils.

1.1.7 This Specification is for contracts which are designed and supervised by Lithos Consulting Limited.

1.1.8 Note should be taken of the requirements of the Construction (Design and Management) Regulations:1994 to the extent that they may be relevant to the works.

1.1.9 This specification has been prepared by Lithos Consulting Ltd based on the suitably modified "Model Specification for Engineered fills to Support Low Rise Structures", written by N A Trenter and J A Charles, Paper 10819, Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, October 1996.

1.2 The proposed development

1.2.1 It is understood that the current area of interest Land Transfer One (LT1) will be divided into four sub-areas as summarised below:

- **Development Area 1**; 93,800m^2 in the west of the site; to be developed with 229 residential dwellings by Strata Homes.
- **Development Area 2**; 42,300m^2 in the northeast; to be developed with 137 residential dwellings by Miller Homes.
- **Development Area 3**; 5,000m^2 in the centre to be developed with a retail building and associated parking.
- **Development Area 4**; 17,000m^2 in the southeast to be developed with a school building & associated outdoor play areas etc.

1.2.2 In addition, a **spine road** is proposed which runs roughly north to south through the site, divides Development Area 1 from Development Areas 2, 3 and 4, and which will extend beyond the southern boundary to provide access to the wider Barnsley West Development.

1.2.3 Portions of all 4 Development areas will be given to POS, adoptable roads, sewers, and gardens (attached to dwellings).

1.2.4 Site layouts for the Development Areas have been provided and a 'composite' development layout has been derived which is shown on Drawings 3104/17 & 3104/17A in Appendix B.

1.2.5 It is understood that the wider Barnsley West site (c. 80 hectares to the south) will be given to a mixed residential and commercial end use in the future.

1.2.6 Access to the development will be from Barugh Green Road in the north.

2 BACKGROUND

2.1 Site description

2.1.1 The site's location is shown on Drawing 3104/1 presented in A to this report. Site details are summarised in the table below:

Detail	Remarks
Location	3km northwest of Barnsley town centre.
NGR	SE 315 077
Approximate area	21.4 hectares (52.9 acres).
Known services	Underground sewers & overhead electric.

2.1.2 A location plan and current salient features are shown on Drawings 3104/3 in Appendix B.

2.1.3 The topography of the site and surrounding area falls to the south with an average gradient of about 1v:40h. The steepest gradients on site are in the southwest where slopes reach about 1v:12h. Ground is generally smooth underfoot with very broad and gentle undulations.

2.1.4 Within LT1, the ground surface has an elevation of c. 125m AOD in the southwest corner, falling to c. 83m AOD in the far northeast part of the site. The topography of the wider site (beyond LT1) rises to the south, reaching an elevation of c. 155m AOD in the far south, and c. 140m AOD in the far east of the site.

2.1.5 LT1 is divided up into 6 fields by mature Hawthorne hedgerows, with openings or gates between fields.

2.1.6 Three overhead electrical utilities run east to west across the south of the site atop wooden posts.

2.1.7 Access can be gained via a gate off Barugh Green Road in the north, via a farmyard which is located off-site to the east, via a gate off Hermit Lane and through adjacent fields to the south or via gaps between residential dwellings along Welland Court (road) and Avon Close (road) to the east.

2.1.8 Shallow drainage ditches run along the base of hedgerows in the north of LT1, which at the time of Lithos' walkover were dry, however during Lithos' ground investigation and following periods of rainfall, the ditches filled with a steady flow of surface water and drained to the northeast.

2.2 Ground investigation

2.2.1 Fieldwork undertaken to date is summarised below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine excavated)	TPs 001 to 071, 101 to 107 & 201 to 224.	1.2m to 4.4m (ave. 3.2m)	Hand vane tests undertaken in 'clean' cohesive soils.
Trial Trenching (machine excavated)	TTs 001 to 022, 101 to 106 & 201 to 216.	1.m to 4.6m (ave. 3.0m)	Excavated across the line of known highwalls.
Cable Percussion Boreholes	BHs 001 to 015 & 201 to 205.	5.4m to 13.4m (ave. 8.7m)	Boreholes advanced to refusal in bedrock/obstructions. Monitoring wells installed.
Rotary Cored Boreholes	RC BHs 001 to 006 & 201 to 204.	13.5m to 16.5m (ave. 15.1m)	-
Rotary Open Probeholes	PHs 001 to 042, 101 to 109 & 201 to 219	3.0m to 39.0m (ave. 26.2m)	Monitoring wells installed in 14 PHs.
Groups of Stitch Probeholes	ST PHs 001 to 009, 101 & 201 to 207	3.0m to 12.0m (ave. 8.2m)	Drilled along the line of known highwalls.

2.2.2 The site can be divided into 4 areas (see Drawing 3104/13 Site Areas in Appendix B) based on ground conditions.

Site area	General location	Approx. Area (m^2)
A	Outside footprint of former opencasts; northern, southern & western peripheries of the site. MG <0.9m.	38,500m^2
B	Outside former opencasts; centre-east & west. MG 0.9m to 2.5m.	35,500m^2
C	Outside former opencasts; centre-east. MG > 2.5m.	10,800m^2
D	Inside former opencast; centre, south & east.	129,200m^2

Made ground

2.2.3 The made ground on site can be categorised as one of 4 broad 'types' which are present in varying quantities across all 4 areas summarised above:

- **Made Ground Topsoil:** Encountered to depths of between 0.2m & 0.5m depth (ave. 0.3m) comprising silty clay with some gravel of mudstone, siltstone and occasional sandstone, coal and pottery.
- **Cohesive Made Ground:** Encountered from the base of Made Ground Topsoil to between 0.4m and greater than 2.6m depth (ave. 0.7m) comprising light brown mottled grey clay with occasional gravel of mudstone and some siltstone.
- **Opencast Backfill:** which can in turn be divided into two further made ground types:
    - **Cohesive Opencast Backfill:** Encountered to depths of between 0.8m and 12.6m depth (ave. 4.1m) comprising clay with gravel of mudstone, siltstone and occasional coal, pottery, brick and sandstone, a low to high cobble content (mudstone and siltstone) and a low to medium small boulder content (mudstone and siltstone).
    - **Granular Opencast Backfill:** Encountered typically from the base of Cohesive Made Ground or Cohesive Opencast Deposits to between 0.9m and greater than 4.1m depth, comprising clayey/silty gravel of mudstone and occasional siltstone, mudstone, coal, brick and pottery with a medium to high cobble content (mudstone and siltstone) and a low to high small boulder content (mudstone and siltstone).

2.2.4 The Made Ground Topsoil was likely site won and stockpiled prior to open-casting and replaced on completion of backfilling the opencast to render the site suitable for agriculture.

2.2.5 The Cohesive Made Ground is interpreted as comprising Residual Soils which have been stripped prior to opencasting and laid down over the Opencast Backfill to create a 'capping layer' to segregate the Topsoil layer (and any grown crops, ploughing, agriculture etc) from the deeper made ground which may have been considered undesirable as a near surface material.

2.2.6 The Cohesive and Granular Opencast Backfill comprised materials which were generated during excavation of the former opencast and then used to backfill excavations on completion of the opencasting. This material often has a significant boulder content.

Natural ground

2.2.7 Natural Soils were only encountered in significant thicknesses in areas beyond the former opencast. And comprised the following succession:

- **Topsoil:** Only encountered in Area A from surface to between 0.25m and 0.3m depth (typically 0.3m) comprising slightly sandy silty clay with occasional gravel of mudstone and siltstone.
- **Cohesive Residual Soil:** Encountered in Area A (from the base of Topsoil) and Areas B & C from the base of made ground, comprising firm to stiff clay with gravel of mudstone and occasionally siltstone and sandstone.
- **Granular Residual Soil:** Encountered in Areas A & B, typically from the base of Cohesive Residual Soil, comprising clayey gravel of mudstone or siltstone.

Rock

2.2.8 All bedrock encountered belongs to the Lower Coal Measures Group; a succession of interbedded mudstones, siltstones and sandstones with intermittent seams of coal, fossiliferous marine bands and ferrous rich ironstones.

Underground mining investigation

2.2.9 LT1 is underlain by 4 coal seams at shallow to intermediate depth; a Thin Coal, the Swallow Wood, the Top Haigh and the Low Haigh coals. Inside the footprint of the former Craven I opencast, the Thin and Swallow Wood Coals have been removed. Coal seam outcrops (based on BGS mapping) are shown on Drawing 3104/8.

2.2.10 A mining investigation was undertaken, comprising the drilling of 56 'deep' rotary open probeholes.

2.2.11 The deep probeholes did **not** encounter any evidence of underground workings in the 4 shallow coal seams. Therefore, the risk posed to surface stability from underground shallow workings across LT1 is considered to be **insignificant**.

2.2.12 No evidence of underground workings for Ironstone was encountered during Lithos' mining investigation.

Groundwater

2.2.13 Groundwater was encountered in 12 trial pits and trial trenches as well as during the drilling of one borehole.

2.2.14 Monitoring wells were installed in 14 shallow probeholes and 20 deeper cable percussion boreholes.

2.2.15 Existing groundwater dip data would suggest that there is not an overall groundwater level within Craven I opencast. It is possible that groundwater within the Opencast Backfill is perched within granular bands, layers and lenses, which in some areas may be interconnected, where as in other areas they may be discrete bodies of water.

2.2.16 In areas of the opencast where granular backfill is prevalent, the local permeability of the backfill may be higher than the surrounding Coal Measures bedrock. Consequently, the backfilled opencast may act as a sump, with surrounding groundwater within the bedrock draining towards the opencast.

2.2.17 In some parts of Craven I opencast there may be a general groundwater flow towards the northeast, broadly parallel with the fall of topography. However, there does not appear to be an even gradient on the groundwater flow, with some large local variations in groundwater level (m AOD), with groundwater even absent in some locations.

2.2.18 It should be noted that any excavations across highwalls, may encounter differing flow rates and groundwater levels where in-situ bedrock and Opencast Backfill is exposed.

Stability

2.2.19 The stability of excavations through natural Residual Soils and bedrock was generally good.

2.2.20 The stability of excavations through made ground was generally moderately good. However, excavations through the Granular Opencast Backfill encountered overbreak and spalling; most notably where oversized materials (cobbles and boulders) were encountered.

Boulders & Oversized material

2.2.21 Boulders were encountered within 35% of machine excavated trial pits / trenches at depths between 0.5m and 3.5m (typical maximum depth of the pits). Further boulders are likely to be present at greater depths.

2.2.22 The prevalence of encountered boulders appears to be higher in the southwest, southern central and southeast, and lower in the north and northeast parts of the Craven I opencast. The size of the encountered boulders ranged between c. 0.4m to >1.2m across.

Geotechnical Testing

2.2.23 A total of 228 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

2.2.24 The geotechnical laboratory test results are presented in Appendix K of Report 3104/1.

Atterberg limits

2.2.25 The plasticity indices of 106 samples of cohesive soil have been determined; results are summarised below:

Soil type	No. samples tested	Moisture content range % (average)	Range of Plasticity Indices % * (average)	Shrinkability
Cohesive Made Ground	17	14.0 – 34.0 (23.0)	16 – 35 (28)	Medium
Cohesive Opencast Backfill	58	4.7 – 33.0 (13.0)	8 - 33 (21)	Medium
Granular Opencast Backfill (with high fines portion)	10	6.4 – 15.0 (10.1)	8 – 16 (11)	Low
Cohesive Residual Soil	17	14.0 – 38.0 (21.0)	16 – 39 (26)	Medium
Coal Measures (weathered bedrock)	4	7.8 – 14.0 (11.0)	10 – 20 (16)	Low

* Modified where appropriate in accordance with Chapter 4.2 of the NHBC Standards

Note. The term Shrinkability is equivalent to the term Volume Change Potential used in Chapter 4.2.

Particle size distribution

2.2.26 The gradings of 40 samples have been determined by wet sieving and the results are summarised in the tables in Section 15.3 of the Lithos Geoenvironmental Appraisal Report 3104/1 (dated March 2022).

2.2.27 Whilst some samples of Granular Opencast Deposits returned a plasticity index of greater than 10, almost all samples submitted for gradings had a portion of fines less than 35% and therefore the Granular Opencast Backfill can generally be considered to be non-shrinkable.

Compaction tests

2.2.28 Laboratory compaction tests are useful wherever ground improvement is anticipated, for example to provide a satisfactory CBR beneath proposed highways.

2.2.29 In accordance with BS5930[1] engineered fill is defined as material which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

2.2.30 Grading and moisture content control the degree to which materials can be effectively compacted. If the grading or moisture content of an in-situ material is not suitable to facilitate its compaction then screening, wetting, or lime addition may be required.

2.2.31 Laboratory compaction testing was scheduled on 37 samples of made ground and 7 samples of natural soil and rock (using a 4.5km rammer) to determine their suitability for re-engineering.

2.2.32 Laboratory compaction tests are only appropriate if:

- At least 90% of the material passes the 37.5mm sieve; and/or
- At least 70% of the material passes the 20mm sieve

2.2.33 It is apparent from the results of the gradings that whilst Cohesive Soils at this site broadly fall within the gradings envelope for compaction tests, the granular soils are generally too coarse (without processing).

[1] *BS5930 (2015) - Code of practice for ground investigations.*

2.2.34 The compaction results are summarised in the tables below:

Sample location & depth	Geology type	Gs (Mg/m³)	MDD (Mg/m³)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids		As received moisture content (%)
					from	to	
BH014 – 0.4m	Cohesive Made Ground	2.66	1.76	17	16.0	22.0	23.0
BH201 – 0.0m – 1.0m	Cohesive Made Ground	2.63	1.65	20	19.5	25.0	23.0
TP012 – 0.1m	Cohesive Made Ground	2.64	1.71	19	17.5	23.0	31.0
TP015 – 0.2m	Cohesive Made Ground	2.64	1.71	18	18.0	22.0	33.0
TP020 – 0.4m	Cohesive Made Ground	2.65	1.79	16	15.5	20.0	22.0
TP105 – 0.5m	Cohesive Made Ground	2.63	1.79	15	15.0	20.5	22.0
TP207 – 0.7m	Cohesive Made Ground	2.63	1.93	11	11.0	16.5	14.0
TP210 – 0.5m	Cohesive Made Ground	2.65	1.81	16	15.0	20.0	19.0
BH014 – 2.0m	Cohesive Opencast Backfill	2.65	1.86	14	13.0	19.0	17.0
BH015 – 3.0m	Cohesive Opencast Backfill	2.62	1.93	12	11.0	16.5	15.0
BH015 – 5.0m	Cohesive Opencast Backfill	2.59	1.92	11	11.0	16.0	14.0
BH201 – 2.0m	Cohesive Opencast Backfill	2.59	2.04	9	8.0	13.0	11.0
BH203 – 2.0m	Cohesive Opencast Backfill	2.62	1.88	13	12.5	17.5	16.0
BH204 – 5.0m	Cohesive Opencast Backfill	2.63	1.99	10	10.0	15.0	15.0
BH205 – 4.0m	Cohesive Opencast Backfill	2.63	1.80	16	15.0	19.5	20.0
TP018 – 0.6m	Cohesive Opencast Backfill	2.67	1.88	15	13.0	18.0	15.0
TP022 – 0.5m	Cohesive Opencast Backfill	2.67	2.11	8	7.5	13.0	7.8
TP023 – 1.3m	Cohesive Opencast Backfill	2.69	2.02	12	10.5	15.5	12.0
TP062 – 3.0m	Cohesive Opencast Backfill	2.59	1.84	13	13.0	18.0	16.0
TP101 – 1.2m	Cohesive Opencast Backfill	2.65	1.87	14	13.0	18.0	17.0
TP104 – 1.5m	Cohesive Opencast Backfill	2.59	1.97	10	9.5	15.0	13.0
TP201 – 0.8m	Cohesive Opencast Backfill	2.64	1.96	11	10.5	15.5	14.0
TP213 – 0.6m	Cohesive Opencast Backfill	2.63	1.99	10	10.0	15.0	16.0
TP220 – 1.0m	Cohesive Opencast Backfill	2.64	1.96	11	10.5	16.0	14.0
TP043 – 2.4m	Cohesive Opencast Backfill	2.6	1.92	11	11.0	15.0	12.0
TP071 – 1.0m	Cohesive Opencast Backfill	2.61	1.86	14	13.0	18.0	14.0
TP071 – 2.0m	Cohesive Opencast Backfill	2.68	1.93	12	12.0	16.0	18.0
TP005 – 1.0m	Granular Opencast Backfill	2.65	2.03	10	9.0	14.0	10.0
TP011 – 2.0m	Granular Opencast Backfill	2.67	2.12	8	7.5	13.0	7.9
TP013 – 0.9m	Granular Opencast Backfill	2.64	2.11	8	7.0	12.0	6.4
TP016 – 0.8m	Granular Opencast Backfill	2.67	2.09	8	8.0	13.0	10.0
TP016 – 1.4m	Granular Opencast Backfill	2.64	2.05	9	8.5	14.0	15.0
TP026 – 0.9m	Granular Opencast Backfill	2.63	1.99	10	10.0	15.0	7.2
TP035 – 0.8m	Granular Opencast Backfill	2.66	2.08	10	8.5	13.0	7.6

Sample location & depth	Geology type	Gs (Mg/m³)	MDD (Mg/m³)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids		As received moisture content (%)
					from	to	
TP049 – 2.5m	Granular Opencast Backfill	2.6	1.95	11	10.0	16.0	14.0
TP067 – 0.9m	Granular Opencast Backfill	2.6	1.98	10	9.5	14.5	14.0
TP102 – 1.2m	Granular Opencast Backfill	2.67	2.09	10	8.5	12.5	7.8
TP066 – 0.9m	Cohesive Residual Soil	2.63	1.73	19	17.0	22.5	25.0
TP104 – 1.5m	Cohesive Residual Soil	2.65	1.79	17	16.0	21.0	20.0
TP106 – 2.8m	Cohesive Residual Soil	2.62	1.83	15	14.0	19.0	21.0
TP001 – 1.4m	Granular Residual Soil	2.69	2.03	10	9.5	15.0	12.0
TP002 – 1.0m	Granular Residual Soil	2.69	2.03	11	10.0	14.5	13.0
TP022 – 2.3m	Granular Residual Soil	2.57	1.99	9	8.9	12.6	9.4
BH203 – 5.0m	Coal Measures	2.63	2.03	9	9.0	14.0	14.0

Note: As received moisture contents which fall outside of the allowable moisture content range are shown in red.

2.2.35 It is apparent that soils across the site fall broadly within or 'close to' the allowable moisture content range to achieve 95% MDD and less than 5% air voids; although the Cohesive Made Ground is often slightly too wet and the Granular Opencast Backfill is on occasion slightly too dry.

2.2.36 Therefore, correction of soil moisture contents should be allowed for during earthworks at this site, notably drying of the Cohesive Made Ground.

2.2.37 Drying out of these soils will require careful management on site. They should be placed in sealed stockpiles during periods of wet weather, or while the site is unattended. During periods of favourable weather (ideally warm & windy) the soils should be spread in thin layers over as wide an area as possible and aerated by turning with an excavator. Alternatively, consideration could be given to lime modification, using nominal lime percentages of 0.5% to 2% (maximum).

2.2.38 The Granular Opencast Backfill may also need to be screened in order to remove any unsuitable and oversized materials (i.e. cobbles and boulders).

Undrained shear strength testing – hand shear vane testing

2.2.39 Hand shear vane testing was undertaken on 'clean' (i.e. not sandy/gravelly) cohesive soils within trial pits in-situ to around 1.2m depth and from larger blocks of excavated clay below that depth.

2.2.40 The results are summarised in Section 15.6 of the Lithos Geoenvironmental Appraisal Report 3104/1.

2.2.41 The results indicate that both made and natural cohesive soils beneath the site are of at least medium strength, generally high strength, and have a broad trend of increasing strength with depth.

3 EARTHWORKS LEVELS, INVERT LEVELS & REGRADE

3.1 Earthworks levels

3.1.1 Subject to the completed earthworks, and final finished ground levels, the following foundation solutions are likely to be the most appropriate:

Site Area	Foundation solution(s)	Remarks (influencing factors)
A. Outside footprint of opencast. MG <0.9m	Strips at 0.9m (Cohesive Residual Soil) & 0.6m (Granular Residual Soil)	Foundations in Cohesive Residual Soil deepened where influenced by trees
B. Outside former opencast centre-east & west. MG 0.9m to 2.5m	Deep strips/trench fill to between 0.9m & 2.5m.	Passing through made ground & founding in underlying Residual Soil or bedrock.
C. Outside former opencast centre-east. MG >2.5m	Piles to between c. 5.0m & 8.0m or rafts/beams on engineered fill.	Highwall location & depth needs to be considered.
D. Inside former opencast	Piles to between c. 8.0m & 14.0m or rafts/beams on engineered fill.	Highwall location & depth needs to be considered.

3.1.2 Final site levels will be determined by Strata, in conjunction with their Earthworks Contractor and Engineering Designer. However, Queensbury Design Drawing QD2088-00-302 – Cut / Fill Depths to Existing Ground Levels indicates that proposed finished ground levels across the bulk (c. 75%) of the development platform will be within ±1m from existing levels.

3.1.3 The Queensbury Design Cut / Fill Drawing suggests the following:

- 8% of the earthworks are in cut >2m.
- 26% of the earthworks are between -1m and 0m cut.
- 50% of the earthworks are between 0m and +1m fill.
- 10% of the earthworks are between +1m and +2m fill.
- 6% of the earthworks are >3m of fill.

3.1.4 The largest areas of upfill are focused along the route of the proposed spine road, to ensure suitable highway gradients are achieved.

3.1.5 Any digital terrain modelling undertaken by the Earthworks Contractor should be designed with a view to enabling a "materials balance" (i.e. volume of cut to broadly equals the volume of fill), and be made available to Strata's Engineering Designer. The digital terrain modeller should consider:

- Volume reduction caused by compaction of loose made ground; removal of obstructions etc
- Whether or not processed arisings/treated soils are retained on site
- The thickness of any soil cover requirements.

3.1.6 Final site levels should then be issued by the Engineering Designer, via an External Works Drawing, which should show:

- Proposed finished floor levels
- Proposed finished road levels
- Garden & driveway levels and gradients

3.2 Turnover of made ground

3.2.1 Made Ground is present across the majority of LT1:

- Area A comprising a veneer of Made Ground Topsoil beyond areas of opencast;
- Area B comprising Cohesive Made Ground and Opencast Backfill to between 1.1m and 2.5m;
- Area C comprising Cohesive Made Ground and Opencast Backfill to greater than 2.5m; and,
- Area D (footprint of former opencast) comprising Cohesive Made Ground and Opencast Backfill to between 5.0m and 12.6m depth.

3.2.2 The required depth of turnover differs across the site depending on the proposed depth of cut and fill and also the depth of existing Made Ground. The table below summarises the turnover requirements:

Site Area	Depth of existing MG	Turnover requirements
A	< 0.9m	• None – topsoil strip only
B – Areas of Cut	1.1m to 2.5m	• Full thickness of MG
B – Areas of Upfill *	1.1m to 2.5m	• Full thickness of MG where the height of engineered upfill is <1m • Over-excavate 1m below existing ground level where the height of engineered upfill is 1m to 2m
C & D – Areas of Cut	>2.5m up to c. 12.5m	• Over-excavate 1m below finished ground levels where cut is >3m • Over-excavate 2m below finished ground levels where cut is >2m but <3m • Over-excavate 3m (or to natural strata whichever is shallower) below finished ground levels where there is up to 1m of cut.
C & D – Areas of Upfill *	>2.5m up to c. 12.5m	• Over-excavate 3m (or to natural strata whichever is shallower) below finished ground levels where there is up to 1m of engineered fill. • Over-excavate a minimum of 2m from existing ground levels where height of engineered upfill is 1m to 2m • Over-excavate a minimum of 1m from existing ground levels where height of engineered upfill is 2m to 3m • Where the height of engineered upfill is >3m, the existing ground (following topsoil strip) should be proof rolled prior to upfilling.

Note * Upfill above existing ground levels minus topsoil thickness

3.2.3 The aim of the regrade earthworks is to ensure that there is a minimum of 3m of engineered fill below finished ground levels, including the benefit of pre-load affect in areas if cut.

3.2.4 Prior to filling back to finished ground levels, the sub-formation should be proof rolled see Section 13.7.

3.2.5 Groundworkers should make all necessary arrangements to prevent off-site migration of pollutants via surface water run-off, inadvertent groundwater disturbance and airborne dust. Groundwater shall be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".

3.3 Site regrade

3.3.1 Regrade of the site is anticipated to facilitate the proposed housing layout. It is understood that Strata will require the appointed earthworks contractor to undertake digital terrain modelling, with a view to:

- Confirming final levels, including Plot FFLs
- Achieving acceptable highway and drive gradients
- Minimising foundation abnormals

3.3.2 Earthworks modelling should consider the possibility of how excess foundation and drainage arisings will be accommodated.

4 ENGINEERED FILL

4.1 Engineered fill is defined as fill which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

4.2 Grading limits for the most common types of general fill are presented in the Appendix A to this specification. The remaining fill types are specified in the DoT Specification.

4.3 Fill shall be classified as follows:

- Unsuitable fill
- General fill
- Restricted fill
- Special fil

5 UNSUITABLE FILL

5.1 Unsuitable fill shall comprise any material so designated by the Engineer and shall include:

- Cohesive soils having a liquid limit in excess of 90% or Plasticity Index in excess of 65%
- Chalk having a fine fraction (<400μm) in excess of 10% at the borrow pit
- Any material containing topsoil, wood, peat or lignite
- Any material containing biodegradables
- Any material containing scrap metal
- Frozen or waterlogged substances
- Material defined as unsuitable by the Engineer because of its type or level of contamination
- Material which, by virtue of its particle size or shape, cannot be properly and effectively compacted (e.g. oversize material, gravels which are tabular and some slate wastes)
- Expansive steel slag

5.2 Unsuitable fill shall not be used at any structurally load bearing location or part of the site but may be used under landscaped areas with the agreement of the Engineer.

6 GENERAL FILL

6.1 General fill shall comprise all fill except unsuitable fill, restricted fill and special fill.

7 RESTRICTED FILL

7.1 Restricted fill shall comprise material which would otherwise be classified as general fill but which contains minerals hostile to the built environment and shall include:

- Pyritic shales
- Gypsiferous clays
- Burnt colliery discard
- Pulverised fuel ash
- Spent oil shale
- Incinerator waste
- Demolition and construction industry waste, at the discretion of the Engineer

7.2 Such fill shall be precluded from use in designated zones, including locations where groundwater may rise to the level of the underside of the deepest foundation and where its use will be condemned by the appropriate authorities on pollution grounds. Such fill shall not be placed to a depth less than one metre from the underside of the deepest foundation.

8 SPECIAL FILL

8.1 Special fill shall comprise material which would otherwise be classed as general fill but which contains durable well graded natural sand and natural gravel or crushed rock, other than argillaceous rock, or durable clean crushed demolition rubble of similar particle size and free from any contaminants. Such fill may be employed as capping layers beneath structure foundations, beneath roads or as backfill to retaining walls.

9 TYPE OF COMPACTION SPECIFICATION

9.1 It is understood by Lithos that foundations in Areas C & D will be placed **within** the engineered fill, with loads transferred to the fill by doubly reinforced strips and or rafts where natural soils are at greater depths than 2.5m depth. Where natural ground is present at depths of less than 2.5m, then natural ground can be utilised for foundations.

9.2 Therefore, as the engineered fill is required to provide direct structural support to foundations, the fill shall be compacted to an **end product** specification, to achieve >95% of the maximum dry density (4.5kg rammer) and less than 5% air voids.

10 SELECTION OF END PRODUCT REQUIREMENTS

10.1 As an end product specification is to be used on the basis of the results of the site investigation which he/she has carried out, the Engineer will provide the contractor with the following:-

10.2 The results of the tests shown below for each type of fill on site:

- Natural moisture content (BS1377: Part2:1990: Section 3)
- Liquid and plastic limits for cohesive soils (BS1377:Part2:1990: Sections 4 and 5).
- Compaction tests to determine maximum dry density and optimum moisture content at the appropriate compactive effort (4.5kg rammer) (BS1377LPart 4:1990: Section 3)
- Particle density (specific gravity) to assist in evaluating the compaction test (BS1377: Part 2:1990: Section 8)
- Particle size distribution by wet sieving method to give the distribution of particle sizes down to fine sand and the percentage of fines (BS1377: Part 2: 1990: Section 9.2)

10.3 A graph is required to show the dry density plotted against moisture content for the 4.5kg rammer method compaction tests, the corresponding optimum moisture contents and maximum dry densities and the 0%, 5% and 10% air voids lines.

10.4 The required level of compaction will be indicated by selecting appropriate moisture content and dry density values. This level of compaction shall form the basis of end product compaction specification.

11 REQUIREMENTS FOR ACCEPTABILITY & TESTING

Permitted Classes and Material Properties for Acceptability

11.1 Excavation arisings will comprise both made ground (opencast backfill) and natural Coal Measures strata, from which only suitable materials will be utilised as engineered fill.

11.2 Permitted classes of earthwork materials for use in the works are listed, together with material properties required for acceptability, in Table 6/1 of the Specification; relevant extracts are copied in Appendix A. The earthworks materials listed in Table 6/1 are not the only permitted materials, however they are the most commonly used class of earthworks materials and based on the site investigation data, those expected to be encountered.

11.3 The fill is expected to comprise made ground or natural soils conforming to the requirements for Class 1C (coarse granular fill), Class 2B (dry cohesive fill) and 2C (stony cohesive fill) as defined in Table 6/1 of Appendix A.

11.4 The majority of made ground soils are expected to be suitable for replacement as fill but the Contractor shall demonstrate that any materials deposited on site are acceptable in accordance with the specification and Table 6/1.

11.5 The areas of deposition of different classes of Made Ground materials and their source shall be recorded by the Contractor and records provided to the Engineer.

11.6 Any soils imported for use in cover soils or landscaping should be tested in accordance with the protocols contained in Appendix C and D.

Requirements for Determining Acceptability

11.7 The Engineer shall be responsible for testing and determining the acceptability and classification of earthworks materials. Classification test samples shall be taken at the point of excavation for site-won materials, with end product testing undertaken at the point of deposition. Imported and stockpiled materials shall be tested at the point of deposition. Testing is to comply with Table 6/2 and any other requirements of this Specification.

11.8 The frequency of testing shall be as given in the table below, unless otherwise agreed by the Engineer for each material of a given class. The Contractor shall allow for testing to be undertaken at the locations required by the Engineer and shall stop works in the test areas as required to facilitate the testing.

APPENDIX 1/5

Table 1/1: Testing Details for Series 600 Acceptable Earthworks Materials

Material Class	Requirement	Minimum Testing Frequency	Test Certificate
Class 1C	Grading & particle density	1 per 500m³ with a minimum of 6 samples per source, with 1 additional test per 5,000m³ of placed fill provided results are consistent	Required
	Moisture content		
	4.5kg compaction		
	In-situ density tests (SRT, NDG, CC)	1 per 500m³ for the first 20,000m³ of placed fill, with 1 per 5,000m³ of placed fill thereafter provided results are compliant	
Class 2B / C	Grading & particle density	1 per 500m³ with a minimum of 6 samples per source, with 1 additional test per 5,000m³ of placed fill provided results are consistent	
	Moisture content & Atterberg's limits		
	4.5kg compaction		
	In-situ-density tests (SRT, NDG, CC)	1 per 500m³ for the first 20,000m³ of placed fill, with 1 per 5,000m³ of placed fill thereafter provided results are compliant	

11.9 Laboratory acceptability testing shall be undertaken on a minimum of 6 samples per material source, with 1 additional test per 5,000m³ of placed fill.

11.10 The frequency of classification and acceptability tests can only be relaxed **if** the results are **consistent** (classification tests) and **compliant** (acceptability tests). If variation is recorded or non-compliant results received, the Engineer can request a higher frequency of testing as shown in Table 1/1.

12 COMPACTION SITE TRIALS

12.1 Sufficient volume of **each type** of material shall be excavated and screened of deleterious material to lay a 10m x 4m x approximately 0.25m thick trial pad on a previously rolled horizontal area of the site. Any soft spots in the subgrade below the trial pad should be removed and replaced with compacted granular material. A guide to the thickness of layer that may be suitable may be obtained from Table 6/4 in this Specification (which is an extract from DoT Specification for Highway Works Series 600 Earthworks).

12.2 The trial shall be conducted using the same compaction plant as is proposed for the main compaction works. A guide to the size and type of plant that may be suitable may be obtained from Table 1 in this specification.

12.3 Where fill is to be placed by **End Product specification** the bulk density and moisture content of the fill in the trial pad shall be determined by sand replacement test and oven-drying in two locations immediately after placement and spreading by the dozer but before any rolling.

12.4 Bulk density and moisture content determinations shall be carried out at different locations after subsequent passes by the roller to give density and moisture content determinations after 1, 2, 4, 6, 8 and 10 passes of the roller.

12.5 Two laboratory determinations of particle density, grading and Atterberg Limits (if applicable) shall be carried out for each type of material.

12.6 The graph of dry density against number of passes shall be drawn and the number of passes required to achieve more than 95% of the maximum dry density in the field trial and less than 5% air voids at the in-situ moisture content shall be determined.

12.7 As a guide, the number of passes should be equal to or greater than the number derived from Table 6/4 in this specification. The number of passes derived from the site trial shall form the method specification for site compaction of that type of material at the in-situ moisture content.

12.8 If it is shown that 5% or less air voids cannot be achieved during the site trial, then the site trial shall be repeated with different conditions, i.e. heavier or different type of roller and/or increased/decreased moisture content and/or thinner layer.

12.9 If it is required to calibrate a Nuclear Density Meter (NDM) then measurements of bulk density and moisture content shall be made using the NDM at locations adjacent to those carried out by sand replacement tests.

12.10 If the source for the fill material alters, and a **new material** is therefore proposed for use, then a site trial shall be performed on this material to demonstrate that it can be compacted satisfactorily before this material is used in the works.

13 PREPARATION OF SITE

13.1 Drainage grips or trenches shall be excavated, as necessary, uphill of the area to be filled to prevent the area becoming flooded. Drainage shall be effected without causing siltation or erosion and water shall be disposed of in a manner to be agreed by the Engineer.

13.2 The area to be filled, whether an existing excavation or otherwise undisturbed ground, shall be graded to falls, and sump pumping or other suitable dewatering facilities shall be provided as necessary by the Contractor to keep the base of the excavation dry at all times.

13.3 Where the area to be filled comprises an existing excavation, the excavation shall be inspected and subsequently monitored by the Contractor, to ensure that there is no danger of its collapse during the works with consequences for safety, for existing buildings or for other construction adjoining.

13.4 All topsoil shall be stripped and, where required for further use, stockpiled in an area provided by the Contractor and agreed by the Engineer.

13.5 All soft and compressible soils or existing fill shall be removed and run to spoil in dumps provided by the Contractor and agreed by the Engineer. The works shall be accomplished in such a way that there is no undercutting of the sides of existing excavations.

13.6 Existing roots of trees or former pipelines or services at the base of the area to be filled shall be excavated and replaced with compacted general fill which shall be compacted to the same specification as adopted for subsequent compaction works.

Note: No tree roots greater than 5mm diameter, no root balls and no masses of fibrous roots shall remain at the base of the excavation.

13.7 The base of the area to be filled shall be proof rolled with a dead weight roller and all soft materials removed and replaced with compacted fill. Where unsuitable material has been excavated, the underlying ground shall be compacted to the same specification as adopted for subsequent compaction works.

14 DISPOSITION OF FILL

14.1 Benching

14.1.1 Where construction is required upon fill placed over sloping natural ground, and where fill thickness is less than 5m, the natural ground shall be benched, with the maximum vertical height of each bench not exceeding 500mm and providing that the fill depth does not vary by more than 15%.

14.1.2 Where, because of the method of working, previously engineered fill placed during the current works has to be benched as to allow new fill to be placed adjacent to it, then the benches only require to be 0.5m high by 1.0m wide providing that the fill is the same material throughout.

14.1.3 Where there are landscaped areas on which no structures are proposed, the underlying fill shall be selected, placed and compacted in the same way as the engineered fill, unless otherwise directed by the Engineer. Where some relaxation of the specification for fill compaction underlying landscaped areas is permitted, there shall be a transition zone between the fill underlying the landscaped area and the fill underlying the structure. The dimensions of the transition zone will depend on the degree to which fill compaction was relaxed for the fill in the landscaped area. The location and extent of fill placed to a reduced standard of compaction shall be recorded.

14.2 Placing and Compacting Fill

14.2.1 Fill shall be placed and compacted in near-horizontal layers of the thicknesses required to achieve the approved method specification, and shall, as far as practicable, be brought up at a uniform rate so that all parts of the site or particular sections of the site reach finished (formation) level at the same time.

14.2.2 The compaction plant selected, the number of passes made and the fill layer thickness and moisture content used shall be to the specified method and the means and manner of control testing.

14.2.3 Where several different types of fill material (all meeting the requirements of Section 4 of this specification) are to be employed, they shall be deposited in such a way that all parts or particular sections of the site receive roughly equal amounts of a given material, in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness.

14.2.4 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the specified level of compaction and shall, where necessary, add water to or dry the fill, in order to obtain this value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.

14.2.5 Cobbles, boulders, rock or waste fragments, the largest dimension of which is greater than two-thirds of the compacted layer thickness, shall **not** be incorporated into the fill.

14.2.6 The likely maximum layer thickness is 300mm, however this is dependent on the mass per metre width of the compactive plant and the earthworks material classification (see Table 6/4 in Appendix A).

14.2.7 No fill shall be placed and left uncompacted at the end of the working day. Compacted fill shall be graded to falls to ensure free run-off of rainwater without ponding.

14.2.8 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all work shall be performed in such a way as to ensure that their existing stability is not impaired.

14.2.9 If weather conditions are such that the specified moisture content and density values cannot be achieved, the Contractor shall cease work until such time as the fill can be placed and compacted to meet specification requirements.

14.2.10 If the results of control tests (Section 15) indicate that the fill is being placed and compacted in such a way that the desired level of compaction is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.

14.2.11 If the results of control tests (Section 15) indicate that antecedent weather conditions (such as frost or heavy rain) have caused deterioration of finished work such that the work no longer meets with the specification, the Contractor shall, at his or her own cost, take such steps as are necessary to bring the fill to specification requirements.

14.3 Identification and Treatment of Soft Spots

14.3.1 Soft spots are to be identified and treated prior to filling.

14.3.2 Soft spots are defined as areas where the exposed surface comprises cohesive material with an undrained shear strength when measured using a Hand Shear Vane (HSV) of less than 50kN/m^2.

14.3.3 Where soft spots are encountered prior to upfilling or within the finished formation of cut areas then these shall be excavated and replaced to their full depth.

14.3.4 HSV testing should be undertaken in accordance with BS1377 (1990) with 3 tests undertaken at each location and an average of the shear strength values used in 'soft spot' determination.

15 CONTROL TESTING

15.1 The **end product** requirements shall be controlled by in-situ and laboratory testing as follows:

- In-situ-dry density (BS1377:Part 9:1990, Section 2) comprising sand replacement density tests, core cutters, nuclear density gauge etc.
- Moisture content determinations (BS1377:Part2:1990, Section 3) shall be performed as soon as is practical after placement so as to prevent changes in moisture content that can be caused by the weather being reported as compaction moisture contents.
- Control tests shall be performed by the Engineer throughout the fill at such frequency and at such locations as shall be deemed necessary by the Engineer at no cost to the Contractor. See Table 1/1.
- Extra testing will be required in visually doubtful areas or previously failed areas.

15.2 The Engineer shall make available a plot of in-situ dry densities against in situ moisture content results on a graph showing that the results lie within or above the shaded area. Should any results lie outside the shaded area, the Contractor shall agree with the Engineer proposals for rectifying the existing situation and for improving future performance.

15.3 The compacted layer thickness shall be checked by the Engineer using profile boards installed by the Contractor at his own cost or by laser level supplied by the Contractor at his own cost.

15.4 The numbering system to be adopted for Quality Control testing shall be decided by the Engineer at the start of the works. The system adopted shall enable the location of each test to be identified in the works ie plan location and level beneath final formation level. The date of test shall also be included.

15.5 For example, Attenuationpond/1.2/25May would indicate a test under the attenuation pond at a depth of 1.2m below final formation level carried out on 25th May. The testing laboratory shall be informed of the number of each test they perform and shall report that number on the results sheet.

16 MONITORING OF FILL PERFORMANCE

16.1 If instructed by the Engineer, the Contractor shall make arrangements for the performance of the fill, once placed, to be monitored. Monitoring may take one or more of the following forms:

- Rod & plate
- Optical levelling of surface monuments
- Standpipes or piezometers
- Load tests
- Other methods as directed by the Engineer

Note: Monitoring of fill performance shall only be carried out if specifically required by the Client and then only after consultation with the Supervising Engineer. Properly compacted fill using this Specification should not be required to meet criteria at the end of the fill operations. The only useful purpose for carrying out such monitoring is to obtain allowable bearing pressures and settlement parameters.

16.2 It is envisaged that **Rod & Plate** settlement monitoring will be required in areas of upfilling at c. six locations, across the development platform. Additional locations may be required.

16.3 **Load tests** (1.2x anticipated design load) placed in general accordance with BS1377: Part 9 will likely be required across the footprint of the former opencast at a minimum of six locations. Additional locations may be required.

16.4 The Contractor shall, within twenty-one working days of receiving notification of the Engineer's intention to monitor fill performance, arrange for the procurement and supply of the equipment to the Engineer's written specification and shall inform the Engineer of the date on which the equipment installation shall commence. The specification shall include:-

- A full description of the nature and type of instrument and the purpose it fulfils
- The number required and the locations and/or depths at which it is to be installed
- The frequency, accuracy and duration for which any readings are to be taken

17 REPORTING

17.1 On satisfactory completion of all the earthworks, the Engineer will provide a Validation Report, comprising relevant site records. This Report will provide confirmation that the earthworks have been carried out in accordance with this Specification.

17.2 The Validation Report shall include, but not be limited to the following:

- A description of the works undertaken
- Records of the works
- Details of any non-compliance and what was done to rectify the non-compliance
- Photographic record of the earthworks
- Geotechnical test results
- As built surveys, including base of excavation and final finished levels
- Constraints drawing, recording any retained below ground obstructions / structures, where exposed during excavations.

APPENDIX A

Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (see Footnotes)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance With:	Acceptable Limits Within:-					
									Lower	Upper				
General Granular Fill	1	C	-	Coarse granular fill	General Fill	Any material or combination of materials, other than material designated as Class 3 in the Contract. (Properties I, ii and iv in the next column shall not apply to chalk). Recycled aggregate.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product: 95% of maximum dry density of BS 1377: Part 4 (4.5kg rammer method) and a dry density correspondin g to a maximum of 5% air voids at field mc	1	C	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) Los Angeles coefficient	Clause 632	-	50				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance With:	Acceptable Limits Within:-					
									Lower	Upper				
General Cohesive Fill	2	B	-	Dry Cohesive Fill	General Fill	Any material or combination of materials other than chalk	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product: 95% of maximum dry density of BS 1377: Part 4 (4.5kg rammer method) and a dry density corresponding to a maximum of 5% air voids at field mc	2	B	-
							(ii) plastic limit (PL)	BS 1377: Part 2	-	65%				
							(iii) moisture content	BS 1377: Part 2 See Note 4	App 6/1	PL -4%				
							(iv) undrained shear strength (remoulded / hand vane)	Clause 632	50kN/m^2	-				

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance With:	Acceptable Limits Within:-					
									Lower	Upper				
General Cohesive Fill	2	C	-	Stony Cohesive Fill	General Fill	Any material or combination of materials other than chalk	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	End product: 95% of maximum dry density of BS 1377: Part 4 (4.5kg rammer method) and a dry density corresponding to a maximum of 5% air voids at field mc	2	C	-
							(ii) plastic limit (PL)	BS 1377: Part 2	-	65%				
							(iii) moisture content	BS 1377: Part 2 See Note 4	App 6/1	App 6/1				
							(iv) undrained shear strength (remoulded / hand vane)	Clause 632	50kN/m^2	-				

Footnotes to Table 6/1

1. Reference to Clauses refers to Clauses within the Manual of Contract Documents for Highway Works Volume 1: Specification for Highway Works: Series 600: Earthworks
2. Tab = Table
3. Where in the acceptable Limits Column reference is made to App 6/1, only those having limits ascribed in Appendix 6/1 shall apply. Where Appendix gives limits for other properties not listed in this Table such limits shall also apply.
4. Where BS1377: Part 2 is specified for mc, this shall mean BS1377: Part 2 or BS812: Part 3 as appropriate.
5. Uniformity Coefficient is defined as the ratio of particle diameters D60 to D10 on the particle distribution curve where:
   D60 = particle diameter at which 60% of the soil by weight is finer
   D10 = particle diameter at which 10% of the soil by weight is finer
6. Determination of moisture content shall be made from that part of the material passing the 20mm BS Sieve.
7. Moisture content limits are subject to confirmation during the works as fill classification data becomes available.

Table 6/2: Grading Requirements for Acceptable Earthworks Materials

Percentage by Mass passing the Size Shown																				
Class	**Size (mm)**		**Size (mm) BS Series**													**Size (microns) BS Series**				**Class**
	500	**300**	**125**	**90**	**75**	**37.5**	**28**	**20**	**14**	**10**	**6.3**	**5**	**3.35**	**2**	**1.18**	**600**	**300**	**150**	**63**	**2**	
1C	100		10-95													0-25			15		1C
2B			100											80-100					15-100		2B
2C			100											15-80					15-80		2C

Table 6/4: Method Compaction for Earthworks Materials: Plants and Methods (Method 1 to Method 6)

Type of Compaction Plant	Ref. No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110mm	N for D = 150mm	N for D = 250mm
Vibratory Roller		Mass per metre width of a vibratory roll													
	1	Over 270 kg up to 450 kg	unsuitable		75	16	150	16	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	Over 450 kg up to 700 kg	unsuitable		75	12	150	12	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	3	Over 700 kg up to 1300 kg	100	12	125	10	150	6	125	10	unsuitable		16	unsuitable	unsuitable
	4	Over 1300 kg up to 1800 kg	125	8	150	8	200	10*	175	4	unsuitable		6	16	unsuitable
	5	Over 1800 kg up to 2300 kg	150	4	150	4	225	12*	unsuitable		unsuitable		4	6	12
	6	Over 2300 kg up to 2900 kg	175	4	175	4	250	10*	unsuitable		400	5	3	5	11
	7	Over 2900 kg up to 3600 kg	200	4	200	4	275	8*	unsuitable		500	5	3	5	10
	8	Over 3600 kg up to 4300 kg	225	4	225	4	300	8*	unsuitable		600	5	2	4	8
	9	Over 4300 kg up to 5000 kg	250	4	250	4	300	6*	unsuitable		700	5	2	4	7
	10	Over 5000 kg	275	4	275	4	300	4*	unsuitable		800	5	2	3	6

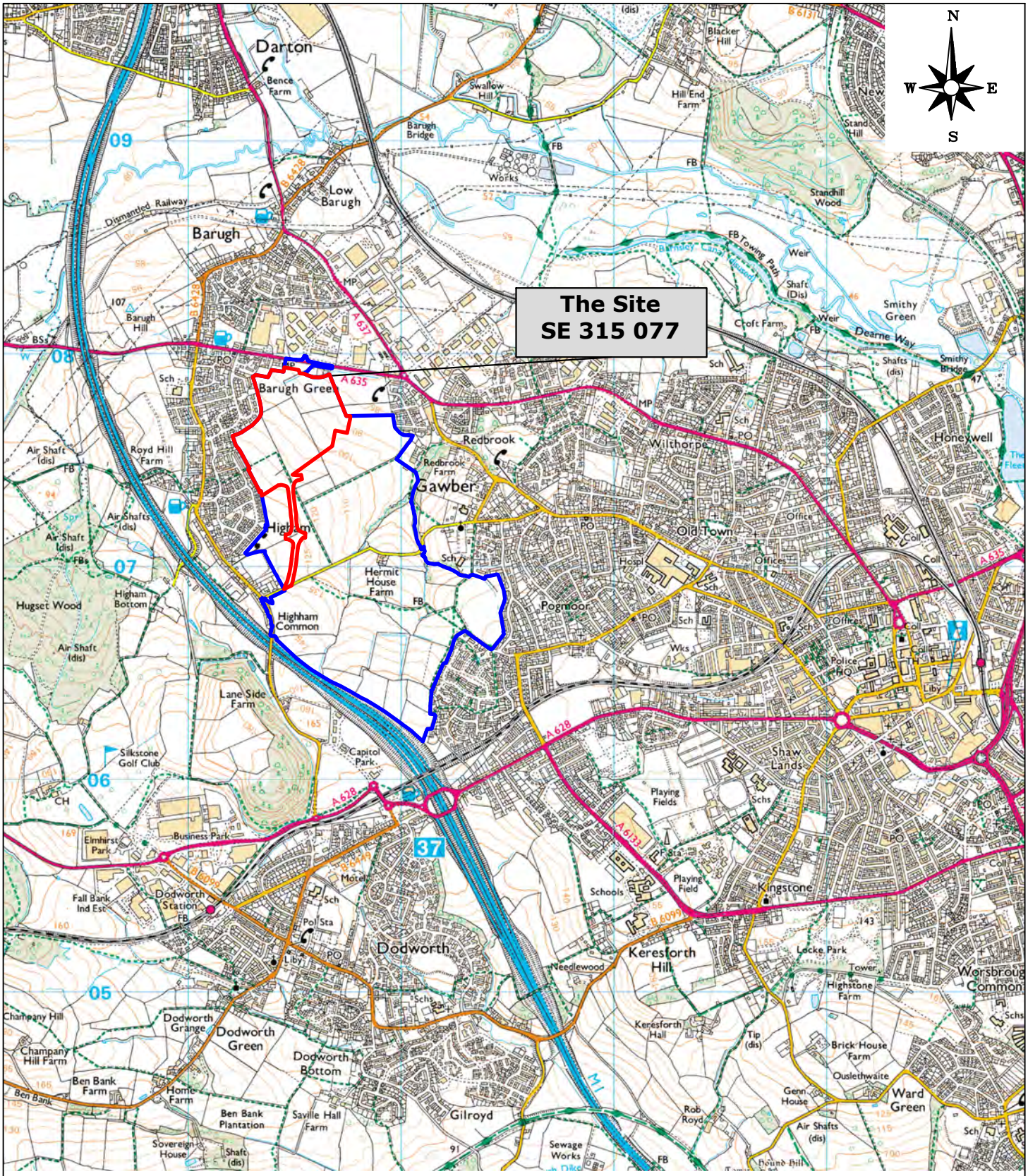
Extracted from Table 6/4 Specification for Highway Works Series 600 Amendment February 2016

Note: In column headed N# the number of passes is to be doubled for material classes 1A, 1B, 2A, 2B, 2C & 2D when such materials occur within 600mm of sub-formation (if capping is required) or formation

For items marked * in the Method 3 column the roller shall be towed by track-laying tractors. Self-propelled rollers are unsuitable

Appendix B

Drawings



APPROXIMATE LAND TRANSFER ONE BOUNDARY

APPROXIMATE WIDER BARNSLEY WEST DEVELOPMENT BOUNDARY

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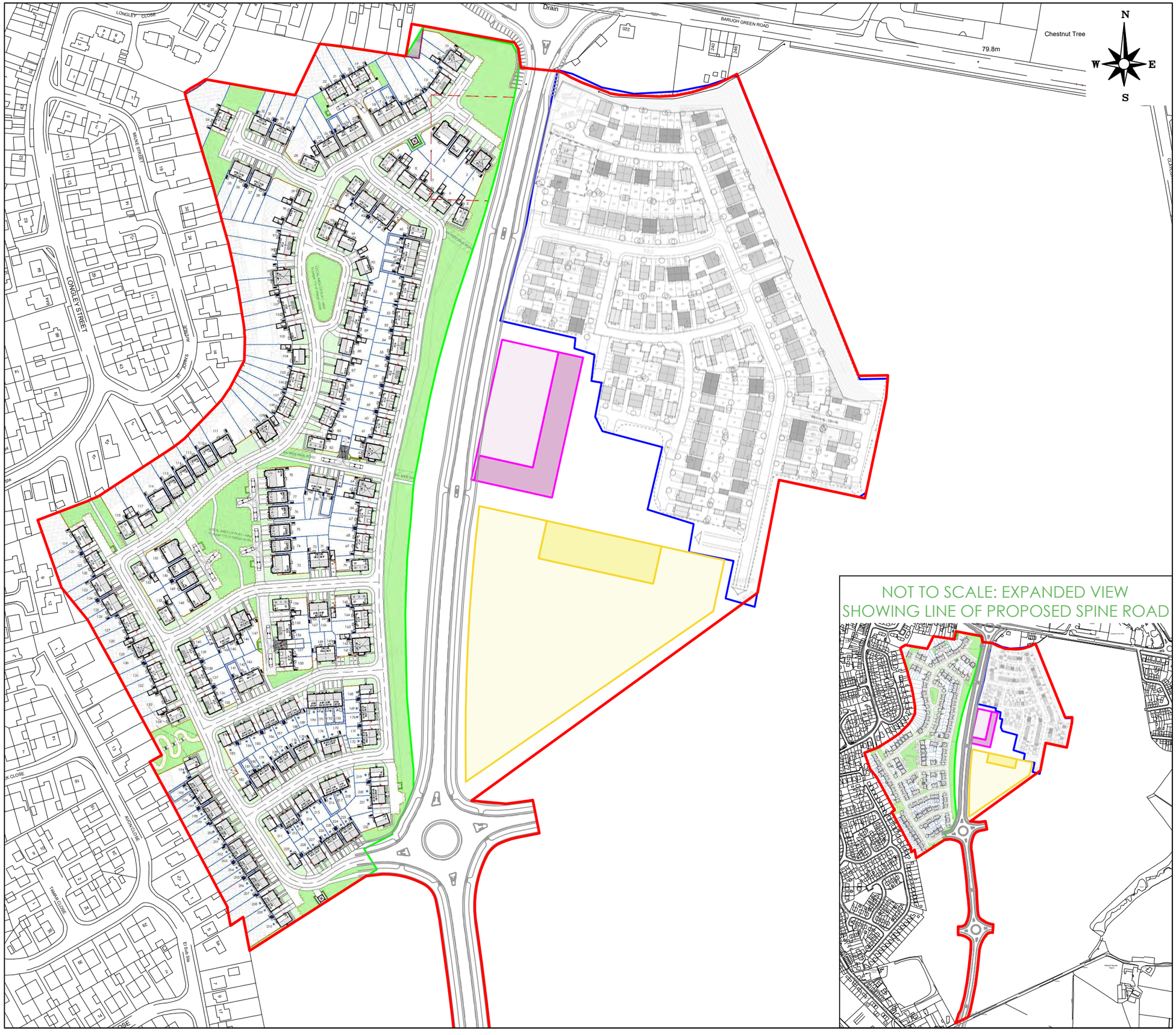
CLIENT	STRATA HOMES
JOB TITLE	BARNSLEY WEST, LAND TRANSFER ONE
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	GLM
DATE	06/10/2021
CHECKED	AG
DATE	06/10/2021
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	3104/1
REVISION	



NOTES

DEVELOPMENT AREA 1

REPRODUCED FROM STRATA HOMES' DRAWING 'BARNSLEY WEST PHASE 1, S75 1 - SKETCH LAYOUT' REF. 20-CL4-SEGB-BWP1-02 REV. J, DATED 18/06/2021

DEVELOPMENT AREA 2

REPRODUCED FROM MILLER HOMES' DRAWING 'BARNSLEY WEST SK04, REF. SK04, ISSUED BY STEN ARCHITECTURE IN MARCH 2021

DEVELOPMENT AREA 3 (RETAIL)

DEVELOPMENT AREA 4 (SCHOOL)

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

NOT TO SCALE: EXPANDED VIEW SHOWING LINE OF PROPOSED SPINE ROAD

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CLIENT

STRATA HOMES

JOB TITLE

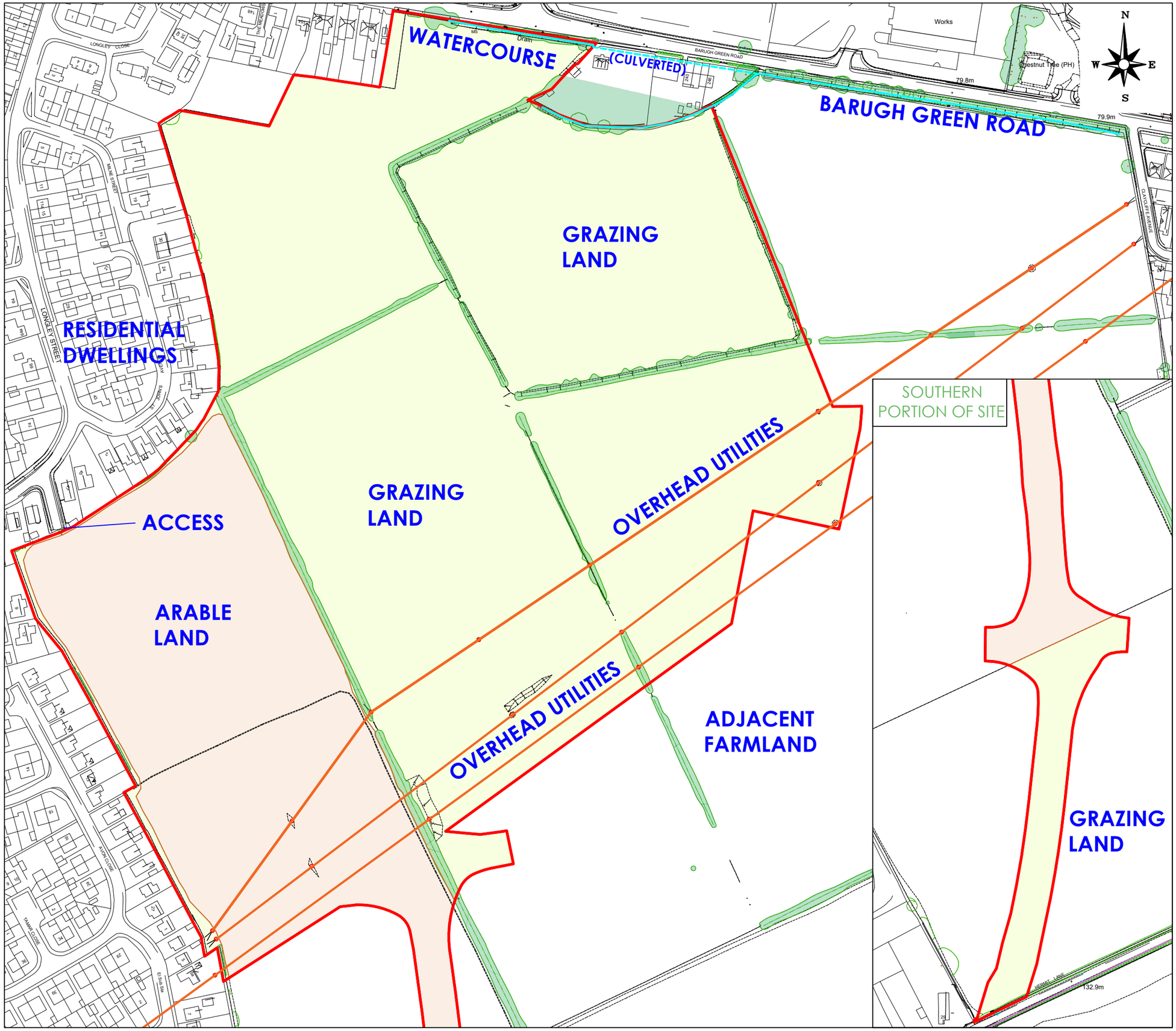
BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
GLM	06/10/2021	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☐
AG	06/10/2021	FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2,500	A3	3104/2	



NOTES

- GRASS & OVERGROWN AREAS
- ARABLE FARMLAND (STUBBLE)
- OVERHEAD UTILITY
- LINE OF WATERCOURSE
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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JOB TITLE

BARNSLEY WEST, LAND TRANSFER ONE

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
GLM	28/10/2021	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	28/10/2021	DRAFT ☐
		FINAL ☑

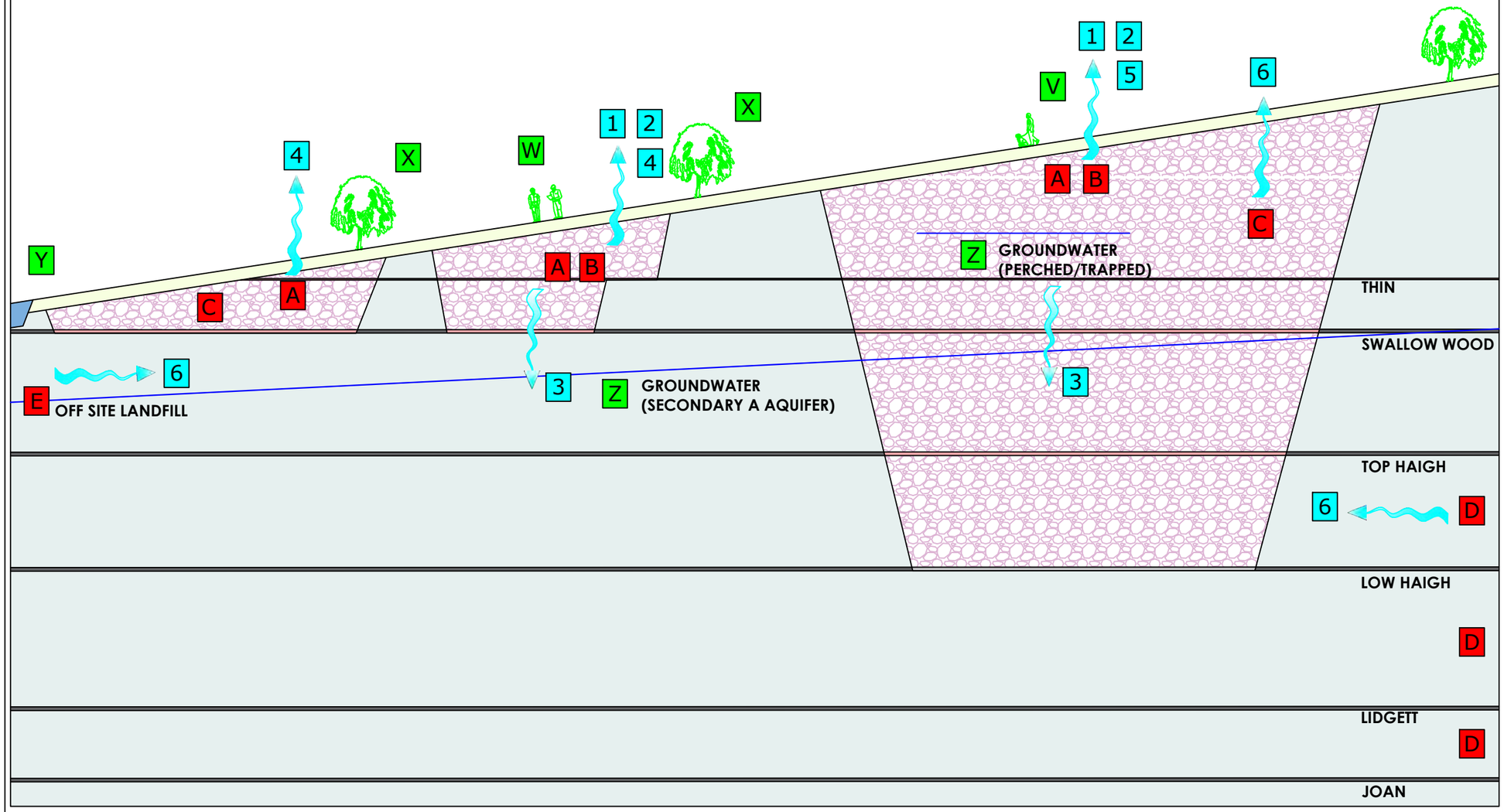
SCALE	SHEET	DRAWING NO.	REVISION
1:1,250	A3	3104/3	

RESIDENTIAL/COMMERCIAL DEVELOPMENT AREAS

CRAVEN I OPENCAST

SPINE ROAD

CRAVEN II OPENCAST



KEY
TOPSOIL
MADE GROUND (OPENCAST BACKFILL)
COAL
LOWER COAL MEASURES

SOURCES
A MADE GROUND (INORGANICS)
B LEAKAGE/SPILLAGE (ORGANICS)
C DEEP MADE GROUND (GAS)
D COAL/MINEWORKINGS (GAS)
E OFF SITE LANDFILL(GAS)

PATHWAYS
1 DERMAL CONTACT
2 INGESTION/INHALATION
3 LEACHING OF CONTAMINANTS
4 UPTAKE BY PLANTS
5 VOLATILISATION
6 MIGRATION OF GAS

RECEPTORS
V END USERS (RESIDENTS)
W SITE WORKERS
X VEGETATION
Y SURFACE WATERS
Z GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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CLIENT

STRATA HOMES

JOB TITLE

BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
GLM	01/11/2021	FOR COMMENT ☐
		FOR APPROVAL ☐
		DRAFT ☐
CHECKED	DATE	FINAL ☑
AG	01/11/2021	

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3104/5	

SOUTHERN PORTION OF SITE

NOTES

- TRIAL PIT LOCATION
- TRIAL TRENCH LOCATION
- CABLE PERCUSSION BOREHOLE LOCATION
- ROTARY CORED BOREHOLE LOCATION
- PROBEHOLE LOCATION
- STITCH PROBEHOLE LOCATION
- GRASS & OVERGROWN AREAS
- ARABLE FARMLAND (STUBBLE)
- LINE OF OVERHEAD UTILITY
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

STRATA HOMES

JOB TITLE

BARNSLEY WEST, LAND TRANSFER ONE

DRAWING TITLE

EXPLORATORY HOLE LOCATION PLAN

DRAWN	DATE	STATUS
GLM	23/12/2021	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	23/12/2021	DRAFT ☐
		FINAL ☑

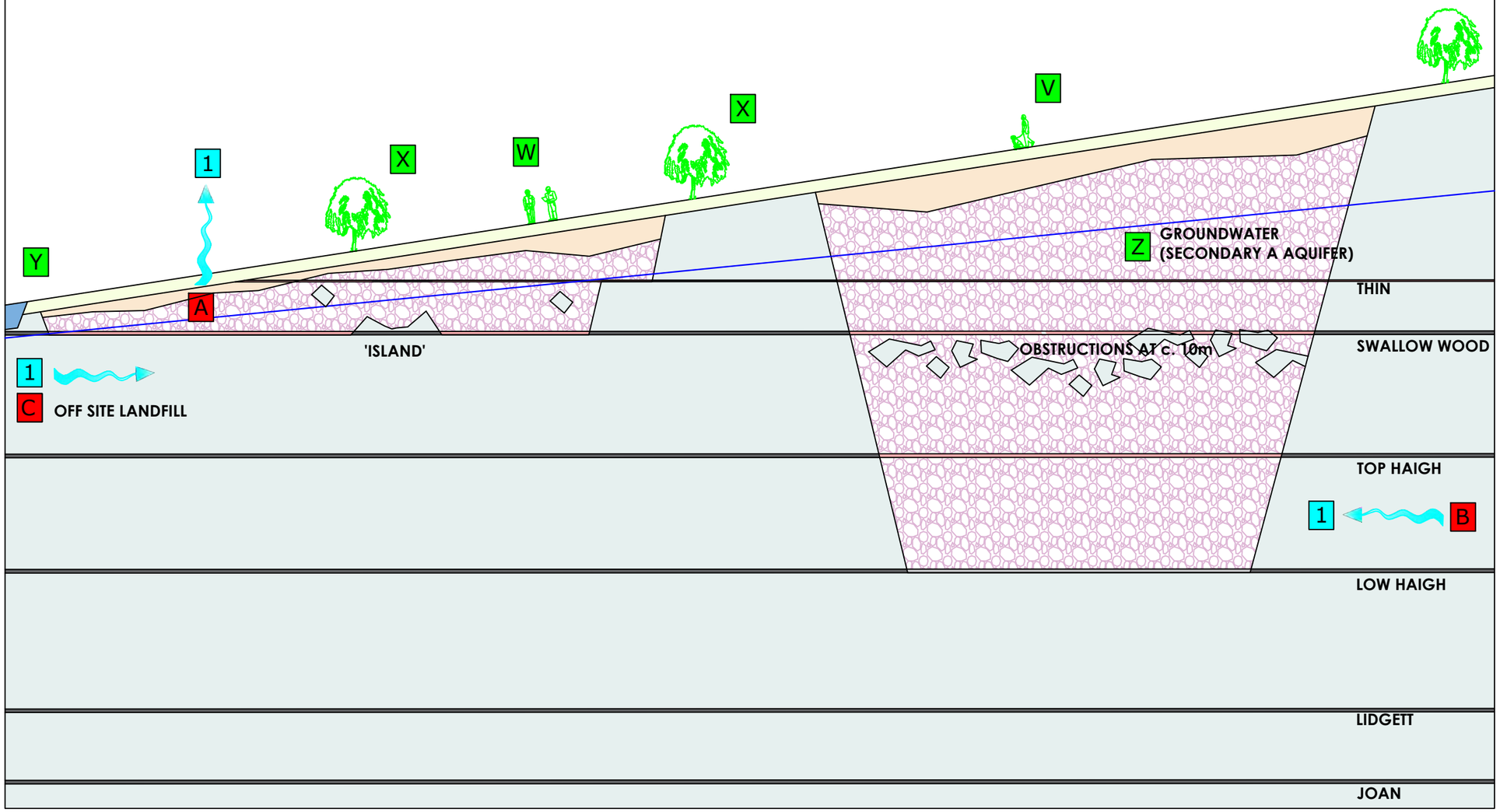
SCALE	SHEET	DRAWING NO.	REVISION
1: 1,250	A1	3104/6	

RESIDENTIAL/COMMERCIAL DEVELOPMENT AREAS

CRAVEN I OPENCAST

SPINE ROAD

CRAVEN II OPENCAST



KEY
TOPSOIL
COHESIVE MADE GROUND
COHESIVE/GRANULAR OPENCAST BACKFILL
COAL
LOWER COAL MEASURES

SOURCES
A DEEP MADE GROUND (GAS)
B COAL (GAS)
C OFF SITE LANDFILL (GAS)

PATHWAYS
1 MIGRATION OF GAS

RECEPTORS
V END USERS (RESIDENTS)
W SITE WORKERS
X VEGETATION
Y SURFACE WATERS
Z GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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STRATA HOMES

JOB TITLE

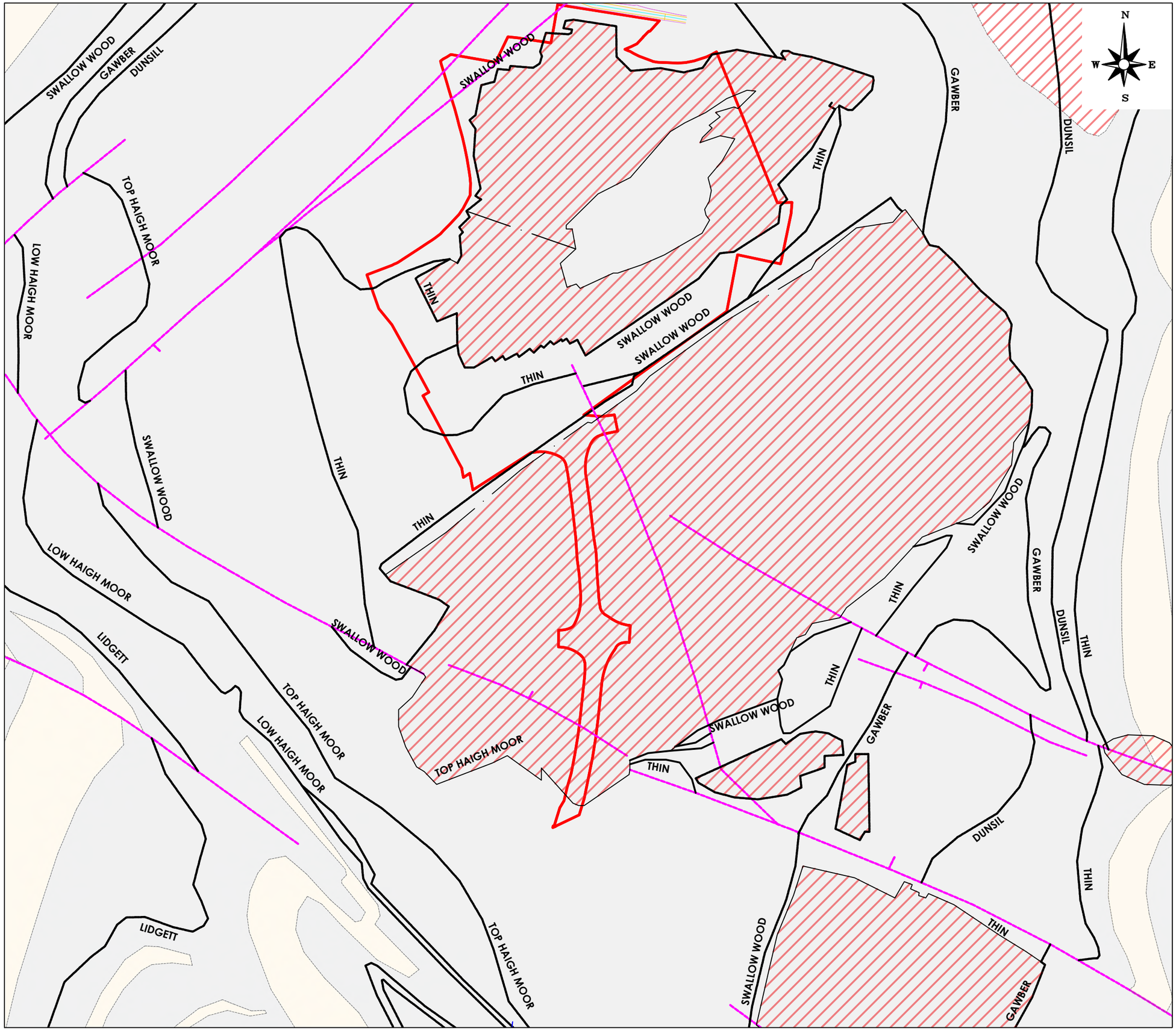
BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
GLM	22/02/2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	22/02/2022	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3104/7	



NOTES

- AREA OF MADE GROUND
- LOWER COAL MEASURES; INTERBEDDED MUDSTONE, SILTSTONE & SANDSTONE
- LOWER COAL MEASURES; SANDSTONE UNIT
- APPROXIMATE LINE OF FAULT
- APPROXIMATE COAL SEAM OUTCROP
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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STRATA HOMES

JOB TITLE

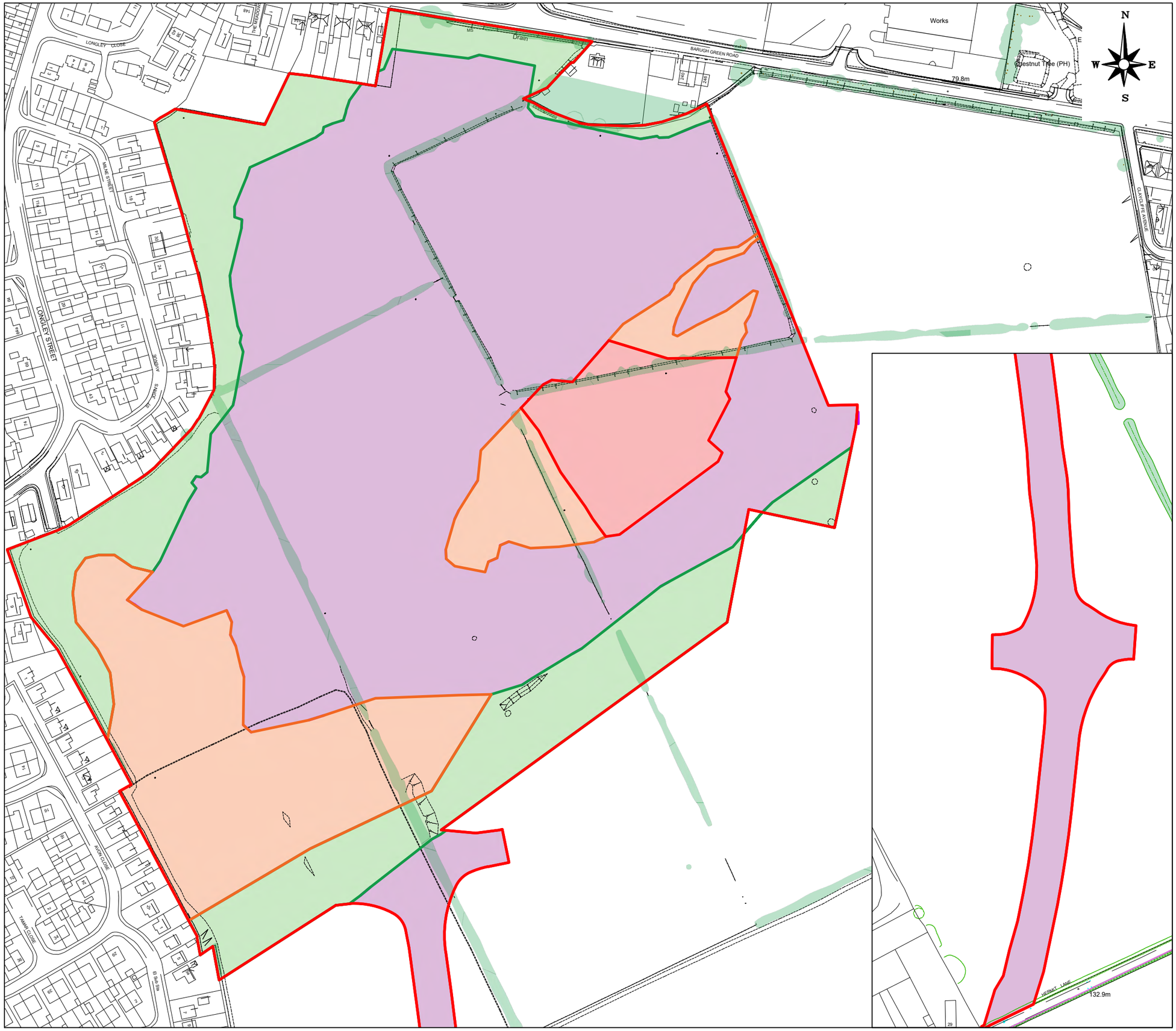
BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

SITE GEOLOGY

DRAWN	DATE	STATUS
GLM	06/10/2021	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	06/10/2021	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	3104/8	



NOTES

- AREA A: <0.9m MADE GROUND & OUTSIDE OF FORMER OPENCAST
- AREA B: 0.9m TO 2.5m MADE GROUND & OUTSIDE OF FORMER OPENCAST
- AREA C: >2.5m MADE GROUND & OUTSIDE OF FORMER OPENCAST
- AREA D: INSIDE FORMER OPENCAST
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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JOB TITLE

BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

SITE AREA BASED ON GROUND CONDITIONS

DRAWN	DATE	STATUS
GLM	06/01/2021	FOR COMMENT ☐
		FOR APPROVAL ☐
		DRAFT ☐
CHECKED	DATE	FINAL ☑
AG	06/01/2021	

SCALE	SHEET	DRAWING NO.	REVISION
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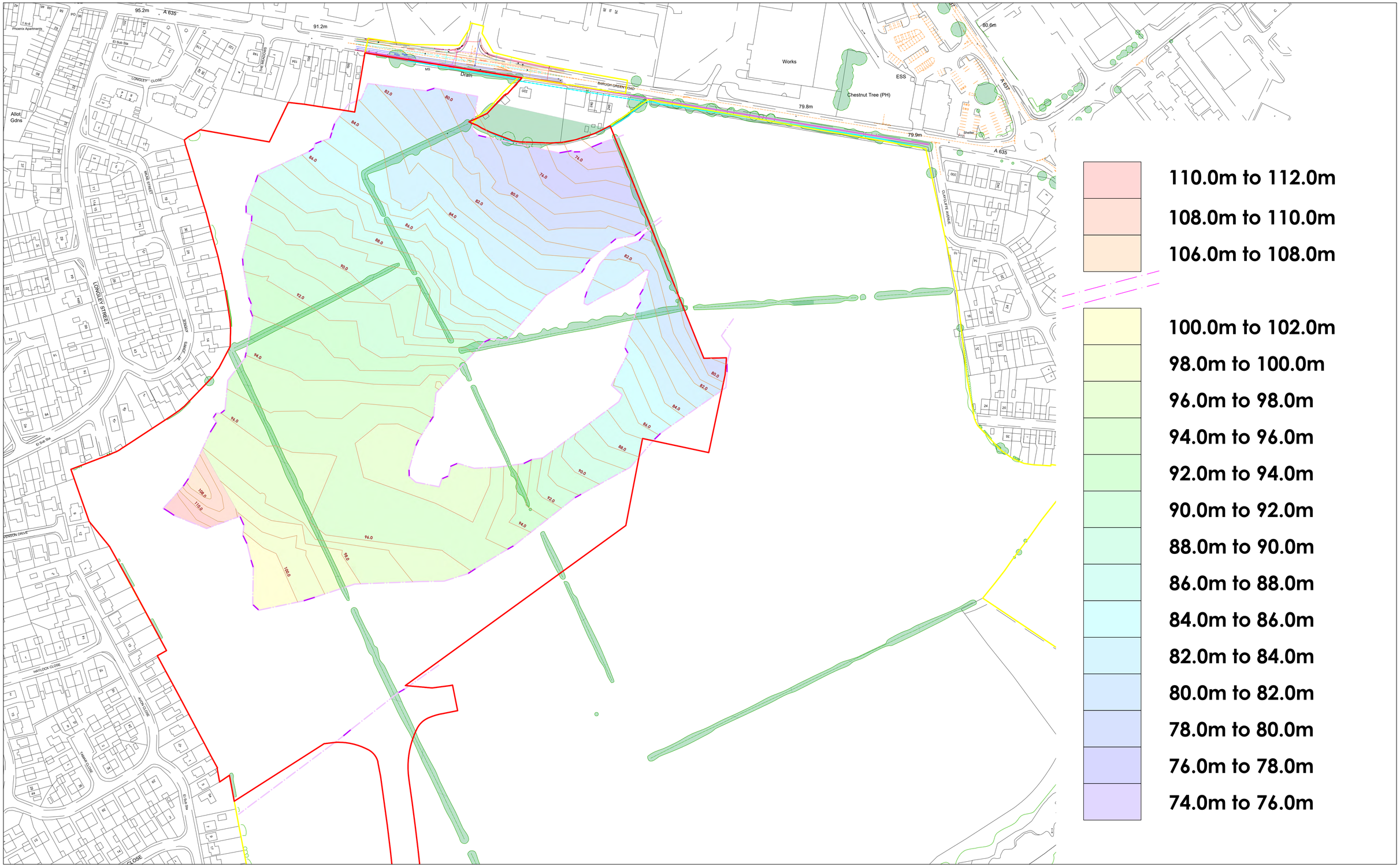

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CLIENT
STRATA HOMES

JOB TITLE
BARNSLEY WEST,
LAND TRANSFER ONE

DRAWING TITLE
BASE OF MADE GROUND INSIDE FOOTPRINT OF FORMER OPENCAST (mAOD)

KEY
100.0 — CONTOUR LEVEL OF BASE OF MADE GROUND
QUARRY HIGHWALL (EXTRAPOLATED BETWEEN HOLES)
QUARRY HIGH WALL (SURVEYED POSITION)
APPROXIMATE SITE BOUNDARY

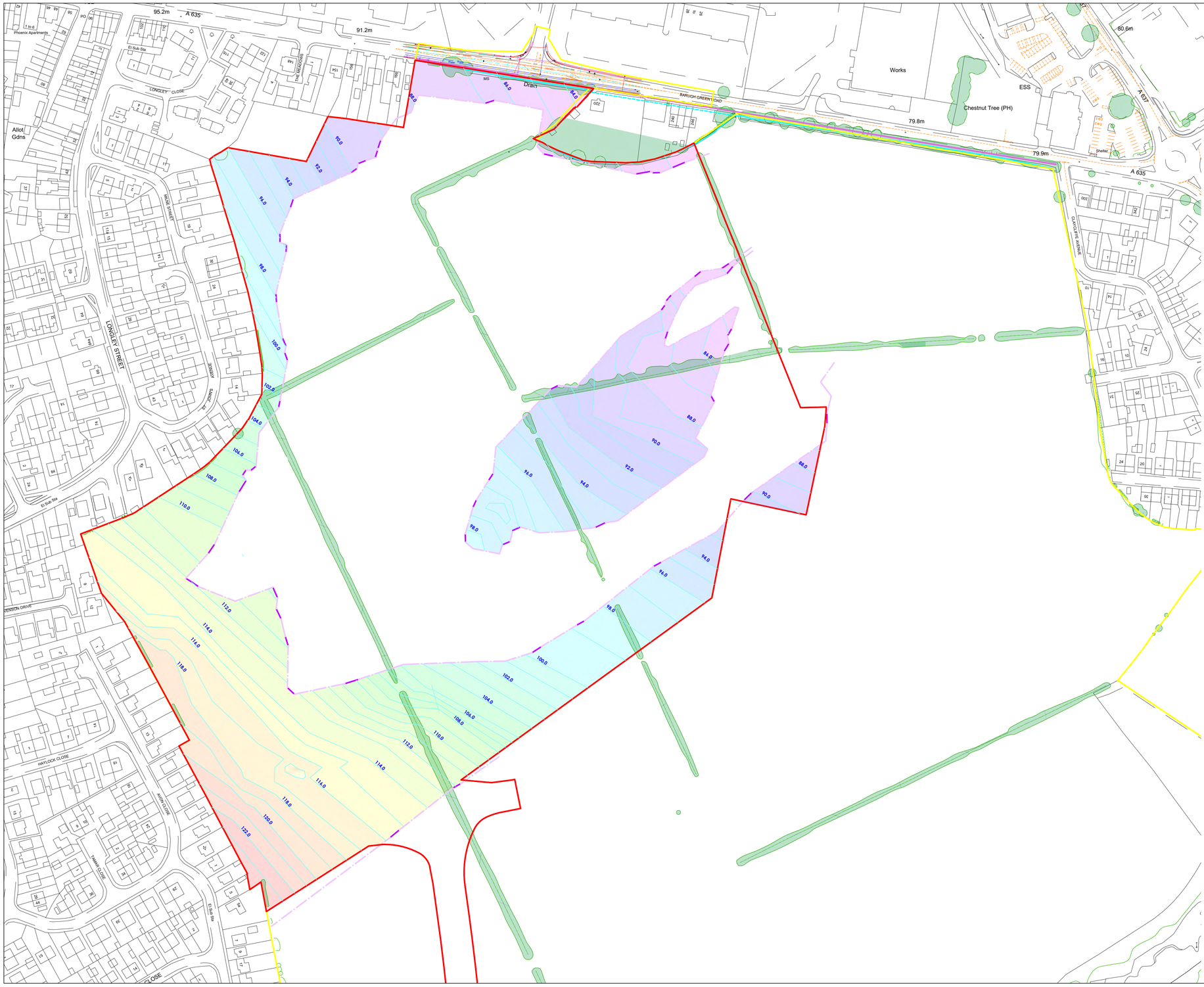
LEVEL OF MADE GROUND INTERPRETED FROM AVAILABLE EXPLORATORY HOLES ADVANCED BY LITHOS

NOTES

REV.	DESCRIPTION	DATE

STATUS: FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☑

DRAWN	DATE
GLM	21/01/2022
CHECKED	DATE
AG	21/01/2022
SCALE	SHEET
1:1,500	A1
DRAWING NO.	REVISION
3104/15A	



- 122.0m to 124.0m
- 120.0m to 122.0m
- 118.0m to 120.0m
- 116.0m to 118.0m
- 114.0m to 116.0m
- 112.0m to 114.0m
- 110.0m to 112.0m
- 108.0m to 110.0m
- 106.0m to 108.0m
- 104.0m to 106.0m
- 102.0m to 104.0m
- 100.0m to 102.0m
- 98.0m to 100.0m
- 96.0m to 98.0m
- 94.0m to 96.0m
- 92.0m to 94.0m
- 90.0m to 92.0m
- 88.0m to 90.0m
- 86.0m to 88.0m
- 84.0m to 86.0m
- 82.0m to 84.0m

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CLIENT: STRATA HOMES

JOB TITLE: BARNSLEY WEST, LAND TRANSFER ONE

DRAWING TITLE: BASE OF MADE GROUND OUTSIDE FOOTPRINT OF FORMER OPENCAST (mAOD)

KEY
- 100.0 CONTOUR LEVEL OF BASE OF MADE GROUND
- QUARRY HIGHWALL (EXTRAPOLATED BETWEEN HOLES)
- QUARRY HIGH WALL (SURVEYED POSITION)
- APPROXIMATE SITE BOUNDARY

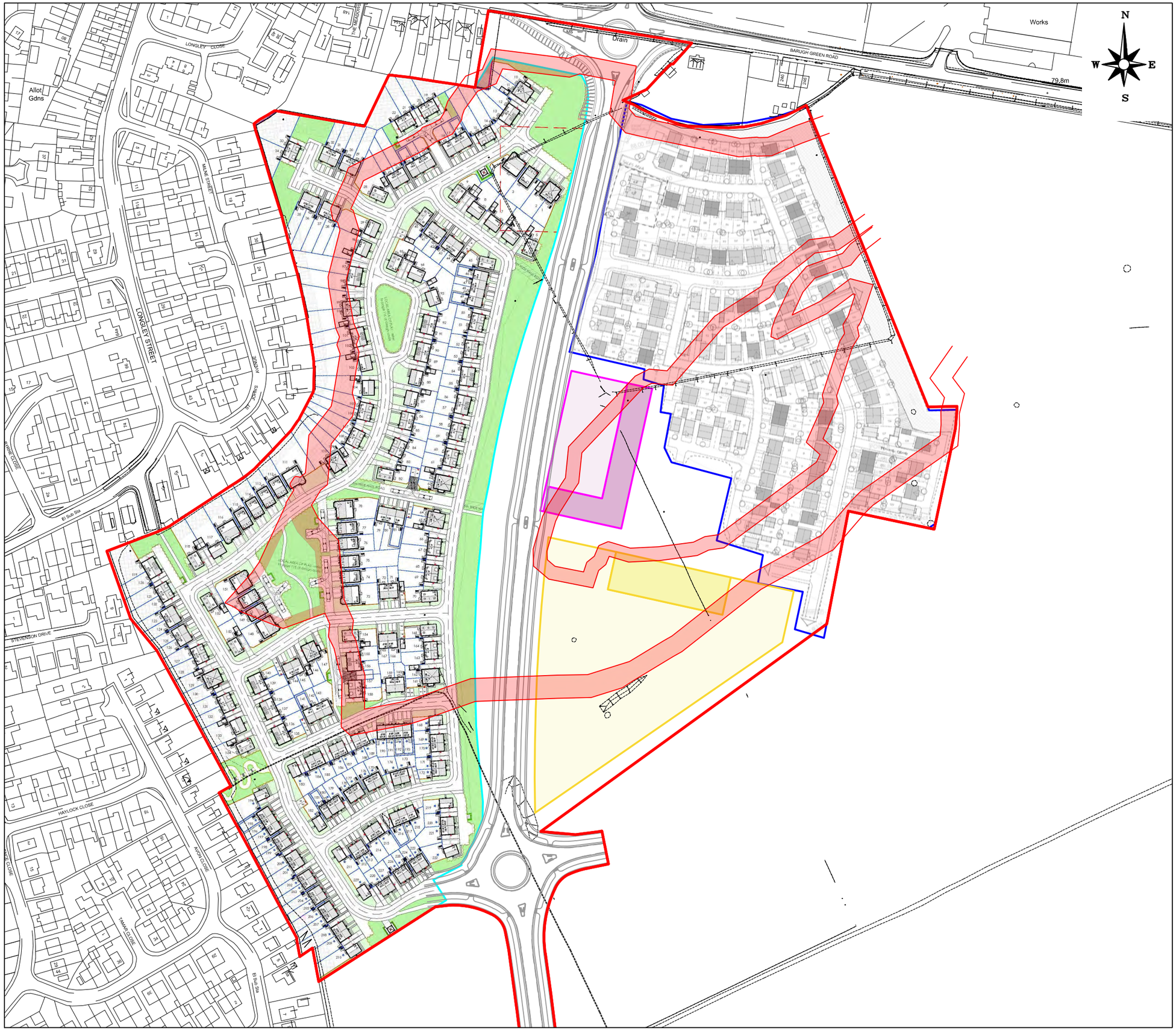
LEVEL OF MADE GROUND INTERPRETED FROM AVAILABLE EXPLORATORY HOLES ADVANCED BY LITHOS

NOTES

REV.	DESCRIPTION	DATE

STATUS: FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☑

DRAWN	DATE
GLM	21/01/2022
CHECKED	DATE
AG	21/01/2022
SCALE	SHEET
1:1,500	A1
DRAWING NO.	REVISION
3104/15B	



NOTES

ZONE OF INFLUENCE OF BURIED HIGHWALLS - MORE ROBUST FOUNDATION SOLUTION REQUIRED

DEVELOPMENT AREA 1

REPRODUCED FROM STRATA HOMES' DRAWING 'BARNSLEY WEST PHASE 1, S75 1 - SKETCH LAYOUT' REF. 20-CL4-SEGB-BWP1-02 REV. J, DATED 18/06/2021

DEVELOPMENT AREA 2

REPRODUCED FROM MILLER HOMES' DRAWING 'BARNSLEY WEST SK04, REF. SK04, ISSUED BY STEN ARCHITECTURE IN MARCH 2021

DEVELOPMENT AREA 3 (RETAIL)

DEVELOPMENT AREA 4 (SCHOOL)

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

STRATA HOMES

JOB TITLE

BARNSLEY WEST,
LAND TRANSFER
ONE

DRAWING TITLE

OPENCAST HIGHWALL ZONE OF INFLUENCE AND PROPOSED LAYOUT

DRAWN	DATE	STATUS
GLM	10/03/2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	10/03/2022	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2,500	A3	3104/16	

Appendix C

Protocol for Soil Import (cover soils)

1 INTRODUCTION

1.1 Isolation of made ground in garden and landscaped areas beneath a cover of "clean" subsoil, and topsoil is often recommended on new developments; most notably when the made ground contains inorganic (and non-volatile organic) contaminants at concentrations above relevant guidance threshold values. A cover solution is not appropriate for volatile or semi-volatile organic contaminants (fuels, solvents etc); removal or treatment will usually be required.

1.2 The thickness of cover is dependent on the end use of the development, nature and degree of contamination (and sometimes the Local Authority whose area the site lies within), Typically for a commercial development between 300mm and 1,000mm thickness is required and for a residential development between 600mm and 1,000mm thickness is required. Regardless of the type of development, where contamination is more significant a granular hard-dig layer or geotextile marker membrane may also be required at the base of the cover.

1.3 The "clean" soil cover blocks potential linkages between the contaminated made ground and future site users. Soil cover is not required beneath areas of hardcover including buildings, private drives, carparking and roads.

1.4 If the made ground is essentially "clean", but contains materials generally considered undesirable as near-surface material in garden and landscaped areas (e.g. oversize materials such as construction/demolition rubble) then placement of cover is also required. In private gardens, in accordance with NHBC Standards Chapter 10.2, a 450mm thick soil cover should be adequate. In landscaped areas a 300mm thick soil cover should be adequate. For both gardens and landscaped areas if the made ground is essentially "clean" and comprises reworked natural soil, the only cover likely to be required is 100mm topsoil.

1.5 The **CML initiative** came into force in April 2003 and relates specifically to residential developments. It requires housebuilders to submit to NHBC (or other warranty providers) a validation report confirming the thickness and quality (i.e. contaminant-free) of the placed soil cover. Validation reports should normally be prepared by independent geoenvironmental consultants.

1.6 Failure to submit cover validation reports promptly will delay issue of the cover note by the warranty provider, which will subsequently delay the release of mortgage funds and hence legal completion; i.e. the financial implications are significant. Consequently, it is essential that cover validation is requested at least 2 weeks prior to the anticipated finalling date.

1.7 For all land uses soil cover is usually placed many weeks after completion of the preparatory/remediation works, and issue of the associated Verification Report, typically at a relatively late stage in the construction programme.

1.8 Prior to placement of soil cover, the appointed remediation contractor and/or groundworker should ensure that ground levels are low enough to accommodate the required cover thickness, taking account of any boundary issues, and, where relevant, without compromising the DPC and any sub-floor ventilation.

1.9 Ideally soil quality should initially be determined by sampling of the source (at least 7 working days before importation to the development site) to demonstrate suitability for use. Further sampling of the material at the site may also be required to demonstrate cross contamination did not occur during the importation process. Samples could also be obtained from stockpiles of site won material on site; there may comprise surplus natural ground development arisings. Soil samples could be obtained after placement of the cover layer, but this is not recommended.

1.10 Imported topsoil should be subject to testing, unless it is being sourced from a reputable commercial supplier able to provide robust certification (certificate date less than 2 months prior to import date). In addition, some analysis in accordance with BS3882 may occasionally be appropriate.

1.11 Where sampling of the source has been carried out, and on receipt of the laboratory results, Lithos will issue a confirmation of soil suitability for importation to the client, who will in turn instruct his contractor to commence importation.

1.12 Clearly, if soil cover is imported and placed before confirmation of its suitability, no guarantee can be given that validation work will yield the desired results. It may therefore be necessary to excavate and export the placed soil cover and/or import further "clean" soil.

1.13 It is likely that it will be necessary to stockpile imported soil cover material at the site. Where soils have been confirmed as suitable for use and temporarily stockpiled on site, stockpiles should be fenced-off and marked as containing certified topsoil/subsoil. The soil should be inspected prior to placement to confirm that it is the same material as previously tested, and that it has not been cross-contaminated with miscellaneous arisings generated during the construction works. Where material has been stockpiled on site for an extensive period of time further sampling may be required at the development site to demonstrate cross contamination has not taken place.

1.14 Soil **thickness** can only be checked after placement; this should be done before turfing / landscaping, but ideally after scaffolding has been dismantled.

1.15 ***Sampling Frequency (to check Soil Quality):*** The number of samples tested will be dependent on the nature of the source, and the quantity of material to be imported. However, in accordance with current YALPAG (Yorkshire & Lincolnshire Pollution Advisory Group) guidance[1], the testing frequency should be as follows:

Nature of source	Number of samples (from any single source material)	
	Up to 500m³	Per additional 500m³
Greenfield	At least 3#	1*
Brownfield	At least 6#	1*
Crushed product	At least 3	1*

* To be agreed with the relevant Local Authority

\# But could be up to 10 samples (if 500m³), depending on the Local Authority area within which the site is located.

1.16 On a typical residential development where gardens comprise a total area of 100m² (front and rear), and a soil cover thickness of 600mm including 100mm topsoil, for a brownfield source this testing frequency equates to approximately one topsoil sample per ten plots and one subsoil sample per two plots. Given the requirement to test a minimum number of samples from any one source, the testing frequency effectively increases for sites with only a small number of plots.

[1] *Verification Requirements for Cover Systems: Technical Guidance for Developers, Landowners & Consultants; Version 4.1, June 2021.*

1.17 **Inspection Frequency (to check soil thickness):** The number of inspection pits excavated to check cover thickness (and collect samples, if required) should be dependent on the end use of the development.

1.18 For **residential developments** the number of plots associated with a given site will dictate the number of inspection pits. The following frequencies are recommended for residential plots.

No. plots within development	Frequency of inspection pits	Remarks
1 to 5	1 pit per plot	e.g. for 3 plots, dig 3 inspection pits
6 to 20	1 pit per 2 plots	e.g. for 9 plots, dig 5 inspection pits
21 to 30	1 pit per 3 plots	e.g. for 23 plots, dig 8 inspection pits
≥ 30	1 pit per 4 plots	e.g. for 39 plots, dig 10 inspection pits

1.19 For **areas of landscaping**, regardless of development type, a minimum of 3 pits per area of soft landscaping are recommended where the landscaped area is greater than 25m^2. In individual landscaped areas smaller than 25m^2 inspection pits are not required.

1.20 Photographs should be taken of each inspection pit to show:

- The thickness of cover material present
- The presence of any geotextile marker or granular hard-dig layer (if required)
- The position of each inspection pit in relation to the plot/area of landscaping

1.21 **Soil Material Suitability**: Inspection pits should be excavated through the entire thickness of any proposed in-situ source material, or cover material (if inspection is post-placement). Stockpiles should be assessed from both the surface and by digging into the "core", to ensure the material is reasonably homogenous.

1.22 The soil material should comply with the following requirements:

- Be clean and free of foreign debris, building waste materials, glass sharps, and contaminants
- Topsoil should not have a gravel content of greater than 30% by dry weight and should generally have a maximum stone size of 50mm in any one direction
- Subsoil should generally have a maximum stone size of 75mm in any one direction
- Not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc)

1.23 **Laboratory Analysis:** Whether samples are taken at source, from stockpiles on site, or from gardens and landscaped areas after placement, they should be forwarded to an analytical laboratory for testing in accordance with one of the Schedules detailed in Table 1 overleaf.

1.24 Additional determinands may be scheduled dependent on the history of the source site, although if this is considered necessary it may suggest the material is unlikely to be suitable for use as clean cover.

Table 1 – Test schedule

Source	Test schedule
Greenfield & Manufactured topsoil	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & speciated PAH Asbestos ID
Brownfield & Soil transfer stations	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC, Speciated PAH & banded TPH* Asbestos ID
Crushed product	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH Asbestos ID

Note: The schedules detailed above have been prepared in accordance with the Secondary Model Procedures and Land Contamination Risk Management, 2020. This document states that analysis should be relevant to potential sources and not merely a set list of parameters applied to each site.

* The YALPAG guidance recommends speciated TPH (TPH CWG) analysis for brownfield sources, but this should not be necessary unless the banded TPH analysis fails the assessment criteria detailed in Table 2 below.

Where crushed product is used at least 600mm below finished garden level, only asbestos analysis will be required.

1.25 Chemical assessment (Tier 1) criteria for imported soils are provided in Table 2, these reflect exposure and toxicological amendments proposed within the C4SL report. Where no C4SL value has been published generic assessment criteria have been derived based on the C4SL assumptions using the CLEA model (version 1.701).

Table 2 - Chemical assessment criteria for imported soils

Contaminant	Source	Tier 1 assessment criteria (mg/kg)	Comments/notes
pH	CLEA		
As	C4SL	37	
Cd	C4SL	26	
Cr (III)	CLEA	4000	
Cr (VI)	C4SL	21	
Pb	C4SL	200	
Ni	CLEA	109	Assessment of human health risk only.
Se	CLEA	434	
Hg	CLEA	199	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.
Vn	CLEA	584	
B	Lithos	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependent).
Cu	DoE	100	
Zn	DoE	200	
Benzo(a)pyrene	C4SL	5	
Naphthalene	CLEA	6	
GRO	CLEA	22	Conservative value based on value for aromatic fraction C7 to C8 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
DRO	CLEA	215	Conservative value based on value for aliphatic fraction C10 to C12 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
LRO	CLEA	1,000	Calculated value above hazardous waste screen in WM3, therefore 1,000mg/kg adopted. This may be reviewed on a site specific basis depending on the source and nature of transfer.

2 VALIDATION REPORTS

2.1 The analytical testing will usually be undertaken on a 3 or 5-day turnaround and the Client/Contractor will be notified of the soil's suitability (or otherwise) immediately after receipt of the results.

2.2 Interim plot validation certificates for residential plots should be issued to warranty providers on a plot by plot (or block by block) basis as development proceeds. Once the full development has been completed these should be pulled together into a final verification report, for submission to the Local Authority to satisfy planning conditions.

2.3 Interim validation certificates will be issued by Lithos for each landscaped area or set of landscaped areas once completed. After Lithos have been able to confirm placement of agreed thicknesses of suitable soil cover in all landscaped areas across the site, and where required to satisfy a Local Authority planning condition, we will prepare and submit a final validation letter report.

Appendix D

Protocol for Soil Import (landscaped areas)

1 INTRODUCTION

1.1 Isolation of made ground in landscaped areas beneath a cover of "clean" subsoil, and topsoil is often recommended on new developments; most notably when the made ground contains inorganic (and non-volatile organic) contaminants at concentrations above guidance threshold values. A cover solution is not appropriate for volatile or semi-volatile organic contaminants (fuels, solvents etc); removal or treatment will usually be required.

1.2 The thickness of cover is dependant on the nature and degree of contamination (and sometimes the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. However, if the made ground is essentially "clean", but contains materials generally considered undesirable as a near-surface material in landscaped areas (colliery spoil, construction\demolition rubble etc) then a 300mm thick cover should be adequate. If the made ground is essentially "clean" and comprises reworked natural soil, the only cover likely to be required is topsoil.

1.3 The "clean" soil cover blocks potential linkages between the contaminated made ground and future users. Soil cover is not required beneath roads, car parking areas or buildings.

1.4 Soil cover is usually placed many weeks after completion of the preparatory\remediation works, and issue of the associated Verification Report, typically at a relatively late stage in the construction programme.

1.5 Prior to placement of soil cover, the appointed remediation contractor and\or groundworker should ensure that ground levels are low enough to accommodate the required cover thickness, taking account of any boundary issues, and without compromising the DPC.

1.6 Ideally soil **quality** should be determined by sampling of the **source** at least 7 working days before importation to the development site. However, samples could be obtained from stockpiles on site; these may on occasion comprise subsoils associated with foundation\ drainage excavations in natural in-situ strata. Alternatively (but not recommended) soil samples could be obtained from landscaped areas after placement.

1.7 Clearly, if soil cover is imported and placed before confirmation of its suitability, Lithos cannot guarantee that our validation work will yield the desired results. In which case, it may be necessary to excavate and export the placed soil cover and\or import further "clean" soil.

1.8 Where samples have been tested at source, and on receipt of laboratory results, Lithos will issue confirmation of soil suitability to the Client, who in turn will instruct his Contractor to commence importation. It will probably be necessary to stockpile soil cover materials prior to placement in landscaped areas. Lithos should inspect the stockpiled material prior to placement, to confirm that it is the same material as previously tested, and it has not been cross-contaminated with miscellaneous arisings generated during the construction works.

1.9 Soil **thickness** can only be checked after placement; this should be done before turfing, fencing etc, but ideally after scaffolding has been dismantled.

1.10 ***Sampling Frequency (to check Soil Quality):*** The number of samples taken will be dependant on the nature of the source, and the quantity of material to be imported. However, typically a minimum of 6 samples of each soil type (from each source) should be tested, with a further sample for each 200m^3 of soil, where the quantity exceeds 1,200m^3. This frequency applies to both subsoil and topsoil; i.e. a minimum 6 samples of each will be required. Clearly, if subsoil were obtained from two different sources, it would usually be necessary to test a minimum of 12 samples.

1.11 **Inspection Frequency (to check Soil Thickness):** The number of inspection pits to check cover thickness (and collect samples, if testing at source has not been undertaken), should be dependant on the number and extent of landscaped areas associated with the development. The following frequencies are recommended:

1.12 For a non-residential development (eg schools, offices), a minimum of 3 inspection pits are recommended per area of soft landscaping.

1.13 **Soil Material Suitability**: Inspection pits should be excavated through the entire thickness of any proposed in-situ source material, or cover material (if inspection is post-placement). Stockpiles should be assessed from both the surface and by digging into the "core", to ensure the material is reasonably homogenous.

1.14 The soil material should comply with the following requirements:

- Be clean and free of foreign debris, building waste materials, glass sharps, and contaminants
- Topsoil should not have a gravel content of greater than 30% by dry weight and should generally have a maximum stone size of 50mm in any one direction
- Subsoil should generally have a maximum stone size of 150mm in any one direction
- Not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc)

1.15 **Laboratory Analysis:** Whether samples are taken at source, from stockpiles on site, or from landscaped areas after placement, they should be forwarded to an analytical laboratory for testing in accordance with one of the Schedules detailed in Table 1.

1.16 Imported topsoil should be subject to such testing, unless it is being sourced from a reputable commercial supplier able to provide robust certification (certificate date less than 2 months prior to import date). In addition, some analysis in accordance with BS3882 may occasionally be appropriate.

Table 1 – Test schedule

Source	Test schedule
Greenfield & Manufactured topsoil	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & speciated PAH Asbestos ID
Brownfield & Soil transfer stations	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC, Speciated PAH & banded TPH Asbestos ID
Crushed product	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH Asbestos ID

Note: The schedules detailed above have been prepared in accordance with the Secondary Model Procedures. This document states that analysis should be relevant to potential sources and not merely a set list of parameters applied to each site.

1.17 Additional determinands may be scheduled dependent on the history of the source site, although if this is considered necessary it may suggest the material is unlikely to be suitable for use as clean cover in landscaped areas.

1.18 Chemical assessment (Tier 1) criteria for imported soils are provided in Table 2.

Table 2 - Chemical assessment criteria for imported soils

Contaminant	Source	Tier 1 assessment criteria (mg/kg)	Comments/notes
pH	CLEA		
As	C4SL	37	
Cd	C4SL	26	
Cr (III)	CLEA	3,000	
Cr (VI)	C4SL	21	
Pb	C4SL	200	
Ni	CLEA	127	Assessment of human health risk only.
Se	CLEA	350	
Hg	CLEA	169	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.
B	Lithos	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependent).
Cu	DoE	80 to 200	
Zn	DoE	200	
Benzo(a)pyrene	C4SL	5.3	Surrogate marker for PAH
Naphthalene	CLEA	9	Calculated target was 142mg/kg driven by outdoor inhalation and direct contact. However, concentrations of this magnitude are likely to present a DRO issue and would not be considered appropriate as cover. Value for Scenario C of Lithos Screening values adopted as a precautionary approach.
GRO	CLEA	34	Conservative value based on value for aromatic fraction C7 to C8 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
DRO	CLEA	154	Conservative value based on value for aliphatic fraction C10 to C12 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
LRO	CLEA	2,000	Calculated value close to soil saturation limit, screening value selected by Lithos considering visual/olfactory impact.

2 VALIDATION REPORTS

2.1 The analytical testing will usually be undertaken on a 3 or 5-day turnaround and the Client/Contractor will be notified of the soil's suitability (or otherwise) immediately after receipt of the results.

2.2 Interim validation letter reports will be issued by Lithos as each landscaped area, or set of landscaped areas, is completed. After Lithos have been able to confirm placement of agreed thicknesses of suitable soil cover in all landscaped areas across the site, and where required to satisfy a Local Authority planning condition, we will prepare and submit a final validation letter report.