EARTHWORKS STRATEGY & GEOTECHNICAL DESIGN REPORT

Harras Dyke Farm
Harras Moor
Whitehaven

Reference	**6439-JPG-P2-XX-RP-G-0602-S2-P03**
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JPG. Cut & Fill Analysis. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-C-1200 S2 P01, dated 7 May 2025.

JPG. Dynamic Compaction Plan. Harras Dyke Farm, Whitehaven. Drawing No. 6439-JPG-ZZ-ZZ-DR-C-1350 S2 P02, dated 27 June 2025.

JPG. Dynamic Compaction Sections. Harras Dyke Farm, Whitehaven. Drawing No. 6439-JPG-ZZ-ZZ-DR-C-1351 S2 P02, dated 27 June 2025.

JPG. General Arrangement of Geogrids. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-C-1352 S2 P01, dated 30 May 2025.

JPG. Foundation Zoning Plan. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-C-1105 S2 P01, dated 14 May 2025.

CONFIDENTIALITY STATEMENT

This report is addressed to and may be relied upon by the following:

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This report has been prepared for the sole use and reliance of the above-named parties. This report shall not be relied upon or transferred to any other parties without the express written authorisation of JPG (Leeds) Limited. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

DOCUMENT HISTORY

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1.0 INTRODUCTION

1.1 Instruction

JPG (Leeds) Limited has been instructed on behalf of Thomas Armstrong (Construction) Limited to produce an Earthworks Strategy and Geotechnical Design Report for a proposed residential development at Harras Dyke Farm, Harras Moor, Whitehaven.

1.2 Objectives

The objective of the Earthworks Strategy and Geotechnical Design Report is to review ground investigation data to confirm the earthworks and ground improvement requirements for the development site.

1.3 Location & Site Description

Harras Dyke Farm is a former opencast coal site, which since restoration, has been used for agricultural land. There was no development, buildings or otherwise, present on the site at the time of the ground investigation.

The site has an irregular shape, occupying an area of approximately 4.4 hectares. There is a change in ground level from north to south, with land on the northern boundary of the site being approximately 6.00m higher than the land on the southern boundary. A fence/hedge/tree line extends north to south through east of the site. The ground surface is generally uneven and rutted.

A concrete plinth in the location of a mineshaft is present in the east of the site.

At the time of the site works there were isolated areas of standing water and boggy areas, in particular on the lower ground in the south and southwest of the site. A small, ponded feature was also present in the southwest.

An overhead power line crosses the northeast boundary of the site, aligned northwest to southeast, extending to adjacent agricultural land to the north. Two United Utilities assets are present within the site, extending north to south adjacent to the eastern boundary and extending east to west adjacent to the southern boundary. Existing surface water drainage is known to be present on site consisting of a series of land drains.

A public right of way that formally crossed the site had been rerouted at the time of the ground investigation.

The northern and eastern boundaries are defined by timber post and mesh field boundaries with Red Lonning (single carriageway) immediately to the east. The southern boundary is defined by a stone wall with Harras Road immediately beyond. A fence line was present in the west at the time of the investigation. However, this fence line did not correspond with the site boundary. Following the investigation, this fence was removed and new fencing erected along the ownership boundary.

Surrounding land use primarily comprises agricultural land. Whitehaven Golf Club is located beyond Red Lonning to the east of the site. Housing developments are located to the south and west of the site. Red Lonning Industrial Estate is located approximately 60m to the southeast of the site.

An aerial photograph of the site is included as Figure 2 in Appendix A.

1.4 Development Proposals

It is proposed to develop the site for a residential end use comprising 90 houses with gardens, garages, access roads and Public Open Space (POS).

A proposed development plan has been provided and is referenced below, a copy is also included in Appendix A.

- Manning Eliott Partnership. a/21/2196/0R1 Site Layout Plan as Proposed. Proposed Housing Development Land at Harras Dyke Farm, Whitehaven. Drawing no. 2258-PL210, dated April 2021.

1.5 Previous Reports

Several consultants including JPG have carried out site assessments, and the resulting reports are referenced below. Pertinent information contained within these reports has been utilised in this current assessment, these are detailed below.

- GEO Environmental Engineering. Phase 1: Desk Top Study Report (Preliminary Environmental Risk Assessment). Land at Harras Dyke, Harras Moor, Whitehaven, Cumbria. Ref, 2015-1558, Dated 23 July 2015.
- GEO Environmental Engineering. Review of Additional Coal Authority Information. Letter, sent by email. Dated 4 September 2015.
- Elliott Environmental Surveys. Coal Mining Risk Assessment. Harras Moor, Whitehaven, Cumbria. Reference, EES16-199, dated 23 December 2016.
- Sirius Geotechnical. Geoenvironmental Appraisal. Harras Moor, Whitehaven. Reference, C7728, dated December 2018.
- GEO Environmental Engineering. Preliminary Maintained Load Test Report. Proposed Residential Development of Land at Harras Dyke Farm, Whitehaven, Cumbria. Reference 2019-3889 dated 8 June 2020.
- GEO Environmental Engineering. Phase II: Ground Investigation Report. Proposed Residential Development of Land at Harras Dyke Farm, Harras Moor, Whitehaven, Cumbria. Reference 2019-3889, dated, 24 November 2020.
- Sword Geotechnical. Geotechnical Assessment. Harras Dyke Farm, Whitehaven, Cumbria. Reference, SG-Harras-001b, dated April 2021.
- Sirius Geotechnical. Supplementary Geotechnical Investigation Report. Harras Dyke Farm, Harras Moor, Whitehaven, Cumbria. Reference C10022, dated July 2024.
- JPG. Rationale and Scoping for Ground Investigation. Harras Road, Whitehaven. Reference, 6439-JPG-XX-XX-RP-G-0601-S2-P01, dated 4 February 2025.
- Zetica. Geophysical Survey of a Former Opencast Mine. Report reference P15594-24-R1-B. Dated 29 May 2025.
- JPG (Leeds). Supplementary Ground Investigation Report. Harras Dyke Farm, Harras Moor, Whitehaven. Reference, 6439-JPG-XX-XX-RP-G-0603-S2-P01, dated May 2025.

1.6 Geotechnical Category

The proposed development has been categorized as Geotechnical Category 2 as defined by British Standard EN 1997-1:2004 Eurocode 7 – Geotechnical Design.

This is because the development includes conventional types of geotechnical structures, earthworks and loading conditions with no exceptional risks identified. The identified geohazards are to be removed or suitably mitigated as part of the enabling works.

2.0 REVIEW OF GROUND INVESTIGATION REPORT

2.1 Fieldwork

Fieldwork was carried out by JPG between 10 March and 3 April 2025. The works undertaken are summarised in Table 2.1.1 below.

Table 2.1.1 – Summary of Ground Investigation Works

Investigation Method	No of Positions	Maximum Depth (m bgl)
Trial Pits	16 (TP101 – TP116)	4.40
Rotary Openhole Boreholes	17 (RO101 – RO116, RO107A)	45.00
Static Cone Penetration Tests	15 (See Lankelma Report for details)	30.38

bgl – below ground level *

The ground investigation was undertaken in general accordance with the techniques outlined in BS5930: 2015 *Code of Practice for Site Investigations*.

The exploratory hole records are contained within the JPG supplementary ground investigation report, and the locations are shown on the exploratory hole plan presented in Appendix A.

2.2 Ground Conditions

A thin veneer of topsoil is present across the majority of the site to depths of between 0.20m and 0.70m bgl, typical thickness 350mm. Topsoil comprises a dark brown, slightly sandy, gravelly clay.

Ground conditions on site vary between the opencast area (centre and north of the site) and the area outside of the opencast in the south and west. The ground conditions are reported separately below for each area.

Opencast Ground Conditions

The topsoil is generally underlain by a firm, dark reddish brown and orangish brown, slightly sandy, gravelly clay with high cobble content, to depths of between 1.10m and 4.90m; typically, 1.40m bgl. It is likely that this is a capping layer of reworked natural material (glacial till) extracted and stockpiled separately as part of the coaling operation. This is consistent with previous site investigation findings where the capping clay was encountered to a typical depth of 1.20m bgl.

The subsoil/capping layer is underlain by colliery spoil, described as grey, clayey gravel, occasionally gravelly clay, with locally interbeds of sand and often with varying proportions of cobbles and boulders. The gravel, cobble and boulder content were found to generally comprise mudstone, siltstone and/or sandstone. The material is considered typical of re-placed opencast overburden material.

The base of the colliery spoil has been proven in all of the JPG rotary openhole boreholes and was found to be between 3.70m and 35.00m bgl. A highwall is present parallel to the eastern, southern and western boundaries of the site, dipping inwards.

In the east of the site, the highwall has been proven (Sirius 2024 and JPG 2025) at depths of between 7.50m and 25.00m, dipping to the west. In the south of the site the highwall has been proven at depths of between 2.40m and 35.00m bgl, dipping to the north. Finally in the west of the site the highwall has been proven at depths of between 4.00m and 42.00m bgl, dipping to the east.

The base of the opencast slopes down steadily from east to west from a depth of 25.00m to 45.00m bgl. The base of the opencast extends beyond the northern boundary.

Coal seams were proven on and beyond the extent of the former opencast area on the highwalls in the east and west of the site. Summaries of proven coal seams within each borehole are presented in Table 4.2 below.

Table 4.2 – Summary of Coal Seams Encountered

Borehole Reference	Depth to Base of Coal Seam (AOD)	Coal Seam Thickness (m)	Rock Cover
RO104	127.60	1.00	3.70
RO108	115.98	0.60	5.80
RO110	127.50	0.40	6.10
RO110	112.20	1.00	20.80
RO111	126.20	0.50	2.00
RO111	120.70	0.20	7.30
RO113	131.60	0.50	7.80
RO113	120.60	1.20	18.50
RO116	133.75	0.50	1.00
RO116	131.35	0.60	3.50

All coal seams encountered were recorded intact. No broken ground or worked coal seams have been recorded outside of the opencast.

Outwith the Opencast Ground Conditions

Natural ground was encountered at shallow depth where a buried highwall is present near the surface of the site in the south and west (TP113, TP114, TP115, TP116). Superficial deposits of glacial till, typically comprising firm, orangish brown and mottled grey, slightly sandy, gravelly clay were encountered at depths of between 0.35m and 1.30m bgl. The base of the glacial till was not proven in any trial pits carried out during the investigation; however, bedrock was proven at a minimum depth of 3.70m bgl at the crest of the highwall. Therefore, we can assume this to be the base of glacial till.

When compared with historical ground investigation data, the ground conditions generally concur. Where discrepancies in borehole data have been identified, greater reliance has been given to the ground conditions encountered in the recent JPG investigation.

2.3 Groundwater Conditions

A summary of the groundwater encountered during the recent investigation is presented in Table 3.2 below.

Table 3.2 – Summary of Recorded Groundwater

Location	Depth (m bgl)	Comments
TP104	2.50	Groundwater seepage
TP107	2.20	Groundwater seepage
TP108	1.80	Groundwater seepage
RO103	18.00	Water strike
RO104	15.00	Water strike
RO106	23.00	Water strike

No groundwater seepages or inflows were noted in the other trial pits. The driller did not record groundwater strikes in any other borehole than those noted in Table 5.6.1.

Groundwater monitoring was carried out by Sirius in 2018 and by GEE in 2019. A summary of the monitored groundwater levels is presented in Tables 5.6.2 and 5.6.3.

Groundwater monitoring was carried out on four occasions by Sirius between 16 October and 27 November 2018. All of the response zones were sealed within the made ground. Groundwater levels in shallow wells (<5.00m bgl) ranged between 2.58m to 5.03m bgl. Water levels typically remained steady with little variation in individual monitoring wells. Groundwater levels in CPR02, which had a response zone between 2.00m and 21.00m bgl, were recorded at an average 20.56m, with little fluctuation.

Groundwater monitoring was carried out 10 occasions by GEE between 4 November 2019 and 16 April 2020. Response zones spanned the made ground, natural ground, coal seams and bedrock to a maximum depth of 4.00m bgl. Groundwater levels for wells targeting the shallow made ground ranged from 0.23m to 3.85m bgl. Wells targeting the natural superficial deposits recorded groundwater levels between 0.10m and 1.93m bgl. Groundwater levels for wells spanning coal seams and bedrock recorded ground levels of between 0.38m to 1.52m bgl.

Over time groundwater levels in all wells generally remained steady or were seen to rise slightly, probably due to the winter period.

When comparing the groundwater levels encountered during monitoring visits between 2018-2020 and the groundwater levels encountered during the JPG investigation it is evident that shallow groundwater recorded in wells is perched, i.e. due to water permeating from the surface, and not indicative of the actual groundwater table.

Groundwater has been encountered between depths of 15.00m and 25.00m bgl Groundwater levels in the natural strata generally remained steady during the monitoring period. It can be observed from the monitoring data that the groundwater gradient is dipping to the west at the base of the made ground within the opencast backfill and within the bedrock.

It should be noted that the groundwater conditions recorded are based on observations made at the time that site work was carried out and groundwater monitoring post fieldwork. Groundwater levels will vary owing to seasonal and weather-related effects.

3.0 EARTHWORKS DESIGN STRATEGY

3.1 General

It is proposed to carry out a reduced dig of approximately 4.00m below finished ground level to create platforms for dynamic compaction (DC). Based on proposed ground levels the treatment area has been divided into four DC platforms. The proposed reduced dig levels are indicated on the dynamic compaction plan and sections referenced below and included in Appendix A of this report.

- JPG. Dynamic Compaction Plan. Harras Dyke Farm, Whitehaven. Drawing No. 6439-JPG-ZZ-ZZ-DR-C-1350 S2 P02, dated 27 June 2025.
- JPG. Dynamic Compaction Sections. Harras Dyke Farm, Whitehaven. Drawing No. 6439-JPG-ZZ-ZZ-DR-C-1351 S2 P02, dated 27 June 2025.

Following the initial cut, DC will be carried out on the backfilled opencast materials. A DC platform is to be created using a granular stone blanket. A weight will be dropped from approximately 12m on a 5.0m x 5.0m grid. Imprints will be measured and filled with granular material. This process will then be repeated in a second pass and validated by the contractor for the DC.

Validation testing is to comprise zone tests using a 2.00m x 2.00m rigid steel test plate. One zone test is to be carried out on each DC platform, the locations of which are to be agreed with the GE. The tests are to be loaded to 2.5x the working load. Based on a bearing pressure requirement of 80kPa, a maximum test load of 800kN is to be applied. It is likely that each zone test on the DC platform will take 13 to 14 hours.

A specification for the DC treatment is to be provided by the specialist contractor and agreed with the NHBC prior to the works.

The extent of the DC treatment is shown on the dynamic compaction plan referenced above.

Following the DC works, the excavated soils are to be engineered in approximate 300mm layers to required formation levels. Subsoil material (brown capping clay) is to be compacted beneath the topsoil to a minimum of 1.00m below finished ground level. Any remaining capping clay material can be incorporated into the bulk earthworks. 300mm of uncompacted topsoil is to be reinstated at ground surface.

A drawing showing the cut and fill from current ground levels has been prepared by JPG, this is referenced below and included in Appendix A.

- JPG. Cut & Fill Analysis. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-C-1200 S2 P01, dated 7 May 2025.

3.2 Compaction Criteria

The brown capping clay, grey cohesive colliery spoil and grey granular colliery spoil have different geotechnical parameters and should be carefully segregated and classified.

Laboratory classification testing for each material is summarised in Table 3.2 below.

Table 3.2 – Materials Classification

Material Type	Moisture Content (%) Range (Mean)	Modified Plasticity Indices (%) Range (Mean)	Maximum Dry Density (Mg/m^3) Range (Mean)	Optimum Moisture Content (%) – Based on 4.5kg Rammer
Natural Glacial Till (Stiff Clay)	14.4 – 20.7 (17.6)	15.4 – 18.5 (17.0)		
Cohesive Capping	19.3 – 29.0 (23.2)	13.3 – 22.3 (17.1)	1.71 – 1.89 (1.83)	15 (+/-2)
Cohesive Colliery Spoil	16.5 – 18.1 (17.3)	12.4 – 13.3 (12.9)	1.84 – 1.94 (1.89)	12 (+/-2)
Granular Colliery Spoil	12.2 – 14.4 (13.4)	12 (12)	2.03 – 2.05 (2.04)	11 (+/-2)

From the above table, it can be seen that the moisture content of the cohesive capping (brown clay) and cohesive colliery spoil (grey clay) is generally too wet. Based on limited testing, the granular colliery spoil is suitable for compaction.

In order to incorporate the capping clay and the cohesive colliery spoil into the earthworks, the material will require drying in order to achieve an acceptable moisture content. This can be achieved by modification (the addition of lime and/or cement) or drying out in windrows or layers with mechanical turning as required for drying purposes.

The granular colliery spoil is generally considered suitable for re-use in the earthworks operation.

Proper selection and control will be required as part of the works to use the excavated materials in the earthworks. The materials should not be allowed to deteriorate during excavation and compaction and must be sufficiently protected from traffic after placement.

The earthworks contractor will be required to improve the bearing characteristics of the fill materials under the proposed development to provide an allowable bearing capacity of at least $80kN/m^2$ throughout.

All filling shall be to an end product specification, to achieve >95% maximum dry density and <5% air voids based on the results obtained from control samples using a 4.5kg rammer.

Earthworks are to be carried out in accordance with this specification, relevant sections of the Manual of Contract Documents for Highway Works: National Highways - Geotechnics Construction CC601 Earthworks and relevant NHBC Standards, in particular Chapter 4.6 *Building on Fill*.

Validation testing of the placed fill shall include nuclear density testing and sand replacement tests at a ratio of 5:1, at a minimum frequency of two per $1,000m^3$ of material placed.

3.3 Obstructions

As the majority of the site has been subject to past opencast coal extraction and there has been no development since the coaling ceased, the possibility of encountering manmade obstructions at shallow depth during the earthworks operation is considered unlikely.

Boulder-sized pieces of rock are present within the colliery spoil. Boulders encountered in excavations will require breaking down, in order to be incorporated into the earthworks.

3.4 Groundwater Control

Land drains comprising black perforated pipe and red clay pipe were encountered in four trial pits (TP106, TP111, TP113 and TP115) during the ground investigation, subsequently causing water seepages and subsequent instability of the excavations. Land drains are to be removed as part of the earthworks and temporary surface water drainage implemented by the earthworks contractor.

In order to control groundwater during the earthworks, a watching brief shall be maintained by the contractor and temporary diversions/rerouting be employed as required. The contractor will be responsible for the following:

- Provide where necessary temporary watercourses, drains, pumping, etc.
- Discharge accumulated water and groundwater into the permanent outfalls of the drainage system where practicable; and
- Provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

3.5 Validation of Earthworks

Compliance testing comprising nuclear density gauge (NDT) or electronic density gauge (EDG) as well as sand replacement densities will be carried out throughout the filling process. The results will be reviewed by the JPG engineer. Where unacceptable failures are recorded, the JPG engineer will request remedial earthworks to take place.

Maintained Load Tests (MLTs) are to be carried out on the finished earthworks platform to confirm that future settlements are acceptable. Three MLTs are to be carried out on site at locations to be agreed with the NHBC. The tests are to be carried out in general accordance with Section 4.2 of BS1377 Part 9.

The test pad will comprise a 0.60m wide by 1.80m long concrete 'dummy' foundation with the base of the test pad at least 500mm below formation level and extending at least 100mm above ground level.

The applied load at the base of the test pad shall be approximately 100kN/m^2 (+/- 5%). This can be achieved by using Legato blocks or similar. Monitoring is to be undertaken using targets affixed to the top of the foundation, not the face of the Legato blocks.

During the preparation and loading of the test pads, it is critical that the pads are not loaded asymmetrically, as this could lead to measured differential settlement and an abortive test result.

An allowance should be made to control surface water around each test for the duration of the monitoring period. This could include the excavation of grips to ensure any surface water is routed away from the testing position and not allowed to collect against the dummy footing.

The MLTs are to be continued for a minimum one-month period and the monitoring reviewed on a weekly basis. The monitoring is to be continued until no further ongoing downward movement is discernible.

In addition, Standard Penetration Tests (SPTs) are to be undertaken in window sample boreholes and samples obtained and tested for moisture content and Atterberg Limits to inform foundation design.

4.0 GEOTECHNICAL DESIGN

4.1 Foundations & Floors

It is anticipated that the most appropriate foundation solution will be a reinforced strip footings constructed on the engineered/treated fill within the opencast area. For plots outside the opencast, it is anticipated that the most appropriate foundation solution will be shallow strip footings constructed onto the glacial till (stiff clay soils). A foundation zoning plan has been prepared by JPG, this is referenced below and included in Appendix A.

- JPG(Leeds) Limited. Foundation Zoning Plan. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-G-1105 S2 P01, dated 14 May 2025.

The reinforced strip foundations within the opencast area should be designed with reinforcement to the top and bottom, with the strips able to span 2.0m and cantilever 1.0m as a minimum. In addition, it is recommended that the strips are joined orthogonally with cross wall foundations to create a cellular 'beam grillage' foundation.

The structural engineer may assume an allowable bearing pressure of 80kPa for reinforced foundations bearing onto the engineered fill, based on a 0.60m wide strip at 1.00m below finished ground level. For footings on natural firm clay soils (glacial till), an allowable bearing pressure of 80kPa may be assumed, increasing to 100kPa in the stiff clay soils.

Based on the presence of deep made ground within the opencast area and shrinkable soils outside the opencast, suspended ground floors should be used.

Detailed design will be the responsibility of the structural engineer appointed by the housebuilder. Detailed foundation design is to take into consideration the effects of heave/shrinkage associated with variation in moisture content of shallow engineered fill. Reference should be made to NHBC Standards Chapter 4.2 *Building near trees*.

Atterberg limit analysis of the brown clay soils and colliery spoil made ground indicates intermediate plasticity and low volume change potential. This assessment is to be confirmed following sampling and testing of the placed fill material on completion of the earthworks.

The provision of reinforcement for foundations in natural ground outside of the former opencast is required given the risk of shrinkable soils.

4.2 Geotechnical Parameters

Based on in situ and laboratory testing of the soils, the geotechnical parameters shown in Table 4.2 below have been derived for the finished development platform. The geotechnical parameters should be confirmed through validation testing on completion of the earthworks.

Table 4.2 –Geotechnical Parameters

Material Type	Bulk Density kN/m3	Undrained Shear Strength (kN/m2)	SPT N Value	Coefficient of Compressibility- Mv (m^2/MN)
Natural Glacial Till (Stiff Clay)	19	50	10	0.20
Engineered Glacial Till	20	40	8	0.20
Cohesive Colliery Spoil	20	40	8	0.10
Granular Colliery Spoil	21 – 22	NA	20	0.05

4.3 Future Settlement

Although there are uncertainties with regard to the magnitude of future creep settlement, it is considered likely that, based on the anticipated maximum thickness of fill, future self-weight settlement of non-engineered fill will generally vary from approximately 17mm to 30mm.

Differential settlement across the highwall may result in differential settlements of up to 1 in 550 (worst case).

As immediate settlement will be accommodated during the construction phase, total settlement (primary consolidation + self-weight settlement) of approximately 35mm to 50mm is predicted over the 60-year design life.

As the engineering/DC treatment within the opencast area will result in a large homogenous mass of soil, future settlement will be of a similar magnitude across the housing plots. Moreover, settlements, including self-weight settlement of the deep made ground, will be gradual and uniform, with the whole development platform settling at a similar rate.

4.4 Roads, Pavements and Hardstanding Surfaces

For preliminary design purposes, a CBR of 5% should be assumed for the engineered fill following the earthworks in below highway areas including footpaths and drives.

Plate tests will be required on the treated surface at formation level to confirm the preliminary design CBR and pavement construction. The earthworks should be designed to achieve a CBR of at least 5% at formation level below any highways, footpaths and drives. If CBRs of less than 5% are obtained, remedial earthworks, removal of soft soils and replacement with suitable engineered fill, and/or ground improvement, e.g. modification of the subgrade, will be required.

Where the proposed highway crosses the highwall associated with the former opencast, geogrids with stone surround should be incorporated into the earthworks to mitigate against differential settlement. The geogrids are to be placed below all services including drainage. The extent of the geogrids is shown on the JPG drawing referenced below.

- JPG. General Arrangement of Geogrids. Harras Dyke Farm, Whitehaven. Drawing no. 6439-JPG-ZZ-ZZ-DR-C-1352 S2 P01, dated 30 May 2025.

4.5 Buried Concrete Design

It is recommended that a Design Sulphate Class of DS-2 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC-2s be adopted for buried concrete.

4.6 Buried Water Supply Pipes

With the absence of any hydrocarbons across all parts of the site, no restrictions on buried pipework materials for new water supplies are required, subject to Local Water Authority confirmation.

5.0 GEOTECHNICAL RISK

A Geotechnical Risk Register has been prepared for the proposed development. The register uses a qualitative approach based on the procedures set out in CD 622 Managing Geotechnical Risk (Revision 1 – March 2020). Under a qualitative risk assessment, the degree of risk is the expected impact of damage, loss or harm for a given hazard, under particular circumstances, which is expressed as:

Degree of Risk = Likelihood x Effect

The register and risk classifications are summarised in Section 8.1 and 8.2 below.

5.1 Degree of Risk, Potential Severity of Harm Occurring & Risk Classification

The likelihood and the scale of effect is determined using Table 5.1.1 and 5.1.2 respectively, which together then provide the risk classification as shown in Table 5.1.3.

Table 5.1.1 – Likelihood of Harm Occurring

Likelihood (L)	Scale
Extremely Unlikely	1
Unlikely	2
Likely	3
Extremely Likely	4
Almost Certain	5

Table 5.1.2 – Potential Severity of Harm Occurring

Scale	Effect (E)	Potential Severity of Harm Occurring
1	Minor	Minor damage or loss – (no human injury)
2	Moderate	Moderate damage or loss (slight injury or illness)
3	Serious	Substantial damage or loss (serious injury or illness)
4	Major	Major damage or loss – (fatal injury)
5	Catastrophic	Catastrophic loss of damage – (multiple fatalities)

Table 5.1.3 – Risk Classification

Risk Classification	Risk Level	Recommended response
1 to 8	Low	Ensure assumed control measures are maintained and reviewed as necessary
9 to 19	Medium	Additional control measures needed to reduce risk rating to a level that is equivalent to a test of "reasonably required" for
20 to 25	High	Activity not permitted. Hazard to be avoided or risk to be reduced to tolerable level.

5.2 Geotechnical Risk Register

The Geotechnical Risk Register is summarised in Table 5.2 below.

Table 5.2 Geotechnical Risk Register

No.	Hazard	Consequence	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Residual Risk
1	Settlement of deep made ground (colliery spoil) below development.	Damage to structures, services and related assets.	3	3	9	Treatment of made ground soils by dynamic compaction and replacement of upper layers with engineered fill.	2	3	6
2	Differential settlement where highway and structures cross high wall of opencast.	Damage to structures, carriageway, services and related assets.	3	3	9	Treatment of made ground soils by dynamic compaction and replacement of upper layers with engineered fill. No more than 1 in 400 differential settlements across residential plots. Geogrids to span length of highway crossing highwall.	2	3	6
3	Potential collapse of unrecorded mine entries.	Damage to structures, carriageway, services and related assets.	2	4	8	Vigilance to be maintained during excavations. If a suspected shaft or adit is encountered, JPG to be notified. If a mine entry is confirmed, Mining Remediation Authority to be notified. If mine entry is proven below highway, it will require treatment, i.e. by drill and grout and/or capping.	1	4	4
4	Potential collapse of unrecorded shallow coal workings	Damage to structures, carriageway, services and related assets.	2	4	8	SI evidence does not suggest coal mined at shallow depth (other than by opencast). Next worked seam at depth below the site is significantly greater than 10x seam thickness below the other shallow opencast worked seams.	1	4	4
5	Potential collapse of existing mineshaft in east of site	Damage to structures, carriageway, services and related assets.	2	3	6	The mineshaft has been capped. During the development and after, it is recommended that secure fencing is erected around the mineshaft/cap. Following this, the risk will remain low.	2	3	6

Appendix A Drawings/Figures



Figure 1 – Site Location Plan	
Site	**Thomas Armstrong (Construction) Limited**
Client	**6439**
Job Number	**NTS**
Scale	**Harras Dyke Farm, Whitehaven**

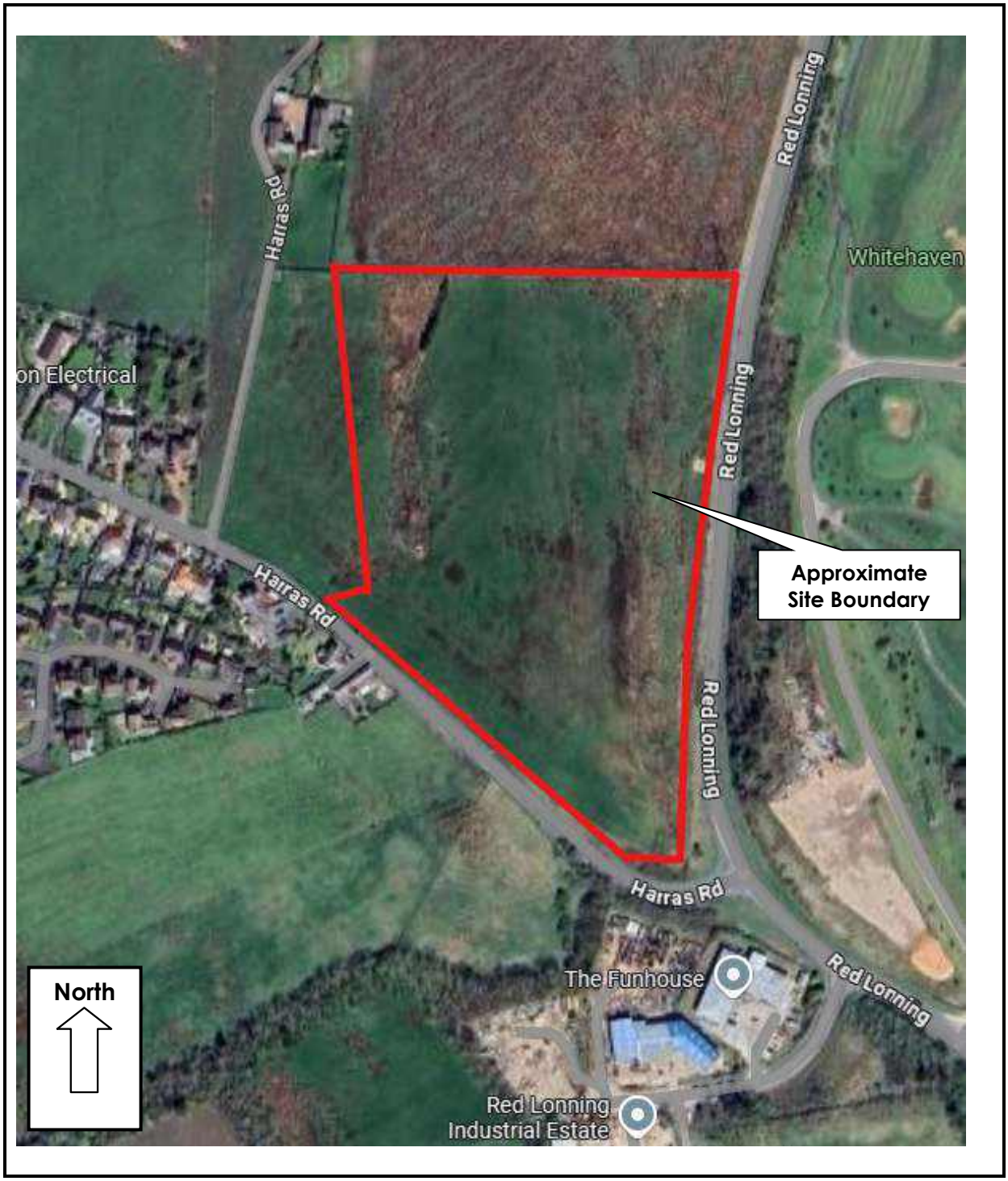
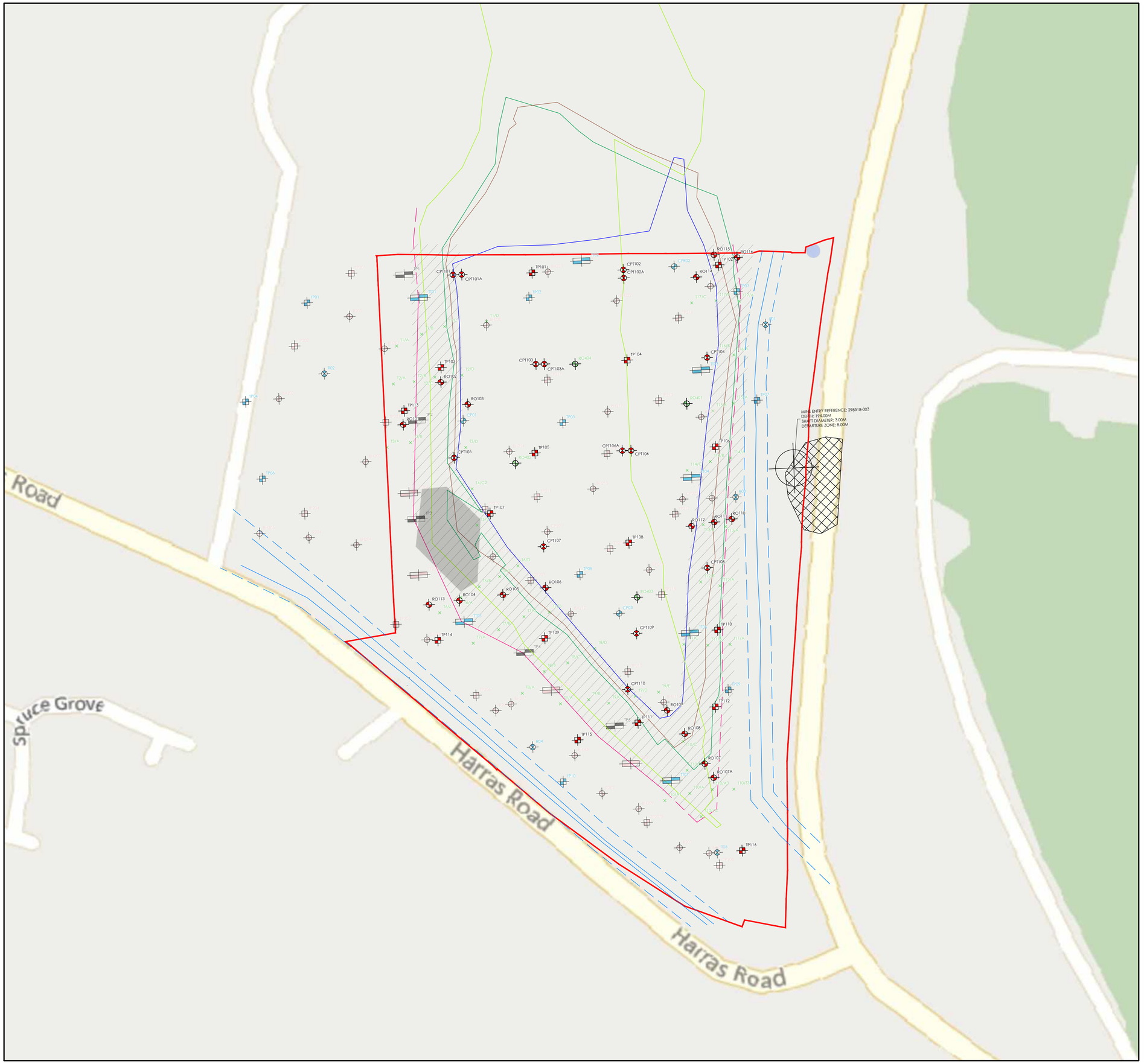


Figure 2 – Aerial Photograph	
Site	**Harras Dyke Farm, Whitehaven**
Client	**Thomas Armstrong (Construction) Limited**
Job Number	**6439**
Scale	**NTS**



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NOTES

ELLIOT ENVIRONMENTAL 2016
- TT — TRIAL TRENCH

SIRIUS GEOENVIRONMENTAL 2018
- TP — TRIAL PIT
- TT — TRIAL TRENCH
- RO — ROTARY OPEN HOLE
- CP — CABLE PERCUSSIVE BOREHOLE

G.E.E 2019
- TP — TRIAL PIT
- TT — TRIAL TRENCH
- BH/CP — WINDOW SAMPLE BOREHOLE / CABLE PERCUSSIVE & ROTARY OPEN BOREHOLE

SIRIUS GEOENVIRONMENTAL 2024
- RO4 — ROTARY OPENHOLE BOREHOLE
- PROBEHOLE TRANSECT

JPG GROUP INVESTIGATION (2025)
- RO — ROTARY OPENHOLE BOREHOLE
- CPT — CONE PENETRATION TEST
- TP — TRIAL PIT

LEGEND
- UNNAMED G OPENCAST EXTENT
- UNNAMED E OPENCAST EXTENT
- BRASSY OPENCAST EXTENT
- UNNAMED C OPENCAST EXTENT
- PROVEN HIGHWALL
- CONJECTURED HIGHWALL
- APPROXIMATE SITE BOUNDARY
- INFILLED GROUND (ACCORDING TO HISTORICAL MAPPING)
- PYLON
- UU WATERPIPE AND 10M EASMENT
- PROJECTED HIGHWALL LOCATION BASED ON ABANDONMENT PLANS AND SITE INVESTIGATION FINDINGS
- APPROXIMATE LOCATION OF PONDED AREA

NOTES
TRIAL TRENCHES THAT IDENTIFIED THE LOCATION OF THE HIGHWALL DO NOT HAVE ACCURATE SURVEY INFORMATION AND THEREFORE ARE APPROXIMATE LOCATIONS ONLY.

0m 12.5m 25m
SCALE 1:500

REV	DESCRIPTION	DATE	CHK	BY
P06	UPDATED WITH SIRIUS PROBEHOLES	08.05.25	JBW	EJS
P05	AS BUILT	07.04.25	JBW	EJS
P04	UPDATED WITH 2024 INVESTIGASTION AND UU PIPELINE	06.03.25	JBW	EJS
P03	BOREHOLE REFERENCES AND INFILLED GROUND UPDATED	25.02.25	JBW	EJS
P02	NHBHC COMMENT	03.02.25	JBW	EJS
P01	FIRST ISSUE	23.10.24	JBW	EJS

Project
HARRAS DYKE FARM
WHITEHAVEN

Drawing Title
EXPLORATORY HOLE LOCATION PLAN
(AS BUILT)

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6439-JPG-ZZ-ZZ-DR-G-1101	S2	P06

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NOTES

EARTHWORKS NOTES

1. JPG PROPOSED EARTHWORKS ANALYSIS IS INDICATIVE ONLY. IT IS BASED ON THIRD PARTY INFORMATION AND THEREFORE JPG DO NOT ACCEPT RESPONSIBILITY FOR VARIATIONS IN THE ACTUAL DEPTH OF SITE STRIP OR ANY OTHER ONSITE EARTHWORKS PARAMETERS THAT MAY EFFECT FINAL CUT AND FILL VOLUMES.
2. ISOPACHYTE COLOUR BANDINGS DENOTE APPROXIMATE CUT AND FILL VOLUMES BETWEEN THE EXISTING SITE STRIP AND PROPOSED FORMATION LEVELS, REFER TO EARTHWORKS ANALYSIS TABLE.
3. AREAS NOT SHADED WITH ISOPACHYTE COLOUR BANDINGS HAVE NOT BEEN INCLUDED IN THE CUT/FILL ANALYSIS.
4. APPROXIMATE EARTHWORK VOLUMES HAVE BEEN DETERMINED BASED ON THE FOLLOWING CAVEATS:

- BULKING FACTORS HAVE NOT BEEN ACCOUNTED FOR.
- ARISINGS FROM DRAINAGE AND FOUNDATION EXCAVATIONS HAVE NOT BEEN ACCOUNTED FOR.
- DEMOLISHED MATERIAL FROM EXISTING BUILDINGS/STRUCTURES HAVE NOT BEEN ACCOUNTED FOR.

EARTHWORKS ANALYSIS

PROPOSED SITE STRIP

ANALYSIS ALLOWS FOR A 300mm SITE STRIP.
TOTAL AREA = 44250m²
TOTAL VOLUME = 13275m³
SITE STRIP MATERIAL DEEMED TO BE UNSUITABLE FOR RE-USE AS ENGINEERING FILL.
TOPOGRAPHICAL SURVEY INFORMATION USED IN THE EARTHWORKS ANALYSIS TAKEN FROM: ATLANTIC GEOMATICS TOPOGRAPHICAL SURVEY DRAWING No. 3184-P-06 DATED SEPT 2023.

PROPOSED FORMATION LEVELS

AN ASSUMED AVERAGE FORMATION DEPTH OF 450mm HAS BEEN APPLIED TO THE ANALYSIS.

ANALYSIS BETWEEN PROPOSED SITE STRIP & PROPOSED FORMATION LEVELS

2D AREA	44250m²
CUT	4920m³
FILL	14845m³
NET (SHORTFALL)	9925m³
MAXIMUM CUT DEPTH	-2.040m
MAXIMUM FILL DEPTH	2.110m

SURFACE LEVEL DATA

MIN. LEVEL	MAX. LEVEL	COLOUR
-3.000m	-2.500m	
-2.500m	-2.000m	
-2.000m	-1.500m	
-1.500m	-1.000m	
-1.000m	-0.500m	
-0.500m	0.000m	
0.000m	0.500m	
0.500m	1.000m	
1.000m	1.500m	
1.500m	2.000m	
2.000m	2.500m	
2.500m	3.000m	

LEGEND

×0.000m DENOTES CUT/FILL SPOT DEPTHS

0m 12.5m 25m
SCALE 1:500

REV	DESCRIPTION	DATE	CHK	BY
P01	FIRST ISSUE.	07.05.25	JBW	LSG

Project
HARRAS DYKE FARM
WHITEHAVEN

Drawing Title
CUT & FILL ANALYSIS

INFORMATION

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LEGEND

- SITE BOUNDARY
- EXTENTS OF EXCAVATION TO CUT LEVELS
- EXTENTS OF DYNAMIC COMPACTION
- CHANGE IN CUT LEVEL
- 10m OFFSET LINE FROM WATER MAIN
- EXTENT OF CUT AREA 1
- EXTENT OF CUT AREA 2
- EXTENT OF CUT AREA 3
- EXTENT OF CUT AREA 4

0m 12.5m 25m

SCALE 1:500

CUT AREA 4
LEVEL = 140.50m

CUT AREA 3
LEVEL = 140.00m

CUT AREA 2
LEVEL = 139.50m

CUT AREA 1
LEVEL = 138.00m

EXTENTS OF DYNAMIC COMPACTION TREATMENT.

ROCK TO BE REMOVED < 4.00m BELOW FINISHED GROUND LEVEL AND REPLACED WITH ENGINEERED FILL.

EXISTING WATER MAIN WITH 10m EASEMENT.

EXISTING WATER MAIN WITH 10m EASEMENT.

EXISTING MINE SHAFT

RISK ITEM - CUT FACE ADJACENT TO EXISTING UTILITY. POSSIBILITY OF REQUIREMENT FOR TEMPORARY WORKS - TBC BY CONTRACTOR.

CUT LEVELS EXTENDED PAST DYNAMIC COMPACTION TREATMENT ZONE TO SPAN HIGHWAYS AND AVOID DIFFERENTIAL GROUND CONDITIONS BENEATH INDIVIDUAL PLOTS. TRUE EXTENT OF DYNAMIC COMPACTION TO BE CONFIRMED ON SITE WHEN UNDERTAKING EXCAVATIONS TO ACCURATELY LOCATE THE HIGHWALL.

10.000

Water Easement

Existing footpath route

HARRAS ROAD

Windsor Terrace

Ward Bdy

Discharge point

MATERIAL QUANTITIES

CUT REF.	AREA m²	TOPSOIL STRIP VOLUME m³	BULK DIG VOLUME m³	IMPORT DC BLANKET VOLUME m³
AREA 1	3270m³	980m³	14645m³	1635m³
AREA 2	7770m³	2330m³	30540m³	3885m³
AREA 3	8775m³	2635m³	33570m³	4390m³
AREA 4	8570m³	2570m³	36020m³	4285m³
TOTAL	**28385m³**	**8515m³**	**114775m³**	**14195m³**

MATERIAL QUANTITY NOTES
- ALL TOPSOIL STRIP VOLUMES HAVE BEEN CALCULATED USING A TOPSOIL STRIP DEPTH OF 300mm.
- ALL BULK DIG VOLUMES HAVE BEEN CALCULATED BETWEEN THE UNDERSIDE OF THE PROPOSED TOPSOIL STRIP AND THE UNDERSIDE OF THE IMPORTED DYNAMIC COMPACTION BLANKET.
- ALL BULK DIG VOLUMES HAVE BEEN CALCULATED USING VERTICAL EXCAVATION FACES BETWEEN EACH DYNAMIC COMPACTION PLATFORM.

REV	DESCRIPTION	DATE	CHK	BY
P02	REVISED DC EXTENTS ALONG NORTHERN BOUNDARY.	27.06.25	EJS	LSG
P01	FIRST ISSUE.	30.05.25	JBW	LSG

Project
HARRAS DYKE FARM
WHITEHAVEN

Drawing Title
DYNAMIC COMPACTION PLAN

INFORMATION

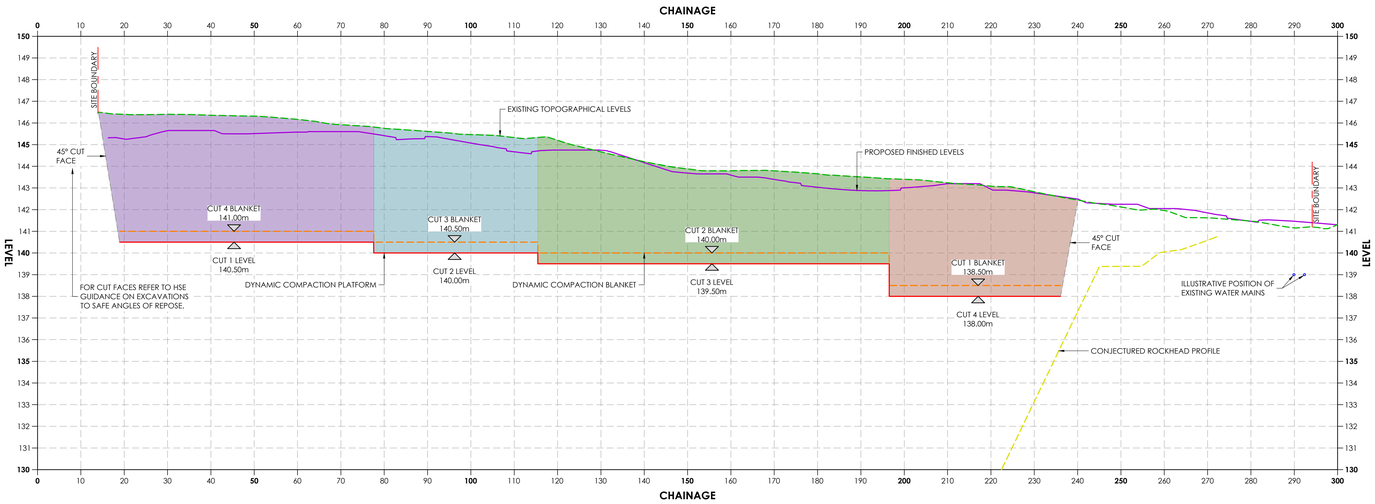
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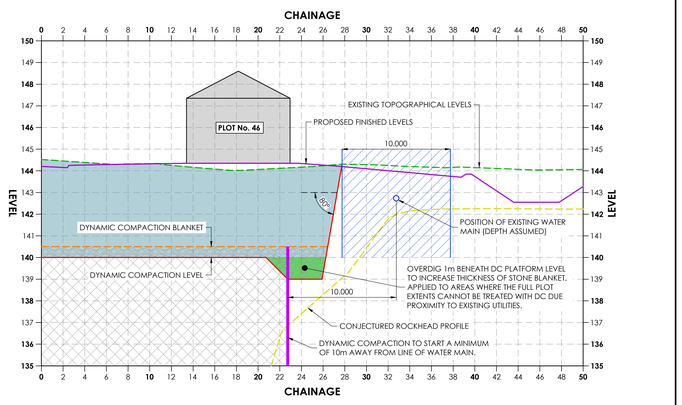
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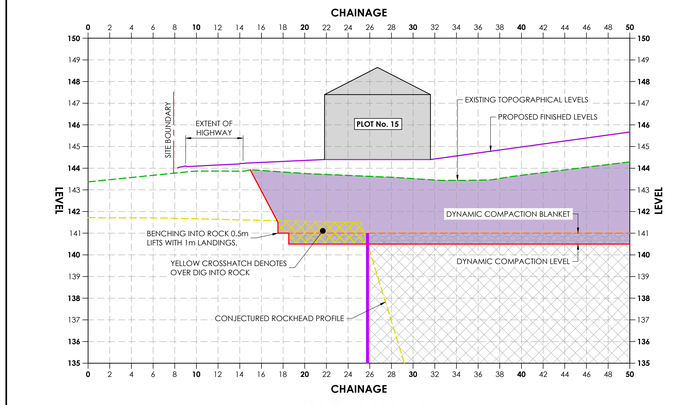
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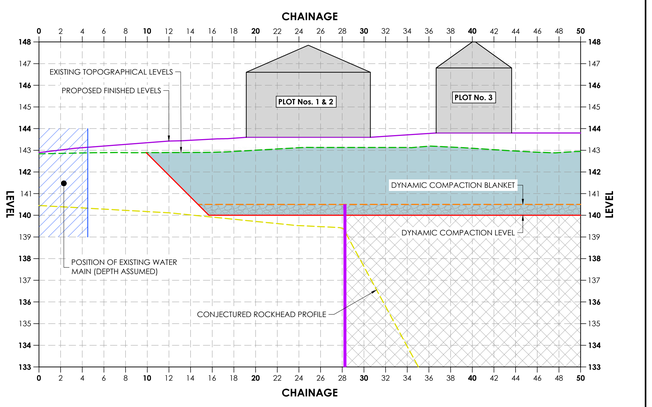
SECTION 1 PROFILE
SCALE H 1:500 V 1:100



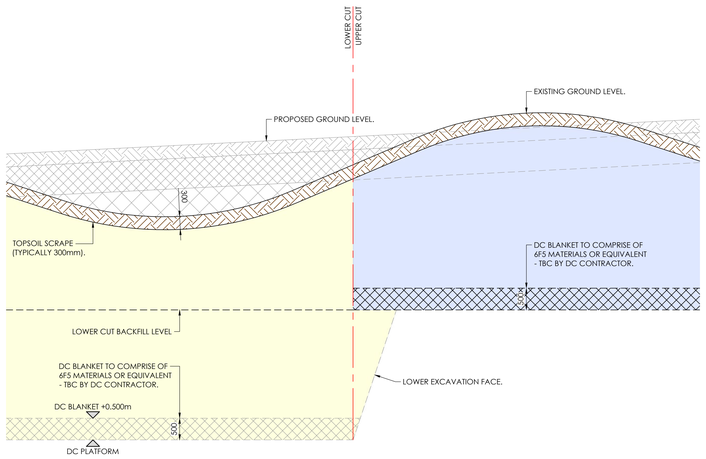
SECTION 2 PROFILE
SCALE H 1:200 V 1:100



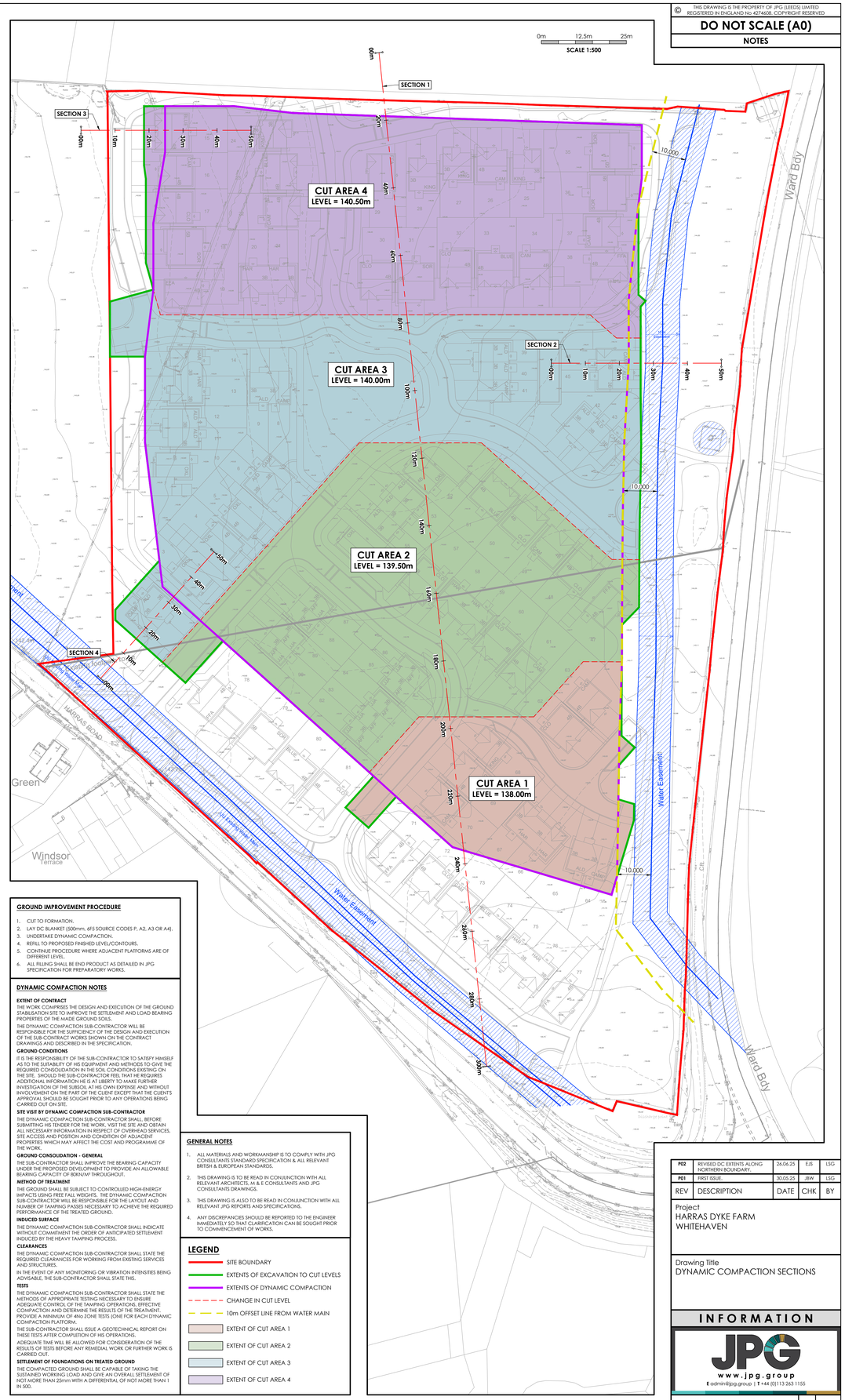
SECTION 3 PROFILE
SCALE H 1:200 V 1:100



SECTION 4 PROFILE
SCALE H 1:200 V 1:100



DYNAMIC COMPACTION TYPICAL ARRANGEMENT
SCALE 1:50



GROUND IMPROVEMENT PROCEDURE

1. CUT TO FORMATION.
2. LAY DC BLANKET (500mm, 6F5 SOURCE CODES P, A2, A3 OR A4).
3. UNDERTAKE DYNAMIC COMPACTION.
4. REFILL TO PROPOSED FINISHED LEVEL/CONTOURS.
5. CONTINUE PROCEDURE WHERE ADJACENT PLATFORMS ARE OF DIFFERENT LEVEL.
6. ALL FILLING SHALL BE ENG PRODUCT AS DETAILED IN JPG SPECIFICATION FOR PREPARATORY WORKS.

DYNAMIC COMPACTION NOTES

EXTENT OF CONTRACT
THE WORK COMPRISES THE DESIGN AND EXECUTION OF THE GROUND STABILISATION SITE TO IMPROVE THE SETTLEMENT AND LOAD BEARING PROPERTIES OF THE MADE GROUND SOILS.

THE DYNAMIC COMPACTION SUB-CONTRACTOR WILL BE RESPONSIBLE FOR THE SUFFICIENCY OF THE DESIGN AND EXECUTION OF THE SUB-CONTRACT WORKS SHOWN ON THE CONTRACT DRAWINGS AND DESCRIBED IN THE SPECIFICATION.

GROUND CONDITIONS
IT IS THE RESPONSIBILITY OF THE SUB-CONTRACTOR TO SATISFY HIMSELF AS TO THE SUITABILITY OF HIS EQUIPMENT AND METHODS TO GIVE THE REQUIRED CONSOLIDATION IN THE SOIL CONDITIONS EXISTING ON THE SITE. SHOULD THE SUB-CONTRACTOR FEEL THAT HE REQUIRES ADDITIONAL INFORMATION HE IS AT LIBERTY TO MAKE FURTHER INVESTIGATION OF THE SUBSOIL AT HIS OWN EXPENSE AND WITHOUT INVOLVEMENT ON THE PART OF THE CLIENT EXCEPT THAT THE CLIENTS APPROVAL SHOULD BE SOUGHT PRIOR TO ANY OPERATIONS BEING CARRIED OUT ON SITE.

SITE VISIT BY DYNAMIC COMPACTION SUB-CONTRACTOR
THE DYNAMIC COMPACTION SUB-CONTRACTOR SHALL, BEFORE SUBMITTING HIS TENDER FOR THE WORK, VISIT THE SITE AND OBTAIN ALL NECESSARY INFORMATION IN RESPECT OF OVERHEAD SERVICES, SITE ACCESS AND POSITION AND CONDITION OF ADJACENT PROPERTIES WHICH MAY AFFECT THE COST AND PROGRAMME OF THE WORK.

GROUND CONSOLIDATION - GENERAL
THE SUB-CONTRACTOR SHALL IMPROVE THE BEARING CAPACITY UNDER THE PROPOSED DEVELOPMENT TO PROVIDE AN ALLOWABLE BEARING CAPACITY OF 80KN/M² THROUGHOUT.

METHOD OF TREATMENT
THE GROUND SHALL BE SUBJECT TO CONTROLLED HIGH-ENERGY IMPACTS USING FREE FALL WEIGHTS. THE DYNAMIC COMPACTION SUB-CONTRACTOR WILL BE RESPONSIBLE FOR THE LAYOUT AND NUMBER OF TAMPING PASSES NECESSARY TO ACHIEVE THE REQUIRED PERFORMANCE OF THE TREATED GROUND.

INDUCED SURFACE
THE DYNAMIC COMPACTION SUB-CONTRACTOR SHALL INDICATE WITHOUT COMMITMENT THE ORDER OF ANTICIPATED SETTLEMENT INDUCED BY THE HEAVY TAMPING PROCESS.

CLEARANCES
THE DYNAMIC COMPACTION SUB-CONTRACTOR SHALL STATE THE REQUIRED CLEARANCES FOR WORKING FROM EXISTING SERVICES AND STRUCTURES.

IN THE EVENT OF ANY MONITORING OR VIBRATION INTENSITIES BEING ADVISABLE, THE SUB-CONTRACTOR SHALL STATE THIS.

TESTS
THE DYNAMIC COMPACTION SUB-CONTRACTOR SHALL STATE THE METHODS OF APPROPRIATE TESTING NECESSARY TO ENSURE ADEQUATE CONTROL OF THE TAMPING OPERATIONS, EFFECTIVE COMPACTION AND DETERMINE THE RESULTS OF THE TREATMENT. PROVIDE A MINIMUM OF 4No ZONE TESTS (ONE FOR EACH DYNAMIC COMPACTION PLATFORM.

THE SUB-CONTRACTOR SHALL ISSUE A GEOTECHNICAL REPORT ON THESE TESTS AFTER COMPLETION OF HIS OPERATIONS.

ADEQUATE TIME WILL BE ALLOWED FOR CONSIDERATION OF THE RESULTS OF TESTS BEFORE ANY REMEDIAL WORK OR FURTHER WORK IS CARRIED OUT.

SETTLEMENT OF FOUNDATIONS ON TREATED GROUND
THE COMPACTED GROUND SHALL BE CAPABLE OF TAKING THE SUSTAINED WORKING LOAD AND GIVE AN OVERALL SETTLEMENT OF NOT MORE THAN 25mm WITH A DIFFERENTIAL OF NOT MORE THAN 1 IN 500.

GENERAL NOTES

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LEGEND

- SITE BOUNDARY
- EXTENTS OF EXCAVATION TO CUT LEVELS
- EXTENTS OF DYNAMIC COMPACTION
- CHANGE IN CUT LEVEL
- 10m OFFSET LINE FROM WATER MAIN
- EXTENT OF CUT AREA 1
- EXTENT OF CUT AREA 2
- EXTENT OF CUT AREA 3
- EXTENT OF CUT AREA 4

REV	DESCRIPTION	DATE	CHK	BY
P02	REVISED DC EXTENTS ALONG NORTHERN BOUNDARY.	26.06.25	EJS	LSG
P01	FIRST ISSUE.	30.05.25	JBW	LSG

Project
HARRAS DYKE FARM
WHITEHAVEN

Drawing Title
DYNAMIC COMPACTION SECTIONS

INFORMATION

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NOTES

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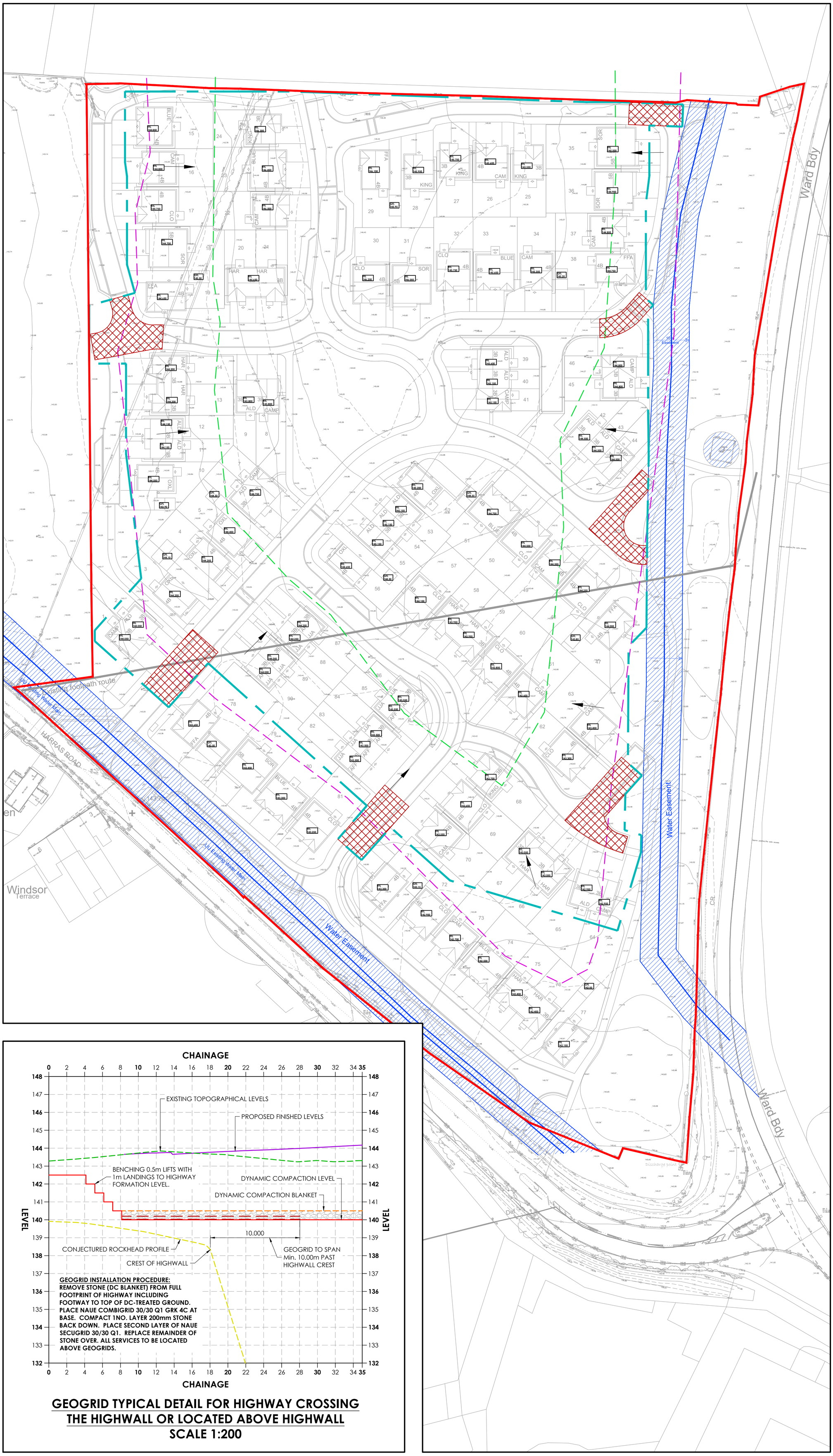
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4. ANY DISCREPANCIES SHOULD BE REPORTED TO THE ENGINEER IMMEDIATELY SO THAT CLARIFICATION CAN BE SOUGHT PRIOR TO COMMENCEMENT OF WORKS.
5. GEOGRIDS TO BE INSTALLED FOLLOWING DYNAMIC COMPACTION TREATMENT.

LEGEND

- SITE BOUNDARY
- EXTENTS OF EXCAVATION TO CUT LEVELS
- HIGHWALL CREST
- HIGHWALL TOE
- EXTENTS OF PROPOSED GEOGRID (DETAILS ON SECTION)

0m 12.5m 25m

SCALE 1:500



CHAINAGE

GEOGRID INSTALLATION PROCEDURE:
REMOVE STONE (DC BLANKET) FROM FULL FOOTPRINT OF HIGHWAY INCLUDING FOOTWAY TO TOP OF DC-TREATED GROUND. PLACE NAUE COMBIGRID 30/30 Q1 GRK 4C AT BASE. COMPACT 1NO. LAYER 200mm STONE BACK DOWN. PLACE SECOND LAYER OF NAUE SECUGRID 30/30 Q1. REPLACE REMAINDER OF STONE OVER. ALL SERVICES TO BE LOCATED ABOVE GEOGRIDS.

GEOGRID TYPICAL DETAIL FOR HIGHWAY CROSSING THE HIGHWALL OR LOCATED ABOVE HIGHWALL

SCALE 1:200

REV	DESCRIPTION	DATE	CHK	BY
P01	FIRST ISSUE.	30.05.25	JBW	LSG

Project
HARRAS DYKE FARM
WHITEHAVEN

Drawing Title
GENERAL ARRANGEMENT OF GEOGRIDS

INFORMATION

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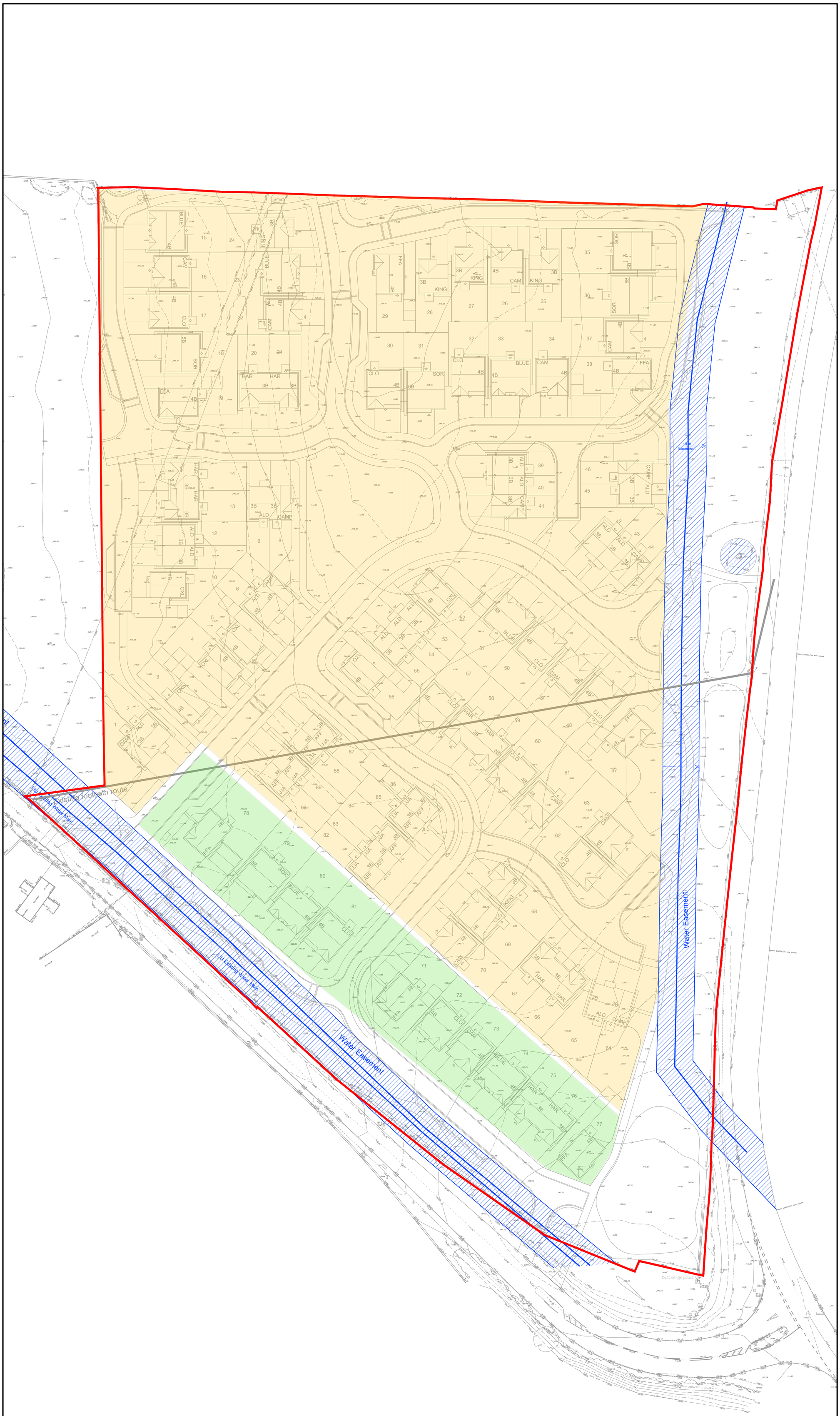
NOTES

EHLP LEGEND

- STANDARD STRIP FOOTINGS BEARING ON TO NATURAL COHESIVE GLACIAL TILL
- REINFORCED STRIP FOOTIN BEARING ONTO ENGINEERED / DYNAMIC COMPACTION TREATED FILL

0m 12.5m 25m

SCALE 1:500



P01	FIRST ISSUE	14.05.25	JBW	EJS
REV	DESCRIPTION	DATE	CHK	BY

Project
HARRAS DYKE FARM
WHITEHAVEN

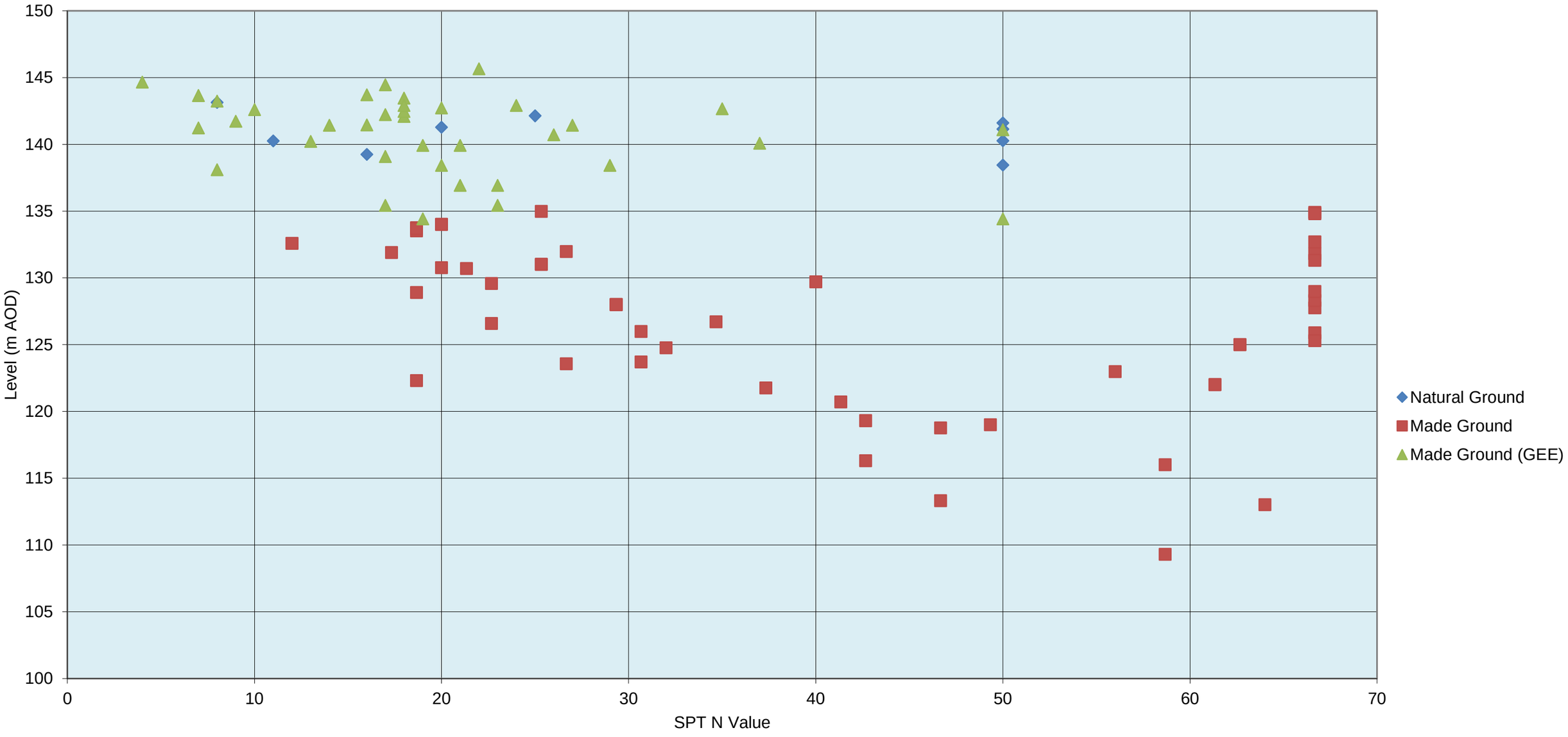
Drawing Title
FOUNDATION ZONING PLAN

INFORMATION

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6439-JPG-ZZ-ZZ-DR-G-1105 | S2 | **P01**

Figure 3: Corrected SPT N Value vs Level (m AOD)



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