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INFINERGY LIMITED

TORRANCE WINDFARM EXTENSION

GEOLOGY, MINING AND GEOTECHNICAL DESKTOP STUDY REPORT

JUNE 2022

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DRAWINGS	TITLE	SCALE
GL10303-C-3102	Mining Constraints	1:2,500
GL10303-C-3103	Geotechnical Constraints	1:2,500

1 INTRODUCTION

- 1.1 Infinergy Limited are proposing to develop an extension to the existing Torrance Wind Farm on land north of Harthill, North Lanarkshire. The development will consist of four new wind turbines and associated access tracks, crane hardstanding areas and a substation. A temporary construction compound will also be required. The preliminary layout of the development is shown on Drawing No. GL10303-C-3102
- 1.2 Infinergy Limited commissioned Wardell Armstrong LLP to prepare a desk study report on the geological, mining and geotechnical settings of the development site area.
- 1.3 The main purpose of this desk study report is to identify the level of risk associated with potential ground instability related to historical mining for the various elements of the wind farm and to highlight any other obvious areas of geotechnical concern that could adversely affect the proposed development. The potential for contamination of land and / or water to affect the site has not been considered in this report.
- 1.4 The methodology adopted and the sources of information used by Wardell Armstrong LLP in providing the services are outlined in this report. The work described in this report is based on the conditions and information as stated at the date the report was completed. The scope of this report and the services are accordingly limited by these circumstances. The findings outlined in the report together with any opinions expressed and recommendations made are considered to be valid and appropriate at the time of preparation and for the specific purpose or purposes intended. Whilst a walk over site visit may have been carried out as part of the work this has been limited to observations only and no other physical investigations, sampling and testing work has been carried out as part of this work.

2 THE SITE

2.1 Sources of Information

2.1.1 The following desktop study sources were utilised in the assessment of the site:

- The British Geological Survey (BGS):
 - Onshore GeoIndex website for solid and drift geology;
 - BGS Sheets NS86NE, NS86SE, NS96NW and NS96SW (1:10,000 scale);
 - BGS Memoir the Economic Geology of the Central Coalfield of Scotland, Area VI, Bathgate, Wilsontown and Shotts, publ. 1923;
- Coal Authority Consultant's Coal Mining Report (CAMR) referenced 51003163939001 and dated 24th May 2022.
- The Coal Authority's (CA) web-based Interactive Map Viewer for information on surface and shallow underground mine workings and mine entries.
- Review of Mining Instability in Great Britain produced by Arup Geotechnics (1991).
- The National Library of Scotland Map web page for the OS County Series 6" sheet Lanarkshire Sheet IX publ. 1921.

2.2 Site Location, Description and History

2.2.1 The site lies to the west of the existing Torrance Wind Farm, north of Harthill and the M8 motorway as shown on Drawing No. GL10303-C-3102. The southern boundary of the site lies partly adjacent to and the Harthill Motorway Service Area. A temporary construction access for abnormal loads turbine delivery is proposed through and from the Service Area.

2.2.2 The site currently comprises primarily commercial forestry in the central and eastern parts of the site with agricultural fields and rough grazing in the western part. Netherton Farm with associated farm buildings is located in the east of the site. The B718, Blackridge to Harthill road passes north south through the western part of the site.

2.2.3 Whilst a formal study of the site history is beyond the scope of this report, where relevant historical land-uses other than farmland are shown on the Ordnance Survey historical mapping they have been identified.

2.2.4 A disused railway line runs north to south through the centre of the site, identified as the 'Shotts Branch'. The railway accessed the former Blairmuckhill Colliery (Pit No. 10)

in the western section of the site (to the north of the proposed position of turbine T4). Another former colliery (Southrigg Colliery Pits Nos. 7 & 8) was located in the north-eastern corner of the site (north of the proposed position of turbine T1). The former Netherton Colliery was accessed via two inclined mine drifts in the northern section of the site.

2.3 Geology

Made Ground

2.3.1 Areas of made ground on and adjacent to the site and recorded on the BGS 1:50,000 scale mapping are shown on Drawing GL10303-C-3103. These are primarily associated with works at the former Blairmuckhill and Southrigg Collieries (which are north of the site area) and the construction of the Harthill Motorway Services Area in the southern part of the site. It is likely that there will be other localised areas of made ground not shown on the mapping associated with previous land uses such as mining and railway construction.

2.3.2 An area of made ground is shown at the location of the crane hardstanding for turbine T1. The origin of this material is not obvious from the mapping history, although it may be mining related or associated with land improvement of a former peatland area.

2.3.3 Due to the land-use history it is possible that these areas of made ground may be contaminated and this should be addressed in future site investigations.

Natural Superficial Deposits

2.3.4 The BGS 1:50,000 scale mapping sheets record the majority of the superficial strata within the site as consisting of glacial till (boulder clay). This generally comprises an over-consolidated sandy clay with inclusions of gravel, cobbles and boulders. Historic boreholes over the site area show depths of glacial till up to c. 13m, although it is unlikely that other areas may also be present. As the glacial till is over-consolidated it is typically of low compressibility with medium to high undrained shear strength, although this can be reduced where it is weathered or softened by water, typically near its upper surface.

2.3.5 Relatively localised areas of peat are also identified on the BGS mapping and recorded locations of these soils on the site have been shown on Drawing GL10303-C-3103. The access road and part of the crane hardstanding is shown to be underlain by peat deposits. There is limited information on the depth of peat, however, a historic

borehole north of Nethererton Farm identified c. 4m of peat (recorded as 'Moss'). Peat soils are highly compressible and generally have very low to low undrained shear strength. They are unsuitable as a founding medium for structures.

Solid Geology

- 2.3.6 The bedrock geology comprises strata of the Carboniferous Lower Coal Measures Formation. This is a cyclic sequence of siltstones, sandstones and mudstones with a number of coal seams and fireclays. The strata dip gently to the west with the angle of dip being generally less than 5 degrees.
- 2.3.7 The strata at outcrop beneath the site includes from the Kiltongue Coal seam to the Lower Drumgray Coal seam but has been disrupted by faulting in the eastern section of the site. An ENE to WSW trending fault runs through the centre of the east of the site with a 15m throw to the north.
- 2.3.8 To the north of the site area, a quartz dolerite sill is intruded into the Carboniferous strata. However, this is not recorded to underlie the site, apart from a small area in the field to the south of Hill Farm. Although potentially suitable as a source of aggregate for construction, it is unlikely that area would be suitable for quarrying due to the depth of superficial deposits.
- 2.3.9 There are a few historic boreholes recorded over the site area with the majority dating from the early 20th century, when the area was being investigated for mining prospects. The logs for some of these boreholes record the Index Limestone and some were drilled through this into the strata of the Limestone Coal Group.
- 2.3.10 The details of the named coal seams beneath the site area in the Lower Coal Measures strata are presented in Table 1, attached as Appendix B.

2.4 **Mining**

- 2.4.1 Details of the mining situation of the site have been obtained from the geological interpretation and from the Coal Authority Consultant's Coal Mining Report (CACMR). It should be noted that the CACMR covers the extent of the proposed wind farm infrastructure but does not correspond exactly with the designated site boundary.

Surface Mining and Quarrying

- 2.4.2 There is no recorded evidence of quarrying or opencast coal extraction on the site.

Underground Mining – Coal and Ironstone

- 2.4.3 The CAMR lists mining beneath and adjacent to the site in eight seams of coal and one seam of ironstone. The depths of recorded workings surface vary between 18m and 517m, the last date of working being 1976.
- 2.4.4 With regards to those workings recorded beneath the site, these are shown on Table 1 (Appendix 2). This indicates recorded workings undertaken at depths between 18m and c. 70m in the Upper Drumgray, Lower Drumgray, Mill, Armadale Ball and Armadale Main coal seams.
- 2.4.5 It is considered that only mine workings in coal seams in and above the Lower Drumgray coal need to be addressed as the other seams are at such a depth to rule out the likelihood of ground instability due to shallow mining collapse and/or any subsidence associated with them would have been contemporaneous with their mining.
- 2.4.6 The CA's Interactive web page shows the extents of the recorded shallow mine workings and areas of probable unrecorded shallow mine workings. In this regard, 'shallow' is considered to be within 30m of the ground surface, in line with the Coal Authority's definition. The presence of probable unrecorded shallow mine workings is confirmed in the CACMR.
- 2.4.7 Turbines T3 and T4 are located over areas of recorded shallow workings as shown on Drawing No. GL10303-C-3102. It is likely that these workings will be associated with the Blairmuckhill, Netherton and Southrigg Collieries that are located to the north of the site area.
- 2.4.8 Turbines T1 and T2 are located close to areas of probable shallow workings defined by geological faulting (as shown on Drawing No GL10303-C-3102). Dependent on the location of the faulting the turbines may be underlain by shallow workings in the Upper Drumgray and/or Lower Drumgray coal seams.
- 2.4.9 The CACMR states that the CA has no records of any subsidence damage or claim for any properties in, or within 50m of the site boundary during the history of the CA. No mine gas emissions have been recorded by the CA within 500m of the site boundary and there are no mine water treatment schemes within the same distance. There are no plans for any underground mining within the site area and no mining licenses are recorded within 200m of the site. No notice has been given under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

2.4.10 Taking into account the presence of the recorded and probable unrecorded shallow mine workings, the CA's interactive web page shows a significant proportion of the site area as being within a Development High Risk Area. This means that the Coal Authority, as a statutory planning consultee in coal mining reporting areas, will require a Coal Mining Risk Assessment (CMRA) to accompany any planning application for development. A CMRA is considered by the CA to be necessary to prove that the developer has taken account of the mining situation in the site, indicate that these mining issues will be investigated appropriately and, if the mining risk is proved to be unacceptable, mitigation measures will be instigated to ensure the stability of the proposed development is not compromised by shallow mining instability.

Geological faulting

2.4.11 The geological mapping indicates the presence of geological faulting in the east of the site, adjacent to the proposed locations of turbines T1 and T2. Any ground movement along the faults associated with the workings will have been contemporaneous with mining in the area and the likely depth of superficial deposits would also mitigate potential ground movement across fault lines.

Mine Entries

2.4.12 The CACMR records the presence of six mine entries (four shafts and two adits) within the area of the report. These relate to the Blairmuckhill, Netherton and Southrigg Collieries. All six mine entries do, however, lie outside the designated site boundary as shown on Drawing No. GL10303-C-3102. The mine entries are sufficiently distant (at least 20m) from the site boundary and the proposed infrastructure that they are not considered to pose a ground instability risk.

2.4.13 The presence of unrecorded mine entries in a mining area can never be discounted and careful watch should be kept when construction works are ongoing for signs of mine entries such as circular or rectangular contrasting soil types or buried brick or stonework. Site operatives should be informed that any suspicious feature in the ground that could be a mine entry should be reported and investigated as appropriate.

Underground Mining – Non Coal

2.4.14 An examination of the *Review of Mining Instability in Great Britain* produced by Arup Geotechnics (1991) has shown no evidence of mining on or in the vicinity of the site apart from the coal and ironstone mining listed above.

3 GEOTECHNICAL AND MINING RISK ASSESSMENT

3.1.1 The main purpose of this desk study report is to identify the level of risk associated with potential mining-related ground instability for the various elements of the proposed wind farm and to highlight any other areas of geotechnical concern that could adversely affect the proposed development. This includes assessment of the superficial deposits within these areas to identify a potentially competent bearing stratum for foundations.

3.2 Mining Instability

3.2.1 The risk of future collapse and settlement of abandoned underground mine workings occurring, depends upon a number of factors. The primary factors are:

- Method of extraction;
- Thickness of the mineable horizon;
- Depth of mine working;
- Pillar dimensions (in the case of partial extraction mine workings)
- Geotechnical nature of the floor and roof strata;
- Geotechnical nature and thickness of surface superficial deposits; and
- Age of mine working

3.2.2 Older mine workings were generally mined by a partial extraction technique referred to as the “pillar and stall” method (known as “stoop and room” in Scotland) where “stalls or rooms” of coal were extracted on a frequently regular “chequerboard” pattern leaving “pillars or stoops” of intact coal in place to support the roof. The problem with such mine workings is that they may only be partially collapsed and can remain open for many hundreds of years. With such workings, the potential remains for further, unpredictable collapse of the overlying strata into the void

3.2.3 With stoop and room mine workings there may be a risk that future collapse of the workings and their overlying strata could result in settlement and voiding at the ground surface. The ground collapse may result in the formation of a void at the ground surface (termed a “crown hole”) formed by the upward migration of the collapse voids. These can be randomly distributed over the mining area, with their position dependent on the interactions between the geometric configuration of the

mined area and the geotechnical parameters of the overlying strata and superficial deposits.

- 3.2.4 For sensitive built structures, the maximum height of collapse in rock overlying stooop and room mine workings is generally taken as five to ten times the seam thickness. Where the risk of future settlement is considered too high, then mitigation by specific design measures and/or detailed investigation and stabilisation of the mine workings may be required. This usually comprises the drilling and injection of cement grout into the mine workings and overlying collapsed strata to infill any remaining voids. Such measures are frequently undertaken for traditional building development where the solid rock cover above the mined seam (or potentially mined seam) is less than ten times the extracted thickness (T) of the seam in question.
- 3.2.5 A RAG assessment has been undertaken to assess the level of risk to the proposed development from surface instability associated with shallow mine workings. A qualitative risk level ('High, Medium or Low') has been allocated to the various elements of the wind farm (turbines, access roads, substation and construction compound).
- 3.2.6 The RAG assessment is shown on Table 2 (Appendix C) and is based on data provided by the Coal Authority and our own interpretation of the geology and mining history of the site area. In general a 'High' risk has been allocated to areas where infrastructure is shown to be underlain by recorded shallow mine workings and a 'Medium' risk for infrastructure located beneath or adjacent to areas of probable shallow workings.
- 3.2.7 The proposed turbines and their associated hardstanding areas will have the greatest sensitivity to mining instability both from the long-term stability of the turbines themselves but also construction health and safety during crane lifting operations. Two of the turbines (T3 and T4) are considered to be within a 'High' risk zone, as they are shown to be underlain by recorded shallow mine workings. Turbines T1 and T2 are categorised to be within a 'Medium' risk zone.
- 3.2.8 As indicated in paragraph 3.2.1, the risk level is dependent on a number of factors. The assessment has been based on the level of data currently available and it is possible that the level of risk will change once further data is obtained. This would primarily comprise information available from mine abandonment plans and that obtained from site specific ground investigations.

3.2.9 The access tracks can be considered less sensitive but do cross zones of 'High' and 'Medium' risk, particularly in the western part of the site. The substation and construction compound are considered to be in 'Low' risk zones.

3.3 Turbine Foundations

3.3.1 Examination of the recorded geology of the superficial deposits over the site area shows areas of made ground and peat overlying glacial till. Made ground and peat is not recorded at the turbine locations, however, this is no guarantee that these materials are not present.

3.3.2 Existing boreholes indicate substantial thicknesses of till, up to 13m comprising boulder clay, silts sands and gravels. The presence of made ground/peat and the depth, nature and suitability of the glacial till as a bearing stratum would need to be confirmed at the proposed location(s) of the turbine locations by ground investigation. The scope of investigation would be dependent on the size of structures and loadings proposed and may include trial pits, cable percussive boreholes and / or rotary cored boreholes, and potentially non-intrusive geophysical surveys.

3.4 Substation Foundations

3.4.1 The substation is shown to be underlain by glacial till. Dependent on the nature and suitability of the glacial till, it is likely that this will be suitable as a bearing stratum. This would, however, be required to be confirmed by ground investigation.

3.5 Access Tracks and Hardstanding Areas

3.5.1 In general, access tracks and hardstanding areas avoid areas of recorded peat, apart from the current proposed location of the access road and hardstanding for T4, which is partly underlain by peat. Localised areas of peat may also be present that are not recorded. These may require removal and replacement of the peat or may be suitable for 'floating' track construction using geotextiles but this is only likely to be suitable over more extensive areas of peat.

3.5.2 The crane hardstanding for turbine T1 is shown to be partly underlain by made ground, however, other areas of made ground are also likely to be present. Deposits of made ground may be suitable as track formation (such as mining spoil) or may require removal and replacement or improvement using geotextiles.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Mining Instability

4.1.1 The site area has been affected by underground mining activity from the mid-19th Century until the 1970s. However, much of the recorded mining below the site was at such depth that any collapse would not cause surface instability. Recorded and probable shallow workings are, however, present at shallow depths that may present a risk of ground instability.

4.1.2 A RAG analysis has been undertaken to assess areas at high, medium and low risk of surface instability associated with shallow mine workings. With regard to the location of the proposed wind turbines, two turbines (T3 and T4) are considered to be within zones of potential 'High' risk of mining instability with turbines T1 and T2 being in zones of 'Medium' risk. The substation is considered to be in a 'Low' risk zone.

4.2 Foundations

4.2.1 The majority of the natural superficial strata within the site consist of glacial till (boulder clay), potentially to significant depths. Dependent on the nature of the glacial till, the material may be suitable as a bearing foundation for the wind turbines, subject to further site-specific investigation.

4.2.2 Areas of peat are recorded on the site, in particular to the east of Turbine T4, beneath the proposed hardstanding and access road. Subject to further investigation, the peat may be suitable for the construction of a 'floating' access track but may require removal and replacement. Beneath the crane hardstanding it will require removal and replacement. A small area of made ground is recorded beneath the T1 hardstanding that may be suitable as a formation subject to further investigation.

4.3 Recommendations

4.3.1 In order to obtain, better understanding of the mining situation at the site, it is recommended that the appropriate mine abandonment plans are obtained from the Coal Authority. These will confirm the extent of the recorded workings in the shallow coal seams and may provide additional information on the depth and thickness of the seams to assist in the stability assessment.

4.3.2 A ground investigation should be carried out at the locations of the proposed wind turbines and infrastructure to:

- Confirm the shallow mining situation and foundation depth and solution for the turbines;
- Confirm the shallow mining situation and bearing strata for the substation;
- Assess the suitability of the glacial till as a formation for the access tracks and hardstanding areas;
- Delineate the extent of made ground and peat deposits;
- Assess the groundwater and ground gas regimes;

4.3.3 Mining investigations would include rotary cored and openhole boreholes, targeting the zones of higher instability risk. A permit will be required from the Coal Authority for these investigations.

4.3.4 Geotechnical investigations would include trial pits; cable percussive and rotary cored boreholes (potentially); peat probing and sampling (if not already undertaken); installation of gas and groundwater monitoring standpipes; and geotechnical laboratory analysis of disturbed and undisturbed soil and rock samples. Non-intrusive geophysical surveys may also be used.

4.3.5 If the information from the site investigation proves an unacceptable level of risk of instability from shallow mine workings, then a suitable ground treatment programme, comprising the drilling boreholes and the injection of pfa/sand/cement grout beneath turbine foundations, will be required prior to construction. As an alternative it may be possible to microsite the turbines to alternative locations where the risk of ground instability is acceptable.

4.3.6 Appropriate mitigation will also be required for crane hardstandings and access roads – dependent on the level of mining risk identified this may comprise enhanced hardstanding design to include sufficient reinforcement to span voids and/or drilling and grout injection at crane outrigger locations.

4.3.7 It is considered unlikely that any ground movement related to the geological faulting is likely to occur, however, an assessment should be made at the relevant turbine locations (T1 and T2) once geotechnical information has been obtained from the ground investigation. If it is still considered a risk then micrositing of the turbines away from the fault location should be considered.

APPENDIX A

Coal Authority Consultant's Coal Mining Report



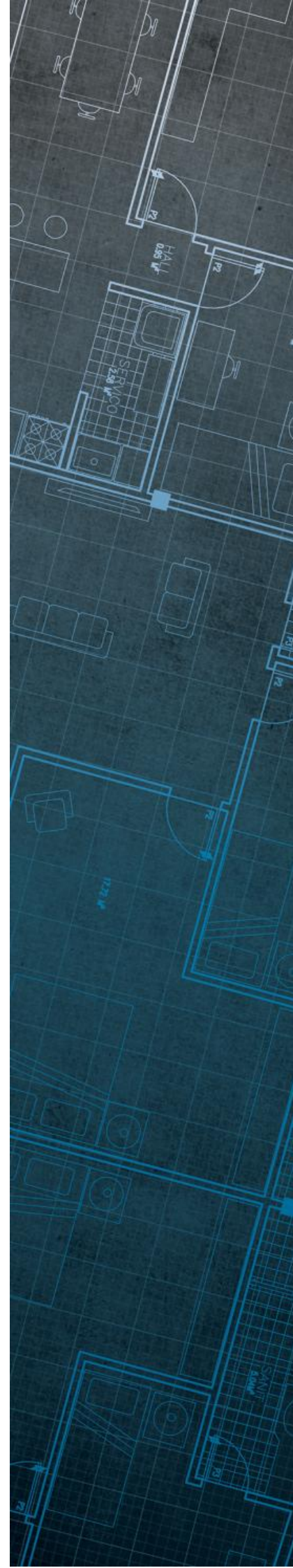
The Coal
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Consultants Coal Mining Report

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Consultants

Coal Mining Report

This report is based on and limited to the records held by the Coal Authority at the time the report was produced.

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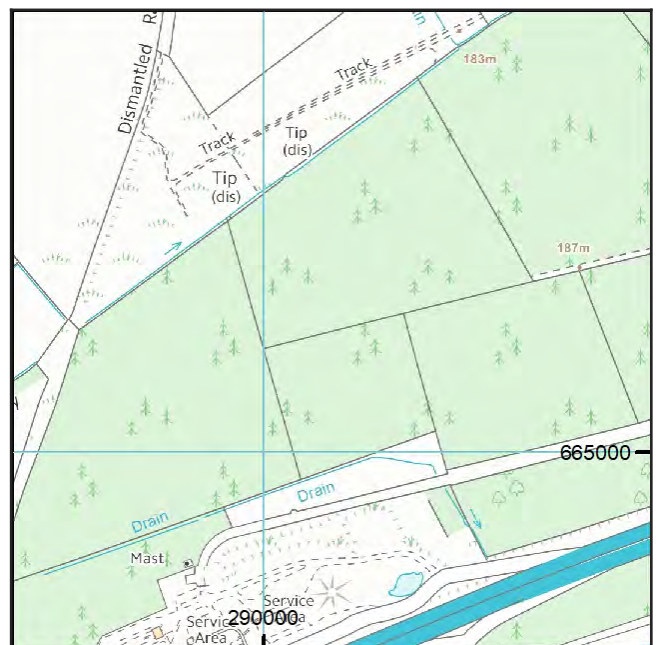
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Approximate position of property



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Section 1 – Mining activity and geology

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
NETHERTON	UPPER DRUMGRAY	Coal	667R	18	Beneath Property	2.0	North-West	60	1948
NETHERTON	UPPER DRUMGRAY	Coal	69Q4	25	Beneath Property	2.1	North-West	58	1947
NETHERTON	UPPER DRUMGRAY	Coal	667S	30	Beneath Property	0.9	North-East	60	1949
NETHERTON	UPPER DRUMGRAY	Coal	667T	40	Beneath Property	0.8	West	60	1944
BLAIRMUCKHILL	LOWER DRUMGRAY	Coal	69Q5	41	Beneath Property	0.8	East	44	1916
SOUTH RIGG	MILL	Coal	6SBC	41	South	3.2	East	61	1919
SOUTH RIGG	MILL	Coal	6SB8	43	Beneath Property	1.7	South-West	61	1918
BLAIRMUCKHILL	UPPER DRUMGRAY	Coal	69Q2	48	Beneath Property	2.4	North	56	1891
NETHERTON	UPPER DRUMGRAY	Coal	69Q3	50	Beneath Property	2.1	North	58	1947
SOUTH RIGG	MILL	Coal	67TJ	51	Beneath Property	1.9	West	60	1922
NETHERTON	LOWER DRUMGRAY	Coal	69QR	55	Beneath Property	3.1	North	49	1950
SOUTH RIGG	ARMADALE MAIN	Coal	67QM	58	Beneath Property	2.3	North-West	65	1916
SOUTH RIGG	MILL	Coal	6SBB	59	Beneath Property	2.1	South-West	61	1924
SOUTH RIGG	ARMADALE BALL	Coal	6T02	61	Beneath Property	3.7	North-West	61	1917
SOUTH RIGG	ARMADALE BALL	Coal	67R5	64	Beneath Property	2.2	South-West	60	1920
SOUTH RIGG	ARMADALE BALL	Coal	6SBZ	66	Beneath Property	3.7	North-West	61	1921
SOUTH RIGG	ARMADALE MAIN	Coal	6B64	68	Beneath Property	0.4	North-West	97	1917
NETHERTON	LOWER DRUMGRAY	Coal	69QQ	70	Beneath Property	3.1	North	49	1950
SOUTH RIGG	ARMADALE BALL	Coal	67R4	70	Beneath Property	3.0	North-West	60	1929
NETHERTON	LOWER DRUMGRAY	Coal	667Z	71	Beneath Property	1.2	North-West	45	1950
SOUTH RIGG	ARMADALE MAIN	Coal	67QL	72	Beneath Property	2.3	North-West	65	1909
SOUTH RIGG	ARMADALE BALL	Coal	6T00	73	Beneath Property	1.9	North-West	66	1927

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
SOUTH RIGG	ARMADALE MAIN	Coal	67QR	74	Beneath Property	2.3	North-West	65	1917
BLAIRMUCKHILL	LOWER DRUMGRAY	Coal	69QO	74	Beneath Property	2.9	North	44	1914
BLAIRMUCKHILL	MILL	Coal	69QC	76	Beneath Property	1.6	North	56	1915
SOUTH RIGG	ARMADALE BALL	Coal	69R6	77	Beneath Property	4.5	West	66	1933
SOUTH RIGG	ARMADALE MAIN	Coal	67QS	79	Beneath Property	2.3	North-West	65	1917
SOUTH RIGG	ARMADALE BALL	Coal	69R5	81	Beneath Property	0.5	North-West	66	1935
SOUTH RIGG	ARMADALE BALL	Coal	67R3	82	Beneath Property	3.0	North-West	60	1934
SOUTH RIGG	MILL	Coal	69QH	83	Beneath Property	1.1	West	58	1931
SOUTH RIGG	ARMADALE MAIN	Coal	67QW	85	Beneath Property	2.1	North	70	1909
SOUTH RIGG	ARMADALE MAIN	Coal	67QK	86	Beneath Property	2.1	North	70	1908
SOUTH RIGG	MILL	Coal	6682	88	Beneath Property	2.7	North-West	61	1938
SOUTH RIGG	ARMADALE MAIN	Coal	69RB	88	Beneath Property	1.1	West	97	1929
SOUTH RIGG	ARMADALE MAIN	Coal	67QU	88	Beneath Property	2.2	North	70	1908
SOUTH RIGG	ARMADALE MAIN	Coal	67QV	90	Beneath Property	2.2	North	70	1908
SOUTH RIGG	ARMADALE BALL	Coal	69R4	93	Beneath Property	1.3	South-West	61	1934
SOUTH RIGG	ARMADALE BALL	Coal	6686	93	North	3.1	North-West	58	1933
SOUTH RIGG	ARMADALE BALL	Coal	67R2	95	Beneath Property	0.5	West	60	1938
BLAIRMUCKHILL	ARMADALE BALL	Coal	69QW	96	Beneath Property	1.9	North	51	1952
SOUTH RIGG	ARMADALE MAIN	Coal	69RC	104	Beneath Property	1.1	West	86	1938
BLAIRMUCKHILL	ARMADALE MAIN	Coal	69RD	105	Beneath Property	1.1	North-East	102	1934
SOUTH RIGG	ARMADALE MAIN	Coal	6689	105	North	2.2	North-West	45	1938
BLAIRMUCKHILL	MILL	Coal	69QB	109	Beneath Property	2.3	North	56	1916
BLAIRMUCKHILL	ARMADALE BALL	Coal	69QV	127	Beneath Property	2.4	North	61	1951
BLAIRMUCKHILL	ARMADALE MAIN	Coal	69RA	129	North-West	1.8	South-East	81	1959
MUIRHEAD	SLATEYBAND IRONSTONE	Ironstone	69PY	142	South	1.5	North	91	1888

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
POLKEMMET	KNIGHTSWOOD GAS	Coal	67RE	509	East	2.2	North-West	120	1969
POLKEMMET	KNIGHTSWOOD GAS	Coal	6B6G	510	South-East	1.5	North-West	135	1968
POLKEMMET	KNIGHTSWOOD GAS	Coal	6B6E	517	South	2.9	North-West	140	1976

Probable unrecorded shallow workings

Yes.

Spine roadways at shallow depth

Distance to spine roadway (m)	Direction to spine roadway
Within	N/A
Within	N/A
Within	N/A
Within	N/A

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	289664-001	289250 664881	This shaft has been filled at some time in the past. There are no details of the fill material or date of filling	Coal	
Shaft	289664-002	289242 664860	This shaft has been filled at some time in the past. There are no details of the fill material or date of filling	Coal	
Adit	289665-001	289903 665283	The adit has been filled to an undetermined specification at some time in the past	Coal	
Adit	289665-002	289915 665328	The adit has been filled to an undetermined specification at some time in the past	Coal	
Shaft	290665-001	290727 665602	This shaft has been filled at some time in the past. There are no details of the fill material or date of filling	Coal	
Shaft	290665-002	290744 665614	This shaft has been filled at some time in the past. There are no details of the fill material or date of filling	Coal	

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

9083	S4	S3550
S869	S3477	S2378
5484	S3589	S1916

Our records show we have more plans than those shown above which could affect the enquiry boundary.

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

Outcrops

Seam name	Mineral	Seam workable	Distance to outcrop (m)	Direction to outcrop	Bearing of outcrop
KILTONGUE	Coal	Yes	Within	N/A	252
LOWER DRUMGRAY	Coal	Yes	Within	N/A	20
LOWER DRUMGRAY	Coal	Yes	Within	N/A	21
LOWER DRUMGRAY	Coal	Yes	Within	N/A	208
LOWER KILTONGUE	Coal	Yes	Within	N/A	6
LOWER KILTONGUE	Coal	Yes	Within	N/A	209
LOWER KILTONGUE	Coal	Yes	Within	N/A	249
MID DRUMGRAY	Coal	Yes	Within	N/A	193
UPPER DRUMGRAY	Coal	Yes	Within	N/A	16
UPPER DRUMGRAY	Coal	Yes	Within	N/A	23

Geological faults, fissures and breaklines

Please refer to the 'Summary of findings' map (on separate sheet) for details of any geological faults, fissures or breaklines either within or intersecting the enquiry boundary.

Faults under or close to the property recorded.

Opencast mines

None recorded within 500 metres of the enquiry boundary.

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

Please refer to the 'Summary of findings' map (on separate sheet) for details of any activity within the area of the site boundary.

Site investigations

None recorded within 50 metres of the enquiry boundary.

Remediated sites

Distance to site remediation (m)	Direction
Within	N/A

See Section 4 for further information.

Coal mining subsidence

The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas

None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes

None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining

None recorded.

Coal mining licensing

None recorded within 200 metres of the enquiry boundary.

Court orders

None recorded.

Section 46 notices

No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Withdrawal of support notices

The property is not in an area where a notice to withdraw support has been given.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

Payments to owners of former copyhold land

The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Section 4 – Further information

The following potential risks have been identified and as part of your risk assessment should be investigated further.

Development advice

The site is within an area of historical coal mining activity. Should you require advice and/or support on understanding the mining legacy, its risks to your development or what next steps you need to take, please contact us.

Remediated sites

The site is within an area of previous interest. It is close to where the Coal Authority has investigated and where necessary remediated mine entries and/or shallow coal mine workings following specific reported hazards.

The site requires further investigation and may influence your risk assessment. We recommend that you order the Coal Authority **Surface Hazards Incident Report**, which will include more information about the hazard.

For further information on specific site or ground investigations in relation to any issues raised in Section 4, please call us on 0345 762 6848 or email us at groundstability@coal.gov.uk.

Section 5 – Data definitions

The datasets used in this report have limitations and assumptions within their results. For more guidance on the data and the results specific to the enquiry boundary, please **call us on 0345 762 6848** or **email us at groundstability@coal.gov.uk**.

Past underground coal mining

Details of all recorded underground mining relative to the enquiry boundary. Only past underground workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination, will be included.

Probable unrecorded shallow workings

Areas where the Coal Authority believes there to be unrecorded coal workings that exist at or close to the surface (less than 30 metres deep).

Spine roadways at shallow depth

Connecting roadways either, working to working, or, surface to working, both in-seam and cross measures that exist at or close to the surface (less than 30 metres deep), either within or within 10 metres of the enquiry boundary.

Mine entries

Details of any shaft or adit either within, or within 100 metres of the enquiry boundary including approximate location, brief treatment details where known, the mineral worked from the mine entry and conveyance details where the mine entry has previously been sold by the Authority or its predecessors British Coal or the National Coal Board.

Abandoned mine plan catalogue numbers

Plan numbers extracted from the abandoned mines catalogue containing details of coal and other mineral abandonment plans deposited via the Mines Inspectorate in accordance with the Coal Mines Regulation Act and Metalliferous Mines Regulation Act 1872. A maximum of 9 plan extents that intersect with the enquiry boundary will be included. This does not infer that the workings and/or mine entries shown on the abandonment plan will be relevant to the site/property boundary.

Outcrops

Details of seam outcrops will be included where the enquiry boundary intersects with a conjectured or actual seam outcrop location (derived by either the British Geological Survey or the Coal Authority) or intersects with a defined 50 metres buffer on the coal (dip) side of the outcrop. An indication of whether the Coal Authority believes the seam to be of sufficient thickness and/or quality to have been worked will also be included.

Geological faults, fissures and breaklines

Geological disturbances or fractures in the bedrock. Surface fault lines (British Geological Survey derived data) and fissures and breaklines (Coal Authority derived data) intersecting with the enquiry boundary will be included. In some circumstances faults, fissures or breaklines have been known to contribute to surface subsidence damage as a consequence of underground coal mining.

Opencast mines

Opencast coal sites from which coal has been removed in the past by opencast (surface) methods and where the enquiry boundary is within 500 metres of either the licence area, site boundary, excavation area (high wall) or coaling area.

Coal Authority managed tips

Locations of disused colliery tip sites owned and managed by the Coal Authority, located within 500 metres of the enquiry boundary.

Site investigations

Details of site investigations within 50 metres of the enquiry boundary where the Coal Authority has received information relating to coal mining risk investigation and/or remediation by third parties.

Remediated sites

Sites where the Coal Authority has undertaken remedial works either within or within 50 metres of the enquiry boundary following report of a hazard relating to coal mining under the Coal Authority's Emergency Surface Hazard Call Out procedures.

Coal mining subsidence

Details of alleged coal mining subsidence claims made since 31 October 1994 either within or within 50 metres of the enquiry boundary. Where the claim relates to the enquiry boundary confirmation of whether the claim was accepted, rejected or whether liability is still being determined will be given. Where the claim has been discharged, whether this was by repair, payment of compensation or a combination of both, the value of the claim, where known, will also be given.

Details of any current 'Stop Notice' deferring remedial works or repairs affecting the property/site, and if so the date of the notice.

Details of any request made to execute preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991. If yes, whether any person withheld consent or failed to comply with any request to execute preventative works.

Mine gas

Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission.

Mine water treatment schemes

Locations where the Coal Authority has constructed or operates assets that remove pollutants from mine water prior to the treated mine water being discharged into the receiving water body.

These schemes are part of the UK's strategy to meet the requirements of the Water Framework Directive. Schemes fall into 2 basic categories: Remedial – mitigating the impact of existing pollution or Preventative – preventing a future pollution incident.

Mine water treatment schemes generally consist of one or more primary settlement lagoons and one or more reed beds for secondary treatment. A small number are more specialised process treatment plants.

Future underground mining

Details of all planned underground mining relative to the enquiry boundary. Only those future workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination will be included.

Coal mining licensing

Details of all licenses issued by the Coal Authority either within or within 200 metres of the enquiry boundary in relation to the under taking of surface coal mining, underground coal mining or underground coal gasification.

Court orders

Orders in respect of the working of coal under the Mines (Working Facilities and Support) Acts of 1923 and 1966 or any statutory modification or amendment thereof.

Section 46 notices

Notice of proposals relating to underground coal mining operations that have been given under section 46 of the Coal Mining Subsidence Act 1991.

Withdrawal of support notices







Published notices of entitlement to withdraw support and the date of the notice. Details of any revocation notice withdrawing the entitlement to withdraw support given under Section 41 of the Coal Industry Act 1994.

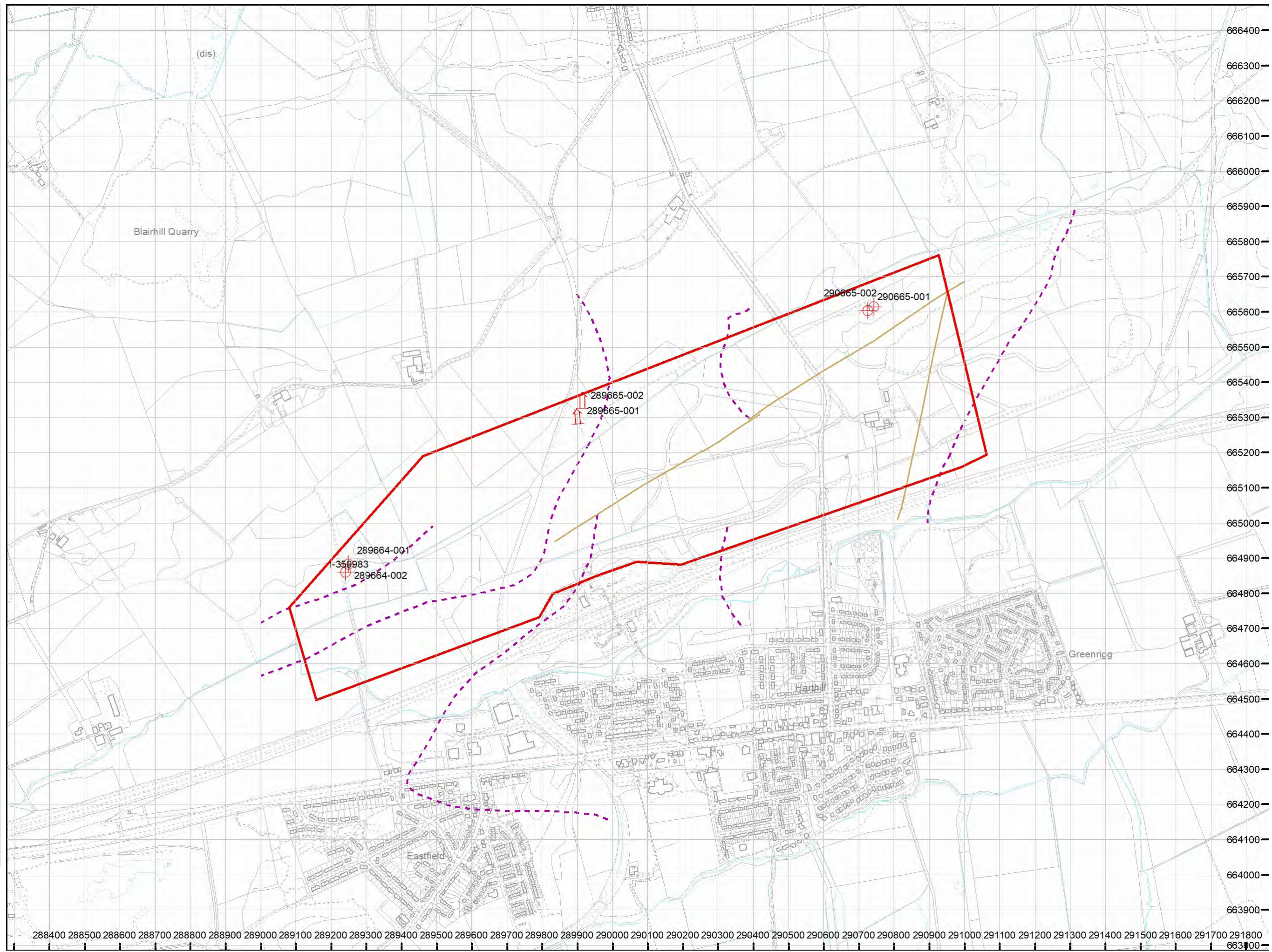
Payment to owners of former copyhold land

Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

- Approximate position of the enquiry boundary shown 
- Disused mine shaft 
- Disused adit 
- Outcrop (Conjectured) 
- Geological faults 
- Remediated sites 



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APPENDIX B

Table 1 - Coal Seam Stratigraphy

Table 1
Details of Coal Seams Below Site Area
in Lower Coal Measures (LCMS) strata

Coal Seam/strata	Seam thickness (m)	Workings recorded in site area (based on CA data)	Likelihood of working and potential depth of working
Quartz Dolerite Sill			
LCMS strata			
Kiltongue Coal	c. 0.3	No	Unlikely to have been worked as thin and of poor quality
LCMS strata			
Greengairs Lime Coal	c. 0.4	No	Unlikely to have been worked as thin and of poor quality
LCMS strata			
Upper Drumgray (Shotts Furnace) Coal	c. 0.9	Yes	Worked extensively from shallow to c. 50m
LCMS strata			
Mid Drumgray (Shotts Low) Coal	c. 0.3	No	Unlikely to have been worked as thin and poor quality
LCMS strata			
Lower Drumgray (Smithy) Coal	c. 0.6	Yes	Worked extensively from shallow to c. 70m
LCMS strata			
Shotts Gas	c. 0.3	No	Unlikely to have been worked as thin and of poor quality
LCMS strata			
Mill Coal	c. 0.7	Yes	Yes, but deeper than c. 40m
LCMS strata			
Armadale Ball	c. 0.6	Yes	Yes, but deeper than c. 60m
LCMS strata			
Armadale Main	c. 0.9	Yes	Yes, but deeper than c. 60m

Note. unrecorded workings could exist in any of the coal seams listed above

APPENDIX C

Table 2 – RAG Assessment of Mining Instability

Table 2
Mining Instability Risk Assessment and RAG Rating

Turbine No.	Superficial Geology	Solid Geology	Recorded mine workings (shallow)	Recorded mine shafts	Coal Authority shallow mining assessment	WA shallow mining assessment	WA shallow mining RAG zone rating	Preliminary SI scope
T1	Boulder clay	LCM Very close to fault outcrop. Between LD and MD (south of fault) or MD and UD (north of fault)	No	Southrigg Colliery (Pits Nos. 7 and 8) c. 100m to N	On edge of HRDA	Potentially within instability zone for LD	Medium	Rotary boreholes at turbine position and hardstanding
T1 access track		Very close to outcrop of LD at corner near Netherton Farm	Yes		Within HRDA at corner near Netherton Farm		High (South and east of Netherton Farm), otherwise Medium and Low	Rotary boreholes in high-risk zone near outcrop of LD
T2	Boulder clay (c13m proved in borehole NS96NW150)	LCM Close to fault outcrop. Between MD and UD (south of fault) or UD and Greengairs Lime (north of fault)	No		On edge of HRDA for UD (N of fault). No outcrop or probable workings shown for MD	Shown to south of fault. Close to instability zone associated with UD (North of fault).	Medium (but Low if fault proved to be sufficiently north of turbine position)	Rotary boreholes at turbine position and hardstanding
T2 access track		Generally, between MD and UD	No		Outwith HRDA		Low to Medium (dependent on fault location)	BHs required if fault found to be S of turbine position)

Table 2
Mining Instability Risk Assessment and RAG Rating

Turbine No.	Superficial Geology	Solid Geology	Recorded mine workings (shallow)	Recorded mine shafts	Coal Authority shallow mining assessment	WA shallow mining assessment	WA shallow mining RAG zone rating	Preliminary SI scope
T3	Boulder Clay	LCM -down dip of Greengairs Lime Coal	Yes UD and LD (Netherton) (Longwall working)	Netherton Colliery adits c. 250m to NE	On boundary of HRDA (Lime Coal?)	Worked seams: Greengairs Lime: Unlikely UD: Yes MD: Unlikely LD : Yes	High	Rotary boreholes at turbine position and hardstanding
T3 access track			Yes UD and LD (Netherton) (Longwall working)		Within HRDA (Lime Coal?)	Worked seams: Greengairs Lime: Unlikely UD: Yes MD: Unlikely LD : Yes	High dependent on rockhead cover above UD)	Rotary boreholes along track
T4	Boulder clay	LCM – Between UD and Greengairs Lime Coal	Yes UD and LD (Blairmuckhill)	Blairmuckhill Shafts (No.10) c.150m to N	Within HRDA	Worked seams: UD: Yes MD: Unlikely LD : Yes	High	Rotary boreholes at turbine position and hardstanding
T4 access track		LCM – Between UD and Greengairs Lime Coal	Yes UD and LD (Blairmuckhill)		Within HRDA	Worked seams: UD: Yes MD: Unlikely LD : Yes	High and Medium	Rotary boreholes along track

Table 2
Mining Instability Risk Assessment and RAG Rating

Turbine No.	Superficial Geology	Solid Geology	Recorded mine workings (shallow)	Recorded mine shafts	Coal Authority shallow mining assessment	WA shallow mining assessment	WA shallow mining RAG zone rating	Preliminary SI scope
Substation		LCM – between MD and UD	No		Outwith HRDA	LD: possibly but likely too deep	Low	Rotary boreholes to confirm rockhead cover over LD
Construction Compound		LCM – between MD and UD	No		Outwith HRDA	LD: possibly but likely too deep	Low	Rotary boreholes to confirm rockhead cover over LD

Notes

LD= Lower Drumgray (worked extensively)

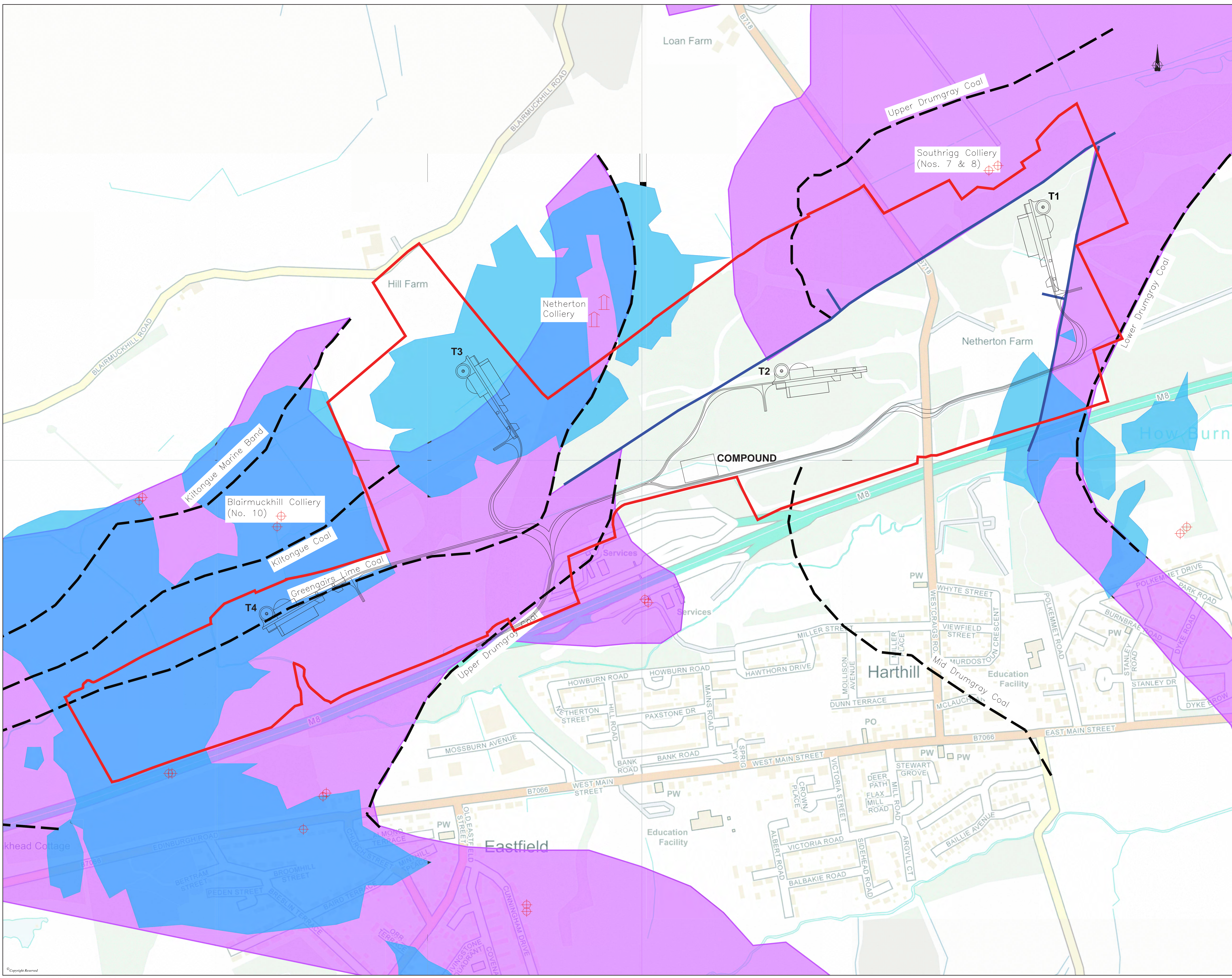
MD = Middle Drumgray (workable, but unlikely)

UD = Upper Drumgray (worked extensively). Also known as Shotts Furnace, Ball

Greengairs Lime (unlikely to be worked)

HRDA = High Risk Development Area

DRAWINGS



- Legend:**
- Site Boundary
 - Location of recorded mineshaft
 - Location of recorded adit
 - - - Conjectured outcrop of named coal seam
 - Fault (tick on downthrow side)
 - Areas of recorded shallow mine workings (less than 30m b.g.l.)
 - Areas of probable shallow coal workings

NOTES:

- Mining information obtained from the Coal Authority.

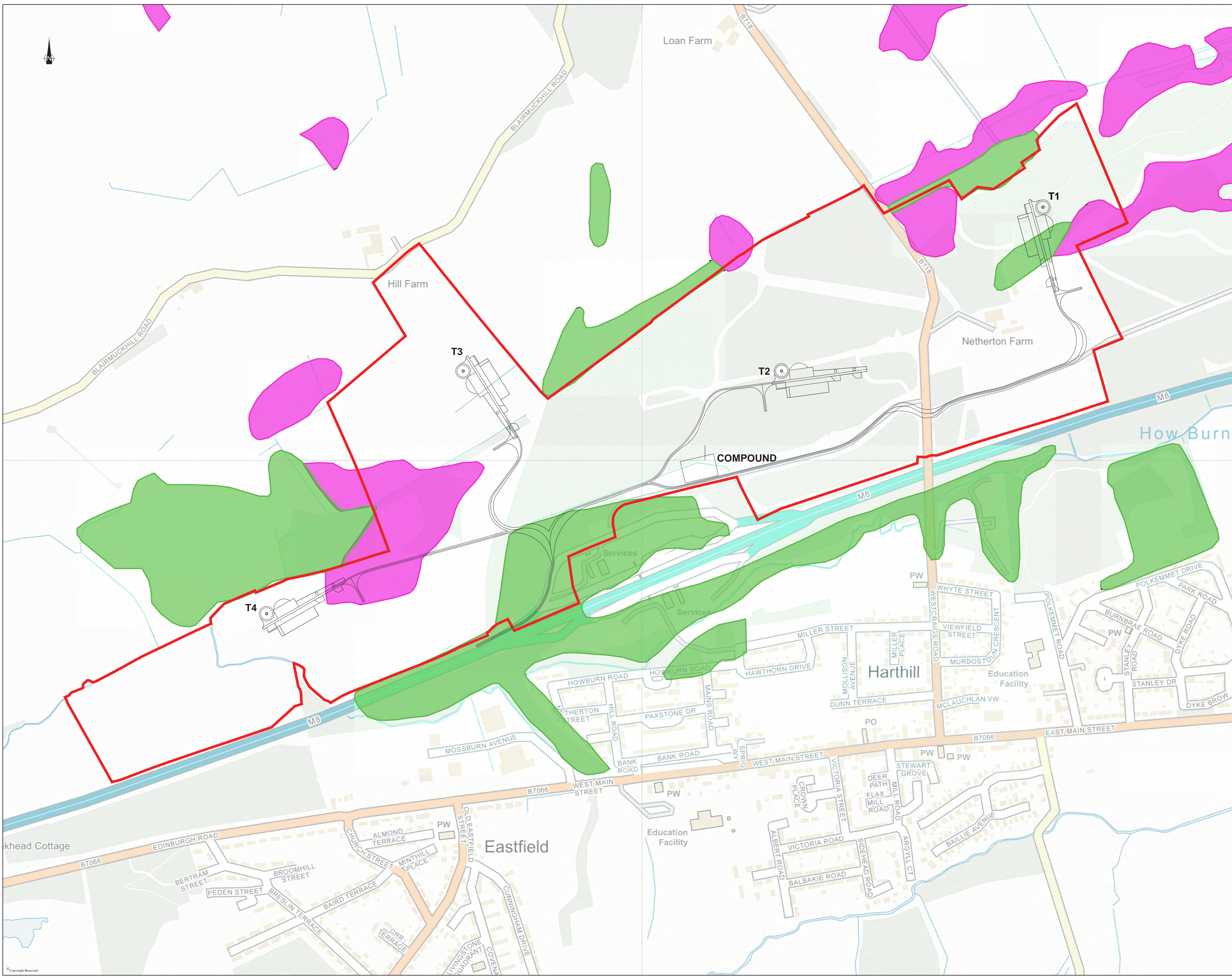
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TORRANCE WINDFARM EXTENSION							
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MINING CONSTRAINTS							
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PROJ SIZE:	A0	SCALE:	1:2500	DATE:	08/06/2022		
DRAWN BY:	SS	CHECKED BY:	MD	APPROVED BY:	MD		

Legend:

- Site Boundary
- Areas of BGS recorded peat
- Areas of BGS made ground

NOTES:

1. Information based on British Geological Survey (BGS) mapping.



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REV	DATE	BY	CHK	REV	DATE	BY	CHK
CLIENT INFENERGY LTD							
PROJECT TORRANCE WINDFARM EXTENSION							
DRAWING TITLE GEOTECHNICAL CONSTRAINTS							
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