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Washery 1A/2A Mining Risk Review

Walters Group

20 May 2024

GCRE001-AWJV-EW-XX-RP-GE-00014

GLOBAL CENTRE OF RAIL EXCELLENCE (GCRE)

Notice

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1. Introduction

1.1 Overview

AtkinsRéalis UK Limited (AtkinsRéalis) was commissioned by Walters Group in early 2022 as their designer to undertake the detailed earthworks design for the Global Centre of Rail Excellence (GCRE) Project, a proposed rolling stock and rail infrastructure testing facility in South Wales. The proposed GCRE development is at the location of the former Nant Helen Opencast Mine, near Onllwyn, and is within influencing distance of historical underground and more recent surface mining features.

AtkinsRéalis have previously provided the following deliverables related to mining risk and remediation for the Project:

- 'Coal Mining Risk Review' (MRR) [1] for the entire GCRE site, which reviewed, synthesised and updated the previous work by Arup [2] [3] [4] (third revision published in January 2023, Doc. Ref. GCRE001-AWJV-00-XX-RP-GE-00003).
- 'Specification for Treatment of Mine Workings and Mine Entries' (Mining Remediation Specification) [5] (fourth revision published in April 2024, Doc. Ref. GCRE001-AWJV-00-XX-RP-GE-00004).
- 'Ground Treatment Design Input Statement' (DIS) [6] (Site wide, fourth revision published in April 2024, Doc. Ref. GCRE001-AWJV-EW-XX-RP-GE-00003).

This Mining Risk Review (MRR) is an addendum to the previous site-wide MRR [1] and is focused on the Washery Phase 1A/2A area of the project.

This MRR has been prepared with cognisance of recent updates to the proposed earthworks in the Washery Phase 1A/2A and new information from the Stage 1 and 2 Ground Investigations (GIs) completed in 2022 and 2023.

In addition AtkinsRéalis have also prepared a Design Input Statement for the latest Washery earthworks layout only:

- 'Ground Treatment Design Input Statement' (DIS) (Washery only, first revision published May 2024, Doc ref GCRE001-AWJV-EW-XX-RP-GE-00015) [6]

1.2 Scope

This MRR aims to assess the mining risk to the proposed earthworks within the Washery Phase 1A/2A (W1A/2A) and, where appropriate, provide initial recommendations for further investigation and mitigation.

The extent of the W1A/2A proposed earthworks boundary considered in this document is as provided to AtkinsRéalis on 12 February 2024. AtkinsRéalis understands that the W1A/2A proposed earthworks model and boundary are still subject to ongoing minor updates, these updates will be captured in any subsequent revision to this MRR but are not considered to be material.

This report also provides a high-level overview of the mining features within the wider Washery footprint, which is beyond AtkinsRéalis' current scope of work (earthworks only). This high-level overview is shared for completeness and for information only. The extent of the proposed W1A/2A earthworks, Washery Footprint and Arcadis Master Plan are shown on Figure 1-1 [7].

This MRR does not cover the updates to the proposed development across the wider GCRE site (Main Alignment and Delta Junction).

1.3 Project & Site Description

The GCRE Project is located immediately south of the village of Abercraf, approximately 20 km north-east of Swansea, South Wales, see Figure 1-1. The approximate centre of the project area is National Grid Reference SN 83290 11091.

The proposed project is divided into three areas: Main Alignment, Delta Junction and Washery. The Main Alignment surrounds and overlies the Nant Helen opencast workings (previously operated for extraction of coal by Celtic Energy) and covers an area spanning approximately 2.7 km by 1.9 km. The Delta Junction section connects the Main Alignment and Washery.

The Washery, herein referred to as 'the Site', lies to the south-east between the villages of Coelbryn and Duffryn, immediately north of the A4109, access to the wider UK rail network is through this area. The Washery will comprise new sidings, train washing facilities, a control centre and other service buildings.

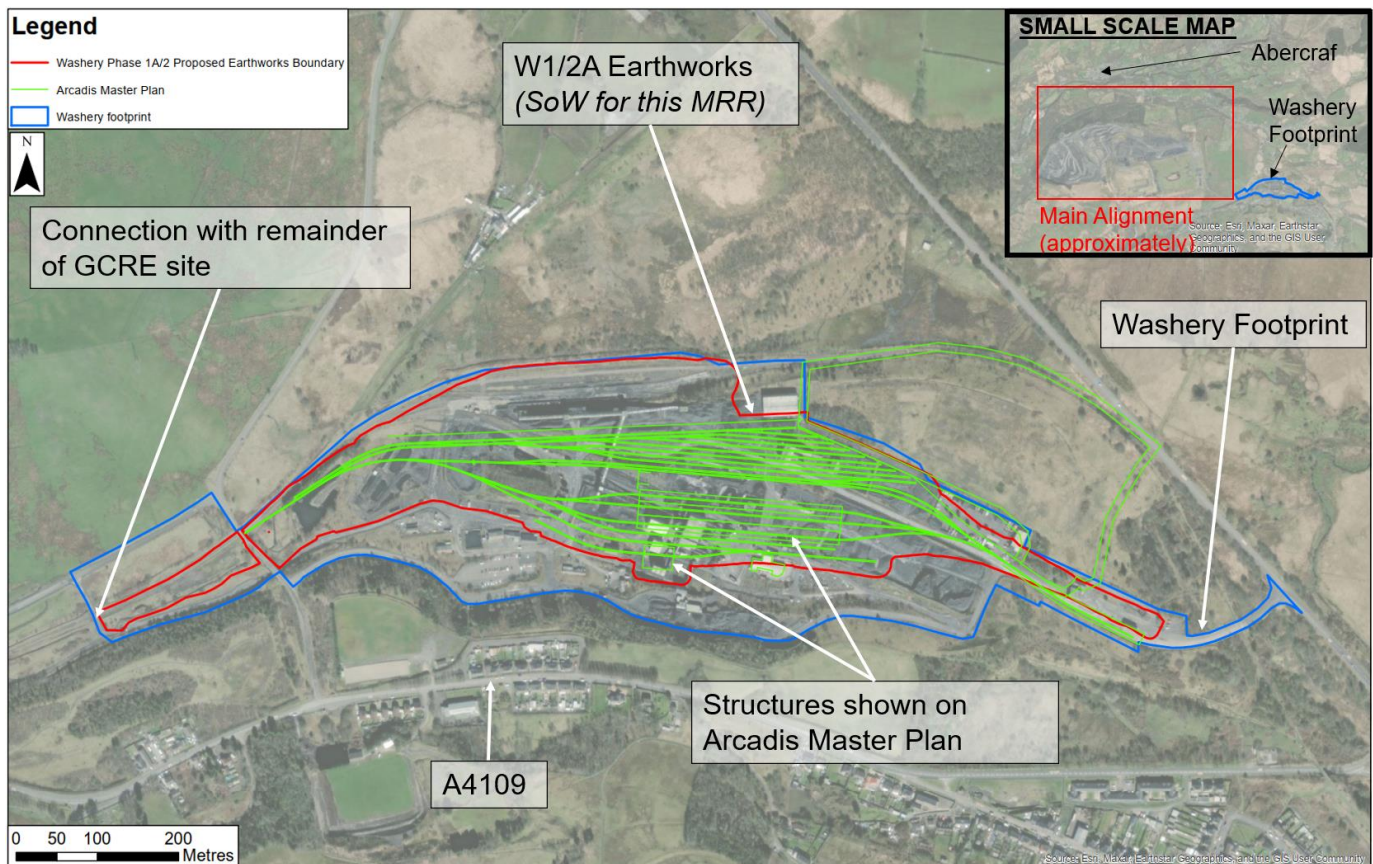


Figure 1-1 - Site overview with various boundaries shown.

1.4 Sources of Information

AtkinsRéalis has used the existing information considered in the previous project-wide MRR [1], with the addition of new information from the Stage 1 and 2 GIs. An overview of the sources of information that were available to AtkinsRéalis at the time of writing is provided in Table 1-1.

Table 1-1 - Sources of information

Owner	Type	Title	Status	Date
British Geological Survey	Online Interactive Map	GeoIndex [8]	Open-Access	2022 (date accessed)
	Geological Map	Merthyr Tydfil, Sheet 231, Solid Edition, 1:50:000 Series [9]	Published	1979
		Merthyr Tydfil, Sheet 231, Drift Edition, 1:50:000 Series [10]	Published	1979
The Coal Authority	Online Interactive Map	Interactive Map Viewer [11]	Open-Access	2022 (date accessed)
	Mine Abandonment Plans and Completion Plans [12]	<u>Dulais Anthracite Colliery</u>		
		6784_99 9999_1 OF 2	Published	1918/1931
		11207_99 9999_1 OF 4	Published	1934
		11207_99 9999_3 OF 4	Published	1934
		11207_99 9999_4 OF 4	Published	1934
		<u>Onllwyn No.1 Colliery</u>		
		SW61_99 9999	Published	1949
Celtic Energy	Opencast Completion Plans [13]	SW133_99 9999	Published	1951
		SW150_99 9999	Published	1953
		SWR750_99 9999	Published	1964
GCRE Co. Ltd	Opencast Completion Plans [13]	<u>Onllwyn Opencast</u>		
		SWR2909_99 9999_1 OF 2 and 2 OF 2	Published	1983
Arup	Employers Requirements	SW164_99 9999	Published	1953
		GCRE Earthworks – Volume 2 (C) GCRE Employers Requirements Document [14]	Issue	12 Sep. 2021
		Land at Nant Helen and Onllwyn Coal Washery - Geotechnical and Geoenvironmental Desk Study [2]	Issue	18 Dec. 2019
		Detailed Mine Workings Study (Ref. 4-70) [3]	Issue	20 Jun. 2020
Arup	Mining Note	Global Centre of Rail Excellence - Ground Investigation Report (Ref. 4-50) [4]	Draft	31 Mar. 2022
Arup	GIR			
Arup	Shapefiles	Risk Zones used in the Geotechnical and Geoenvironmental Desk Study.	N/A	N/A
		Areas of shallow mine workings used in the GIR.		
		Nant Helen Geotechnical Borehole Locations.		
		Location of underground workings.		
Arup	Shapefiles	Mine entry location points; including the Easting, Northing, type, azimuth and Coal Authority ID.		

Owner	Type	Title	Status	Date
Quantum Geotech	GI Factual Report	Global Centre of Rail Excellence Ground Investigation: Factual Report (Ref. Q0652/FR_01) [15]	Draft	7 Feb. 2022
	AGS data	Q0652 210222 [16]	Draft	24 Feb 2022
Pauley	3D model	'GCRE Scaled Assets' 3D model [17].	N/A	16 Dec 2021
Groundsure	Report	Groundsure Report (Ref: GSIP-2021-12345-10399) [18]	Issue	2022
	Shapefiles	Standard Groundsure reporting shapefiles, including but not limited to BGS geology, borehole locations and locations of opencast workings.	N/A	2022
Jackson Geo Services	GI Factual Report	GCRE Stage 1 Ground Investigation Factual Report	Issue	March 2023
		GCRE Stage 2 Ground Investigation Factual Report	Issue	September 2023
AtkinsRéalis	Mining Risk Review	Coal Mining Risk Review (MRR)	Issue	January 2023 (third revision)
	Specification	Specification for Treatment of Mine Workings and Mine Entries (Grouting Spec)	Issue	April 2024 (fourth revision)
	Design Input Statement (Entire GCRE Project Site)	Ground Treatment Design Input Statement (DIS)	Issue	April 2024 (fourth revision)
	Design Input Statement (Washery Only)	Ground Treatment Design Input Statement (DIS)	Issue	May 2024

2. Mining History

2.1 Overview

This section provides an overview of the history of mining across the entire GCRE project including the site, with key historical mining features identified from historical mapping (1876-2019) as well as available aerial imagery (1945-2019). Additional information is provided in the project-wide MRR [1].

2.2 Historical Maps

2.2.1 General

From the earliest maps on record, the project area has been subject to extensive industrial activity revolving around the extraction of coal. These activities are initially recorded as a collection of underground workings in the 19th and 20th centuries before becoming an opencast colliery in the latter part of the 20th century.

Coal mining as an industrial activity in the South Wales valleys predates the 1876 maps, as such unidentified underground and surface workings from before this date may exist across the Main Alignment, Delta Junction and Washery. The near-200-year mining history of the areas has created a legacy of potential risks and constraints, these are discussed in further detail throughout this report. A chronology of known underground and surface mining history is provided in Table 2-1.

Table 2-1 - Known historical mineral workings

Dates	Collieries	Type of mining
1840 - 1968	Hendre Ladis Colliery (located 1.4km to the western boundary)	Underground
1840 - 1964	Onllwyn Colliery	Underground
1864 - 1938	Gwaucnclawdd	Underground
1872 - 1964	Seven Sisters Colliery	Underground
1872 - 1967	Abercraf Colliery (also known as the Abercrave Colliery)	Underground
1893 - 1913	International Colliery	Underground
1905 - 1947	Dulais Colliery	Underground
1914 - 1978	Glynllech Colliery	Underground
Unknown	Cwm Tawe Colliery	Underground
1946 - 1949	Onllwyn	Opencast
1952 - 1953	Cefn Byrle	Opencast
1963 - 1973	Abercraf /Gwaunton 1	Opencast
1972 - 1982	Onllwyn (expansion in the east)	Opencast
1986 - 1999	Nant Helen	Opencast
2002 - Present	Nant Helen Extension	Opencast

2.2.2 Washery Site Specific

A summary of the mining history specifically within the Site is summarised in Table 2-2, based on a review of available historical mapping and aerial photography [2].

Table 2-2 - Summary of mining history within the site.

Date	Description
1876 / 1877 (Historical Map)	The site is largely undeveloped moorland. One tramway passes along the north and east of the site, linking the Onllwyn Colliery to the Neath and Brecon Railway main line.
1901 / 1903 (Historical Maps)	In the east of the site, 'Old Coal Levels', 'Old Quarries' and an 'Old Coal Pit' are shown for the first time.
1945 (Aerial Photographs)	Railway infrastructure and stockpiles shown in the centre of the site for the first time.
1948 (Historical Maps)	The centre of the site is labelled as a 'colliery'. A 'Brickworks' is shown to be present within the south of the Site.
1965 (Historical Maps)	Further development of railway infrastructure in the centre of the Site.
1977 (Aerial Photographs)	Increased infrastructure and numerous pond features now present. Land east of the site shows further development of numerous stockpiles/spoil heaps.
2019 (Aerial Photographs)	Site contains a varied array of coal processing infrastructure with a limited network of rail lines running along the centre of the site.

2.3 Published Geology

A summary of the geology of the site is presented below based on a review of the BGS GeoIndex [8], BGS geological maps [9] [10] for the site and the opencast workings extents from Celtic Energy [13].

2.4 Made Ground

BGS mapping shows [9] Made Ground beneath the majority of the site and limited areas of infilled ground in the east of the Washery Footprint (Figure 2-1). The Made Ground is likely associated with the historical leveling of railway sidings and buildings which formerly occupied the site, as detailed in Section 2.2.2, as well as colliery spoil.

2.5 Superficial Deposits

BGS Geological Maps [9] show Peat in the north and west of the Washery Footprint and Glacial Till in the far east of the Washery Footprint (Figure 2-1). Glacial Till typically comprises a heterogenous mixture of clay, sand and gravel with cobbles and boulders of various sizes and shapes (diamicton). Peat typically comprises a partially decomposed mass of vegetation that has been deposited under largely anaerobic conditions, usually found in bogs or swamps.

2.6 Bedrock Geology

The bedrock beneath the site comprises the South Wales Middle Coal Measures Formation (SWMCMF) and South Wales Lower Coal Measures Formation (SWLCMF) in the west and east of the Washery Footprint, respectively. These formations are divided by the NNW-SSE-trending Glyncorrwg Fault, a normal fault that cuts across the centre of the site. The Chapel Fault is also mapped approximately 20 m west of the Washery Footprint with a NNW-SSE orientation, crossing the track approaching the Washery. Unrecorded faults may be present within the site.

The SWMCMF and SWLCMF are reported to comprise rhythmic sequences of mudstones (commonly containing pyrite), siltstones, sandstones, grits, fireclays, seatearths and coals; the coals found in these measures tend to be amongst the thickest and most economically significant in South Wales. A summary of the named coals found within the SWMCMF and SWLCMF is provided in Table 2-3.

BGS Geological Maps [9] indicate that dip angles for the bedding in the coal measures are typically between 5° and 15° in a west to south-westerly direction. However, there are localised variations to this, with several anticlines and synclines shown.

A geological map of the bedrock geology and linear features is provided below (Figure 2-2).



Table 2-3 - Interpreted coal seam sequence within SWLCMF and SWMCMF

Seam	Other names	Typical seam section thickness
<u>South Wales Middle Coal Measures</u>		
Soap	Two Feet-nine	-
Stwrin	Two Feet-nine	-
Four feet	Upper Four Feet, Lower Four Feet, White Four Feet, Wite, Stwrin	0.9m
Eight feet	Lower Eight Feet, Six Feet, Black	-
Cornish	Red Vein, Two Feet	0.76m
Harnlo	-	-
Nine feet	Big	2.7 - 3.0m
Brass	Bute, Peacock	0.9 - 1.4m
<u>South Wales Lower Coal Measure</u>		
Yard	Lower Peacock, Lower Brass	-
Bluers	Bluers, upper Bluers, lower, Seven Feet	0.6 - 0.85
Rhyd	Five Feet, Little Brass	0.75m
Grey	Gellideg	0.66m
Middle	Gellideg	0.63m
New	Lower	0.69m
Bryn	Gnaplog	0.5m
<u>Table Key</u>		
	= coal seam potentially located beneath the site.	

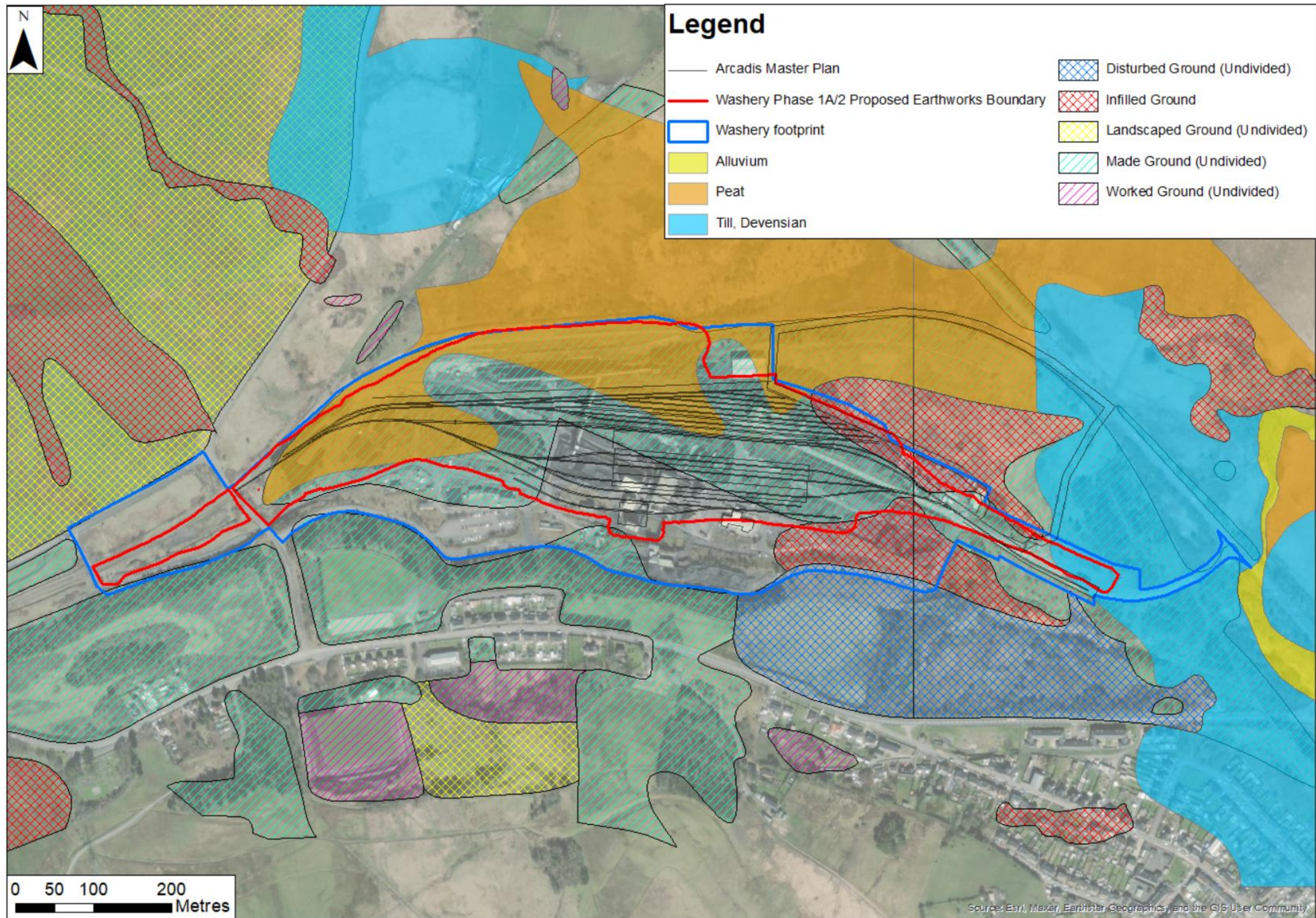


Figure 2-1 - Superficial deposits and artificial ground (BGS) [8]

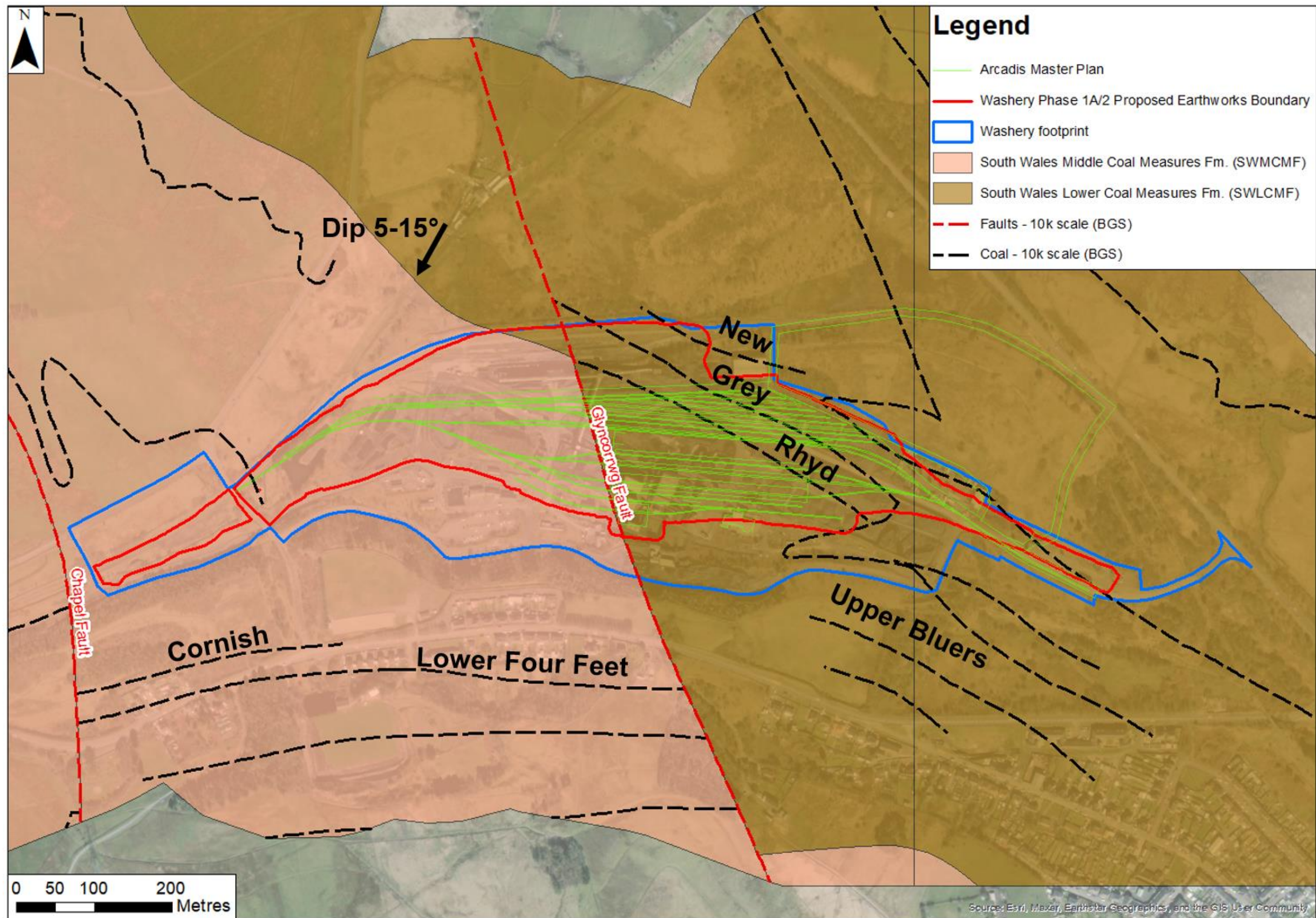


Figure 2-2 - Bedrock and linear geology (BGS) [8]

3. Ground Investigation

3.1 Overview

This section aims to provide a summary of the pertinent existing GI information concerning the mining risks within the site. Further information on the GIs can be found in the main body of the AtkinsRealis GIR, upon completion.

Three phases of GI to inform the design development of the entire project have been completed to date, Table 4-1 provides further information on the purpose of each phase and areas of the project investigated. Additionally, historical borehole logs from 1989 are also available.

Table 4-1 - Summary of GI phases at the GCRE site

Phase	Fieldwork Dates	Parties Involved	General Purpose
Historical GI	1989	Completed by Norwest Holst Soil Engineering Ltd on behalf of British Coal.	Not specified.
Preliminary GI	November 2021 to January 2022.	Specified by Arup. Completed by Quantum Geotechnical Limited.	Preliminary GI across the Main Alignment, Delta Junction and Washery.
Stage 1 GI	7 November to 23 December 2022, and 17 to 2 February 2023 (two phases)	Specified by AtkinsRéalís (formerly Atkins). Completed by Jackson Geo.	GI focused on the Washery 1A (approximately located in the west and north of the wider Washery), including rotary cored boreholes to investigate mining activities across the area of the Washery 1A and further rotary probing at the locations of three conjectured mine entries in the east of the Washery 1A.
Stage 2 GI	27 March to 16 June 2023	Specified by AtkinsRéalís (formerly Atkins). Completed by Jackson Geo.	GI across the Main Alignment, Delta Junction and Washery. This included additional investigations targeted in the proposed substation and at selected recorded adits within the Washery and wider project area.

3.2 Historical Ground Investigation

A total of eight historical boreholes were drilled within the Washery Footprint in 1989 for British Coal, with an additional six boreholes located south of the Washery Footprint. The boreholes comprised cable percussion with rotary coring follow-on and progressed to depths of between 22 m and 45 m bgl. Coal seams were recorded in all eight boreholes within the Washery Footprint, as summarised in Appendix A.1, Table 6-1. No evidence of underground mine workings or mine entries was recorded in the borehole logs.

3.3 Preliminary Ground Investigation

3.3.1 Intrusive Survey

The Preliminary GI comprised a total of six boreholes (excluding redrills) and 13 trial pits were completed within the Washery Footprint, with a further borehole and eight trial pits within the wider Washery. Several exploratory holes were scoped to investigate selected recorded workings and mine entries in the Washery.

The Preliminary GI found coal seams at five borehole locations within the Washery Footprint (BH01, BH30R, BH31R, BH33R and BH34R) with thicknesses of up to 3.2 m, as summarised in Appendix A.2, Table 6-2. Borehole BH30R also encountered two distinct levels of voiding and/or soft material infill, as summarised in Table 3-2.

Borehole BH34R was drilled to 30 m bgl to investigate workings within Bluers Seam but encountered no direct evidence for workings (further information on the Bluers Seam workings is provided in Section 5). However, a 1.9 m thick coal seam was recorded at 22.1 m bgl, with 12.2 m of bedrock cover.

Table 3-2 - Evidence of workings encountered during Preliminary GI

Borehole ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log description
BH30R	9.7	3.2	2	VOID
BH30R	20.1	13.6	1	VOID
BH30R	21.1	14.6	0.9	Soft Drill (Drillers Description)

3.3.2 Geophysical Survey

Geophysical surveying was completed by Terradat to investigate a select number of mine entries in and around the Washery Footprint, as shown in Figure 3-1. The investigation comprised magnetic, electromagnetic and microgravity geophysical surveying across four distinct zones (Figure 3-1) [15].

Terradat identified geophysical anomalies near several recorded mine entry locations, many of which were subsequently investigated further by Quantum Geotech using trial pits, as summarised in Table 3-3. None of these trial pits uncovered any additional evidence for mining features, possibly due to the thickness of Made Ground. Maps showing the key geophysical findings for mine entries that are close enough to potentially influence the earthworks design are displayed in Figure 3-2 and Figure 3-3.

Further details of the geophysical anomalies encountered in the Washery are provided in the Terradat Geophysical Survey Report, which is included in Appendix IX of the Quantum Geotech Factual Report [15].

Table 3-3 - Summary of geophysical survey findings

Survey Zone	Mine Entry ID	Geophysical Findings ^[NOTE 1]	Subsequent Intrusive Findings (Preliminary GI)
1	284210-023	N/A – access not possible due to vegetation.	N/A – access not possible due to vegetation.
	284210-029	<i>“Small, isolated dipolar response within the expected location of the mine shaft” (Z1-6)</i>	Investigated by trial pit TP37 to 4.5 m bgl. No evidence uncovered.
	284210-035	<i>“Isolated dipolar anomalous response, near to expected adit location” (Z1-9)</i>	Investigated by trial pit TP38 to 4.0 m bgl. No evidence uncovered.
2	285210-001	<i>“Distinct large and circular area of low gravity values” (Z2-17)</i>	Investigated by trial pit TP12 to 4.5 m bgl. No evidence uncovered.
	285210-026	Access to exact recorded location of adit not possible due to obstructions. Nearby anomaly: <i>“Linear zone of low gravity values” (Z2-15)</i>	Access to exact recorded location of adit not possible due to obstructions. Nearest investigation was by trial pit TP36 to 4.0 m bgl. No evidence uncovered.
	285210-27	Access to exact recorded location of shaft not possible due to vegetation. Nearby anomaly: <i>“Circular zone of low gravity values” (Z2-14)</i>	Access to exact recorded location of shaft not possible due to vegetation. Nearest investigation was by trial pit TP13 to 4.0 m bgl. No evidence uncovered.
	285210-028	<i>“Linear zone of low gravity values, coinciding with EM anomaly Z2-12” (Z2-18)</i>	Investigated by trial pits TP14 and TP14A to 3.5 m bgl. No evidence uncovered.
3	284210-019	N/A – access not possible due to obstructions and terrain.	N/A – access not possible due to obstructions and terrain.
	284210-020	<i>“Increase in magnetic response adjoining access road” (Z3-4)</i>	Investigated by trial pits TP17 to 4.0 m bgl. No evidence uncovered.
4	285210-025	<i>“Zone of large dipolar instrument responses near to proposed adit location” (Z4-1)</i>	Investigated by trial pits TP35 to 4.0 m bgl. No evidence uncovered.

Tables Notes

^[NOTE 1] Descriptions of anomalies taken from Terradat Geophysical Survey Report in Appendix IX of the Quantum Geotech Factual Report [15].

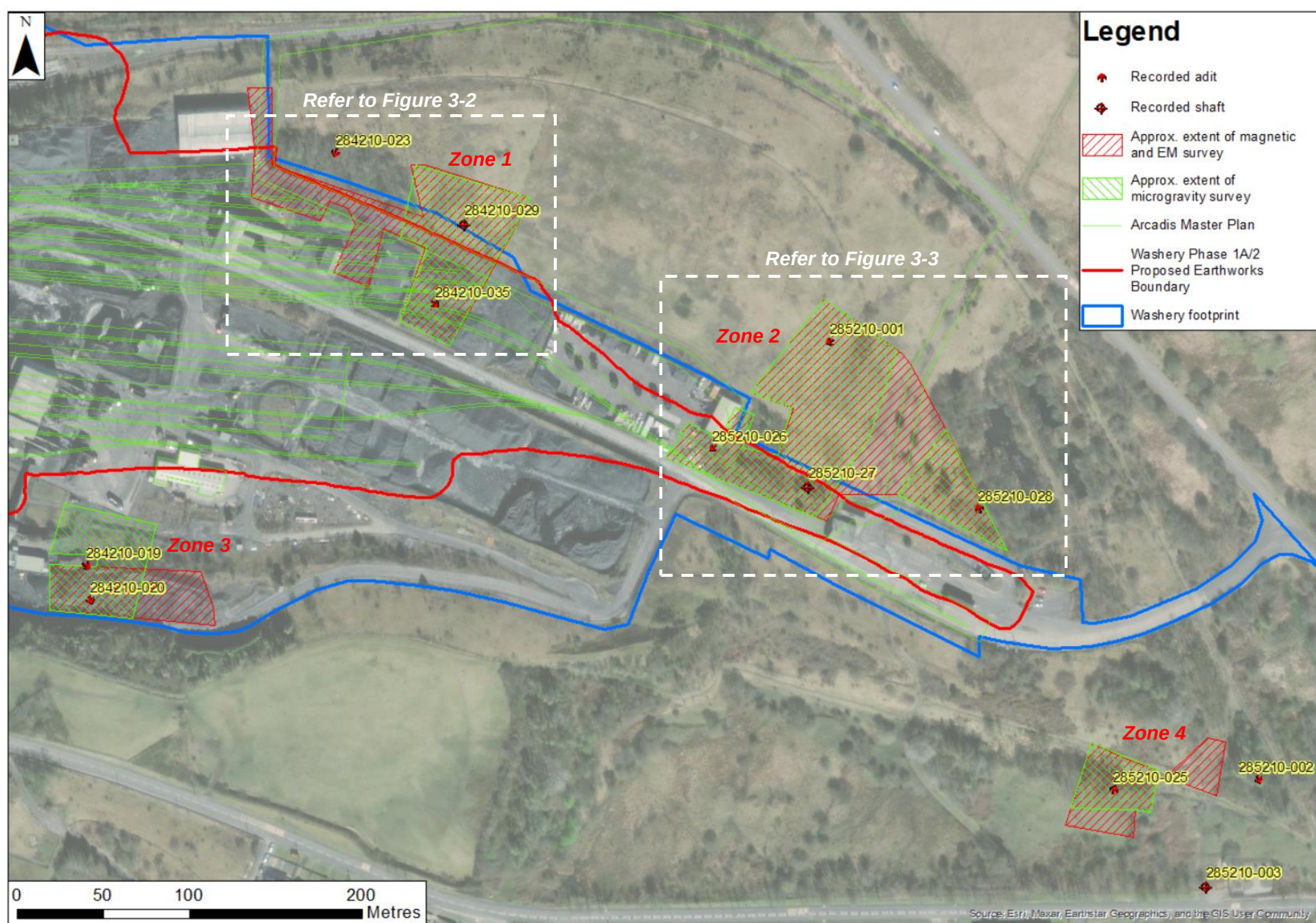


Figure 3-1 - Overview of geophysical survey work undertaken in the Washery

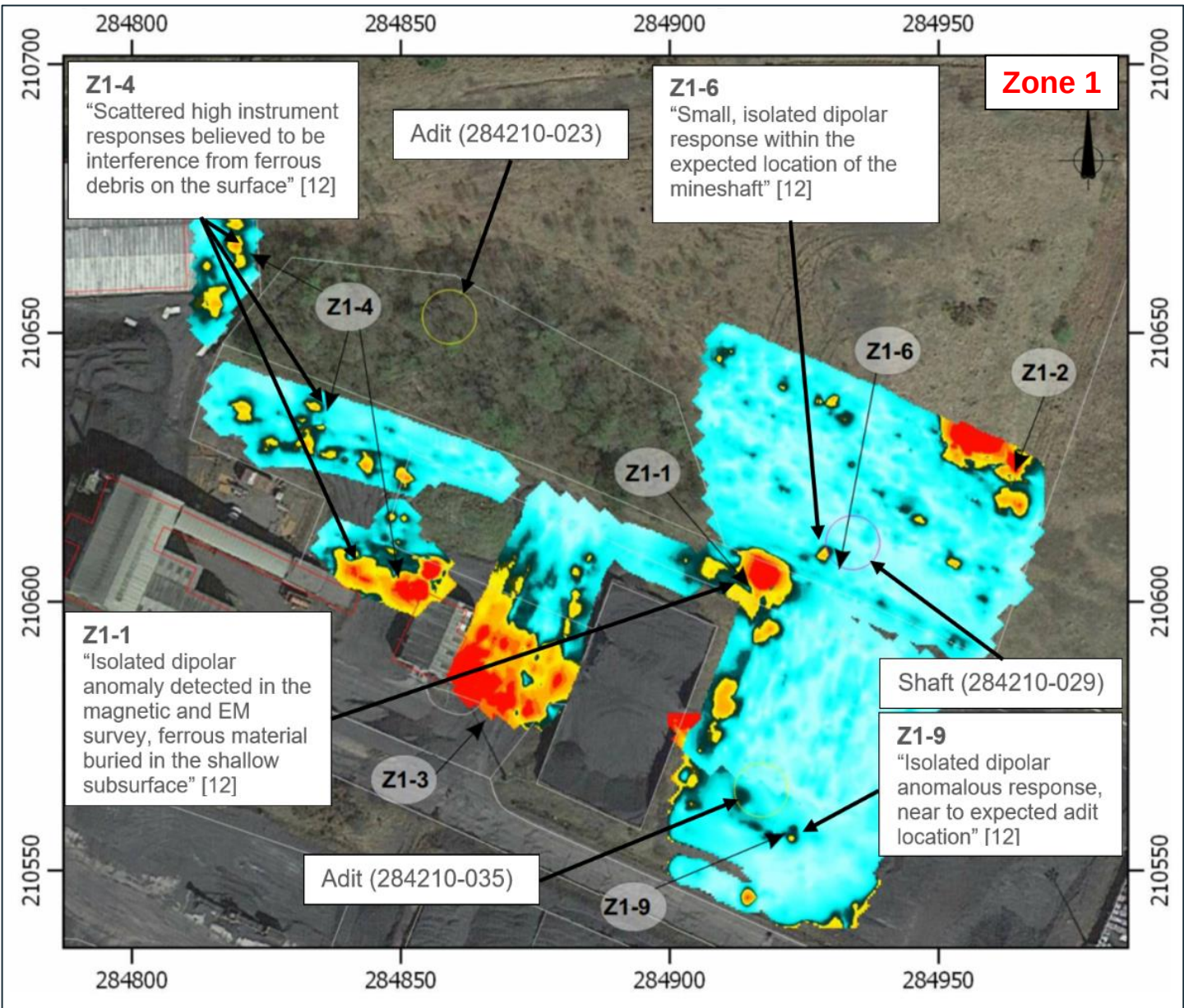


Figure 3-2 - Magnetic analytical signals indicative of significant ferrous metal anomalies, image taken from the Terradat Geophysical Survey Report [15]

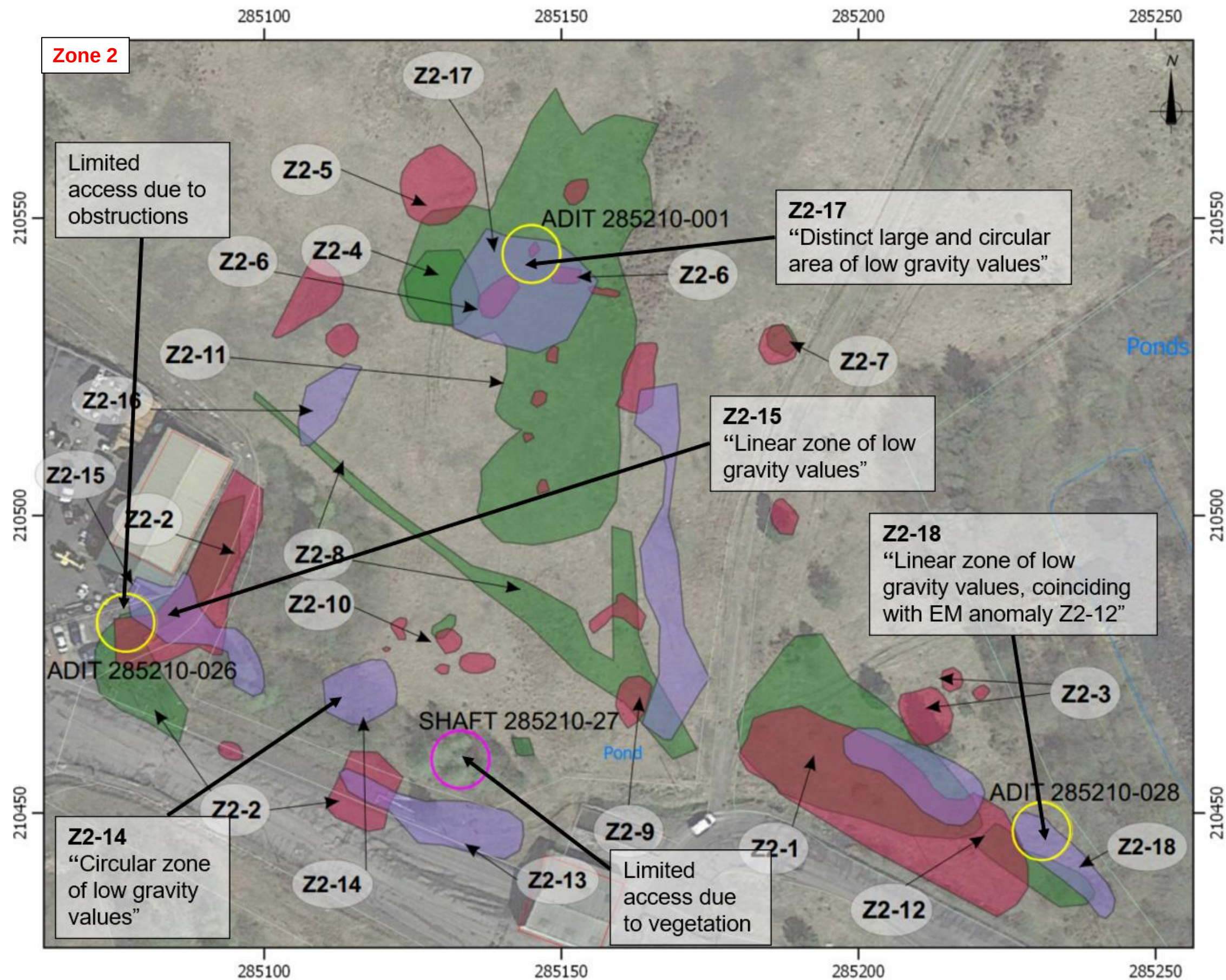


Figure 3-3 - Summary of anomalies eastern side of Washery Footprint, image taken from the Terradat Geophysical Survey Report [15].

3.4 Stage 1 Ground Investigation

The Stage 1 GI comprised 15 cored boreholes (excluding redrills) and 14 trial pits within the Washery Footprint. Three sets of probe holes were also drilled, comprising a total of 61 locations, in grid and linear patterns to attempt to locate legacy mine entries. A list of the coal seams encountered and the evidence for underground mining from the Stage 1 GI is provided in Appendix A.3, Table 6-3 and Table 6-4, respectively.

The key findings from the Stage 1 GI in the Washery were as follows:

- On the western limit of the site, borehole S1-BH107B encountered 0.7 m wide void at 15.4 m bgl, with 10 m of bedrock cover. This void agrees with the location of recorded workings within the Peacock Seam. The nearby borehole S1-BH114 encountered high pressure artesian groundwater at similar depth interpreted to be the same underground workings in flooded state.
- Approximately 25 m north-east of the Washery Footprint, borehole S1-BH106 encountered a 0.9 m wide void at 16.1 m bgl, with 3.6 m of bedrock cover. No mine abandonment plans are available this part of the site. This is interpreted as unrecorded workings within the New Seam.
- Adit 284210-035 was investigated, with voiding recorded in a linear alignment trending north-west to south-east. The adit was traced in a south-east direction to the edge of the previous Washery 1A boundary and remains open in this direction.
 - Voids were encountered at a total of two distinct levels across the probe holes, as shown on Figure 3-4 and summarised below:
 - 1 to 1.5 m wide voiding at 10 to 10.7 m bgl, with 4 to 4.6 m of bedrock cover (probe holes SOP003.2, SOP003.5, SOP003.6, SOP003.8 and SOP003.9) which is assumed to be the adit; and
 - 1.7 m wide voiding at 19.5 m bgl, with 13.5 m of bedrock cover (probe hole SOP003.16), interpreted to be another level of unknown workings.
 - Additional to the above, the borehole logs state 'possible filled void' in SOP003.15 from 12 to 13 m bgl and 'banded coal workings' in SOP003.16 from 14 to 16 m bgl. AtkinsRéalis were onsite providing technical supervisions of the works and did not observe any indication of this reported voiding, the presence of the void was not reported to AtkinsRéalis by the drill team, as all other voids were reported. The geological coding attached to the horizon by the drilling contractor does not suggest voiding. As such AtkinsRéalis assumes that these records do not relate to mine workings.
- Borehole S1-BH110 in the centre of the site also encountered a 0.6 m wide section of no recovery at 9 m bgl, at the boundary between superficial/Made Ground and bedrock. This is assumed not to represent a mining void but rather difficult conditions and hole collapse at the soil / bedrock interface.
- Adit 284210-023 and shaft 284210-029 were investigated by probing, no evidence of these mine entries was encountered.

All other rotary-cored boreholes encountered only intact coals.

A summary map of the findings is presented on Figure 3-5 and Figure 3-7. The ground models produced after the completion of the Stage 1 and Stage 2 GI are reproduced in Appendix C.

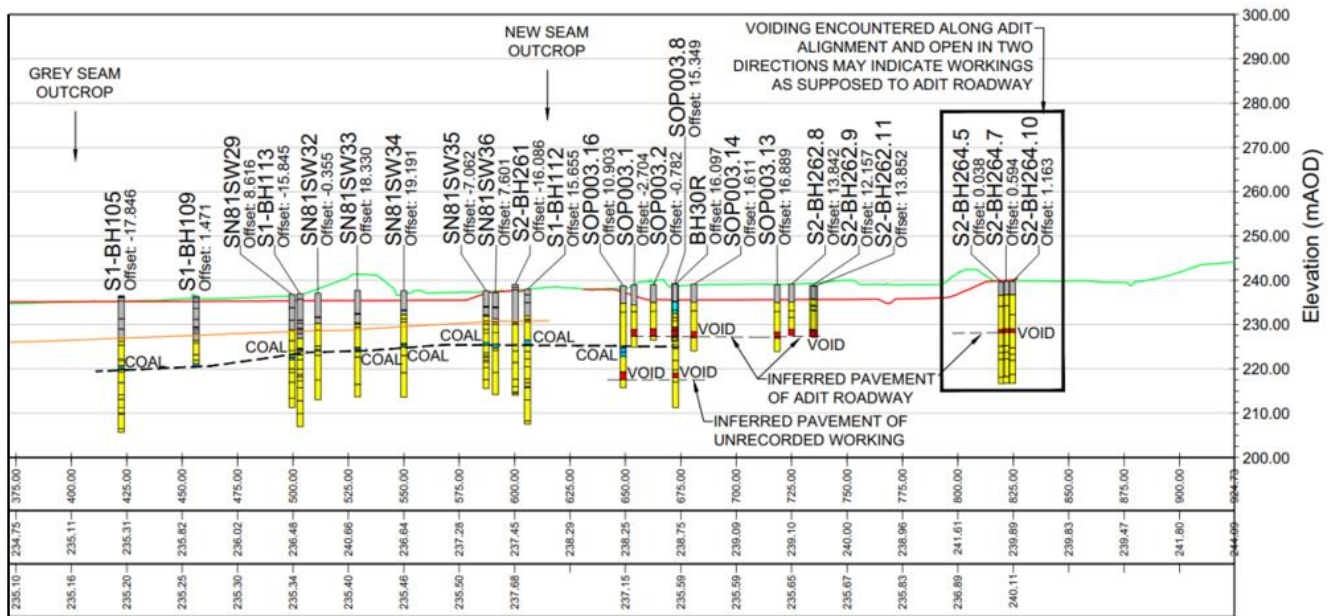


Figure 3-4 - Extract of Stage 1 GI ground model in the washery, taken from drawing in Appendix C

3.5 Stage 2 Ground Investigation

The Stage 2 GI comprised 21 cored boreholes and 46 trial pits within the Washery Footprint (excluding redrills). Five sets of probe holes were also drilled, comprising a total of 42 locations, in grid and linear patterns to attempt to locate mine entries. A list of the coal seams encountered and the evidence for underground mining from the Stage 2 GI is provided in Appendix A.4, Table 6-5 and Table 6-6, respectively.

The key findings from the Stage 2 GI in the Washery were as follows:

- Adit 284210-035 was further investigated to delineate it further south-east. The investigation encountered additional 1.3 to 1.5 m wide voiding at 10 to 10.2 m bgl, with 4.2 to 5.5 m of bedrock cover (S2-BH262.7, S2-BH262.8, S2-BH262.9 and S2-BH262.11).
- Adit 285210-001 was investigated where it trends beneath the proposed development. The investigation found 1.5 to 2.5 m wide voids at 21 to 22 m bgl, with 13.5 to 16 m of bedrock cover (S2-BH264.5 & S2-BH264.7-13). The voiding was constrained on the north-west side but not constrained on the remaining sides (south-west, north-east and south-east) such it is not confirm if this is infact the adit or may be unknoww workings.
- Adit 285210-026 was investigated where it trends beneath the proposed development. The investigation found 1.5 m wide voids at 12 m bgl, with 4.5 m of bedrock cover (S2-BH263.2 & S2-BH263.26-29).
- All other rotary-cored boreholes encountered only intact coals.

A summary map of the findings is presented on Figure 3-7.

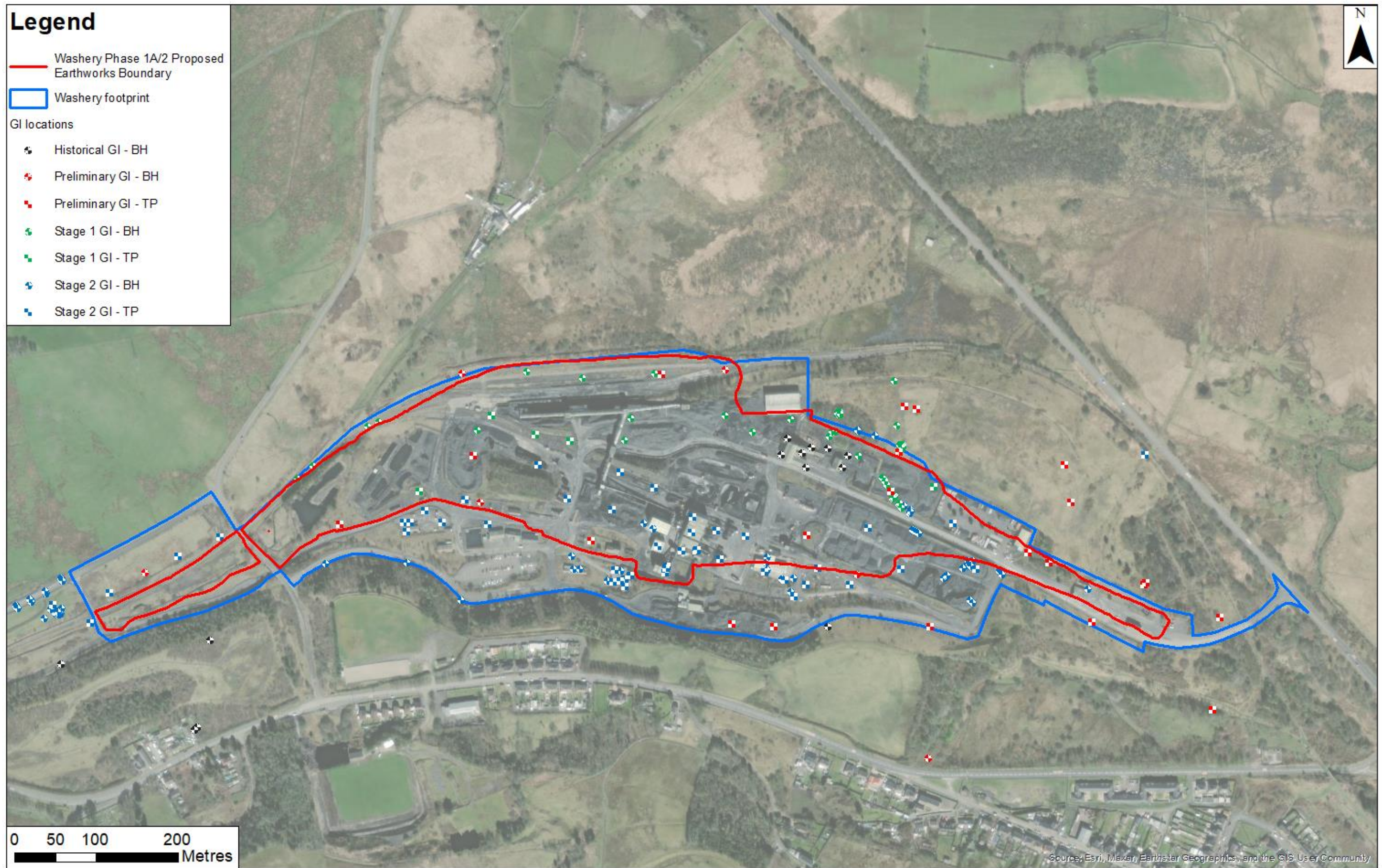


Table 3-4 - Overview of GI in the Washery (further plans with labels are provided in Appendix B)

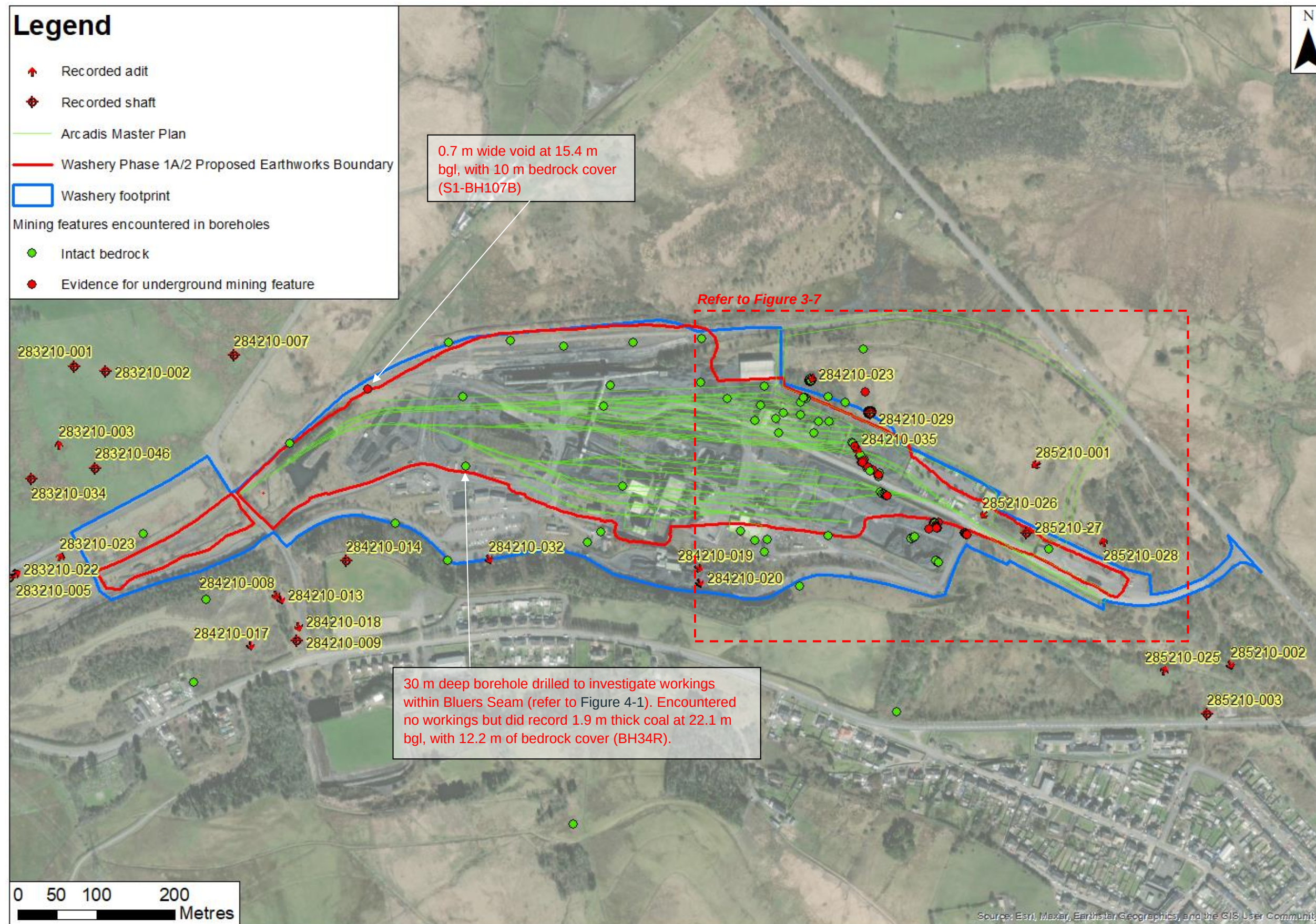


Figure 3-5 - Borehole locations that recorded evidence of mining features or intact bedrock without any evidence for mining features.

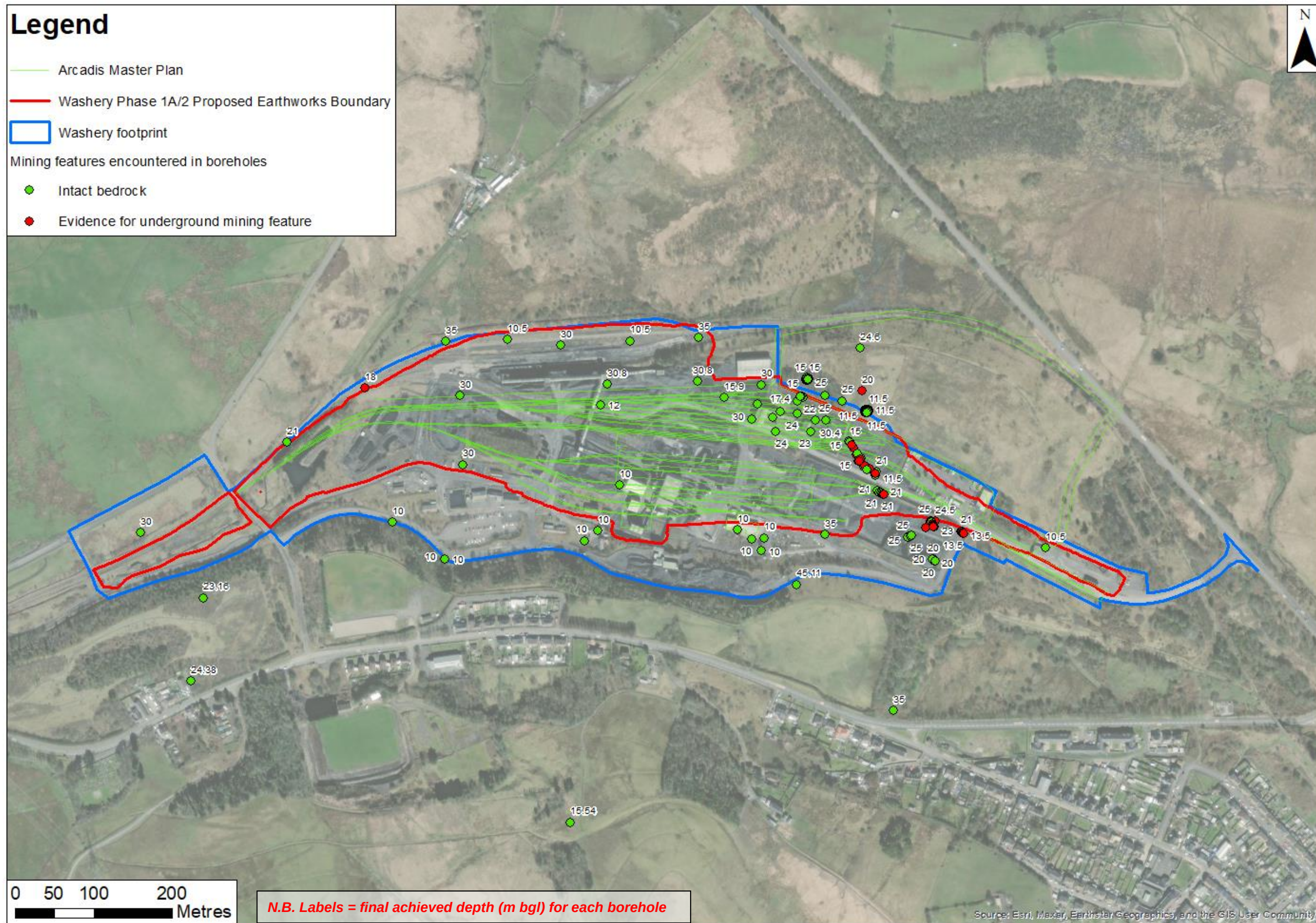


Figure 3-6 - Borehole locations that recorded evidence for underground mining features and intact bedrock without any evidence for mining features, with final achieved depth annotated.

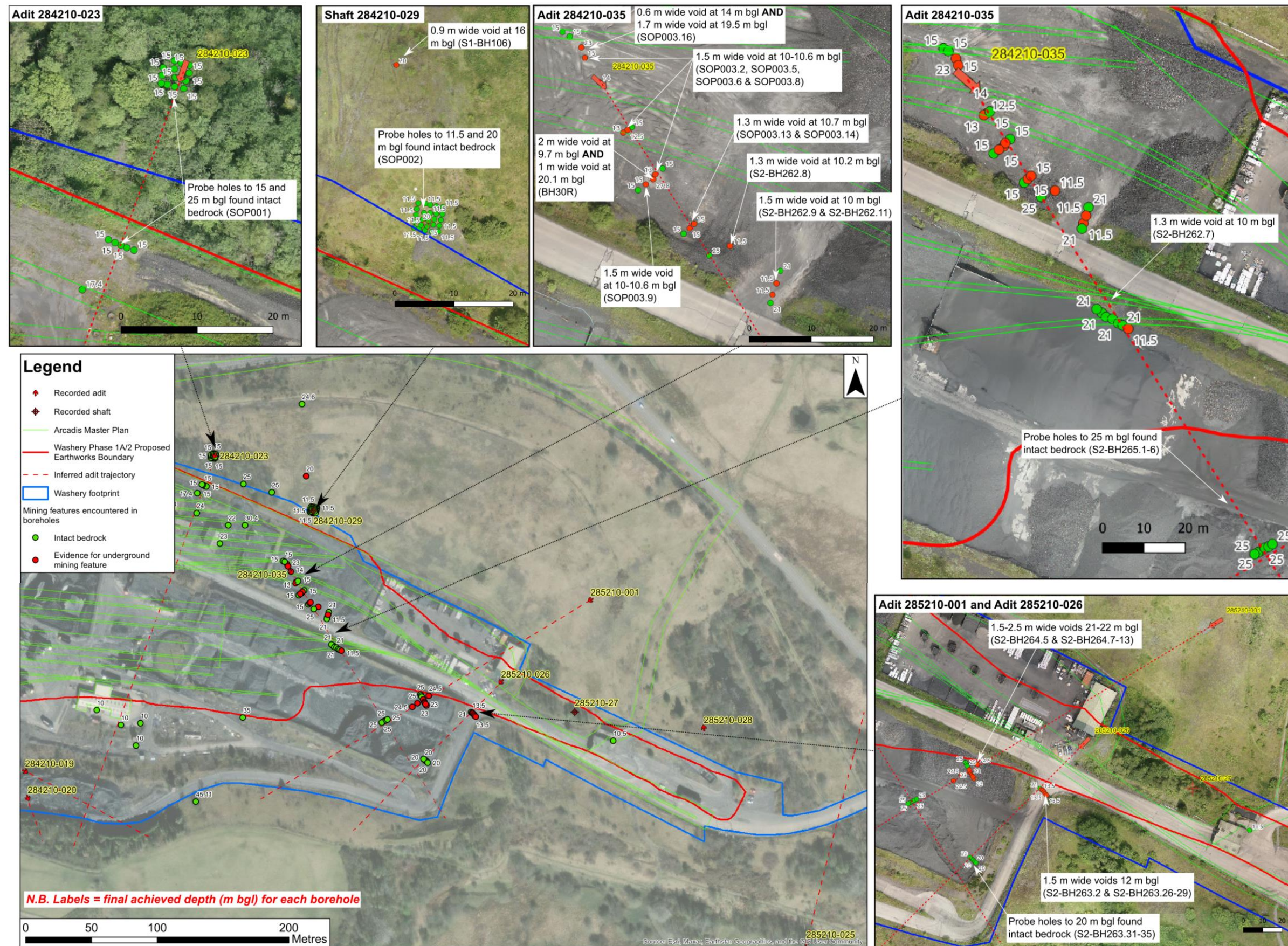


Figure 3-7 - Summary of key GI findings in the east of the Washery

4. Mining Hazards

4.1 Mine Workings

Workings in three seams are mapped in the area of the site on abandonment plans, as summarised in Table 4-1. Further unrecorded workings were also encountered in the GI, as discussed in Section 3.

Table 4-1 - Summary of recorded workings within the site.

Seam Name	Assumed Extraction Thickness (m)	Required Bedrock Cover [10t] (m) ^[Note 3]	Approximate Depth (bgl)	Minimum Expected Bedrock Cover (m)	Likely Impact on Proposed Earthworks ^[Note 4]
Peacock	0.7 ^[Note 1]	7	15	10	No, recorded workings situated beneath proposed earthworks investigated by GI and found to have sufficient bedrock cover to mitigate collapse.
Bluers	2 ^[Note 2]	20	20	10	Yes, shallow recorded workings located directly beneath proposed earthworks.
Brass	2 ^[Note 2]	20	Not proved.	Not proved.	No, recorded workings situated >40 m south of proposed earthworks.

Table notes

^[Note 1] Based on borehole S1-BH107B which encountered 0.7 m wide void.

^[Note 2] Based on a typical roadway height of 2 m.

^[Note 3] Following guidance within CIRIA C758D Abandoned Mine Workings Manual [19], mine working treatment is required if the seam under consideration is located within ten times (10t) the seam thickness of rockhead

^[Note 4] Only considers the impact of recorded workings on proposed earthworks. Unrecorded workings also likely pose a risk.

4.2 Mine Entries

Two shafts and five adit portals are reported within the current Washery Footprint, with an additional three adit portals reported beyond the boundary but with roadways potentially dipping beneath the Washery Footprint. Four adits (284210-023, 284210-035, 285210-001 and 285210-026) and two shafts (285210-278 and 284210-029) potentially impact the proposed W1A/2A earthworks. A summary of the mine shafts is presented in Table 4-2 and a summary of the mine adits is presented in Table 4-3.

A summary of key mine entry and mine working information together is provided in Figure 4-1.

Table 4-2 - Summary of mine shafts within influencing distance of the site

Mine Entry	Potential Impact on Proposed W1A/2A Earthworks	Location Relative to Proposed Earthworks	Easting (m)	Northing (m)	Depth (m)	Shaft Diam. (m)	Treatment Records	Current Status
284210-029	<u>Yes</u> ^[1]	15 m NE	284934	210611	10	2.5	No records of treatment.	Investigated by probe holing but found no evidence of shaft.
285210-27	<u>Yes</u>	50 m E	285133	210459	10	1.25	No records of treatment.	Not previously investigated as location beyond previous site boundary.

Table notes

^[1] Investigation completed without encountering shaft, residual risk that shaft is present in area and poses collapse risk remains.



Table 4-3 - Summary of mine adits within influencing distance of the Washery Footprint

Mine Entry	Potential Impact on Proposed W1A/2A Earthworks	Location Relative to Proposed Earthworks	Easting (m)	Northing (m)	Azimuth (degrees)	Current Status
284210-019	No	Portal 60 m S, roadway dipping away	284715	210414	118	Not proposed for investigation.
284210-020	No	Portal 80 m S, roadway dipping away	284717	210394	160	Not proposed for investigation.
284210-023	<u>Yes</u> ^[Note 2]	Portal 20 m NE, roadway dipping beneath	284859	210653	200	Investigated but no evidence of adit was uncovered.
284210-032	No	Portal 100 m SW, roadway dipping away	284448	210424	151	Not proposed for investigation.
284210-035	<u>Yes</u>	Portal directly beneath, roadway dipping beneath	284917	210565	131	Investigated and partially delineated. [Note 1]
285210-001	<u>Yes</u>	Portal 80 m NE, roadway dipping beneath	285145	210544	239	Investigated and partially delineated. [Note 1]
285210-025	No	Portal 320 m SE, roadway dipping away (passes under wider Washery but not Washery Phase 1A/2A earthworks)	285309	210284	14	Not proposed for investigation.
285210-026	<u>Yes</u>	Portal directly beneath, roadway dipping beneath	285077	210482	225	Investigated and partially delineated. [Note 1]

Table notes

^[1] 'Partially delineated' up to the previous Washery site boundary, may be open under current site.

^[2] Investigation completed without encountering shaft, residual risk that shaft is present in area and poses collapse risk remains.

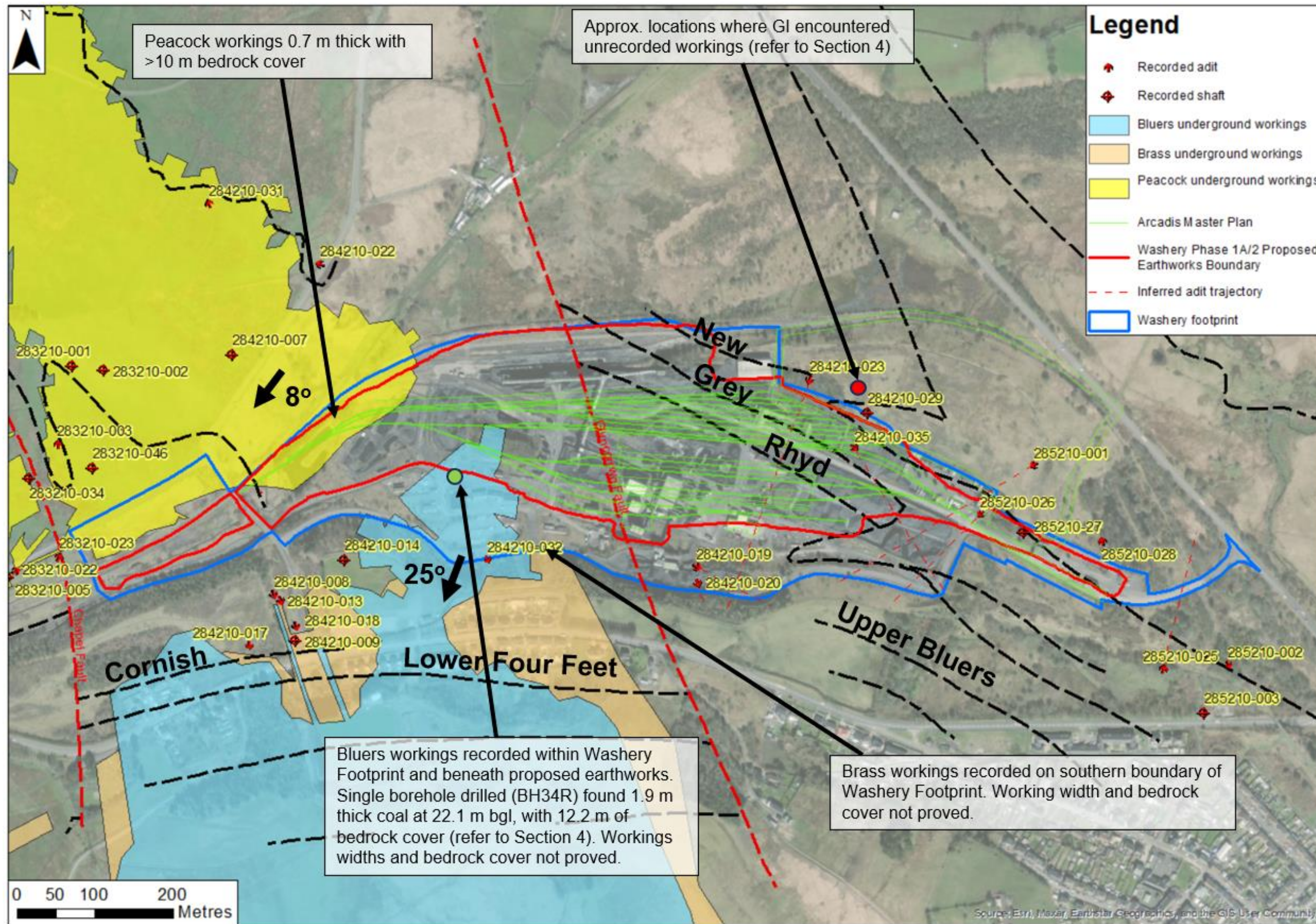


Figure 4-1 - Summary of available information on mine workings within the Washery Footprint

4.3 Surface Mining

Based on a review of available literature, there is no direct evidence of surface mining recorded within the Washery Footprint, however, recent and historical surface mining has occurred across large parts of the Main Alignment and Delta Junction, as discussed in the MRR [1]. Unrecorded surface mining may be present within the Washery Footprint, particularly around coal outcrop locations.

Surface mining will result in a variable rockhead level which should be considered in foundation design. Surface workings are often infilled by poor quality and/or uncompacted backfill with poor bearing and settlement characteristics, structures placed within this material may experience excessive settlements, structures placed across the highwall of a poorly backfilled surface working may be impacted by differential settlement.

4.4 Mine Gas

Mine gas monitoring has been undertaken across the Washery Footprint as part of the Preliminary GI, Stage 1 GI and Stage 2 GI. Details on the scope and findings of the mine gas monitoring can be found in the 1A/2A Geo-Environmental Interpretive Report [20]. A summary of the conclusions and recommendations from the 1A/2A Geo-Environmental Interpretive Report are presented below. Full details and rationale on the mine gas risks and recommendations are detailed in the 1A/2A Geo-Environmental Interpretive Report [20].

4.4.1 Conclusions

A summary of the conclusions from the 1A/2A Geo-Environmental Interpretive Report [20] are presented below:

- Due to the type, depth and age of coal mine workings on-site, nature of the development (absence of enclosed spaces where gas risk may occur) and site circumstances (water levels, geology and cover soils) it is considered that within the site, a **low risk** from coal mine gas is present where confined spaces will not be present.
- A **moderate risk** is considered to be presented to any structures that have enclosed spaces such as the UKRRIN building and future structures such as train maintenance depot, electricity substation, maintenance sheds and Innovation Hub and Characterisation Situation 3 (CS3) is considered to be present.
- There is a potential for unacceptable risks to off-site receptors and on-site buildings to occur during the remediation of mine workings. Grouting works have the potential to displace gases and groundwater that may then migrate and present a risk if not managed by appropriate working methodologies and risk assessment of the remediation works. No grouting works are currently proposed in the Washery area.
- It should be noted that carbon monoxide exceeds its STEL in S1-BH05, while depleted oxygen levels are also present which would pose a risk of asphyxiation if present within confined spaces or on-site buildings. It is considered that gas protection installed to protect against coal mine gas risk will mitigate this potential risk.

4.4.2 Recommendations

A summary of the recommendations from the 1A/2A Geo-Environmental Interpretive Report [20] are presented below:

- Detailed design of ground gas protection measures within the site should be completed in accordance with CIRIA C80 [21] and CL:AIRE's Good practice in assessing mine gas emissions [22];
- Shaft locations are confirmed by GI, treated and/or buildings are not constructed within 50 m of any shaft locations. Building design is not within AtkinsRealis scope however based on the provided layouts no buildings appear to be within in 50m of mapped mine shaft locations, the 50m exclusion zone is to be defined once shaft locations are confirmed.

- If piled foundation solutions are being considered, additional risk assessment will be required to assess the risks to future properties as the piling may result in direct pathways being created;
- Appropriate health and safety measures should be implemented during any on-site works and a safe system of work must always be implemented to address risks of asphyxiation from elevated methane, carbon dioxide or reduced oxygen concentrations if entry to a confined space is required and unavoidable. Guidance issued by the HSE for working in confined spaces should be followed;
- Groundwater samples should be tested for dissolved methane, further GI completed and the gas risk re-assessed if buildings from Stage 2 and 3 works are planned in these locations;
- Once all monitoring works are complete, all boreholes and wells must be decommissioned through backfilling and sealed in a manner that prevents them from acting as migration pathways for mine gas. Decommissioning on monitoring wells should be completed in line with the EA's Good practice in the decommissioning of redundant boreholes and wells [47];
- Where remediation of mine workings is proposed an assessment of the acute risks associated with the remediation measures e.g. grouting of workings and potential for displacement of mine gas will be required; and
- Further gas monitoring is recommended to reduce uncertainty and conservatism in the coal mine gas risk assessment with respect to buildings in the south of the site.

4.5 Mine Water

Coal mine water can pose a variety of hazards, including environmental, health, and safety hazards. The main hazards are as follows:

1. **Environmental hazards:** Acid mine drainage (AMD) is the release of acidic water from coal mines, which can cause environmental damage by contaminating local water sources. AMD occurs when water flows through sulfur-bearing rocks, such as coal, and reacts with the sulfur to form sulfuric acid. This acidic water can leach heavy metals and other contaminants from the surrounding rock, making it unsuitable for human consumption or agricultural use and impact on water quality.
2. **Flooding hazards:** Coal mine water can also cause rapid flooding, which can result in disruptions to construction and operation.
3. **Explosion and fire hazards:** Methane gas when combined with water, can create explosive conditions. If water comes into contact with electrical equipment, it can create a fire hazard.
4. **Health hazards:** Coal mine water can contain harmful substances, including heavy metals, arsenic, and other toxins, which can pose human health risks.
5. **Stability hazards:** Rapid draining or inundation of water can result in collapse of the workings and/or shaft.

During the Stage 1 GI within the Washery, boreholes S1-BH107 and S1-BH114 encountered artesian conditions possibly linked to flooded workings in the Peacock seam in the west of the Washery Footprint, however workings encountered in the east of the Washery Footprint were found to be dry.

5. Conclusions and Recommendations

5.1 Conclusions

An MRR in support of detailed earthworks design for the Global Centre of Rail Excellence (GCRE) Project, has concluded that proposed earthworks in the Washery Phase 1A/2 area are undermined by legacy underground and potential-opencast mineral workings and mine entries.

Desk study review and investigations have identified workings within the Peacock, Bluers and Brass Coal Seams, with associated mine entries (shafts and adits) as being present. Recorded workings in the Bluers seam may pose a risk to the operation and safety of the proposed earthworks in the Washery. A summary of the risks and recommendations for each mining hazard are included in Table 5-1. Unrecorded mine workings have already been encountered beneath the site, other unknown mine workings may be present, unknown mine entries may also be present

An overview of the residual mining risks and proposed GI required to investigate the associated risks within the proposed W1A/2A earthworks are shown in Table 5-1.

Any artesian flows encountered during GI or construction shall be immediately sealed. Mine water shall not be discharged into any existing waterbodies without agreement and licenses with appropriate regulators. Consideration shall be given to the impacts on the hydrogeological regime and the impacts on the surrounding area prior to the treatment of any flooded mine workings and/or mine entries.

5.2 Next Steps

An overview of the mining risks and required investigations were presented to GCRE on 26th April 2024. Due to programme and budget constraints at the time no further GI will be undertaken at the site immediately however further GI can be accommodated in the future. The main outcomes of the discussion is as follows:

- GCRE wish to continue with the react and treat approach previously defined for the Washery in relation to collapse risk from known and unknown shallow workings whereby no remedial measures will be employed ahead of construction and any defects that occur due to mining subsidence will be treated reactively. The earthworks and track assets are considered to be of low sensitivity. See also Design Impact Statement [6].
- Mine shaft locations, specifically 285210-27, will be further investigated ahead of construction.
- Unknown mine workings may be further investigated prior to construction on a case-by-case basis with reference to the proposed overlying structures and their sensitivity. For example, additional investigation may be undertaken beneath buildings in the Washery which are considered to be sensitive to mining related subsidence.

A summary of mining risks and proposed actions is given in Table 5-1.

Changes to the proposed earthworks layout would require review and potential revision of this MRA.

While no treatment is currently proposed within the Washery future investigation and assessment may necessitate the design of backfilling and capping of mine shafts and drill and grout or excavate and bulk replace treatments of mine workings, for further details see the Design Impact Statement [6].

Table 5-1 - Summary of mining risks and recommendations for proposed W1A/2A earthworks

Hazard	Title/ID	Status of Risk to Proposed W1A/2A Earthworks	Recommendations
Mine Workings	Peacock (recorded workings)	Mine workings investigated during GI and confirmed to have acceptable bedrock cover.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	Bluers (recorded workings)	Shallow workings recorded directly beneath proposed earthworks. Insufficient GI to confirm absence or presence of workings.	Probe drilling to investigate potential shallow workings to be considered with reference to sensitivity of overlying assets.
	Brass (recorded workings)	Situated >50 m south of proposed earthworks. Unlikely to impact on proposed earthworks.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	Unrecorded workings	Unrecorded workings were uncovered at multiple borehole locations. The extent of unrecorded workings is unknown based on available information.	Probe drilling to investigate unrecorded shallow workings to be considered with reference to sensitivity of overlying assets.
Mine Shafts	284210-029	Investigated by probe holing but found no evidence of shaft.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	285210-27	Yet to be investigated.	Probe drilling to investigate mine shaft location and condition.
Mine Adits	284210-019	Portal 60 m south of proposed earthworks, with roadway dipping away. Unlikely to impact on proposed earthworks.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	284210-020	Portal 80 m south of proposed earthworks, with roadway dipping away. Unlikely to impact on proposed earthworks.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	284210-023	Investigated by probe drilling around adit portal and north-east extent of proposed earthworks but no evidence of adit uncovered. Roadway potentially continues further south-west beneath proposed earthworks. Potentially impacts on proposed earthworks	Probe drilling to investigate potential shallow workings to be considered with reference to sensitivity of overlying assets.

Hazard	Title/ID	Status of Risk to Proposed W1A/2A Earthworks	Recommendations
	284210-032	Portal 100 m south-west of proposed earthworks, with roadway dipping away. Unlikely to impact on proposed earthworks.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	284210-035	Investigated and shallow voiding was constrained on three sides (in the north-west, south-west and north-east) but not constrained south-east. Likely impacts on proposed earthworks.	Probe drilling to investigate potential shallow workings to be considered with reference to sensitivity of overlying assets.
	285210-001	Investigated and shallow voiding uncovered but not laterally constrained. Likely impacts on proposed earthworks.	Probe drilling to investigate potential shallow workings to be considered with reference to sensitivity of overlying assets.
	285210-025	Portal 320 m south-east of proposed earthworks, with roadway dipping away. Unlikely to impact on proposed earthworks.	No further investigation proposed as part of proposed W1A/2A earthworks design.
	285210-026	Investigated and shallow voiding uncovered but not laterally constrained. Likely impacts on proposed earthworks.	Probe drilling to investigate potential shallow workings to be considered with reference to sensitivity of overlying assets.

6. References

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- [2] Arup, "Land at Nant Helen and Onllwyn Coal Washery - Geotechnical and Geoenvironmental Desk Study, Job number 264904-00, Issue," 18 December 2019.
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- [4] Arup, "Global Centre of Rail Excellence - Ground Investigation Report, Job number 284523, File reference 4-50, Draft 1," 31 March 2022.
- [5] Specification for Treatment of Mine Workings and Mine Entries (Doc Ref GCRE001-AWJV-00-XX-RP-GE-00004), Revision 4., 2023.
- [6] Atkins, Ground Treatment (Including Void Stabilisation) Design Input Statement (Doc Ref GCRE001-AWJV-EW-XX-RP-GE-00003), Revision 4., 2023.
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- [8] British Geological Survey, "Geoindex Onshore," [Online]. Available: <http://mapapps2.bgs.ac.uk/geoindex/home.html>. [Accessed 23 June 2020].
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- [18] Groundsure, "Groundsure Report Ref: GSIP-2021-12345-10399," 2022.
- [19] CIRIA, "Abandoned Mine Workings Manual C758D," CIRIA, London, 2019.
- [20] AtkinsRéalis, "1A/2A Geo-Environmental Interpretive Report, P01. GCRE001-AWJV-00-XX-RP-CLAH-00004," 2024.
- [21] CL:AIRE, "Technical Bulletin 17: Ground Gas Monitoring and 'Worst-Case' Conditions," CL:AIRE, 2018.
- [22] BSI, "BS8485: 2015+A1:2019 - Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases in New Building Developments," 2019.
- [23] CL:AIRE, "Good Practice for Risk Assessment for Mine Gas Emissions," 2021.
- [24] Environment Agency, "Good practice for decomisioning redundant boreholes and wells, October 2012," 2012.
- [25] AtkinsRéalis, "Ground Treatment (Including Void Stabilisation) Design Input Statement (Washery Only), P01. GCRE001-AWJV-EW-XX-RP-GE-00015," 2024 (2).

APPENDICES

Appendix A. Summary of GI Records

A.1 Historical GI

Table 6-1 - Coal seams encountered during the Historical GI.

Borehole ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log Description
SN81SW29	14.2	6.2	0.55	Vitreous-sub vitreous, slightly weathered COAL : Joints at 45°
SN81SW30	14.2	7.2	0.83	Vitreous COAL. Evidence of slickensided joint surfaces
SN81SW31	13.9	7.0	0.5	COAL
SN81SW32	12.7	5.9	0.3	COAL
SN81SW33	13.1	5.8	0.5	COAL
SN81SW34	12.2	6.8	0.5	COAL
SN81SW35	11.68	6.0	0.57	Vitreous COAL slickenside joint surfaces
SN81SW36	11.59	4.9	0.81	COAL with 45-60° slickened joint surfaces

A.2 Preliminary GI

Table 6-2 - Coal seams encountered during the Preliminary GI.

Borehole ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log Description
BH01	13.2	8.2	1.7	Weak coal (drillers description)
BH30R	13.7	7.1	0.6	Weak to medium strong black coal
BH31R	16.0	5.6	1.1	Coal (drillers description)
BH31R	25.5	15.1	1.0	Coal (drillers description)
BH32R	11.8	7.5	3.2	Weak black coal, highly weathered to fine to coarse angular gravel and cobbles
BH33R	28.1	23.2	0.8	Coal (drillers description)
BH34R	22.1	12.2	1.9	Weak coal (drillers description)



A.3 Stage 1 GI

Table 6-3 - Coal seams encountered during the Stage 1 GI

Location ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log Description
S1-BH102	19.5	14.05	0.03	Very weak black COAL.
S1-BH102	20.1	14.65	0.4	Very weak black COAL.
S1-BH103	19.4	6.05	1.2	Very weak black COAL.
S1-BH105	15.8	4.65	0.7	Very weak black COAL.
S1-BH105	16.7	5.55	0.05	Very weak black COAL.
S1-BH108	13.9	10.9	1.1	Very weak black COAL.
S1-BH109	15.2	4.6	0.7	Very weak black COAL.
S1-BH110	7.35	0	1.35	Very weak black COAL.
S1-BH112	11.45	4.75	1	Very weak black COAL.
S1-BH113	12.27	2.22	0.64	Very weak black COAL.
S1-BH116	12.2	3.8	0.58	Very weak black COAL.
SOP001.10	8	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.11	8	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.12	8.5	N/A [Note 1]	0.5	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.14	8	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.15	8	N/A [Note 1]	2	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.16	9	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.17	8	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.18	8	N/A [Note 1]	1	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.19	8	N/A [Note 1]	0.5	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP001.2	9.5	N/A [Note 1]	1.3	NO RECOVERY. Wet COAL (Driller's description).
SOP001.3	9.6	N/A [Note 1]	0.8	NO RECOVERY. Wet COAL (Driller's description).
SOP001.4	9.4	N/A [Note 1]	0.6	NO RECOVERY. Damp black COAL (Driller's description).
SOP001.5	9.4	N/A [Note 1]	0.9	NO RECOVERY. Dry black COAL (Driller's description).



SOP001.6	9.5	N/A [Note 1]	0.9	NO RECOVERY. COAL (Driller's description).
SOP001.7	9.2	N/A [Note 1]	1.5	NO RECOVERY. MUDSTONE and coal (Driller's description).
SOP003.4	13	N/A [Note 1]	1.3	NO RECOVERY. COAL (Driller's description).

Table notes

[Note 1] Measurement between rockhead and coal not provided in drillers logs.

Table 6-4 - Evidence of workings encountered during Stage 1 GI.

Borehole ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log description
S1-BH106	16.1	3.6	0.9	NO RECOVERY. Void/mine workings (Driller's description)
S1-BH107B	15.4	10.4	0.7	NO RECOVERY. Mine workings with some fragments of timber coming up with drilling flush. Significant increase in water. Possible partially collapsed or back stowed workings. (Driller's description)
SOP003.1	10	4	1.5	VOID.
SOP003.2	10	4	1.5	VOID.
SOP003.5	10	4	1.5	VOID.
SOP003.6	10	4	1.5	VOID.
SOP003.8	10.6	4.6	1.6	VOID.
SOP003.9	10.6	4.6	1.6	VOID.
SOP003.13	10.7	4.7	1.3	VOID.
SOP003.14	10.7	4.7	1.3	VOID.
SOP003.16	19.5	13.5	1.7	VOID.

A.4 Stage 2 GI

Table 6-5 - Coal seams encountered during the Stage 2 GI.

Location ID	Depth Top (m bgl)	Depth below rockhead (m)	Thickness (m)	Description
S2-BH245	8	3	0.4	Very weak black COAL.
S2-BH246	7.7	0	0.3	Extremely weak black COAL.
S2-BH247	7.5	3.25	0.6	Very weak thinly laminated black COAL.
S2-BH253.1	6.5	4.34	1.5	NO RECOVERY. COAL (Driller's description).
S2-BH262.1	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).



Location ID	Depth Top (m bgl)	Depth below rockhead (m)	Thickness (m)	Description
S2-BH262.10	14.5	N/A [Note 1]	1.9	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.12	14.5	N/A [Note 1]	1.9	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.2	6.5	1	2	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.2	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.3	6.5	1	2	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.3	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.4	6.5	1	2	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.4	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.5	6.5	1	2	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.5	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.6	6.5	1	2	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.6	14	8.5	2.1	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.7	6	0	1.5	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH262.8	6	0	1.5	NO RECOVERY. SHALE/COAL (Driller's description).
S2-BH263.31	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH263.33	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH263.34	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH263.35	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH264.1	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH264.10	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH264.11	16.5	11	1.4	NO RECOVERY. COAL (Driller's description).
S2-BH264.12	16.5	11	1.4	NO RECOVERY. COAL (Driller's description).



Location ID	Depth Top (m bgl)	Depth below rockhead (m)	Thickness (m)	Description
S2-BH264.13	16.5	11	1.4	NO RECOVERY. COAL (Driller's description).
S2-BH264.2	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH264.3	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH264.5	16	10.5	1.5	NO RECOVERY. COAL (Driller's description).
S2-BH264.7	16	10.5	1.5	NO RECOVERY. COAL (Driller's description).
S2-BH264.8	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH264.9	16.5	11	1.3	NO RECOVERY. COAL (Driller's description).
S2-BH265.1	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.1	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.2	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.2	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.3	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.3	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.4	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.4	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.5	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.5	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.6	11.5	0	2	NO RECOVERY. SHALE/COAL (Driller's Description)
S2-BH265.6	17	5.5	2.5	NO RECOVERY. SHALE/COAL (Driller's Description)

Table 6-6 - Evidence of workings encountered during Stage 2 GI.

Borehole ID	Depth (m bgl)	Depth below rockhead (m)	Thickness (m)	Log description
S2-BH262.11	10	5.5	1.5	NO RECOVERY. Void/workings (Driller's description).
S2-BH262.7	10.2	4.2	1.3	NO RECOVERY. Void/workings (Driller's description).
S2-BH262.8	10.2	4.2	1.3	NO RECOVERY. Void/workings (Driller's description).



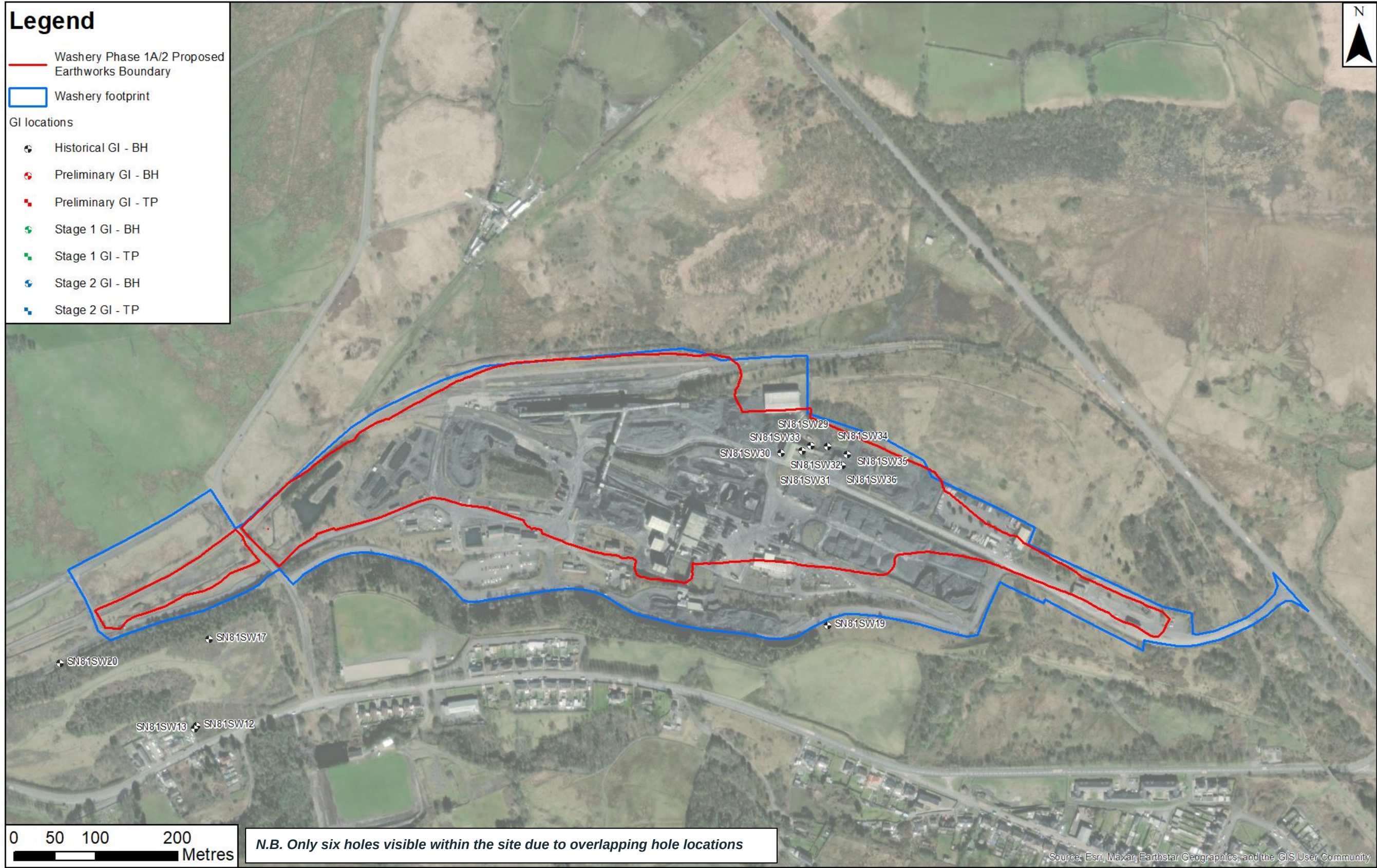
S2-BH262.9	10	5.5	1.5	NO RECOVERY. Void/workings (Driller's description).
S2-BH263.2	12	4.5	1.5	NO RECOVERY. VOID/soft (Driller's description)
S2-BH263.26	12	4.5	1.5	NO RECOVERY. VOID/soft (Driller's description)
S2-BH263.27	12	4.5	1.5	NO RECOVERY. VOID/soft (Driller's description)
S2-BH263.28	12	4.5	1.5	NO RECOVERY. VOID/soft (Driller's description)
S2-BH263.29	12	4.5	1.5	NO RECOVERY. VOID/soft (Driller's description)
S2-BH264.10	21	13.5	2	NO RECOVERY. VOID (Driller's description).
S2-BH264.11	22	14.5	2.5	NO RECOVERY. VOID (Driller's description).
S2-BH264.12	22	14.5	2.5	NO RECOVERY. VOID (Driller's description).
S2-BH264.13	22	14.5	2.5	NO RECOVERY. VOID (Driller's description).
S2-BH264.5	21.5	16	1.5	NO RECOVERY. VOID (Driller's description).
S2-BH264.7	21.5	16	1.5	NO RECOVERY. VOID (Driller's description).
S2-BH264.8	21	13.5	2	NO RECOVERY. VOID (Driller's description).
S2-BH264.9	21	13.5	2	NO RECOVERY. VOID (Driller's description).



Appendix B. Borehole Location Plans



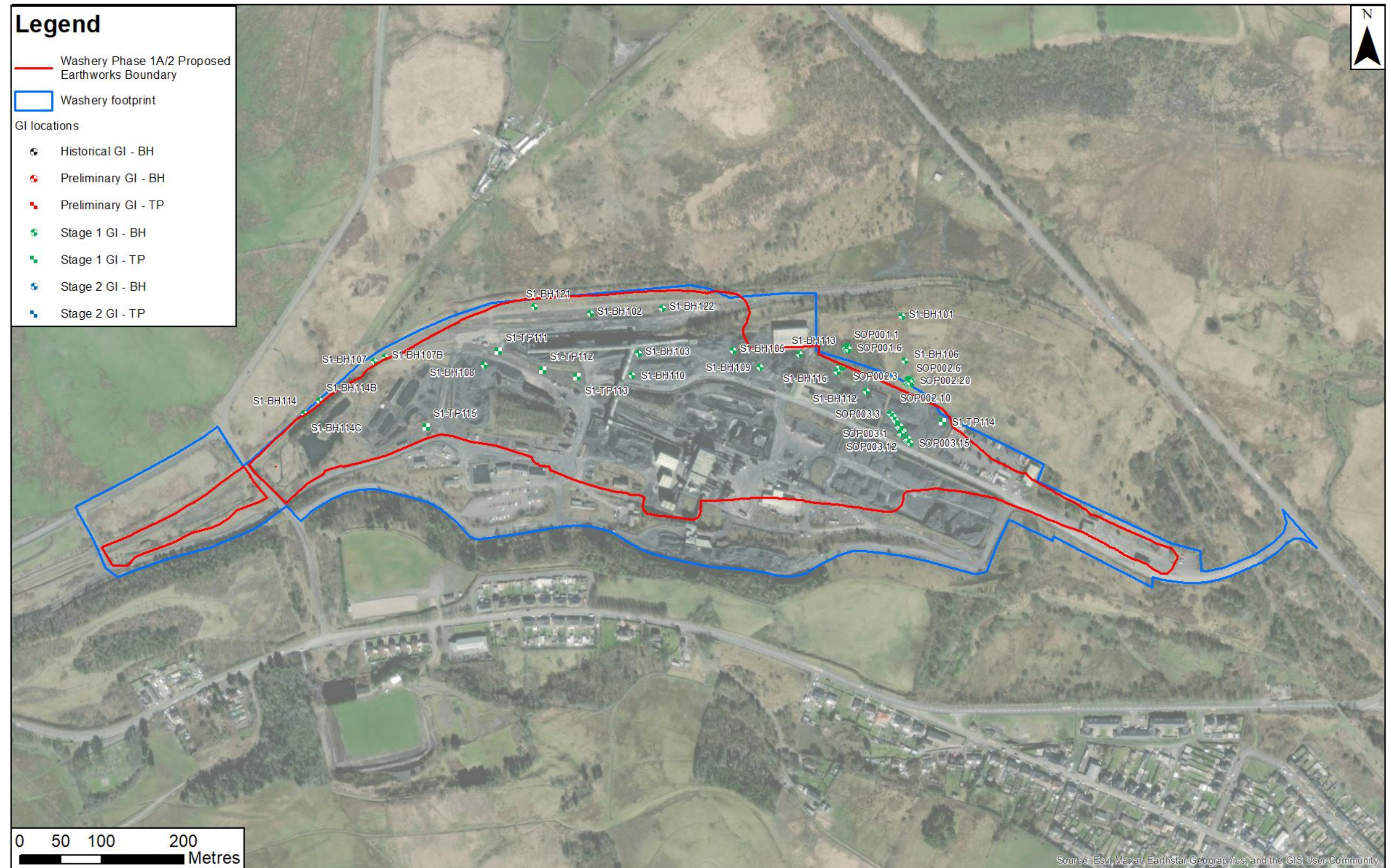
B.1 Historical Ground Investigation

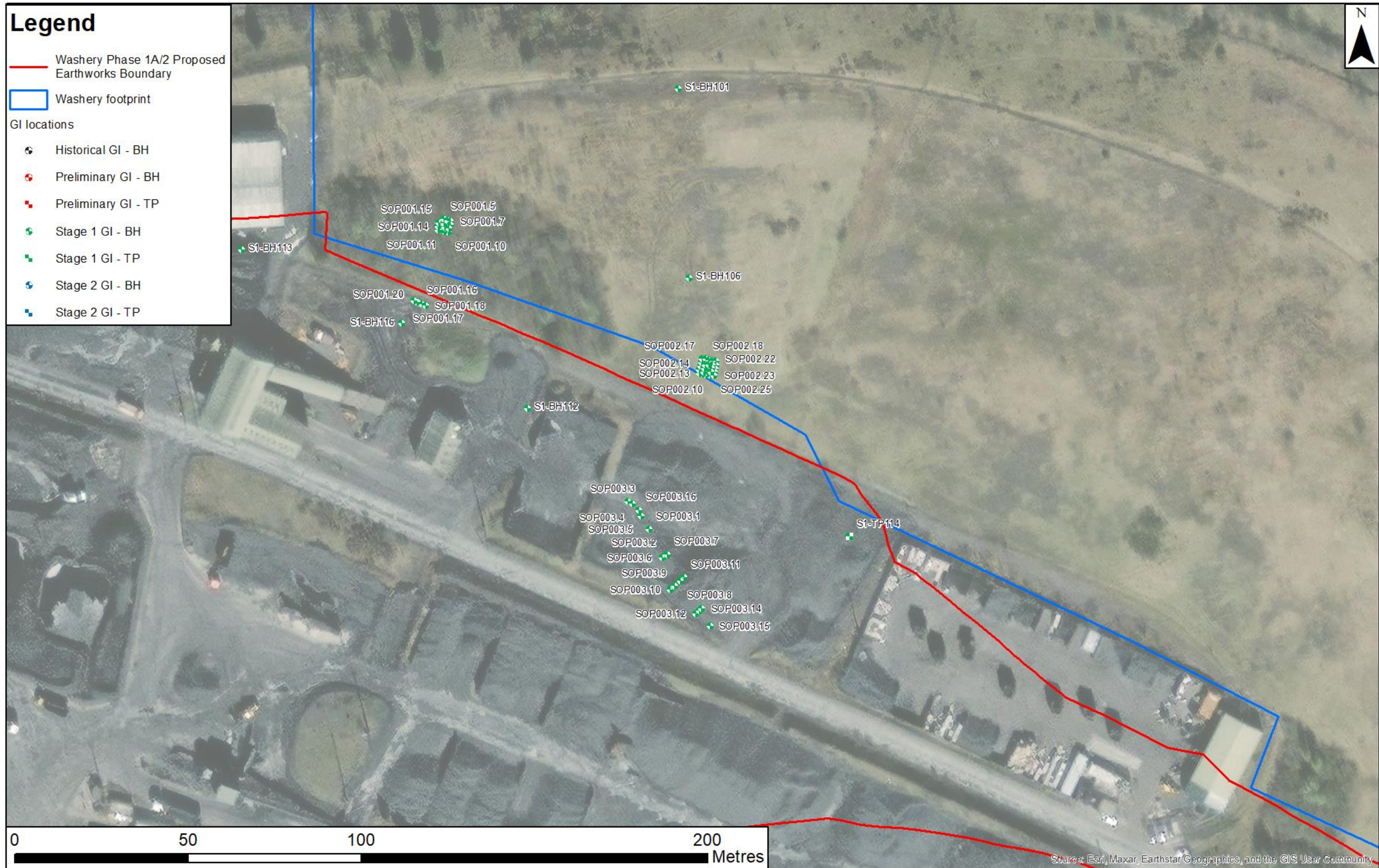


B.2 Preliminary Ground Investigation

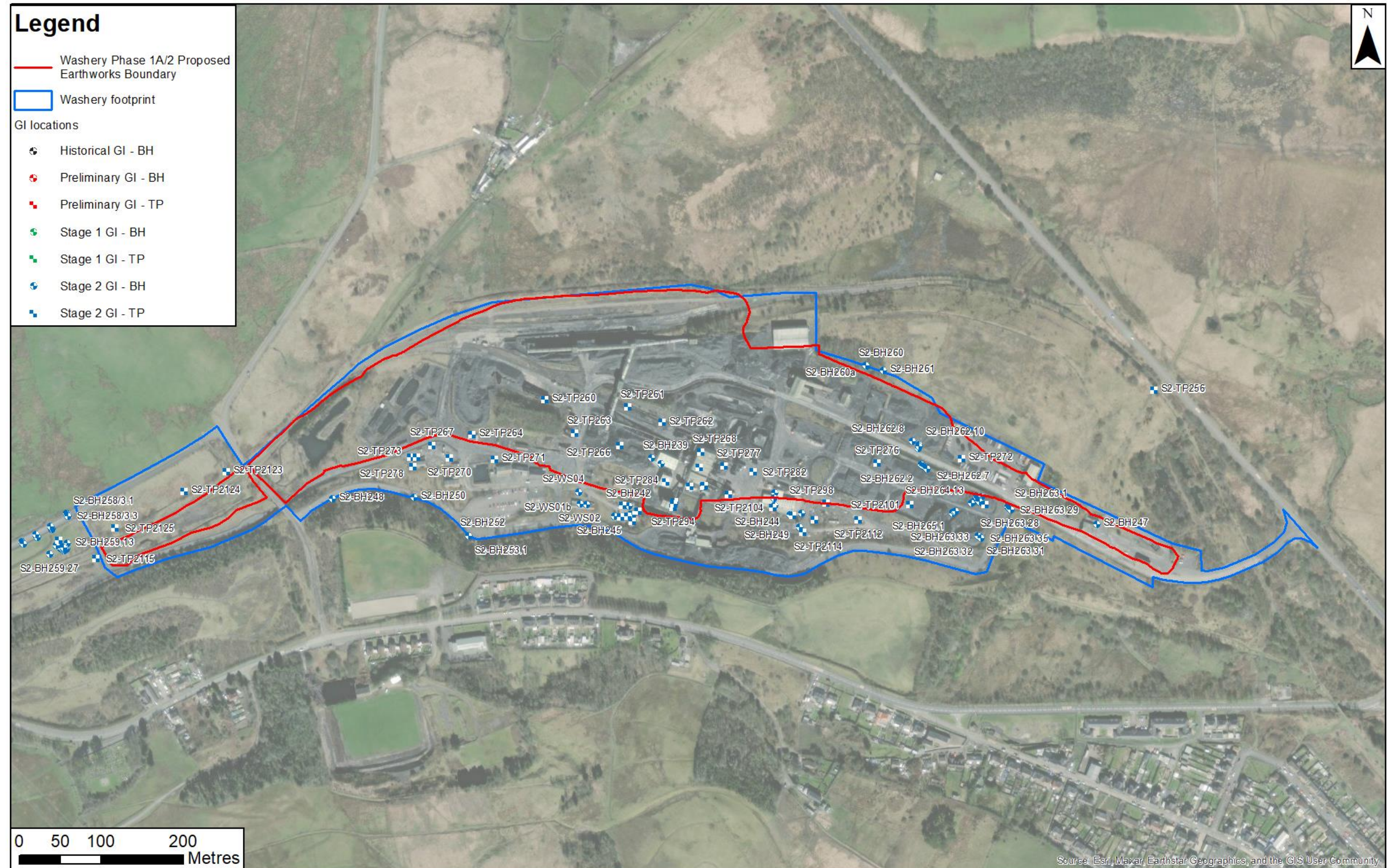


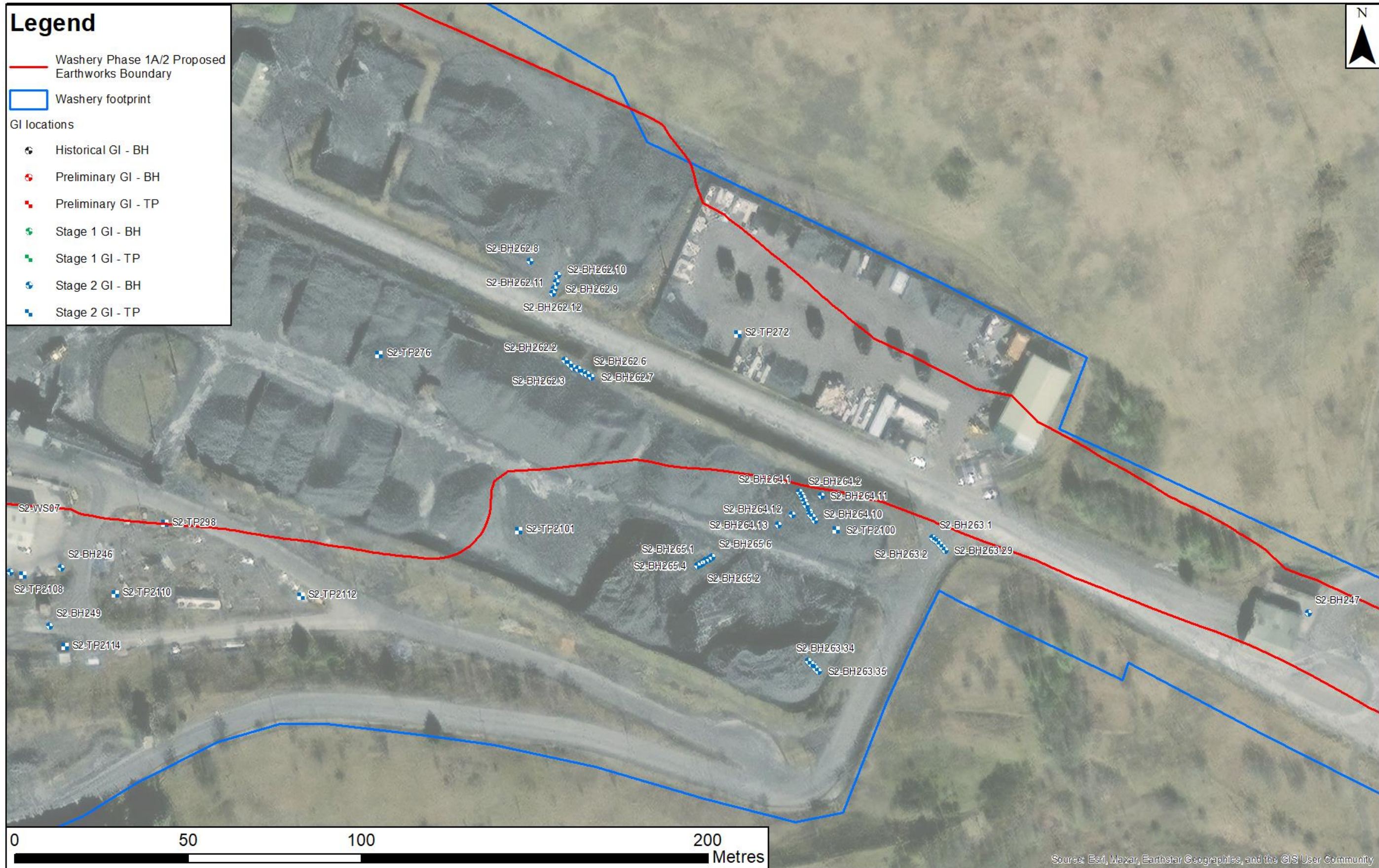
B.3 Stage 1 Ground Investigation





B.4 Stage 2 Ground Investigation





Appendix C. Ground Models



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