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Ground Investigation Report

Proposed Residential Development

Land off Nunsfield Road, Buxton

August 2024



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Issuing office: Soiltechnics Ltd
Unit 9, Clarence Avenue, Westpoint Enterprise Park, Trafford Park, Manchester M17 1QS
Tel: 0161 9470270 E-mail: mail@soiltechnics.net

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Heat Map of Depth to Bedrock (m bgl)	Soiltechnics	August 2024	STQ4642-D02-A
Heat Map of Depth to Bedrock (m AOD)	Soiltechnics	August 2024	STQ4642-D03-A

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Non-technical Summary

Topic	Commentary
Site description	The majority of the site is currently occupied by grazing/pasture/agricultural land, which slopes from east to west towards Nun Brook. The brook is culverted along the majority of the western boundary. The north-western corner of the site is currently occupied by dense vegetation.
Development proposals	The scheme will comprise a large residential development (low rise housing) with private gardens/landscaping and access roads across the central body of the wider of the site. An associated attenuation basin is proposed to the northwest, and a main access road into the site from the A6 roundabout to the southeast.
Ground conditions	Ground conditions across the majority of the residential development comprises topsoil overlying bedrock. Bedrock of the Eyam Limestone Formation underlies the majority of the area with the exception of the southeast (Bee Low Limestone) and west/southwest (Bowland Shale Formation). Bedrock deposits are typically initially weathered to a mixture of clays and sand/gravel, with bedrock present at depths <1m within topographically higher parts of the site. An isolated area of Made Ground was present on the main development site, and localised reworked soils. Deep Made Ground including waste materials (fabric, plastic, ash, clinker, metal etc) was recorded in the north-western corner of the site within the extents of the former Hogshaw Refuse Tip, with the thickness not proven (>5.84m bgl) in this area. Made Ground was also present within the infilled former Russia Mere near to the southeast of the site, with the thickness not proven locally (>5.45m bgl). Made Ground contained brick, slate, asphalt and ceramic with fragments of metal and glass. Groundwater is likely to be present largely within topographically lower areas of the site, close to Nuns Brook. Where encountered, groundwater varied between depths of 2.62m and 3.98m bgl during the 2019 investigation and depths of 1.90m and 2.90m bgl during the 2023-2024 investigation. Locally it was observed at much shallow depths, however this is likely the result of failed seal in the well.
Dissolution	Following completion of GPR and intrusive investigations, there is evidence of possible dissolution features present locally on site, which could be attributed to dissolution of the surface of the Eyam Limestone and subsequent infilling. Voiding is not present, but rather more poorly consolidated natural weathered soils or infilled features. With the exception of the initial 1m of soils below surface level across the site, this is most notable within the western half of the site, where there is a significant deepening of weathered bedrock deposits of varying composition, with evidence of very localised poorly consolidated materials. The GPR responses identified below depths of 1m are also typically consistent with the moderate risk area of ground dissolution as mapped by Envirocheck. We consider there to be a low-moderate risk of dissolution affecting the site in areas where more significant deposits of weathered bedrock area present. The development should be designed on the premise that dissolution features could be present locally in such areas.
Foundation and slab solution, CBR	It is anticipated that Made Ground will be largely limited to the northwest of the site, associated with the Hogshaw Refuse Tip, and to the southeast in the area of the former infilled Mere, where dwellings are not proposed. Based on the identified risk of dissolution onsite, where possible, foundations should be located within the intact bedrock horizons of the Eyam Limestone, which will allow the use of traditional strip/trench fill type foundations. We recommend such foundations are reinforced to mitigate against the possible effects of dissolution during the lifetime of the development. Where it is not practicable to extend foundations into intact bedrock, and given the risk of dissolution of the upper horizons of the Eyam Limestone Formation, it is recommended a reinforced raft type foundations are adopted in such areas. Given the site is proposed to be terraced, such a solution should be achievable where required. Raft foundations could also be utilised in areas where site won natural fill is placed during earthworks, providing it is appropriately conditioned. Piled foundations could also be considered where weathered natural soils are of more significant depth and/or where more significant deposits of engineered fill are placed during earthworks. In areas where raft foundations are not adopted, ground bearing floor slabs can be adopted where they are remote from trees and where Made Ground and Topsoil deposits are fully removed within the footprint of the building. In areas close to existing major vegetation at the site or where Made Ground is present locally, it is recommended a suspended ground floor is adopted.

Topic	Commentary
	A concrete class of DS-1 and AC-1/1s is required in natural soils. Where concrete is required in the area of the refuse tip or infilled former Mere, a concrete class of DS-3 AC-3 will be required. We have based the CBR assessment on current condition of soils below existing surface level. Reassessment of such values will be required following finalisation of cut and fill works across the site. Clearly, in areas of significant fill, the compaction achieved on such material will dictate overall subgrade CBR value. The subgrade is anticipated to comprise a mix of granular and clay based soils, and CBR values of 3-4% are considered appropriate for a variety of construction conditions. The near surface formation materials in the area of the access road will comprise largely granular Made Ground soils associated with infilling of the former mere, which will exhibit variable composition and compaction. Additional conditioning of soils will be required to limit the amount of settlement across pavements. In such areas.
Slope Stability and Retaining Walls	Slope stability and retaining wall analysis is currently being completed as part of a preliminary optioneering exercise and will be reported under separate cover. In view of the ground conditions encountered and anticipated loading, it is considered likely that shallow spread foundations will be suitable where they can be constructed within bedrock. In other areas of the site, providing trench fill/strip foundations are heavily reinforced, it is likely such foundations would provide suitable support.
Drainage potential	Based on correspondence received from the EA, use of SUDS onsite is prohibited due to the potential mobilisation of contamination in the area of the Hogshaw refuse tip, impacting Nun Brook and shallow groundwater bodies. We understand at present, proposals are for surface water collection via a drainage basin proposed in the lowest area of the site to the northwest, which ultimately discharges into Nun Brook upstream of the existing culvert.
Chemical contamination and remedial requirements	GAC exceedances have been encountered within the proposed residential development areas within Made Ground recorded within natural topsoil. Exceedances of heavy metals within topsoil are marginal, and due to the undeveloped nature of the site are considered to be naturally occurring. Topsoil/naturally deposited soils can be reused within the proposed development where necessary. Due to asbestos and elevated PAHs/metals encountered within the Made Ground in the proposed drainage basin and access road, it is recommended that soft landscaping in such areas are installed with a suitable cover system to sever pathways between proposed site users and identified contamination. Construction operatives working in the area of the proposed drainage basin and access road will need to adopt special precautions, including use of RPE (fitted half masks), disposal overalls and decontamination facilities, in combination with mechanical dust suppression. Exceedances of heavy metals compared to EQS values have been encountered in Nun Brook, likely due to elevated natural background concentrations of heavy metals within soils in the region. Very similar contaminant levels were encountered in both surface water samples upstream and downstream of the site indicating that water quality is unlikely to be adversely impacted by the site.
Radon, gas risk and protection measures	Highly elevated methane and carbon dioxide levels were recorded in 2019 beneath the area of the proposed drainage basin in the refuse tip. Ground gas monitoring undertaken in 2024 did not indicate any significant concentrations of carbon dioxide or methane within boreholes beneath the proposed residential development area indicating that migration of significant concentrations of landfill gases is not occurring. Ground gas protection measures are not considered necessary in new residential houses. It should be noted, however, that full radon protection measures will be required in new buildings as the site lies largely within a Higher Probability radon area (membrane and ventilated subfloor void for foundations excluding rafts, membrane and sump for rafts). Such measures will afford a degree of protection against any landfill gases, regardless.
Waste characterisation	No WAC assessment has been undertaken at this stage therefore only a preliminary hazardous waste classification has been provided to determine if soils are hazardous or non-hazardous. Made Ground within the refuse tip area would be classified as hazardous waste. Further WAC analysis prudent to determine potential requirements for treatment prior to disposal. Providing any visually identifiable fragments of ACMs are picked and segregated (and disposed as hazardous waste), Made Ground within the area of the former Russia Mere would be classified as non-hazardous waste. Further WAC analysis may allow classification to inert. In addition, soils in the area of localised Made Ground within the main development site would be classified as non-hazardous waste. Further WAC analysis may allow classification to inert.

Topic	Commentary
	Clean uncontaminated, natural materials would be considered suitable for disposal as non-hazardous waste in an inert landfill site without the requirement for further testing. Topsoil is typically unsuitable for disposal to inert landfill sites due to high organic carbon content.
Recommendation for further works	Discovery strategy for the event of exposing previously unencountered contamination. A Remediation Strategy and subsequent Verification Report on completion. A Materials Management Plan to facilitate the reuse of Made Ground materials on site, where necessary, with subsequent verification to demonstrate compliance. Hazard screening assessment indicates a low risk of encountering UXO during ground investigation works; however, the review does not specifically cover the construction phase and development of the site. A project specific risk assessment should be undertaken, to be completed by a specialist. Once development layouts are confirmed, a plot specific analysis is recommended to confirm foundation requirements and the need for any supplementary investigation. In addition, this will need to consider cut and fill requirements. It is possible that if piled foundations are adopted, a further ground investigation comprising of deeper boreholes will be required on site to establish design parameters ahead of construction. A foundation works risk assessment could also be required to support planning to determine if the use of piled foundations could create vertical pathways into the aquifers below the site and promote the mobilisation of contamination. We recommend that prior to works commencing, soils which are proposed for fill are tested to determine their suitability for reuse (geotechnically). Reassessment of CBR values should be completed once cut and fill levels are understood. Current waste classifications are preliminary only it is recommended to undertake WAC sampling and testing before or during the construction works to fully characterise the waste soils intended for disposal. Surface water compliance testing should be completed within Nun Brook before, during and after construction of the basin, to ensure development it not causing detrimental impact to surface waters.

1 Introduction

1.1 Scheme Outline

- 1.1.1 It is understood the scheme will comprise a large residential development (low rise housing), with associated gardens, infrastructure, drainage basin and access roads constructed to standards allowing adoption by the local highway authority. Development layouts are yet to be determined, however, the extent of the redline boundary for the site is presented in Appendix A.
- 1.1.2 It is understood that the development is controlled under the High Peak Borough Council (HPBC) planning regime, under application reference HPK/2023/0192.
- 1.1.3 The report is based on the project proposals and information outlined above; should the scheme change then it will be necessary to review the conclusions and recommendations presented in this report.
- 1.1.4 It should be noted that Soiltechnics completed ground investigations across a wider area in February 2019, with the latest report revision issued in April 2023 (ref R-STQ4642M-G01-Rev03). In addition, the area of the proposed roundabout and access road into the development site was investigated in March 2019 and reported in June 2019 (ref R-STQ4642M-G02). These investigations included the site under currently consideration and such data has been utilised, and supplemented where necessary, in production of this latest report.

1.2 Brief

- 1.2.1 This report has been prepared following instructions received from our Client, Barratt Homes Manchester. The overall brief of works is to:
- i) Undertake a ground investigation at the site to establish the prevailing ground conditions and identify potential abnormal development constraints.
 - ii) Support the planning application by assessing the potential risks from contamination at the site.
 - iii) Determine geotechnical parameters and provide a geotechnical appraisal for the scheme.
- 1.2.2 The objectives of this report are outlined below:
- i) Review and summarise desk study information.
 - ii) Undertake a land contamination Tier 1 preliminary risk assessment.
 - iii) Summarise the intrusive investigation works undertaken and associated laboratory testing.
 - iv) Present a ground model summarising the ground and groundwater conditions at the site including relevant geotechnical parameters.
 - v) Provide a geotechnical appraisal for the project and highlight key geotechnical issues that may impact upon the proposed scheme.
 - vi) Undertake a land contamination Tier 2 generic quantitative risk assessment.
 - vii) Provide recommendations to inform an Options Appraisal and Remediation Strategy, should they be required.
 - viii) Provide a waste characterisation assessment of soils at the site for potential disposal to landfill.

1.3 Definition of Scope

- 1.3.1 The phasing and scope of the ground investigation works is broadly defined by the following documents.

Title	Document Reference	Publisher	Investigation Scope
Code of practice for ground investigations	BS 5930: 2015	British Standards Institution	Phase 1: Desk study Phase 2: Preliminary investigation
Eurocode 7 — Geotechnical design Part 2: Ground investigation and Testing	BS EN 1997-2: 2007	British Standards Institution	Preliminary Investigation
Investigation of potentially contaminated sites – Code of practice	BS 10175: 2011+A2:2017	British Standards Institution	Preliminary Investigation (desk study) Exploratory Investigation
Land contamination risk management	Online resource, updated April 2021	Environment Agency	Stage 1 Risk Assessment: Tier 1: Preliminary risk assessment Tier 2: Generic quantitative risk assessment

Table 1-A: Definition of Investigation Scope

1.4 Limitations

- 1.4.1 Soiltechnics disclaims any responsibility to our Client and others in respect of any matters outside the scope of this report. This report has been prepared with reasonable skill, care and diligence in accordance with the terms of our contract, taking account of the resources, investigations and testing devoted to it by agreement with our Client. This report is confidential to our Client and Soiltechnics accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

2 Desk Study

2.1 Sources of information

2.1.1 Reference has been made to the following sources of information:

- An Envirocheck Report and historical map records, presented as Appendix R.
- British Geological Survey (BGS) GeoIndex – Onshore database.
- BGS Sheet 99 (Scale 1:50 000) – Chapel en le Frith (1977), BGS Sheet 111 (Scale 1:50 000) – Buxton (1978).
- Ordnance Survey OpenData.
- Environment Agency open-source databases.
- Google mapping services.
- Interrogation of search engines for anecdotal information on the site history and other readily available online resources.
- Previous Soiltechnics Ltd ground investigation reports.

2.2 Site Description

2.2.1 The proposed development lies within Buxton, approximately 700m northeast of the town centre. The post code for the site is SK17 7BS, and the site is accessed from the A6 to the east.

2.2.2 An aerial image showing the approximate site boundary is presented below, followed by a table summarising the key site features. A site location plan is provided within Appendix A.



Figure 2-A: Aerial photograph and approximate site boundary

Theme	Feature
Current site use	The site is currently used as grazing/pasture/agricultural land, with stone walls and fences forming field boundaries. The area of the proposed drainage basin falls within an area of roughly vegetated land.
Local area land use	Adjacent sites are occupied by residential land and a cemetery to the south/southeast, whilst agricultural land occupies the north. A golf club borders the site to the northeast, whilst a single development (agricultural services, forming Nunsfield Farm) borders the site to the east. To the west, the site is bounded by woodland with a railway line beyond.
Topography	Surface levels fall by some 20m to 30m from east to west towards Nun Brook.
Buildings, surfacing and other permanent features	The site is surfaced in grass throughout. The proposed drainage basin area is roughly vegetated.
Boundary features	The site is bounded by either wire and post fencing or stone fencing on all sides.
Vegetation	Mature trees and vegetation are limited to the boundaries of the site excluding the northern (formed by a wall).
On-site / adjacent surface water features	Nun Brook, a small stream, flows north to south through the area of woodland adjacent to the west of the site. A section of the brook is culverted. The proposed drainage basin area falls over part of the culverted section of the brook.
Environmental Designations	The site is not reported to be within or in close proximity to any areas of designated sensitive land use, such as a Ramsar Site, Site of Special Scientific Interest (SSSI), or Special Area of Conservation.
Injurious and invasive weeds	Whilst Japanese Knotweed was not observed on site, it was observed offsite to the west and southwest of the site with the wooded area of the former Hogshaw Refuse Tip.
Asbestos containing material (ACM) in buildings	Not applicable – no structures present on site.
ACMs on site	No suspected ACMs were observed in any surface debris.
Potential sources of contamination	Infilled pond to the southeast of the site. Former landfill known to be present beyond the west of the site and within proposed drainage basin area.
Evidence for ground instability	Depressions noted locally on site.

Table 2-A: Site Description

2.2.3 The observations provided above are made by a Geoenvironmental Engineer, who is not a specialist in asbestos surveying or invasive weed identification. Any associated comments are intended for use by this report only, and not for any other purpose.

2.2.4 Photographic records of the site are presented in Appendix D.

2.3 Planning Records

2.3.1 A search of online planning records held for the site by High Peak Council reveals no previous planning records on or adjacent to the site.

2.4 Previous Reports

2.4.1 Soiltechnics have previously completed the following reports in relation to the site.

Author	Document Title	Date & Document Reference	Report Context
Soiltechnics	Ground Investigation Report	April 2023 R-STQ4642M-G01_Rev03	Soiltechnics previously undertook a similar ground investigation for Barratt Homes Manchester across a larger development area, which included the site boundary currently under consideration. The site is known as 'Zone 3' within this previous report. The report included a Phase I and II contamination assessment and geotechnical appraisal.
Soiltechnics	Ground Investigation Report	June 2019 R-STQ4642M-G02	Ground investigation in support of a proposed roundabout on the existing A6 carriageway to support the proposed residential development.
Soiltechnics	Remediation Strategy	April 2023 RSTQ4642M-RS01	A remediation strategy to support development of the the spine road access area.

Table 2-B: Summary of previous reports

2.5 Site History

- 2.5.1 Historically, the north-western part of site formed part of open land until a refuse tip was recorded between 1967 and 1988. The eastern part of the site was used as agricultural land with Russia Mere (a pond) recorded between 1879 and 1967 between the southeastern extent of the site. Beyond the west of the site the land was used for various activities including a railway line with sidings, an engine shed (1898 to 1974), in addition to allotment gardens (1922 to 1967) and playing fields to the southwest (1977 to present day).
- 2.5.2 A chronological summary of the site's history is provided below.

Date	On-site	Off-site
1879	Site recorded as open space and largely agricultural. Nun Brook flows through the site's north-western extent and then adjacent to western site boundary similar to present day. Russia Mere (a bathing pond) recorded in south-eastern extent of site.	Old lime kiln recorded 150m to the north. Quarry features located 200m to the east and northeast of the site. Graveyard and Church recorded adjacent to the south. Railway line recorded 100m beyond western site boundary. Brick Yard with pits recorded beyond railway line. Nuns Farm recorded in area of present day Nunsfield Farm (beyond east of site).
1882	No significant change.	Quarries are located 400m to the northeast and east of site. Brick Yard 400m west.
1898-99	No significant change.	Railway sidings and associated engine shed 60m west of site. Quarry 250m east of site.
1921-22	No significant change.	Quarry expanded in size 250m to the east. Housing development recorded adjacent to southern site boundary. Nuns Farm now recorded as Nunsfield Farm.
1938	No significant change.	No significant changes.
1955	No significant change.	Further development of railway sidings 50m west of site.
1967	Russia Mere no longer recorded within southeast of site. North-western extent of site assumed to be occupied by refuse tip.	Refuse tip present immediately adjacent to west of site. Graveyard to south extended adjacent to site including embankment. Extensive development of sidings 50m west of site including turn table and coal hangar. Extensive earthworks forming an embankment also noted surrounding railway land. Allotment gardens border the site to the southwest. Golf courses recorded beyond eastern site boundary.

Date	On-site	Off-site
1973	Nun Brook not recorded within area of refuse tip in northwest of site. Assumed to be culverted.	Railway sidings, engine shed and associated structures no longer recorded in mapping beyond the southwest of the site. Further residential development beyond the south of the site. Old lime kiln beyond north of site no longer recorded. Quarries 200m east of site no longer recorded.
1990-2006	Refuse tip within northwest of site recorded as working (disused).	Refuse tip beyond west of site recorded as workings (disused). Expansion of Nunsfield Farm beyond the east of the site.
2023	No significant changes.	Area of former refuse tip no longer recorded as 'workings'.

Table 2-C: Summary of site history

2.6 Regulatory Enquiries

- 2.6.1 Soiltechnics have contacted Local Authority Building and Environmental Health officers at High Peak borough Council regarding the site. We have not received a response to date. If any information of notable relevance is received following issue of this report we will update accordingly.
- 2.6.2 As part of the planning consultation process, the Environment Agency (EA) and HPBC Environmental Health Officer (EHO) have provided comment. Copies of correspondences received are presented in Appendix O.
- 2.6.3 In summary, the EA objected to the application due to the risk development of the site posed to controlled waters and in particular, Nun Brook. Further ground investigation and risk assessment was recommended.
- 2.6.4 The Environmental Health Department had no objection to the development, providing a report and associated ground investigation and risk assessment was presented, focused on the current redline boundary under consideration. The planning application was recommended to be conditioned with the typical requirements to protect human health and controlled waters.

2.7 Anticipated Geology

- 2.7.1 Based on a review of available records, deposits of Alluvium are present in the area of Nun Brook. Otherwise, superficial deposits are not recorded across the site. Bedrock of the Bowland Shale Formation is present immediately adjacent to the west of the site and within the northwest of the site, with Eyam Limestone Formation present centrally and to the east. Bee Low Limestone Formation is present in the southeast of the site in the area of the proposed access road.
- 2.7.2 Made Ground is likely to be present in the northwest of the site (proposed drainage basin) associated with the historic refuse tip, and to the southeast where the former Mere was present.
- 2.7.3 A summary of the anticipated geology underlying the site is summarised as follows:

Stratum	Bedrock / superficial	Anticipated thickness (m)	Typical description
Alluvium (confined to Nun Brook) – northwest of site	Superficial	<5m	Clays, silts, sands, gravels
Bowland Shale Formation – west/northwest of site	Bedrock	>20m	Mudstone, siltstone, sandstone
Eyam Limestone Formation – centre and east of site	Bedrock	<20m	Limestone

Stratum	Bedrock / superficial	Anticipated thickness (m)	Typical description
Bee Low Limestone Formation – southeast of site	Bedrock	>70m	Limestone

Table 2-D: Summary of anticipated geology at the site

2.8 Hydrogeology and Groundwater Sensitivity

2.8.1 The general hydrogeological profile of the site is provided in the table below.

Stratum	Aquifer Designation	Stratum Thickness (m)	Groundwater commentary
Alluvium (confined to Nun Brook) – northwest of site	Secondary A	<5m	Low to moderate permeability. Likely to contain groundwater in connectivity with the brook.
Bowland Shale Formation – west of site	Secondary A	>20m	Permeable in fractures. Likely to contain basal groundwater where it overlies the limestone.
Eyam Limestone Formation – centre and east of site	Principal Aquifer	<20m	Permeable in fractures.
Bee Low Limestone Formation – southeast of site	Principal Aquifer	>70m	Permeable in fractures.

Table 2-E: Preliminary Hydrogeological Model

2.8.2 During the 2019 ground investigation, groundwater was observed only locally and typically at a depth between 1.0m to 3.0m bgl.

2.8.3 The site is not located within a Source Protection Zone.

2.8.4 There are no recorded potable groundwater abstraction licences within 1km of the site.

2.9 Hydrology and Surface Water Sensitivity

2.9.1 The sites closest water course is Nun Brook, a small stream flowing through the northwest of the site, and adjacent to the western boundary in a north-south direction. Nun Brook is culverted beneath the former refuse tip, and is open channel to the north and south of the tip.

2.9.2 There are 2 No. recorded potable surface water abstraction licenses within 1km of the site. Both are recorded 967m southwest of the site and relate to abstractions for Hotels; Public Houses and conference centres: General use.

2.10 Flood Risk

2.10.1 Whilst the majority of the site falls within a Flood Zone 1 area, part of the north-western extent of the site is recorded within a Flood Zone 2 and 3, associated with Nun Brook.

2.10.2 The site is largely recorded in an area shown to have limited potential for groundwater flooding to occur, with the exception for the northwest of the site which is recorded as have a potential for groundwater flooding of property situated below ground level.

2.10.3 It should be noted that this information does not constitute a site-specific Flood Risk Assessment and one may be required for the scheme.

2.11 Non-Mining Ground Instability Hazard

2.11.1 The Envirocheck Report includes hazard ratings due to natural ground instability, which have been derived by the BGS. These hazards have been summarised in the table below.

Hazard	Hazard Potential	Discussions
Collapsible ground	Very low	N/A
Compressible ground	Moderate	Associated with the presence of Alluvium around Nun Brook, typically comprising of loose clay, silt and gravel.
Ground dissolution	Moderate	Associated with the surface of the Eyam Limestone Formation present in topographically lower parts of the site where they underlay the Bowland Shale Formation.
Landslide	Low	N/A
Running sand	Low	N/A
Shrinking or swelling clay	Very Low	N/A

Table 2-F: Non-Mining Ground Stability Hazards

2.11.2 Envirocheck also reports areas at high risk of ground dissolution 17m west and 27m southwest of the site.

2.11.3 Envirocheck also records the presence of a natural sink hole and solution pipe 637m to the southeast of the site, present within limestone deposits. The risks associated with dissolution are discussed further in Section 7.

2.12 Quarrying and Mining

2.12.1 The site falls outside of a Coal Mining Reporting Area.

2.12.2 There are 11 No. BGS recorded mineral sites located within 1km of the subject site. The nearest is located 300m east of site and comprised an opencast used to extract limestone commodities. Operations have since ceased.

2.13 Landfill and Infilled Ground

2.13.1 Envirocheck reports 1 No. historic landfill site within 1km of the subject site. The historic landfill encroaches onto the site within the northwest and is recorded as the Hogshaw Refuse Tip. Records indicate the site was licenced for receipt of industrial and commercial wastes.

2.13.2 Furthermore, the Local Authority planning portal of High Peak Borough Council, also records a refuse tip in the area of the existing Hogshaw recreational ground some 200m southwest of the site.

2.13.3 The following table summarises current and historical landfill sites and infilled ground records within 250m from the site to the site.

Name	Distance from site (m)	Type of record	Waste deposited / resource extracted	Further information
Hogshaw Refuse Tip	27m NW	Historical landfill	Industrial/Commercial waste	Mapped 1967-90
Potentially infilled land	227m NW	Non water	Unknown filled ground (pit / quarry)	Mapped 1977
Potentially infilled land	0m SE	Water	Unknown filled ground (Russia Mere)	Mapped 1955

Name	Distance from site (m)	Type of record	Waste deposited / resource extracted	Further information
Potentially infilled land	209m SE	Water	Unknown filled ground (Pond / Marsh)	Mapped 1955

Table 2-G: Summary of landfill and infilled ground records

2.14 Recent industrial activity

- 2.14.1 There are no regulated facilities or activities in the vicinity of the site under IPPC or LAPPC control, and no registered radioactive substances.
- 2.14.2 The site is in a primarily residential / rural area. As such there are a limited number of commercial and industrial properties in close proximity to the site. The following table summarises the pertinent potentially contaminating Contemporary Trade Directory entries within 100m of the site.

Name	Direction	Distance from site	Activity
Buxton 4 X 4 Ltd	SE	34m	Active, garage services
G & R Leigh	SE	45m	Inactive, agricultural merchants

Table 2-H: Summary of Contemporary Trade Directory Entries

- 2.14.3 There are no recorded pollution incidents to controlled water or discharge consents held within 250m upstream of the site.

2.15 Radon

- 2.15.1 A detailed Radon Report has been obtained from the BGS, presented in Appendix P. The report indicates that the site lies within a Higher Probability Radon area where 10-30% of homes are above the action level. This is with the exception of a very small area of the western boundary, which falls within an area >30%, and a small zone to the north which falls within an area where 1-3% of homes are above the action level. Full radon protection measures will be required in all new buildings.

2.16 Underground Infrastructure

- 2.16.1 Copies of all utility plans obtained are presented as Appendix M. The plans are provided for information only and should not be relied upon to be accurate. In addition, it is worth noting that the public utility plans provided by the asset owners typically exclude private service runs.
- 2.16.2 A review of the plans indicates electric cabling to run beneath the southern extent of the site, as well as along the western site boundary and through the site within the northwest.
- 2.16.3 In addition, BT Openreach cabling crosses the south-eastern corner of the site from Nunsfield Road leading up to Nunsfield Farm.
- 2.16.4 The asset holder (Electricity Northwest and BT Openreach) should be consulted at the earliest opportunity to identify any construction constraints that may apply.
- 2.16.5 In addition, we have received records of Nestlé Waters UK Ltd pipe which traverses across the site. A copy of their records is presented in Appendix M. The route of the pipe is also presented in Appendix A.

2.17 Unexploded Ordnance (UXO) Hazard Screen

- 2.17.1 A UXO hazard screen has been undertaken by Soiltechnics (as a non-specialist) in accordance with CIRIA C785 to determine if further specialist risk assessment is required. This has been carried out with reference to the Zetica bomb density maps, area-specific bomb strike maps (where available), and a review of historical mapping and possible military sites in the area. A summary is presented below.

Hazard	Outcome	Discussion
Question 1: Are there any indicators of former military land use on site?	No	A review of the site's history has not identified indicators of former military use on site.
Question 2: Are there any indicators of historical bombing on or near the site?	No	The site falls within a low bombing density area however a military site has been identified in the surrounding area, ~1km towards Buxton Town Centre. A review of historical mapping records did not reveal any indicators of bombing in the area.

Table 2-1: UXO Hazard Screen

- 2.17.2 The risk review concluded that there was not a credible risk of encountering UXO during the ground investigation. It should be noted that this preliminary risk review does not consider risks to the construction phase.

3 Tier 1 Preliminary Contamination Risk Assessment

3.1 Objectives

- 3.1.1 The objective of this preliminary risk assessment (PRA) is to determine the suitability of the site for the proposed redevelopment and end users, in terms of the risk from contamination. The assessment comprises the following steps:
- Identify potential contaminant linkages (PCLs) between sources, pathways and receptors.
 - To provide data to assist in the design of potential exploratory and detailed intrusive investigations and to give an early indication of possible remedial requirements, if necessary.

3.2 Evaluation Criteria

- 3.2.1 The following assessment is undertaken within the legislative framework of the planning system. Therefore, the assessment needs to identify if land contamination could pose an unacceptable risk to human health or the environment, within the context of the proposed development site. In the context of the existing site use, as a minimum, land should not be capable of being determined as 'contaminated land' under Part IIA of the Environmental Protection Act 1990.
- 3.2.2 The risk criteria for the proposed development is based on a 'minimal risk' approach, whereas under the existing land use a designation of 'contaminated land' would only apply if there is a significant possibility of significant harm (SPOSH).

3.3 Methodology

- 3.3.1 The objectives listed above are achieved by utilising the information presented within the desk study to develop an initial conceptual site model (iCSM) and identification of potential unacceptable risks. Depending upon the outcome of the Tier 1 assessment, it may be necessary to undertake a Tier 2 generic quantitative risk assessment (GQRA).
- 3.3.2 An iCSM relies upon the identification and assessment of PCLs. A contaminant linkage comprises of three key components:
- Source – a contaminant or pollutant that is in, on or under the land and that has the potential to cause harm or pollution.
 - Pathway – Current and post-development routes by which a receptor is, or could be, affected by a contaminant.
 - Receptor – Something that could be adversely affected by a contaminant, for example a person (current and proposed end users or neighbours), controlled waters and ecosystems.
- 3.3.3 The Tier 1 risk assessment has been produced with reference to the following guidance:
- ['Land contamination risk management'](#) (EA, 2021).
 - BS 10175:2011+A2:2017 'Investigation of potentially contaminated sites – Code of Practice'.
 - CIRIA C552 'Contaminated land risk assessment- a guide to good practice', 2001.
 - BS EN ISO 21365:2020 'Soil quality – Conceptual site models for potentially contaminated sites'
 - BS 8576:2013 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOC)'.

3.4 Source Assessment

3.4.1 The table below summarises identified sources based on the findings of the desk study. Where appropriate, further discussion has been provided in the paragraphs which follow.

Potential Sources	Contaminant(s) of concern	Detail	Viable source?
On-site sources			
Made Ground within Hogshaw Refuse Tip and infilled land within area of proposed access road associated with former Russia Mere <i>(on and off site)</i>	Various inorganic and organic compounds (hydrocarbons, metals, asbestos)	Known use of land as a landfill for deposited waste, including industrial and commercial, within the northwest of site. Unknown infilled material associated with former Russia Mere within southeast of site. Range of contaminants likely to be present.	Y
	Permanent ground gases (CH ₄ and CO ₂)	Elevated concentrations of ground gas generated from thick Made Ground and landfill waste with high levels of putrescible material anticipated in the latter.	Y
Made Ground of unknown origin	Metals, polycyclic aromatic hydrocarbons (PAH), asbestos	The site has remained largely unchanged throughout recorded history with the exception for the landfill site and infilled Russia Mere (detailed above).	N
	Permanent ground gases (CH ₄ and CO ₂)	Elevated concentrations of ground gas generated from thick Made Ground with high levels of putrescible material is not anticipated with the exception for the landfill site and infilled Russia Mere (detailed above).	N
Agricultural land	Various inorganic and organic compounds (hydrocarbons, metals, asbestos)	Agricultural activities undertaken throughout recorded history. Possible range of contaminants within soils, however, in recent years land has been primarily used for pasture, and significant concentrations of pesticides/herbicides are unlikely to currently persist.	N
Alluvium	Permanent ground gases (CH ₄ and CO ₂)	Elevated concentrations of ground gases generated over time and trapped within the underlying soils not anticipated. Thickness of alluvium soils anticipated to the <5.0m, and are not laterally extensive.	N
Radon	Radon	The site is recorded as being in an area where largely 10-30% of homes are above the action level, and full radon protection measures are necessary. x	Y
Off-site sources			
Former Railway Land	Metals, hydrocarbons (PAHs and TPHs), semi volatile/volatile organic compounds (SVOC/VOCs), asbestos	Railway Land including engine shed, coal hangar and sidings. Whilst a wide range of contaminants is likely, any significant contamination is highly unlikely to migrate upgradient to site.	N
Commercial trades (garage services and agricultural merchants)	Metals, hydrocarbons (PAHs and TPHs)	Garage services recorded 34m southeast of site, and inactive agricultural merchants 45m southeast of site. Given scale of trades, migration of significant chemical contamination considered highly unlikely.	N

Potential Sources	Contaminant(s) of concern	Detail	Viable source?
Potentially infilled land	Permanent ground gases (CH ₄ and CO ₂)	Infilled land recorded 209m southeast and 227m northwest of site. The nature of infill is unknown, possible thick Made Ground with high levels of putrescible material could be present.	Y
Allotment gardens	Metals, polycyclic aromatic hydrocarbons (PAH).	Possible range of contaminants within soils, however, pesticides/herbicides are unlikely to be persistent and migrate to site, and other contaminants likely to be present within the allotments and unlikely to migrate upgradient.	N

Table 3-A: Contamination source assessment

3.5 Receptor Assessment

3.5.1 The following table summarises the identified receptors based on current site conditions and our understanding of the proposed end use:

Receptor Category	Principal Receptor	Receptor present?	Detail
Human health	Users of the current site	Yes	Currently used for as pasture/grazing land.
	End user of the developed site	Yes	Proposed residential use, with private gardens.
	Construction operatives and other site investigators	Yes	Site to be developed.
	Adjacent site users and off-site members of the public	Yes	Public footpath and residential properties present adjacent to site.
Controlled waters	Surface waters	Yes	Surface waters (Nun Brook) runs directly through the northwest of the site (culverted) and adjacent to the site's western boundary. Open course adjacent to northwest and southwest.
	Groundwater	Yes	Site over superficial Secondary A Aquifer and Principal Aquifers at depth.
Sensitive ecosystems and species	Current site	No	Site is not currently within, or proposed to form, a designated environmentally sensitive area (e.g. SSSI, RAMSAR, AONB, SPA, SAC).
	Developed site	No	
Property	Soft landscaping (current)	Yes	Shrubs and trees present along site boundaries.
	Soft landscaping (proposed)	Yes	Private gardens and public open spaces proposed.
	Building materials	No	Concrete classification to be assessed under the geotechnical investigation.

Table 3-B: Receptor assessment

3.6 Pathway Assessment

3.6.1 The following table summarises the generic human health pathway assessment for the site, assuming a range of contaminant sources within the underlying soils. Source-specific pathways are considered within the ICSM in subsequent report sections.

Human Health Exposure Pathway	Pasture/grazing land (current)	Residential land with private gardens (proposed)	Construction operatives	Adjacent Site Users
Ingestion, inhalation and dermal contact with soils and dusts	✓	✓	✓	✓ (inhalation only)
Ingestion, inhalation and dermal contact with site derived dusts indoors	✓	✓	✓	✗
Ingestion of home-grown vegetables	✗	✓	✗	✗
Inhalation of vapours in outside spaces	✓	✓	✓	✓
Intrusion and inhalation of vapours indoors	✗	✓	✓	✗
Accumulation and Inhalation of ground gas in enclosed structures	✗	✓	✓	✗
Permeation into below-ground drinking water pipes	✗	✓	✗	✗

Table 3-C: Generic pathway assessment

3.6.2 The following table summarises generic pathways for the site which could be viable for the identified controlled water receptors, given our understanding of the hydrogeological model and assuming a range of contaminants in the sub-surface.

Controlled Water Exposure Pathways	Current Setting	Proposed Setting	Mechanism
Site characteristics			
Leaching via infiltration through unsurfaced areas, and surface run-off	✓	✓	Mobilisation
Leaching via infiltration through cracks/joints in hardstanding areas and drainage infrastructure	✗	✓	Mobilisation
Leaching via saturation from groundwater flooding and shallow/perched groundwater bodies	✓	✓	Mobilisation
Infiltration through sustainable drainage systems	✗	?	Mobilisation
Preferential lateral pathways (e.g. underground services)	✓	✓	Migration
Preferential vertical pathways (e.g. piling, vibro-stone columns)	✗	?	Migration
Hydrogeological characteristics			
Vertical migration through permeable strata into shallow aquifers and perched groundwater bodies	✓	✓	Migration
Vertical migration through permeable strata into sensitive aquifers at depth	✗	✗	Migration
Lateral migration within shallow and perched groundwater bodies into surface waters	✓	✓	Migration

Table 3-D: Generic pathway assessment

3.7 Initial Conceptual Site Model (iCSM)

3.7.1 The table below presents our approach to the assessment of risks associated with PCLs. The categories below are based upon the definitions within CIRIA C552 (2001), with the addition of a 'negligible likelihood' scenario, which is to be used where there is no realistic scenario in which harm could occur.

3.7.2 The initial conceptual site model (iCSM) is presented within the following tables overleaf.

		Consequence of harm			
		Severe	Medium	Mild	Minor
Probability of harm	High likelihood	Risk: Very high (high – severe)	Risk: High (high – medium)	Risk: Moderate (high – mild)	Risk: Moderate/Low (high – minor)
	Likely	Risk: High (likely – severe)	Risk: Moderate (likely – medium)	Risk: Moderate/Low (likely – mild)	Risk: Low (likely – minor)
	Low Likelihood	Risk: Moderate (low – severe)	Risk: Moderate/Low (low – medium)	Risk: Low (low – mild)	Risk: Very low (low – minor)
	Unlikely	Risk: Moderate/Low (unlikely – severe)	Risk: Low (unlikely – medium)	Risk: Very low (unlikely – mild)	Risk: Very low (unlikely – minor)
	Negligible Likelihood	Risk: Low (negligible– severe)	Risk: Very Low (negligible– medium)	Risk: Very Low (negligible– mild)	Risk: Negligible (negligible– minor)

Table 3-E: iCSM Risk Ratings

RECEPTOR: PROPOSED END USERS				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
Made Ground within Hogshaw Refuse Tip and infilled land within access road associated with former Russia Mere (on and off site)	Metals, PAHs, TPHs	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Moderate (likely – medium)	Elevated levels of inorganic and organic contaminants could be present in the Made Ground deposits due to its origin and composition (e.g. uncontrolled industrial/commercial and domestic waste).
	Asbestos fibres and ACMs	Inhalation of dusts	Risk: Moderate (likely – medium)	Asbestos could be present in uncontrolled material within the Made Ground.
	Permanent ground gases (CH4 and CO2)	Migration through the sub-surface into enclosed spaces	Risk: Moderate (low – severe)	Whilst the landfill is expected to be lined, due to it being partially onsite, the migration of ground gases at high volumes poses a potential risk and cannot be discounted at this stage.
Made Ground of unknown origin	Metals, PAHs, asbestos	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	The site has remained largely unchanged throughout recorded history with the exception for the landfill site and infilled Russia Mere (detailed above).
	Permanent ground gases (CH4 and CO2)	Migration through the sub-surface into enclosed spaces	Risk: Low (unlikely – medium)	Elevated concentrations of ground gas generated from thick Made Ground with high levels of putrescible material is not anticipated with the exception for the landfill site and infilled Russia Mere (detailed above).
Agricultural land	Metals, PAHs, TPHs	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	Agricultural activities undertaken throughout recorded history. Possible range of contaminants within soils, however, in recent years land has been primarily used for pasture, and significant concentrations of pesticides/herbicides are unlikely to currently persist.
Geological Units	Radon	Migration through the sub-surface	Risk: High (high – medium)	The majority of the site is in a Higher Probability Area and full radon protection measures are recommended.
Alluvium	Permanent ground gases (CH4 and CO2)	Migration through the sub-surface	Risk: Low (unlikely – medium)	Elevated concentrations of ground gases generated over time and trapped within the underlying soils not anticipated. Thickness of alluvium soils anticipated to the <5.0m, and are not laterally extensive.
Former Railway Land	Metals, PAHs, TPHs, SVOC/VOCs, asbestos	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	Railway Land including engine shed, coal hangar and sidings. Whilst a wide range of contaminants is likely, any significant contamination is highly unlikely to migrate upgradient to site.
Commercial trades (garage services and agricultural merchants)	Metals, PAHs, TPHs	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	Given scale of trades, migration of significant chemical contamination considered highly unlikely.
Potentially infilled land	Permanent ground gases (CH4 and CO2)	Migration through the sub-surface into enclosed spaces	Risk: Moderate/Low (unlikely – severe)	Infilled land recorded 209m southeast and 227m northwest of site. Given the distance from site, it is considered unlikely that permanent ground gases from the infilled land will migrate onto the site.

RECEPTOR: PROPOSED END USERS				
Allotment Gardens	Metals, PAHs	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	Possible range of contaminants within soils, however, pesticides/herbicides are unlikely to be persistent and migrate to site, and other contaminants likely to be present within the allotments and unlikely to migrate upgradient.

Table 3-F: iCSM – Proposed End Users

RECEPTOR: CONSTRUCTION WORKERS				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
Made Ground	Asbestos fibres and ACMs	Inhalation of dusts	Risk: Moderate (likely – medium)	If present on site, likely limited to the area of former landfill within the northwest of the site, and infilled mere to southeast. Asbestos in soils can present an acute risk to construction workers, particularly during the enabling works phases. Very low and trace concentrations often pose a low risk if appropriate controls are put in place.
All other contamination sources, excluding asbestos	Metals, PAHs, TPHs	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (low – mild)	No gross contamination of high-risk contaminants anticipated (e.g. cyanide, benzene, and vinyl chloride). Standard PPE and hygiene protocols for working on brownfield sites are likely to be sufficient to the mitigate risk.
Unexploded Ordnance	UXO	Direct contact / explosion	Risk: Moderate/Low (unlikely – severe)	Hazard screening assessment indicates a low risk of encountering UXO during ground investigation works; however, the review does not specifically cover the construction phase and development of the site. A project specific risk assessment should be undertaken, to be completed by a specialist.

Table 3-G: iCSM – Acute Exposure to Construction Workers

RECEPTOR: ADJACENT SITE USERS FOLLOWING COMPLETION				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
All identified potential contaminant sources	Metals, PAHs, TPH, (S)VOCs, Asbestos	Ingestion, inhalation and contact with soils, dusts and vapours	Risk: Low (unlikely – medium)	Based on the exposure pathways that would be present from the developed site, and on the anticipated levels of contamination, it is considered unlikely that a pollutant linkage could pose an unacceptable risk to off-site receptors.

Table 3-H: iCSM – Chronic Exposure to Adjacent Site Users

RECEPTOR: ADJACENT SITE USERS DURING THE CONSTRUCTION PHASE				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
Asbestos fibres and ACMs within the Made Ground	Asbestos	Inhalation of dusts	Risk: Moderate/Low (low – medium)	Potential risk associated with generation of air-borne asbestos fibres and dust during construction main earthworks phase. Whilst there is a low likelihood of harm occurring due to the effect of fresh-air dilution, the risk cannot be discounted at this stage.
All other potential contaminant sources	Metals, PAHs, TPH	Ingestion, inhalation and contact with soils, dusts, and vapours	Risk: Low (unlikely – medium)	Unlikely to pose a viable risk to off-site receptors.

Table 3-I: iCSM – Acute Exposure to Adjacent Site Users

RECEPTOR: PROPOSED PLANTING				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
Contaminants within topsoil and the shallow sub-surface	Metals, pH and inorganics	Direct contact and root uptake	Risk: Very low (low – minor)	Elevated levels of phytotoxic contaminants may be present in Topsoil, however, site used as pasture for many years and based on site reconnaissance, trees and mature vegetation do not show any significant barren areas, signs of poor growth, or evidence of significant vegetative stress.

Table 3-J: iCSM – Phytotoxic Risk to Proposed Planting Scheme

RECEPTOR: CONTROLLED WATERS				
Potential Source	Contaminants of Concern	Pathway	Tier 1 Risk Assessment (probability of harm x consequence)	Discussion
All potential contaminant sources outlined above	Various	Leaching and lateral migration (Surface water)	Risk: Moderate (likely – medium)	Potential leachable contaminants within the Made Ground associated with former Hogshaw Refuse Tip and infilled Russia Mere. There is a potential for contaminants to be mobilised through the infiltration of rainwater, followed by the lateral migration along preferential pathways.
		Leaching and vertical migration (Groundwater)	Risk: Moderate/Low (low – medium)	Contaminants within shallow aquifer expected to quickly discharge into Nun Brook as they migrate downslope. Possibility of some impact to the shallow principal aquifer where Made Ground is present upslope to the southeast.

Table 3-K: iCSM – Controlled Waters Risk

- 3.7.3 The risk to identified receptors from the proposed developments under the planning regime are assessed under a ‘minimal risk’ approach. Whereas, the risk to receptors under the current and continued use of the site is dealt with under the regulatory framework of the Part IIA regime, where Soiltechnics consider if there is a reasonable chance of a ‘significant potential of significant harm’ (SPOSH) occurring. This is not equivalent to a due diligence assessment for the continued use of the site to aid in determining potential contaminated land liabilities or land valuations.

3.7.4 The following table sets out the risk to current users considering a SPOSH approach:

Receptor	Potential Source	Contaminants of Concern	Pathway	Preliminary Assessment: Is their reasonable evidence of SPOSH?	Discussion
Human Health (Current and adjacent site users)	All potential contaminant sources identified above	Various Contaminants	Inhalation, ingestion and contact with soils, dusts and vapours.	Yes	Whilst potential contamination sources have been identified, Soiltechnics have not encountered any evidence which indicates there could be a significant possibility of significant harm to human health occurring from contamination on site.
Controlled Waters (Surface water and groundwater)	All potential contaminant sources identified above	Various Contaminants	Mobilisation and migration	No	Whilst potential contamination sources have been identified, Soiltechnics have not encountered any evidence which indicates there could be a significant possibility of significant harm to controlled waters occurring from contamination on site.
Ecosystems	All potential contaminant sources identified above	Various Contaminants	Direct contact and root uptake	No	The site does not fall within a relevant designation for environmentally sensitive land (e.g. SSSI, NRA, Ramsar).
Property	All potential contaminant sources identified above	Various Contaminants	Various pathways	No	Through undertaking the desk study, no evidence of potentially significant harm occurring to property has been identified.

Table 3-L: *iCSM – Current Site Risks (Part IIA)*

3.8 Preliminary Risk Assessment Conclusions and Recommendations

- 3.8.1 In summary, the PRA has not highlighted any potential contaminant linkages (PCL) which could pose a significant possibility of significant harm under the current land use. In terms of the proposed development scheme, a minimal risk approach applies, and PCLs have been identified which require further consideration.
- 3.8.2 In particular the area of the former Hogshaw Refuse Tip and infilled Russia Mere could give rise to a wide range of contaminants. Further intrusive investigation works are recommended to further refine the assessment and to determine if any remedial measures are necessary.
- 3.8.3 The site is at a moderate risk from ground gases migration associated with the former Hogshaw Refuse Tip and infilled Russia Mere. Furthermore, there is considered to be a high risk radon across the site and full protection measures will be required in proposed developments.
- 3.8.4 Overall, each PCL identified as posing a risk of 'Moderate/Low' or higher should be considered as part of an intrusive Tier 2 generic quantitative risk assessment (GQRA). The following table summarises the principal receptors at risk which require further investigation to support the proposed development.

Receptor Category	Principal Receptor	PCL Present Requiring Further Investigation?
Human health	Current site users	No
	Proposed site users (soils, dusts, and vapour)	Yes
	Proposed site users (permanent ground gas)	Yes
	Proposed site users (radon)	Yes – Full radon protection measures required.
	Adjacent site users and off-site members of the public (during the long-term use of the site)	No
	Adjacent site users and off-site members of the public (during the construction phase)	Yes - Asbestos risk only
	Construction operatives	Yes - Asbestos risk only
Controlled waters	Surface waters	Yes
	Groundwater	Yes
Property	Soft landscaping (current)	No
	Soft landscaping (proposed)	No
	Potable infrastructure	Yes
	Building materials	To be considered by the specifier

Table 3-M: Receptors at Risk Under The Proposed Scheme

4 Ground Investigation

4.1 Objectives

- 4.1.1 The ground investigation scope and location of exploratory holes was determined by Soiltechnics Ltd, based upon our overall brief outlined in Section 1.
- 4.1.2 The objectives of the fieldwork were to:
- i) Establish ground and groundwater conditions at the site.
 - ii) Obtain samples for subsequent laboratory testing.
 - iii) Install gas and groundwater monitoring wells and undertake a programme of monitoring visits.

4.2 Fieldwork summary

- 4.2.1 Fieldwork was initially undertaken on site as part of the 2019 ground investigation across the wider area (R-STQ4642M-G01-Rev03), between 21st January 2019 and 8th February 2019.
- 4.2.2 Fieldwork was supplemented with further investigations undertaken between 6th November 2023 and 16th November 2023, and the 26th February 2024.
- 4.2.3 A summary of the works completed is set out in the table below, along with the location of the exploratory logs. Photographic records of the trial pits are presented in Appendix D, and the exploratory hole location plan is presented within Appendix A.

Exploratory Hole Logs	Method	Qty	Final Depth Range (m bgl)	Comments
2019 Investigation				
Appendix B	Machine-excavated trial pits	7	1.00 - 3.30	TP01-TP04, TP08, TP11, TP13, Trial pits terminated on bedrock.
		2	3.40 - 4.00	TP05-TP06 Trial pits terminated at scheduled depth.
		1	1.80	TP18 Trial pit terminated due to potential asbestos contamination encountered.
Appendix C	Dynamic windowless sampling boreholes	2	3.50 - 5.00	DTS01, DTS08 Borehole terminated due to obstruction.
		11	0.60 - 3.90	DTS02, DTS03, DTS06, DTS07, DTS09-DTS12, DTS15, DTS17, DTS28 Borehole terminated on anticipated bedrock.
		6	4.00 - 5.45	DTS04, DTS05, DTS13, DTS18, DTS27, DTS102 Borehole terminated at scheduled depth.
2023-2024 Investigation				
Appendix B	Machine-excavated trial pits	13	0.60 - 2.30	TP101, TP103-TP106, TP110-TP117 Trial pit terminated on bedrock.
		5	2.30 – 4.00	TP102, TP108A, TP109, TP118, TP119 Trial pit terminated at scheduled depth.
		1	2.20	TP107 Trial pit terminated due to instability

Exploratory Hole Logs	Method	Qty	Final Depth Range (m bgl)	Comments
Appendix C	Dynamic windowless sampling boreholes	2	1.20 – 1.40	TP108B, TP108C Trial pit excavated to confirm lateral extent of Made Ground
		15	0.40 – 4.01	WS07-WS19 Borehole terminated on suspected bedrock
		1	5.38	WS06 Boreholes terminated at scheduled depth.
		7	1.00 – 5.84	WS01A, WS01B, WS02-WS05 Boreholes terminated due to refusal on obstructions within landfill area.

Table 4-A: Summary of fieldwork undertaken

4.2.4 All soils encountered were described in accordance with BS EN ISO 14688 “Identification and Classification of soil”.

4.3 Sampling

4.3.1 During the fieldwork, sampling of soil, rock and groundwater for geotechnical purposes has been undertaken in accordance with BS EN ISO 22475-1 “Geotechnical Investigation and testing – sampling by drilling and excavation and groundwater measurements”.

4.3.2 Samples collected for chemical analysis have been taken and handled in accordance with BS ISO 18400-105:2017 “Soil quality — Sampling Part 105: Packaging, transport, storage and preservation of samples”.

4.3.3 Various sampling and sub-sampling methodologies have been adopted as appropriate, with the primary aim of obtaining the highest quality sample class practicable.

4.3.4 Untested chemical and geotechnical samples will be held for a period of 4 weeks from the date of the first report issue, after which they will be disposed of.

4.4 In-situ Testing

4.4.1 The following table summarises the field testing carried out during both the 2019 and 2023-2024 investigations. The results are summarised on individual exploratory hole logs where appropriate and detailed within the Appendices indicated.

Tests	Qty	Applicable standard / guidance	Location of Results
Standard penetration test (SPT)	128	BS EN ISO 22476-3	Included within logs Detailed in Appendix E
Pocket penetrometer	103	Manufacturer’s instructions	Included within logs Detailed in Appendix E
Dynamic probing	59	BS EN ISO 22476-2	Appendix F
Variable head permeability	2	BS EN ISO 22282-2	Appendix G

Table 4-B: Summary of field testing undertaken

4.5 Monitoring Installations

4.5.1 Instrumentation installed within exploratory holes during the fieldwork are shown on the logs within Appendix B and are summarised below:

Installation type	Target Stratum	Qty	Exploratory hole ID
Gas monitoring well (2019 investigation)	Made Ground	1	DTS04
	Weathered Eyam Limestone Formation	1	DTS06
	Weathered Bee Low Limestone Formation	1	DTS13
Gas monitoring well (2023-2024 investigation)	Weathered Eyam Limestone Formation	12	WS06-WS12, WS14-WS17, WS19

Table 4-C: Summary of monitoring installations

4.6 Monitoring visits and groundwater sampling

4.6.1 A summary of the gas and groundwater spot monitoring visits undertaken is outlined in the table below. Results of the post fieldwork monitoring are presented in Appendix I.

4.6.2 Overall, nine ground gas monitoring visits were undertaken over a period of 4 months, with an additional visit completed 5 months later.

Date	Purpose
18/02/2019	Gas spot monitoring and ground water level monitoring
04/03/2019	Gas spot monitoring and ground water level monitoring
20/03/2019	Gas spot monitoring and ground water level monitoring
01/04/2019	Gas spot monitoring and ground water level monitoring
18/04/2019	Gas spot monitoring and ground water level monitoring
29/04/2019	Gas spot monitoring and ground water level monitoring
21/11/2023	Gas spot monitoring and ground water level monitoring
05/12/2023	Gas spot monitoring and ground water level monitoring
04/01/2024	Gas spot monitoring and ground water level monitoring
16/01/2024	Gas spot monitoring and ground water level monitoring
30/01/2024	Gas spot monitoring and ground water level monitoring
15/02/2024	Gas spot monitoring and ground water level monitoring
26/02/2024	Gas spot monitoring and ground water level monitoring
13/03/2024	Gas spot monitoring and ground water level monitoring
22/08/2024	Gas spot monitoring and ground water level monitoring

Table 4-D: Summary of post fieldwork spot monitoring

4.7 Investigation Constraints

4.7.1 The table below outlines restrictions and constraints to the investigation methods which either limited the design of the original scope of work or resulted in a deviation from the agreed scope.

Detail	Impact
Fieldwork constraints	
Gas monitoring in locations WS08, WS10 and WS11 was restricted due to heavy snowfall on the visit of 16/01/2024.	Reduces data available for decision making.
Gas monitoring in locations WS07, WS08, WS11, WS14 could not be located due to height of vegetation on the visit of 22/08/2024.	Reduces data available for decision making.

Table 4-E Table of site restrictions

4.8 Ground Penetrating Radar (GPR) Survey

- 4.8.1 A ground penetrating radar (GPR) survey was conducted on site by Atlas Geophysical, with the principal aim of the investigation to identify the potential presence of voiding/dissolution features across the site.
- 4.8.2 Data acquisition was completed between Monday 23rd October 2023 and Thursday 26th October 2023.
- 4.8.3 Ground Penetrating Radar (GPR) methods rely on observing the reflections from short duration pulses of electromagnetic energy. These pulses (or scans) are transmitted into the structure, and reflections from material boundaries or embedded features (rebar, buried utilities or voids) are detected by a receiver. The time duration between each scan and reflected signal is recorded in conjunction with a distance between scans to provide a continuous cross-section of the structure, enabling rapid assessment of thickness and condition over large areas. By assessing the amplitude, phase, and scatter of received signals, it is possible to determine the material thickness and construction changes. Assessing cracking and changes in compaction, bond, and relative moisture content is often possible.
- 4.8.4 A SIR4000 GPR system manufactured by Geophysical Survey Systems Inc. (GSSI), coupled to an antenna operating at a centre frequency of 250 MHz, was used to capture data across the site.
- 4.8.5 For the investigation, a series of parallel profile positions were collected with an approximate 1.0m spacing.
- 4.8.6 The system does not require a linear grid to be marked out before the survey. Instead, data are acquired with spatial information directly from an GNSS receiver mounted on the equipment, with a positional accuracy of +/- 500mm.
- 4.8.7 All thickness/depth values quoted have been based on an assumed velocity of GPR signals through the ground materials. Quoted values should be expected to be accurate to +/- 10%.
- 4.8.8 A copy of the Atlas Geophysical 'Geophysical Investigation Report' is presented within Appendix N.

5 Laboratory testing

5.1 Overview

5.1.1 Samples obtained from exploratory holes were sent to independent accredited laboratories for geotechnical and chemical testing.

5.2 Geotechnical Testing

5.2.1 All geotechnical testing was conducted during the 2019 investigation as part of the previous ground investigation (R-STQ4642M-G01_Rev03).

5.2.2 Geotechnical laboratory test results are presented in Appendix H, and the total number of geotechnical tests undertaken is summarised below:

Qty	Test
11	Moisture content
5	Particle size distribution (coarse)
5	Particle size distribution (fines)
6	Atterberg limits
5	BRE Suite D

Table 5-A: Summary of geotechnical laboratory testing

5.3 Chemical Testing

5.3.1 The chemical testing schedule was prepared by Soiltechnics using a targeted and judgemental approach, based upon the initial conceptual site model and fieldwork observations. This is further elaborated on within subsequent report sections.

5.3.2 Chemical testing was undertaken during the 2019 and the 2023-2024 investigations.

5.3.3 Chemical laboratory test results are presented in Appendix J, and the total number of chemical tests undertaken is summarised below:

Sample Type	Qty	Testing	Suite Name
Soils	18	Selected Contamination Suite [metals, cyanides, PAHs, phenol]	ST Suite 1
	9	Comprehensive Contamination Suite [metals, cyanides, PAHs, TPH CWG, (S)VOCs & inorganics]	ST Suite 17
	5	Basic Classification Suite [metals, cyanides, PAHs, phenol, banded TPH & asbestos]	Basic Classification Suite
	17	Asbestos screening	-
	4	Asbestos quantification	-
Leachate	2	Comprehensive Contamination Suite [metals, cyanides, PAHs, TPH CWG, (S)VOCs & inorganics]	ST Suite 17
Water	5	Comprehensive Contamination Suite [metals, cyanides, PAHs, TPH CWG, (S)VOCs & inorganics]	ST Suite 17

Table 5-B: Summary of chemical laboratory testing

6 Ground Investigation Findings

6.1 Ground Model

- 6.1.1 Ground conditions encountered were relatively consistent across the site and were broadly in line with those anticipated from the desk study.
- 6.1.2 The tables below present our generalised interpretation of geological and hydrogeological conditions at the site. Unless otherwise stated in subsequent interpretive report sections, this represents the adopted ground model.
- 6.1.3 Further detail about the ground conditions encountered is provided in the relevant sub-sections below.

Stratum	Brief description	Top depth range (m bgl)	Adopted model top depth (m bgl)	Thickness (m)
Soft and hard surfacing	Topsoil (sandy gravelly clay or clayey sand).	G.L.	G.L.	0.15 – 0.50
Made Ground (locally)	Reworked clays and gravels of anthropogenic material	G.L.	G.L.	0.10 – >2.45
Made Ground (Hogshaw Refuse Tip)	Dark grey to brown, clay, sand and gravel with gravels of anthropogenic materials.	G.L.	G.L.	>3.5 to >5.84
Made Ground (Infilled land within access road associated with former Russia Mere)	Reworked clays and gravels of anthropogenic materials.	G.L.	G.L.	0.5 - >5.45
Weathered Bowland Shale Formation (within topographically lower western/south-western parts of site only)	Stiff brown and dark grey clay (thinly laminated locally) becoming a medium dense to very dense mudstone/shale gravel with depth.	0.3 – 1.9	0.3	2.5 - >3.73
Weathered Eyam Limestone Formation	Soft to stiff brown gravelly clay with gravels of limestone, becoming a very dense limestone gravel with depth.	0.15 – 0.50	0.50	0.4 - >5.13
Weathered Bee Low Limestone Formation (within topographically higher south-eastern parts of site)	Stiff orangish brown sandy clay.	0.3 – 1.75	1.75	0.7 - >4.15

Table 6-A: Ground Model

6.2 Topsoil

- 6.2.1 Topsoil was encountered in all exploratory holes with the exception for locations noted as having Made Ground present from surface (such as the the area of the refuse tip). The base of the unit was typically 0.25m bgl and varied between 0.15m and 0.5m thick locally.
- 6.2.2 Topsoil was predominately observed as a dark brown slightly sandy slightly gravelly clay or clayey sand with frequent rootlets and gravels of limestone and quartzite. Locally the Topsoil contained anthropogenic material where present above Made Ground.

6.2.3 A photograph of the Topsoil encountered is presented below.



Figure 6-A: Topsoil encountered within TP104

6.3 Made Ground

6.3.1 Made Ground outside of the former Hogshaw Refuse Tip and Access Road was observed locally across the site within TP108A, TP108C (north of site), and TP119 (central northern part of site). Such deposits typically comprised reworked natural soils (clays and cobbles) and some gravels of anthropogenic material including metal, glass, clinker and ceramic.

6.3.2 A photograph of the Made Ground encountered is presented below.



Figure 6-B: Made Ground encountered in TP108A

6.4 Made Ground (Former Hogshaw Refuse Tip)

6.4.1 Made Ground encountered within the area of the proposed drainage basin (former Hogshaw Refuse Tip) was observed to a depth >5.84m bgl.

6.4.2 The Made Ground observed as both a cohesive and granular material with gravels consisting of brick, plastic, concrete, glass, clinker, slag, with frequent fragments of metal, wood, plastic, wire, paper, timber tiles and fabric.

6.4.3 A photograph of the Made Ground present in the refuse tip area is presented below.



Figure 6-C: Typical Made Ground observed within the area of the proposed drainage basin

6.5 Made Ground (Area of Former Russia Mere)

- 6.5.1 Made Ground within the area of the proposed access road (former Russia Mere) was observed to a depth of 0.5m to >5.45m bgl.
- 6.5.2 The Made Ground was observed as both a cohesive reworked natural soils and granular material, with the latter containing gravels and cobbles of brick, slate, asphalt and ceramic with fragments of metal and glass.
- 6.5.3 In areas adjacent to the access road redline boundary currently under consideration (former DTS102 and DTS18), deep deposits of suspected reworked Bee Low Limestone were encountered. These were not however present within the area of access road.
- 6.5.4 A photograph of the granular Made Ground encountered in the area of the proposed access road is presented below.



Figure 6-D: Made Ground observed within the area of the proposed access road

6.6 Weathered Bowland Shale Formation

- 6.6.1 The Weathered Bowland Shale Formation was encountered within the west and southwest of the site. The depth of the underlying unweathered bedrock was recorded between depths of 2.2m and >5.38m bgl.
- 6.6.2 The weathered deposits of the Bowland Shale Formation were typically observed as a stiff brown slightly silty clay and sandy clayey gravel, with gravel comprising mudstone and shale.
- 6.6.3 A photograph of the Weathered Bowland Shale Formation encountered is presented below.



Figure 6-E: Weathered Bowland Shale Formation deposits encountered in DTS10

6.7 Weathered Eyam Limestone Formation

- 6.7.1 The Weathered Eyam Limestone Formation was encountered in most exploratory holes with the exception of those in the northwest (basin area) and southeast of the site (access road). The thickness of the underlying unweathered bedrock was recorded between 0.4m and 5.38m bgl.
- 6.7.2 The weathered deposits of the Eyam Limestone Formation were typically observed as a soft to firm brown clay at shallow depths with gravels and cobbles of limestone and sandstone at depth.
- 6.7.3 A photograph of the Weathered Eyam Limestone Formation encountered is presented below.



Figure 6-F: Weathered Eyam Limestone Formation deposits

6.8 Weathered Bee Low Limestone Formation

- 6.8.1 The Bee Low Limestone Formation was encountered only locally within the southeast of site (within DTS13, TP08, TP13, TP101, TP102 and TP118). The depth of the underlying unweathered bedrock was recorded between 1.0m and >5.45m bgl.
- 6.8.2 The weathered deposits of the Bee Low Limestone Formation were typically observed as stiff orangish brown sandy clay or medium dense orangish brown clayey very silty very gravelly sand, with gravels of limestone and mudstone. Locally the Weathered Bee Low Limestone Formation was observed as a limestone gravel at depth.
- 6.8.3 A photograph of the Weathered Bee Low Formation encountered is presented below.



Figure 6-G: Weathered Bee Low Formation deposits

6.9 Groundwater

6.9.1 A summary of the groundwater level data obtained during the fieldworks phase is presented below.

Exploratory hole ID	Groundwater observation
DTS02	Groundwater encountered at 1.9m depth, filling borehole to 1.3m in 10 minutes.
DTS03	Groundwater encountered at 2.3m depth, filling borehole to 2.0m in 10 minutes.
DTS04	Groundwater encountered at 3.0m depth. Water level remained constant.
DTS05	Groundwater encountered at 3.0m depth. Water level remained constant.
DTS10	Groundwater encountered at 1.0m depth. Water level remained constant.
TP107	Slight groundwater seepage at 1.7m depth.
TP109	Slight groundwater seepage at 1.3m depth.
WS06	Slow groundwater seepage at 1.0m depth.
WS16	Slow groundwater seepage at 3.0m depth.
WS17	Slow groundwater seepage at 1.9m depth.

Table 6-B: Summary of groundwater observations during the fieldworks

6.9.2 Groundwater level data obtained during the monitoring phase is presented in Appendix I. Where encountered, groundwater varied between 2.62m and 3.98m bgl during the 2019 investigation and 1.90m and 2.90m bgl during the 2023-2024 investigation. Within WS06, groundwater levels varied between 0.39m to 1.40m bgl, and between 0.07m and 1.22m bgl in WS17.

6.9.3 Groundwater levels are expected to vary seasonally and in response to recent weather conditions. Long term monitoring will provide a reasonable quantification of such variation.

6.10 Evidence of Possible Contamination

- 6.10.1 During the ground investigation works no evidence of gross contamination was noted with the exception for anthropogenic materials contained within the Made Ground (i.e. brick, plastic, concrete, glass, clinker, slag, with frequent fragments of metal, wood, plastic, wire, paper, timber tiles and fabric) local to the area of the former Hogshaw Refuse Tip and the infilled former Russia Mere.
- 6.10.2 Between depths of 2.4m to 2.8m bgl in TP109 located in the northern part of the site, evidence of suspected hydrocarbon contamination was noted in natural weathered Bowland Shale Formation deposits.
- 6.10.3 In addition, hydrocarbon contamination was identified in the WS02 in the area of the former Hogshaw refuse tip, between depths of 1.5m to 1.7m bgl.
- 6.10.4 Within TP18, the trial pit was terminated due to the potential presence of asbestos contamination encountered at depth.

6.11 Obstructions and Instabilities

- 6.11.1 The table below summarises the obstructions and instability encountered that affected the progress of the investigation works.
- 6.11.2 The general stability of exploratory holes during excavation are also recorded on their relevant exploratory logs.

Strata / Area	Depth range (m bgl)	Issue	Description
Made Ground	1.0 – 5.0	Obstruction	Boreholes terminated due to obstruction.
Made Ground (granular soils)	0.0 – 1.9	Instability	Collapse of trial pit sides locally widening pit.
Weathered Bowland Shale Formation	2.8 – 3.0	Obstruction	Locally termination on bedrock.
	0.0 – 1.9	Instability	Collapse of trial pit sides locally within granular deposits widening pit.
Weathered Eyam Limestone Formation	0.4 – 4.01	Obstruction	Locally termination on bedrock.
	0.2 – 0.7	Instability	Collapse of trial pit sides locally within granular deposits widening pit.
Weathered Bee Low Limestone Formation	1.0 – 3.30	Obstruction	Locally termination on bedrock.

Table 6-C: Summary of obstructions and instability encountered during the investigation works

7 Dissolution Features

7.1 Overview

7.1.1 Eyam Limestone and Bee Low Limestone are typically rich in Calcium Carbonate. CIRIA reports PR11 and C574 (relating to chalk sites) states 'The presence of dissolution features should be expected on all calcium carbonate rich sites'. Dissolution features in general comprise the following:

- Sinkhole, formed by dissolution of near surface limestone reducing their volume and creating a surface depression.
- Dissolution pipe, a cone or pipe like cavity typically in filled with limestone which has subsided into the cavity, with the infill limestone much weaker than the surrounding.
- Swallow holes, a surface feature where a void in the limestone continuously or intermittently 'swallows' wholly or partially a surface stream.

7.1.2 Dissolution features pose a hazard to foundations because of the presence of one or more of the following features, which are generally located above the groundwater table:

- Large variations in intact chalk horizon
- Loose chalk or superficial deposits infilling pipes
- Cavities or caves within the chalk
- Dissolution widened discontinuities in the chalk affecting its load carrying capacity

7.1.3 The moderate risk of ground dissolution outlined in Section 2.11 is associated with limestones in the upper horizons of the Eyam Limestone Formation, where they underlie the more impermeable Bowland Shale Formation. The areas at risk of dissolution are located in topographically lower parts of the site adjacent to the brook and landfill area in the northwest, and offsite adjacent to the southwest (refer to Appendix A for details). Such areas typically lie adjacent to the channel of Nun Brook and limestones here are likely to be more susceptible to dissolution as groundwater and surface accumulates downslope in the lower portions of the site, which is also down dip of the limestone formations in the area (bedding planes dip to the west at ~22°).

7.2 Preliminary Risk Assessment and Mitigation

7.2.1 The risk that these hazards present to a building relates to its vulnerability, which in turn relates to the foundation type. A building on shallow spread type foundations and ground bearing floors is more vulnerable than piled foundations extending through the base of these features supporting a suspended ground floor slab. A qualitative risk assessment has been undertaken and summarised below:

Item	Observation / enquiry	Assessed risk
Surface features	Localised evidence of surface depressions on site in areas of TP108A-TP108C and TP109 in the northern part of the site. Envirocheck record a natural sink hole and solution pipe 637m to the SE. No adverse movement in ground surface noted across the site.	Low-moderate
Variation in density of near surface soils	It was noted during site investigations that localised areas of near surface weathered Eyam Limestone Formation exhibited low shear strengths and SPT N Values, mainly in the northern/north-eastern part of the site. Furthermore, there are variations in the thickness of more weathered deposits overlying bedrock within this part of the site and to the central/southern area.	Moderate

Variation in intact limestone horizon	No significant penetration was gained into limestone deposits to assess this, however, noted that thickness of overlying weathered material does vary.	Low-moderate
Adverse movement in nearby buildings	No adverse movement in neighbouring properties close to the site (viewed from public roads / footways only).	Low
Envirocheck data base	Assessed risk considered moderate.	Moderate
Enquiries to local authority building control and NHBC	High Peak Borough Council were contacted as part of the 2019 investigation but failed to respond. The client contacted the NHBC for advice during the 2019 investigation. They have indicated that in such areas they would typically require plots to be founded on raft foundations. Further probe holes would typically be required to confirm that presence, or otherwise, of dissolution features and depth to bedrock, following which reinforced trench fill foundations could be adopted rather than rafts.	Moderate

Table 7-A: Preliminary risk assessment of dissolution features

7.2.2 Based on the above, the risk of the site being subject to the effects of dissolution features is considered moderate to high.

7.2.3 On the above a non-intrusive geophysical survey has been undertaken by a specialist across the site to determine if there are any anomalies near surface which could indicate the presence of such features.

7.3 Geophysical Survey

7.3.1 The Geotechnical Survey was completed by Altas Geophysical. A copy of their report is presented within Appendix N.

7.3.2 To summarise, the survey has identified possible below ground voided features which require further investigation. These are largely situated within the centre and north of the site, but also locally within the south and southeast at depth.

7.3.3 None of areas identified would however be considered significantly voided, rather there is an increased possibility that those areas identified have increased levels of clay, air or moisture content (which often are associated with loose material or areas that are voided).

7.3.4 A series of responses that relate to possible buried features, such as previous agricultural activity, possible anthropogenic activity and a buried utility have been identified, suggesting that data quality was good.

7.3.5 A summary of GPR anomalies (or responses) of interest are presented in Table 7-B, including extracts of the interpretation presented in Figure 7-A and Figure 7-B below.

Response(s)	Depth (m bgl)	Description
1a	0.4-0.6	Not all related, possibly associated with small areas of voiding.
1d		Discrete high amplitude responses, as well as more continuous high amplitude boundaries, can be identified across this area, and it is possible that some of these responses are related to potential voiding.
2a	0.8-1.0	Relate to responses associated with those labelled 1a.
2d		Relates to response associated with 1d.
3a	1.4-1.6	Relate to responses associated with those labelled 1a/2a.
3d		Relates to response associated with 1d/2d. Much less extensive at this depth.

Response(s)	Depth (m bgl)	Description
3e		This may be related to a change in the ground material rather than possible voiding but due to an absence of data at shallower depths it has been labelled as possible voiding.
4a		Relate to responses associated with those labelled 1a/2a/3a.
4b	2.0-2.2	Responses from this depth range provide a more significant contrast and it is possible that the variations presented are related to natural variations in material. For this reason, wide areas of response have been identified, and it is possible that the natural variations in material properties at this depth are responsible for the contrasts that are being observed, rather than voiding. It is at these depths where weathered materials typically transition into bedrock and/or different geology.
4c		Relates to response associated with 1d/2d/3d. However, are more rectilinear at this depth and could be anthropogenic in origin.

Table 7-B: Summary of anomalies of interest identified during the GPR survey



Figure 7-A: GPR responses 1a-1d (0.4-0.6m bgl) and 2a-2f (0.8-1.0m bgl)



Figure 7-B: GPR responses 3a-3d (1.4-1.6m bgl) and 4a-4c (2.0-2.2m bgl)

7.4 Intrusive Investigations

- 7.4.1 Intrusive investigations comprised a combination of dynamic probing and trial pitting to confirm the presence/absence of possible voiding/dissolution type features. Dynamic probe locations were spread across the site in areas of likely dwellings to gain sufficient spatial coverage. Trial pits were utilised to target specific anomalies of interest identified in the GPR or dynamic probe data.
- 7.4.2 The dynamic probing investigation consisted of 59 No. probes in total (refer to Appendix A for locations). Raw data is presented in Appendix F. Generally, the initial 1m of soils below surface exhibited low blow counts, associated with Topsoil/subsoils, localised Made Ground and the more weathered upper horizons of the Eyam Limestone. Those that exhibited relatively low blow counts below depths of 1m bgl are discussed further below.

Location	Description	Exploratory location in vicinity	Anomaly in GPR Data	Comments
DP2	Evidence of soft/loose ground to 2.5m bgl	TP107, TP108A-C, TP109, DTS02, TP02, WS09	1a, 3a, 4a	Made Ground encountered to a depth of 0.75-1.8 around TP108A-C, competent natural below and surrounding. GPR response likely to relate to areas of Made Ground. Depth to bedrock consistent in area. WS09 had some localised softer soils at 2m bgl. Possible localised solution feature.
DP3	Evidence of soft/loose ground to 2m bgl			
DP4	Evidence of soft/loose ground to 2.5m bgl			
DP20	Evidence of soft/loose ground to 1.5m bgl	TP105, WS11	1a, 2a	Limestone gravels of the Weathered Eyam Limestone Formation present, with some clays. Some softer/loose SPT N value and shear strengths noted in clays. Depth to bedrock consistent in area.

Location	Description	Exploratory location in vicinity	Anomaly in GPR Data	Comments
DP25	Evidence of soft/loose ground to 1.4m bgl	WS08, DTS03	1a, 2f	Low SPT recorded in natural soft clay/silt to a depth of 1.5m in WS08. Depth to bedrock consistent in area.
DP33	Evidence of soft/loose ground to 2.9m bgl	TP111, WS12, DTS07,	3a, 3d, 4c	Depth to bedrock consistent in TP111 and WS12. SPT N values and shear strengths noted to be good/consistent in weathered materials. Response likely to relate transition into the Bowland Shale Formation deposits. DP penetrates to depths of 3m+ in an area where bedrock is around 2m. Possible localised solution feature.
DP35	Evidence of soft/loose ground to 1.8m bgl			
DP40	Evidence of soft/loose ground to 1.6m bgl	TP119, WS10	3a, 4a	Made Ground present to 1.4m in TP119, with old wall/road/channel represented by lense of cobbles/gravel in side of pit. Natural weathered soils competent albeit deepened in area of TP119.
DP45	Evidence of soft/loose ground to 1.4m bgl, then 2.6m-3.3m bgl.	TP114, TP04	1d, 2d, 3d, 4c	No soft/voided material noted. Bedrock present at 0.7-1.0m bgl. DP penetrates to depths of 4m+ in an area where bedrock is shallow. Possible localised solution feature.
DP56	Evidence of soft/loose ground to 1.0-1.7m bgl	TP112, WS17	3e, 4a	No soft/voided material noted. Weathered Bowland Shale pinches into the slope of the site from the west (WS17). Could be related to transition into the Bowland Shale Formation deposits.

Table 7-C: Summary of significant anomalies identified during dynamic probing investigations

7.4.3 In addition to the above, a slight surface depression was noted within the area of TP108A-C and TP109. Following intrusive investigation, Made Ground and reworked natural deposits of the Eyam Limestone Formation were noted to depths of 1.7m bgl. TP108B (furthest west of the set of TP108 pits) recorded natural soils and therefore Made Ground materials in TP108A/B are unlikely to relate to the former Hogshaw Refuse Tip. This could relate to localised infilling of surface depressions over the years as a result of localised dissolution.

7.4.4 Intrusive investigation undertaken at TP109 did not identify any evidence of voiding/loose/soft ground attributed to the presence of possible dissolution features.

7.5 Conclusion

7.5.1 There is evidence of possible features present locally on site which could be attributed to dissolution of the surface of the Eyam Limestone and subsequent infilling. Voiding is not present, but rather more poorly consolidated natural weathered soils or infilled features (TP108A/C). With the exception of the initial 1m of soils below surface level across the site, this is most notable within the western half of the site, particularly around the areas of DP33, DP35, DP40, and DP45, where there is a significant deepening of weathered bedrock deposits of varying composition, with evidence of very localised poorly consolidated materials. This is particularly evident within the heat mapping of dynamic probe results presented in Appendix F, and also highlights possible issues around the of DP3-DP5 in the north but this is largely attributed to the presence of Made Ground.

7.5.2 The GPR responses identified below depths of 1m are also typically consistent with the moderate risk area of ground dissolution as mapped by Envirocheck (refer to Drawings D01-D03 in Appendix A).

- 7.5.3 It is also noted that many of the geophysical anomalies encountered to date are consistent with the variable nature of the weathered bedrock deposits across the site, and transition between the Eyam Limestone and the overlying Bowland Shale Formation. Based on Drawing D02 (refer to Appendix A), the depth to bedrock (taken as DP refusal) is variable, however, ground levels are highly variable across the site. When depth to bedrock is corrected to ordnance datum, (refer to Drawing D03 presented in Appendix A), it is noted that top of bedrock level across the site is relatively consistent, and also consistent with topographical changes, providing some degree of comfort that dissolution of the limestone bedrock is limited/localised.
- 7.5.4 Based on the above, we consider there to be a low-moderate risk of dissolution affecting the site in areas where more significant deposits of weathered bedrock area present. The development should be designed on the premise that dissolution features could be present locally in such areas, which is discussed further within Section 8.

8 Geotechnical Discussion

8.1 Scheme Overview

- 8.1.1 The following assessments are made on the investigatory data presented in the preceding sections of this report and are made with reference to the specific nature of the development. Should scheme proposals change then it is recommended that the validity of the conclusions of this report in relation to the revised scheme are checked.
- 8.1.2 It is understood that the scheme will comprise a large residential development, with associated gardens, infrastructure, drainage basin and access roads constructed to standards allowing adoption by the local highway authority. Given the sloping nature, the site will effectively be terraced to facilitate development, with a requirement for retaining structures.
- 8.1.3 Proposed layouts are yet to be determined, however, the extent of the redline boundary for the site is presented in Appendix A.
- 8.1.4 Once development layouts are confirmed, a plot specific analysis is recommended to confirm foundation requirements and the need for any supplementary investigation. In addition, this will need to consider cut and fill requirements.
- 8.1.5 In view of the scheme proposals, the geotechnical elements considered in this report are outlined below:
- Building foundations
 - Floor slab
 - Slope stability and retaining walls
 - Drainage
 - Pavement

8.2 Geotechnical Category

- 8.2.1 In accordance with BS EN1997-1:2004 + A1:2013 (Eurocode 7), the project is designated as Geotechnical Category 2. This category includes projects with *conventional types of structures and foundations with no exceptional risk, or difficult ground or loading conditions*. Furthermore, *routine design procedures* are appropriate.
- 8.2.2 It should be noted that this Report does not constitute a Geotechnical Design Report (GDR) as defined in Eurocode 7. Accordingly, a GDR should be prepared by the designer during the detailed design phase

8.3 Key Geotechnical Issues

- 8.3.1 In view of the ground conditions, the following list summarises the key geotechnical issues that may impact the scheme and will therefore need to be appropriately managed during the lifecycle of the project:
- Made Ground
 - Low strength natural soils
 - Bedrock