Crest Nicholson

Land North East of Harpenden Between Lower Luton Road, Bower Heath Lane and Common Lane

Preliminary Geotechnical Report

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Geotechnical Report
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Appendices

1 INTRODUCTION

1.1 RPS Appointment

RPS Consulting has been appointed by Crest Nicholson to review an existing Phase 1 Desk Study and undertake an initial phase of ground investigation works at a site located on Land North East of Harpenden between Lower Luton Road, Bower Heath Lane and Common Lane.

Geophysics surveys have been carried out as part of the investigations – these were undertaken by Terradat, a recognised leading geophysics specialist, on behalf of RPS.

1.2 Scope and Objectives

The objectives of the investigation works by RPS Group were to:

- Confirm the general geology of the site and ground conditions.
- Assess the potential presence of cavities in the chalk bedrock either as a result of natural dissolution processes or from extraction by quarrying/mining.
- Make an initial assessment of likely foundations.
- Make an initial assessment of design parameters for infrastructure including roads, earthworks and soakaway drainage.
- Determine suitable further investigation works.
- Assess contamination presence and the need for remediation or mitigations measures. Land contamination is reported in a separate report.

The present report has been produced to support an outline planning application. The approach of the investigation is intended to be in accordance with National Planning Policy Framework (Specifically paragraphs 196-201: Ground Conditions and Pollution)

It should be noted that further investigations will be required in order to undertake final designs and to support a reserved matters planning application. It is recommended that these further investigations should be designed and undertaken when there are fuller details available of the proposed development including final layout, stormwater strategy and proposed changes to ground levels.

1.3 Existing Reports

The following reports have been made available to RPS and have been used and relied upon by RPS in the preparation of the present Geotechnical Report.

- *Phase I Desk Study Report*, by Southern Testing, dated 29 October 2024.
- *Soakage Test Report*, by Southern Testing, dated 15 October 2024

2 THE SITE

2.1 Location and Description

The site is located on the northern edge of Harpenden to the north east of the Lower Luton Road (the B653).

The near centre of the site is at National Grid Reference 514500 216080.

The Site is located within the Metropolitan Green Belt.

The Local Planning Authority is St Alban's District Council.

The site covers 32.937 hectares. It comprises an irregularly shaped parcel of land consisting of several fields which at present are mainly used by an Equestrian Centre; a further part in the east is also used for keeping horses.

The buildings associated with the Equestrian Centre are located in the west and include stables, hay storage buildings, yards and training grounds.

Ground levels fall from around 130.5m AOD in the north to 89m AOD in the west and 112.5m AOD in the south east. The eastern half of the site has a shallow valley feature running north west to south east; levels fall relatively steeply across the western half towards the west.

Other features of the site include:

- A communications mast and compound near the site centre.
- A main farm track runs east to west through the middle of the site from the Equestrian Centre to the north east boundary.
- Trees and hedgerows are at the field boundaries.
- There are several shallow depressions at the site surface in the centre and the east – these are discernible on aerial LIDAR images and on the topographic survey.

There are no permanent surface water features on site. The present site layout is shown on the Trial Pit Layout in Appendix A.

2.2 Surrounding Land Uses

The site is surrounded mainly by farmland to the west, north and east with small areas of woodland. Low-rise residential housing exists to the south together with allotments, a primary school and small light industrial units.

The River Lea (or Lee) is present around 30m south of the western-most part of the site.

3 INVESTIGATION WORKS

3.1 Findings of Desk Study by Southern Testing

3.1.1 Site History

The site has a history of use for farmland. The buildings that form the Equestrian Centre date from the 1950s and later.

A small mineral extraction pit is recorded to the immediate south east to the north of Whitings Close but not apparently impinging on the site.

For full details of the site history and setting reference should be made to the *Phase I Desk Study Report*, by Southern Testing.

3.1.2 Geology

The majority of the site is indicated to be underlain by bedrock of the Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated).

The Chalk Rock Member outcrops in the lower western part of the site with the underlying Holywell Nodular Chalk Formation and New Pit Chalk Formation outcropping in the extreme west of the site.

Most of the eastern half of the site (above approximately 123m AOD) is shown to have a superficial cover of Clay With Flints over the chalk bedrock; the Clay With Flints is shown as absent in the valley to the east of the site centre.

3.1.3 Cavities Occurrence Assessment

A Cavity Occurrence Assessment was undertaken by Stantec as part of the Desk Study by Southern Testing. The main findings of this include:

- A record exists of natural solution pipes approximately 730m south of the site.
- Records exist for 2 man-made mining records at 180m and 890m from the site – to the east and south.
- No records exist of natural or man-made cavities on the site.

Stantec assessed the geology, geomorphology and hydrogeology of the site and concluded that in respect of the potential for solution features – a rating of **Moderately High to High** in the central and eastern portion of the site where the feathering margin with the superficial Clay With Flints is present to **Moderately Low to Moderate** in the western portion of the site.

In respect of historical chalk mining the potential was assessed as **Moderately High to High** for the central and eastern portion of the site where the Clay With Flints deposit is recorded and **Low** for the western section of the site where the water table lies above or near the chalk interface.

It was recommended that further investigations be undertaken at the site to assess risks from cavities including by geophysics and intrusive works.

3.2 Summary of Soakage Tests

Soakage tests were undertaken at 14 locations by Southern Testing in accordance with BRE 365 *Soakaway Design*. The tests were more successful in the west of the site with several locations in the east failing to give meaningful infiltration rates.

Southern Testing concluded that:

The rates recorded generally fell into two groups: good or very poor, and were broadly dictated by the geology. Where clay soils were encountered rates were very poor, leading to the tests being abandoned. Where chalk was observed particularly structured chalk, rates were good to very good. Typically, a minimum soakage rate of 0.1 litres/m^2/min is required for conventional soakaways to meet the BRE365 requirement of a soakaway half empty time less than 24 hours. On this basis the use of conventional soakaways might appear viable on parts of this site.

For full details of the infiltration tests reference should be made to the *Soakage Test Report*, by Southern Testing.

3.3 Investigations by RPS

In February and March 2025 a preliminary intrusive investigation was undertaken by RPS by machine-excavated trial pits. The trial pits were located to give general coverage across the site in the areas of proposed development; several surface features were specifically targeted including shallow depression features visible at the surface and a shallow valley feature running north west to south east through the near middle of the site. Areas of proposed Public Open Space in the north were not targeted for investigation at this stage.

The trial pits were logged by an experienced geotechnical engineer. Representative soil samples were taken for laboratory testing – for geotechnical classification.

A total of 25 trial pits were formed on site generally to around 3m depth. All pits were immediately backfilled after logging precluding the long-term observation of stability or groundwater.

Further soakaway infiltration tests were undertaken at the approximate positions of proposed stormwater ponds in the west of the site – in general accordance with BRE365.

The Trial Pit Layout is presented in Appendix A. The trial pits logs are presented in Appendix B. Laboratory geotechnical test results are presented in Appendix D.

3.4 Geophysics Surveys

The geological site setting has been indicated by the Desk Study to potentially have natural or man-made cavities and it was determined that a phased investigation of the site would be the likely most cost-effective approach to identifying geotechnical risks and to derive suitable designs for foundations and infrastructure.

Geophysics can be effective at identifying possible cavity features and locations of anomalous ground conditions that may require targeted intrusive investigation.

RPS appointed Terradat to undertake an initial geophysics investigation of the site.

The first phase of investigation consisted of an electromagnetic ground conductivity of the development area of the site – this provides data on shallow soil types to several metres depth. This was followed by 7 electrical resistivity tomography (ERT) profile surveys (cross sections providing deeper soil data to around 20m depth). The ERT profiles were positioned to intercept surface depression features and anomalous features identified by the electromagnetic survey.

The findings of the RPS trial pits were used by Terradat in the initial interpretation of the geophysics findings.

The Terradat report on the findings of the geophysics surveys is presented in Appendix E.

4 GROUND CONDITIONS

4.1 Geology

The investigations to date have generally confirmed the anticipated geology beneath the site. The majority of the site has a covering of Clay With Flints – this varies in thickness according to topography and evidently weathering/erosion of the underlying chalk bedrock.

There are several shallow depressions at the site surface. Intrusive investigations and the geophysics surveys suggest these are associated with solution features in the underlying chalk. No voids have been found.

It should be understood that investigations to date have been constrained by lack of access in and around the working Equestrian Centre. Also ERT geophysics surveys were not possible in the field in the east not forming part of the Equestrian Centre.

4.2 Ground Conditions

The trial pits have indicated the following:

Across the undeveloped majority of the site there is a sandy gravelly clayey agricultural topsoil of generally 250-300mm thickness.

Over the central and eastern part of the site Clay With Flints is confirmed beneath the topsoil cover – this was typically a stiff reddish brown sandy gravelly clay; the gravel being of sub-angular flint. Laboratory testing shows this material to have variable plasticity between 11% and 48% depending on sand and gravel content.

The Clay With Flints extended below the depth of several trial pits – over 3m depth – particularly in the east of the site. It thins out to the west and was absent in several trial pits.

The chalk bedrock was encountered in 15 of the 25 trial pits – mainly in the west of the site. The chalk was generally found to consist of a highly weathered gravelly clay or clayey gravel. The chalk gravel was assessed as being of low density and strength. Soil strengths generally increased with depth into the chalk.

Where the chalk was encountered near to the ground surface it was considered suitably firm to generally support shallow foundations. The softest chalk was encountered in trial pits TP8 and TP24 where the surface of the chalk was 2.0-2.9m below the surface – at these locations it was particularly weak and of a putty-like consistency.

Four trial pits were located over shallow depression features (TP11, TP13, TP18 and TP21). In three of these shallow made ground was present at the surface consistent with historic attempts to infill these features and provide a level ground surface for farming. The pits into these features showed a reworked predominantly clay material was present derived from the Clay With Flints and generally logged as firm to stiff. Trial pit TP13 showed reworked chalk to be present with lower soil strength and greater groundwater presence than seen in other features.

4.3 Groundwater

At the time of investigation in February 2025 several of the shallow depression features had water present at the surface and in shallow soils.

Most of the trial pits did not encounter any groundwater and it is indicated in the Desk Study that the water table is likely to be generally at least 10m below the ground surface.

4.4 Summary of Geophysics Findings

The initial electromagnetic survey of the site showed the following:

- Clearly differing zones across the site from east to west of differing soil types and broadly corresponding to the presence of chalk at shallow depth or the Clay With Flints.
- Within each of the broad zones of similar soil types a number of anomalies were identified which could represent differing contrasting soils (for example locally higher sand and gravel content) or differing moisture content or ground disturbance due to solution features or workings.

The electrical resistivity tomography (ERT) profile surveys were located to intercept visible surface depression features (identified from topographic survey and LIDAR) and anomalous features from the electromagnetic survey. Briefly the ERT surveys showed a number of features at the surface and extending to beyond the depth of each survey showing locally differing ground conditions with some bearing the characteristics of possible solution features. Some features correspond to surface visible features but others do not.

The geophysics surveys have provided a number of locations where further intrusive investigations should be undertaken including by deep boreholes and or probing – it should be understood that geophysics alone does not identify soil types and that confirmatory intrusive investigations are needed to interpret and assess the findings. For full details of the findings of the geophysics surveys reference should be made to the report in Appendix E.

5 DEVELOPMENT PROPOSALS

Outline application for demolition of existing buildings and structures and construction of a mixed-use development comprising residential dwellings (including affordable housing), children's home, elderly extra care facility, local centre (flexible retail/ health/ community use), sports pitches and associated building, green infrastructure and landscaping works (to include public open space and community growing space); primary school with early years provision, vehicular and active travel infrastructure (including pedestrian and cycle access) and diversion of Bower Heath Lane; drainage works; and related infrastructure. All matters reserved save for access from Lower Luton Road.

Detailed proposals for development of the site were not available at the time of writing this report but from an Illustrative Concept Masterplan (see Appendix A) provided by the client it is understood that development will include the following:

- Clearance of the existing Equestrian Centre buildings.
- Regrading of ground levels to suit the proposed development.
- Development of the southern part of the site predominantly with low-rise residential housing including detached, semi-detached and terraced houses and blocks of flats with private gardens and new access roads.
- Homes of a mix of sizes to meet local needs. Exact mix is to be confirmed but likely to include one to five beds.
- Extra Care facility for elderly residents.
- A children's home.
- Primary School (inc a Nursery).
- A Local Centre that provides a flexible range of uses including retail, café, healthcare and community uses.
- Open space, including formal sports pitches and play areas.
- Existing tree belts and hedgerows will be retained, and additional trees, hedges, and grasslands will be planted.
- Sustainable on-site drainage to incorporate soakaways and storage ponds.
- Entry to the site will be from the Lower Luton Road at the western end of the site.

6 GEOTECHNICAL ASSESSMENT

6.1 Ground Stability

The investigations to date have broadly confirmed the anticipated geology for the site – Clay With Flints over bedrock chalk.

In general the Clay With Flints has been established as firm to stiff or even very stiff; it has a variable sand and gravel content but can be highly plastic and shrinkable. It will generally be suitable to support building foundations and roads and infrastructure but it will be prone to softening when wet and to heave and shrinkage with changing moisture content particularly when near to trees and hedgerows.

The entire site is underlain by chalk bedrock and there is evidence of solution features in the central and eastern parts of the site – there appears to be numerous locations where cavities in the chalk have resulted in infilling and settlement at the surface. No voids have been encountered to date but their presence cannot be discounted. From the trial pits undertaken over the shallow depressions the findings suggest these are essentially natural features except for shallow man-made infilling undertaken at the surface. There was no indication that the depressions represented past mineral extraction locations. The infilled solution features present a hazard for development as surface settlements may result from the higher compressibility of infill materials or from loose soils or voids at depth being destabilised during construction or post-construction resulting in large settlements of the ground surface.

Further investigation works are recommended to more fully assess the nature of possible solution features across the site.

6.2 Excavations

It should be possible to form excavations to at least 3-5m with conventional plant. Trial pits were generally stable for the short period of excavation and logging but the chalk in particular is likely to become rapidly unstable where of low strength or when groundwater is present.

All excavations should be planned and undertaken accordingly.

Excavations for entry or to be left open for any significant period of time will need to be suitably battered back or shored.

It is unlikely that strong groundwater seepages will be encountered. It is envisaged that it will be possible to control groundwater in excavations by periodic pumping from sumps.

The site is located over chalk bedrock with the potential for cavities resulting from natural solution (or less likely from quarrying/mining). The evidence to date suggests that such cavities if present at the site have been infilled by surface soils. It will be important that groundworkers and anyone forming excavations at the site are aware of the potential for cavities which may be present as voids or very loose ground. A watch should be kept during all excavations for any evidence of solution features or cavities as might be indicated for example by:

- Very soft or loose ground.
- Voids – typically disk shaped and may be present at almost any depth below the surface.
- Contrasting or change in soil types where the soil changes colour or type suddenly either vertically or laterally.

Where any such anomalous ground conditions are encountered or suspected RPS or the client should be contacted immediately to undertaken inspection and assessment.

6.3 Earthworks

It is anticipated that there will be a need to undertake a degree of regrading of ground levels on site primarily to provide a suitable profile for drainage and roads designs.

The Clay With Flints will be suitable for use as fill provided that the moisture content is suitably controlled. Additional compaction testing should be undertaken to determine suitable earthworks design parameters. Cutting and filling of the site should be carried out in accordance with a suitable specification and the completed earthworks should be subject to appropriate validation testing. Because of the inherent variability of the Clay With Flints it will likely be impractical to set specific moisture criteria and it will be more important to ensure desiccated or excessively wet soils are not included in fill. It is envisaged that suitably placed fill should be able to achieve a CBR of at least 2.5%.

The chalk on site will not generally be suitable for use as engineered fill (for the support of structures or main infrastructure) because of its low strength and variability. In general chalk derived from site is likely only to be suitable for use as general fill to gardens and landscaped areas.

6.4 Foundations

It is envisaged that a variety of foundation types will be required across the site. The comments below are mainly applicable to low-rise housing; they will be relevant to other forms of building but specific detailed assessment will be required for non-residential buildings.

Much of the site is considered likely suitable for the use of shallow traditional spread foundations – trench fill, strips and pads. A number of factors will need to be considered in the design of foundations and further investigations will be necessary to determine design parameters for all locations across the site.

The following are factors that must be considered in foundation designs and will need to be further assessed with additional site investigations.

Laboratory testing shows the Clay With Flints and shallow chalk soils have a plasticity index in the range 11-48%. Foundations will need to be designed ensuring an appropriate minimum depth below original ground surface to ensure foundations are placed in moisture stable ground. A minimum foundation depth of 900mm where the modified plasticity index is in the range 20-40% is recommended with a minimum depth of 1m required where the plasticity index if 40% or greater. In proximity to trees and hedgerows additional deepening will be required together with heave protection measures - it is recommended in accordance with NHBC Standards Chapter 4.2.

Where the depth of any required engineered filling exceeds 1-2m consideration should be given to special foundations and piling would generally be recommended.

Where the surface of the chalk is several metres below the ground surface locally low soil strengths were apparent. For spread foundations in the Clay With Flints it will be necessary to assess the depth to the chalk and that a suitable thickness of competent soils will result beneath foundations to limit settlements to acceptable limits. Where soft chalk is present at least 2m of firm to stiff Clay With Flints would be considered suitable to ensure settlements are acceptable.

Over the positions of the surface depressions our initial assessment is that special foundations will be required and that some form of grouting of such features should be considered, in order to stabilise the ground, in conjunction with piled or raft-type foundations.

In areas where a relatively high risk of solutions features is identified but where no such features are positively identified it would be recommended to design foundations to be capable to resisting a localised loss of support – of the order of 1-3m. Rafts or ground beams would be suitable. If a programme of probing of plots is also undertaken prior to foundation construction the design loss of support could be designed accordingly – a higher density of probing could reduce the dimension of the notional loss of support. This is likely to apply to the central and eastern part of the site.

A further method of designing foundation over zones identified of high risk of solution features is to re-engineer a depth of soils particularly if significant site regrading is proposed and to use a reinforced foundation capable to spanning a loss of support. The final design would take into account the depth of engineered fill – the greater the depth of controlled fill the lower the risk of loss of support.

Where the chalk bedrock is shallow (within 1 to 1.5m of the site surface) it appears to be of reasonable strength and suitable for deepened trench fill foundations. There is less risk of foundations that are placed in the chalk suffering a loss of support because of solution features but some nominal reinforcement is likely to be recommended.

The site would appear suited to the use of driven or bored piles where a special foundation is required. The depth of suitable piles is yet to be determined and will required suitable boreholes.

Ground improvement by dynamic compaction or vibro stone columns are not considered suitable techniques for the site because of the low strength chalk and cohesive nature of shallow soils.

6.5 Ground Floor Slabs

Several factors will need to be considered when determining suitable ground floor designs for the site:

- The potential for loss of support due to presence of solution features.
- The plasticity/shrinkability of the Clay With Flints and chalk and the potential for heave where surface soils are desiccated particularly in proximity to trees and hedgerows.
- Any requirement for regrading ground levels and the presence of fill or made ground.

For low-rise residential housing it is recommended that suspended precast ground floors should be allowed with a suitable ventilated void to accommodate possible heave.

For larger buildings (schools, healthcare and for public and commercial uses) precast ground floors will be suitable but it may be possible to use ground bearing floor slabs provided that suitably stable ground is proven. For ground bearing slabs it would be necessary to stabilise any potential solution features, ensure any fill is suitably engineered in place and that formations are moisture stable and will not be liable to shrinkage or heave movements.

6.6 Infrastructure

6.6.1 Roads/Hardstandings

No CBR testing has been undertaken to date as it is anticipated that there will be significant changes to ground levels.

The Clay With Flints is likely to give relatively poor CBR values in the range 2-5% depending on the sand and gravel content.

The surface of the chalk is also likely to give poor CBR values – it will also be particularly susceptible to softening in wet weather conditions.

It will be important to preserve formations in poor weather conditions.

Where suspected solution features are present or potentially likely it may be appropriate to reinforce road foundations by use of geogrids.

6.6.2 Soakaways

The results of soakage infiltration testing indicates that the chalk will be capable of providing means of disposal of stormwater. The results of the tests by Southern Testing and by RPS indicate infiltrations rates for the chalk in the west of the site of around 4×10^{-5} to 9×10^{-5} m/s.

It is recommended that once the stormwater scheme is more fully designed further confirmatory infiltration testing should be undertaken at proposed locations of stormwater disposal.

The site is located over chalk bedrock with evidence for the presence of solution features. In accordance with the recommendations of CIRIA document C574 *Engineering in Chalk* it is recommended that any soakaways are located at least 20m away from buildings. It would be recommended also that soakaways are located away from main roads – say by at least 10m distance.

6.6.3 Drainage and Water Supply Mains

Where solution features are present on a site located over the chalk outcrop these can be destabilised by leakage from drains or water supplies. It will be particularly important therefore that all drains and water supplies are ensured water-tight on completion and it is recommended that testing of all such mains is recorded as satisfactory on this site as part of the construction process.

7 FURTHER INVESTIGATIONS

The works reported in the present document are of a preliminary nature and it is recommended that further investigations are undertaken – these should be determined once a layout has been finalised and most importantly when proposed ground levels have been designed.

The recommended objectives of further investigations and recommended techniques are summarised in the following table.

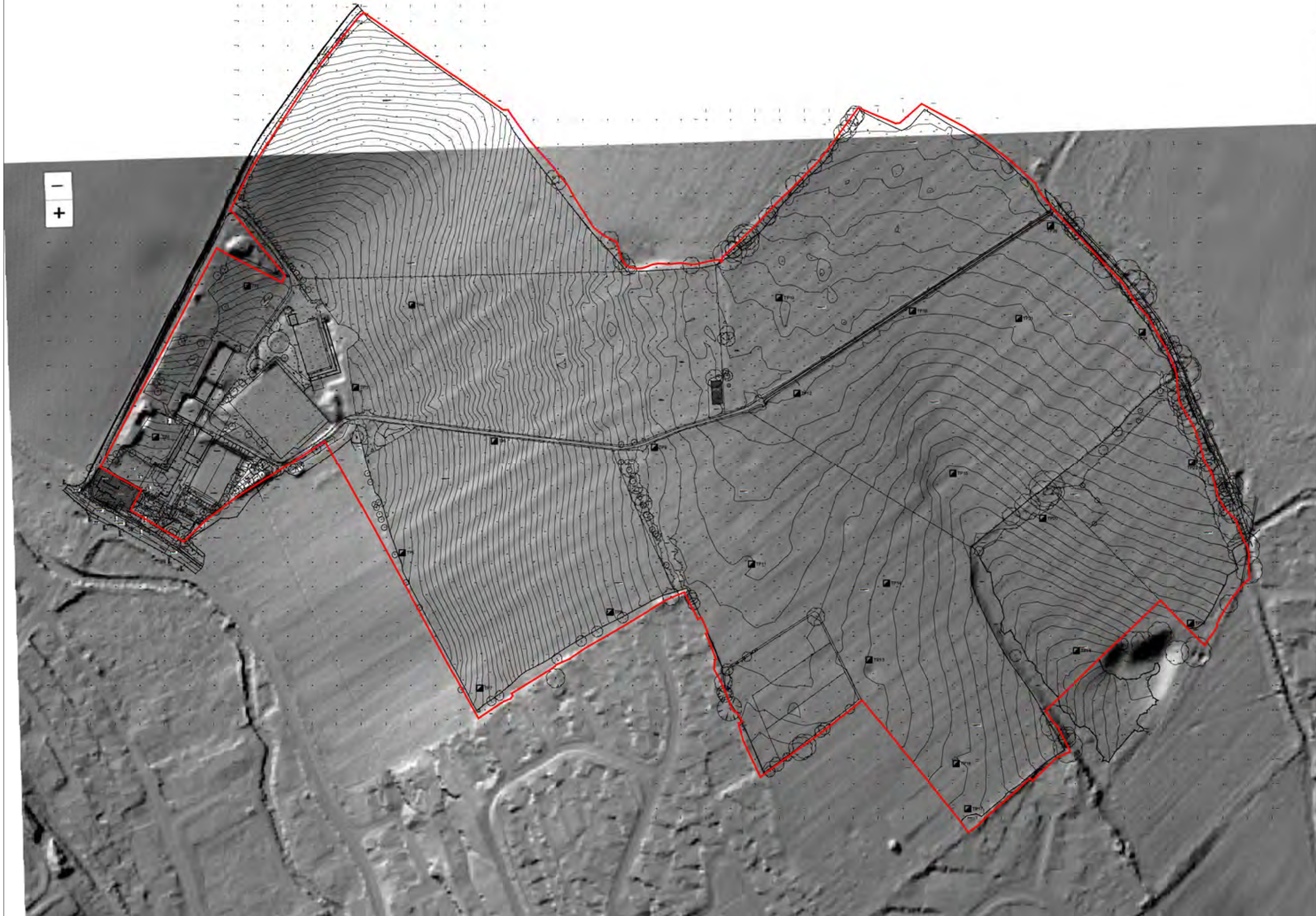
Investigations and testing in respect of possible contaminants are discussed separately in the *Land Contamination Report* by RPS.

Objective	Extent	Techniques
A series of anomalous features have been identified by the geophysics surveys that are considered necessary to investigate.	At locations across the site as indicated by the geophysics surveys, topographic survey and trial pits.	A proportion of locations should be investigated by cable percussion boreholes with lorry mounted static cone penetration testing used to supplement the boreholes.
An increased density of shallow exploratory holes is recommended to better delineate the extent and thickness of the Clay With Flints and to confirm its strength.	Across the majority of the site – particularly the central and eastern parts where the Clay With Flints forms a significant cover.	Trial pits supplemented with window sampler boreholes.
To determine deep soil strengths for pile design purposes.	Particularly where piled foundations may be likely.	Cable percussion boreholes with rotary follow-on if required to penetrate chalk bedrock at depth.
To confirm ground conditions in the area of the Equestrian Centre.	The western part of the site currently occupied by the buildings and yards of the Equestrian Centre,	Trial pits and boreholes.
Further assessment of soils likely to be used for cut and fill is recommended together with assessment of proposed road formations.	Site-wide but particularly where extensive earthworks are proposed.	Trial pits, insitu (plate) testing and laboratory testing of recovered soils.
Geophysics ERT profiles in the east of the site – non Equestrian Centre land – where not previously accessible.	Fields 7 and 8 in the Terradat report.	ERT survey with potential follow-on boreholes in features of interest.

Table 1 - Recommended Further Investigations

Appendices

Appendix A Drawings



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Project: Lower Luton Road, Harpenden

Title: Trail Pit Layout

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notes

rev	date	comment(s)	name	check

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status: **PLANNING** RIBA Stage: 2

client: Crest Nicholson

job: Lower Luton Road, Harpenden

title: Illustrative Concept Masterplan

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Appendix B Trial Pit Logs

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Trial Pit Log

Trial Pit ID: **TP1**

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	Date: 27-02-2025
Job No.	CAS31270	Dimensions (m): 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged: PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Grey brown sandy clayey TOPSOIL		
				3.00		Structureless CHALK composed of slightly sandy slightly gravelly CLAY. Dm		

Remarks Chalk excavates as soft to firm marl

Stability Pit sides unstable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP2**

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date 27-02-2025
Job No.	CAS31270	Dimensions (m) 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged PA

Samples & Insitu Testing: Depth (m)	Type	Testing	Strata Details: Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Grey brown very gravelly clayey TOPSOIL		
				1.30		Firm to stiff orange brown very sandy gravelly CLAY		
				2.75		Structureless CHALK composed of silty slightly gravelly CLAY. Gravel is very weak low density white chalk. Dm		

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP3**

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level		Date: 27-02-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m		Scale
Client: CREST NICHOLSON			Logged: PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Dark grey brown sandy gravelly clayey TOPSOIL		
				1.20		Firm to stiff reddish brown very sandy gravelly CLAY Gravel is mainly of flint		
				3.20		Structureless CHALK composed of silty slightly gravelly CLAY. Gravel is very weak low density white chalk. Dm		

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP4**

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords	Date: 27-02-2025	
	Ground Level		
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m	Scale	
Client: CREST NICHOLSON		Logged: PA	

Samples & Insitu Testing			Strata Details					
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				3.10		Structureless CHALK composed of silty sandy gravelly CLAY with occasional flint gravel. Dm / Dc		

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: TP5

Project: LOWER LUTON ROAD, HARPENDEN		Co-ords Ground Level	Date: 27-02-2025
Job No.: CAS31270		Dimensions (m): 0.6 x 3.0m	Scale:
Client: CREST NICHOLSON			Logged: PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				0.40		Light brown gravelly CLAY		
				3.10		Structureless CHALK composed of cream white and orange brown sandy gravel with occasional flint gravel and cobbles. Chalk gravel is very weak angular to sub-angular fine to coarse Dm grading to Dc		

Depth scale: 1, 2

Remarks

Stability: Some local spalling of pit sides.

Groundwater: None encountered.

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Trial Pit Log

Trial Pit ID	TP6
Project	LOWER LUTON ROAD, HARPENDEN
Co-ords	
Ground Level	
Date	27-02-2025
Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m
Scale	
Client	CREST NICHOLSON
Logged	PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				0.30		Firm reddish brown sandy gravelly CLAY		
				2.90		Structureless CHALK composed of sandy gravelly CLAY. Gravel is weak low density sub-angular chalk. Occasional flint gravel. Dc		

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: TP7

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date: 27-02-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m	Scale
Client: CREST NICHOLSON		Logged: PA

Samples & Insitu Testing			Strata Details					
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.15		Grey brown sandy gravelly clayey TOPSOIL		
				0.25		Stiff reddish brown sandy very gravelly CLAY. Gravel of angular flint.		
				2.70		Structureless CHALK composed of silty sandy gravelly CLAY. Gravel is very weak and low density. Dc		

Depth scale: 1, 2

Remarks

Stability: Pit sides stable.

Groundwater: None encountered.

Trial Pit Log

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Trial Pit ID	TP8		
Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	
Date	27-02-2025	Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m	Scale	
Client	CREST NICHOLSON	Logged	PA

Samples & Insitu Testing: Depth (m)	Type	Testing	Strata Details: Level	Depth	Strata Description	Water	Backfill
				0.20	Grey brown sandy gravelly clayey TOPSOIL		
				0.50	Firm to stiff friable dark brown sandy CLAY		
				2.00	Firm to stiff dark reddish brown sandy gravelly CLAY Occasional flint cobbles.		
3		PI = 14		3.40	Structureless CHALK composed of sandy gravelly CLAY. Gravel is very weak low density white chalk. Dm		

Remarks Chalk excavates as soft putty

Stability Pit sides stable.

Groundwater None encountered.

Trial Pit Log

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Trial Pit ID	TP9		
Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	Date 27-02-2025
Job No.	CAS31270	Dimensions (m) 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.25		Grey brown sandy gravelly clayey TOPSOIL		
1		PI = 44				Firm to stiff sandy very gravelly CLAY Gravel is sub-angular flint. Gravelly clayey chalk present below 1.1m in face of pit. Dm		
2								
3		PI = 19		3.60				

Remarks Chalk excavates as soft putty

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP10**

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date: 27-02-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m	Scale:
Client: CREST NICHOLSON		Logged: PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				2.90		Stiff to very stiff orange brown sandy gravelly CLAY Gravel is coarse sub-angular flint.		

Remarks

Stability: Pit sides stable.

Groundwater: None encountered.

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Aurora House, Deltic Avenue, Rooksley, Milton Keynes MK13 8LD
T:+44 (0)1908 669 898 E: rpsmks@rpsgroup.com

Trial Pit Log

Trial Pit ID: TP11

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date 27-02-2025
Job No.	CAS31270	Dimensions (m) 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.25		Grey brown sandy gravelly clayey TOPSOIL		
				0.65		MADE GROUND. Clayey gravelly chalk.		
				3.70		Firm to stiff dark orange brown sandy gravelly CLAY Gravel of flint. One pit face showing structureless CHALK composed of sandy gravelly CLAY Dm		

Depth scale (m): 1, 2

Remarks Trial pit located over surface depression feature

Stability Pit sides stable.

Groundwater None encountered.

Trial Pit Log

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Trial Pit ID	TP12	
Project: LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date: 27-02-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m	Scale
Client: CREST NICHOLSON		Logged: PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.30		Grey brown sandy gravelly clayey TOPSOIL		
				2.80		Stiff to very stiff light orange brown very sandy gravelly CLAY Gravel of angular flint.		

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP13**

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level		Date: 27-02-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m		Scale:
Client: CREST NICHOLSON			Logged: PA

Samples & Insitu Testing			Strata Details					
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.30 - 0.60		MADE GROUND. Grey brown clayey topsoil with clayey chalk.		
				2.20		Firm reddish brown sandy gravelly CLAY. Gravel of sub-angular flint.		
				3.50		Soft very silty gravelly CLAY consisting of reworked chalk.		

Remarks Trial pit located over surface depression

Stability Pit sides stable.

Groundwater Seepage at 2.4 - 2.5m

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Trial Pit Log

Trial Pit ID	TP14
Project	LOWER LUTON ROAD, HARPENDEN
Co-ords	
Ground Level	
Date	27-02-2025
Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m
Scale	
Client	CREST NICHOLSON
Logged	PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				1.70		Stiff orange brown sandy gravelly CLAY. Gravel is flint.		
		PI = 11		3.30		Structureless CHALK composed of silty sandy gravelly CLAY. Dm grading to Dc		

Remarks

Stability: Pit sides stable.

Groundwater: None encountered.

Trial Pit Log

RPS
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Aurora House, Deltic Avenue, Rooksley, Milton Keynes MK13 8LD
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Trial Pit ID	TP15		
Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	
Date	27-02-2025	Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m	Scale	
Client	CREST NICHOLSON	Logged	PA

Samples & Insitu Testing / Strata Details

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				1.40		Firm grey brown very sandy gravelly CLAY with occasional flint cobbles.		
				3.00		Firm to stiff dark reddish brown sandy very gravelly CLAY with occasional large flint cobbles.		

Remarks Trial pit located in low point of a valley feature

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP16**

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date: 27-02-2025
Job No.	CAS31270	Dimensions (m): 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged: PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
						Grey brown sandy gravelly clayey TOPSOIL		
				0.30		Firm to stiff very sandy gravelly CLAY. Gravel of flint.		
				0.48		Stiff to very stiff sandy gravelly CLAY with occasional flint cobbles. Gravel of flint.		
				2.80				

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: TP17

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date 27-02-2025
Job No.	CAS31270	Dimensions (m) 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged PA

Samples & Insitu Testing			Strata Details					
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.20		Grey brown sandy gravelly clayey TOPSOIL		
				1.20		Stiff reddish brown sandy gravelly CLAY. Gravel is flint.		
2		PI = 25		3.00		Structureless CHALK composed of sandy very gravelly CLAY. Dm		

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP18**

Project: LOWER LUTON ROAD, HARPENDEN		Co-ords Ground Level	Date: 27-02-2025
Job No.: CAS31270		Dimensions (m): 0.6 x 3.0m	Scale
Client: CREST NICHOLSON			Logged: PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.30		Grey brown sandy gravelly clayey TOPSOIL		
				0.75		MADE GROUND. Clayey gravelly reworked chalk.		
2		PI = 34		3.20		Firm to stiff (locally soft to firm) grey brown sandy gravelly CLAY. Gravel of flint.		

Remarks Trial pit located over shallow surface depression

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID: **TP19**

Project	LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level	Date: 13-03-2025
Job No.	CAS31270	Dimensions (m): 0.6 x 3.0m	Scale
Client	CREST NICHOLSON		Logged: PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.30		Grey brown sandy gravelly clayey TOPSOIL		
				3.00		Soft to firm grey brown gravelly very sandy CLAY.. ... becoming stiff below 1.4m and very stiff below 2.0m Increasing gravel content with depth. Gravel is sub-angular flint.		

Depth scale: 1, 2

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Trial Pit Log

Trial Pit ID	TP20
Project	LOWER LUTON ROAD, HARPENDEN
Co-ords	
Ground Level	
Date	13-03-2025
Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m
Scale	
Client	CREST NICHOLSON
Logged	PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.15		Grey brown sandy gravelly clayey TOPSOIL		
				2.70		Stiff to very stiff orange brown very sandy gravelly CLAY. Gravel is sub-angular flint.		

Depth scale: 1, 2

Remarks

Stability: Pit sides stable.

Groundwater: None encountered.

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Trial Pit Log

Trial Pit ID	TP21
Project	LOWER LUTON ROAD, HARPENDEN
Co-ords	
Ground Level	
Date	27-02-2025
Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m
Scale	
Client	CREST NICHOLSON
Logged	PA

Samples & Insitu Testing			Strata Details				Water	Backfill
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description		
				0.30		Grey brown sandy gravelly clayey TOPSOIL		
				3.50		Grey brown very sandy gravelly CLAY. Locally much flint gravel.		

Depth scale: 1, 2, 3

Remarks Trial pit located over shallow surface depression

Stability Pit sides stable.

Groundwater None encountered.

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Aurora House, Deltic Avenue, Rooksley, Milton Keynes MK13 8LD
T:+44 (0)1908 669 898 E: rpsmks@rpsgroup.com

Trial Pit Log

Trial Pit ID: TP22

Project: LOWER LUTON ROAD, HARPENDEN	Co-ords Ground Level		Date: 13-03-2025
Job No.: CAS31270	Dimensions (m): 0.6 x 3.0m		Scale
Client: CREST NICHOLSON			Logged: PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.28		Grey brown sandy gravelly clayey TOPSOIL		
				0.85		Firm to stiff reddish brown sandy gravelly CLAY. Gravel mainly of sub-angular flint.		
1				2.60		Structureless CHALK composed of sandy very clayeye GRAVEL. Gravel is weak and low density. Dm / Dc		
2								

Samples & Insitu Testing | Strata Details

Remarks

Stability Pit sides stable.

Groundwater None encountered.

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Aurora House, Deltic Avenue, Rooksley, Milton Keynes MK13 8LD
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Trial Pit Log

Trial Pit ID	TP23
Project	LOWER LUTON ROAD, HARPENDEN
Co-ords	
Ground Level	
Date	13-03-2025
Job No.	CAS31270
Dimensions (m)	0.6 x 3.0m
Scale	
Client	CREST NICHOLSON
Logged	PA

Samples & Insitu Testing			Strata Details					
Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.28		Grey brown sandy gravelly clayey TOPSOIL		
				2.80		Stiff to very stiff reddish brown sandy gravelly CLAY. Gravel of sub-angular flint.		

Remarks

Stability: Pit sides stable.

Groundwater: None encountered.

Trial Pit Log

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Trial Pit ID	TP24		
Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	
Date	27-02-2025		
Job No.	CAS31270	Dimensions (m)	0.6 x 3.0m
Scale			
Client	CREST NICHOLSON	Logged	PA

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.30		Grey brown sandy gravelly clayey TOPSOIL		
1		PI = 25				Stiff to very stiff orange brown sandy gravelly CLAY. Gravel of flint.		
2.4		PI = 48		2.90				
				3.10		Structureless CHALK composed of slightly gravelly very silty CLAY. Dm		

Remarks Chalk excavates as soft putty

Stability Pit sides stable.

Groundwater None encountered.

Trial Pit Log

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Aurora House, Deltic Avenue, Rooksley, Milton Keynes MK13 8LD
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Trial Pit ID	TP25		
Project	LOWER LUTON ROAD, HARPENDEN	Co-ords / Ground Level	
Date	27-02-2025		
Job No.	CAS31270	Dimensions (m)	0.6 x 3.0m
Scale			
Client	CREST NICHOLSON	Logged	PA

Samples & Insitu Testing / **Strata Details**

Depth (m)	Type	Testing	Level	Depth	Legend	Strata Description	Water	Backfill
				0.40-0.70		Grey brown sandy gravelly clayey TOPSOIL		
1		PI = 36				Firm to stiff dark orange brown sandy very gravelly CLAY Gravel is sub-angular flint.		
2		PI = 39		2.70				
3				3.50		Structureless CHALK composed of sandy gravelly CLAY. Dm		

Remarks

Stability Pit sides stable.

Groundwater None encountered.

Appendix C Trial Pit Photographs

Trial Pit TP3

Trial Pit TP5

Trial Pit TP8

Trial Pit TP10

Trial Pit TP13 Location

Trial Pit TP13

Trial Pit TP18 Location

Trial Pit TP18

Trial Pit TP19

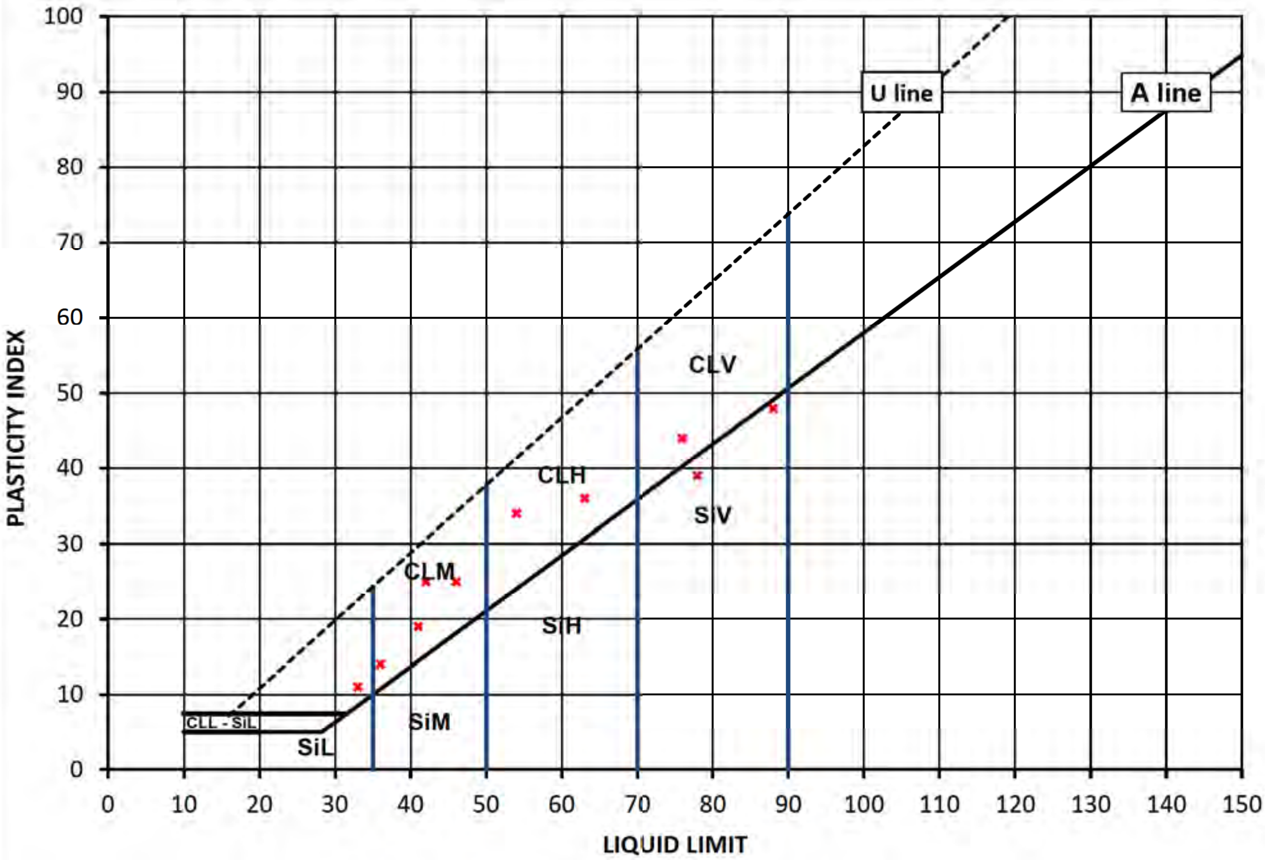
Trial Pit TP21

Trial Pit TP22

Trial Pit TP23

Appendix D Laboratory Test Results

GEOTECHNICS	Plasticity (A-line) Chart
Project No. PL250131	Project Name Harpenden Project



Legend based on BS EN ISO 14688-2:2018

		Plasticity		Liquid Limit
CL	Clay	L	Low	below 35
Si	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90

Organic O append to classification for organic material (eg CHO)

Notes	Date Printed
Plotted Test results from BS EN ISO 17892-12 include 4pt and 1pt tests, unless otherwise detailed on the classification summary report. See individual results for more detail. A' line derivation above PI of 6, PI = 0.73 (LL-20)	16/05/2025

Summary of Classification Test Results

Project Number: PL250131
Project Name: Harpenden Project

Hole Number	Sample ID	Top (m)	Base (m)	Type	Specimen Description	W Water Content %	Passing 425µm %	LL Liquid Limit %	PL Plastic Limit %	PI Plasticity Index %	Particle Density Mg/m^3	Remarks
TP14		2.50		D	White gravelly chalky CLAY.	33.7	31	33 1pt (1.015)	22	11		
TP17		2.00		D	Brown slightly gravelly CLAY.	39.2	54	46 1pt (1.008)	21	25		
TP18		2.00		D	Brown slightly gravelly CLAY.	27.4	75	54 1pt (1.018)	20	34		
TP24		1.00		D	Light brown slightly gravelly CLAY.	20.2	88	42 1pt (1)	17	25		
TP24		2.40		D	Light brown slightly gravelly SILT.	29.2	86	88 1pt (1.018)	40	48		
TP25		1.00		D	Light brown gravelly CLAY.	15.9	40	63 1pt (1.018)	27	36		
TP25		2.00		D	Brown slightly sandy SILT.	40.7	87	78 1pt (1.018)	39	39		
TP8		3.00		D	White slightly gravelly chalky CLAY	34.6	90	36 1pt (1)	22	14		
TP9		1.00		D	Brown slightly gravelly CLAY.	29.9	93	76 1pt (1.018)	32	44		
TP9		3.50		D	White slightly gravelly chalky CLAY.	38.8	83	41 1pt (1)	22	19		

All tests performed in accordance with BS EN ISO 17892 unless specified otherwise.

Key:

Liquid Limit
80g / 30deg fall cone with increasing water content unless specified otherwise
Sample washed through 0.425mm sieve unless specified otherwise
1pt - single point test (including factor)
* BS1377 method

Particle density
sp - small pycno
gj - gas jar BS1377

Plastic Limit
NP - Non Plastic

Printed 16/05/2025

UKAS TESTING 1365

Appendix E Geophysics Report

GEOPHYSICAL SURVEY REPORT

Project

Geophysical survey to map potential dissolution features

Location

Harpenden, Hertfordshire

Client

RPS Consulting UK

Head Office
Unit 1
Link Trade Park
Penarth Road
Cardiff CF11 8TQ
United Kingdom

Telephone: +44 (0)2920 700127
www.terradat.co.uk

TERRA DAT
down to earth **geophysics**

Job reference: 9217
Date: April 2025
Version: 1

GEOPHYSICAL SURVEY REPORT

Project

Geophysical survey to map potential dissolution features

Location

Harpenden, Hertfordshire

Client

RPS Consulting UK

Project Geophysicist:	Mag K Zorn MSc FGS	[redacted]
Reviewer:	Dr Jonathan Thomas BSc FGS	[redacted]
Job Reference:	9217	
Date:	April 2025	

CONTENTS

FIGURES

APPENDICES

1 EXECUTIVE SUMMARY

A geophysical survey was conducted at a site to be developed for housing north of Harpenden, Hertfordshire. The survey work was commissioned by RPS Consulting UK (the Client), and the initial Phase 1 survey took place between the 18th and 21st of March, followed by Phase 2 from the 31st of March to the 2nd of April 2025. The aim of the survey was to provide information on the potential presence of dissolution features associated with the chalk bedrock.

The survey area covered approximately 20ha and was split across eight fields. The Phase 1 survey included an electromagnetic ground conductivity survey across the site, followed by seven Electrical Resistivity Tomography (ERT) profiles in Phase 2. The ERT profiles were positioned primarily to target anomalous features identified from LiDAR data and the EM survey.

Electromagnetic (EM) measurements of ground conductivity were recorded using a towed GEM-2 instrument, and the resulting plots display a wide range of responses across the survey area. These include changes in superficial cover and shallow bedrock variations. The most significant features have been highlighted and tabulated in the corresponding plots.

Seven electrical resistivity tomography (ERT) profiles were set out to target and further investigate features of interest to characterise the underlying geology. These sections mapped ground conditions up to 20m depth, and several anomalous features potentially associated with dissolution processes were observed.

To help refine the interpretation, it is recommended that the main anomalies identified by the geophysical survey be ground-calibrated, and a list of potential locations has been compiled.

2 INTRODUCTION

This report describes a geophysical survey completed at a site to be developed for housing north of Harpenden, Hertfordshire. The initial Phase 1 survey took place between the 18th and 21st of March, followed by Phase 2 from the 31st of March to the 2nd of April 2025. The work was carried out for RPS Consulting UK (the Client) with the aim of providing information on the potential presence of dissolution features in the chalk bedrock.

2.1 Site description

The site is located north of Harpenden (National Grid coordinates E514500, N21600) in fields east of the B653 Lower Luton Road, Hertfordshire (Plate 1), which are used for grazing by *Greenacres Equestrian*. The site measures approximately 20ha, split into eight fields (Figure 2 and Plate 2), and is under consideration for potential housing development. Most of the fields were covered in short grass and enclosed by electric fencing, which was selectively switched off during the survey. A mobile phone mast was located in the centre of the survey area.

Publicly available Lidar imagery (Defra, 2015) indicates a few anomalous zones (e.g. depressions) spread across the site, which have been highlighted in Figure 1B.

***Plate 1**: Geophysical survey location in a dashed yellow line north of Harpenden, Hertfordshire (Google Satellite Image, 2025).*

Field 1 comprised two separate zones immediately north of the stables; the northern part of this survey area comprised a zone of ~50m x 40m of a sparsely grassed livery yard and a small paddock with trees connected by a small path through hedges located in the south. The southern area was relatively limited, with trees situated within and around the survey area.

Field 2 comprised a ~200m x 200m large field situated on the sloping ground south of the access track; the field was covered in short grass with electric fencing around its perimeter.

Field 3 comprised a ~400m by 200m field in the centre of the survey area, which was covered in short grass. A number of anomalous Lidar features have been detected in this field, some of which were visible as considerable depressions on the surface.

Field 4 had to be accessed through Field 3 and was surrounded by fencing, with three additional parallel fence divisions crossing the field. At the time of Phase 1, the electric fences within and around this field were switched on, and the gate was locked, which meant the field could not be accessed. During Phase 2, however, access was provided. Long grass covered the survey area, and a large depression was noted within this field.

Field 5 was north of the access track and immediately east of the mast. A Lidar anomaly has been noted north of this survey area.

Field 6 is south of the access track and west of Common Lane, which borders the site to the east. This field was also covered in short grass; a subtle valley feature and a number of visible depressions are found within this field.

Field 7 and **Field 8** in the southeastern part of the site are separated from the rest of the fields accessible through Common Lane. Two Lidar anomalies have been noted, and the valley feature from Field 6 extends into Field 7. Access during Phase 2 was not possible to these two fields due to livestock not being able to be moved.

Plate 2a: *Southern area of Field 1, looking southwest.*

Plate 2b: *The western part of Field 2 at the bottom of the slope with the mast in the background, looking northeast.*

Plate 2c: *Western part of Field 3, looking partially over into Field 4, separated by fences, looking southeast.*

Plate 2d: *At the entrance of Field 4, showing fences crossing the survey area, looking southeast.*

Plate 2e: *Field 6, looking east.*

Plate 2f: *Field 8, looking southwest towards Field 7.*

2.2 Geological setting

British Geological Survey (BGS) geological maps (NERC, 2025) show the survey area to be underlain by the Lewes Nodular Chalk and Seaford Chalk Formation; there is a partial cover of recorded superficials in the eastern part of the survey area comprising clay with flint, silt, sands and gravels.

Trial pit results (provided by the Client) completed prior to the geophysical survey suggest a sequence of topsoil, clay, sands and gravels underlain by chalk bedrock. Depth to chalk varies across the site, but broadly speaking, very shallow chalk (~ <1m) has been encountered in the west of the site, no chalk has been found in trial pits towards the centre of the site, and deep sandy clay over bedrock has been encountered in the east of the site.

2.3 Survey objectives

The primary objective of the survey was to locate possible dissolution features within the chalk bedrock.

2.4 Survey design

Given the nature of the targets under investigation, it was decided to adopt an integrated survey approach comprising the following techniques:

- **Ground conductivity survey (*Geophex GEM-2*)**: – to map variations in ground conductivity that may be associated with changes in the ground character and/or features potentially related to chalk dissolution.

- **Electrical Resistivity Tomography (ERT, *IRIS Syscal Junior*)** – to provide an electrical cross-section of the ground for identification of localised resistivity anomalies that may be related to chalk dissolution.

At the request of the Client, the survey was divided into two phases: a Phase 1 EM survey and a targeted Phase 2 ERT survey.

2.5 Quality control

The geophysical data are collected in line with normal operating procedures as outlined by the instrument manufacturer and TerraDat company policy. On completion of the survey, the data are downloaded from the survey instrument onto a computer and backed up appropriately. The acquired dataset is initially checked for errors that may be caused by instrument noise, low batteries, positional discrepancies, etc., and any field notes are either written up or incorporated in the initial data processing stage. The dataset is processed using the standard processing routines, and once completed, the resulting plots are subject to peer review to ensure the integrity of the interpretation. Our quality control standards are BS EN ISO 9001: 2015 certified.

3 SURVEY DESCRIPTION

3.1 Geophysical survey

The survey was carried out using the following geophysical methods:

- Ground conductivity survey (EM, *Geophex GEM-2*)
- Electrical Resistivity Tomography (ERT, *IRIS Syscal Junior*)

Background information on these survey methods is provided in the Appendices, and a summary of the techniques with a brief description of the on-site activity is described below.

3.2 Survey layout and topographic survey

A network-corrected RTK dGPS system (EMLID REACH) was used to set out a series of survey grid control points, record the position of all ERT electrodes and gather general points for a simple topographical base plan. The system utilises a real-time mobile phone network correction that is rated to an accuracy of +/- 25 mm. All measurements were referenced to the National Grid (OSTN15) using the network correction.

To optimise data collection, the orientation of the EM survey lines in each field was recorded parallel to the main fence lines, while the position and extent of the ERT profiles were based on a combination of the results of the EM survey and observed surface depressions.

3.1 Ground conductivity survey (*EM*)

An electromagnetic survey involves transmitting an electromagnetic field into the subsurface and picking up the returning signal via a receiver in the same instrument. Data are acquired on a grid covering the area of interest, and a contoured plan of the variation in ground conductivity and in-phase response (sensitive to disturbed ground and metal) across the site is produced. The presence of conductive materials in the subsurface, such as metal, ash, clay, water, mudstone, some contaminants, leachate, etc., can be evident as regions of high values on the ground conductivity plan. Materials such as coarse-grained sediments and well-drained made-ground, dry zones and many bedrock types will appear as regions of low values.

3.1.1 Ground conductivity - field activity

The conductivity data were acquired using a multi-frequency *Geophex GEM-2* instrument along a series of 3m spaced survey lines (Plate 3). The data were positioned using a dGPS system, and the instrument was pulled behind a quadbike across the survey area. For this survey, the instrument was primarily configured to investigate depths down to 3 to 5m below ground level.

Item	Description
System	GEOPHEX GEM-2
Frequency	Multifrequency 47KHz, 13Khz, and 4KHz
Line Spacing	3m
Reading interval	20 cm
Acquisition method	Towed behind a quadbike
Depth of investigation	Up to 3 - 5 m

Table 1: *GEM-2 equipment list and data acquisition parameters.*

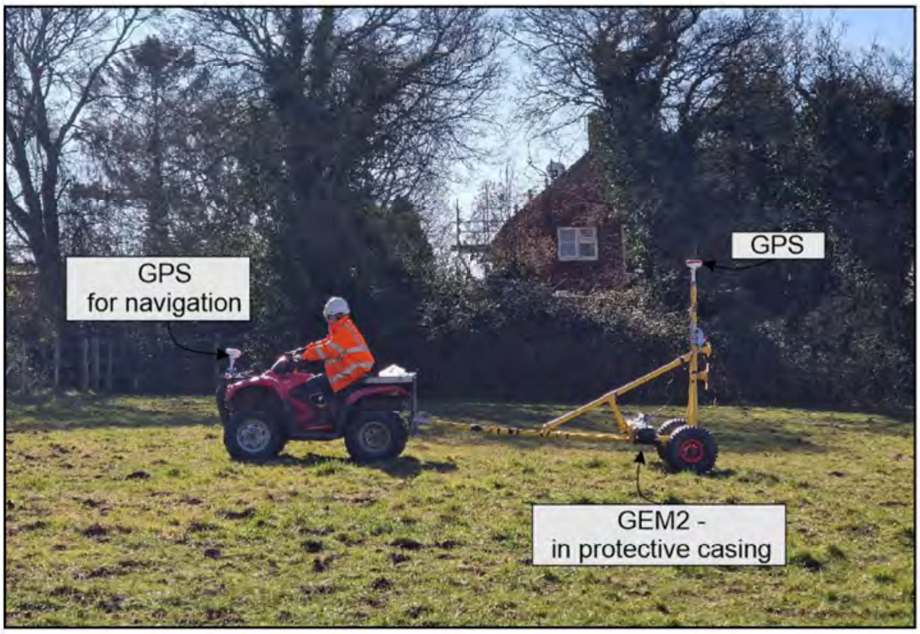


Plate 3*: The GEM-2 ground conductivity instrument with a dGPS in Field 2.*

3.1.2 Ground conductivity - data processing

The dataset was downloaded from the data logger and compiled using the dedicated software *WINGEM-3*. Initial editing was carried out to remove positional errors and rogue values. The data were then exported as an 'XYZ' file and translated into the OSGB36 Coordinate system using the OSTN02 transformation. The next step was to bring the data into *Oasis montaj*, where it was edited and gridded to enhance any features of interest. The resultant colour contour plots were then integrated with the base plan information, and the resulting plans were exported to *CorelDraw* for final annotation.

3.1 Electrical Resistivity Tomography (ERT) survey

An ERT survey involves the injection of DC electrical current into the ground at various electrode locations along a profile line. An electrical cross-section of the subsurface is then derived from the recorded data. A diverse range of features such as clay-rich sediments, the water table, gravel lenses, fracture zones, infilled solution features, bedrock structure and leachate can be imaged in cross-section using a resistivity survey. A feature may be targeted using resistivity tomography given sufficient electrical contrast with its surroundings. A description of the field activity is provided below, and some background information on the survey method is found in the Appendix.

3.1.1 ERT survey - field activity

A 72-electrode *IRIS Syscal Junior* resistivity system (Plate 4) was used to acquire six resistivity profiles at an electrode spacing of 2m, applying the Wenner-Schlumberger S4-DP (deep) array and one ERT profile at 5m spacing, applying the Wenner-Schlumberger S4-SH (shallow) array to provide high-resolution models of the top ~20m of the ground.

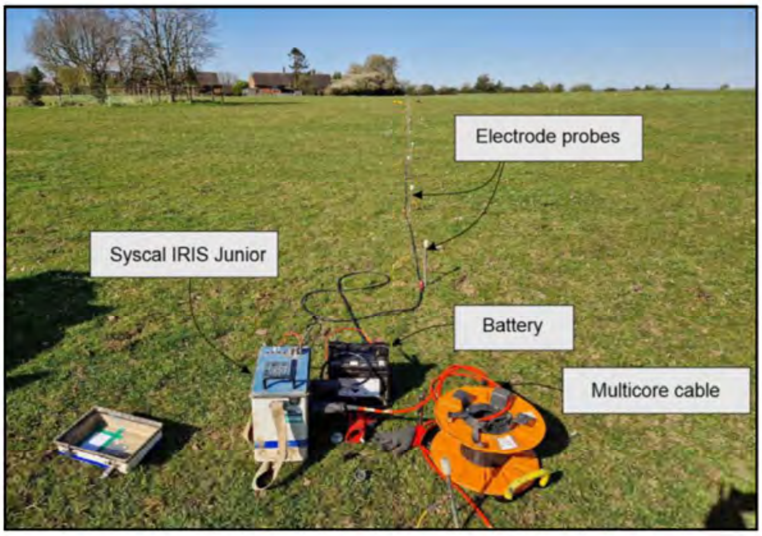


Plate 4: *An Iris Syscal instrument with associated cables and power supply in Field 3.*

Item	Description
System	1x IRIS SYSCAL Junior
Cables	4x 18 channel cables
Electrodes	72 x stainless steel electrodes
Minimum Electrode spacing	2m (S4-DP) and 5m (S4-SH)
Array Type	Wenner-Schlumberger
Cycles/time	Min 3 stack / 500ms
Depth of investigation	Up to ~20m

Table 2: *ERT equipment list and data acquisition parameters.*

ID		Easting	Northing	Elevation	Electrode spacing	Length
ERT 2	START	514279.5	215992.3	109	2m	142m
	END	514307.3	215853.2	109.3		
ERT 3	START	514282.7	215860.9	106.8	5m	534m
	END	514770.7	216076	125.7		
ERT 4	START	514730.6	216215.5	128.6	2m	142m
	END	514745.7	216074.3	125.2		
ERT 5	START	514512.6	216035.3	126.3	2m	142m
	END	514628.4	216117.1	126.1		
ERT 6	START	514514	215823.7	123.7	2m	142m
	END	514639	215885.8	122.7		
ERT 7	START	514692.8	215751.9	121.2	2m	140m
	END	514721.7	215888.1	119.3		
ERT 8	START	514530.8	215934.9	125.2	2m	142m
	END	514672.1	215924.9	121.6		

Table 3: *ERT profile start/end coordinates and profile information.*

3.1.2 ERT survey - data processing

The data were downloaded from the instrument using the PROSYS II software; the profiles were processed using the RES2DINV software to derive modelled geo-electrical cross-sections of the subsurface. Elevation data (accuracy +/- 25mm) were incorporated within the respective data sets before the inversion process.

To improve the inversion model's fit to the observed data, the process was refined, where applicable, by removing outliers based on the RMS error. The RMS values for all three acquired datasets were typically less than 4%, indicating an excellent fit between the measured and modelled data.

The modelled data was then exported into Surfer, where it was gridded (kriging with a cell size of half the electrode spacing) and presented as 2D cross-sections of apparent resistivity. These cross-sections were then exported to CorelDraw for final annotation.

4 RESULTS AND INTERPRETATION

The results of the geophysical survey are shown as a series of plots and sections in Figures 2 to 8. Figure 9 provides a summary plot showing the position of the key features of interest together with some recommended positions for ground calibration.

A description of the interpretation process and a broad discussion of the results for each technique is given below.

4.1 EM ground conductivity survey - background

The results of the electromagnetic survey are presented as a compilation of colour-contoured plots of the ground conductivity and the In-Phase signal in Figure 2. To highlight more subtle variations within the individual fields, more detailed plots of the ground conductivity using customised colour scales are shown in Figures 3, 4, and 5.

Following a review of the electromagnetic data, it was decided only to consider the response of the 47,000 Hz frequency channel. A relative increase in conductivity values usually indicates a localised increase in the clay/water content, which, for example, could signify either a lateral change in lithology or a change in bedrock depth. However, it can also represent interference from adjacent metallic features (both above and below ground). Extreme fluctuations in conductivity values are usually indicative of instrument 'overload' due to high metal content and usually correlate with anomalous readings in the in-phase response.

The interpretation of the conductivity data is based on both published electrical properties of typical sedimentary materials (Table 4) and, when available, correlation with on-site information.

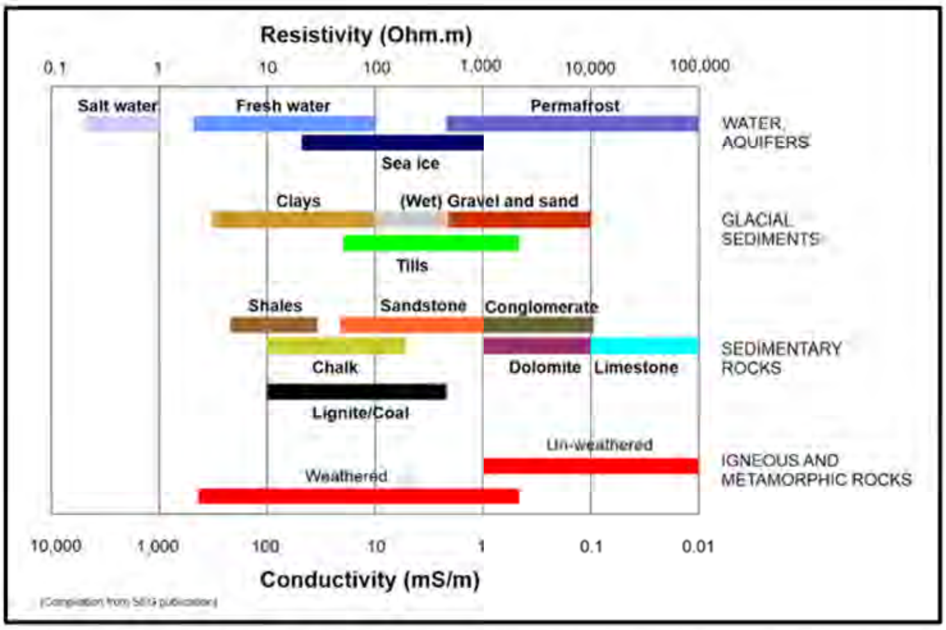


Table 4: *Table of resistivity/conductivity of typical sedimentary materials.*

The results of the electromagnetic survey show zones of differing electromagnetic responses; for the ground conductivity plot, 'red' zones (lower conductivity) are interpreted to be linked to an increase in granular or moisture-deficient ground material, while 'blue' zones (more conductive) are interpreted to present an increase in clay and/or moisture content within the subsurface.

The direct identification of solution features associated with the dissolution of the underlying chalk can vary and depend on the local geology. Typically, potential solution features are identified by localised 'bull's eye' or 'circular' anomalies that can either represent clay-filled (i.e. more conductive) pockets or wash-out/granular-filled zones (i.e. more resistive).

4.2 EM ground conductivity survey - discussion

The results of the EM survey mapped a combination of broad zones and isolated features indicating subtle changes in ground character, which are interpreted to represent changes in the thickness and character of superficials and/or depth to more competent chalk.

In a regional setting, the survey has mapped broad geological zones very well across the entire site (Figure 2). The survey highlights low conductivity values in the west of the site, particularly across the slope of the hill, which is interpreted as resistive shallow chalk bedrock. The central part of the survey area presents very high conductivity values, which is likely to represent a thickening of superficials containing increased clay and moisture content. The "speckled" appearance of low and high conductivity in the eastern part of the survey area is interpreted as superficials comprising an increased ratio of sands and gravels or alternating pockets of conductive clays within shallower chalk (particularly compared to the centre of the site). A linear zone of low conductivity associated with the subtle valley feature in the southeast of the site is interpreted as either increased gravels and sands or shallow weathered chalk.

The main features and anomalous areas have been highlighted in the respective plots, and a detailed summary of all geophysical results per field is given in Section 4.4.

The EM results correlate well with the ERT survey and show that the EM survey mapped the bulk ground conductivity to ~3-4m BGL. As some of the highlighted EM features represented characteristics associated with potential chalk dissolution, they were selected to be further targeted by the ERT survey. It should be noted that not all of the EM features displaying dissolution feature characteristics could be targeted within the scope of this survey.

4.3 ERT survey results - background

The results of the ERT survey are shown in Figures 6, 7, and 8 as detailed 2D cross-sectional resistivity profiles. To highlight both subtle variations and the broader geo-electric units, the sections are presented using both the standard rainbow and a simplified colour scale. The selection of the contour interval for the simplified colour scale was tailored to highlight the main features.

The vertical and horizontal axes display elevation above ordnance datum (m AOD) and chainage in meters along the profile line, respectively. The interpretation of the modelled resistivity sections is based on both published electrical properties of typical sub-surface materials (Table 4) and, when available, correlation with on-site information or observations.

Generally, areas of high resistivity indicate the presence of dry granular material and areas of low resistivity indicate the presence of high clay and moisture content. Table 5 shows a simple relationship between resistivity and geological setting. However, due to the non-uniqueness of the electrical properties (i.e. different materials exhibiting the same resistivity values), the final interpretation may be limited and may require additional calibration (i.e., drilling or other supplementary geophysical techniques).

RESISTIVITY	TYPICAL GEOLOGICAL SETTING
High	Dry, granular clay-deficient material,
Intermediate	Mixed sediments/fill material.
Low	Clay-rich, water-saturated sediments.

Table 5: *A simplified relationship between resistivity and geological setting*

The resolution of the ERT survey is subjective as it is based on a combination of electrode spacing, electrode array type and resistivity contrast. The main underlying principle is that the resolution decreases exponentially with depth. If the target geological boundaries are relatively abrupt with good electrical contrasts, then this should result in sharp resistivity boundaries. However, with variable geology and more transitional boundaries, these resistivity boundaries become more 'blurred'.

The most commonly used electrode arrays are the Wenner-Schlumberger (WS) and Dipole-dipole. Even though the Dipole-dipole array is more sensitive to horizontal changes in resistivity (i.e. better at resolving thin vertical features) than the WS array, the modelled sections can exhibit greater RMS error due to the low signal strength relative to noise. Given that the Wenner-Schlumberger array is moderately sensitive to both horizontal and vertical structures, it may be considered a better compromise. For this particular site, the Wenner-Schlumberger array has been applied.

4.4 ERT survey results - discussion

Of the seven ERT profiles laid out across the site, six were specifically set out to target features detected in the EM survey and Lidar anomalies (ERT 2, 4, 5, 6, 7, and 8), while ERT 3 was positioned to map the regional geological sequence.

The ERT profiles correlate well with the EM survey and highlight the variability of the depth of the superficial to bedrock across the site. Several potential anomalous features have been identified in the profiles, which may be relevant in relation to the dissolution or weakening of the bedrock.

Overall, the ERT results indicate high resistivity values in the shallow surface in the west of the site, indicating outcrops of shallow bedrock at the western slope. For the rest of the site, variations in low and very low resistivity values indicate different superficial materials overlying more resistive chalk bedrock. Based on the range of values and geometry, the resulting modelled resistivity sections broadly suggest three geo-electric layers reflecting the underlying geology:

- **U1** - Unit in the shallow surface displaying very low resistivity values, interpreted to represent material of high clay and moisture content, representing superficials of high clay and silt content.
- **U1a** - Transition zone between conductive and resistive unit, characterised by intermediate resistivity values, interpreted to represent a mix of superficial deposits and weathered chalk
- **U2** - Unit of high resistivity values, interpreted to present chalk bedrock.

Superimposed on this established geo-electrical sequence is a series of local variations that include undulations, vertical discontinuations, or pockets within the resistive layer interpreted as the bedrock. These variations can be considered anomalous and are of particular importance regarding the potential presence of dissolution of the bedrock. The main features detected in the ERT profiles have been highlighted in the accompanying figures and are described in Table 6 below.

ID	RESISTIVITY FEATURE DESCRIPTION
R1	Localised anomalous zone indicating intermediate resistivity values.
R2	Intermediate resistivity values indicate shallow bowl-like depression increase in clay or moisture-rich material.
R3	Broad vertical anomalous feature intersecting the U2 layer, highlighting intermediate values.
R4	Distinct bowl-shaped anomaly of intermediate resistivity values indicating discontinuation of U2.
R5 and R8	Two separate zones of intermediate resistivity values at either end of the ERT profile within the broad transition zone, indicating potential further deepening of intermediate resistivity value s/ change in chalk lithology.

R6 and R7	Two separate areas indicate a bowl-shaped deepening of the broad transition boundary.
R9	Bowl-shaped undulation in the U2 unit
R10	Sub vertical zone intersecting the U2 unit indicating discontinuation / vertical anomalous feature within the chalk bedrock.
R11 and R12	Two separate zones of decreased resistivity values intersecting U2.
R13	Bowl-shaped undulation in the U2 unit.
R14	Broad zone of intermediate resistivity values intersecting U2 extending to depths.
R15	Subtle depression in the upper U2 boundary, indicating undulation in the chalk, overlain by low resistivity values and intermediate resistivity values in the shallow surface.
R16	Reduction in resistive U2 unit, resistivity values may indicate weakening of bedrock or change in lithology.
R17	Discontinuation of U2; vertical feature of intermediate resistivity values.
R18	Depression and thinning in the upper boundary of U2 may indicate the weakening of chalk.
R19 and R20	Anomalous areas coincide with the location of the topographical valley visible on the surface; the U2 unit appears to drop off, which further gets intersected by intermediate values, indicating a change in bedrock lithology / potential weakening.
R21	Anomalous discontinuity in the resistive layer in the vicinity of a subtle but anomalous EM feature.

***Table 6**: Summary of main anomalous features detected in the ERT survey.*

4.5 Detailed summary discussions of individual fields

Field 1

Due to limited space availability, no ERT was acquired in Field 1. The EM indicates relatively low conductivity values compared to the rest of the survey area, suggesting shallow bedrock with little superficial cover or relatively more sandy clay deposits. Some pockets of increased conductivity have been mapped, which may be related to a localised increase in clay and moisture.

Field 2

Field 2 is characterised by high resistivity values compared to the rest of the site. The ERT survey results in this field confirmed the lack of conductive superficials indicating chalk outcrop in the western part of this field. Conductivity values increase further up the slope, where a thick layer of superficials and a deeper transition zone of intermediate resistivity values have been suggested by the ERT.

A few smaller zones of low conductivity have been highlighted, which indicate a localised increase in clay and moisture content. ERT 2 and ERT 3 were laid out to target some of these anomalies and confirmed that some of these anomalous zones may be associated with dissolution features. Two recommendations for intrusive investigations with regard to potential dissolution features have been made for this field.

Field 3

Field 3 is characterised by very high conductivity values compared to the rest of the site, interpreted to represent a high clay and moisture content within the shallow sub-surface. The ERT survey confirmed a thick layer of conductive material/superficials and a broad transition zone of intermediate resistivity values / weathered chalk, particularly in the north of the field. In the south of the field, a broad channel-shaped zone of high conductivity values indicates increased clay or moisture-rich material. Plotting the EM results of this field on an individually fitting colour scale, a large number of localised pockets of high-conductivity material are mapped. Some of these were targeted in the ERT survey, which partially confirmed anomalous features that extended to depth. Some correlations could also be made with visible Lidar surface features. Overall, numerous anomalous features have been mapped by geophysics, and some recommendations for intrusive investigations have been made.

Field 4

Field 4 was inaccessible during Phase 1; therefore, no EM data was acquired. However, the ERT profile laid out to target two Lidar features confirmed anomalous features at depth at these locations. The resistive unit (U2) representing bedrock is generally mapped as relatively homogenous with a continuous horizontal boundary. The main exceptions are a subtle undulation in the centre of the field and a significant vertical anomalous intersection in the chalk bedrock at the border of the field.

Field 5

Field 5, located to the north of the access track, was only surveyed with the EM. The results indicate that the broad conductive zone mapped to the south extends into this field. Some isolated zones of low conductivity indicate an increase in granular and sandy superficials or more shallow chalk.

Field 6

Field 6 is characterised by a number of visible depressions and a subtle valley in the south of this field. Results of the EM survey indicate that the broad zone of very low conductivity values overlaps with Field 3 in the northwest. This zone is bordered by resistive values that follow the valley feature (ERT profile 3 indicates thickening of the transition zone) interpreted as sandy gravelly superficials and/or shallow weathered chalk. The eastern part of Field 6 is characterised by a broad zone of intermediate conductivity values comprising localised pockets of more resistive or more conductive material. This "speckled chaotic" appearance is interpreted to represent fluctuating pockets of sandy/clay superficial deposits or shallow chalk. A number of undulations and anomalous features have been mapped within these fields, ranging from subtle undulations and vertical discontinuities within the bedrock to bowl-like depressions within the upper chalk bedrock boundary, some of which correlate with the location of visible Lidar anomalies.

Fields 7 and 8

Fields 7 and 8 were limited to the EM survey only, as access was not possible during Phase 2. The results indicate the broad zone of high conductivity overlapping from Field 6. The valley feature characterised through resistive values from Field 6 extends and broadens in the south, interpreted as a thinning of superficials and/or shallow chalk. Within this broad zone, numerous isolated pockets of high conductivity representing clay-rich pockets within shallow chalk bedrock have been mapped. It is recommended to ground-truth EM anomalies representing characters of chalk dissolution if possible.

4.6 Summary

The geophysical surveys completed at the site mapped broad ground characteristics and defined numerous localised variations. The EM survey provided a good I overview of the site, whilst the ERT survey targeted specific features in depth. The surveys identified local variations both at the superficial/bedrock interface and within the deeper bedrock unit that may be associated with the dissolution of the chalk.

Even though numerous zones that may indicate dissolution of the bedrock have been highlighted, only a representative number were selected for intrusive investigations (Table 7 and Figure 10). These recommendations were chosen to calibrate the main characters of anomalies mapped in the ERT survey. Once intrusive investigations are completed, it may be possible to refine the interpretation and apply it to other locations replicating similar characters.

ID	EASTINGS	NORTHINGS
1	514286.9	215954.2
2	514356.1	215892.9
3	514553.2	216064
4	514606.3	215869.7
5	514709.6	215830.3
6	514736.6	216156.4

***Table 7**: Locations of recommended intrusive investigations.*

5 CONCLUSIONS

- The geophysical survey has provided a non-invasive means for investigating the subsurface with a high degree of spatial coverage.

- The results of the ground conductivity survey and the electrical resistivity tomography survey correlate well and ably characterise the subsurface. The survey outlined a wide range of responses across the survey area, including broad zones and localised, isolated anomalies.

- The EM survey mapped the bulk ground conductivity to approximately ~3-4m bgl and indicated subtle changes within the superficial deposits. These include broad zones of clay-rich material, particularly in the centre of the site and more granular material in the east; outcrops of chalk bedrock have been mapped in the west. Across the site, a large number of small anomalous isolated pockets of differing material have been mapped.

- The modelled resistivity sections support the observed EM variations within the shallow superficials. The ERT survey proved to be a successful technique for detecting variations in ground conditions at depth. It has identified local variations both at the bedrock boundary and within the bedrock unit that may be associated with the dissolution of the chalk.

- Given that for some of the anomalous features in the ERT results, there is no corresponding EM response, some additional ERT may provide a more comprehensive insight into the subsurface. This may be more relevant in parts of the site where the chalk bedrock is deeper.

- It is recommended to ground-truth the main anomalies identified by the geophysical survey. If any additional information (e.g. borehole information) becomes available, it may be possible to extend the interpretation further and calibrate the datasets.

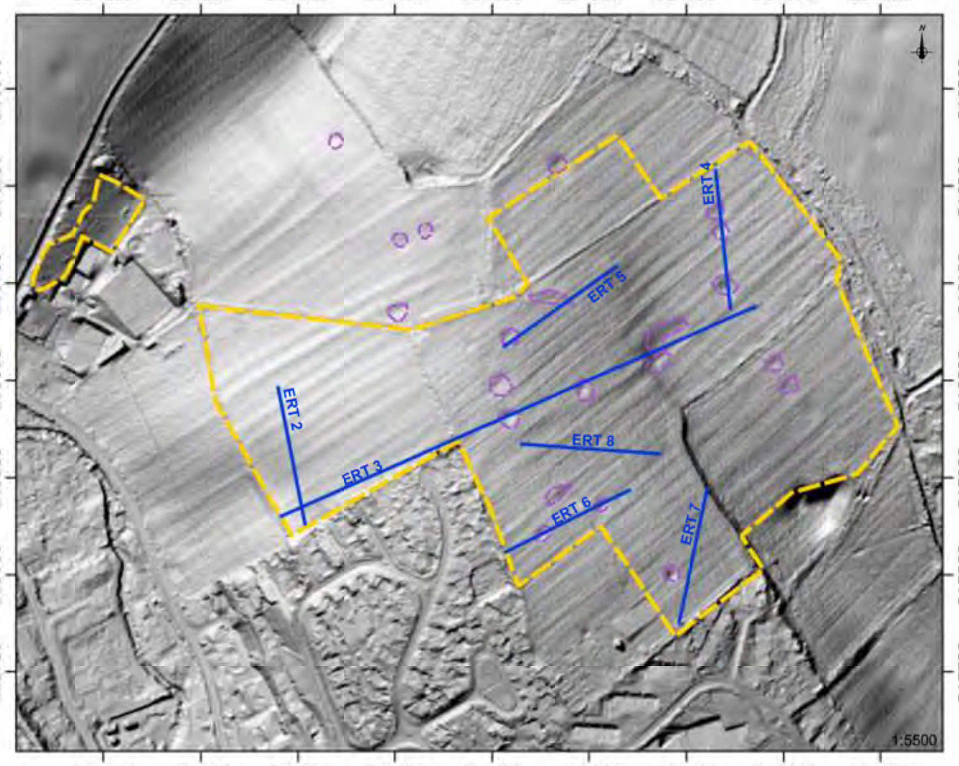
Disclaimer

This report represents an opinionated interpretation of the geophysical data. It is intended to guide follow-up invasive investigation. Features that do not produce measurable geophysical anomalies or are hidden by other features may remain undetected. Geophysical surveys complement invasive/destructive methods and provide a tool for investigating the subsurface; they do not produce data that can be taken to represent all the ground conditions found within the surveyed area. Areas that have not been surveyed due to obstructed access or any other reason are excluded from the interpretation.

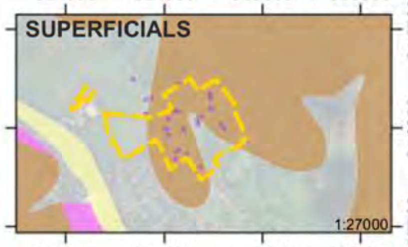
Figures

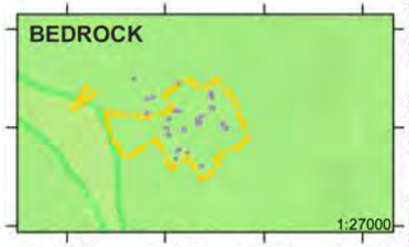
A - SITE OVERVIEW (Overlaid on Google Satellite Imagery, 2025)

B - LiDAR IMAGERY (Defra, 1m resolution, 2015, with ERT survey profile locations)



C - GEOLOGICAL INSERTS (BGS, 2025)



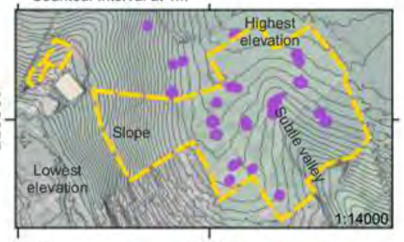


KEY GEOLOGY

- Clay with Flints - clay, silt, sand and gravel
- Alluvium - Clay, silt, sand and gravel
- Keysgrave catchment subgroup - sand and gravel
- Lewes Nodular Chalk and Seaford Chalk Formation
- Chalk rock
- Holywell Nodular Chalk and New Pit Chalk Formation

D - TOPOGRAPHICAL INSERT (DEFRA, 2025)

Countour interval at 1m



SITE LOCATION

KEY

- Geophysical survey area
- Outline of subtle Lidar feature
- ERT survey profile locations

NOTES

- All maps produced in QGIS, 2025.

- Satellite images, Google, 2025; not geo-referenced by Terradat.

- For locating geophysical features in the field please refer to coordinates rather than measuring from the Google satellite image.

SITE NOTES

The survey was designed to characterise the ground and to locate potential dissolution features within the chalk bedrock in preparation for a potential housing development at a site northeast of Harpenden, Hertfordshire. The area is underlain by the Lewes Nodular Chalk and Seaford Chalk Formation with a partial cover of superficials comprising clay with flints, silt, sand and gravel.

The majority of the survey area comprised fields used for grazing which were relatively flat and covered in short grass, divided by fencing and hedges. The exceptions were Field 1, which was a small soil covered paddock behind the stables, and Field 2, which was on a slope. Field 4 was excluded from the EM survey due to the expected interference from the metal fences.

An electromagnetic survey was completed across the whole accessible area in Phase 1; an ERT survey was completed in Phase 2 comprising 7 ERT profiles.

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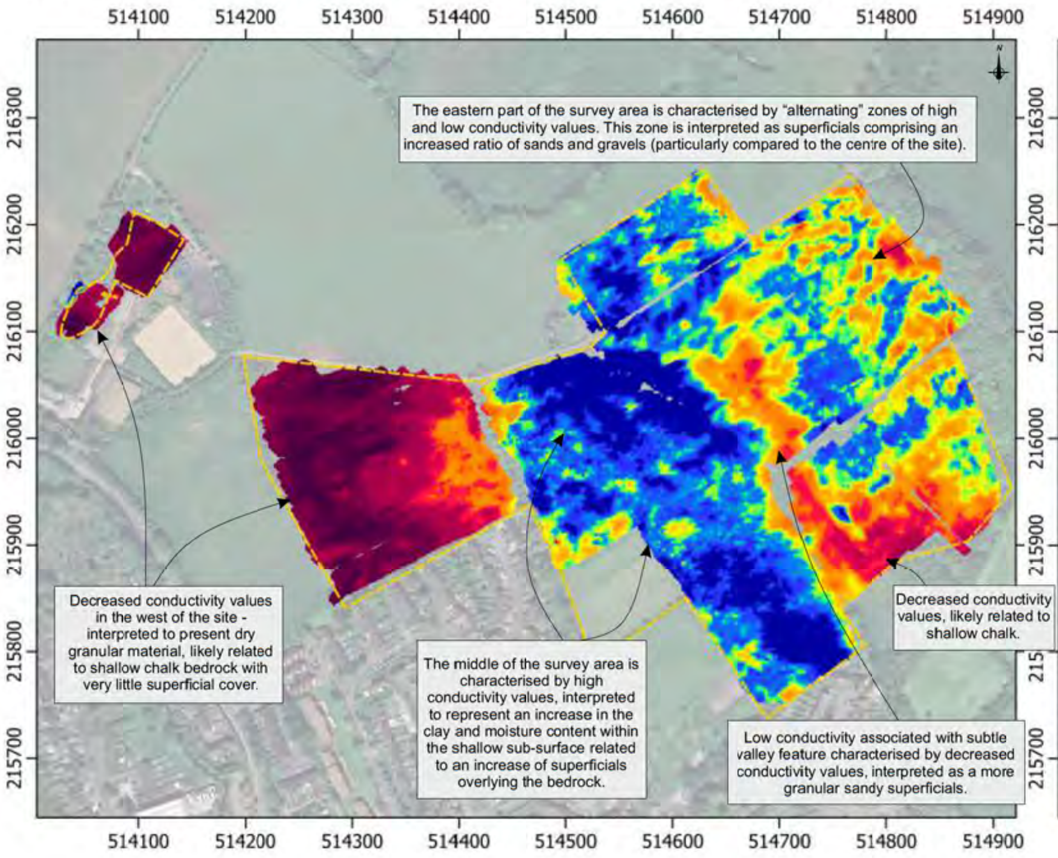
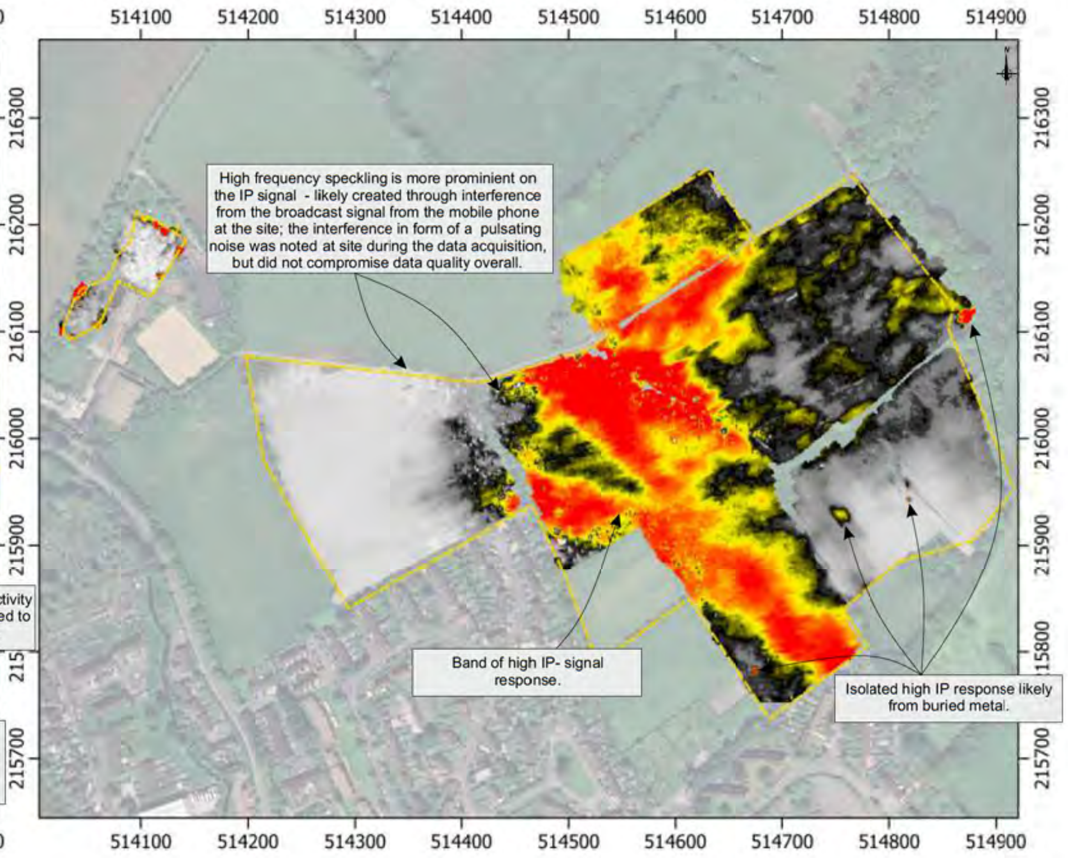
Title:	SITE OVERVIEW
Project:	HARPENDEN, HERTFORSHIRE
Scale:	See individual plots
Drawn by/Ref:	KZ/9217/1
Date:	April 2025

FIGURE 1

A - ELECTROMAGNETIC SURVEY RESULTS - GROUND CONDUCTIVITY (47MHz)



B - ELECTROMAGNETIC SURVEY RESULTS - IN-PHASE SIGNAL (47MHz)



NOTES

The results of the electromagnetic survey mapped different ground characteristics and potential features of interest.

It highlights zones of increased ground conductivity (in blues) which are interpreted to relate to an increase in clay and moisture content. Low ground conductivity (in reds) is interpreted to represent zones of decreased clay and moisture content or shallow bedrock. Areas that show extreme values or instrument overload indicate buried or surface metal.

Some "pulsing" signal interference was noted when on site, which is seen as speckles across the site in the data plots; this noise is thought to relate to some interference caused by some frequency output from the mobile phone mast located in the centre of the survey area.

Plot A presents the results of the EM Ground conductivity survey with all fields on the same colour scale allowing an easy comparison and interpretation for broad geological characters across the site. It highlights low conductivity values in the west of the site located at the slope of the hill, which is interpreted to present more resistive shallow chalk bedrock. The middle zone of the survey area represents high conductivity values which is interpreted to represent a thickening of superficials containing increased clay and moisture content. Intermediate conductivity values were mapped in the east of the site; pockets of low and high conductivity are interpreted to present more gravelly sandy superficials.

Plot B shows the results of the In-phase signal which is particularly sensitive to disturbed ground or metal.

KEY

Description of main EM features

Outline of Lidar feature location

EM survey site

COLOUR SCALES

A - Ground Conductivity (mS/m)

38.2 42.3 55.3 71.5 79.5 85.1 88.6 91.5 93.3 94.6 96.5 100.5 111.7

B - In-Phase signal (p/p/m)

-2108.9 -1643.2 -1429.4 -1253.7 -1090.9 -930.1 -733.1 -429.3

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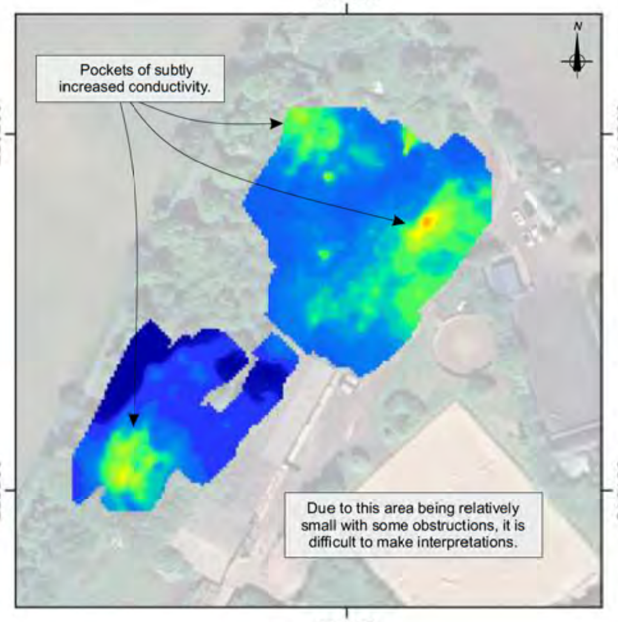
Title: **EM RESULTS - TOTAL SURVEY AREA**

Project: **HARPENDEN, HERTFORSHIRE**

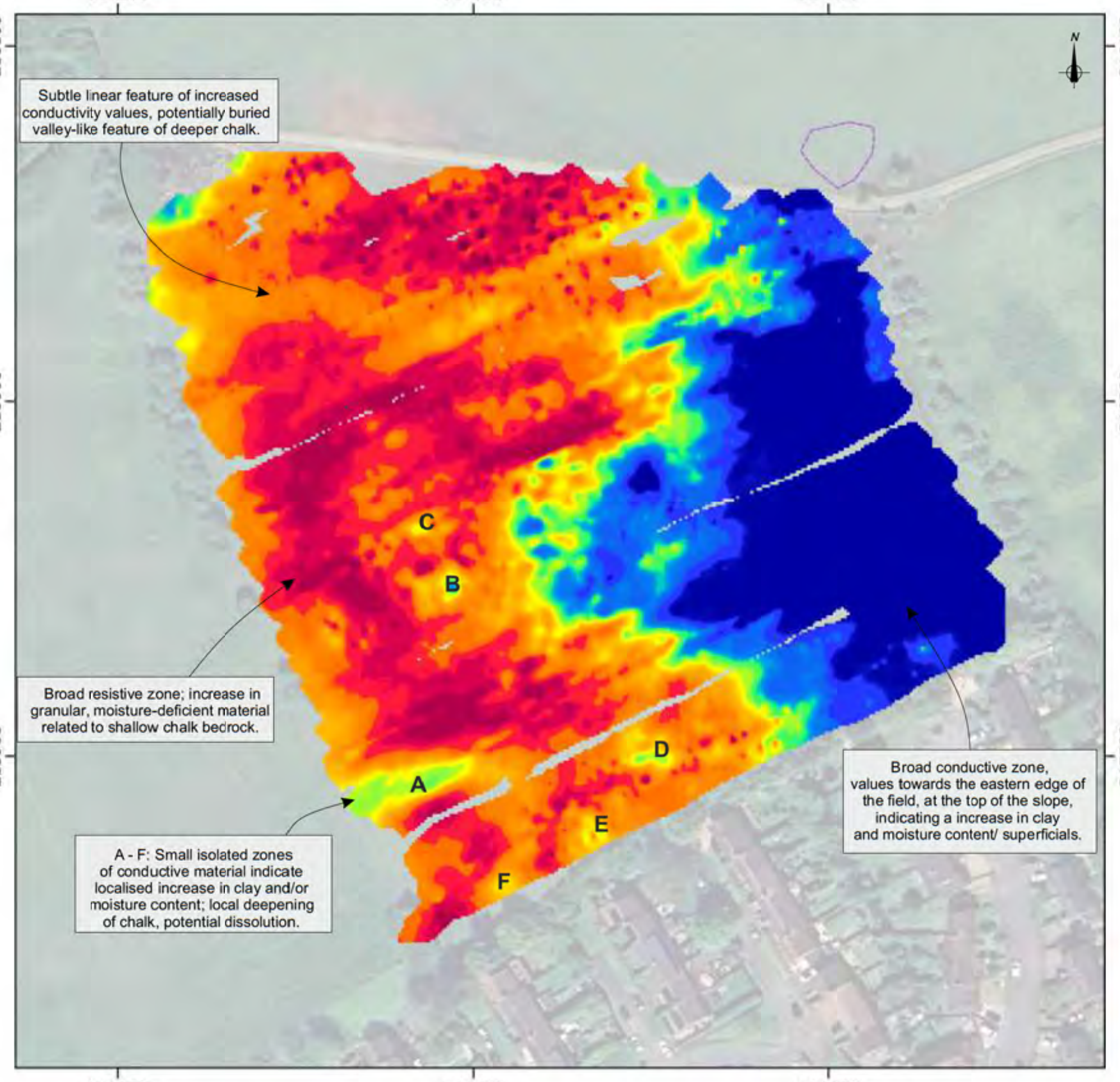
Scale: 1:5000 @ A3
Drawn by/Ref: KZ/9217/2
Date: April 2025

FIGURE 2

A - ELECTROMAGNETIC SURVEY RESULTS - GROUND CONDUCTIVITY (47MHz) - FIELD 1

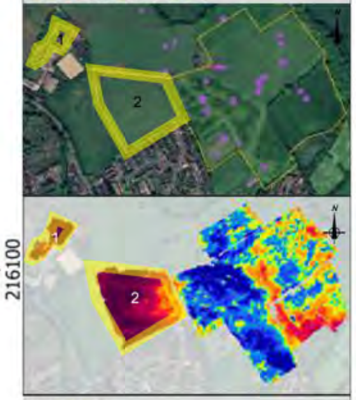


B - ELECTROMAGNETIC SURVEY RESULTS - GROUND CONDUCTIVITY (47MHz) - FIELD 2



Overall range of EM values 19 - 87 mS/m

LOCATION PLOT



NOTES

This plot presents the results of the electromagnetic survey using individual customised colour scales to highlight subtle variations within the individual fields.

Field 1 represents the most western field north of the stables. Due to bushes and trees overgrowing the edges, it was not possible to extent to the field boundary. Some localised, subtle variations have been mapped.

Field 2 is characterised by resistive ground compared to the rest of the survey area. In the eastern part of the field where the slope levels out, values become more conductive (increase in superficials).
Although the field is relatively homogenous within its broad sense, some subtle localised variations have been mapped.

No major Lidar anomalies have been observed in these two fields.

KEY

Main features detected in EM survey

Outline of Lidar feature location

COLOUR SCALES

Ground Conductivity (mS/m)

18.4 32.6 37.5 41.0 43.9 46.3 48.7 51.2 53.5 56.2 59.2 62.8 68.8

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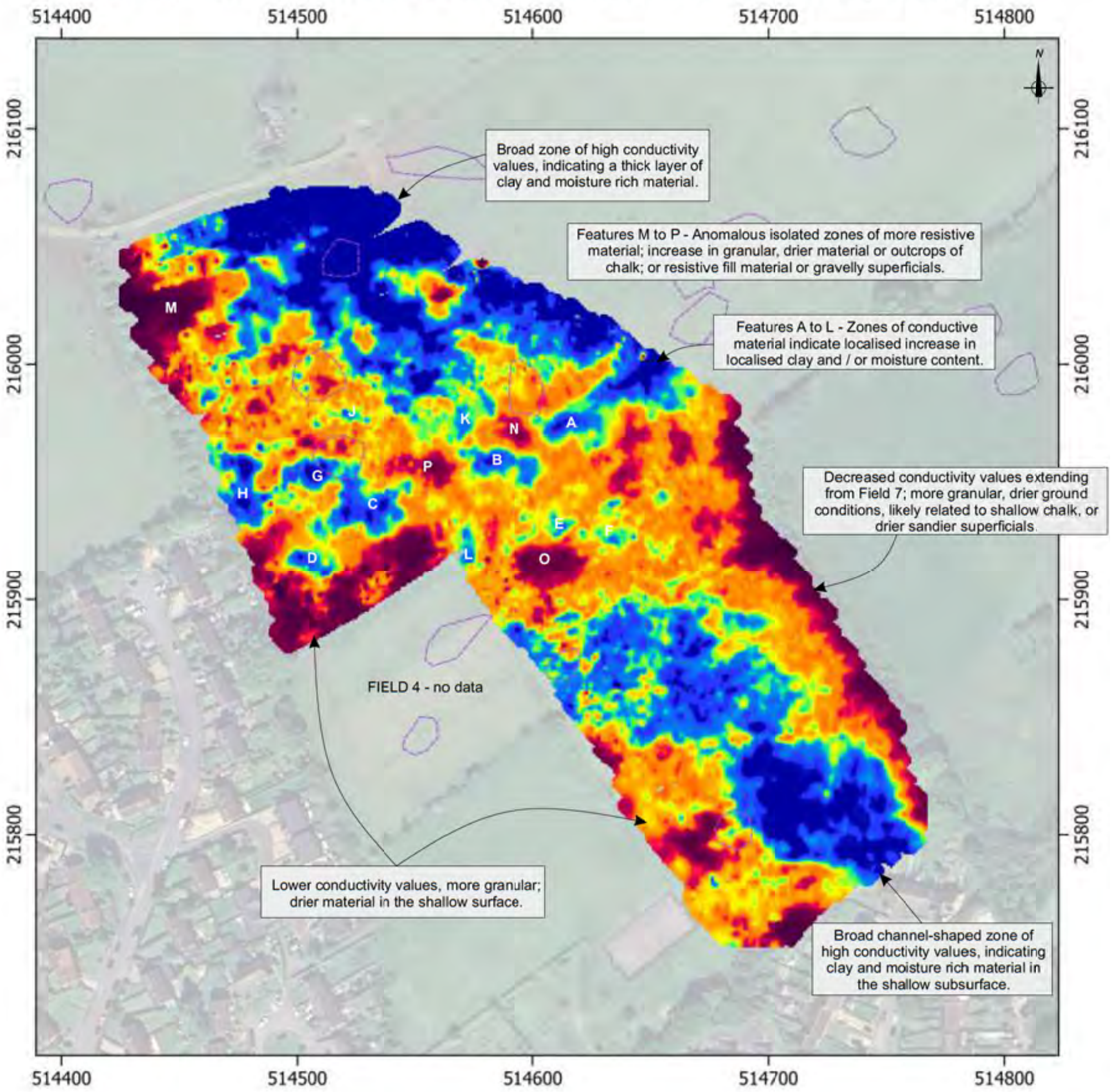
Title: **DETAILED EM RESULTS - FIELD 1 AND FIELD 2**

Project: **HARPENDEN, HERTFORSHIRE**

Scale:	1:1500 @ A3
Drawn by/Ref:	KZ/9217/3
Date:	April 2025

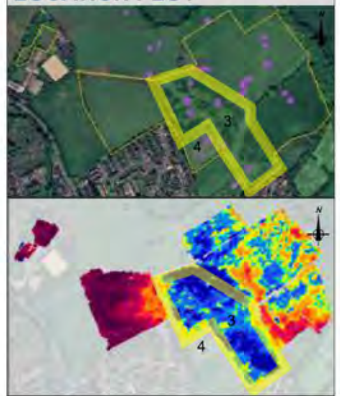
FIGURE 3

A - ELECTROMAGNETIC SURVEY RESULTS - GROUND CONDUCTIVITY (47MHz) - FIELD 3



Overall range of EM values 8 - 163 mS/m

LOCATION PLOT



NOTES

Plot A presents the results of the electromagnetic survey using individual customised colour scales to highlight subtle variations within the individual fields.

Field 3 is the central field south of the track with a number of Lidar depressions noted within this field. Compared to the rest of the site, this field exhibits the highest conductivity values. Applying a more detailed colour scale, some subtle variations are highlighted.

Field 4, adjoining Field 3 in the west, was inaccessible due to locked gates and electric fences crossing the survey area which could not be switched off.

KEY

Main features detected in EM survey

Outline of Lidar feature location

COLOUR SCALES

Ground Conductivity (mS/m)

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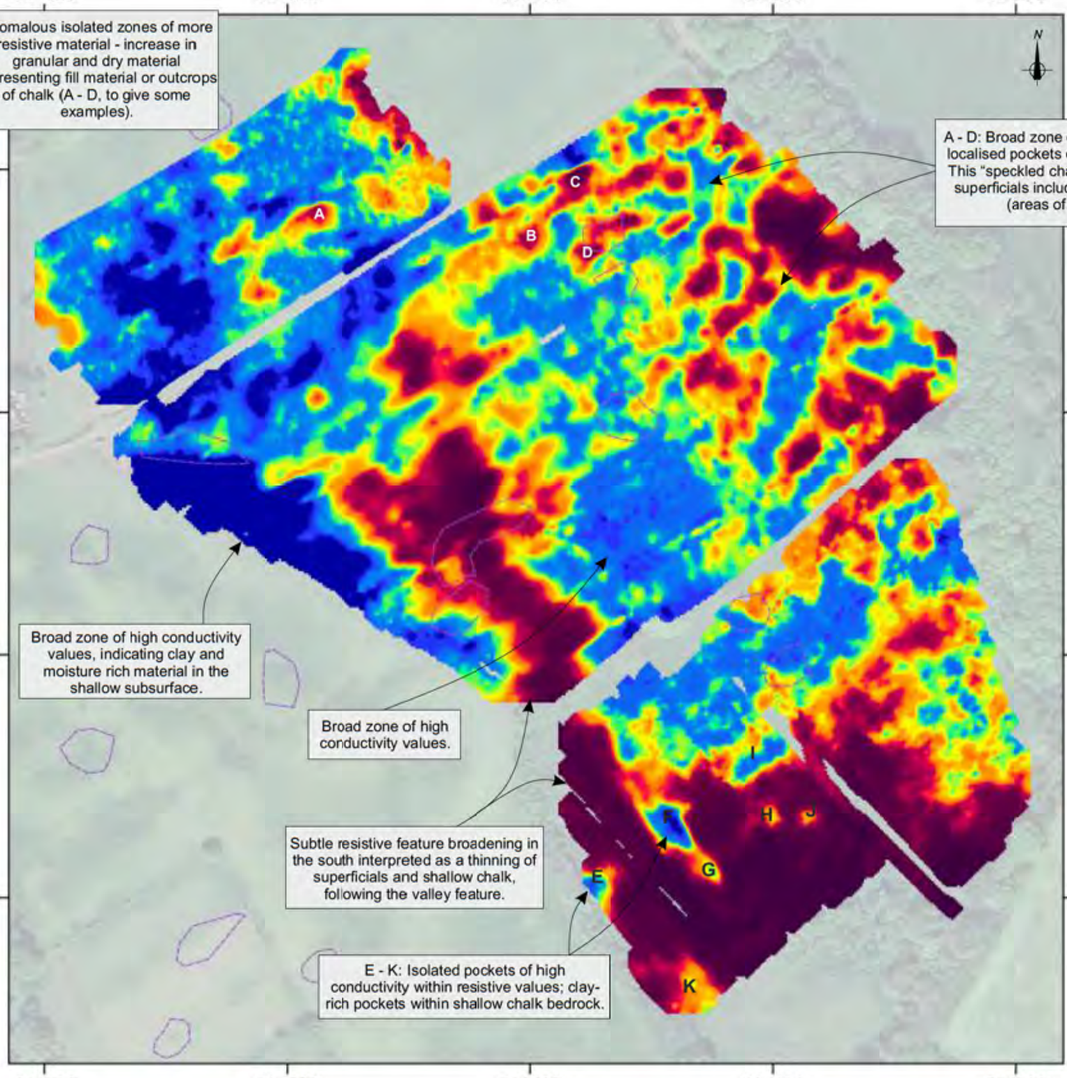
Title: **DETAILED EM RESULTS - FIELD 3**

Project: **HARPENDEN, HERTFORSHIRE**

Scale:	1:2200 @ A3
Drawn by/Ref:	KZ/9217/4
Date:	April 2025

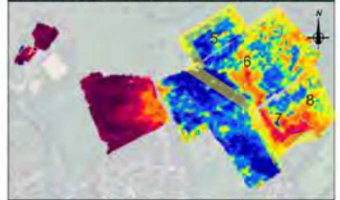
FIGURE 4

A - ELECTROMAGNETIC SURVEY RESULTS - GROUND CONDUCTIVITY (47MHz) - FIELDS 5, 6, 7 and 8



Overall range of EM values 51 - 140 mS/m

LOCATION PLOT



NOTES

This plot presents the results of the electromagnetic survey using individual customised colour scales to highlight subtle variations within the individual fields.

Plot A combines the four fields in the east of the site which are separated by fencing, a path or mature hedges and trees, yet, due to their similar values, all have been presented on the same colour scale.

The area presented shows high conductivity values in the west, likely related to clay and moisture rich superficials, overlapping from Field 3. This zone is intersected by a channel-shaped feature of more resistive values broadening in the south in Field 7, coinciding with a gentle linear valley at site. This feature may represent shallow chalk with more gravelly sandy superficials. The eastern part of this area shows a speckled chaotic distribution of more or less conductive material which may indicate zones of more sandy and gravelly superficials vs. pockets of superficials of high clay and silt content (high conductivity values).

KEY

Main features detected in EM survey

Outline of Lidar feature location

COLOUR SCALES

Ground Conductivity (mS/m)

75.5 86.6 89.7 92.3 94.4 96.2 98.0 99.8 101.6 104.1 107.0 111.6

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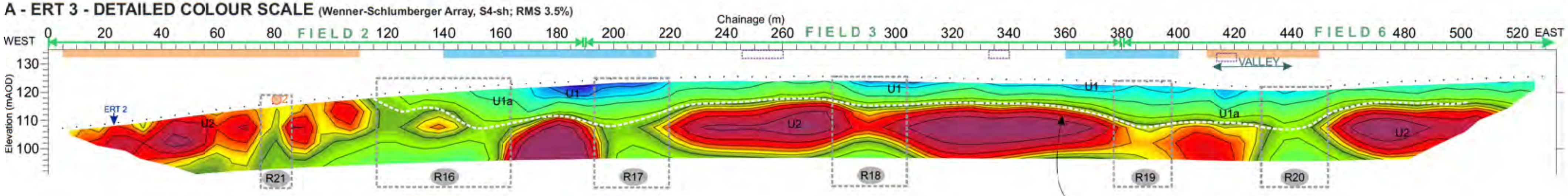
Title: **DETAILED EM RESULTS - FIELDS 5, 6, 7 and 8**

Project: **HARPENDEN, HERTFORSHIRE**

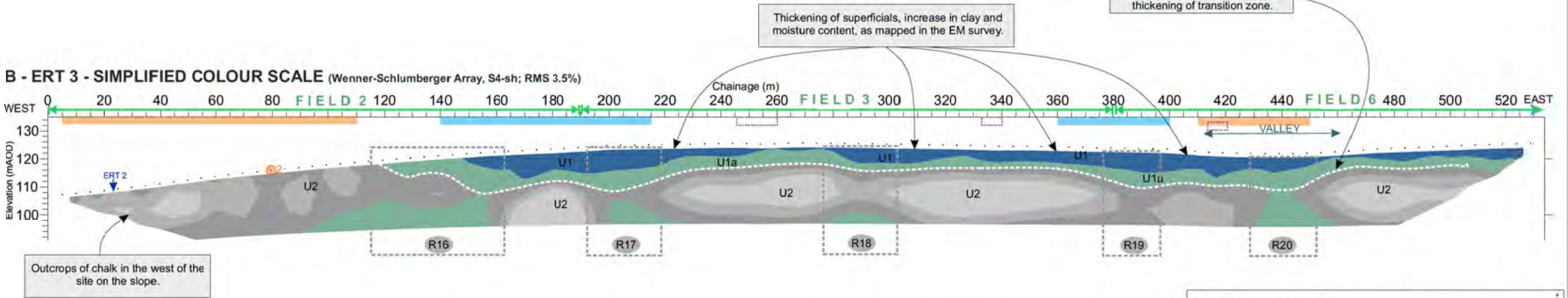
Scale:	1:2200 @ A3
Drawn by/Ref:	KZ/9217/5
Date:	April 2025

FIGURE 5

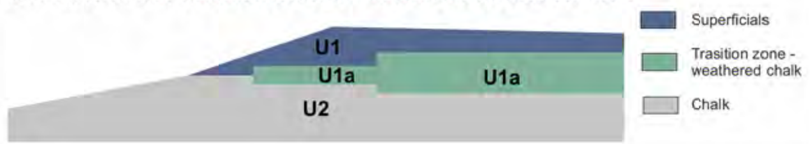
A - ERT 3 - DETAILED COLOUR SCALE (Wenner-Schlumberger Array, S4-sh; RMS 3.5%)



B - ERT 3 - SIMPLIFIED COLOUR SCALE (Wenner-Schlumberger Array, S4-sh; RMS 3.5%)



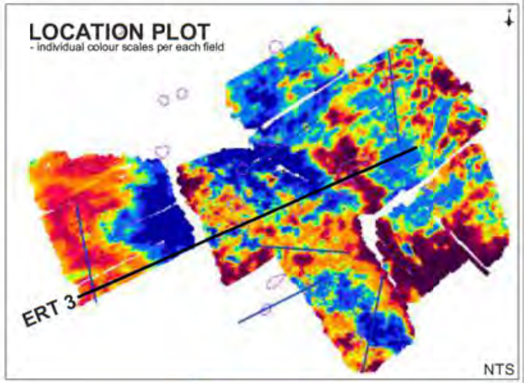
SCHEMATIC REPRESENTATION OF GEOLOGY FOUND AT SITE



ANOMALOUS FEATURE DESCRIPTION

R16 - Reduction in resistive U2 unit, resistivity values may indicate weakening of bedrock or change in lithology.
R17 - Discontinuation of U2; vertical feature of intermediate resistivity values.
R18 - Depression and thinning in the upper boundary of U2 which may indicate weakening of chalk.
R19 and **R20** - Anomalous areas coinciding with location of topographical valley visible on the surface; the U2 unit appears to drop off which further gets intersected by intermediate values, indicating change in bedrock lithology / potential weakening.
R21 - Anomalous discontinuity in resistive layer in vicinity of subtle but anomalous EM feature.

LOCATION PLOT
- individual colour scales per each field



NOTES

This figure shows the results of ERT profile 3 (in a detailed and simplified colour scale), acquired to provide clarification on geological characters across the whole site. The profile is 533m long and was acquired with a different array as the rest of the profiles (an array put out with 5m spaced electrodes, yet, providing comparable resolution in the shallow surface to the other array).

The profile highlights (1) the relative variability of superficials depth to bedrock across site; (2) the transition zone between clay-rich material/superficials and chalk bedrock also appears deeper in some zones; (3) the U1 unit appears to indicate more intermediate resistivity values; and (4) a number of additional anomalies have been located in this profile, which may be relevant in relation to dissolution or weakening of the bedrock.

GEO-ELECTRICAL UNIT DESCRIPTION

U1 - Unit in the shallow surface displaying very low resistivity values, interpreted to represent material of high clay and moisture content, likely representing superficials.

U1a - Transition zone between conductive and resistive unit

U2 - Unit of high resistivity values, interpreted to present chalk bedrock.

KEY ERT

- ERT survey profile location
- Selected EM feature of high conductivity
- Selected EM feature of low conductivity
- Surface feature (as described)
- Anomalous feature detected in the ERT survey
- Extent of Lidar feature
- ERT# ERT profile crossing
- Recommendation for intrusive investigation
- Based on 65 Ohm.m. contour

COLOUR SCALE

Resistivity Ohm.m

12 15 18 21 25 34 49 63 74 81 88 94 100 107 120 136 171

5 35 65 95 130

Reduced clay and water content

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Title: RESULTS ERT PROFILE 3

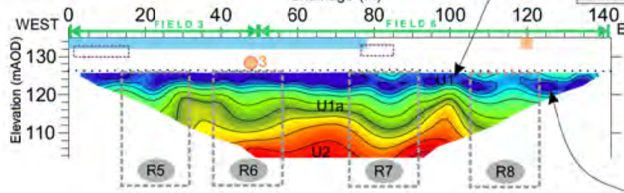
Project: HARPENDEN, HERTFORSHIRE

Scale:	1:1400 @ A3
Drawn by/Ref:	KZ/9217/6
Date:	April 2025

FIGURE 6

FIELD 3

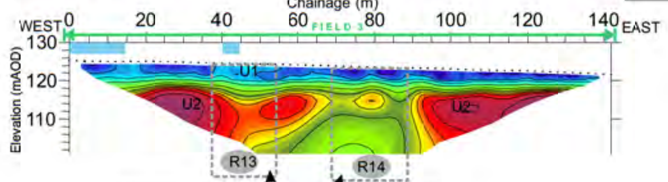
A - ERT 5 (Wenner-Schlumberger Array; S4-dp; RMS 2.5%)



Thicker strata of low resistivity values (superficials) with a deeper transition zone (weathered chalk) in the north of Field 3; the shallow resistive strata as seen in other ERT profiles lies deeper in ERT 5.

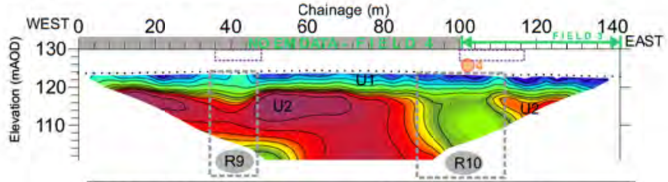
Comparing detailed resistivity values of the shallow U1 unit it appears that superficials in the east of the site contain more granulars and sands (particularly compared the centre, as mapped in EM survey).

B - ERT 8 (Wenner-Schlumberger Array; S4-dp; RMS 1.7%)



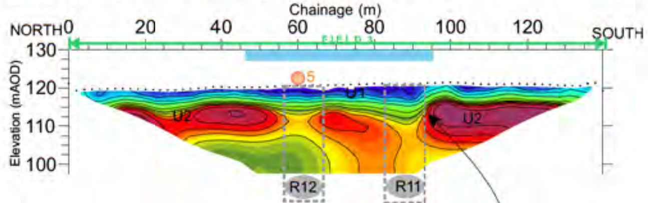
Two characters of potential chalk bedrock weaknesses (R13 and R14)

C - ERT 6 (Wenner-Schlumberger Array; S4-dp; RMS 1.8%)



ERT profile 6 displays stable conditions of the U2 unit presenting a continuous horizontal subsurface; exceptions are R9 and R10 which indicate an undulation and a mayor vertical anomalous intersection in the chalk bedrock.

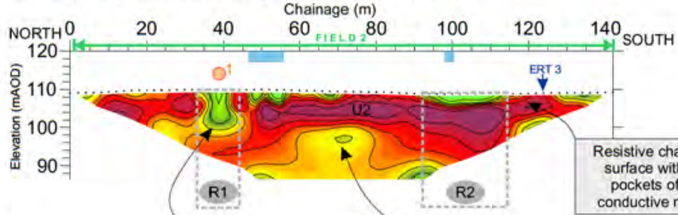
D - ERT 7 (Wenner-Schlumberger Array; S4-dp; RMS 1.9%)



The U2 layer is intersected by zone of generally decreased resistivity values; a "step" in the chalk bedrock subsurface (R11) and a thinning in resistive values (R12) indicate possible weaknesses in the bedrock.

FIELD 2

E - ERT 2 (Wenner-Schlumberger Array; S4-dp; RMS 1.7%)



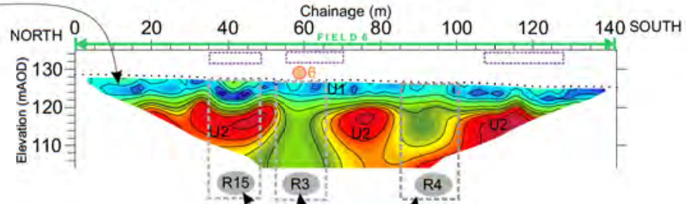
Resistive chalk at the surface with small pockets of more conductive material.

Isolated anomalous feature in the shallow bedrock likely related to locally weakened chalk lithology.

Conductive zone

FIELD 6

F - ERT 4 (Wenner-Schlumberger Array; S4-dp; RMS 2.9%)



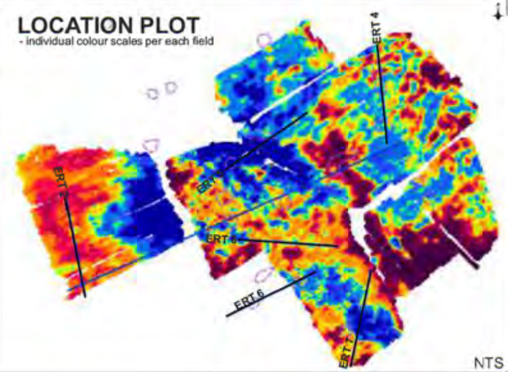
ERT profile 4 mapped three different features of potential dissolution of the bedrock.

COORDINATES ERT

		Easting	Northing	Elevation
ERT2	START	514279.5	215992.3	109.0
	END	514307.3	215853.2	109.3
ERT3	START	514282.7	215860.9	106.8
	END	514770.7	216076.0	125.7
ERT4	START	514730.6	216215.5	128.6
	END	514745.7	216074.3	125.2
ERT5	START	514512.6	216035.3	126.3
	END	514628.4	216117.1	126.1
ERT6	START	514514.0	215823.7	123.7
	END	514639.0	215885.8	122.7
ERT7	START	514692.8	215751.9	121.2
	END	514721.7	215888.1	119.3
ERT8	START	514530.8	215934.9	125.2
	END	514672.1	215924.9	121.6

LOCATION PLOT

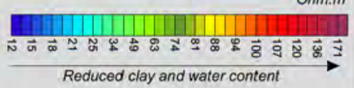
- individual colour scales per each field



KEY ERT

- ERT survey profile location
- Selected EM feature of high conductivity
- Selected EM feature of low conductivity
- Surface feature (as described)
- Anomalous feature detected in the ERT survey
- Extent of Lidar feature
- ERT# ERT profile crossing
- Recommendation for intrusive investigation

COLOUR SCALE



NOTES

ERT profiles 2, 4, 5, 6, 7, and 8 mapped the ground to a maximum depth of ~20m BGL highlighting subtle differences in ground characters. Deviations or features mapped in the ERT survey have been highlighted and marked as R1 to R15.

The range of ERT values distinguish between zones of different ground characters; resistive zones are interpreted to represent material of more granular and / or drier character and bedrock; low resistivity zones are interpreted to comprise high amount of fine particles, clay or an increase in moisture content.

GEO-ELECTRICAL UNIT DESCRIPTION

U1 - Unit in the shallow surface displaying very low resistivity values, interpreted to represent material of high clay and moisture content, likely representing superficials.

U1a - Transition zone between conductive and resistive unit

U2 - Unit of high resistivity values, interpreted to present chalk bedrock

ANOMALOUS FEATURE DESCRIPTION

R1 - Localised anomalous zone indicating intermediate resistivity values.
R2 - Intermediate resistivity values indicating shallow bowl-like depression; increase in clay or moisture-rich material.
R3 - Broad vertical anomalous feature intersecting U2 layer, highlighting intermediate values.
R4 - Distinct bowl-shaped anomaly of intermediate resistivity values indicating discontinuation of U2.
R5 and **R8** - Two separate zones of intermediate resistivity values at either end of the ERT profile within the broad transition zone, indicating potential further deepening of intermediate resistivity value s/ change in chalk lithology.
R6 and **R7**- Two separate areas indicating bowl-shaped deepening of broad transition boundary.
R9 - Bowl-shaped undulation in the U2 unit
R10 - Sub-vertical zone intersecting the U2 unit indicating discontinuation / vertical anomalous feature within the chalk bedrock.
R11 and **R12** - Two separate zones of decreased resistivity values intersecting U2.
R13 - Bowl-shaped undulation in the U2 unit.
R14 - Broad zone of intermediate resistivity values intersecting U2 extending to depths.
R15 - Subtle depression in the upper U2 boundary, indicating undulation in the chalk, overlain by low resistivity values and intermediate resistivity values in the shallow surface.

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Title: **ERT RESULTS - TARGETED PROFILES**

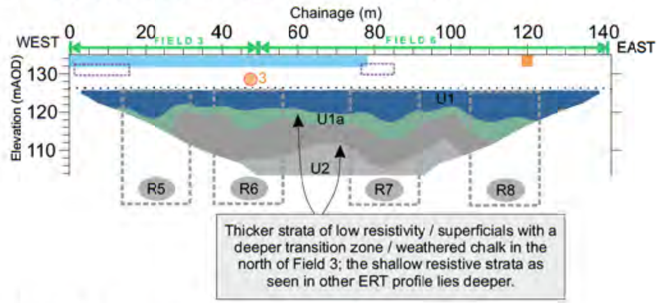
Project: **HARPENDEN, HERTFORSHIRE**

Scale:	1:1400 @ A3
Drawn by/Ref:	KZ/9217/7
Date:	April 2025

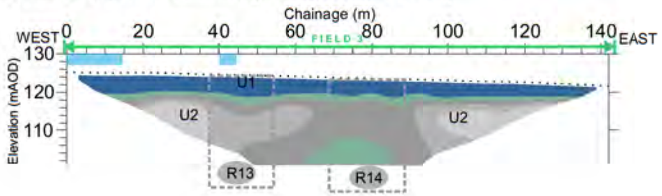
FIGURE 7

FIELD 3

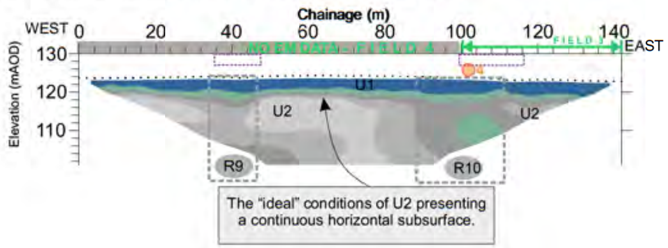
A - ERT 5 (Wenner-Schlumberger Array; S4-dp; RMS 2.5%)



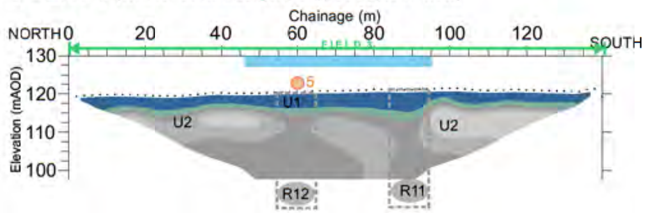
B - ERT 8 (Wenner-Schlumberger Array; S4-dp; RMS 1.7%)



C - ERT 6 (Wenner-Schlumberger Array; S4-dp; RMS 1.8%)

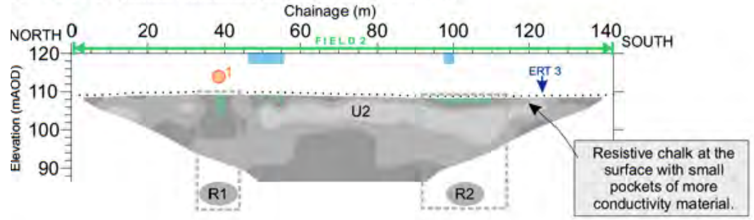


D - ERT 7 (Wenner-Schlumberger Array; S4-dp; RMS 1.9%)



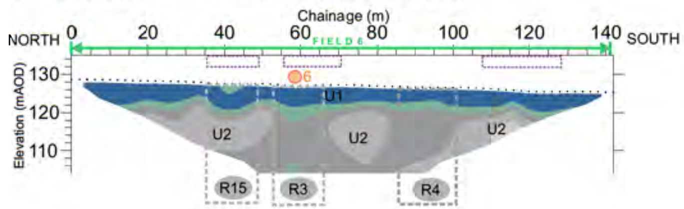
FIELD 2

E - ERT 2 (Wenner-Schlumberger Array; S4-dp; RMS 1.7%)



FIELD 6

F - ERT 4 (Wenner-Schlumberger Array; S4-dp; RMS 2.9%)

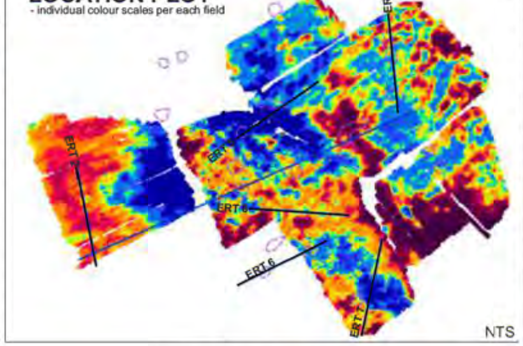


COORDINATES ERT

		Easting	Northing	Elevation
ERT2	START	514279.5	215992.3	109.0
	END	514307.3	215853.2	109.3
ERT3	START	514282.7	215860.9	106.8
	END	514770.7	216076.0	125.7
ERT4	START	514730.6	216215.5	128.6
	END	514745.7	216074.3	125.2
ERT5	START	514512.6	216035.3	126.3
	END	514628.4	216117.1	126.1
ERT6	START	514514.0	215823.7	123.7
	END	514639.0	215885.8	122.7
ERT7	START	514692.8	215751.9	121.2
	END	514721.7	215888.1	119.3
ERT8	START	514530.8	215934.9	125.2
	END	514672.1	215924.9	121.6

LOCATION PLOT

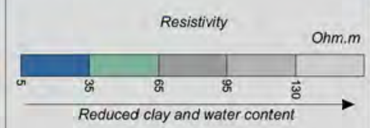
- individual colour scales per each field



KEY ERT

- ERT survey profile location
- Selected EM feature of high conductivity
- Selected EM feature of low conductivity
- Surface feature (as described)
- Anomalous feature detected in the ERT survey
- Extent of Lidar feature
- ERT# ERT profile crossing
- Recommendation for intrusive investigation

COLOUR SCALE



NOTES

This figure shows the results of the ERT profiles, same as in Figure 6, but presented in a simplified colour scale.

It helps to highlight different geological characters mapped within the site, in particular, the distribution of superficials. The western part of the site indicates a lack of the low resistivity unit U1 (on the slope, eg. ERT 2 and 3), whilst the thickest unit of superficials has been mapped in the northern centre of the site.

The ERT profiles indicate the upper boundary of the chalk bedrock very well; even if anomalous features as shown in Figure 6 may appear more subtle in the simplified colour scale.

GEO-ELECTRICAL UNIT DESCRIPTION

U1 - Unit in the shallow surface displaying very low resistivity values, interpreted to represent material of high clay and moisture content, likely representing superficials.

U1a - Transition zone between conductive and resistive unit

U2 - Unit of high resistivity values, interpreted to present chalk bedrock.

ANOMALOUS FEATURE DESCRIPTION

R1 - Localised anomalous zone indicating intermediate resistivity values.
R2 - Intermediate resistivity values indicating shallow bowl-like depression; increase in clay or moisture-rich material.
R3 - Broad vertical anomalous feature intersecting U2 layer, highlighting intermediate values.
R4 - Distinct bowl-shaped anomaly of intermediate resistivity values indicating discontinuation of U2.
R5 and **R8** - Two separate zones of intermediate resistivity values at either end of the ERT profile within the broad transition zone, indicating potential further deepening of intermediate resistivity value s/ change in chalk lithology.
R6 and **R7**- Two separate areas indicating bowl-shaped deepening of broad transition boundary.
R9 - Bowl-shaped undulation in the U2 unit
R10 - Sub-vertical zone intersecting the U2 unit indicating discontinuation / vertical anomalous feature within the chalk bedrock.
R11 and **R12** - Two separate zones of decreased resistivity values intersecting U2.
R13 - Bowl-shaped undulation in the U2 unit.
R14 - Broad zone of intermediate resistivity values intersecting U2 extending to depths.
R15 - Subtle depression in the upper U2 boundary, indicating undulation in the chalk, overlain by low resistivity values and intermediate resistivity values in the shallow surface.

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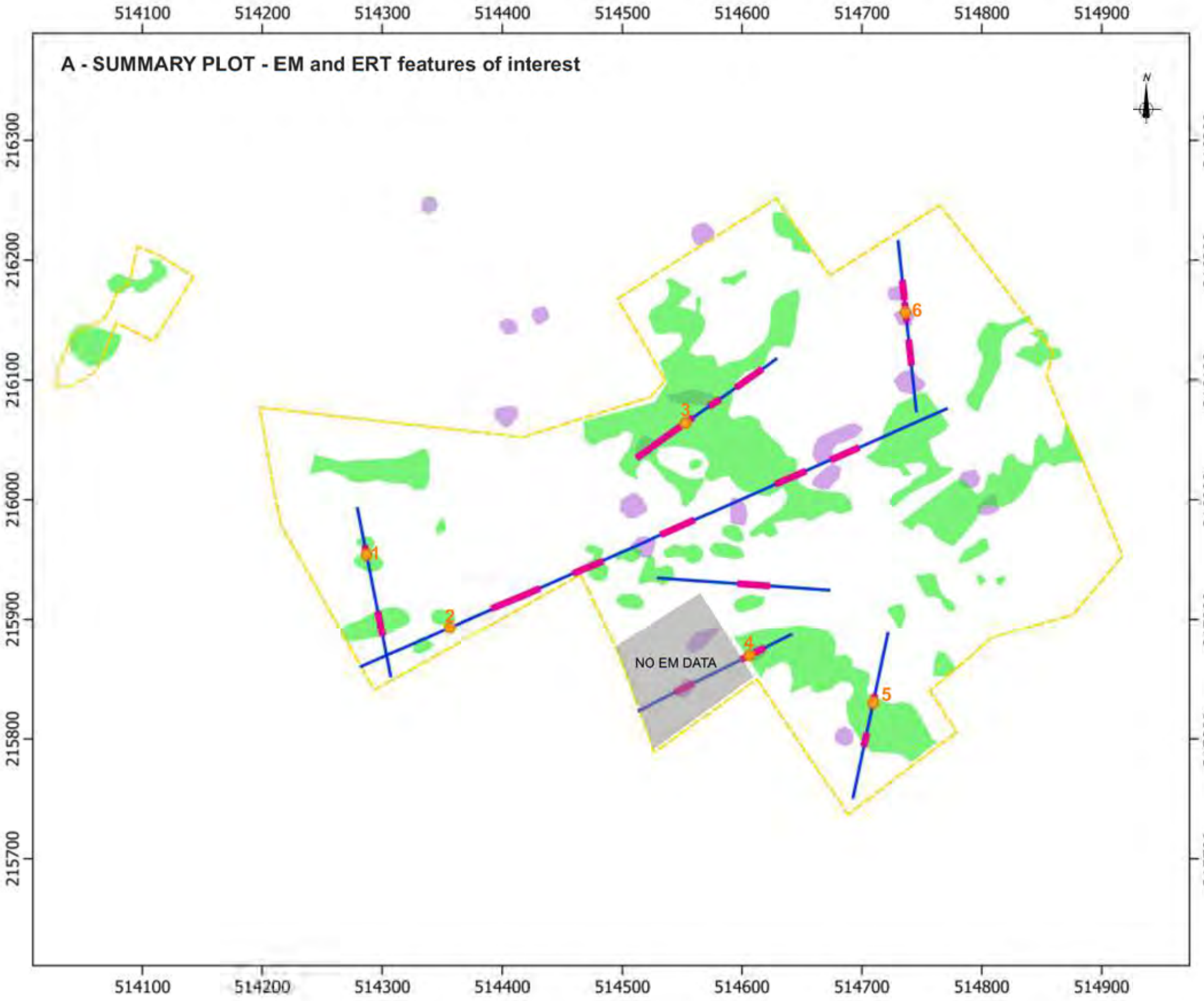
Title: **TARGETED PROFILES SIMPLIFIED COLOUR SCALE**

Project: **HARPENDEN, HERTFORSHIRE**

Scale:	1:1400 @ A3
Drawn by/Ref:	KZ/9217/8
Date:	April 2025

FIGURE 8



B - COORDINATES FOR RECOMMENDED INTRUSIVE INVESTIGATIONS

ID	EASTINGS	NORTHINGS
1	514286.9	215954.2
2	514356.1	215892.9
3	514553.2	216064.0
4	514606.3	215869.7
5	514709.6	215830.3
6	514736.6	216156.4

NOTES

This figure shows main anomalies and features of interest with regards to potential presence of dissolution or weakening of the bedrock. Due to the large number of isolated and broad zones, anomalies have been generalised.

Comparing the results of the EM survey with the locations of anomalous Lidar features, it becomes clear that anomalous features which may represent dissolution of the chalk bedrock are not obvious in the EM survey; no correlation of EM features with Lidar features has been possible. Yet, the ERT results provided useful information on the general geology across the site highlighting changes in superficials and depth to bedrock. The survey managed to clarify locations of weakened or changed bedrock lithology, and displayed different characters of weaknesses or changes within the bedrock.

Some recommendations for intrusive investigations were given. Considering the large amount of potential weaknesses and dissolution features, it would be advisable to extend the ERT survey further to get an enhanced image of subsurface features away from Lidar anomalies.

KEY

- Geophysical survey area
- ERT survey profile location
- Lidar features
- Feature of interest detected in the EM survey
- Feature of interest detected in the ERT survey
- Recommendation for intrusive investigation and ID

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Title: SUMMARY

Project: HARPENDEN, HERTFORSHIRE

Scale: 1:4000 @ A3

Drawn by/Ref: KZ/9217/9

Date: April 2025

FIGURE 9

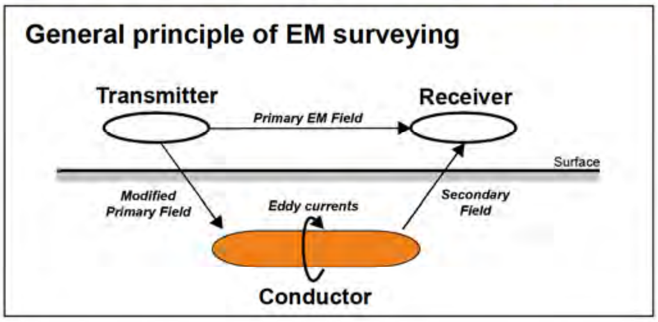
Appendices

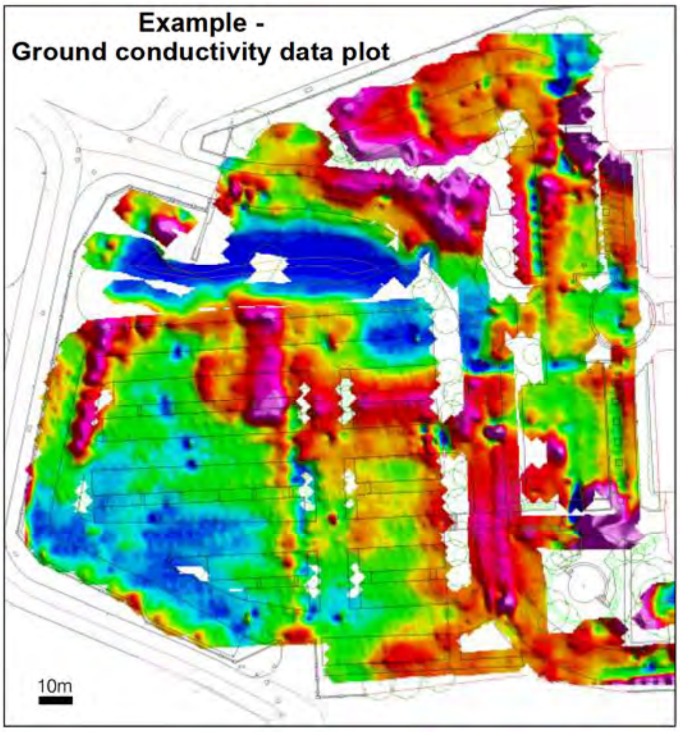
Electromagnetic Survey

The electromagnetic (EM) technique involves the generation of an EM field at the surface and measuring the response of the ground as it propagates into the subsurface. The main components of an EM survey instrument are a transmitter (for the generation of the primary field) and a receiver (for measuring the induced secondary field). The instrument functions by inducing current into the ground via a transmitter coil which causes the generation of secondary electromagnetic fields in any ground conductors present within the depth range of the particular instrument. These secondary fields are measured at a receiver coil, and the instrument can record ground conductivity and in-phase component (metal indicator) at each survey station.

Electromagnetic (EM) surveys are carried out using man-portable instruments with readings taken on a regular grid or along selected traverse lines. If site conditions permit, the EM instrument may be mounted/towed behind a quad bike and positional control is provided by dGPS. The selection of the particular EM instrument (GEM2/EM-38/EM-31/EM-34) is based on the required penetration depth of the survey.

The results from the EM survey can be presented as colour contoured plots of conductivity and inphase (metal response) data. In general terms, a relative increase in conductivity values usually indicates a local increase in clay content or water saturation. However, if there is a corresponding increase in the inphase response, the influence of some artificial source is likely (i.e. metal).





At the end of the survey, the data are downloaded to a field computer and corrected for instrument, diurnal and positional shifts. Additional editing may be carried out to remove non-essential or 'noisy' data values/positions. The dataset is then processed to enhance any identifiable anomalies.

Constraints

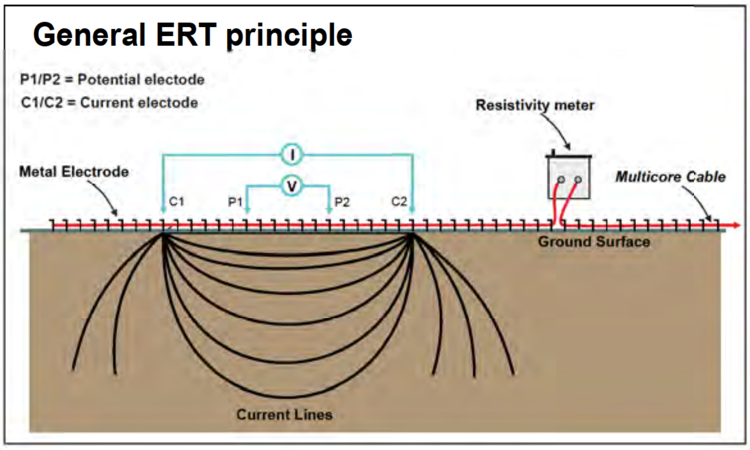
Power lines, buildings, metal structures (fences, rebar, vehicles, debris etc.) and buried services can interfere with the electromagnetic measurements.

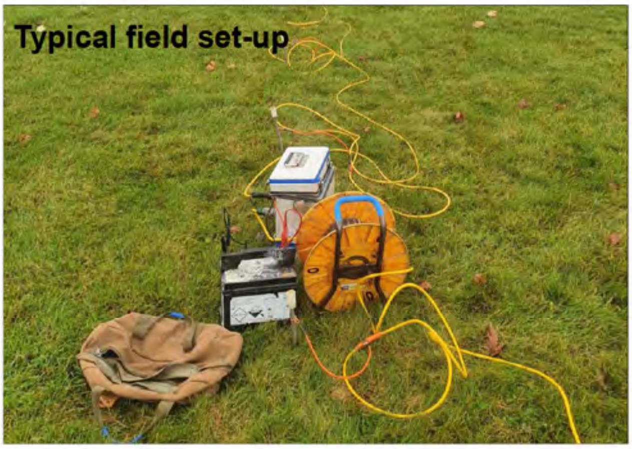
Electrical Resistivity Tomography

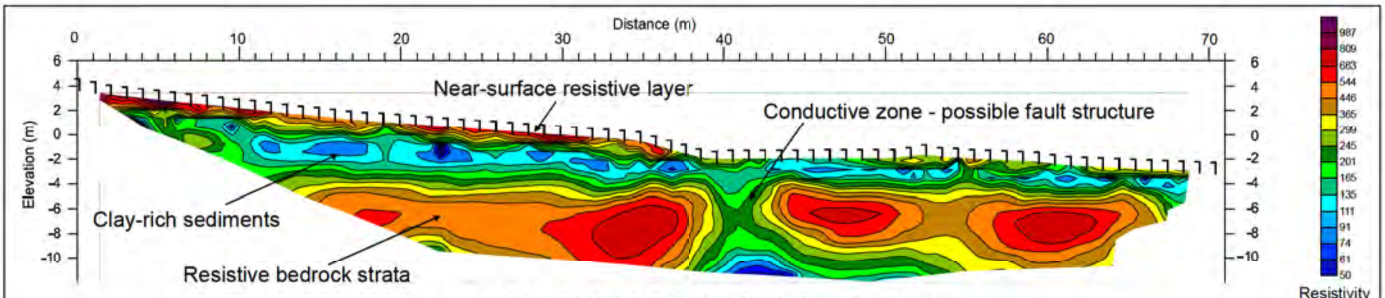
The resistivity technique is a useful method for characterising the sub-surface materials in terms of their electrical properties. Variations in electrical resistivity (or conductivity) typically correlate with variations in lithology, water saturation, fluid conductivity, porosity and permeability, which may be used to map stratigraphic units, geological structures, sinkholes, fractures and groundwater.

The acquisition of resistivity data involves the injection of current into the ground via a pair of electrodes and then the resulting potential field is measured by a corresponding pair of potential electrodes. The field set-up requires the deployment of an array of regularly spaced electrodes, which are connected to a central control unit via multi-core cables. Resistivity data are then recorded via complex combinations of current and potential electrode pairs to build up a pseudo cross-section of apparent resistivity beneath the survey line. The depth of investigation depends on the electrode separation and geometry, with greater electrode separations yielding bulk resistivity measurements from greater depths.

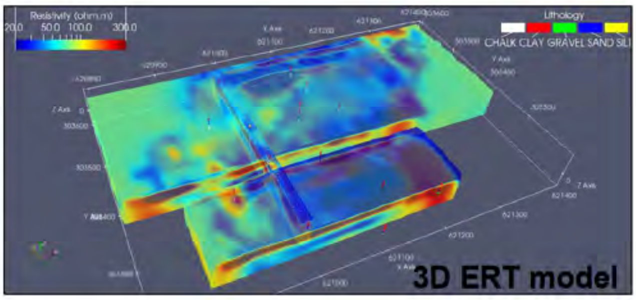
The recorded data are transferred for processing. To derive a cross-sectional model of true ground resistivity, the measured data are subject to a finite-difference inversion process via RES2DINV software.







Modelled 2D resistivity section



The true resistivity models are presented as colour contour sections revealing spatial variation in subsurface resistivity. The 2D method of presenting resistivity data is limited where highly irregular or complex geological features are present, and a 3D survey may be required. Geological materials have characteristic resistivity values that enable identification of boundaries between distinct lithologies on resistivity cross-sections. At some sites, however, there are overlaps between the ranges of possible resistivity values for the targeted materials which therefore necessitates use of other geophysical surveys and/or drilling to confirm the nature of identified features.

Constraints:

Readings can be affected by poor electrical contact at the surface. An increased electrode array length is required to locate increased depths of interest therefore, the site layout must permit long arrays. Resolution of target features decreases with increased depth of burial.

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