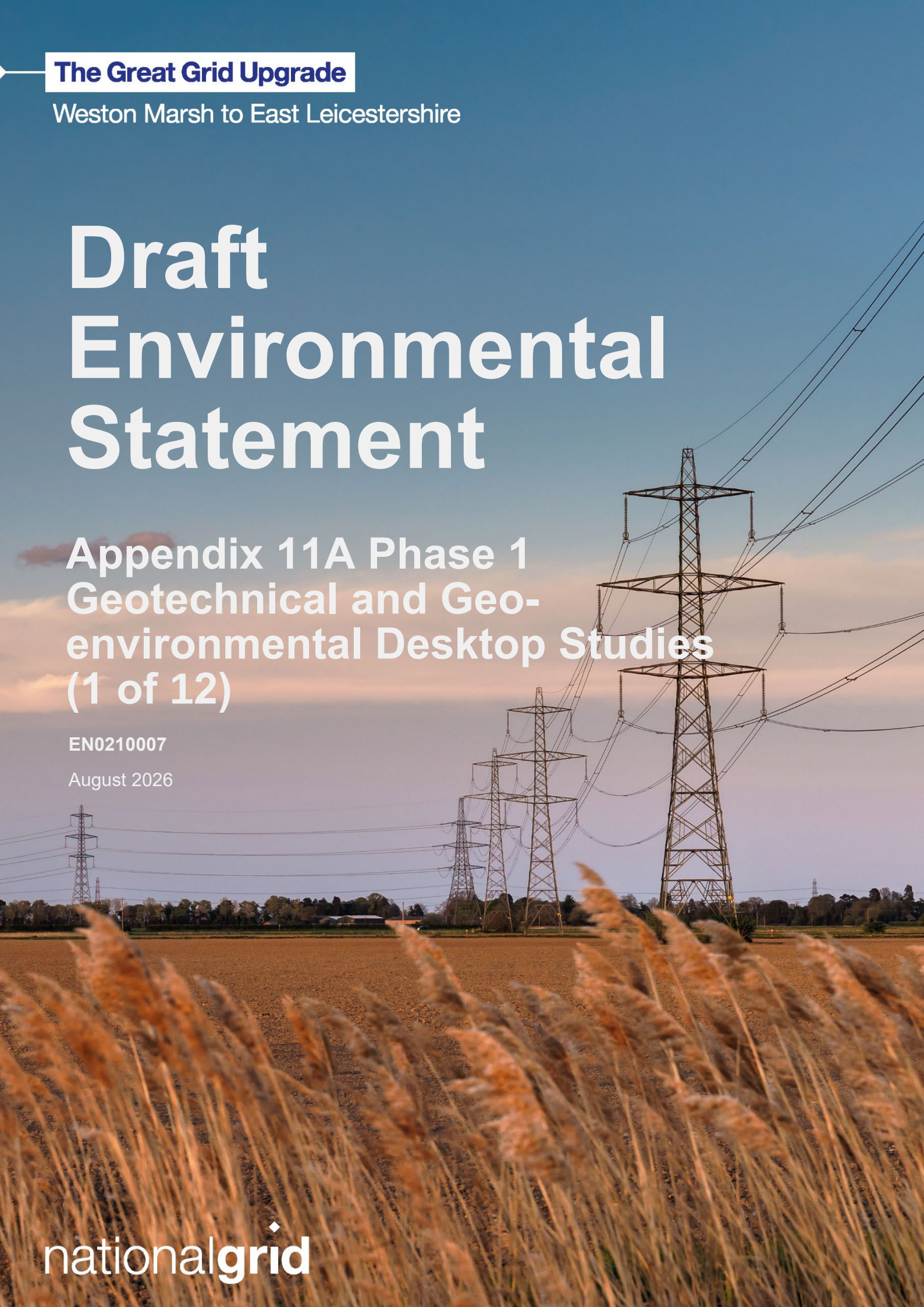




The Great Grid Upgrade

Weston Marsh to East Leicestershire

Draft Environmental Statement

Appendix 11A Phase 1 Geotechnical and Geo- environmental Desktop Studies (1 of 12)

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August 2026

nationalgrid

11A. Phase 1 Geotechnical and Geo- environmental Desktop Studies



The Great Grid Upgrade

Weston Marsh to East Leicestershire

Phase 1 Geotechnical and Geo- Environmental Desktop Study Report

Weston Marsh to WMEL A Overhead Line

June 2026

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The methodology adopted and the sources of information used by AECOM Arup in providing its services are outlined in this report. The work described in this report was undertaken between November 2025 and June 2026 and is based on the conditions encountered and the information available during the said period of time. The scope of this report and the services are accordingly factually limited by these circumstances. AECOM Arup disclaim any undertaking or obligation to advise any person of any change in any matter affecting the report, which may come or be brought to the attention of AECOM Arup after the date of the report.

Any risks identified in this report are perceived risks, based on the information reviewed during the Desktop Study and therefore partially based on conjecture from available information. The

study is limited by the non-intrusive nature of the work and actual risks can only be assessed following a physical investigation of the site.

The opinions expressed in this report and the comments and recommendations given are based on a desk-based assessment of readily available information. At this stage intrusive investigations have yet to be undertaken at site to establish actual ground and groundwater conditions.

Reference to historical Ordnance Survey (OS) maps provides invaluable information regarding the land use history of a site. However, historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps.

Executive Summary

On the instruction of National Grid Electricity Transmission (NGET), AECOM Arup Joint Venture (AAJV) has undertaken a Phase 1 Geotechnical and Geo-environmental Desktop Study for the Weston Marsh to WMEL-B Overhead Line routes to provide baseline ground information in support of the Development Consent Order (DCO) and future ground investigation and design. This report comprises the Phase 1 Geotechnical and Geo-environmental Desktop Study for the overhead line route between Weston Marsh and WMEL-A Substation.

The Proposed Development is understood to comprise the construction of the new overhead line route comprising towers and permanent haulage/maintenance roads, alongside other associated enabling works (including potential cut/fill and drainage). The site, defined by the Design Freeze (DF) 2 Revision (Rev) B draft Order Limits, is linear in nature, forming a corridor approximately 30.7km in length through a rural setting predominantly consisting of agricultural fields. The site extends from the new Weston Marsh Substation B in the east (527910 327146) to the proposed new WMEL-A Substation located to the south of the village of Burton Coggles, in the west (498443 323745). For the purpose of this assessment, the site is divided into seven (7) regions based on common geological, ground engineering and topographical settings.

The published British Geological Survey (BGS) 1:50,000 scale (Map Sheets 143 Bourne, 1971 and 1972, and 144 Spalding, 1992) and 1:10,000 scale maps indicate the site is underlain by a generally conformable sedimentary sequence of Jurassic limestones, sandstones and mudstones, most notably the Oxford Clay, Rutland, and Lincolnshire Limestone formations, overlain by quaternary superficial deposits of glacial, fluvial and marine origin. A patchwork of observed and inferred faults is mapped in western regions of the site. Larger faults, including the Woodlands Fault, strike approximately east to west, downthrown to the south east, with minor interconnecting faults generally striking south west to north east.

The BGS maintains an archive of historical exploratory hole records throughout the UK. A limited number of these exploratory holes, mostly historical with the most recent record from 1997, are within proximity of the site such that they which were considered useful to inform the geological and groundwater conditions under the site. In situ test data from the exploratory hole records were limited, and, upon a high-level review of a list of historical ground investigation reports noted to be on the National Grid Enterprise Content Management (ECM) portal, none of the reviewed reports are considered relevant to the site at the time of writing.

The preliminary ground model for the site indicates that coverage and thickness of superficial deposits throughout the site is significant, with uninterrupted Tidal Flat deposits and River Terrace deposits over the eastern half of the site overlying the Oxford Clay Formation, and Till (boulder clay) covering parts of the western half of the site, cut by valley features exposing the underlying and generally conformable sequence of Jurassic sandstones, mudstones and limestones, with Alluvium filling valley floors.

There is evidence of historical quarrying and surface workings on the site. In addition, part of the site lies within a designated Mineral Safeguarding Area for the Lincolnshire Limestone, therefore consultation with the Mineral Planning Authority is required and potentially a full Minerals Assessment ahead of the works.

The main ground related hazards vary across the site, directly related to the geotechnical properties of the superficial and/or bedrock materials and variable groundwater level, including settlement, running sands, and the potential for voids from karst features and mining features.

Notable potential sources of contamination on the site include localised areas of Made Ground (associated with on and off-site structures and infrastructure) and infilled land (associated with infilled pits and ponds), with widespread general agricultural land use across the majority of the site throughout its mapped history, as well as localised land use for pumping stations (water and sewage), historical blacksmith, railway land, tanks, landfill, vehicle repairs, and electricity substations. Risks from these potential contaminant sources have been assessed for three identified receptor groups (Human Health, Controlled Waters and Property). Human health risks are generally considered Low to Moderate/Low, with the highest risk to on-site construction and GI workers from inhalation of dust fibres, particularly asbestos, and elevated risk where asbestos is a Contaminant of Potential Concern (CoPC) at specific on-site or off-site sources. A Moderate risk is also appropriate for construction/GI workers regarding inhalation of ground gases associated with the off-site landfill and sewage pumping station, where general assessment in accordance with BS 8576 identifies a 'moderate to very high' generation potential. Controlled waters are the most sensitive receptors due to highly variable superficial geology that may allow contaminant migration, with risks highest where sources coincide with Secondary A or Principal Aquifers and lower where Made Ground, infilled land or agricultural land is present, or where sources are linked to less vulnerable aquifers (Secondary B or Unproductive). Surface water risk arises from groundwater baseflow permeable units and from surface runoff over impermeable units. Risks to property, including pylon foundations, livestock and crops, are considered Very Low to Low due to the relatively mild consequence.

Based on preliminary findings, it is anticipated that, from a geotechnical perspective, earthworks, retaining structures, and bespoke foundation designs will be required to manage changes in ground levels and loading associated with the development of the site. The need and extent of these works will depend on the final layout of the development, given the variable topography, ground conditions, and the access requirements and limitations for the haulage/maintenance roads.

It is recommended that a ground investigation is undertaken in accordance with UK Specification for Ground Investigation 3rd Edition. In brief, the outline scope of works is anticipated to include boreholes, trial pitting, in-situ testing (including Standard Penetration Testing, California Bearing Ratio Tests, Infiltration Tests, PID headspace and Percolation Tests), sampling of soil and groundwater, geotechnical and geo-environmental laboratory testing and groundwater and gas monitoring.

Access for a site reconnaissance (walkover) was not available prior to the completion of this report; however, the site will be revisited by AAJV Geotechnical/Geo-environmental Engineers in advance of any intrusive works. Any additional findings will be incorporated into subsequent reporting and investigation specifications to further profile ground risks.

1. Introduction

1. Introduction

1.1 Terms of appointment

- 1.1.1 On the instructions of National Grid Electricity Transmission (NGET), hereafter referred to as ‘the Client’, the AECOM Arup Joint Venture (“AAJV”) has carried out a Phase 1 Geotechnical and Geo-environmental Desktop Study of the site known as Weston Marsh to WMEL-A overhead lines, associated with the overall Weston Marsh to East Leicestershire (WMEL) project (“the Project”).

1.2 Background and Proposed Development

- 1.2.1 This revision of the Desktop Study report has been produced on the assumption that the site, defined by the Design Freeze (DF) 2 Revision (Rev) B draft Order Limits (‘Draft Order Limits Boundary – DF2 Rev B P02 – 21/05/2026’) shown in Figure 1 in Appendix A, will be redeveloped as a new overhead line route with associated haul roads between proposed new substations at Weston Marsh and WMEL-A (reported separately in LSTC Group report **20_210792_39** and AAJV report **WMEL-AAJ-SS51-ZZZZZZ-RPT-GE-000001** respectively).
- 1.2.2 The haul roads are proposed to enable the construction of the towers, along with a number of permanent access roads to provide long-term maintenance access. Earthworks (cut and fill), along with localised crossing points to accommodate existing infrastructure and natural features, are proposed to facilitate haul road construction and may also be required for other enabling works such as construction compound and laydown areas.
- 1.2.3 It is noted that the development proposals are in development stages and consequently are subject to further change. The findings of this report should be reviewed if changes to the extents of the site Redline Boundary areas are proposed.
- 1.2.4 The development of the site is anticipated to require the following stages:
- Establishment of site construction compound and laydown areas.
 - Construction of haul roads (including earthworks and crossings).
 - Construction of attenuation ponds and drainage channels.
 - Construction of overhead line towers.
- 1.2.5 It is noted that as part of the DF2 Rev B boundary order limits, local detached areas of boundary are present. These are understood to be associated with offsite highway works or works compounds. These detached areas are outside the scope of this Report.
- 1.2.6 For ease of reference, the site has been divided into 7 Regions (Regions 1-7) based on anticipated common geological, ground engineering and topographical settings, with the longer Regions of the site then being further divided into Sub-regions. The Sub-regions are intended to capture particular features and zones of geographic importance in greater detail than the main Regions. The Region and Sub-region divisions are shown in Figure 1 in Appendix A and summarised in Table 1.1.

Table 1.1. Sub-region extents and geographical references

Region	Sub-region	Extents (from)		Extents (to)		Description (key geographical references)
		Easting	Northing	Easting	Northing	
1	1a	527910	327146	526764	327366	River Welland and Vernatt's Drain
	1b	526764	327366	525271	327593	A16 and River Glen
	1c	525271	327593	523699	327605	South of Surfleet
	1d	523699	327605	522182	327640	Sleaford to Spalding line crossing
	1e	522182	327640	521075	327665	North of Coward's Lane
	1f	521075	327665	519268	327740	Cheal Lane to Beck Bank
	1g	519268	327740	517190	327055	North west of Northgate
	1h	517190	327055	515565	326581	South Forty Foot Drain
	1i	515565	326581	513851	326324	Haconby Lode East
	1j	513851	326324	512368	326100	Haconby Lode West
2	2a	512368	326100	511083	325909	East of Haconby
	2b	511083	325909	509650	325692	North of Haconby
	2c	509650	325692	508693	325254	West of Haconby
	2d	508693	325254	507578	324572	South east of Stainfield
3	- ¹	507578	324572	505806	324510	Hangman's Lane
4	- ¹	505806	324510	504855	324758	East Glen River valley
5	- ¹	504855	324758	503244	324225	North of Home Farm
6	- ¹	503244	324225	501301	324135	West of Norwood Farm
7	7a	501301	324135	499733	323777	South of Corby Glen to West Glen River
	7b	499733	323777	498443	323754	West Glen River to WMEL-A

Notes:¹ Regions not sub-divided due to short length and similar geological conditions.

1.3 Report objectives

- 1.3.1 The primary objective of this report is to provide baseline information to support the Development Consent Order (DCO) for the scheme and inform ground investigation scope and specification, alongside subsequent interpretative reporting and design and construction stages of the project.
- 1.3.2 This report has been prepared following the recommended good practice outlined in accordance with Eurocode 7 (BS EN 1997-2:2007) and the UK government guidance resource “Land Contamination: Risk Management (LCRM)” (Updated 2025) and comprises:
- A description of the site layout and setting.
 - A review of the site’s geological, hydrological and hydrogeological setting, and public domain geo-environmental information to build up a more accurate understanding of the site and surrounding environmental setting/sensitivity.
 - The identification and review of potential geotechnical hazards and constraints, including the production of a preliminary geotechnical risk register, with consideration given to presence of historical mining and underground structures.
 - An appraisal of current and historical development and land use across the site and the surrounding area, with a particular emphasis on identifying potential on-site and off-site contamination sources.
 - The production of an initial Conceptual Site Model (CSM) and Preliminary (Qualitative) Risk Assessment in accordance with the guidance document Environment Agency, Land Contamination Risk Management (LCRM 2025) (Ref 13.34).
 - Preliminary recommendations for additional geotechnical and geo-environmental investigation and assessment works required.

1.4 Sources of information

- 1.4.1 The following sources of information have been considered in the authoring of this report, either accessed directly or within the Project Fuse viewer:
- British Geological Survey (BGS) Geoindex, Mapping (1:50k and 1:10k scale) and Memoirs.
 - British Geological Survey (BGS) Historical Borehole Records.
 - Groundsure Insights GIS Dataset, including historical mapping, associated with the DF2 Revision B draft Order Limits (included as part of the Project ‘Fuse’ WebGIS and therefore not appended here).
 - Coal mining/mineral extraction records, including Mining Remediation Authority map viewer. (Ref 13.48)
 - Freely available InSAR data.
 - BGS/ICE seismic hazard assessment for UK.
 - Environment Agency Magic Maps. (Ref 13.31)
 - Environmental Agency Catchment Data Explorer. (Ref 13.38)

- RadonUK. (Ref 13.64)
 - Council planning portals. (Ref 13.3, Ref 13.4, Ref 13.24, Ref 13.32, Ref 13.41, Ref 13.48, Ref 13.53, Ref 13.54, and Ref 13.56)
 - LandIS Soilscales. (Ref 13.45)
 - Zetica UXO Risk Map. (Ref 13.65)
 - Fellows International Group Preliminary UXO Risk Assessment from June 2026 (included in Appendix F).
- 1.4.2 Specific information sources are referenced throughout this report, and a bibliography is included in Report Section 13.
- 1.4.3 It is noted that a site reconnaissance has not been feasible at the time of reporting and is subject to land access agreements. Once the site reconnaissance has been completed, the findings should be incorporated in a further revision of this report, the Ground Investigation Specification, and/or subsequent Ground Investigation Report as appropriate.
- 1.4.4 The Detailed Unexploded Ordnance (UXO) risk assessment for the site is also awaited at the time of writing and findings should be reviewed and incorporated into subsequent ground investigation specifications.
- 1.4.5 Furthermore, non-intrusive or intrusive survey data has not been made available at the time of writing and therefore has also not been considered. Subject to when non-intrusive survey data is received, this may be reviewed in this report and findings updated as necessary. Intrusive survey data will be reviewed during the interpretative reporting stage of the project.

1.5 Draft Order Limits variations and report revisions

- 1.5.1 The following general changes between the DF2 Revision B and previously reported DF1.5 draft Order Limits are summarised below:
- Haul road deviation between 526490 327440 and 525810 327600, rerouted to cross the A16 between 250m to 350m further north than the proposed overhead line alignment (Region 1b).
 - Haul road deviation between 523200 327660 and 522620 327680, rerouted between 650m to 850m north along the east and west sides of the Sleaford to Spalding railway line to the level crossing on Gubbole's Drove (Region 1d).
 - Haul road deviation between 509770 325650 and 509330 325600, rerouted to cross the A15 around 315m further north than the proposed overhead line alignment (Region 2c).
 - Haul road deviation between 505650 324520 and 505260 324630, rerouted around 350m south to follow the meander of the East Glen River (Region 4).
 - Haul road deviation between 502750 324260 and 502450 324270, rerouted to cross Swinstead Road around 1.1km further south than the proposed overhead line alignment (Region 6).
 - Change of alignment of Region 6 to extend west along the south side of Bourne Road, south of Corby Glen.

- Change of alignment of Region 7 to extend west, crossing the West Glen River to around 1.1km south of Corby Glen, then splitting into a west and north arm toward the WMEL-A site boundary.
- Site wide addition of areas to build attenuation ponds and drainage.
- Site wide addition of areas to build construction compound and laydown areas.
- Local re-alignments of haul routes to account for and deconflict with existing field boundaries, land access restrictions, and environmental/ecologically sensitive areas.

1.5.2 The updates made to this revision of the report post previous issue are summarised in Table 1.2. No further updates have been made to this report other than those presented here.

Table 1.2. Summary of report revisions

Revision	Report Section	Details
P03	All Report Sections and Appendices	Update to account for DF2 Revision B draft Order Limits.

2. Site setting

2. Site setting

2.1 Location

- 2.1.1 The site is linear in nature and extends from the proposed Weston Marsh Substation B, north of the village of Weston, Lincolnshire (527910 327146) to the proposed WMEL-A Substation, adjacent to the East Coast Main Line (ECML) to the south of the village of Burton Coggles, Lincolnshire (498443 323754). The Site Location Plan, including extents of associated draft Order Limits, is presented in Figure 1 in Appendix A.

2.2 Description and setting

- 2.2.1 The site extends approximately 30.7km from east to west through a predominantly rural setting generally formed of agricultural fields with associated field boundaries, drainage ditches, local woodland, and both natural and manmade surface water features. The alignment of the site crosses numerous public access routes including roads, railways and public rights of way, together with existing buried and overhead line infrastructure. The draft Order Limits generally incorporate a working width of approximately 150m from the proposed overhead line alignment, with expanded footprints in selected areas around significant crossings, potential construction access routes, locations of proposed enabling works (construction compounds, laydown areas and attenuation ponds) and where specialist construction activities are anticipated to be required. The topography along the site is generally flat and low lying across the Lincolnshire Fens in the east and rises to gently rolling hills and valleys across the western half of the site.
- 2.2.2 For the purpose of this assessment, the site is divided into seven (7) Regions based on common geological, ground engineering and topographical settings. Table 2.1 presents a high-level description of each Region of the site, with notable intersecting and immediately adjacent ground features based on background Ordnance Survey (OS) and satellite mapping presented in the Fuse viewer. This summary and the presence of additional details/notable features should be reviewed following the site reconnaissance.

Table 2.1. Site description and notable adjacent features summary

Region	Description (moving east to west)	Notable adjacent features
1	The Region generally extends east to west through flat arable farming fields, starting north of Wykeham, with a kink to the south west between Northgate Road and South Forty Foot Drain, and ending to the east of Haconby. The following features are crossed: 1. River Welland (527380 327360) extending north east to south west (Region 1a). 2. Vernatt's Drain (527270 327420) extending	The following are noted: - Square shaped bunded pit/depression (approx. 110 x 110m) (527080 327290) (Region 1a). - Unidentified structure (potential pumphouse) (527879 327294) (Region 1a).

Region	Description (moving east to west)	Notable adjacent features
	north east to south west (Region 1a).	- Spalding Golf Club and artificial surface water feature adjacent north (526764 328349) (Region 1a and 1b).
	3. Blue Gowt Drain (526490 327370) extending north east to south west (Region 1b).	- Farmstead/small business park (525980 327410) (Region 1b).
	4. West Marsh road (526230 327430) extending south to north turning west to join the A16 (Region 1b).	- Farmstead with greenhouses (525942 327415) (Region 1b).
	5. Unnamed drain (526210 327440 and 526170 327450) extending south to north, turning west through culvert beneath A16 (Region 1b).	- Small farmstead to north (524700 327630) (Region 1c).
	6. Electrical overhead line (LV, undefined) (526120 327470) extending east to west and with HV overhead line going underground near this location (Region 1b).	- Riverside copse of the east side of the River Glen crossing (524210 327590) (Region 1c).
	7. A16 Single Carriageway (526100 327480) extending north east to south west (Region 1b).	- Haul roads either side of the Sleaford to Spalding railway line extend north to Gubble's Drove (522960 328470 and 522470 328350) to link at the level crossing (Region 1d).
	8. Old Sea Drain (525950 327520) extending north west to south east (Region 1b).	- Poultry Farm ~160m to the south (521788 327316) (Region 1e).
	9. White Cross Lane (525260 327580) extending north east to south west (Region 1b).	- Water network main daylight across the South Forty Foot Drain 10 to 15m to the north of the overhead line crossing (516570 326780) (Region 1h).
	10. B1356 (Surfleet Road) (525090 327590) extending north to south (Region 1c).	- Water Treatment Works ~170m north of the access road (516517 327710) (Region 1h).
	11. Cuckoo Lane (524690 327600) extending north east to south west (Region 1c).	- Haconby Lode extends sub-parallel along the south boundary of the site (Region 1j).
	12. River Glen (524210 327610) extending north east to south west (Region 1c).	
	13. Sleaford to Spalding railway line (523040 327640) extending north to south (Region 1d).	
	14. Cheal Lane (521080 327660) extending north to south, with a culvert beneath the crossing (Region 1e/f).	
	15. Beck Bank (519270 327730) extending north to south (Region 1f/g).	
	16. Parson Drove (518260 327580) extending east to west (Region 1g).	
	17. Electrical overhead line (HV, undefined) (516580 326770) extending north to south (Region 1h).	
	18. South Forty Foot Drain (516570 326760) extending north to south (Region 1h).	
	19. Electrical overhead line (HV, undefined) (516300 326660) extending north to south (Region 1h).	
	20. Bourne-Dowsby Fen electrical overhead line (NG, 33kV) extending north to south (516080 326630) (Region 1h).	
	21. Buried high pressure gas main (Feeder 9) (515920 326600) extending north to south (Region 1h).	

Region	Description (moving east to west)	Notable adjacent features
	22. Electrical overhead line (HV, undefined) (513810 326290) extending north to south (Region 1j). 23. Haconby Lode (513020 326150) extending east to west (Region 1j). 24. Circa. 53 other minor agricultural drains, roadside drainage ditches and/or seasonal watercourses. 25. Numerous field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and drains.	
2	The Region generally extends east to west through flat arable farming fields, passing north of Haconby, turning south west between the A15 and Stainfield Road, and turning back east to the north of Hanthorpe. The following features are crossed: 1. Car Dyke (511650 325960) extending north east to south west (Region 2a). 2. Buried high pressure gas mains (Feeder 22 and 24) (511510 325960) extending north to south (Region 2a). 3. Historical Railway line (dismantled) north east of Haconby (511090 325910) extending north to south (Region 2b). 4. Electrical overhead line (11kV) (510060 325770) extending north to south (Region 2b). 5. B1177 (Main Road) (509680 325720) extending north east to south west (Region 2c). 6. A15 Single Carriageway (509470 325690) extending north to south (Region 2c). 7. West Road (508630 325230) extending east to west (Region 2d). 8. Electrical overhead line (undefined) (508150 324710) extending north west to south east (Region 2d). 9. Stainfield Road (508120 324630) extending north to south east (Region 2d). 10. Circa. 27 minor agricultural drains, roadside drainage ditches and/or seasonal watercourses. 11. Numerous field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and drains.	The following are noted: - Lagoon (infilled) and copse adjacent to north site boundary (511670 326090) (Region 2a). - Marshy/boggy land to the south east of the site boundary (508460 324630) (Region 2d). - Agricultural compound north of Region 2d (507790 325070).
3	The Region generally extends east to west through rolling arable farming fields to the north east of Elsthorpe.	The following are noted: - Agricultural complex to the north (506100

Region	Description (moving east to west)	Notable adjacent features
	The following features are crossed: 1. Buried high pressure gas main (507420 324560) extending north to south. 2. Electrical overhead line (NG, 132kV) (507230 324560) extending north to south. 3. Private single lane road (507180 324560) extending north to south. 4. Hangman's Lane (505940 324520) extending north east to south west. 5. Buried high pressure gas main (505930 324520) extending north to south. 6. Circa. 5 minor agricultural, roadside drainage ditches and/or seasonal watercourses. A number of field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and drains.	324950).
4	The Region generally extends east to west through rolling arable farming fields within a wide river valley to the north of Elsthorpe. The following features are crossed: 1. Elsthorpe Road (505680 324530) extending north to south. 2. East Glen River (505350 324610) meandering north east to south west within the site boundary, extending overall north to south. 3. Electrical overhead line (HV, undefined) (505210 324640) extending north west to south east. 4. Circa. 2 minor agricultural, roadside drainage ditches and/or seasonal watercourses. A number of field boundaries, often incorporating small hedgerows, trees/small copses, access tracks and drains.	No significant adjacent features are identified.
5	The Region generally extends north east to south west through rolling arable and livestock farming fields to the north west of Elsthorpe. The following features are crossed: 1. Paved farm track (Bradley JV) (504300 324830) extending north to south. 2. Paved farm track (Fisher M) (503240 324220) extending north east to south west. 3. Number of field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and drains.	The following are noted: - Livestock farming complex centred to the south of site boundary (504260 324400), outbuildings within site boundary. - Bourne-Grantham South overhead line extends within 60m of the western end of Region 5.
6	The Region generally extends east to west through	The following are noted:

Region	Description (moving east to west)	Notable adjacent features
	rolling arable and livestock farming fields towards the south edge of Corby Glen. The following features are crossed: Bourne-Grantham South electrical overhead line (NG, 132kV) (502910 324220) extending north west to south east (Region 6a). Swinstead Road (502490 324220) extending north to south. A151 (Bourne Road) (502350 324200) extending north west to south east. Number of field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and field boundary drains.	Agricultural structures (4No. poly-tunnels) (503210 324300) (Region 6a). Bourne-Grantham South overhead line extends sub-parallel to the route within the site boundary between the paved farm track (Fisher M) and Stainfield Road.
7	The Region generally extends east to west across the wide West Glen River valley, through rolling arable farming fields, splitting into a north and west arm (crossing the ECML), and meeting the east and south edges of the WMEL-A site boundary. The following features are crossed: 1. B1176 (Swinstead Road) (500520 323930) extending north west to south east (Region 7a). 2. West Glen River (499730 323780) extending north to south (Region 7a/b). 3. Unnamed paved road (499380 323750) extending north to south (Region 7b). 4. ECML (499160 323720) extending north west to south east (Region 7b). 5. Station Road (499110 324690) extending east to west (Region 7b north arm, haul road only). 6. Electrical overhead line (undefined) (499100 324710 and 498470 324660) extending east to west (Region 7b north arm, haul road only). 7. Electrical overhead line (HV, undefined) (498550 324690 and 498350 325160) extending north west to south east (Region 7b north arm, haul road only). 8. Number of field boundaries, generally oriented north to south, often incorporating small hedgerows, trees/small copses, access tracks and field boundary drains.	The following are noted: - Corby Glen WRC (waste water treatment facility) lies approximately 100m to the north arm of Region 7b (centred 499310 324650). - Agricultural complex adjacent south (496935 323560).

2.3 Topography

- 2.3.1 The site topography based on LiDAR data (Ref 13.35), with estimated and interpolated slope angles, is presented in Figure 2 in Appendix A. This information is summarised in Table 2.2. LiDAR data used to derive slope angles is provided as a composite Digital Terrain Model (DTM) with an accuracy of 1m. Presence of notable

topographical features and accuracy of slope angles should be reviewed during a site reconnaissance.

Table 2.2. Site topography and slope angle summary

Region	Topographical description (moving east to west)
1	This Region is generally flat and lies between approximately 3 to 5m AOD. The following topographical changes are noted: 1. >15° slope angles of the River Welland raised flood defence embankments (527380 327360) (Region 1a). 2. >15° slope angles associated with the banks on an unnamed agricultural drain crossed twice (526210 327440 and 526170 327450) (Region 1b). 3. 5.7 to 15° slope angles associated with the River Glen raised flood defence embankments (524210 327610) (Region 1c). 4. 3.5° to 5.7° slope angles of the Sleaford to Spalding line railway embankment (523040 327640) (Region 1d). 5. >15° slope angles associated with the banks of unnamed agricultural drains (521080 327650 and 520290 327680) (Region 1f). 6. >15° slope angles of the South Forty Foot Drain raised flood defence embankments (516570 326760) (Region 1h). 7. 3.5 to 15° slope angles of agricultural drains, riverbanks and raised road bases throughout the Region. Such slopes may be locally >15°. Slopes are generally less than 2m in height.
2	This Region lies on a wider hill side and generally rises to the west from approximately 3 to 42m AOD at slope angles no greater than 3.5°. The following topographical changes are noted: 1. >15° slope angles associated with the banks of Car Dyke (511650 325960) (Region 2a). 2. A short segment falling from 34 to 27m AOD where the Region extends between the villages of Haconby and Stainfield. Slope angles are no greater than 3.5° (Regions 2c and 2d) 3. 3.5 to 15° slope angles of agricultural drains and raised road bases throughout the Region. Such slopes may be locally >15°. Slopes are generally less than 2m in height.
3	The Region extends over the peak of a broad hill feature, rising to the west from approximately 42 to 64m AOD and then falling to about 55m AOD at slope angles generally between 3.5° and 6°. The following topographical changes are noted: 1. 3.5° to 5.7° sustained slope angles approaching the east side of East Glen River valley, locally up to 15°. 2. 3.5° to 15° slope angles of agricultural drains, riverbanks and raised road bases throughout the Region. Such slopes may be locally >15°. Slopes are generally less than 2m in height.
4	This Region lies within a wide valley feature, formed by the East Glen River, between approximately 54 to 42m AOD with slope angles up to 5.7° on both sides of the valley. The following topographical changes are noted:

Region	Topographical description (moving east to west)
	1. 5.7° to 15° riverbank slope angles of the East Glen River (505430 324640 and 505411 324313 (haul road crossing)). 2. 3.5° to 15° sustained slope angles on the eastern valley side, between the East Glen River and Elsthorpe Road. The elevation change is in the order of about 10m.
5	This Region rises to the west out of the East Glen River valley from approximately 58m AOD and over the crest of a broad, generally flat-topped hill at approximately 72 to 76m AOD, which then falls to 65m AOD at slope angles no greater than 3.5° The following topographical changes are noted: 1. 3.5 to 5.7° slope angles of agricultural drains throughout the Region. Such slopes may be locally >15°. Slopes are generally less than 2m in height.
6	This Region extends over wide gently rolling fields at approximately 75 to 78m AOD at slope angles generally no greater than 3.5°. The following topographical changes are noted: 1. Unnamed river and valley feature between 56 to 63m AOD at sustained slope angles up to 15° (502660 324240). 2. 3.5° to 15° slope angles of an east to west linear ridge feature intersecting Swinstead Road (502450 323970), approximately overlying the mapped alignment of the Woodlands Fault. 3. 3.5° to 15° slope angles of agricultural drains, riverbanks and raised road bases throughout the Region. Such slopes may be locally >15°. Slopes are generally less than 2m in height.
7	This Region extends over wide gently rolling fields and across a valley feature formed by the West Glen River and the ECML, with elevations between approximately 53 to 83m AOD. The northern arm of Region 7b interacts with two additional wide valley features to the west of Corby Glen. The following topographical changes are noted: 1. 5.7 to 15° riverbank slope angles of the West Glen River (499730 323780) (Region 7a/b). Locally slopes of >15° may be present at the riverbank. 2. 5.7 to 15° sustained slope angles associated with the north east to south west running valley feature to the south of the A151 (Station Road) (Region 7b north arm). Locally slopes of >15° may be present. 3. 5.7 to 15° sustained slope angles associated with the north east to south west running valley feature to the north of the A151 (Station Road) (Region 7b north arm). Locally slopes of >15° may be present. 4. 5.7 to 15° slope angles of the ECML railway embankment (499160 323720) (Region 7b west arm).

Notes:

It is observed on the topographical slope gradient layer that some areas showing high slope angles are the result of LiDAR data picking up the height difference between the ground and tall vegetation (trees and hedgerows).

3. Geological and environmental setting

3. Geological and environmental setting

3.1 Overview

- 3.1.1 The environmental setting, including the topography, geology, hydrogeology and hydrology, are the key factors that influence the nature of ground hazards on site, the way in which contaminants in the soil or groundwater can be transported on or off site, and also the way in which contamination can affect applicable receptors including controlled waters, users of the site, and properties.

3.2 Published geology

BGS geological mapping

- 3.2.1 AAJV has reviewed publicly available information and summarised the anticipated geological succession for the site. The published 1:50,000 (1:50k) and 1:10,000 (1:10k) scale geological maps of the area produced by the BGS indicate the site is underlain by a generally conformable sedimentary sequence of Jurassic limestones, sandstones and mudstones, overlain by quaternary superficial deposits of glacial, fluvial and marine origin. Coverage of superficial deposits varies, and the lower (older) bedrock strata outcrop westward.
- 3.2.2 The superficial and bedrock geology underlying the site is shown in Figure 3 and 4 respectively in Appendix A. The complete geological succession underlying the site is summarised in Table 3.1, together with the summarised BGS Lexicon (Ref 13.20) description. The relevant portion of the geological sequence for each Region of the site, considered for the purposes of this report, are provided in Table 3.2 to Table 3.8.
- 3.2.3 The associated available BGS published geological maps and their coverage is summarised below. It is noted that 1:10k scale map coverage is not available from Region 1a to Region 1f and therefore the geology described in those regions is exclusively based on 1:50k mapping information.
- 1:50,000/1:63,360 scale map sheets:
 - 144 (Spalding) combined solid and drift, published 1992 (Ref 13.16): Region 1a to Region 2a
 - 143 (Bourne) separate solid and drift, published 1971 (Ref 13.12) and 1972 (Ref 13.13) respectively: Region 2a to Region 7b
 - 1:10,000/1:10,560 scale map sheets:
 - TF12NE (Lincolnshire) published 1981 (Ref 13.14): Region 1g to Region 1i
 - TF12NW (Lincolnshire) published 1981 (Ref 13.15): Region 1i to Region 2b
 - TF02NE (Lincolnshire) published 1969 (Ref 13.7): Region 2c to Region 2d
 - TF02SE (Lincolnshire) published 1969 (Ref 13.8): Region 2d to Region 5

- TF02SW (Lincolnshire) published 1969 (Ref 13.9): Region 6
- SK92NE (Lincolnshire) published 1969 (Ref 13.10): Region 7b (north arm)
- SK92SE (Lincolnshire) published 1969 (Ref 13.11): Region 7

Table 3.1. Geological succession from published mapping

Geological stratum	Geology type	Parent unit	Age	BGS Lexicon description	Published thickness (m)
Made Ground	Artificial	Artificially modified ground	Quaternary Period	Made Ground is an area where the pre-existing (natural or artificial) land surface is raised by artificial deposits.	N/R
Alluvium	Superficial	Fluvial deposits	Quaternary Period	Alluvium is a general term for clay, silt, sand and gravel. It is the unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Normally soft to firm compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.	Variable, influenced by topography
Tidal Flat Deposits/ Fenland Formation	Superficial	Intertidal deposits/ British Coastal Deposits Group (COAS)	Quaternary Period (Flandrian Age)	Formation encompasses the marine, estuarine and terrestrial deposits that were formed in the Fens and adjacent areas during the Holocene and previous interglacial periods. The complex includes fresh and brackish water peats, salt marsh clays, fluvial silts and fine-grained sands, marine sands, and beach-face sands and gravels. In the centre of the Fen Basin, five stratigraphical units are present. In ascending order these are basal sand and gravel, the Fen Lower Peat, Barroway Drove Beds, Nordelph Peat and Terrington Beds. Barroway Drove Beds comprise intertidal soft grey clays and silty clays cut by tidal channels and creeks infilled with silt and fine-grained sand. Terrington Beds comprise marine and brackish water silts and fine-grained sands.	Variable
River Terrace Deposits	Superficial	Fluvial deposits	Quaternary Period	Sand and gravel, locally with lenses of silt, clay or peat.	Variable

Geological stratum	Geology type	Parent unit	Age	BGS Lexicon description	Published thickness (m)
Glaciofluvial Deposits	Superficial	Proglacial deposits	Quaternary (Pleistocene Epoch)	Glaciofluvial deposits were deposited by meltwater streams. Includes mostly coarse-grained sediments (i.e. sand and gravel) with some finer-grained layers (i.e. clay and silt). Sand and gravel, locally with lenses of silt, clay or organic material.	Variable
Till (diamicton)	Superficial	Glaciogenic deposits	Quaternary (Mid Pleistocene Epoch)	Till is unsorted and unstratified drift, generally overconsolidated, deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. It consists of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape (diamicton).	Variable
Oxford Clay Formation	Bedrock	Ancholme Group	Jurassic (Callovian – Oxfordian Age) 166.1–157.3 Ma	Silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules. Over most of the outcrop it comprises a tripartite succession: lower part (Peterborough Member) silicate-mudstone, mainly brownish-grey, fissile, organic-rich ("bituminous"), with subordinate beds of pale to medium grey, blocky mudstone; middle part (Stewartby Member) silicate-mudstone, mainly pale to medium grey, smooth to slightly silty, blocky, with subordinate beds of silty shell-debris rich mudstone; upper part (Weymouth Member) mudstone, mainly pale grey, calcareous, smooth, blocky.	c. 50 to 70m
Kellaways Sand Member	Bedrock	Kellaways Formation	Jurassic (Callovian Age) 166.1–163.5 Ma	Silicate sandstone and silicate siltstone, pale grey, calcareous cemented, with interbeds of sandy and silty mudstone. Sandstone/siltstone generally weakly cemented, but locally strongly cemented, typically into "doggers".	c. 3 to 5m
Kellaways Clay Member	Bedrock	Kellaways Formation	Jurassic (Callovian Age) 166.1–163.5 Ma	Silicate mudstone, grey, commonly smooth in basal part, but more generally silici-silty or silici-sandy, locally with thin beds of siltstone and sandstone, and nodules of argillaceous limestone.	c. 2 to 3m

Geological stratum	Geology type	Parent unit	Age	BGS Lexicon description	Published thickness (m)
Cornbrash Formation	Bedrock	Great Oolite Group	Jurassic (Bathonian – Callovian Age) 168.3–163.5 Ma	Limestone, medium- to fine-grained, predominantly bioclastic wackestone and packstone with sporadic peloids; generally and characteristically intensely bioturbated and consequently poorly bedded, although better bedded, commonly somewhat arenaceous units occur in places, particularly in the upper part. Generally bluish grey when fresh, but weathers to olive or yellowish brown. Thin argillaceous partings or interbeds of calcareous mudstone may occur.	c. 2 to 4m
Blisworth Clay Formation (Great Oolite Clay)	Bedrock	Great Oolite Group	Jurassic (Bathonian Age) 168.3–166.1 Ma	Silicate-mudstone, grey, commonly variegated purplish red, yellow and green, poorly bedded to blocky. Commonly contains fossil rootlets and sideritic ironstone nodules, and locally with impersistent beds and lenses of argillaceous limestone including (mainly in the south of the East Midlands Shelf) shell fragmental wackestones, packstones and grainstones, and (mainly in the north East Midlands Shelf) sandstone. Mudstone weathers to highly plastic clay.	c. 2 to 4m
Blisworth Limestone Formation (Great Oolite Limestone)	Bedrock	Great Oolite Group	Jurassic (Bathonian Age) 168.3–166.1 Ma	Pale grey to off-white or yellowish limestones with thin marls and mudstones, fossiliferous, bioturbated peloidal, ooidal and shell-fragmental more-or-less argillaceous packstones and wackestones, subordinate cross-bedded ooidal shell-fragmental grainstones.	c. 6 to 7m
Rutland Formation (Upper Estuarine Series)	Bedrock	Great Oolite Group	Jurassic (Bajocian – Bathonian Age) 170.3–166.1 Ma	A succession of up to seven shallowing upward, essentially delta-type rhythms, comprising ideally of a grey marine mudstone passing up into non-marine mudstone and siltstone, with a greenish-grey rootlet bed at the top. Presence of sandstone and mudstone members in areas. Subordinate sandstone beds occur higher in the sequence locally, as well as typically shelly and shell-detrital marine limestones and calcareous mudstones, notably in the mid part, the Wellingborough Limestone Member.	c. 8 to 12m (c. 3 to 4m Wellingborough Limestone Member)

Geological stratum	Geology type	Parent unit	Age	BGS Lexicon description	Published thickness (m)
Upper Lincolnshire Limestone Member	Bedrock	Lincolnshire Limestone Formation	Jurassic (Bajocian Age) 170.3–168.3 Ma	Limestone, overwhelmingly dominated by high-energy ooidal and shell fragmental grainstones, but includes secondarily recrystallized and micritized lithologies. Upper boundary disconformable, commonly markedly eroded and karstified contact between ooidal and bioclastic grainstone of the Upper Lincolnshire Limestone and the non-calcareous non-marine sandstones, siltstones and mudstones of the overlying Rutland Formation.	c. 15m
Lower Lincolnshire Limestone Member	Bedrock	Lincolnshire Limestone Formation	Jurassic (Bajocian Age) 170.3–168.3 Ma	Limestones, dominated by low energy calcilutite, and peloidal wackestone and packstone. Commonly includes sandy limestone or calcareous sandstone in basal part and contains substantial units of mudstone.	0 to c. 20m
Grantham Formation (Lower Estuarine Series)	Bedrock	Inferior Oolite Group	Jurassic (Aalenian Age) 174.1–170.3 Ma	Mudstones, sandy mudstones and argillaceous siltstone-sandstone, which is commonly ferruginous, and containing generally abundant plant debris, interpreted as both non-marine and marine facies, comprising several shallowing-upwards, delta-type rhythms with typically a tripartite succession.	c. 5 to 8m
Northampton Sand Formation	Bedrock	Inferior Oolite Group	Jurassic (Aalenian Age) 174.1–170.3 Ma	Sandy, berthierine-ooidal and sideritic ironstone, greenish grey where fresh, weathering to brown limonitic sandstone, typically displaying a box-stone structure. The basal part, is commonly muddy and less ferruginous. The uppermost beds are generally more or less ferruginous sandstone. The unit includes lenses of mudstone and limestone in places, and contains a fairly abundant marine fauna of bivalves, brachiopods and ammonites, which are not generally evident in weathered sections.	c. 4 to 8m

Geological stratum	Geology type	Parent unit	Age	BGS Lexicon description	Published thickness (m)
Whitby Mudstone (Upper Lias Clay)	Bedrock	Lias Group	Jurassic (Toarcian Age) 182.7-174.4 Ma)	Medium and dark grey fossiliferous mudstone and siltstone, laminated and bituminous in part, with thin siltstone or silty mudstone beds and rare fine-grained calcareous sandstone beds; dense, smooth argillaceous limestone nodules very common at some horizons; phosphatic nodules at some levels. Nodular and fossiliferous limestones occur at the base in some areas.	Up to c. 120m

Region 1

- 3.2.4 Table 3.2 summarises the geological strata that are present in Region 1 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 1 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.2. Geological succession from published mapping for Region 1

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Made Ground	Artificially modified ground	Mapped in Region 1b	Unknown, no record.
Tidal Flat Deposits	Intertidal deposits	Total coverage	Published geological records suggest in the order of 5m to 10m, thinning to the west. Potentially up to 30m in buried valleys.
(Fen Lower Peat sub-unit)		Locally mapped in Region 1j	Nearby borehole records suggest around 0.5m to 1.5m.
Oxford Clay Formation	Ancholme Group	Mapped in Region 1a to 1i	Published geological records suggest from over 34m in the east, thinning gradually and disappearing in the west.
Kellaways Sand Member	Kellaways Formation	Mapped in Region 1j	Published geological records suggest around 1m to 3m.
Kellaways Clay Member	Kellaways Formation	Mapped in Region 1j	Published geological records suggest around 2m to 6m.

- 3.2.5 No linear features are mapped on BGS 1:50k or 1:10k mapping in Region 1 of the site. As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfills are mapped on or within 250m of Region 1 of the site.

Region 2

- 3.2.6 Table 3.3 summarises the geological strata that are present in Region 2 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 2 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.3. Geological succession from published mapping for Region 2

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Alluvium	Fluvial Deposits	Local coverage in Region 2d	Variable, generally confined to valley floors and natural watercourses.
River Terrace Deposits	Fluvial deposits	Local coverage in Region 2a and 2b	Variable.
Glaciofluvial Deposits	Proglacial deposits	Local coverage in Region 2b	Variable, generally found at the edge of the River Terrace Deposits.
Oxford Clay Formation	Ancholme Group	Locally mapped in Region 2b and 2c	Lower layers underlying Tidal Flat Deposits and isolated outcrops on higher elevation landforms may be up to around 5m thick.
Kellaways Sand Member	Kellaways Formation	Locally mapped in Region 2a to 2d	Published geological records suggest around 1m to 2m.
Kellaways Clay Member	Kellaways Formation	Locally mapped in Region 2b and 2d	Published geological records suggest around 2m to 3m.
Cornbrash Formation	Great Oolite Group	Region 2a. Locally mapped in Region 2d	Published geological records suggest around 2m to 4m.

- 3.2.7 No linear features are mapped on BGS 1:50k mapping in Region 2 of the site. As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 2 of the site.

Region 3

- 3.2.8 Table 3.4 summarises the geological strata that are present in Region 3 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 3 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.4. Geological succession from published mapping for Region 3

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Till	Glaciogenic deposits	Widespread coverage	Highly variable, thin or absent in topographic lows and thick over topographic highs, and may be up to around 10m to 11m.
Oxford Clay Formation	Ancholme Group	Widespread coverage	Lower layers occurring as isolated outcrops on higher elevation landforms may be up to around 3m to 4m thick.
Kellaways Sand Member	Kellaways Formation	West of Region (underlies Oxford Clay Formation)	Published geological records suggest around 2m to 5m.
Kellaways Clay Member	Kellaways Formation	West of Region (underlies Kellaways Sand Member)	Published geological records suggest around 1m to 4m.
Cornbrash Formation	Great Oolite Group	West of Region (underlies Kellaways Clay Member)	Published geological records suggest around 2m to 4m.

- 3.2.9 No linear features are mapped on BGS 1:50k mapping in Region 3 of the site. As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 3 of the site.

Region 4

- 3.2.10 Table 3.5 summarises the geological strata that are present in Region 4 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 4 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.5. Geological Succession from published mapping for Region 4

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Alluvium	Fluvial deposits	Local coverage (centre, valley floor)	Variable, generally confined to valley floors and natural watercourses.
Kellaways Sand Member	Kellaways Formation	Locally mapped (upper valley slopes)	Published geological records suggest around 1m to 4m.
Kellaways Clay Member	Kellaways Formation	Locally mapped (mid- valley sides)	Published geological records suggest around 3m to 4m.
Cornbrash Formation	Great Oolite Group	Locally mapped (mid- valley sides)	Published geological records suggest around 1m to 4m.
Blisworth Clay Formation	Great Oolite Group	Locally mapped (lower valley sides)	Published geological records suggest up to around 4m.
Blisworth Limestone Formation	Great Oolite Group	Locally mapped (centre, valley floor)	Published geological records suggest up to around 2m.

- 3.2.11 No linear features are mapped on BGS 1:50k mapping in Region 4 of the site. As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 4 of the site.

Region 5

- 3.2.12 Table 3.6 summarises the geological strata that are present in Region 5 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 5 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.6. Geological Succession from published mapping for Region 5

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Till	Glaciogenic deposits	Widespread coverage	Highly variable, thin or absent in topographic lows and thick over topographic highs, and where the boundary with the underlying Oxford Clay is not clear, combined thickness may be up to 21m.
Glaciofluvial Deposits	Proglacial deposits	Local coverage	Variable, generally found at the edges of Till deposits.
Oxford Clay Formation	Ancholme Group	Widespread coverage	Where boundary with the overlying Till, is not clear, combined thickness may be up to 21m.
Kellaways Sand Member	Kellaways Formation	Locally mapped (underlies Oxford Clay Formation)	Published geological records suggest around 1m to 4m.
Kellaways Clay Member	Kellaways Formation	No outcrop (underlies Kellaways Sand Member)	Published geological records suggest around 2m to 3m.

- 3.2.13 The following linear features are mapped on BGS 1:50k and 1:10k mapping in Region 5 of the site:
- 1No. inferred fault (Woodlands Fault) is mapped cross cutting Region 5, north east of Swinstead, extending to the east from a patchwork of fault blocks in Region 7. The mapped fault line strikes approximately west to east and then turns north east to

intersect the site at the western edge of Region 5, with the downthrown side to the south east. The youngest geological unit that is displaced by the fault is the Oxford Clay.

- 3.2.14 Whilst these faults are interpreted to be passive and not believed to be associated with any active tectonic regime, the potential for fault movements and associated ground stability hazards is extant.
- 3.2.15 As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 5 of the site.

Region 6

- 3.2.17 Table 3.7 summarises the geological strata that are present in Region 6 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 6 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.7. Geological succession from published mapping for Region 6

Geological stratum	Parent unit	Mapped coverage	Anticipated thickness
Alluvium	Fluvial deposits	Local coverage (valley floor)	Variable, generally confined to valley floors and natural watercourses.
Glaciofluvial Deposits	Proglacial deposits	Local coverage	Variable, generally found at the edges of Till deposits.
Kellaways Sand Member	Kellaways Formation	East valley slope	Published geological records suggest around 1m to 4m.
Kellaways Clay Member	Kellaways Formation	East valley slope and outcrop in centre of Region 5	Published geological records suggest around 1.5m to 4m.
Cornbrash Formation	Great Oolite Group	Mapped across central area	Published geological records suggest around 1m to 2m.
Blisworth Clay Formation	Great Oolite Group	Mapped around central area (underlying Cornbrash Formation)	Published geological records suggest up to around 4m.
Blisworth Limestone Formation	Great Oolite Group	Locally mapped in west	Published geological records suggest around 1m to 2m.
Rutland Formation	Great Oolite Group	Locally mapped in west	Published geological records suggest around 2m to 10m.

- 3.2.18 The following linear features are mapped on BGS 1:50k and 1:10k mapping in Region 6 of the site:
- 1No. inferred fault (Woodlands Fault) is mapped to the south of and striking parallel to Region 6, extending from the east to the west from a patchwork of fault blocks in Region 7. Where the haul road within Region 6 extends south along Swinstead Road,

this intersects the Woodlands Fault at 502440 323940, with the downthrown side to the south east. The youngest geological unit that is displaced by the fault is the Oxford Clay.

- 3.2.19 Whilst these faults are interpreted to be passive and not believed to be associated with any active tectonic regime, the potential for fault movements and associated ground stability hazards is extant.
- 3.2.20 As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 1 of the site.

Region 7

- 3.2.21 Table 3.8 summarises the geological strata that are present in Region 7 of the site based on available BGS published geological maps. It is noted that the geological succession here is limited to those strata that are mapped within Region 7 and/or those underlying strata, identified in borehole records, which are anticipated to potentially influence and be relevant to the assessment of ground conditions and geotechnical/geoenvironmental risk (i.e. bearing strata, karst, confined aquifers).

Table 3.8. Geological succession from published mapping for Region 7

Geological stratum	Geology type	Parent unit	Mapped coverage	Anticipated thickness
Alluvium	Superficial	Fluvial deposits	Locally mapped (West Glen River valley floor)	Variable, generally confined to valley floors and natural watercourses
Till	Superficial	Glaciogenic deposits	Locally mapped in Region 7b west arm	Highly variable, thin or absent in topographic lows and thick over topographic highs, and may be around 1m to 5m
Blisworth Limestone Formation	Bedrock	Great Oolite Group	Locally mapped (West Glen River valley floor)	Published geological records suggest up to around 2m, but may vary, repeat, or be absent due to local faulting.
Rutland Formation (including Wellingborough Member)	Bedrock	Great Oolite Group	Locally mapped in Region 7b west arm	Published geological records suggest around 4m, but may vary, repeat, or be absent due to local faulting.
Upper Lincolnshire Limestone Member	Bedrock	Lincolnshire Limestone Formation	Widespread coverage	Published geological records around 24m to 28m, but boundary with Lower Lincolnshire Limestone may be poorly defined. May vary, repeat, or be absent due to local faulting.

Geological stratum	Geology type	Parent unit	Mapped coverage	Anticipated thickness
Lower Lincolnshire Limestone Member	Bedrock	Lincolnshire Limestone Formation	Partial coverage of Region 7b north arm (underlies Upper Lincolnshire Limestone)	Published geological records suggest around 1m to 4m, but boundary with Upper Lincolnshire Limestone may be poorly defined. May vary, repeat, or be absent due to local faulting.
Northampton Sand	Bedrock	Inferior Oolite Group	Locally mapped in Region 7b north arm	Published geological records suggest around 4m to 8m, but may vary, repeat, or be absent due to local faulting.

3.2.22 The following linear features are mapped on BGS 1:50k and 1:10k mapping in the vicinity of Region 7 of the site:

- A patchwork of unnamed observed and inferred faults are mapped to the west of the village of Corby Glen and extending into the WMEL-A substation boundary area. The larger faults strike approximately east to west, including the Woodlands Fault, with minor interconnecting faults generally striking south west to north east, and north to south along the alignment of the West Glen River between Corby Glen and Swayfield villages. No observed or inferred faults intersect the site in Region 7a, and the Woodlands Fault line extends approximately 300m to 500m to the south of Region 7b.
- The whole fault assembly lies within the north and west arms of Region 7b and displaces the Rutland, and Upper and Lower Lincolnshire Limestone Formations, and exposes a minor outcrop of the underlying Northampton Sand Formation. The Woodlands Fault extends further east and strikes sub-parallel to Region 7a, and intersects the overhead line alignment at the Swinstead Road crossing.

3.2.23 Whilst these faults are interpreted to be passive and not believed to be associated with any active tectonic regime, the potential for fault movements and associated ground stability hazards is extant.

3.2.24 As per the landfill records presented in the Groundsure Insights GIS Dataset, no landfill is mapped on or within 250m of Region 7 of the site.

3.3 BGS geological memoirs

- 3.3.1 Based on the BGS geological memoirs for Map Sheet 142 (Melton Mowbray) (Ref 13.25), which covers parts of the geology present in Regions 6 and 7, and Map Sheet 129/145 (King's Lynn and The Wash) (Ref 13.42), which covers parts of the geology in Region 1 and 2, Table 3.9 provides a summary of recorded information pertaining to ground hazards/engineering nature of associated ground conditions in the area which are then considered in subsequent parts of this report. It is noted that geological memoirs are not available for the majority of the area through which the site extends, covering the geology present in Regions 3, 4 and 5, associated with Map Sheet 143 (Bourne) and 144 (Spalding).

Table 3.9. Engineering nature and ground conditions pertaining to mapped geology

Stratum	Summary of BGS memoir commentary
Artificial Deposits/ worked ground	Noted to represent areas where natural material is known to have been removed. The unknown and variable geotechnical properties and nature of infill/backfilled materials may influence expected ground conditions.
Alluvium	Peaty deposits or lenses of running sand in Alluvium indicated in areas of highly compressible ground. Morphology and thicknesses described as: "Underlies widespread flats along main streams with narrow tracts in tributaries: up to 5m" and "Alluvium of the minor tributary valleys is seldom more than 3m thick".
Tidal Flat Deposits	Unconsolidated to normally consolidated clays silts and sands with peat are noted to be mostly poor foundation materials, which vary considerably in lithology both laterally and vertically. Four sub-units are described: • Terrington Beds: soft clay with thinly interlaminated silts and sands, moisture 10 to 40%, and shear strength usually less than 40kPa. • Nordelph Peat: woody to fibrous peat, usually 1m to 3m thick where infilling old channels or depressions, moisture 40 to 100%, dry density 1.3Mg/m³, and shear strength usually less than 20kPa. • Borroway Drove Beds: soft, slightly silty or sandy clay with peaty root holes in the upper parts. Moisture 25-50%, dry density 1.3Mg/m³ and shear strength usually lower than 20kPa. Sprawling channels of less compressible silt form slightly raised 'roddons'. • Fen Lower Peat: similar properties to Nordelph Peat, thickness and continuity vary where infilling old channels and gullies.
River Terrace Deposits	Outside of Map Sheet, relevant commentary not identified. Consist of pebbly sands and gravels compose of local limestone with flint and other erratics, forming a discontinuous spread at the western edge of the low-lying Fens and extend up the present-day valleys to the west. They extend east beneath the Tidal Flat Deposits becoming finer grained and less gravelly.

Stratum	Summary of BGS memoir commentary
Glaciofluvial Deposits	Sporadic and discontinuous outcrops of clay or silty clay have been mapped that generally occur as lenses within glaciofluvial deposits. Although observed in limited outcrops, they form an extensive sheet which was deposited from the uplands at the western edge of the Fens eastward across the Wash. Erosion has largely removed most exposures, but they extend beneath the Tidal Flat Deposits.
Till (diamicton)	Till is the dominant lithology type in the upland areas (Region 2 onward), comprising grey, sandy, calcareous clay derived from Jurassic mudstones, and containing chalk, flint and other erratics. Glaciofluvial and glaciolacustrine deposits are associated with in.
Oxford Clay Formation	Dark grey, rhythmically bedded, shelly mudstone with thin bituminous beds, passing up into pale grey calcareous mudstone, with an extensive subcrop, some 30km in width, and thicknesses ranging between 30m to 65m. It lies beneath the Quaternary Tidal Flat Deposits dipping gently east to north-east. Elsewhere, it is noted that the high calorific value of bituminous beds has been significant in the development of the brickmaking industry. As such, the presence of old surface workings may be expected within the Oxford Clay.
Kellaways Sand Member	Proven in boreholes to be persistent throughout the Wash region and the Fens, comprises fine grained, laminated and bioturbated, silty and calcareous cemented sandstone, around 3m to 5m thick. Locally, sands may be cemented to form doggers.
Kellaways Clay Member	Similarly proven to be persistent, present always with the overlying Kellaways Sand Member, comprises olive-grey, silty in part mudstone with common ammonites, bivalves and gastropods, and with small phosphatic nodules in middle and basal part of bed.
Cornbrash Limestone Formation	A thin, laterally persistent fine grained, bioturbated, shelly and shell-fragmental limestone with marl partings, which lies non-sequentially on a bored/burrowed surface of the underlying Blisworth Clay Formation. No reference is made to potential dissolution issues or suspected presence to karst features.
Blisworth Clay Formation	Thin but laterally persistent marine soft silty brownish grey and dark olive-grey mudstone with oysters and rootlets, likely underlying the whole of the district. Listric surfaces and rootlets common at many levels.

Stratum	Summary of BGS memoir commentary
Blisworth Limestone Formation	Thin, but laterally persistent, brackish marine, dense, bluish grey and grey shelly and shell-fragmental oolitic limestone, with common bivalves; oyster-rich bed at base, likely underlying the whole of the district. The marine transgression at the base of the limestone is everywhere marked by an erosion surface which has locally cut down into the underlying Rutland Formation. No reference is made to potential dissolution issues or suspected presence to karst features.
Rutland Formation (Upper Estuarine Series)	Rhythmically interlaminated/interbedded brackish marine to freshwater, greenish and brownish grey sandstone, siltstones, mudstones and shelly limestones, with seatearths and rootlets. Listric surfaces are common, as well as carbonised rootlets and rootlet traces, and small clay-ironstone nodules in the basal siltstone. A basal erosion surface extends down irregularly into underlying Lincolnshire Limestone. No reference is made to potential dissolution issues or suspected presence to karst features in the limestone beds or at the boundary with the underlying Lincolnshire Limestone.
Lincolnshire Limestone (Upper and Lower formations)	Comprises a significant aquifer in eastern England, with annual fluctuations of 18m. It is usually separated into the Upper and Lower Lincolnshire Limestone formations. The Upper Lincolnshire Limestone is described as pale greenish grey, clayey (weathered) at top, passing down into compact, oolitic and shell fragmental limestone with micritic matrix. The stratigraphical boundary is commonly based on the so-called ‘Crossi Bed’ (brachiopod species <i>A. crossi</i>) which appears to be mostly of pure lime mudstone. The Lower Lincolnshire Limestone is described as a variable sequence of massive to thinly bedded, uniformly fine-grained ‘calcarenite’ with interbedded grey mudstone, micaceous sandstone or sandy limestone. Where near the surface, overlying soils are characterised by pale brown, clayey soils strewn with abundant tabular brash of cream-coloured limestone. No specific reference is made to potential dissolution issues or suspected presence to karst features.

Stratum	Summary of BGS memoir commentary
Grantham Formation (Lower Estuarine Series)	Sandstone interbedded with pale grey fissile mudstones, upon which the Lincolnshire Limestone lies unconformably. It is poorly exposed and dies out to the east. The Grantham Formation is not anticipated to have any influence on ground conditions at the site.
Northampton Sand Formation	Does not outcrop at the site, but where outcropping further west is described as a dark reddish brown sandy loam with abundant brash of hard, limonite-cemented quartzose fine grained ferruginous sandstone and some ooidal ironstone. Recorded as 4m thick, on average, dying out to the east. The formation itself is not anticipated to influence ground conditions on the site, however the economic value of ironstone in this formation has led to extensive exploration in the region, with underground workings noted around the west of the site.
Whitby Mudstone	Well laminated, olive green to dark blue-grey, fissile mudstone with a few beds of nodular limestone. It is 55m thick on average and indicated to be of intermediate to high plasticity. The Whitby Mudstone is not anticipated to have any influence on ground conditions at the site.
Structures	The Woodlands Fault crossing Regions 5, 6 and 7, and the patchwork of fault blocks in Region 7b are interpreted to be part of late Jurassic minor folding and faulting associated with the Cimmerian Orogeny. The Woodlands Fault downthrow is south east up to 120m. Geological Faults in this region are of ancient origin and are currently inactive. However, in common with other parts of Britain this district is affected from time to time by earthquakes.
Mineral Resources	Ironstone mining is present in the Northampton Sands near the surface in the west of the site. The exploration for ironstone resources extended east, resulting in numerous boreholes sunk across the Fens. It is understood that lower grade surface ironstone resources were identified in the east, and that had they been identified historically, they may have been worked. The economics of underground mining are unlikely to be favorable in the near future, so that with the notable exceptions of gypsum and oil, potential resources are those which can be won at or near to the surface.

Stratum	Summary of BGS memoir commentary
Groundwater and flooding	The low-lying eastern part of the site (3m to 5m AOD) is largely comprised of recent coastal/marine and floodplain deposits, representing successive phases of marine transgression and regular flooding as recent as medieval times. Exploration and mineral extraction pits in the region are noted to flood easily, indicating shallow groundwater, and the construction of flood defense embankments and all field boundaries marked by agricultural drains indicate a well-established flood management regime. In the higher relief west part of the site, smaller valleys are noted to be moderately incised and that associated streams can be prone to flash flooding. Distribution of Alluvium is indicated to allow tracts of floodable ground to be readily recognised. The Northampton Sand Formation is indicated to have been exploited for water where the aquifer is confined, suggesting potential for artesian waters. The Grantham Formation is noted to act as a lower permeability horizon, separating water in the Lincolnshire Limestone Formation above, from that in the Northampton Sand Formation below.
Abandoned mine workings/mined ground and shafts	Ironstone mining of the Northampton Sands is understood to have occurred to the north west of the site within the Easton Ironstone Mine, whose mineral planning area boundary lies close to Region 7 of the site. As the mineral planning area is noted as “wholly underground”, and in the absence of detailed records of mining extents, the potential for the secondary effects of nearby underground mining activities must be considered.
Surface quarrying	There are many disused pits within and around the site, as indicated on the BGS 1:10k series maps, and a known history of surface workings dating back to Roman times (building stone, brick clay, surface weathered clay ironstone, and salt), many of which have been backfilled and now exist as small copses and/or slight topographic depressions around present day agricultural fields. The oldest workings are not likely to be recorded on historical mapping. The constraints on development around worked-out excavations relate to variable ground conditions, including drainage, between the natural surface and the fill. The geotechnical properties and nature of the backfilled materials may significantly influence the risk of differential settlement on overlying infrastructure.
Bedrock solution/dissolution	No specific reference is made to potential dissolution issues or suspected presence to karst features.
Aggressive ground chemistry	In general, mudstones recorded on site are indicated to pose a risk of sulphate attack to buried concrete

Stratum	Summary of BGS memoir commentary
Radon	Natural radon levels are recorded to be generally low in the region, with elevated levels associated with outcrops of the Lias Group and in particular the Marlstone Rock Formation, which do not outcrop in the vicinity of the site.
Ground stability	The substrates can affect the foundation conditions in a number of ways, for example: • Natural occurrence of sulphates (gypsum) in the mudstone strata (Oxford Clay, Kellaways Clay, Blisworth Clay, mudstone layers within the Rutland Formation) can produce deleterious effects on concrete. • Weathering of mudstone strata increases the natural moisture content, plasticity and swelling potential. • Tidal Flat Deposits, peaty deposits or lenses of running sand in Alluvium can result in areas of highly compressible ground with low or easily disturbed bearing capacities. Slope stability is a potential issue particularly where building development is extended onto steeper valley sides. These areas, together with outcrops of head that may contain relict shear surfaces, have the potential to be reactivated by loading, undercutting or excavating into slopes, or by introducing water into the slope from drains or soakaways. Unstable conditions would be favored by increased ingress of water from natural or artificial sources, and at times of exceptionally heavy and sustained rainfall. Clays of the mudstone strata and Till deposits may be of intermediate to very high plasticity, with strength generally increasing with depth as weathering and stress relief effects decline. Such clays may be subject to slope instability and high compressibility, as well as shrinkage and swelling problems. Excavations can generally be carried out by digging, but ripping may be necessary for sequences with strong limestone beds. Water may flow along joints in limestone beds causing flooding to excavations.
Earthquakes	Earthquakes, although infrequent and of generally small magnitude, nonetheless pose a potential problem across the region, despite it being one of the less seismically active parts of the UK. Seismic loading of unconsolidated sediments of the Tidal Flat Deposits and Alluvium, where shallow ground conditions are present, have the potential to result in liquefaction and subsequent settlement.

3.4 Exploratory holes

Selected exploratory hole records

- 3.4.1 The BGS maintains an archive of historical exploratory hole records throughout the UK (Ref 13.19). AAJV has searched the database and those which are considered to provide useful information on the ground profile at the site, together with the links to the BGS digital records, are highlighted in Table 3.10. From the search, 54 No. selected exploratory holes located within 500m of the site have been referenced in producing this report, and relevant information from the records is considered as part of the preliminary ground models in Report Section 8.2. The locations of the selected exploratory holes with respect to the site are shown on Figure 4 in Appendix A, and copies of the exploratory hole record scans are presented in Appendix B.

Table 3.10. Summary of BGS exploratory holes on/near the site

Region	BGS hole ID	Easting	Northing	Date recorded ¹	Depth ² (m bgl)	Digital log ³
1	TF22NE73	528000	327200	1937	3.1	Link
	TF22NE31	526144	327594	March 1985	1.5	Link
	TF22NW32	524790	327980	January 1979	104.5	Link
	TF22NW10	522730	328440	September 1925	94.8	Link
	TF22NW23	521110	327130	March 1980	96.0	Link
	TF22NW31	520890	327560	June 1990	80.0	Link
	TF12NE21	516620	326510	1977	5.0	Link
	TF12NE28	516660	326540	August 1964	12.2	Link
	TF12NE29	516660	326540	August 1964	9.1	Link
	TF12NE1	516500	327150	August 1956	9.5	Link
	TF12NW10	513030	325710	1914	36.9	Link
	TF12NW33	513040	325690	March 1977	57.9	Link
	TF12NW1	510800	325440	December 1961	7.9	Link
2	TF12NW19	510340	325370	1914	31.0	Link
	TF02NE28	509500	325350	1931	40.0	Link
	TF02NE21	509360	325910	October 1959	60.4	Link
	TF02NE13	509000	325000	April 1959	57.6	Link
	TF02SE43	508130	324790	1899	39.6	Link
	TF02SE18	508070	324910	April 1959	60.7	Link
	TF02NE31	507590	325020	1934	58.7	Link
3	TF02NE19	507000	325000	September 1959	64.9	Link
	TF02SE20	507000	324000	April 1959	71.3	Link
	TF02SE25	506840	324840	December 1959	76.2	Link

Region	BGS hole ID	Easting	Northing	Date recorded ¹	Depth ² (m bgl)	Digital log ³
4	TF02SE117	505920	324570	May 1980	8.0	Link
	TF02SE118	505950	324440	May 1980	4.3	Link
	TF02SE90	505610	324780	November 1975	44.2	Link
	TF02NE2	505160	325000	August 1958	48.0	Link
5	TF02NW18	504000	325080	October 1958	65.5	Link
	TF02SW32	504190	324490	October 1945	74.7	Link
	TF02SW6	504000	324080	1958	84.4	Link
6	TF02SW4	503080	323940	1958	58.8	Link
	TF02SW38	503010	323750	November 1975	43.5	Link
	TF02SW25	501870	324630	July 1945	53.3	Link
	TF02SW19	501880	324080	December 1958	59.4	Link
7	TF02SW35	501090	323850	June 1957	47.2	Link
	TF02SW1	500960	323940	April 1958	40.8	Link
	TF02SW36	500660	323610	1922	45.7	Link
	TF02SW26	500620	324510	July 1945	41.1	Link
	TF02SW2	500020	324040	May 1958	27.7	Link
	SK92SE92	499820	323380	October 1975	15.0	Link
	SK92SE93	499800	323400	N/D	14.5	Link
	SK92SE10	499700	324190	May 1941	6.7	Link
	SK92SE11	499680	324050	May 1941	6.1	Link
	SK92SE9	499660	324190	May 1941	5.8	Link
	SK92SE8	499470	324420	June 1941	5.8	Link
	SK92SE7	499390	324520	April 1941	8.5	Link
	SK92SE104	499047	324110	June 1997	4.0	Link
	SK92SE87	499030	324020	1927	39.6	Link
	SK92NE143	498970	325140	October 1971	31.0	Link
	SK92SE100	498600	324400	September 1954	28.7	Link
	SK92SE17	498530	324010	November 1959	41.1	Link
	SK92SE82	498410	324560	November 1925	32.0	Link
	SK92SE30	498290	324630	May 1943	35.7	Link
	SK92SE31	498280	323530	June 1960	49.7	Link

Notes:

¹ N.D. = No date available.

² Logged depths have been converted from feet and inches to metres where required.

³ Exploratory hole records referenced in the table are publicly available on the BGS GeoIndex Viewer (Ref 13.19).

Region 1

3.4.2 The encountered strata from BGS historical exploratory hole records within Region 1 are summarised in Table 3.11.

Table 3.11. Encountered geology in historical exploratory holes in/near Region 1

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 4, 5, 6}
Made Ground	0.0	0.5 – 1.2	0.5 – 1.2	Made Ground, silt/clay warp
Tidal Flat Deposits (Peat layer) ³	0.0 – 1.2 (3.5 – 3.9) ³	4.3 – 12.0 (4.1 – 4.8) ³	5 – 12.0 (0.6 – 1.3) ³	Drift, fen deposits, firm/soft (soft dark brown/black peat)
Till	3.4 – 12.0	6.4 – 45.0	2.0 – 33.0	Boulder Clay
Oxford Clay Formation	6.1 – 45.0	44.0 – 67.0	0.0 – 48.3	Clay and stone, hard shaley clay
Kellaways Sand Member	4.6 – 67.0	0.0 – 71.0	0.0 – 4.0 (8.5) ⁷	Sand and stone
Kellaways Clay Member	5.2 – 71.0	8.5 – 74.0	3.0 – 8.5	Grey clay and stone
Cornbrash Formation	8.5 – 574.0	10.8 – 76.0	2.2 – 4.2	Stone band, rock
Blisworth Clay Formation	10.8 – 76.0	17.8 – 79.0 ⁸	0.9 – 7.0 ⁸	Grey clay and stone

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF22NE31, TF22NW32, TF22NW10, TF22NW23, TF22NW31, TF12NE21, TF12NE28, TF12NE29, TF12NE1, TF12NW10, and TF12NW33.

² Logged depths have been converted from feet and inches to metres where required.

³ Peat layer described in TF12NE21, TF12NE1, and TF12NW33 (Lower Peat).

⁴ TF22NW31 describes chalk between 5m – 75m bgl, likely reference to interbedded carbonate layers within the Oxford Clay, with groundwater bearing fissures at 30m and 60m bgl.

⁵ Groundwater recorded in TF12NE21 at 3.4m bgl (1956, Tidal Flat Deposits), TF22NW10 at 16.3m bgl (1979, Lincolnshire Limestone), TF12NE28 at 7.6m bgl (with resting level at 3.1m bgl) (1964, Oxford Clay, resting level in Tidal Flat Deposits), TF12NE29 at 3.1m bgl (1964, Tidal Flat Deposits), and TF12NE1 at 7.9m bgl (1956, “boulder clay”).

⁶ Artesian groundwater conditions in TF22NW32 (1925, producing strata not recorded), TF22NW23 (1980, Lincolnshire Limestone), TF12NW10 (1941, producing strata not recorded), and TF12NW33 (1977, producing strata not recorded).

⁷ Kellaways Sand and Clay members logged as single unit in TF22NE23.

⁸ Base not encountered, stratum not fully penetrated.

Region 2

3.4.3 The encountered strata from BGS historical exploratory hole records within Region 2 are summarised in Table 3.12.

Table 3.12. Encountered geology in historical exploratory holes in/near Region 2

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 3, 4}
Glaciofluvial Deposits	0.5 – 0.6	2.7 – 3.2	2.1 – 2.7	Sandy clay to clayey silt with some fine gravel, yellow clay and gravel
Kellaways Clay Member	1.8 – 5.8	4.0 – 8.4	2.1 – 2.6	Grey blue clay
Cornbrash Formation	1.8 – 8.4	3.6 – 10.9	1.8 – 3.7	Limestone with shell fragments, blue and brown rock
Blisworth Clay Formation	0.0 – 10.5	3.1 – 16.9	3.1 – 6.4	Stiff mottled, fissured shaly clay, dark/light clay
Blisworth Limestone Formation	3.1 – 16.9	3.7 – 20.3	0.6 – 3.4	Limestone, grey, shell fragments and oolites
Rutland Formation	3.7 – 20.3	10.4 – 29.6	5.7 – 10.5	Clay, limestone, sand, marl, rhythmic beds
Lincolnshire Limestone (undifferentiated)	10.4 – 29.6	21.6 – 56.5	>7.1 – 29.7	Oolitic limestone, clay, limestone with A. Crossi (brachiopod)
Glaciofluvial Deposits	0.5 – 0.6	2.7 – 3.2	2.1 – 2.7	Sandy clay to clayey silt with some fine gravel, yellow clay and gravel
Oxford Clay Formation	0.5	4.9 ⁵	>4.4 ⁵	Clay

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF12NW1, TF12NW19, TF02NE28, TF02NE21, TF02NE13, TF02SE43, TF02SE18, and TF02NE31.

² Logged depths have been converted from feet and inches to metres where required.

³ Groundwater recorded in TF02NW1 at c. 2.6 to 2.7m (1961, Cornbrash Formation), TF02NE28 at 0.3m bgl (1931, surface soils over Kellaways Sand), TF02NE21 at 28.5m bgl (1959, Blisworth Limestone), TF02NE13 at 23.2m bgl (1959, Lincolnshire Limestone), TF02SE18 at 29.3m bgl (1959, Lincolnshire Limestone), and TF02NE31 at 29.3m bgl (1934, Rutland).

⁴ Natural groundwater levels not recorded in TF12NW19 (1914) and TF02SE43 (1899); records describe “good supply – overflow” and “very good supply” respectively.

⁵ Base not encountered, stratum not fully penetrated.

Region 3

3.4.4 The encountered strata from BGS historical exploratory hole records within Region 3 are summarised in Table 3.13.

Table 3.13. Encountered geology in historical exploratory holes in/near Region 3

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 3}
Till	0.0 – 0.4	4.6 – 10.7	4.6 – 10.7	Boulder clay, firm to stiff, with sandstone gravel and mudstone lithorelics
Oxford Clay Formation	5.0 – 10.7	6.1 – 14.0	1.5 – 3.4	Clay
Kellaways Sand Member	6.1 – 14.0	10.7 – 16.9	2.4 – 4.6	Sand and sandstone with clay partings
Kellaways Clay Member	10.7 – 16.9	12.2 – 18.4	1.5 – 4.0	Grey clay
Cornbrash Formation	12.2 – 18.4	15.2 – 20.9	2.4 – 3.0	Limestone
Blisworth Clay Formation	15.2 – 20.9	19.5 – 26.8	4.3 – 5.9	Clay
Blisworth Limestone Formation	19.5 – 26.8	25.3 – 29.4	2.6 – 5.8	Limestone
Rutland Formation	25.3 – 29.4	34.4 – 39.6 ⁴	>9.1 ⁴	Clay, limestone

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF02NE19, TF02SE20, TF02SE25, and TF02SE117.

² Logged depths have been converted from feet and inches to metres where required.

³ Groundwater recorded in TF02NE19 at 35.1m bgl (1959, base of Rutland), TF02SE20 at 23.5m bgl (1959, Blisworth Limestone), TF02SE25 at 41.2m bgl (1959, Lincolnshire Limestone), and TF02SE117 at 2.2m bgl (1980, Till).

⁴ Base not encountered, stratum not fully penetrated.

Region 4

3.4.5 The encountered strata from BGS historical exploratory hole records within Region 4 are summarised in Table 3.14.

Table 3.14. Encountered geology in historical exploratory holes in/near Region 4

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 5, 6}
Alluvium	0.0	5.0	5.0	Clay – grey-brown/brownish washings, gravel
Kellaways Clay Member	0.4	4.1	3.7	Firm, brown and grey silty clay, occasional fine sand, clayey sand
Cornbrash Formation	4.1	4.3 ³	>0.2 ³	Limestone
Blisworth Clay Formation	0.0	4.0	4.0	Great Oolite Clay
Blisworth Limestone Formation	4.0	6.0	2.0	Great Oolite Limestone
Rutland Formation	5.0 – 6.0	11.9 – 13.2	6.9 – 7.2	Upper Estuarine Series, sandy yellow clay, grey clay, limestone
Upper Lincolnshire Limestone	11.9 – 13.2	24.4	12.5 (31.0 ⁴)	Limestone, Crossi (brachiopod) beds
Lower Lincolnshire Limestone	24.4	41.3 – 44.2 ⁷	>16.9 ⁷	Limestone, clay parting, ragstone

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF02SE118, TF02SE90, and TF02NE2.

² Logged depths have been converted from feet and inches to metres where required.

³ Where encountered, base of unit not recorded, so thickness is given as minimum value.

⁴ Upper and Lower Lincolnshire Limestone logged as single unit in TF02SE90.

⁵ “Cavity” recorded in TF02SE90 at 21m bgl within the Lincolnshire Limestone, with no drilling returns deeper than that.

⁶ Groundwater recorded in TF02SE90 at 21m bgl (1975, Lincolnshire Limestone), and TF02NE2 at 9.4 and 11.9m bgl (1958, base of Rutland, Lincolnshire Limestone).

⁷ Base not encountered, stratum not fully penetrated.

Region 5

3.4.6 The encountered strata from BGS historical exploratory hole records within Region 5 are summarised in Table 3.15.

Table 3.15. Encountered geology in historical exploratory holes in/near Region 5

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 4}
Till	0.0	1.8 – 7.0	1.8 – 4.6 (20.7) ³	Brown/dark boulder clay
Oxford Clay Formation	0.0 – 7.0	12.1 – 20.7	5.2	Boulder clay , grey sandy clay
Kellaways Sand Member	1.8 – 20.7	5.7 – 21.8	1.1 – 3.9	Purple sandstone, sand
Kellaways Clay Member	5.7 – 21.8	7.8 – 24.1	2.1 – 2.3	Grey and blue clay, clay
Cornbrash Formation	7.8 – 24.1	10.2 – 26.3	2.2 – 2.4	Limestone, with clay bands
Blisworth Clay Formation	10.2 – 26.3	14.8 – 32.4	4.6 – 6.1	Grey clay, blue and green clay
Blisworth Limestone Formation	14.8 – 32.4	20.1 – 34.5	2.1 – 5.3	Limestone
Rutland Formation	20.1 – 34.5	30.3 – 45.8	10.2 – 11.3	Grey and green clay, oolitic limestone
Upper Lincolnshire Limestone	30.3 – 45.8	41.9 – 57.4 ⁵	>11.6 ⁵	Oolitic Limestone, limestone with A.Crossi (brachiopods)

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF02NW18, TF02SW32, and TF02SW6.

² Logged depths have been converted from feet and inches to metres where required.

³ Till (boulder clay) and Oxford Clay logged as single unit in TF02SW6.

⁴ Groundwater recorded in TF02NW18 at 25.9m bgl (1958, Rutland), TF02SW32 at 46.9m bgl (1945, Lincolnshire Limestone), and TF02SW6 at 9.1m bgl (resting water level) (1958, producing strata not recorded).

⁵ Base not encountered, stratum not fully penetrated.

Region 6

3.4.7 The encountered strata from BGS historical exploratory hole records within Region 6 are summarised in Table 3.16.

Table 3.16. Encountered geology in historical exploratory holes in/near Region 6

Assumed stratum	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ¹
Cornbrash Formation	0.0	1.2 – 1.8	1.2 – 1.8	Limestone
Blisworth Clay Formation	0.0 – 1.8	2.8 – 8.4	2.8 – 6.8	Blue/grey/green clay
Blisworth Limestone Formation	2.8 – 8.4	4.6 – 10.8	1.8 – 2.7 (4.6) ³	Limestone, light grey to blue
Rutland Formation	4.6 – 10.8	14.3 – 21.3	9.7 - 11	Dark grey-green clay, grey blue limestone
Upper Lincolnshire Limestone	14.3 – 21.3	33.5 – 34.7 (46.0) ⁴	13.4 – 14.0 (31.7) ⁴	Limestone, A. Crossi bed (brachiopod)
Lower Lincolnshire Limestone	33.5 – 34.7	43.0 – 51.2 ⁶	16.5 – 16.8 ⁶	Limestone, clay parting, ragstone

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF02SW4, TF02SW38, TF02SW25, and TF02SW19.

² Logged depths have been converted from feet and inches to metres where required.

³ Blisworth (Great Oolite) Clay and Limestone logged as single unit in TF02SW25.

⁴ Upper and Lower Lincolnshire Limestones logged as single unit in TF02SW25.

⁵ Groundwater recorded in TF02SW4 at 28.7m bgl (1958, Upper Lincolnshire Limestone), TF02SW38 at 22.7m bgl (1975, Lincolnshire Limestone), and TF02SW19 at 21.9m bgl (1958, Upper Lincolnshire Limestone).

⁶ Base not encountered, stratum not fully penetrated. ² Logged depths have been converted from feet and inches to metres where required.

⁷ Till (boulder clay) and Rutland Formation (Upper Estuarine Series) logged as single unit in TF02NW13.

⁴ Blisworth (Great Oolite) Clay and Limestone logged as single unit in TF02SW25.

⁵ Upper and Lower Lincolnshire Limestones logged as single unit in TF02SW25.

⁶ Groundwater recorded in TF02NW15 at 39.3m bgl (1945, Lower Lincolnshire Limestone), TF02NW14 at 31.9m bgl (1958, Upper Lincolnshire Limestone), TF02NW1 at 23.2m bgl (1958 (lower Lincolnshire Limestone), and TF02NW13 at 7.0m bgl (1958, within Till, but anticipated to have risen from Lincolnshire Limestone).

⁷ Drilling notes identify “water lost” in TF02NW15 at 15.2m bgl and in TF02NW13 at 30.5m bgl (both Upper Lincolnshire Limestone). Presence of karst cavities is suspected.

8

Region 7

3.4.8 The encountered strata from BGS historical exploratory hole records within Region 7 are summarised in Table 3.17.

Table 3.17. Encountered geology in historical exploratory holes in/near Region 7

Assumed stratum ³	Approximate depth from (m) ²	Approximate depth to (m) ²	Approximate thickness (m) ²	Logged description ^{1, 4, 5, 6}
Head	0.0	0.3 – 3.4	3.4	Soil and clay, brown topsoil with limestone cobbles/weathered limestone
Till	0.0	2.4 – 4.9	2.4 – 4.9	Boulder clay
Blisworth Limestone Formation	4.9	5.8	0.9	Limestone
Rutland Formation	0 – 5.8	2.1 – 10.7	2.1 – 4.9	Sand and clay
Upper Lincolnshire Limestone Member	0.0 – 10.7	12.7 – 36.9	12.2 – 24.4 (32.3) ³	Limestone, white lime, oolitic limestone buff coloured in upper part
Lower Lincolnshire Limestone Member	0.5 – 36.9	1.5 – 42.4	0.5 – 19.4	Ragstone, very hard grey limestone Hard and soft bands and thin clays
Grantham Formation	1.5 – 34.7	2.1 – 47.7	0.6 – 18.4 (10.7) ⁷	Clay, sandstone (named as Lower Estuarine Series)
Northampton Sand Formation	0.5 – 45.1	5.6 – 49.4	0.8 – 6.1	Sandy clay, soft rock, sandstone and ironstone
Whitby Mudstone	6.6 – 49.4	>6.7 – 49.7 ⁸	>3.0 ⁸	Clay (named as Upper Lias)

Notes:

¹ Summary of geological descriptions from BGS historical boreholes TF02SW35, TF02SW1, TF02SW36, TF02SW26, TF02SW2, SK92SE92, SK92SE93, SK92SE10, SK92SE11, SK92SE9, SK92SE8, SK92SE7, SK92SE104, SK92SE87, SK92NE143, SK92SE100, SK92SE17, SK92SE82, and SK92SE30.

² Logged depths have been converted from feet and inches to metres where required.

³ Upper and Lower Lincolnshire Limestones logged as single unit in a number of boreholes.

⁴ Groundwater recorded in TF02SW1 at 26.2m bgl (1958, Lower Lincolnshire Limestone), TF02SW2 at 22.4m bgl (1958, Northampton Sand Formation), SK92SE92 at 3.8 to 7.6m bgl (1976, Lower Lincolnshire Limestone), SK92SE93 at 9.0m bgl (Upper Lincolnshire Limestone), SK92SE10 at 4.4m bgl (1941, Northampton Sand Formation), SK92SE11 at 4.0m bgl (1941, Northampton Sand Formation), SK92SE8 at 4.0m bgl (1941, Northampton Sand Formation), SK92SE7 at 6.6m bgl (1941, Northampton Sand Formation), SK92NE143 at 23.8 and 29.0m bgl (1971, Upper and Lower Lincolnshire Limestone respectively), SK92SE100 at 26.1m bgl (1954, producing strata not recorded), SK92SE17 at 32.0m bgl (1959, Lower Lincolnshire Limestone), and SK92SE82 at 14.3m bgl (1925, noted to have water strike in sandstone). Drilling notes identify “lost circulation” (air rotary) in SK92NE143 below 29.0m bgl. M

⁵ Natural groundwater levels not recorded in TF02SW35 (1957); records describe “a fair supply”.

⁶ Several horizontal small to large fissures and shattered/broken rock recorded in SK92NE143 between 9.3 and 14.5m bgl, within the Lincolnshire Limestone. Aperture size and infill material not recorded.

⁷ Grantham and Northampton Sand formations logged as single unit in SK92SE82.

⁸ Base not encountered, stratum not fully penetrated.

3.5 Soils and soil chemistry

Soilscapes classification

- 3.5.1 Information obtained from Soilscapes (Ref 13.45) classifies and describes the soils in the vicinity of the site. A summary of the Soilscapes description for each Region of the site is presented in Table 3.18.

Table 3.18. Soilscapes soil descriptions

Region	Sub-region	Soilscapes ID	Soilscapes name	Summarised Soilscapes description
1	1a to 1h	21	Wisbech	Loamy and clayey soils of coastal flats with naturally high groundwater (Marine Alluvium), mostly drained (to local groundwater). Vulnerable to pollution from nutrients, pesticides and wastes applied to land.
	1h to 1j	21	Wallasea 2	Loamy and clayey soils of coastal flats with naturally high groundwater (Marine Alluvium), mostly drained (to local groundwater). Vulnerable to local erosion and pollution from nutrients, pesticide sand wastes applied to land.
2	2a	21	Wallasea 2	As above.
	2a to 2b	5	Badsey 2	Freely draining lime-rich loamy soils (River terrace and lacustrine gravel), well drained (to chalk or limestone groundwater). Vulnerable to nitrate leaching, soil capping and erosion linked with nutrient enrichment.
	2b to 2d	22	Curdridge	Loamy soils with naturally high groundwater (Jurassic sand and clay), mostly drained (to local shallow groundwater), some lower permeability clayey soils. Vulnerable to pollution from nutrients, pesticides and wastes applied to land.
	2d	5	Aswarby	Freely draining lime-rich loamy soils Mainly fine loamy gleyic brown calcareous earths, freely draining (to chalk or limestone groundwater).. Vulnerable to leaching of nitrate to groundwater; surface capping and erosion of chalk soils under cereals is linked with nutrient enrichment and silting of chalk streams and their gravel spawning beds

Region	Sub-region	Soilsclapes ID	Soilsclapes name	Summarised Soilsclapes description
3	East of 3	22	Curdridge	As above.
	-	18	Ragdale	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (Chalky till), impeded drainage (to stream network). Vulnerable to overland flow pollution (organic slurry, fertilisers, pathogens, sediment)
	West of 3	3	Elmton 3	Shallow lime-rich soils over chalk or limestone (Jurassic limestone and clay), well drained (to chalk or limestone groundwater), some deeper lower permeability clayey soils. Vulnerable to nitrate leaching, soil capping and erosion of chalk soils linked with eutrophication.
4	-	3	Elmton 3	As above
	West of 4	18	Ragdale	As above.
5	-	18	Ragdale	As above.
6	-	3	Elmton 3	As above.
7	-	3	Elmton 3	As above.
	West of 7b	18	Ragdale	As above.

Agricultural Land Use Classification

3.5.2 Natural England reports the Agricultural Land Use Classification (ALC) (Ref 13.52) of the land through which the site extends, based on the published 1:250,000 scale mapping as follows:

- Regions 1a to 1g inclusive are classified as Grade 1 – Excellent quality agricultural land.
- Regions 1h to 2d inclusive are classified as Grade 2 – Very good quality agricultural land.
- Regions 2d to 7b inclusive are classified as Grade 3 – Good to moderate quality agricultural land.

Soil chemistry

3.5.3 The BGS Soil Chemistry datasets provide indicative information on regional concentrations of five potentially harmful elements (PHEs): arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni) and lead (Pb) in soil. Elevated concentrations of these PHEs can exist because of natural geological conditions or possible anthropogenic contamination. The following BGS estimated soil chemistry levels

presented in Table 3.19 are attributed to the vicinity of the site based on the geometric mean concentrations of available data.

3.5.4 Table 3.20 presents the estimated soil chemistry levels attributed to the site on a region-by-region basis.

3.5.5

Table 3.19. Estimated soil chemistry (site wide)

Potentially harmful element	Estimated geometric mean concentration (mg/kg)
Arsenic	< 15 to 25
Cadmium	< 1.8
Chromium	40 to 120
Nickel	15 to 45
Lead	< 100

Table 3.20. Estimated soil chemistry (by Region)

Potentially harmful element	Estimated geometric mean concentration (mg/kg)						
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6 ⁴	Region 7 ⁴
Arsenic	< 15	< 15 ²	15 to 25	15 to 25	15 to 25	15 to 25 ⁶	15 to 25
Cadmium	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
Chromium	60 to 90 ¹	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90 ⁵
Nickel	15 to 30	15 to 30 ³	15 to 30	30 to 45	30 to 45	30 to 45 ⁴	30 to 45
Lead	< 100	< 100	< 100	< 100	< 100	< 100	< 100

Notes:

¹ 40 to 60 mg/kg in Region 1c to 1g.

² 15 to 25 mg/kg in Region 2b.

³ 15 to 30 mg/kg in Region 2a and 2d.

⁴ 15 to 30 mg/kg in Region 3, 6a, 6c.

⁵ 90 to 120 mg/kg in Section 6b, 6c, 7a, 7b.

⁶ <15 mg/kg in Region 3, 4, 6a, 6b, 6c, 7a, 7b

3.6 Ground stability

Groundsure natural ground stability records

3.6.1 Table 3.21 shows the variable hazard potential for natural ground stability hazards across the site based on Groundsure information, with Table 3.22 presenting a more detailed breakdown on a region-by-region basis.

3.6.2 Note, these do not represent AAJV's risk/hazard ratings for these ground stability matters and further detailed identification and assessment of these is presented in

Report Section 11 and the Preliminary Geotechnical Risk Register presented in Appendix D.

Table 3.21. Ground stability records (site wide)

Hazard type	Hazard potential – site wide
Collapsible ground	Negligible to very low
Compressible ground	Negligible to high
Ground dissolution	Negligible to high
Slope instability (landslides)	Very low to high
Running sands	Negligible to high
Shrinking or swelling clay	Negligible to high

Table 3.22. Ground stability records (by Region)

Hazard type	Hazard potential						
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
Collapsible ground	Negligible risk.	Negligible to very low risk.	Negligible to very low risk.	Negligible to very low risk.	Negligible to very low risk.	Negligible to very low risk.	Negligible to very low risk.
Compressible ground	Moderate risk associated with widespread coverage of unconsolidated sediments of the Tidal Flat Deposits and high water table.	Generally negligible, with a localised area of high risk associated with the unconsolidated Alluvium channel south east of Stainfield (Region 2d).	Negligible risk.	Generally negligible, with a localised area of high risk associated with the unconsolidated Alluvium channel along the floor of the East Glen River valley.	Negligible risk.	Generally negligible, with a localised area of moderate risk associated with the unconsolidated Alluvium channel along an unnamed watercourse.	Generally negligible, with a localised area of high risk associated with the unconsolidated Alluvium channel along the floor of the West Glen River valley (Region 7a/b).
Ground dissolution	Negligible risk.	Generally negligible to very low, with a localised area of low risk associated with the Alluvium channel overlying the Cornbrash Limestone south east of Stainfield (Region 2d).	Negligible risk.	Generally negligible to low, with a localised area of moderate risk associated with the Alluvium channel overlying the Blisworth Limestone along the floor of the East Glen River valley.	Negligible risk.	Negligible to very low risk.	Low to moderate risk associated with the karstic nature of the Upper Lincolnshire Limestone and the upper contact with the Rutland Formation. Negligible to very low risk associated with the Rutland Formation.
Slope instability (landslides)	Generally very low to low, with localised areas of high risk associated with crossing the flood	Generally very low to low, with localised areas of moderate risk associated with crossing some	Very low risk.	Moderate risk associated with the sustained slope of the eastern valley side and crossing	Very low risk.	Generally very low to low, with localised areas of moderate risk associated with a valley feature, the	Generally very low to low, with localised moderate risk associated with crossing the West Glen River (Region

Hazard type	Hazard potential						
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
	defence embankments of the River Welland (Region 1a) and River Glen (Region 1c), and moderate risk associated with crossing some agricultural drains and raised road embankments.	agricultural drains and raised road embankments.		the East Glen River and Elsthorpe Road.		ridge feature of the Woodlands Fault, and crossing some agricultural drains and raised road embankments.	7a/b), ECML railway embankment (Region 7b west arm), and the valley features and sustained hillside slope (Region 7b north arm).
Running sands	Generally moderate risk associated with widespread coverage of unconsolidated silts and sands of the Tidal Flat Deposits and high water table, with localised high risk associated with channelised sand and silts of the Tidal Flat Deposits (Region 1i).	Generally negligible to low, with localised area of moderate risk associated with the with unconsolidated silts and sands of the Tidal Flat Deposits and high water table (Region 2a).	Negligible to low risk.	Generally negligible to low, with localised areas of moderate risk associated with the mapped outcrop of the Kellaways Sandstone Member and the unconsolidated Alluvium channel along the floor of the East Glen River valley.	Negligible to low risk.	Generally negligible to very low, with localised areas of low risk associated with the mapped outcrops of the Kellaways Sandstone Member and the unconsolidated Alluvium channel along an unnamed watercourse.	Generally negligible, with a localised area of low risk associated with the unconsolidated Alluvium channel along the floor of the West Glen River valley (Region 7a/b).

Hazard type	Hazard potential						
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
Shrinking or swelling clay	Generally low risk associated with widespread coverage of unconsolidated medium plasticity cohesive sediments of the Tidal Flat Deposits, with localised moderate risk associated with variations in those deposits and shallowing sandstone bedrock (Region 1i and 1j).	High risk associated with mapped outcrops of the high plasticity Oxford Clay Formation and Kellaways Clay Member.	Moderate to high risk associated with mapped outcrops of the medium plasticity Till and high plasticity Oxford Clay Formation.	Moderate risk associated with mapped outcrops of the high plasticity Oxford Clay Formation, Kellaways Clay Member, and Blisworth Clay Formation.	Low to moderate risk associated with mapped outcrops of the medium plasticity Till and high plasticity Oxford Clay Formation.	Low to moderate risk associated with mapped outcrops of the high plasticity Kellaways Clay Member and Blisworth Clay Formation.	Negligible to very low risk.

3.7 Ground movements and seismic hazard

- 3.7.1 A review of freely available InSAR data from the European Ground Motion Services (EGMS) (Ref 13.28), updated annually from 2016 to present, indicates that settlements on the site are generally low, with the majority of data points showing settlement mean velocities of approximately 1.2mm per year. Settlement values vary significantly with points and clusters of points along the route of the site showing mean velocities of up to 3mm to 5mm per year. Clusters of points with higher mean velocities are generally concentrated in the east of the site (Regions 1 and 2) which generally corresponds to areas of weaker ground conditions.
- 3.7.2 In 2020 BGS seismologists completed a seismic hazard assessment for the UK, producing seismic hazard plans. This was undertaken with support from the Institution of Civil Engineers (ICE), other seismologists and engineers based in the UK and with oversight from the British Standard Institution (BSI) sub-committee B/525/8 for Eurocode 8 (EC8): Earthquake resistant design of structures (Ref 13.50).
- 3.7.3 A review of this plan has shown that the site is in a low seismicity area with a peak ground acceleration (PGA) with 10% probability in 50 years (475 years return period) at <0.02g and 2% probability in 50 years (2500 years return period) at 0.02g – 0.04g
- 3.7.4 A Review of the BGS Geindex (Ref 13.19) recorded earthquake map shows the epicentre of one historical earthquake recorded in 2021 lies approximately 4.5km to the north of Region 1g of the site. The earthquake hypocentre was at approximately 7.5km depth and the Richter local magnitude was recorded as 1.8. The location of this earthquake does not appear to correlate to any known or inferred geological faults.

3.8 Ground dissolution and karst risk

- 3.8.1 As outlined in Table 3.1, the site crosses geology of the Great Oolite Group (Rutland Formation) and Inferior Oolite Group (Upper Lincolnshire Limestone Member, Lower Lincolnshire Limestone Member, Grantham Formation and Northampton Sand Formation). The dominant Jurassic age limestones of the Lincolnshire Limestone Formation outcrop in Region 7 of the site. A cursory review of publications on karst features has been undertaken and findings summarised below.
- 3.8.2 As per Farrant and Cooper, 2008 (Ref 13.40), “Jurassic limestones extend across much of central, southern and eastern England in a belt from Dorset to North Yorkshire” and “although the karst in these rocks is not as well developed as in the more massive Palaeozoic limestone terrain”. Karst terrains are highlighted to be “well developed in the Lincolnshire Limestone south of Grantham”; Grantham is located 14km north east of Region 7 of the site. The BGS 2022 report on Karst in Jurassic limestones (Ref 13.18) supports this, outlining that “karst is best documented in the Grantham to Stamford area, associated with the East Glen, West Glen and Witham rivers; but there is evidence for karst throughout the area” and that “karst is particularly developed in the Lincolnshire Limestone Formation”, whilst also adding that “there is also evidence of karst in the limestones of the Great Oolite Group”. This elevated karst risk in the Lincolnshire Limestone Formation correlates with the Groundsure hazard ratings presented for ground dissolution in Table 3.22.

- 3.8.3 With regards to issues resulting from karst in the Lincolnshire Limestone Formation, Farrant and Cooper, 2008 states that “water supply protection is the main issue, although localised subsidence and areas of irregular rock head are to be expected”. The BGS 2022 report further outlines the presence of stream sinks, swallow holes and dissolution pipes/dolines (latter at the boundary between the Great Oolite Group and underlying Lincolnshire Limestone Formation) all being recorded within the Lincolnshire Limestone Formation.
- 3.8.4 Springs are understood to occur throughout the area inclusive of both the Inferior Oolite Group and the Greater Oolite Group. These are indicated to occur between the Inferior Oolite Group and the Lias Group, alongside between the Rutland Formation and Lincolnshire Limestone and the Kellaways/Oxford Clay Formation and the Great Oolite Group. Tracer testing has been carried out in the area as outlined by Atkinson and Farrant, 2015 (Ref 13.2) confirming hydraulic connection between stream sinks/swallow holes and boreholes, including that at Burton-le-Coggles, which was indicated to link to boreholes further in Elsthorpe, which in turn indicated links to a swallow hole at Easton Wood 4.5km west of Region 7. This highlights the potential for contamination pathways through karstic terrains.
- 3.8.5 It is noted here that the Groundsure Insights GIS Dataset did not return any natural cavity data points or sinkhole events. It is assumed that such searched databases would include point data for karst features presented in the BGS 2022 report, however, this may not be the case. Furthermore, due to the large-scale nature of the maps presented in the BGS 2022 report, associated karst features have not been digitised. It should be appreciated that karst records are reflective of where studies have been completed and this, paired with their ongoing natural formation of such features makes associated databases/records inherently incomplete.
- 3.8.6 Overall, karst terrains, including recorded, potential and likely unrecorded features, are considered to pose a significant risk to ground stability, including of collapse settlement due to sub-surface voids, in Region 7 of the site. This Region should be inspected and reviewed during site reconnaissance, including specific targeting of recorded and potential features.

3.9 Mining and mineral extraction

Planning policy for mineral use

- 3.9.1 The National Planning Policy Framework (NPPF) for England 2024 (Ref 13.51) requires minerals planning authorities to promote sustainable use of mineral resources in their Local Plans. This includes defining mineral safeguard zones to ensure that specific mineral resources of local or national importance are not sterilised by non-mineral development (without assuming that the identified minerals will be worked). If it is necessary for non-mineral development to take place then the local planning authority should set out policies to encourage the prior extraction of minerals, where practicable and environmentally feasible.
- 3.9.2 When determining planning applications local planning authorities must ensure that, amongst other matters, there are no unacceptable impacts on the natural and historic environment, human health or aviation safety (taking into account cumulative effects from multiple sites); unavoidable noise, dust and particle emissions, and vibrations are controlled, mitigated or removed at source; and to not normally permit other developments in mineral safeguard zones.

- 3.9.3 The 1:100,000 BGS Mineral Resources map of Lincolnshire - South (Ref 13.17), alongside BGS GeoIndex record the site to be underlain by the mineral resources summarised in Table 3.23. Of these minerals, the Lincolnshire Minerals and Waste Local Plan (2016) designates the Lincolnshire Limestone Formation extent as a Mineral Safeguarding Area (MSA) and outlines the associated Policy M11.
- 3.9.4 Historical mineral planning permissions for ironstone are also recorded locally encroaching on the site as outlined in Table 3.23 based on Groundsure information. In relation to ironstone mining and other minerals, the local mineral plans outline the following:
- Ironstone: areas with planning permissions for ironstone working are indicated to be dormant and are said to be unlikely to begin works in the foreseeable future. This is attributed to the decline of the steel industry in the UK and the reported low-grade quality of the ironstone in Lincolnshire. It is further outlined that it is unlikely for ironstone working to take place in the foreseeable future, other than as a source of building stone.
 - Coal: The coal measures are said to never have been worked. Deep coal reserves are however indicated to have the potential for Coal Bed Methane (CBM) extraction in Lincolnshire, although no subsequent proposals or applications for production of CBM are noted to have come forward. No Underground Coal Gasification (UCG) are noted to be in operation.
- 3.9.5 A cursory review of satellite imagery does not indicate current large-scale quarrying/mineral extraction activities in the mapped historical mineral planning permission extents.
- 3.9.6 With regards the use of the Lincolnshire Limestone Formation as a mineral resource, the crushed aggregate is indicated to be of low strength and poor frost resistance therefore only suitable for construction fill or as a sub-base roadstone material. In addition, the variable lithology of the Lincolnshire Limestone Formation is indicated to mean it is unlikely to form a high purity for lime production. These factors are said to reduce its extraction desirability for construction usage (British Geological Survey, 2002).
- 3.9.7 Considering the presence of safeguarded limestone mineral resources in the west of the site, consultation with the Mineral Planning Authority (MPA) is required at the pre-application stage. While the Proposed Development may meet exemption criteria, meaning a full Minerals Assessment (MA) may not be necessary, the exemption reason must be clearly stated in the Planning Statement accompanying the application or referenced in the local plan evidence base supporting the site allocation. The MPA should be consulted for guidance on these considerations.
- 3.9.8 The reviewed mineral resource safeguarding and planning permission data is limited to the date in which studies/permissions/policies were undertaken/made and therefore, the potential for unrecorded or future changes to these cannot be discounted.

Table 3.23. Summary of mineral resources, safeguarding and mineral planning permissions

Region	BGS mineral resources and extent	Safeguarded minerals	Mineral planning permissions extents
1	None recorded	None recorded	None recorded
2	None recorded	None recorded	None recorded
3	None recorded	None recorded	None recorded
4	None recorded	None recorded	None recorded
5	Deep Coal (up to 1200m) along north boundary	None recorded	None recorded
6	Deep Coal (up to 1200m) under most of Region	None recorded	None recorded
7	Limestone under whole Region Deep Coal (up to 1200m) under whole Region	Limestone (Lincolnshire Limestone Formation)	Region 7b north arm, historical planning permission, Easton Mine, underground working for Ironstone, Status: Valid, granted 11/04/58.

Historical underground aggregate/mineral mining (excluding coal)

- 3.9.9 The strata underlying the western extents of the site comprise resources for mineral extraction, including aggregates from the Lincolnshire Limestone Formation and metalliferous ore within ironstone from the Northampton Sand Formation. These resources are indicated by the geological memoirs to have generally been mined further west of the site via surface quarrying, although some underground operations are also indicated.
- 3.9.10 Ironstone mining at Easton Mine, the surface processing site of which is indicated to be located 4.5km north west of Region 7b, is described as wholly underground. The mineral planning area for Easton Mine is shown to include the northern extents of the north arm of Region 7b and is assumed to be associated with planned underground extraction of the Northampton Sand Formation beneath the overlying Lincolnshire Limestone Formation in the area. From available information, it is unclear whether permission has been acted upon, as Lincolnshire County Council, 2016 (Ref 13.46) notes most are now dormant, and where working is still taking place, this is limited to the overlying limestone. The permission is thought to correspond with the transfer of Easton Mine to the United Steel Company who began work on the Easton Mine in 1958, until its closure in 1967 (Ref 13.47). Although associated workings are not recorded on site, the presence of unrecorded workings cannot be discounted considering the mapped geology.

- 3.9.11 A review of the Arup (1991) East Midlands review of mining instability in Great Britain (Ref 13.1) notes two large ironstone mines to be present within South Kesteven of which one was the Easton Mine and noted within the county to be extensively worked both by underground and opencast methods. The mining area code reference is 73105 and the Easton Mine was noted to be active and outputting ironstone between the 1930s and 1964. Working methods were listed as roadways, pillar and stall whilst access was through adits. It is be noted that an extract of the Ironstone Railways & Tramways of the Midlands by Tonks, 1963 (Ref 13.57) was posted on the Industrial Railway society where commentary states “The ironstone properties of the Ore Mining Branch of the United Steel Companies Ltd. are confined to Rutland and Lincolnshire and can be conveniently grouped together for study. There have been quite a few changes since 1958, the most important, perhaps, being the opening of a completely fresh mining area” this area may correspond to the aforementioned mineral resource area.

Historical surface workings of aggregate/mineral quarrying and mining

- 3.9.12 Table 3.24 presents the available information on surface mining and quarrying operations, past and present that have taken place within 250m of the site.

Table 3.24. Quarrying within 250m of the site

Co-ordinates	Distance and direction	Name/descriptor	Licence number	Dates	Type	Status/material quarried	Anticipated impact on ground stability
510383, 325608	120m south of Region 2b	Haconby	N/R	1887	Surface workings	Ceased Clay and shale	Low
502920 324110	Eastern part of Region 6	Norwood Gravel Pit (location 1)	N/R	1887 to 1983	Surface workings	Ceased Sand and gravel	Low
503010 324580	240 north of eastern part of Region 6	Norwood Gravel Pit (location 2)	N/R	1887 to 1983	Surface workings	Ceased Sand and gravel	Low
498732 325508	60m west of Region 7b	Burton Le Coggles Stone Pit (location 1)	N/R	1887 to 1982	Surface workings	Ceased Limestone	Low
498652 325391	80m north of Region 7b	Burton Le Coggles Stone Pit (location 2)	N/R	1887 to 1982	Surface workings	Ceased Limestone	Low
498127 325364	110m north east of Region 7b	Burton Le Coggles Stone Pit (location 3)	N/R	1905 to 1982	Surface workings	Ceased Limestone	Low

Co-ordinates	Distance and direction	Name/descriptor	Licence number	Dates	Type	Status/material quarried	Anticipated impact on ground stability
• 498215 324921	• 70m south of Region 7b	• Unspecified pit	• N/R	• 1982	• Surface workings	• Ceased • N/R	• Moderate

Coal mining and mine gas

- 3.9.13

Based on the records of the Mining Remediation Authority (Ref 13.49), the site lies outside the coal mining reporting area. There is no recorded or suspected evidence of historical mining of the deep coal in the surrounding areas. It is therefore inferred that the risk of coal mining is low. The subsequent risk from mine gas is considered negligible.

Mine Gas (non-coal mining)

- 3.9.14

The BGS details hazards associated with legacy mining operations and includes former ironstone workings. When exposed to water, ironstone workings may generate hydrogen sulphide gas, which may cause an explosive atmosphere if it accumulates in a confined space. Ironstone mining may have occurred under the mineral planning area for Easton Mine, shown to include the northern extents of the north arm of Region 7b, (detailed within Section 3.9 of this report). Ironstone mining at Easton Mine, the surface processing site of which is indicated to be located 4.5km north west of Region 7b, is described as wholly underground. Although associated workings are not recorded on site, the presence of unrecorded workings and associated spoil heaps cannot be discounted considering the mapped geology.

3.10 Radon

- 3.10.1

The UK Health Security Agency’s UK Radon website (Ref 13.64) was reviewed along with information from the more refined BGS database presented in the Groundsure Insights GIS Dataset to determine potential radon risks for the site. Table 3.25 below outlines the radon risk on site based on more accurate Groundsure data.

Table 3.25. Summary of radon potential

Region	Radon potential	Radon risk	Remarks
1	< 1%	Low	Isolated radon risk of 1 to 3% noted 60m north of Region 1j.
2	< 1%	Low	None
3	< 1%	Low	None
4	< 1%	Low	None

Region	Radon potential	Radon risk	Remarks
5	< 1%	Low	None
6	< 1%	Low	Majority of Region 6 <1%, with far western extent noting 10-30% encroaching into the area.
7	10 to 30%	High	Region 7a occupied entirely by a 10-30% radon potential. Within Region 7b isolated areas of <1% are present within a mostly 10-30% radon potential. The northern extent of Region 7b noted 5 to 10%.

3.11 Hydrogeology

Aquifer classification

- 3.11.1 Groundwater bodies are classified by the Environment Agency (EA) under the Water Framework Directive (WFD) (Ref 13.39), whereby water bodies in England are classed as High, Good, Moderate, Poor or Bad, defined by chemical status and quantitative status. The chemical status assesses the compliance with environmental quality standards for pollutants (i.e., whether they exceed criteria) whilst quantitative status evaluates whether groundwater affects water levels and dependent ecosystems (i.e., is it sustainable).
- 3.11.2 A search of the EA's Catchment Data Explorer (Ref 13.38) was conducted regarding the groundwater quality beneath the site. Part of the site between 505517 324713 (Region 4) and 497935 324786 (west of Region 7b) lies within the Welland Mid Jurassic Unit (GB40501G445300). The groundwater body has an overall status of Good from the Cycle 3 (2019) data. The remaining areas of site do not fall within a groundwater body.
- 3.11.3 According to the Groundsure Insights GIS Dataset, the following aquifer designations have been noted along the extent of the site, outlined in Table 3.26.

Table 3.26. Aquifer classification

Unit	Aquifer Designation	Location Details
Superficial Deposits		
Tidal Flat Deposits	Unproductive	On-site of Region 1a to Region 2a. Extending off-site to the north and south.
River Terrace Deposits	Secondary A	On-site of Region 2a and Region 2b. Extending off-site to the north, south and west.

Unit	Aquifer Designation	Location Details
Glaciofluvial Deposits	Secondary A	On-site of Region 2b and Region 6a. Extending off-site to the south and north, respectively for the two regions.
Alluvium	Secondary A	On-site of Region 2d, Region 4, Region 6 and Region 7a/b. Noted extending off-site from the above within 250m of Region 2d, 4, 6, and 7b.
Till	Secondary Undifferentiated	On-site of Region 1i, 3 and Region 5. All areas extend off-site to the north and south.
Peat	Unproductive	Isolated area to the west onsite of Region 1j. Isolated area offsite to the north of Region 1j.
Bedrock Geology		
Oxford Clay Formation	Unproductive	On-site of Region 1a to Region 1j, Region 2b to 2d, Region 3 and Region 5. Extending off-site from the above regions to the north and south.
Kellaways Sand Member	Secondary A	On-site of Region 1j, Region 2b to 2d, Region 3 to Region 5 and Region 6. Extending off-site from the above regions to the north and south.
Kellaways Clay Member	Unproductive	On-site of Region 1j to Region 2a, Region 2b, Region 2d, Region 3 to Region 4 and Region 6. Extending off-site from the above regions to the north and south, as well as Region 5 to the north.
Cornbrash Formation	Secondary A	On-site of Region 1j to Region 2b, 2d, Region 4, Region 6. Extending off-site from the above regions to the north and south, as well as Region.
Blisworth Clay Formation	Unproductive	On-site of Region 4 and Region 6. Extending off-site from the above regions to the north and south, as well as Region 3 to the south.

Unit	Aquifer Designation	Location Details
Blisworth Limestone Formation	Principal	On-site of Region 4 and Region 6. Extending off-site from the above regions to the north and south, as well as Region 3.
Rutland Formation	Secondary B	On-site of Region 6 and Region 7b. Extending off-site from the above regions to the north and south, as well as Region 7b to the west.
Upper Lincolnshire Limestone	Principal	On-site of Region 6 and Region 7b. Extending off-site from the above regions to the north and south, as well as Region 7b to the west.
Lower Lincolnshire Limestone	Principal	On-site of Region 6, 7a and 7b. Extending off-site from the above regions to the north and south.

- 3.11.4 Note that the entirety of the site from the River Welland (Region 1a, 527371 327364) to beyond Region 7b (498443 323754) is positioned within a Nitrate Vulnerable Zone. The EA defines a Nitrate Vulnerable Zone as areas designated as being at risk from agricultural nitrate pollution.

Licensed groundwater abstractions and Source Protection Zones

- 3.11.5 Eight groundwater abstraction points have been identified within 250m of the site in the Groundsure Insights GIS Dataset. Of these, only four was recorded as active. Where the abstraction point is within 1km of another region of the site this has been noted. These are listed in Table 3.27.
- 3.11.6 Standard search boundaries for abstraction points would extent to a 1km radius of the site, however due to the extent of the site, GIS data was only obtained for 250m of red line boundary.

Table 3.27. Environment Agency licenced groundwater abstractions (on or within 250m of site)

Co-ordinates	Distance (m) and direction	Licence number	Use
516300 327300	On site of access route and ~510m north of the route (Region 1h)	4/30/12/*G/0086A [historical]	General Farming & Domestic

514550 327000	~10m west of access route and ~470m north of route (Region 1i)	4/30/12/*G/0040A	General Farming & Domestic
514528 326987 514500 327000	~35 - 60m west of access route from Region 1i and ~475m north of route	4/30/12/*G/0040B (3 No. entries) 4/30/12/*G/0040B [historical – 5 No. entries]	Transfer Between Sources, Spray Irrigation, Trickle Irrigation
522200 327800	~85m north (Region 1d) (~50m east of access route). Within 1km of Region 1e	4/30/12/*G/0015 [historical – 2 No. entries]	General Farming and Domestic and Transfer between Source
516800 327700	120m west of access route and ~690m north of route (Region 1h)	4/30/12/*G/0076A	General Farming & Domestic
498250 324680	~136m west of Region 7b	5/31/11/*G/0062 [historical]	General Farming and Domestic
513540 326635	~165m north of Region 1j	4/30/12/*G/0020	General Farming and Domestic
516490 327745	230m north of access route (Region 1h) and ~870m north of route	4/30/12/*G/0301/R02 [historical] 4/30/12/*G/0266 [historical] 4/30/12/*G/0301/R03 4/30/12/*G/0301/R03 [historical] 4/30/12/*G/0301/R01 [historical] 4/30/12/*G/0301 [historical] 4/30/12/*G/0301/R01L [historical] 4/30/12/*G/0288 [historical]	Potable Water Supply - Direct

- 3.11.7 The closest historical (expired in 2019) potable abstraction (license number 4/30/12/*G/0301/R02) entry is located ~215m north of access route, with an additional entry ~880m north of the route (Region 1h) at 516490 327735. The abstraction point is a potable water supply. Potable abstractions are the sensitive receptors, meaning in the vicinity of these points the risk to controlled waters is likely

to be elevated, however where abstractions are noted for farming and domestic use, the risk is lower.

- 3.11.8 The Environment Agency identifies Source Protection Zones (SPZ) which show the extent of a groundwater source catchment, those present within 250m of the site listed in Table 3.28. These are divided into three zones, definitions of which are outlined below:
- SPZ1 – Defined by a 50-day travel time from any pollution below the water table to the groundwater source, with a minim radius of 50m. It is the area immediately around an abstraction point for domestic/food supply purposes and is where groundwater is the most vulnerable to pollution.
 - SPZ2 – Defined by a 400-day travel time from a point below the water table, with a minim radius of 250 – 500m, depending on the size of the abstraction.
 - SPZ3 – Defined as the area around a groundwater source where all groundwater is presumed to end up at the abstraction point, covering the entire catchment area based on the volume abstracted and effective rainfall.

Table 3.28. Source Protection Zones (by Region)

Type of SPZ	Distance (m) and direction ¹	Extent of SPZ (within 250m)
SPZ 2 – outer catchment	On-site (Region 1g)	518155 327536 to 517760 327321
SPZ 2 – outer catchment	On-site (Region 1g to Region 3)	517760 327321 to 506821 324625
SPZ 2 – outer catchment	On-site (Region 3 to Region 7a)	506821 324625 to 499346 325585
SPZ 2c – confined aquifer	On-site (Region 1i)	515014 326179 to 513678 325966
SPZ 3 – total catchment	On-site (Region 7a to 7b)	499141 323762 to 498090 323881
SPZ 1 – inner catchment	On-site of access route (south of Region 1h)	517504 326868 to 515987 326153
SPZ 1 – inner catchment	On-site of access route (north of Region 1h)	516294 327128 to 514857 326794

Notes:

¹ Distance to off-site SPZ given at their closest point.

- 3.11.9 The Environment Agency Identifies Drinking Water Safeguard Zones for Surface Water. The site does not fall within the surface water safeguard area.

Preliminary hydrogeological model and flow direction

- 3.11.10 Due to the extent of the site, the groundwater flow direction within the superficial aquifers will likely be influenced by local topography and watercourses. The topography on the site varies across each Region between 3m AOD to the east (Region 1) and 85m AOD to the west (Region 7), in general sloping down towards the east. The presence of valleys formed by rivers, such as the East Glen River (Region 4 and 5) and West Glen River (Region 7) has resulted in sloped areas along

the site which will likely influence the direction of groundwater flow in alignment with the surface water flow via baseflow within permeable superficial deposits. This baseflow is likely to be limited laterally within unproductive aquifer superficial deposits on-site or where a confining (cohesive) layer is present relating to vertical migration of groundwater, such as for the Oxford Clay Formation, Kellaways Clay Formation and Blisworth Clay Formation which act as confining layers for the underlying aquifers. Rapid flow pathways may be associated with the Limestone Formation, karstic features, and swallow holes (Regions 6 and 7).

- 3.11.11 Groundwater at depth within the limestone formations is considered likely. The BGS Hydrogeological Map for North East Lincolnshire (Ref 13.6) was reviewed for the site, showing groundwater contours indicating groundwater flow within the Lincolnshire Limestone towards the east. None to limited data was provided for the remaining bedrock formations. Eight groundwater abstraction points have been identified within 250m of the site in the Groundsure Insights GIS Dataset. Of these, four were recorded as active. Where the abstraction point is within 1km of another region of the site this has been noted. These are listed in Table 3.27.

3.12 Hydrology

Surface water features

- 3.12.1 The Environment Agency Catchment Data Explorer (Ref 13.38), Groundsure information, and other publicly available sources have been reviewed to identify relevant hydrological features on site and in the surrounding area. There are numerous surface water features on site including rivers, streams and drains, however due to the vast number of these only the named watercourses noted on site or within 250m of the site boundary have been listed in Table 3.29. Along with this, where available, associated EA Water Body ID and General Quality Assessment (GQA) status have been included.
- 3.12.2 In areas, small unnamed watercourses are present within 250m of the proposed haulage roads on site. It should be should that where this is the case, the potential for runoff into these watercourses is possible. For this reason, these have also been included within Table 3.29. If an unnamed drain is noted to cross a haulage road but is not identified as a watercourse under the WFD then this has not been included in the below table.
- 3.12.3 In addition to the below a number of small ponds (detailed within Report Section 4) and an on-site reservoir (Region 1a, 527088 327291) are present.

Table 3.29. Surface water quality

Surface water feature (EA Water Body ID)	GQA status ¹ ₂	Direction and distance (m)	Crossing overhead line	Details
Region 1				
Wykeham Drain	No information available ³ .	On-site (Region 1a)	N/A	Flowing towards the north east then east

Surface water feature (EA Water Body ID)	GQA status ¹ ₂	Direction and distance (m)	Crossing overhead line	Details
River Welland (GB205031050685)	Ecological: Moderate Chemical: Fail	On-site (Region 1a)	527380 327360	Flowing towards the north east. Also known as the Welland - confluence Greatford Cut to tidal water body.
Vernatt's Drain (GB205031050705)	Ecological: Moderate Chemical: Fail	On-site (Region 1a)	527270 327420	Flowing towards the north east
Blue Gowt Drain	No information available ³ .	On-site (Region 1b)	526490 327370	Flowing towards the north east
Unnamed drain	No information available ³	On-site (Region 1b)	526210 327440 and 526170 327450	-
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 1b)	525530 327550	-
Old Sea Drain	No information available ³ .	On-site (Region 1b and 1c)	525950 327520 (1b)	-
River Glen (GB105031050720)	Ecological: Moderate Chemical: Fail	On-site (Alignment) (Region 1c) On-site (site boundary)	524210 327610	Flowing towards the north east
Clink's Drain	No information available ³ .	On-site (Region 1b to 1d)	524680 327588 (1b) 524067 327593 (1c) 522377 327629 (1d)	Flowing towards the east
New Drain	No information available ³ .	On-site (Region 1e and 1f)	521082 327662 (1e) 520288 327677 (1f)	Flowing towards the east, then south
Hammond Beck	No information available ³ .	On-site (Region 1f and 1g)	516570 326747 (1f)	-

Surface water feature (EA Water Body ID)	GQA status ¹ ₂	Direction and distance (m)	Crossing overhead line	Details
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 1g)	518679 327756	-
Black Sluice IDB Draining to the South Forty-Foot Drain (GB205030051515)	Ecological: Moderate Chemical: Fail	On-site (Region 1h)	520288 327677	South Forty-Foot Drain (516570 326760)
Haconby Lode	No information available ³ .	On-site (Region 1j)	512909 326163 513020 326150	Flowing towards the east/south east. Adjoins to South Forty-Foot Drain to the east.
Star Lode	No information available ³ .	124m south (Region 1h)	N/A	Adjoins to South Forty-Foot Drain to the west
Region 2				
Haconby Lode	No information available ³ .	On-site (Region 2a)	512390 326080 512349 326074	Flowing towards the east/south east. Adjoins to South Forty-Foot Drain to the east.
Scotten Dike	No information available ³ .	On-site (Region 2a)	512044 326027	Flowing towards the north east, then east
Car Dyke (GB104028052501)	Ecological: Poor Chemical: Fail	On-site (Region 2a)	511650 325960	Flowing towards the north east
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 2b)	510386 325733	-
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 2b)	510343 325722	-
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 2b)	510043 325677	-
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 2c)	509263 325637	-
Region 3				

Surface water feature (EA Water Body ID)	GQA status ¹ ₂	Direction and distance (m)	Crossing overhead line	Details
East Glen River (GB105031055480)	Ecological: Poor Chemical: Fail	234m south	-	Flowing towards the south
Unnamed [crossing haulage road]	No information available ³ .	On-site	506060 324594	-
Region 4				
East Glen River (GB105031055480)	Ecological: Poor Chemical: Fail	On-site	505350 324610	Flowing towards the south
Region 5				
Unnamed [crossing haulage road]	No information available ³ .	On-site	503774 324602	-
Unnamed [crossing haulage road]	No information available ³ .	On-site	503489 324392	-
Region 6				
Unnamed [crossing haulage road]	No information available ³ .	On-site (Region 6a)	501836 324642	-
Region 7				
West Glen River (GB105031050770)	Ecological: Moderate Chemical: Fail	On-site (Region 7a)	499730 323780	Flowing towards the south east

Notes:

¹GQA based on most recent Cycle 3 data (2019 or 2022).

²Ecological status applies to surface water bodies and is based on the following quality elements: biological quality, general chemical and physico-chemical quality, water quality with respect to specific pollutants (synthetic and non synthetic), and hydromorphological quality. There are five classes of ecological status (high, good, moderate, poor or bad). Ecological status and chemical status together define the overall surface water status of a water body. The classification status for the surface water body against the environmental standards for chemicals that are priority substances and priority hazardous substances. Chemical status is recorded as good or fail. A status of good means that concentrations of priority substances and priority hazardous substances do not exceed environmental quality standards. The chemical status classification for the water body, and the confidence in this (high or low), is determined by the worst test result. Chemical status and ecological status together define the overall surface water status of a water body. For groundwater see "Groundwater chemical status".

³No EA Water Body information available for the listed surface water feature.

Licensed surface water abstractions

- 3.12.4 Two surface water abstractions have been identified within 250m of the site, with all entries active unless otherwise stated. These are listed in Table 3.30.

- 3.12.5 Standard search boundaries for abstraction points would extent to a 1km radius of the site, however due to the extent of the site, GIS data was only obtained for abstraction points within 250m of red line boundary.

Table 3.30. Environment Agency licensed surface water abstractions (on or within 250m of site)

Co-ordinates	Distance (m) and direction	Licence number	Abstraction source	Use
524174 327578	On-site (Region 1c)	5/31/14/*S/0169	River Glen	Spray Irrigation – Direct
502900 324000	~115m south (Region 6a)	5/31/12/*S/0022	Spring/ Collection Tank	General Farming and Domestic

4. Historical Land Use

4. Historical Land Use

4.1 Introduction

- 4.1.1 Historical Ordnance Survey (OS) maps of the site and the wider environments were provided by Groundsure (scales 1:2,500, 1:10,560 and 1:10,000) and these, alongside publicly accessible historical aerial photography from Google Earth Pro (Ref 13.43), have been reviewed and summarised in this Report Section.
- 4.1.2 The historical OS maps obtained date between 1886 and 1995, with aerial photography dating from 1999 to present day (2026). A tabulated summary of the historical development on the site is presented in Appendix C.
- 4.1.3 Where dates are stated, these refer to the dates of maps on which the features are present, have changed use or are no longer annotated, and do not necessarily refer to the exact dates of existence of a particular feature. Development that may have occurred between map editions is recorded as occurring on the later published map, hence there are some limitations to the accuracy to the date of development unless supplementary evidence is available.

4.2 Site and site surrounding area history

- 4.2.1 The site is predominantly occupied by agricultural fields both in its present-day use and historically. Farms, hamlets and drainage channels are noted along the extent within 250m of the overhead line alignment, as well as numerous roads and named and unnamed watercourses (drains, rivers and becks) crossing the alignment. Extending across Regions 1b, 1d and 7b of the site, railway lines are present dating back to earliest mapping (1886).
- 4.2.2 A number of ponds are noted both on-site and within 250m, appearing infilled between 1903 and 2021, as well as quarries/pits infilled between 1903 and 1981. Other more contaminative sources are noted within 250m of the site, included tanks (Region 1a, 1b and 1c) from the 1968 – 1995 mapping and an electricity substation (Region 1c) from 1987 to present day. Historically, a smithy was present 160m north of Region 2d between 1886 and 1903, and a piggery on-site of Region 1c between 1968 and 1995. Those identified from a geo-environmental perspective have been listed in Report Section 4.3.

4.3 Summary of potential historical contaminative sources

4.3.1 This paragraph summarises potential sources of contamination on-site and, in the vicinity, associated with historical features identified in Report Section 4.2 inclusive of the Contaminants of Potential Concern (CoPC) (Ref 13.26). These include the following:

On-site

- Infilled Ground (all regions) – associated with former ponds and quarries/pits infilled with unknown materials. Contaminants of Potential Concern (CoPC) include: metals and metalloids, Polycyclic Aromatic Hydrocarbons (PAH), Semi-volatile Organic Compounds (SVOCs), pH, Asbestos Containing Materials (ACM)/asbestos and ground gas (methane and carbon dioxide).
- Made Ground (all regions) – associated with infrastructure such as roads, and embankments crossing the site. CoPC include: metals and metalloids, cyanides (total, free), SVOCs, Volatile Organic Compounds (VOCs), TPH, PAH, pH, ACM/asbestos and ground gas (methane and carbon dioxide).
- Railway Land (Region 1b, 1d and 7b) – crosses site at 526098 327463, 523053 327615 and 498127 324962. CoPC include: metals and metalloids, SVOCs, VOCs, PAH, TPH, Polychlorinated Biphenyls (PCBs), sulphate, ACM/asbestos, herbicides and glycols.
- Agricultural Land (all regions) – CoPC include: TPH (anticipated to be minimal), ammoniacal nitrogen, herbicides and pesticides.
- Tanks (Region 1b) – one area labelled as tanks noted on-site, however a number of farms with potentially unrecorded tanks are also present. CoPC include: PAH, TPH and asbestos.
- Animal Management Sites (Region 1c) – piggery associated with Cuckoo Lane Farm at 524672 327634. CoPC include: metals and metalloids, SVOCs, VOCs, PAH, organochlorine pesticides, sulphate, sulphide, ammoniacal nitrogen and pathogens.
- Ironstone mining may have occurred under the mineral planning area for Easton Mine, shown to include the northern extents of the north arm of Region 7b, and is detailed within Section 3.9 of this report. Ironstone mining at Easton Mine, the surface processing site of which is indicated to be located 4.5km north west of Region 7b, is described as wholly underground. Although associated workings are not recorded on site, the presence of unrecorded workings and associated spoil heaps cannot be discounted considering the mapped geology. Exposure of workings to water may result in the generation of hydrogen sulphide, especially of concern if shallow workings overlie the Lincolnshire Limestone Formation (described as underlying the Limestone Formation). Abandoned mines and mine entries can also release other gases, posing explosion or health risks if they remain unflooded. Other potential CoPC include metals and metalloids, Polycyclic Aromatic Hydrocarbons (PAH), Semi-volatile Organic Compounds (SVOCs), pH, Asbestos Containing Materials (ACM)/asbestos and ground gas (methane and carbon dioxide).

Off-site

- Infilled Ground (all regions) – associated with former ponds and quarries/pits/surface workings infilled with unknown materials. See CoPC listed above for potential on-site source.
- Made Ground (all regions) – associated with infrastructure such as roads, embankments and buildings. See CoPC listed above for potential on-site source.
- Railway Land (Region 1b, 1d and 7b) – railway land extending off-site from crossings detailed above. See CoPC listed above for potential on-site source.
- Agricultural Land including farms (all regions) – see CoPC listed above for on-site source.
- Blacksmiths ('smithy') (Region 2d) – noted adjacent north of Region 2d at 508046 324956. CoPC include: Metals and metalloids, PAH, TPH, ACM/asbestos, pH and cyanide.
- Tanks (Regions 1a, 1b and 1c) – tanks labelled off-site, however a number of farms with potentially unrecorded tanks are also present along the OHL alignment. See CoPC listed above for on-site source
- Electricity substation (Region 1c) – noted at 525204 327835. CoPC include: TPH and PCBs.
- Sewage Pumping Station (Region 1c).
- Detailed localities of the above sources deemed relevant to the scheme are outlined in Report Section 9.2.
- Ironstone mining may have occurred under the mineral planning area for Easton Mine, shown to include the northern extents of the north arm of Region 7b, and is detailed within Section 3.9 of this report. Ironstone mining at Easton Mine, the surface processing site of which is indicated to be located 4.5km north west of Region 7b, is described as wholly underground. Although associated workings are not recorded on site, the presence of unrecorded workings and associated spoil heaps cannot be discounted considering the mapped geology. Exposure of workings to water may result in the generation of hydrogen sulphide, especially of concern if shallow workings overlie the Lincolnshire Limestone Formation (described as underlying the Limestone Formation). Abandoned mines and mine entries can also release other gases, posing explosion or health risks if they remain unflooded. Other potential CoPC include metals and metalloids, Polycyclic Aromatic Hydrocarbons (PAH), Semi-volatile Organic Compounds (SVOCs), pH, Asbestos Containing Materials (ACM)/asbestos and ground gas (methane and carbon dioxide).

4.4 Unexploded ordnance risk

- 4.4.1 The regional UXO mapping published by Zetica (Ref 13.65) shows that the site lies within a zone that experiences a low risk of Unexploded Bombs (UXB), defined by Zetica as "an area indicated as having 15 bombs per 1000 acres or less." It is noted that these maps only include information on potential for bombing to have occurred in the area and do not include all potential sources of UXO, such as historical land use.
- 4.4.2 A Preliminary UXO Risk Assessment has been undertaken for the site by Fellows International Group (FIG), which is presented in Appendix G. FIG's

assessment includes research and review of satellite and aerial photography, historical mapping, archival material and First and Second World War UK bombing data within a 5km radius of the site. The assessment aims to identify military or potential UXO related activities that raises the risk of encountering a UXO during intrusive activities (e.g. below-ground construction, ground investigation).

- 4.4.3 FIG's Preliminary UXO Risk Assessment has identified potential sources of UXO risk on or within 5km of the Site as listed in Table 4.1.

Table 4.1: Sources of potential UXO identified by Preliminary Assessment

Potential UXO Source	Description of source
WW2 Aerial Bombing	Bombing activity gives rise to the potential existence of undiscovered unexploded bombs. Initial research has identified four areas of WW2 bombing in proximity to the site.
Military Airfields	Military airfields were sometimes subjected to attack and are also related to military activity. This can result in potential encounter with UXO in areas located in proximity to an airfield site. One military airfield has been identified in proximity to the site.
Bombing Decoy Sites	RAF and Royal Navy decoy sites were constructed in the vicinity of legitimate targets to deceive and decoy enemy bombers. For obvious reasons, such sites were often built in remote and uninhabited areas. Some were more successful than others and received relatively high bombing rates. Two decoy sites have been identified in proximity to the site.
Explosive Ordnance Clearance (EOC) Tasks & Reports	EOC tasks are potential indicators of the existence of legacy munitions. There are no recorded post-war explosive ordnance clearance tasks in proximity to the site.
Ordnance Factory/Ordnance Storage Facilities	Ordnance factories were responsible for the manufacture of arms and ammunition, and ordnance storage facilities were used for storing of live munitions. One munitionsfactory/ordnance storage facility has been identified in proximity to the site.

- 4.4.4 Given the potential sources of UXO identified, it is recommended that a Detailed UXO Risk Assessment is carried out. Detailed assessment has been commissioned and is in production at the time of this report issue. This assessment should be reviewed and findings incorporated into subsequent ground investigation specifications and any intrusive construction works.

5. Review of Historical Site Investigation

5. Review of historical site investigation

- 5.1.1 AAJV has undertaken a high-level review of a list of historical ground investigation reports noted to be on the National Grid Enterprise Content Management (ECM) portal. None of the reviewed reports are considered relevant to the site at the time of writing. AAJV are currently unaware of any additional site-specific ground investigation reports in addition to the historical BGS exploratory hole records summarised in Report Section 3.
- 5.1.2 If relevant historical reports become available, subsequent reporting should be updated to include associated findings.

6. Regulated Activities and Statutory Consultation

6. Regulated Activities and Statutory Consultation

6.1 Introduction

- 6.1.1 The key relevant features that characterise the site and surrounding area are summarised in this Report Section, along with an indication of the risk to the land quality of the site. Generally, any regulated activities within 250m of the site could, depending upon their nature, represent potential off-site sources of contamination.

6.2 Regulatory database review

- 6.2.1 Table 6.1 summarises information obtained from the regulatory database information contained in the Groundsure Insights GIS Dataset. The table outlines the total number of entries present with respect to each Region (1 to 7). Details have been recorded for entries within 250m of red line boundary, with the and location with respect to the Sub-region included.
- 6.2.2 Regulatory information is excluded from the table below where it is not within the specified distances, where there is no information for the given topic or where entries are duplicated.

Table 6.1. Summary of regulatory information

Subject	Region	Number present		Details
		On-site	0 – 250m	
<u>Regulatory Processes</u>				
Discharge consents	Region 1	1	4	1 No. entry on-site (Region 1h, 517000 327000) for unspecified effluent (historical). 2 No. entries 70m south (Region 1c, 524610 327490) for final/treated effluent onto land (active and historical). 2 No. entries ~170m north (Region 1c, 525200 327840) for sewer storm overflow into Fens Drain (active and historical).
	Region 2	0	2	1 No. entry ~30m north (Region 2b, 511000 326000) for final/treated effluent into an unknown receiving water (historical). 1 No. entry ~170m north (of the alignment) and ~50m south (of the access route boundary) (Region 2b, 510000 326000) for an unspecified effluent onto land (historical).
	Region 3	0	0	No entries within 250m of the site boundary.
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	1	1 No. entry ~170m south (Region 7b, 499530 323460), discharge from a pumping station into tributary of the River Glen (historical), AW5NF301.
Dangerous substances list 2	Region 1	0	0	No entries within 250m of the site boundary.
	Region 2	0	0	
	Region 3	0	0	

Subject	Region	Number present		Details
		On-site	0 – 250m	
Pollution incidents to controlled waters	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
	Region 1	0	0	No entries within 250m of the site boundary.
	Region 2	0	2	1 No. entry ~20m south east (Region 2d, 508280 324433) from biodegradable materials/wastes. All impacts are Category 4 (C4) – no impact. 1 No. entry ~40m south (Region 2a,) from an unidentified pollutant. Impact to water Category 3 (minor) and impact to land/air Category 4 (no impact).
	Region 3	0	0	No entries within 250m of the site boundary.
	Region 4	0	1	1 No. entry ~10m south (Region 4, 505905 324072) from oils and fuels. Air impact Category 4 (no impact) and land/water impact Category 3 (Minor).
	Region 5	0	0	No entries within 250m of the site boundary.
	Region 6	0	1	1 No. entry ~210m south (Region 6, 499900 323500) of route from soils and clays (inert materials and waste). The air impact is Category 4 (no impact) and the impact to land and water is Category 3 (minor).
	Region 7	0	0	No entries within 250m of the site boundary.
<u>Licensed Waste Management Facilities and Industrial Land Uses</u>				
Historical landfill	Region 1	1	1	1 No. landfill from onsite (Region 1d, 522537 328375) for household waste and liquid sludge associated with sewage settling beds. Extends laterally offsite north of Region 1e. 1 No. landfill adjacent to access route and ~60m south of alignment (Region 1d, 523467 327262) associated with a farm for household waste.

Subject	Region	Number present		Details
		On-site	0 – 250m	
	Region 2	0	0	No entries within 250m of the site boundary.
	Region 3	0	0	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
Landfill waste exemptions	Region 1	42	133	- EPR/FF0536HR/A001 for disposal of agricultural waste – on-site (Region 1b, 525980327405) - WEX178654 for storing of sludge – on-site (Region 1h, 516270 326735) - WEX177649 for storage of sludge – on-site (Region 1i., 514730 326420) - WEX464346, WEX208787, WEX333121 (39 No. entries) for the using, storing and disposal of waste exemptions inclusive of agricultural and construction waste – on-site (Region 1b, 526340 326875) - EPR/CE5156WM/A001 (10 No. entries) for the using, storing and disposal of waste exemptions inclusive of agricultural and non-agricultural waste – 132m southwest (Region 1b, 525745327260) - WEX066289, WEX345273, WEX217545, WEX399109, WEX270010, WEX129621 (6 No. entries) for the using and disposal of waste exemption for agricultural waste – 30m west (Region 1b, 525896 327288) - WEX223258, WEX347716, WEX021321, EPR/KE5786PD/A001 (41 No. entries) for the using, treating and disposal of various animal, agricultural and domestic waste – 8m north west (Region 1c, 524750 327660) - EPR/XE5559YW/A001 (2 No. entries) for disposal of agricultural waste ~105m north (Region 1c, 525165 327775) - WEX009539, EPR/ZH0677BY/A001 (10 No. entries) for disposal and using construction and agricultural waste ~120m north (Region 1c, 525080 327880)

Subject	Region	Number present		Details
		On-site	0 – 250m	
				• EPR/UE5753QJ/A001, WEX017066, WEX311035, WEX179981 (12 No. entries) for the disposal of agricultural waste ~ 230m south and on-site for the access route (Region 1d, 523170 327135) • EPR/NE5682MH/A001 (10 No. entries) for the disposal, treating, storing and use of agricultural waste – 220m north of the alignment and ~ 60m west of the access route (Region 1d, 522965 328075) • EPR/NH0676US/A001 (4 No. entries) for use, treatment and disposal of dredging and construction waste – ~90m south of the alignment and 15m east of the access route (Region 1f, 519320 327545) • EPR/QH0875BC/A001, WEX012559 (9 No. entries) for the disposal and use of agricultural waste – ~95m north of the alignment and ~10m east of the access route (Region 1g, 519270 327910) • WEX198785 (10 No. entries) for using, storing, treating and disposing of agricultural waste, plant matter and construction waste – ~140m south of the alignment and 50m south east of the access route (Region 1g, 518985 327520) • WEX041267, EPR/ZH0179DW/A001 (20 No. entries) for using, storing, treating and disposal of plant matter, dredging, agricultural waste and construction waste – ~120m south (Region 1h, 517575 327025) • WEX177533 for the storing of sludge – ~220m north of the alignment and ~10m east of the access route (Region 1h, 515560 326870) • WEX177334, WEX173500, WEX178618 for storage of sludge – ~15mm, ~80m and ~70m south (Region 1i, 515610 326430, 515630 326370 and 514790 326180)
	Region 2	0	42	• WEX309628, WEX178681, WEX015201, WEX442396 (8 No. entries) for disposal of dredged waters – 60m northeast (Region 2c, 509785 325970) • WEX018906, WEX177941 (24 No. entries) for the use, storage, treatment and disposal of construction waste, agricultural waste, domestic waste and composting – ~70m north (Region 2d, 508025 325000)

Subject	Region	Number present		Details
		On-site	0 – 250m	
				- WEX442304 (9 No. entries) for the use and disposal of agricultural waste and ash – ~110m northwest (Region 2d, 508095 325035) - EPR/DH0376SK/A001 for storage, using, treating and disposal of waste located ~590m south of site boundary (route alignment) and ~220m south of access route
	Region 3	0	11	WEX020239, WEX182091 (11 No. entries) for the use, storage and disposal of construction and agricultural waste – ~220m north (506080 324890)
	Region 4	0	0	No entries within 250m of the site boundary
	Region 5	0	0	
	Region 6	0	11	- WEX294684 for the storage of sludge – ~150m north (Region 6, 502470 324470) - WEX045138, WEX221280 (10 No. entries) for the disposal and use of agricultural and construction waste – 70m south (Region 6, 503100 323925) and ~15m west of access route.
	Region 7	3	1	- WEX349347 for storage of sludge – on site (Region 7b, 498070 324740). - WEX417247, WEX344199 (2 No. entries) for storage of sludge – on-site (Region 7b, 498490 324640) - WEX448721 for storage of sludge – ~25m west of access route and ~185m north (Region 7a, 498970 325080)
Recent industrial land uses	Region 1	0	7	- Electricity Substation ~165m north (Region 1c, 525205 327835) - Sewage Pumping Station ~165m north (Region 1c, 525200 327845) - A distribution and haulage company ~150m north (Region 1c, 525130 327890, open source data shows it to be temporarily closed) - A vehicles components company ~220m north (Region 1c, 525140 327970) - Water Pumping Station ~115m north (Region 1c, 524805 32800) - Water Pumping Station ~245m north (Region 1h, 516485 327085)

Subject	Region	Number present		Details
		On-site	0 – 250m	
	Region 2	1	9	• Pumping Station ~110m south (Region 1h, 516620 326550) • 1 No. Water Pumping station on-site (Region 2d, 508120 324585) • Water Pumping Station ~25m north (Region 2b, 510245 325900) • 5 No. Silos ~215m south of the alignment and ~5m east of the access route (Region 2b, vicinity of 510600 325520) • 1 No. Silo ~100m north (Region 2d, 508095 325040) • 1 No. agricultural contractor (contract services) ~120m north (Region 2d, 508050 325055) • Solar Panel ~100m north (Region 2d, 507815 324770)
	Region 3	4	2	• 4 No. pylons on-site. • 1 No. silo (506185 324995) and 1 No. solar panel (506230 324985) ~220m north.
	Region 4	0	0	• No entries within 250m of the site boundary.
	Region 5	1	1	• 1 No. pylon on-site and 1 No. pylon ~90m east (503680 324070)
	Region 6	2	6	• 2 No. pylons on-site and 1 No. pylon ~160m north (502245 324450) • 5 No. silos ~100m – 150m south (501010 323930 to 501045 323840)
	Region 7	0	4	• Disused workings (quarries) 5~60m north west (Region 7b, 498650 325391) • Disused quarry 150m north (Region 7b, 498149 325401) 1 No. sawmill and 1 No. concrete products (ABC Concrete) located 150m south (Region 7b, 498665 324410) • 2 No. mast (telecommunication feature) ~165m south (Region 7b, 498675 324370) and ~200m west (Region 7a, 499050 324100)
	Region 7	0	4	• Disused workings (quarries) 5~60m north west (Region 7b, 498650 325391) • Disused quarry 150m north (Region 7b, 498149 325401) 1 No. sawmill and 1 No. concrete products (ABC Concrete) located 150m south (Region 7b, 498665 324410) • 2 No. mast (telecommunication feature) ~165m south (Region 7b, 498675 324370) and ~200m west (Region 7a, 499050 324100)
Tanks (current/ recent)	Region 1	1	2	• Roofed storage tank on-site (Region 1b, 526030 327417) • Open storage tank on-site (Region 1b, 525933 327469) • Roofed storage tank ~110m north (Region 1f, 519327 327925)
	Region 2	0	0	• No entries within 250m of the site boundary.
	Region 3	0	0	

Subject	Region	Number present		Details
		On-site	0 – 250m	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
Historical tanks	Region 1	1	2	- On-site (Region 1b, 526030 327415) dated 1996 2 No. tanks ~115m south (Region 1c, 524554 327399) dated 1985 and 1995
	Region 2	0	0	No entries within 250m of the site boundary.
	Region 3	0	0	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
Historical industrial land uses	Region 1	1	6	- Railway building – on-site (Region 1b, 526108 327468) - Unspecified ground workings ~200m south (Region 1a, 527439 326948) - Water Pumping Station ~145m south (Region 1h, 516620 326546) - Draining Pump ~205m north of alignment and ~170m east of access route (Region 1h, 516459 327024) - Unspecified depot ~220m north (Region 1c, 525137 327969) - Sewage settling bed adjacent to the site boundary (Region 1e, 522420 328355). - Railway Sidings ~220m north (Region 1b, 526515 328590)
	Region 2	1	3	- Pumping station on-site (Region 2d, 508146 324588). - Unspecified quarry ~120m south (Region 2b, 510383 325603) - Smithy – adjacent north (Region 2d, 508046 324956) - Railway sidings ~250m south of the alignment and adjacent to the access route (Region 2b, 510960 325548).

Subject	Region	Number present		Details
		On-site	0 – 250m	
	Region 3	0	0	No entries within 250m of the site boundary.
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	16	- Gravel pits/disused pits 6 No. entries from ~220m north (503002 324578) and 1 No. adjacent to the site (502903 324100) - Unspecified ground workings ~136m south west (499951 325471) - Pump house ~208m north east (501428 325212) 2 No. entries unspecified quarry, 3 No. ground workings, 2 No, unspecified pit ~150m north (500675 324300)
	Region 7	7	15	- Cuttings – 6 No. entries adjacent to on-site (Region 7b, 498156 324929) - Cutting ~3 No. entries 150m south (Region 7b, 498605 324400); within this area there are also 4 No. for railway buildings, 3 No. entries for railway stations and 3 No. entries for railway sidings (Section 7b, 498409 324650). - Railway building ~25m east (Region 7b, 498092 325024) - Unspecified pit ~25m east (Region 7b, 498210 324925) 1 No. unspecified ground workings on site (Region 7a, 499260 323985)
	Historical energy features	0	2	2 No. electricity substations (historical) ~165m north (Region 1c, 525204 327835).
	Region 2	0	0	No entries within 250m of the site boundary.
	Region 3	0	0	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	

Hazardous substances

Subject	Region	Number present		Details
		On-site	0 – 250m	
Control of Major Accident Hazards (COMAH)	Region 1	0	1	1 No. entry ~245m south of alignment / ~170m south of access route (Region 1e, 521752 327325) classified as a historical Notification of Installations Handling Hazardous Substances (NIHHS) site.
	Region 2	0	0	No entries within 250m of the site boundary.
	Region 3	0	0	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
Site of Special Scientific Interest	Region 1	0	0	No entries within 250m of the site boundary.
	Region 2	1	0	1 No. entry on-site and known as Dunsby Wood SSSI (Region 2c, 509038 325878).
	Region 3	0	0	No entries within 250m of the site boundary.
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	0	
	Region 7	0	0	
Conservation Areas	Region 1	0	0	No entries within 250m of the site boundary.
	Region 2	0	0	
	Region 3	0	0	
	Region 4	0	0	
	Region 5	0	0	
	Region 6	0	1	

Subject	Region	Number present		Details
		On-site	0 – 250m	
	Region 7	0	1	1 No. entry 77m north (Region 7b, from 497967 325579) for Burton Le Coggles.

- 6.2.3 No entries were recorded for the following: active landfills, historical or active petrol stations, historical or active garages, historical or active military land, explosive sites, Licensed Industrial Activities Part A1, Pollution Inventory Substance, Pollution Waste Transfer, historical licenced industrial activities (IPC), waste sites, hazardous substance storage, pollution inventory's, Ramsar sites, Special Areas of Conservation (SAC), Special Protection Areas (SPA), National or Local Nature Reserves, Green Belts, Nitrate Sensitive Areas, world heritage sites, National Parks, and Areas of Outstanding Natural Beauty.
- 6.2.4 In summary, several possibly contaminative sources have been recorded along the extent of the site. Namely the historical landfills, anticipated infilled disused pits/quarries, electricity substations, tanks, historical railway sidings, smithy, agricultural chemical storage (silos), sewage pumping station and haulage site. There is a limited number of sources which could have the potential to generate ground gas including the Sewage Pumping Station (Region 1c, 525200 327845) both present off-site, landfills and anticipated infilled land within the disused pits/quarries. The ground gas risk has been discussed further within Report Section 9.3. There are very few environmental designations within 250m of the site which may pose as sensitive receptors, however the general risk to controlled waters and human health still remains.

6.3 Regulatory consultation

Planning information

- 6.3.1 The council web-based planning portals that were identified within the extent of the site were reviewed to identify whether there are existing planning conditions which relate to the site area. The following councils have been reviewed and summarised within Table 6.2.
- 6.3.2 Note, for Lincolnshire County Council and South Holland District a 'Map View' was not available on the planning portal website. Therefore, postcodes have been obtained along the extent of the site and searched within the databases. These postcodes were taken at a designated frequency along the scheme and therefore it is likely that not all planning applications within the vicinity of the site were picked up. Additionally, the portals do not provide the buffer used when searching the database. It is likely that only applications with that specific post code were searched for without the option for a buffer to be inputted during the search. A review of all relevant planning application data is outside of the scope of this report.

Table 6.2. Summary of planning information

Planning council	Regions covered	Findings
Lincolnshire County Council	Region 1 to Region 7	Based on the post codes entered no planning applications were found: PE12 6HN, PE11 4AL, PE11 4AX, PE11 3QR, PE11 3TG, PE10 0UN, PE10 0XD, PE10 0RR, PE10 0LU, NG33 4JF, NG33 4ND and NG33 4FP.

Planning council	Regions covered	Findings
South Holland District Council	Region 1a to Region 1h	Based on the post codes entered no planning applications were found: PE12 6HN, PE11 4AL, PE11 4AX, PE11 3QR, PE11 3TG and PE10 0UN.
South Kesteven District Council	Region 1h to Region 7b	No applications relating to geo-environmental or geotechnical information present within 250m of the site.

Environment Agency flooding data

6.3.3 The Environment Agency map for planning (Ref 13.36) and long-term flood risk map (Ref 13.37) were accessed alongside the Groundsure flood zone data and confirmed that the following flooding risks are recorded for the site:

Flooding from rivers

6.3.4 Flooding from rivers varies between a Very Low and High chance along the extent of site, as detailed below:

- Very Low Chance – Region 1a to 1c and 1g to 1j.
- Low Chance – Region 1a to 1e, 1g to 1j, 2a, 2d, 4, 6a and 7a.
- Medium Chance – Region 1, 2a, 2d, 4, 6a and 7a.
- High Chance – Region 1a, 1c, 1h, 2a, 2d, 4, 6a and 7a.
- No chance rating noted – Region 2b, 2b, 3, 5, 6a and 7b.

6.3.5 The yearly chance of flooding is defined as the following; very low is more than a 0.1% chance each year, low is between 0.1% and 1% chance each year, medium is between 1% and 3.3% chance each year and high is more than a 3.3% chance each year.

6.3.6 Where the chance of river flooding is highest is concentrated along the alignment of the major rivers/drains including the River Welland, Vernatt's Drain, River Glen, South Forty-Foot Drain, Car Dyke, East Glen River and West Glen River (listed from east to west).

Surface water flooding

6.3.7 The surface water (i.e. fluvial) flooding risk is typically Very Low. Areas where the topography is low-lying such as around various drainage networks and/or watercourses are susceptible to higher levels of risk. There are various isolated areas of Low to High risk of surface water flooding chances recorded along the entirety of the site extent which have not been individually listed here due to the large number of features.

Groundwater flooding

6.3.8 The groundwater flooding risk is Negligible for the site extents.

6.3.9 A formal flood risk assessment is outside the scope of this report.

7. Site reconnaissance

7. Site reconnaissance

- 7.1.1 This Desktop Study has been prepared to support the Development Consent Order (DCO) scoping and preliminary assessment stages. Access for a site reconnaissance (walkover) was not available prior to the completion of this draft.
- 7.1.2 An external inspection of the site will be undertaken by a suitably qualified and experienced AAJV Engineer. The report will be subsequently updated to reflect the findings.
- 7.1.3 The aim of the visit will be to:
- identify the range of activities carried out on the site;
 - identify any obvious potential sources of ground contamination (such as visual evidence of spills, asbestos, or stressed vegetation) or geotechnical issues (such as karst depressions or slope instability); and,
 - validate the provisional risk ratings presented in this report.
- 7.1.4 Accordingly, all risk ratings presented herein are provisional and based on a precautionary assessment of available desktop data. These will be reviewed and updated within the final Environmental Statement (ES) following the completion of the walkover and intrusive investigations.
- 7.1.5 The site will be revisited ahead of any intrusive works by AAJV Geotechnical/Geo-environmental Engineers to inform future works. Any findings additional to those outlined in this report will be accounted for in subsequent reporting and specifications.

8. Preliminary anticipated ground models

8. Preliminary anticipated ground model

8.1 Overview

- 8.1.1 Based on the review of published geological and hydrogeological information and a selection of historical borehole records, the ground conditions within the site are anticipated to comprise a generally conformable sedimentary sequence of Jurassic limestones, sandstones and mudstones, overlain by quaternary superficial deposits of glacial, fluvial and marine origin.
- 8.1.2 Variations in thickness and continuity, and complexities in these successions are anticipated in areas due to the carving of valleys and hills by glaciers and/or rivers, and the subsequent erosion and deposition of superficial deposits, together with changes in sea level, the solution of limestone bedrock forming karst features, mining of ironstone, faulting, infilled mineral workings and ponds of unknown depth and composition, and other more localised historical and present day developments.

8.2 Preliminary ground model

- 8.2.1 Summaries of the preliminary anticipated ground models for the site, split by Regions are presented in Table 8.1 to Table 8.7, alongside a breakdown of anticipated features that could impact the outlined succession and have the potential to result in abnormal ground conditions based on reviewed information. The anticipated ground models for each Region are preliminary and will require confirmation through site-specific intrusive ground investigation to inform the design and construction of the Proposed Development. As part of this a review of the risk posed by the preliminary geotechnical hazards/constraints (as per Report Section 11) will also be required.

Region 1

- 8.2.2 Region 1 is generally characterised by low-lying, flat agricultural land formed of expansive and uninterrupted Tidal Flat Deposits, which overlie the Oxford Clay Formation in the east and the Kellaways Sand Member in the west. The preliminary anticipated ground model for Region 1 is shown in Table 8.1.

Table 8.1. Preliminary ground model for Region 1

Stratum	Anticipated occurrence	Generalised description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
Tidal Flat Deposits	Site wide, continuous coverage	Unconsolidated and lightly consolidated loamy clayey, silty and sandy soils with peaty areas. Successive phases of marine/coastal and fluvial deposition form distinct floodplains and paleochannels (roddons).	5m to 15m with a potential of up to 30m in buried valleys
Oxford Clay Formation	Site wide, continuous coverage, thinning and petering out to the west	Grey, silty silicate mudstone, fissile to blocky textures, with variable limestone/calcareous mudstone and shell debris. Upper layers may show a weathering profile to produce clay soils.	34m (east) to 0.6m (west)
Kellaways Sand Member	Site wide	Interbedded pale grey siltstone and sandstone with calcareous cement and minor interbeds of silty to sandy mudstone.	1m to 2m
Kellaways Clay Member	Site wide	Grey smooth to silty mudstone, with locally thin beds of siltstone, sandstone and nodular limestone.	2m to 3m
Cornbrash Formation	Site wide	Bluish grey to weathered yellowish brown fine grained bioturbated limestone (packstone and wackestone).	2m to 4m

Groundwater

An unconfined source of groundwater is anticipated to be shallow (0m to 3m bgl) across all of Region 1 due to the low-lying topography and the shallow groundwater encounters recorded in nearby historical borehole records. Due to the variable permeability and extents of the interbedded clay, silt and sand surface soils, groundwater levels are expected to be moderately sensitive to seasonal fluctuations in precipitation and irrigation, with high drawdown and recharge rates. Groundwater may be brackish and is sensitive to pollutants. Much of Region 1 is also noted to have an elevated fluvial and tidal flooding risk, as evidenced by the abundance of agricultural drains and flood defence embankments, which is likely to impact the composition and salinity of the local groundwater. Artesian conditions noted in several BGS borehole records indicate a deeper confined source of groundwater.

Anticipated features impacting succession/presence of abnormal ground conditions

- Potential for elevated settlement is anticipated site wide in the unconsolidated Tidal Flat Deposits with a high moisture content due to the relatively shallow groundwater table. The presence and extents of channelised deposits or pockets of peat or clay will influence settlement rates and amounts.
 - Areas of high compressibility are anticipated over identified surface peat deposits (Region 1i) and where the subsurface 'Fen Lower Peat' is recorded in some historical borehole records.
 - Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - Running sand conditions are likely where excavations are made below groundwater levels into unconsolidated sand deposits.
 - The potential plasticity of weathered mudstone strata, including the Oxford Clay and Tidal Flat Deposits, may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Chemical reactions of sulphate mineral bearing strata, particularly the Oxford Clay, (BRE Construction Division, 2005), and to a lesser extent Tidal Flat Deposits, may result in deleterious effects to buried concrete structures.
 - Artesian groundwater conditions, if present, may compromise the installation of foundation structures (piles), where overlying confining strata are penetrated.
-

Region 2

- 8.2.3 Region 2 is generally characterised by a swathe of River Terrace Deposits where the ground begins to rise in elevation, and outcrops of the typical sequence of Jurassic bedrock formations, including basal beds of the Oxford Clay, and the Kellaways and Cornbrash formations. The preliminary anticipated ground model for Region 2 is shown in Table 8.2.

Table 8.2. Preliminary ground model for Region 2

Stratum	Anticipated occurrence	Generalised description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
River Terrace Deposits	Swathe of deposits forming a band extending north to south, approximately 600m to 1500m wide (Region 2a to 2b)	Sand and gravel, locally with lenses of silt, clay or peat.	Variable
Alluvium	Restricted to river valley floors and tributaries	Unconsolidated fluvial deposits comprising clay, silt, sand and gravel.	Variable
Oxford Clay Formation	Basal beds outcrop in areas of higher elevation	Grey, silty mudstone, fissile to blocky textures, with variable limestone/calcareous mudstone and shell debris. Upper layers may show a weathering profile to produce clay soils.	Up to around 5m thick
Kellaways Sand Member	Site wide	Interbedded pale grey siltstone and sandstone with calcareous cement and minor interbeds of silty to sandy mudstone.	1m to 2m
Kellaways Clay Member	Site wide	Grey smooth to silty mudstone, with locally thin beds of siltstone, sandstone and nodular limestone.	2m to 3m
Cornbrash Formation	Site wide	Bluish grey to weathered yellowish brown fine grained bioturbated limestone (packstone and wackestone).	2m to 4m

Groundwater

The shallow groundwater source (0m to 3m bgl) is likely to be within the Kellaways Sand Member and River Terrace Deposits in the eastern parts of Region 2 in the low-lying areas. Due to the permeable nature of the River Terrace Deposits, groundwater levels are expected to be sensitive to seasonal fluctuations in precipitation and irrigation, with high drawdown and recharge rates, as well as sensitive to pollutants.

Further west, based on borehole records, deeper groundwater (23m to 29m bgl) is expected in the Blisworth and Lincolnshire Limestones, confined by the overlying mudstone strata. These groundwater levels may be sensitive to seasonal fluctuations in precipitation as well as local abstractions and irrigation.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - Running sand conditions are likely where excavations are made below static groundwater levels into unconsolidated sand and gravel of the River Terrace Deposits.
 - The potential plasticity of weathered mudstone strata, including the Oxford Clay, may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Potential for elevated settlement is anticipated where Alluvium is present (Region 2d).
 - Chemical reactions of sulphate mineral bearing strata, particularly the Oxford Clay (BRE Construction Division, 2005), may result in deleterious effects to buried concrete structures.
 - Artesian groundwater conditions, if present, may compromise the installation of foundation structures (piles), where overlying confining strata are penetrated.
-

Region 3

- 8.2.4 Region 3 is generally characterized by undulating hills and meadows formed of thick deposits of glacial Till overlying conformable layers of bedrock which outcrop in the valley sides. The preliminary anticipated ground model for Region 3 is shown in Table 8.3.

Table 8.3. Preliminary ground model for Region 3

Stratum	Anticipated occurrence	Typical description	Anticipated thickness (m)
Till	Forms thick blankets over topographic highs	Firm to stiff clay	Variable, but up to 10m to 11m
Oxford Clay Formation	Site wide	Grey, silty silicate mudstone, fissile to blocky textures, with variable limestone/calcareous mudstone and shell debris. Upper layers may show a weathering profile to produce clay soils.	Up to 3m to 4m
Kellaways Sand Member	Site wide	Interbedded pale grey siltstone and sandstone with calcareous cement and minor interbeds of silty to sandy mudstone.	Up to 5m
Kellaways Clay Member	Site wide	Grey smooth to silty mudstone, with locally thin beds of siltstone, sandstone and nodular limestone.	1m to 4m
Cornbrash Formation	Site wide	Bluish grey to weathered yellowish brown fine grained bioturbated limestone (packstone and wackestone).	2m to 4m

Groundwater

Based on BGS borehole records, groundwater may be as shallow as 2m bgl, but the main sources of groundwater are anticipated to be confined within the Blisworth Limestone and the base of the Rutland Formation/Lincolnshire Limestone at depths between 23m to 41m bgl. It is understood that seasonal groundwater levels fluctuations within the Lincolnshire Limestone can be significant, and may also be affected by local abstractions and irrigation.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - The potential plasticity of the Till and weathered strata in the Oxford Clay may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Chemical reactions of sulphate mineral bearing strata, particularly the Oxford Clay (BRE Construction Division, 2005), may result in deleterious effects to buried concrete structures.
-

Region 4

- 8.2.5 Region 4 is generally characterised by the landform of the East Glen River valley and the outcropping of the Blisworth Formation underlying the Kellaways Clay. Alluvium lies on the valley floor along the river, but elsewhere the loamy topsoil lies directly on bedrock. The preliminary anticipated ground model for Region 4 is shown in Table 8.4.

Table 8.4. Preliminary ground model for Region 4

Stratum	Anticipated occurrence	Typical description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
Alluvium	Restricted to river valley floors and tributaries	Unconsolidated fluvial deposits comprising clay, silt, sand and gravel.	Variable
Kellaways Clay Member	Site wide	Grey smooth to silty mudstone, with locally thin beds of siltstone, sandstone and nodular limestone.	2m to 3m
Cornbrash Formation	Site wide	Bluish grey to weathered yellowish brown fine grained bioturbated limestone (packstone and wackestone).	3m to 5m
Blisworth Limestone Formation	Site wide	Oolitic limestone.	6m to 7m
Blisworth Clay Formation	Site wide	Stiff calcareous mudstone.	2m to 4m

Groundwater

Based on BGS borehole records, groundwater is anticipated to be confined at the base of the Rutland Formation/within the Lincolnshire Limestone at depths between 9m to 21m bgl. It is understood that seasonal groundwater levels fluctuations within the Lincolnshire Limestone can be significant, and may also be affected by local abstractions and irrigation.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - The potential plasticity of weathered mudstone strata may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Chemical reactions of sulphate mineral bearing strata may result in deleterious effects to buried concrete structures.
 - Potential for elevated settlement is anticipated where Alluvium is present.
 - Running sand conditions are likely where excavations are made below static groundwater levels into unconsolidated sand and gravel layers within the Alluvium.
 - The presence of dissolution features within the Lincolnshire Limestone (karst) is anticipated, in particular near and at the upper boundary with the overlying Rutland Formation, which may reduce strength of the rock, lead to settlement or collapse, and impact constructability of deep foundations (piles).
-

Region 5

8.2.6 Region 5 is generally characterised by a thick blanket of Till forming elevated landforms, overlying the Kellaways Sand Member and basal members of the Oxford Clay Formation. The preliminary anticipated ground model for Region 5 is shown in Table 8.5.

Table 8.5. Preliminary ground model for Region 5

Stratum	Anticipated occurrence	Typical description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
Till	Site wide	Firm to stiff glacial clay.	Variable, up to 12m
Glaciofluvial Deposits	West extent	Sand and gravel, locally with lenses of silt, clay or organic material.	Variable
Oxford Clay	Site wide	Grey, silty silicate mudstone, fissile to blocky textures, with variable limestone/calcareous mudstone and shell debris. Upper layers may show a weathering profile to produce clay soils.	Up to 5m
Kellaways Sand	Site wide	Interbedded pale grey siltstone and sandstone with calcareous cement and minor interbeds of silty to sandy mudstone.	3m to 5m

Groundwater

BGS borehole records indicate confined groundwater sources are found at 25m to 47m bgl within the Lincolnshire Limestone, confined by the overlying Rutland Formation. Confining pressures are anticipated to be such that resting water levels within wells may be around 9m bgl. It is understood that seasonal groundwater levels fluctuations within the Lincolnshire Limestone can be significant, and may also be affected by local abstractions and irrigation.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - The potential plasticity of the Till and weathered mudstone strata may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Chemical reactions of sulphate mineral bearing strata, particularly the Oxford Clay (BRE Construction Division, 2005), may result in deleterious effects to buried concrete structures.
 - The presence of dissolution features within the Lincolnshire Limestone (karst) is anticipated, in particular near and at the upper boundary with the overlying Rutland Formation, which may reduce strength of the rock, lead to settlement or collapse, and impact constructability of deep foundations (piles).
-

Region 6

8.2.7 Region 6 is generally characterised by topographically high ground with partial coverage of Till and underlain by the Blisworth and Rutland formations. A typical geological sequence is shown in Table 8.6.

Table 8.6. Preliminary ground model for Region 6

Stratum	Anticipated occurrence	Typical description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
Alluvium	Restricted to river valley floors and tributaries	Unconsolidated fluvial deposits comprising clay, silt, sand and gravel.	Variable
Glaciofluvial Deposits	East extent	Sand and gravel, locally with lenses of silt, clay or organic material.	Variable
Kellaways Sand Member	Site wide	Interbedded pale grey siltstone and sandstone with calcareous cement and minor interbeds of silty to sandy mudstone.	1m to 4m
Kellaways Clay Member	Site wide	Grey smooth to silty mudstone, with locally thin beds of siltstone, sandstone and nodular limestone.	1.5m to 4m
Cornbrash Formation	Site wide	Bluish grey to weathered yellowish brown fine grained bioturbated limestone (packstone and wackestone).	1m to 2m
Blisworth Clay Formation	Site wide	Stiff calcareous mudstone	2m to 4m
Blisworth Limestone Formation	Site wide	Oolitic limestone	6m to 7m
Rutland Formation	Site wide	Argillaceous mudstones and siltstones, with subordinate sandstones and limestones	8m to 12m

Groundwater

Anticipated to be between 23m to 39m bgl, based on historical borehole records, within the Lincolnshire Limestone, confined by the overlying Rutland Formation. Confining pressures are anticipated to be such that resting water levels within wells may be much shallower. It is understood that seasonal groundwater levels fluctuations within the Lincolnshire Limestone can be **significant and** may also be affected by local abstractions and irrigation. Subsurface karst voids of approximately 15m and 30m bgl may provide significant fracture flow.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - The potential plasticity of the Till and weathered mudstone strata may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Chemical reactions of sulphate mineral bearing strata may result in deleterious effects to buried concrete structures.
 - Potential for elevated settlement is anticipated where Alluvium is present.
 - Running sand conditions are likely where excavations are made below static groundwater levels into unconsolidated sand and gravel layers within the Alluvium and glaciofluvial deposits.
 - The presence of dissolution features within the Lincolnshire Limestone (karst) is anticipated, in particular near and at the upper boundary with the overlying Rutland Formation, which may reduce strength of the rock, lead to settlement or collapse, and impact constructability of deep foundations (piles).
-

Region 7

- 8.2.8 Region 7 is generally characterised by the West Glen River valley landform and the outcropping of the Rutland Formation and Upper Lincolnshire Limestone with no superficial cover beyond the Alluvium in the valley floor. A typical geological sequence is shown in Table 8.7.

Table 8.7. Preliminary ground model for Region 7

Stratum	Anticipated occurrence	Typical description	Anticipated thickness (m)
Made Ground	Localised features across the site	Artificially modified ground, where the pre-existing (natural or artificial) land surface is raised/infilled by artificial deposits.	Unknown
Alluvium	Restricted to West Glen River valley floor	Unconsolidated fluvial deposits comprising clay, silt, sand and gravel.	Variable
Blisworth Limestone Formation	West end of Region 7b	Oolitic limestone.	6m to 7m
Rutland Formation (including Wellingborough Member)	Region 7b	Argillaceous mudstones and siltstones, with subordinate sandstones and limestones.	8m to 12m
Upper Lincolnshire Limestone Member	Site wide	Ooidal and shell fragmental grainstone. Karstified upper boundary and basal bed of <i>A. crossi</i> .	Up to 20m
Lower Lincolnshire Limestone Member	Site wide	Calclutite, and peloidal wackestone and packstone, with sandy limestone or calcareous sandstone and frequent mudstone.	8m to 12m

Groundwater

Anticipated to be between 14m to 29m bgl based on historical borehole records, within the Lincolnshire Limestone. As the Lincolnshire Limestone occurs at surface level, groundwater conditions are considered to be unconfined and expected to be sensitive to local abstractions, seasonal fluctuations in precipitation and irrigation, and pollutants. Heavily karstified zones around 9 to 15m bgl likely provide significant fracture flow.

Anticipated features impacting succession/presence of abnormal ground conditions

- Areas of Made Ground may not be suitable to place foundations upon due to the unknown geotechnical properties and nature of backfilled materials.
 - Chemical reactions of sulphate mineral bearing strata may result in deleterious effects to buried concrete structures.
 - The potential plasticity of weathered mudstone strata may result in elevated susceptibility to shrink-swell behaviour where close to the surface with low confining pressure and exposed to moisture changes.
 - Potential for elevated settlement is anticipated where Alluvium is present.
 - Running sand conditions are likely where excavations are made below static groundwater levels into unconsolidated sand and gravel layers within the Alluvium.
 - The presence of dissolution features within the Lincolnshire Limestone (karst) is anticipated, in particular near and at the upper boundary with the overlying Rutland Formation, which may reduce strength of the rock, lead to settlement or collapse, and impact constructability of deep foundations (piles).
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9. Initial Conceptual Site Model

9. Conceptual Site Model and Preliminary Risk Assessment

9.1 Introduction

- 9.1.1
- The preliminary CSM has been developed to identify potentially complete contaminant linkages that may require further investigation to assess their existence and/or potential significance. The potential sources of contamination on or in the vicinity of the site, receptors on or near the site, and pathways on or near the site are discussed within the following paragraphs.
- 9.1.2
- A summary of the applicable legislative and planning framework, and AAJV’s approach to assessment used in the following paragraphs is presented in Appendix E.

9.2 Sources of potential contamination

- 9.2.1
- Based on the site setting, history and land uses described in preceding Report Sections, the following potential sources of contamination and CoPC listed in Report Section 4.3 have been identified and are presented in Table 9.1. Note that distances for the same feature identified on historical mapping and regulatory consultation data may vary slightly. All features are identified as current unless stated as historical.
- 9.2.2
- The CoPC are based on information provided in the Department of Environment Industry Profiles (Ref 13.26) and AAJV’s industry experience.

Table 9.1. Potential sources of contamination

Source	Region(s)	Description	CoPC
On-site and off-site Infilled land	All	Various ponds have been noted on and within 250m of the site (all regions) from earliest mapping, which have since been infilled. A number of quarries and pits that have since been infilled are also noted within 250m of Region 2b, 6a, 6b, and 7b. The nature of the infill material is unknown.	Metals and metalloids, Polyaromatic Hydrocarbons (PAHs), pH, asbestos containing material (ACM)/asbestos and ground gas (carbon dioxide and methane).

Source	Region(s)	Description	CoPC
On-site and off-site Made Ground	All	Made Ground is not recorded in published sources of information as on-site or within 250m of the site. However, due to the presence of various roads, railways, structures, canalised watercourses, and infilled ponds, pits and quarries, Made Ground is anticipated across all regions. The nature of the infill material is unknown.	Metals and metalloids, PAHs, pH ACM/asbestos and ground gas (carbon dioxide and methane).
On-site and off-site Railway land/ buildings	1b, 1d, 2b and 7b	A number of present-day railway lines are noted to cross the site at 527402 327369, 526098 327463, 523053 327615 and 499146 323737 (Regions 1a, 1d and 7b), extending off-site. Railway building on-site of Region 1b, and sidings within 250m of Region 2b and 7b. The nature of the Made Ground associated with the historical and present-day railway lines is unknown.	Metals and metalloids, Semi-Volatile Organic Compounds (SVOCs), Volatile Organic Compounds (VOCs), TPH, PAH, Polychlorinated Biphenyls (PCBs), sulphate, herbicides and glycols.
On-site and off-site Agricultural Land Use	All	Agricultural land is noted along the entire extent of the site and in the surrounding area – including use of chemicals on land and agricultural machinery. Numerous Landfill Waste Exemptions associated with Agricultural activities are located on and off site, related to the treatment and disposal of agricultural waste on and off-site of Region 1b, 1c, 1d, 1g, 1h, 2d, 3, 6a.	Metals and metalloids, Total Petroleum Hydrocarbons (TPH) (anticipated to be minimal), ammoniacal nitrogen, herbicides and pesticides.
On-site and off-site Tanks	1a, 1b, 1c and 1f	A number of historical and current tanks have been noted along the extent of the site, with tanks on-site of Region 1b and off-site of Regions 1a, 1b, 1c and 1f. Details with co-ordinates are given in Appendix C and Report Section 6.2. The content of the tanks is unknown.	PAH, asbestos and TPH

Source	Region(s)	Description	CoPC
On-site and off-site Water pumping stations	1a, 1h, 2b, 2d and 6b	Water pumping stations noted on-site of Region 1a and 2d and off-site of Regions 1h, 2b and 6a. Details with co-ordinates are given in Appendix C and Report Section 6.2.	Metals and metalloids, cyanides (total, free), SVOCs, VOCs, TPH, PCBs, nitrate, sulphate, sulphide, pH, ACM/asbestos and ammoniacal nitrogen.
On-site and off-site Animal production sites	1c	A Piggery is noted ~250m south (524672 327634).	Metals and metalloids, SVOCs, VOCs, PAH, organochlorine pesticides, sulphate, sulphide, ammoniacal nitrogen and pathogens. Gases derived from manure degradation.
Leaks from existing gas mains On-site and off-site	3 and 7b	3 No. gas pipelines cross the site in Region 3 507377 324568A and 505990 324523, and Region 7b 497716)	Methane (CH ₄) and carbon dioxide (CO ₂)
On-site and off-site Historical Ironstone Mining	7b	The mineral planning area for Easton Mine is shown to include the northern extents of the north arm of Region 7b. Although no workings are recorded on site, the presence of unrecorded workings and associated spoil heaps cannot be discounted. Exposure of workings to water (flooded workings) may result in generation of hydrogen sulphide.	Metals and metalloids, Polyaromatic Hydrocarbons (PAHs), pH, ground gas (carbon dioxide, methane, hydrogen sulphide).
Off-site Sewage pumping station/ storage of sludge sites	1c, 1h, 1i, 6a, 7a and 7b	A sewage pumping station was recorded ~165m north of Region 1c (525200 327845). Storage of sludge was noted on-site of Regions 1h, 1i and 7b and off-site of Region 1h, 1i, 6, 7a and 7b.	Metals and metalloids, cyanides (total, free), SVOCs, VOCs, TPH, PCBs, nitrate, sulphate, sulphide, pH, ACM/asbestos, ammoniacal nitrogen, pathogens and ground gas (carbon dioxide and methane).

Source	Region(s)	Description	CoPC
Off-site Distribution and haulage, vehicle and components	1c	A distribution and haulage company ~150m north of the alignment in Region 1c (525130 327890) and a vehicles components company ~220m north of the alignment (Region 1c, 525140 327970)	Metals and metalloids, SVOCs, VOCs, PAH, PCBs, Organolead compounds, Free sulphur and pH.
Off-site Blacksmith	2d	A historical smithy is noted adjacent north of the alignment in Region 2d (508046 324956).	Metals and metalloids, PAH, TPH, ACM/asbestos, pH and cyanide.
Off-site Electricity substations	1c	An electricity substation recorded ~165m north of the alignment at 525205 327835.	TPH and PCBs.

9.3 Ground gas sources

9.3.1 The identified sources of ground gas within the above table have been further characterised in Table 9.2 using BS 8576:2013 “Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)” – Figure 6 to determine the ground gas generation potential of the sources.

Table 9.2. Potential sources of contamination (ground gas)

Source	BS 8576 ground gas generation potential	Justification
Made Ground	Very Low	Due to the nature of the features on-site and off-site which are likely to lead to the presence of Made Ground (roads, railway, buildings with limited contamination risk) the risk from ground gas generation is considered to be Very Low in accordance with BS 8576, as it is likely that the Made Ground present is of low biodegradable organic content (<5% organic matter).
Infilled Ground	Very Low to Low	Numerous ponds, pits and quarries were assumed to be infilled from their disappearance on historical OS mapping. These features are noted both on-site and within 250m along the extent of the alignment. BS 8576 states infilled ponds less than 15m diameter and infilled before the 1930s to 1940s are of Very Low risk. The date in which these features are infilled varies between 1903 and 2021 for ponds and 1903 and 1981 for quarries/pits. Based on the varied age of infill and sizing of the features a Very Low to Low risk is considered appropriate, with the higher of the two risks deemed for those larger quarries/pits and more recently infilled ponds.

Source	BS 8576 ground gas generation potential	Justification
Peat	Very Low	Localised areas of peat have been noted as layers within superficial deposits in Region 1, associated with the Tidal Flat Deposits and River Terrace Deposits. While peat is anticipated to be present on the site, it is classified as having a Very Low ground gas generation potential by BS 8576 due to its low degradable organic content and is therefore unlikely to represent a significant source of ground gas generation.
Animal waste	Low	A piggery is noted on-site of Region 1c, additionally farms are also noted along the extent of the site with the potential for animal waste products to be present both historically and in present day. Although BS 8576 does not explicitly state animal waste as a source of ground gas generation, anaerobic degradation processes create carbon dioxide and methane. BS 8576 states that natural soils with a high degradable organic content may have a Low ground gas generation potential.
Sludge storage	Low to Moderate	The storage of sludge is noted on-site of Region 1e, 1h, 1i and 7b and off-site of Region 1d, 1h, 1i, 6, 7a and 7b. From the landfill waste exemption entries, it is unknown the details of the sludge, whether it is of sewage origin or not. In accordance with BS5876 the presence of sewage sludge results in a Moderate ground gas generation potential. The entries are noted on farms with it likely the sludge to be sewage origin.
Sewage pumping station	Moderate	The potential for sewage sludge deposition on site cannot be discounted due to the presence of Sewage Pumping Station 165m north of Region 1c. In accordance with BS5876 the presence of sewage sludge results in a Moderate ground gas generation potential which will require further consideration.
Landfill	Moderate to Very High	There are two historical landfills within 250m of the site. One present onsite of Region 1e, extending into Region 1d for household waste and liquid sludge. The other is for household waste noted adjacent to the access route and ~60m south of Region 1d. For the onsite landfill the area is associated with sewage settling beds. The license for the landfill was issued in 1977 and surrendered in 1981. Based on this and along with the fact it's associated with sewage sludge, in line with BS 8576 the risk of ground gas generation is classed as Moderate. For the offsite landfill, the date in which activities ceased here is unclear. From historical OS mapping the drainage channels in the area were no longer present from 1972, potentially indicating the start of its use as a landfill site. Equally, the landfill has since been named as a farm, not present on mapping until 1972. Review of the 1999 aerial imagery on Google Earth for the area shows agricultural land. Based on this and BS 8576 the landfill here has a High to Very High ground gas generation potential dependent on when it was last active.

Source	BS 8576 ground gas generation potential	Justification
Leaks from existing gas mains	Very low	Existing gas mains have been identified crossing the OHL in Region 3 and 7b. Although stated by BS8576 that methane and carbon dioxide may be generated by leaks in gas mains, it is considered reasonable that gas generation potential from existing mains is very low due to modern construction, maintenance and surveillance of the mains.

9.4 Potential receptors

9.4.1 Potential receptors associated with the site are shown in Table 9.3.

Table 9.3. Potential receptors

Receptor group	Receptor	Description
Human health	Construction and Ground Investigation Workers	Workers involved in the GI and construction phases.
	Maintenance Workers	Maintenance workers of the pylons and OH cables.
	Trespassers/General Public	Areas where pylons/overhead lines are located are within open fields which are accessible to users of public footpaths or trespassers.
	Site Users	Site users include owners and users of the various land uses crossed by the overhead line alignment including farmland with crops and livestock and solar farms.
	Adjacent Site Users	Residential housing, commercial properties and farms present within 250m of the alignment.
Controlled Waters	Unproductive Aquifers	Tidal Flat deposits, Oxford Clay Formation, Kellaways Clay Member and Blisworth Clay Formation.
	Secondary Undifferentiated Aquifers	Till
	Secondary B Aquifers	Rutland Formation
	Secondary A Aquifers	River Terrace Deposits, Glaciofluvial deposits, Alluvium, Kellaways Sand Member and Cornbrash Formation.
	Principal Aquifers	Blisworth Limestone Formation, Upper Lincolnshire Limestone and Lower Lincolnshire Limestone.
	Surface Waters ¹	Major watercourses inclusive of main and ordinary rivers, streams and drains as described in Report Section 3.12 and those connecting to them.

Receptor group	Receptor	Description
Property	Buildings and Infrastructure – Concrete	Concrete foundations associated with the pylons.
	Buildings and Infrastructure – Structures with Enclosed Spaces	Buildings adjacent to the site inclusive of housing, commercial units and substations.
	Buildings and Infrastructure – Services	Underground services passing beneath the site associated with the surrounding land uses.
	Livestock	Livestock and crops in fields beneath the overhead line alignment, adjacent to the pylon towers and surrounding land.
	Crops	
Sensitive sites ¹	Conservation Areas	Burton Le Coggles north of Region 7b.
	SSSI	SSSI noted on-site Region 2c (Dunsby Wood)

Notes:

¹A comprehensive assessment on surface water quality and impact, and sensitive site use will be undertaken by the Environmental teams.

9.5 Potential pathways

Potential pathways associated with the Proposed Development are shown in Table 9.4.

Table 9.4. Potential pathways

Pathway group	Pathway
Human health	Ingestion of soil, dust, and water
	Inhalation of dust – indoor and outdoor
	Dermal contact – indoor and outdoor
	Vapour intrusion and inhalation – indoor and outdoor
	Gas ingress – explosive atmosphere
	Gas ingress – inhalation
Controlled Waters	Leaching and vertical migration through unsaturated zone
	Lateral migration in groundwater
	Vertical migration in groundwater
	Direct run-off

Pathway group	Pathway
Property	Baseflow from groundwater to surface water
	Migration via preferential pathways – underground services, pipes and granular material
	Gas intrusion – explosion
	Direct contact – corrosion
	Direct contact – permeation of water pipe
	Plants via root uptake/Direct Uptake
	Dermal contact/inhalation of dust/ingestion
Sensitive sites	Plants via root uptake

9.6 Discounted sources/pathways/receptors

9.6.1 The following sources, pathways and receptors shown in Table 9.5 are discounted from the conceptual site model with the justification presented.

Table 9.5. Discounted sources/pathways/receptors

Group	Discounted Item	Justification
Source	Animal management sites - piggery	The piggery on-site is unlikely to be a viable source of contamination affecting the site as no processing operations are taking place. These sites are only to raise/keep the animals.
	Leaks from existing gas mains	Unlikely that the standard operation of the gas main is a source of contamination. It is considered reasonable that gas generation potential from existing mains is very low due to modern operational procedures. Mitigation measures implemented prior to ground investigation and construction works, included utility surveys, aim to prevent potential damage to existing utilities. Risk to construction works from potential gas accumulation will be covered under Risk Assessments and Method Statements, required under the CDM regulations. It is expected that any potential gas generated will dissipate into the open air.
Pathways	Preferential pathways – service ducts	Due to the extent of the site, its rural setting and the localised construction/GI works taking place in the vicinity of the pylons, services are unlikely to pass close to the towers themselves. Therefore, the pathway is considered very unlikely to be present.
	Direct contact – permeation of water	Pylons are likely to be positioned away from current water supply pipes.

	pipe	
	Plants via root uptake (for sensitive sites only)	Sensitive sites have been removed as a receptor; therefore, associated pathways are void.
Receptors	SSSI	The sensitive sites within 250m of the site have been discounted from this Desktop Study are being reviewed separately by an environmental team exclusively under separate cover.
	Buildings and infrastructure – services	Due to the extent of the site, its rural setting and the localised construction/GI works taking place in the vicinity of the pylon towers, services are unlikely to pass close by to the towers themselves.

- 9.6.2 Note, the 'gas ingress – explosion' pathway been discounted due to the only sources of ground gas generation being from Made Ground and infilled land, both of which are noted to have a Very Low to Low ground gas generation potential, in accordance with BS8576 (see Table 9.2). This pathway has remained present with respect to off-site sources which were noted to generate a Moderate (sewage pumping station, sewage settling beds landfill) to Very High (landfill) ground gas generation potential in the vicinity of Region 1c to Region 1e, respectively.
- 9.6.3 While the active railway represents a potential source of contamination (glycols and hydrocarbons), the proposed pylon locations are subject to a mandatory operational standoff distance (outside the railway boundary fence). Consequently, excavation works will be confined to natural soils within the adjacent agricultural land. The direct contact and ingestion pathways for soil-bound contaminants (such as asbestos or metals in ballast) are therefore considered incomplete due to lateral separation. Specific 'Railway Suite' testing (/glycols and hydrocarbons) is not proposed for these pylon locations, as the receptor will not interact with the source materials.
- 9.6.4 Even though the risk from the historical ironstone mining is considered to be very low, it has not been discounted as a risk as further investigation into this is recommended (see Section 12.1.1 Mining Risk Assessment (for ironstone mining) Region 7b falls within the mineral planning area for Easton Mine, although underground and / or surface workings and associated spoil heaps are unconfirmed to be present on site. Exposure of ironstone workings to water may produce hydrogen sulphide, which may present explosive atmospheres in confined spaces, and contribute to the acidity of groundwater and soils.

9.7 Preliminary Risk Assessment

- 9.7.1 AAJV's approach to the preliminary risk assessment follows the guidance outlined in CIRIA C552 (Ref 13.27) and is described in further detail in Appendix E.
- 9.7.2 The qualitative preliminary risk assessment of the possible linkages of the above sources, exposure and transport pathways and receptors is provided in detail in Appendix F. The majority of the site is deemed as low risk due to the low-level contaminative sources or where a credible pathway is not present between the source and receptor.

9.7.3 A summary of the risk assessment in has been included in Table 9.6.

Table 9.6. Summary of moderate/ low to moderate risks

Pathway group	Pathway	Risk Rating
Human Health Inhalation of dust and asbestos	<u>On-site:</u> Water Pumping Stations, Tanks, Railway Land (Regions 1a, 1b, 1d, 2d and 7a)	Moderate/Low
	<u>Off-site:</u> Sewage Pumping Station, Water Pumping Station, Landfill, Blacksmiths and unrecorded surface ironstone workings and spoil heaps (Regions 1c, 1d, 1h, 2b, 6, and 7b)	
Human Health Inhalation of vapours	<u>Off-site only:</u> Railway Land, Made Ground, Infilled Land, Agricultural Land, Tanks, Electricity Substation, Distribution and Haulage site, vehicle component site Sewage Pumping Station, Water Pumping Station, Landfill, and Blacksmiths (all regions)	Moderate/Low
Human Health Ground Gas Inhalation and Explosion	<u>On-site:</u> Historical landfill (sewage settling beds) – Region 1d, Unrecorded surface and underground ironstone workings and spoil heaps (Region 7b)	Moderate
	<u>Off-site:</u> Sewage Pumping Station, Landfills, and unrecorded surface ironstone workings and spoil heaps – Regions 1c to 1e, and 7b	
Controlled Waters Leaching into Principal and Secondary A Aquifers	<u>On-site and Off-site:</u> Made Ground, Infilled Land, Agricultural Land (All Regions)	Moderate/Low
	<u>On-site and Off-site:</u> Railway Land, Water Pumping Stations, Blacksmith, and unrecorded surface and underground ironstone workings and spoil heaps (Regions 2b, 2d, 6 and 7b)	Moderate
Controlled Waters Run-off/baseflow into Surface Waters	<u>On-site</u> Run-off in areas of impermeable soils Baseflow in areas of permeable soils	Moderate/Low
	<u>Off-site:</u> Water Pumping Station (Region 1h) and unrecorded surface ironstone workings and spoil heaps (Region 7b)	

10. Review of geotechnical risk and Preliminary Engineering Assessment

10. Review of Geotechnical Risk and Preliminary Engineering Assessment

10.1. Preliminary Geotechnical Risk Register

10.1.1 A Preliminary Geotechnical Risk Register is presented in Appendix D which describes the main ground related hazards/constraints on the site (excluding ground contamination) and mitigation measures which may be implemented to eliminate or reduce the risk by means for further investigation or during the design phase. The following risks/constraints are currently anticipated associated with the site.

- Generally unproven ground conditions due to absence of ground investigation information across the site.
- Variations in stratigraphy and engineering properties across the site, leading to variations in ground conditions and potentially design/construction/maintenance requirements.
- Widespread natural compressible deposits (Tidal Flat Deposits) of variable thickness through the east of the site, leading to potentially high total and differential settlements when loaded.
- Local natural compressible deposits such as peat and Alluvium.
- Potential for shrink/swell behaviour within cohesive deposits.
- Potential for shallow groundwater in lower lying topographies/around rivers/surface water features.
- Potential for confined aquifers, including evidence of springs and artesian groundwater.
- Potential for shallow bedrock/natural obstructions, including boulders in tills.
- Potential for natural or induced running sand conditions where shallow groundwater conditions are present in unconsolidated silt and sand soils.
- Presence of recorded karst features and likely additional unrecorded/associated karst terrains, including swallet/sink/shake holes and stream sinks.
- Potential for slope instability issues, including relict shear surfaces, soils at residual strengths, increases in pore pressures, and possible signs of local slope instabilities in existing sloping topographies.
- Geological boundaries, faulting and buried channels resulting in sudden changes in geology.
- Aggressive ground chemistry, anticipated to be most prevalent in mudstone bedrock formations and tills, subject to constituents.
- Surface mineral extraction, including local recorded/suspected pits, with associated buried high walls and infill (including local infilled ponds).

- Potential underground mineral extraction is associated with the Easton Ironstone Mine in the west of the site (Region 7 and 7b).
- Potential for local anthropogenic obstructions associated with no longer present historical developments.
- Presence of existing utilities (buried and overhead), including existing overhead lines and towers with foundations.
- Access constraints caused by generally rural/agricultural setting with numerous field boundaries, surface water features and associated culverts, alongside existing road and rail infrastructure.
- Potential for damage to existing developments/infrastructure if not suitably considered.
- Potential UXO risk identified by preliminary assessment, with further detailed assessment required to further inform risk and subsequent mitigation.

10.1.2 Further details regarding the site's geotechnical risks/constraints are contained in the Preliminary Geotechnical Risk Register in Appendix D and local risks/constraints presented on Figure 10 in Appendix A. This risk register is a live document and will be reviewed and refined following site reconnaissance and as the geotechnical design and assessment progresses to allow management of the geotechnical risks. As part of risk refinement and assessment, site-specific ground investigations are required to identify underlying ground conditions and assess ground related risks.

10.1.3 To mitigate these risks, it is recommended that site-specific ground investigations (GI) are undertaken to identify underlying ground conditions and assess ground related risk. The GI should be carried out in accordance with safe digging procedures in accordance with HSG47 and PAS128 guidance. GPR surveys should be undertaken, and services marked out prior to any intrusive works. Designs should account for potential settlement by incorporating appropriate design parameters and should aim to minimise the impact on existing services wherever possible.

10.2 Preliminary Engineering Assessment

10.2.1 This preliminary engineering assessment is based on the scope of the Proposed Development as outlined in Report Section 1. No site-specific intrusive ground investigations have been completed to support ground engineering assessments at the time of writing, therefore the high-level commentary and preliminary recommendations only are presented herein and are reliant on limited publicly available desk-based sources as referenced throughout this report.

Foundations

10.2.2 Foundations are predominantly anticipated to be required to support the proposed towers along the new overhead line route. More locally, foundations are also anticipated to be required for enabling works/haul roads, mainly where bridged crossings are required, such as over existing linear infrastructure/water features which intersect the route of the site.

10.2.3 The type and geometry of these foundations will be dependent on the associated structural loads and the ground conditions, including associated hazards/constraints, present beneath/adjacent to the development footprint of the structure.

- 10.2.4 In general, Made Ground, and the identified superficial Tidal Flat Deposits, Head and Alluvium deposits are not considered suitable founding stratum, whereas the superficial Till and bedrock geology are anticipated to be suitable founding stratum. This is subject to the variability of the geology encountered, including lateral/vertical consistency, presence of boulders in the Till creating hard spots/risks of differential settlement, slope instabilities, presence of natural voids within limestones, and voids associated with legacy mining (ironstone) in other bedrock geology.
- 10.2.5 Where high vertical and/or lateral structural loads are imparted by the Proposed Development, the need for deeper foundation solutions over traditional shallow foundations increases in likelihood. Likewise, where unfavourable shallow ground conditions are present, such as deep Made Ground, soft Tidal Flat Deposits or Alluvium or loose/variable Head (including with potential for relict shear surfaces), deep foundations will likely be required to transmit loads to underlying deeper competent bearing stratum.
- 10.2.6 In general, shallow soils are anticipated to be unconsolidated clays, silts and sands associated with the Tidal Flat Deposits in the east of the site, and glacial Tills (boulder clay) in the west of the site. Most areas overlie the mudstone bedrock of the Oxford Clay Formation. Clays/mudstones are prone to shrink-swell on changes in moisture content, and consequently, heave will likely need to be taken into account in foundation design, including accounting for the presence of trees/shrubs, such as through ensuring suitable foundation depths and incorporation of heave protection or excavation and replacement with granular engineered fill.
- 10.2.7 Where there is potential for local variations in the nature of shallow soils and bedrock (including interbedded softened soils), alongside local areas of Made Ground or weathered bedrock horizons with boulders (more likely in limestone/sandstone areas), associated bearing and settlement risks would also require consideration to manage differential settlement risks, such as through deepening of foundations to a competent homogenous bearing stratum or incorporating reinforcement.
- 10.2.8 It is noted that if foundations are constructed around the crests of existing slopes or adjacent to existing infrastructure, due consideration will need to be given to loading interactions, including accounting for requirements of specific asset owners.

Haul road/pavement foundations

- 10.2.9 In general, haul roads/pavements (except where constructed atop of embankments) are anticipated to be predominantly formed on superficial clayey or silty soils. Assuming the subgrade is formed of clay and silt soils, relatively low long-term equilibrium design CBR/subgrade modulus values may be expected in the Tidal Flat Deposits in the east of the site and may be present in the Tills in the west of the site, subject to the plasticity index of the clays and depth of groundwater. Oxford Clay is likely to have a low CBR based on its anticipated plasticity index.
- 10.2.10 Assuming the above, incorporation of ground improvement (informed by a specialist ground improvement contractor) or geo-grid layer may require consideration in haul road design, alongside a separation geotextile to manage migration of fines into capping layers, in particular around connections and intersections with public highways and existing infrastructure.

- 10.2.11 Subject to movement tolerances and maintenance requirements, consideration of the shrink-swell behavior of high plasticity clayey and silty soils should account for direct and indirect root action from trees and established hedgerows, both in the short term (seasonal cycles) and long-term (new growth, planting, removal). Effects can be managed by the excavation and replacement of desiccated soils at formation level to an agreed engineering specification.
- 10.2.12 There is the potential for fine sands and silt to be present along the alignment which will need to be considered for frost susceptibility.
- 10.2.13 The presence of hard spots formed by boulders in Tills is considered likely, which poses a risk of differential settlement beneath haul roads/pavement areas. Suitable measures should be taken to ensure this could be managed, where identified, through breaking and excavating such boulders and backfilling the void with suitable fill materials to an agreed engineering specification.
- 10.2.14 Where haul roads/pavements are formed on engineered fill i.e. where embankments are required, the design CBR/subgrade modulus value would be subject to the type and as-built quality of the earthwork.

Earthworks

- 10.2.15 Earthworks are anticipated to be required to form haul roads, and potentially construction compound and laydown areas. All earthworks will require undertaking in accordance with an agreed engineering specification and where feasible, should aim to maximise the re-use of site-won material to achieve a cut/fill balance.
- 10.2.16 Ground investigation and subsequent earthworks classification testing will be required to assess suitability of the site won materials for re-use. In general, where excavations in rock are made, it is anticipated that a greater degree of processing will likely be required to enable re-use as engineered fill. The crushed aggregate from Lincolnshire Limestone is noted to be of low strength and poor frost resistance (Ref 13.44) therefore may only be suitable for construction fill or as a sub-base, as opposed to structural fill, however testing should be undertaken to confirm this. Re-use of site won materials derived from sandstones, such as the Kellaways Sand Member and the Rutland Formation, or the sands and gravels from the River Terrace Deposits as aggregate for higher quality/structural fill may be feasible.
- 10.2.17 Site won material from Till and mudstones could be considered as general fill, however use as structural fill is not anticipated to be feasible due to likely shrink-swell and aggressive ground characteristics. The potential effects on drainage and groundwater conditions of re-using these materials as fill below the original ground level should be accounted for, due to their typically low permeability.
- 10.2.18 Site won materials derived of Made Ground, Tidal Flat or Alluvium deposits are not anticipated to be suitable for re-use as engineered fill due to their typically variable/low strength/organic characteristics. Such materials may be suitable for re-use as fill for landscaped areas, subject to settlement tolerances within these. They may also be suitable for treatment, subject to further assessment to the sulphate content of these deposits.
- 10.2.19 Fill works should be designed and carried out with consideration for loading interactions with underlying and adjacent ground, including loading around the crests of existing slopes/near existing infrastructure, together with accounting for requirements of specific asset owners.

Excavations

- 10.2.20 Excavations in the east of the site are anticipated to be predominantly within unconsolidated clays, silts and sands associated with the Tidal Flat Deposits and the sands and gravels of the River Terrace Deposits. In the west of the site, excavations are anticipated to be mostly within glacial Till (boulder clay) over higher elevation areas. Cuttings in lower valley sides and floors are anticipated to encounter bedrock strata at the surface or underlying thin gravelly topsoil, together with limited narrow zones of Alluvium in the valley floors.
- 10.2.21 Cuttings and excavations within superficial deposits should be feasible with conventional excavation plant. However, where boulders are present or intact bedrock is encountered this may not be feasible. The ease of excavation will vary depending on the weathering profile/strength of the bedrock and nature of the associated discontinuities. In general, it is recommended to avoid significant magnitudes of cuttings in bedrock as this could require more significant excavation techniques such as ripping or blasting.
- 10.2.22 Safe working slope angles for cuttings will be subject to the associated soil/bedrock conditions, groundwater regime and loading interactions. The presence of soft/ loose soils, discontinuities in rock dipping unfavourably to the cutting face, shallow groundwater/springs and relict shear surfaces/soils at residual strengths are examples of ground conditions that could reduce the permitted safe slope angles for excavations. Alternatively, engineering measures can be put in place to enable steeper angles such as soil nails, rock bolts and mesh and retaining structures.
- 10.2.23 The potential presence of loose soils, associated with the Tidal Flat Deposits and/or the upper weathered profile of bedrock in excavations, becoming fluidised by rises in pore pressures cannot be discounted. The potential for running sand conditions will increase where excavations in such materials extend below groundwater level. Excavation methods should be considered in relation to non-static groundwater conditions, natural and designed drainage, and dewatering options.
- 10.2.24 Close or continuous support will be required for any personnel-entry to excavations. Excavation angles should be adjusted according to the anticipated strata and groundwater levels encountered.
- 10.2.25 Considering the presence of springs and potential for shallow groundwater, such as in lower lying areas around surface water features, the incorporation of adequate drainage during design and construction will be required. Furthermore, if piling is required, avoidance of penetrating confined aquifers/artesian waters is recommended.
- 10.2.26 Where significant cuttings in clay/mudstone soils are found to be required, the unloading of confining pressure can result in heave of the lower soils, potentially forcing foundations out of the ground or destabilising the excavation. Management options, such as anchoring piles into the underlying strata should be considered.
- 10.2.27 UXO risk will require assessment prior to breaking ground to inform risk management/ mitigation measures.
- 10.2.28 Utility surveys will be required to inform constraints posed by utilities prior to breaking ground or passing under or working adjacent to overhead utilities. It is recommended that these are undertaken in accordance with PAS 128.

Infiltration drainage

- 10.2.29 Infiltration drainage could be considered to manage surface water drainage associated with haul roads and construction compound and laydown areas.
- 10.2.30 Shallow infiltration drainage is considered unlikely to be feasible across the majority of the site due to shallow groundwater levels in the low-lying areas in the east of the site within the Tidal Flat Deposits, and large coverage of Till in the west of the site which are anticipated to be formed of relatively impermeable clay soils. This poor permeability is also expected in the underlying Oxford Clay and other mudstone formations, where upper weathered profiles are also likely to comprise clay soils.
- 10.2.31 Infiltration into intact bedrock comprised of sandstones and limestones could be feasible however, subject to where the outcrops are located with respect to the development, the nature of associated fractures, and effective permeability.
- 10.2.32 If infiltration drainage is found to be feasible for use on site, careful consideration will need to be given if any such drainage is located near the crests of slopes, karst features or possible underground mine workings, as concentrated discharge of water is considered to increase risk of instabilities.
- 10.2.33 Based on the anticipated ground model, the feasibility of shallow infiltration drainage (soakaways) is considered negligible to low across the majority of the route:
- Infiltration is likely unfeasible within Eastern Region (Tidal Flat Deposits) due to the presence of shallow groundwater tables (buoyant conditions) and the low permeability of the estuarine silts and clays.
 - Infiltration in the Western Region (Glacial Till and Oxford Clay) is considered potentially feasible although may be unsuitable due to the dominance of cohesive soils (clays) which exhibit negligible permeability.
 - Limited infiltration potential may exist within localized outcrops of Sandstone and Limestone. However, this is subject to fracture flow characteristics and introduces significant geotechnical risks, specifically slope instability (if discharging near valley crests) and solution features (karst) in soluble carbonate rocks.

Geo-environmental constraints and groundwater protection

- 10.2.34 In accordance with CIRIA C753 (The SuDS Manual) (Ref 13.27) and the Environment Agency's 'Groundwater Protection: Principles and Practice' (GP3) (Ref 13.33, the following constraints apply to any proposed infiltration features:
- The EA generally prohibits the discharge of surface water into the ground within Source Protection Zones (SPZ1) without a Permit. Where the route traverses SPZ1, infiltration is considered a High Risk to potable water quality. It is likely Detailed Quantitative Risk Assessment (DQRA) and targeted sampling for persistent pollutants (including organochlorine pesticides) would be required to validate any such design.
 - Infiltration is prohibited in areas where soil contamination has been identified, as this may mobilise pollutants into the underlying aquifer. Based on the Historical Review, infiltration is not suitable at identified 'Hotspots' including the Former Railway Lines, Historical Pumping Infrastructure, historical landfills, and historical ironstone mining planning area (Region 1d, 1e, 1h, 2b, 2d and 7b).

- Outside of SPZ1 and identified hotspots, the risk from diffuse agricultural pollution is considered sufficiently low to permit infiltration, provided adequate pre-treatment (catch pits/filter drains) is incorporated to manage suspended solids.

Aggressive ground chemistry

- 10.2.35 The presence of aggressive ground conditions is anticipated, primarily associated with mudstone bedrock and Tills, and to a lesser extent Tidal Flat Deposits and Alluvium, subject to composition of the parent rocks, presenting a risk of chemical attack for embedded concrete structures within the site. When excavated, sulphide bearing mudstones and weathered clay soils can oxidise, increasing the risk of sulphate attack which can lead to deterioration of foundations if not properly mitigated, and so the presence of elevated sulphate/sulphide levels could preclude the use of some forms of ground improvement, such as lime stabilisation.
- 10.2.36 These conditions, alongside the potential aggressivity of other stratum and groundwater, will require further assessment during the site-specific GI and confirmation through testing, to inform appropriate design of concrete mixes in accordance with BRE SD1 (Ref 13.23).

10.3 Abnormal ground conditions

- 10.3.1 The above paragraphs include general high-level commentary considering general ground conditions; however, significant abnormal ground conditions are anticipated on the site such as karstic areas associated with the Lincolnshire Limestone strata, local areas of potential slope instabilities, and possibility for unrecorded underground mining.
- 10.3.2 Where confirmed to be present in this report, or where identified through further assessment/ground investigation, such ground conditions would likely have a significant impact on design and construction on site, including the above preliminary design advice.
- 10.3.3 Of these, karst features are expected in Region 7 of the site and are considered to pose an immediate and long-term risk to ground stability, which will require consideration throughout design, construction and future risk management/maintenance. The incorporation of remedial schemes, designing foundations to span voids/ignoring base resistance, avoiding/offsetting infiltration drainage/avoiding any concentrated water flows, and inspections of cuttings/formations are examples of some of the measures that should be considered going forwards as part of a risk based approach that will need to be taken to the management and mitigation of subsidence risks associated with karst.
- 10.3.4 Design options will need to be reviewed where potential landslips are confirmed to be present, including relict shear surfaces and soils that are unlikely to stand up even at relatively shallow angles in cuttings/excavations and likely be poor from a load bearing perspective due to variability and presence of soils at residual strengths. This includes the potential for open fissures associated with cambered rock, and difficulties founding in such conditions. Alongside this, the wider scale risk of re-activating slip surfaces by loading with earthwork embankments would require consideration. Avoiding developments in these areas could be considered, or incorporation of slope stability measures and inclusion of deep foundation to transmit loads down to deeper competent stratum.

- 10.3.5 If suspected mining features are confirmed to be associated with underground mine workings, remedial measures may be required, subject to the nature and condition of the feature, together with its proximity to the site.
- 10.3.6 It is also noted that the presence of nearby faulting, though restricted to a single inferred intersection of the route of the site, also has the potential to cause abnormal/sudden changes in ground conditions, which will also require consideration as the project progresses.
- 10.3.7 Further detailed investigation and assessment is required to better understand the risks associated with the above aspects, refine the ground and conceptual site models, enable design development and inform construction.

10.4 Geotechnical Complexity Class

- 10.4.1 The geotechnical works relate to the construction of new overhead line towers and haul roads (including associated earthworks and crossing points), alongside construction compound and laydown areas.
- 10.4.2 The existing ground investigation information available for the site is limited. Consequently, there is uncertainty in the lateral variations in the composition of superficial soils, the depth of bedrock and the groundwater regime across the site. Where identified, karst features, potential slope instability and possible underground mining will elevate the geotechnical complexity of the site.
- 10.4.3 It is recommended that Geotechnical Complexity Class GCC2 is applied for this site in accordance with EC7. This classification can be reviewed once further assessment is undertaken and ground investigation information is obtained for the site.

10.5 Geotechnical Category

- 10.5.1 Geotechnical structures are classified into a Geotechnical Category that combines the uncertainty and complexity of the ground and ground-structure interaction with the consequence of failure of the structure.
- 10.5.2 The project is currently classified as Geotechnical Category 2 as defined in BS EN 1997 for the proposals stated in Report Section 1. Projects in Geotechnical Category 2 include conventional types of geotechnical structures, earthworks and activities, with no exceptional geotechnical risks, unusual or difficult ground or loading conditions. For this category, geotechnical data analysis will normally be required to ensure that the fundamental requirements are satisfied.

11. Conclusions

11. Conclusions

11.1 Geotechnical conclusions

- 11.1.1 The preliminary ground models for the site suggests that ground conditions will generally comprise superficial tidal flat deposits in the east with some glacial till deposits in the west of the site, locally interspersed with alluvial and head deposits, underlain by bedrock geology formed of a sequence comprising mid to late Jurassic mudstones, sandstones and limestones, increasing in age moving east to west. In addition, there are associated mapped areas of karst features, faulting, buried channels, and local surface mining, with nearby potential underground mining.
- 11.1.2 The changes in ground conditions and topography moving across the site will result in different engineering characteristics and ground hazards/constraints as outlined in the Preliminary Geotechnical Risk Register, requiring consideration in design, construction and future maintenance. The most significant of these ground hazards is currently anticipated to be the presence of compressible deposits in the east of the site, resulting in potential significant settlement, and karst features in the west of the site, resulting in significant subsidence risk. In addition, due consideration will need to be given to all identified hazards/constraints on site.
- 11.1.3 Further assessments and investigations are required to confirm ground conditions, investigate hazards and inform design development; recommendations for such are outlined in Report Section 12. It should be appreciated however that due to the nature of some of the ground risks on the site, mainly associated with solution of limestone bedrock and formation of karst features, complete risk mitigation will likely not be possible, with residual risks requiring ongoing management.

11.2 Geo-environmental conclusions

- 11.2.1 Potential sources of contamination have been identified on and within 250m of the site to various historical and current potentially contaminative activities. Isolated areas of Made Ground and infilled land are considered likely to be present relating to the historical and current land use at the site. Additionally, site-wide historical and current agricultural land use also represents a source of contamination, and. These sources are considered as being associated with relatively low levels of contamination.. Sources of higher-level contamination are also present both on-site and within 250m of the site buffer, including pumping stations (water and sewage), historical blacksmith, railway land, tanks, landfills, vehicle repairs, and electricity substations. Higher levels of contamination are expected to be associated with the historical ironstone mining on Region 7, if these are proven to be present.
- 11.2.2 With regard to human health the risks are generally considered to be Low to Moderate, with the greatest risk present to workers on-site during construction and GI phases with respect to construction/GI workers for the risk of inhalation of ground gas from the on-site sludge storage and off-site sludge storage, landfill and sewage pumping station sources where a 'moderate to very high' risk of ground gas generation in accordance with BS 8576 was identified. Unrecorded ironstone workings may be a sources of hydrogen sulphide when exposed to groundwater,

generating a flammable gas. Here this risk is highest where GI/construction workers may enter confined spaces where asphyxiating or explosive gases accumulate. A Moderate/Low risk is given for the inhalation of dust fibres, in particular asbestos fibres. Where certain sources (on-site or off-site) have asbestos as a CoPC the risk in the vicinity of these is elevated, particularly for GI/construction workers where material is more likely to be disturbed. A Moderate/Low risk is also given for vapours where volatile organic compounds are noted and could be disturbed during works. All other risks are deemed as Low for human health.

- 11.2.3 Controlled waters are considered to be the most sensitive receptors, with the superficial geology on-site noted to be highly variable potentially enabling migration of contamination (if present). The risk to controlled waters is greatest where sources are present within the vicinity of a Secondary A or Principal Aquifer, reducing in risk where 'lower risk' sources such as Made Ground, infilled land and agricultural land are present or where less vulnerable aquifers such as Secondary B or Unproductive Aquifers are present. The risk to surface waters is present through baseflow groundwater movements, as well as surface runoff where impermeable soils such as glaciofluvial deposits, river terrace deposits, Alluvium, Till, tidal flat deposits and the Oxford Clay Formation are present resulting in runoff.
- 11.2.4 The risks to property inclusive of pylon foundations, livestock and crops are considered to be Very Low to Low, primarily due to the 'mild' consequence given.
- 11.2.5 Based on the available Desktop Study information and the Proposed Development, the site is classified overall as having a Very Low to Moderate risk with respect to contaminated land, predominantly driven by risks to controlled waters. Where risks are noted above Low, the associated sources have been summarised below in Table 11.1 with respect to their risk rating (C552) and a discussion of the risk.

Table 11.1. Summary of risks above low risk

Receptor and linkage	Source (risk within 250m of feature)	Risk Rating	Discussion
Human health Inhalation of dust and asbestos	<u>On-site:</u> Water Pumping Stations, Tanks, Railway Land (Regions 1a, 1b, 1d, 2d and 7a)	Moderate/Low	Direct exposure pathways can be mitigated using cover systems.
	<u>Off-site:</u> Sewage Pumping Station, Water Pumping Station, Landfills, and Blacksmiths (Regions 1c, 1d, 1e, 1h, 2b and 6a)		During on-site construction/GI activities it is assumed that workers will adhere to all site rules and wear appropriate PPE to mitigate risks (i.e., face masks and gloves, if required).
Human health Inhalation of vapours	<u>Off-site only:</u> Railway Land, Distribution and Haulage site, Vehicle component site, Sewage Pumping Station, Sludge	Moderate/Low	Where the risk is higher for construction workers, it is assumed that workers will adhere to all site rules and wear

Receptor and linkage	Source (risk within 250m of feature)	Risk Rating	Discussion
	Storage, Water Pumping Station, Landfills, and Blacksmiths – Regions 1c, 1d, 1e, 1h, 1i, 2b, 2d, 6a, 7a and 7b		appropriate PPE to mitigate risks (i.e., face masks and gloves, if required).
Human health Ground gas inhalation and explosion	<u>On-site:</u> Sludge Storage – Regions 1i, 1h and 7b <u>Off-site:</u> Sewage Pumping Station, Sludge Storage Landfills, unrecorded ironstone workings – Regions 1c, 1d, 1e, 1h, 1i, 6a, 7a and 7b	Moderate	Where the risk is higher for construction workers, it is assumed that workers will incorporate mitigating strategies when entering confined spaces (i.e., gas monitors).
Controlled Waters Leaching into Principal and Secondary A Aquifers	<u>On-site and Off-site:</u> Made Ground, Infilled Land, Agricultural Land (All Regions) <u>On-site and Off-site:</u> Railway Land, Water Pumping Stations Blacksmith, and unrecorded ironstone workings (Regions 2b, 2d, and 7b)	Moderate/Low Moderate	Potential contaminants may enter groundwater and/or surface water on-site. The absence of data confirming the presence/absence of a cohesive layer acting as a barrier makes it possible that contaminants may migrate into groundwater below. Agricultural land limits the amount of surface runoff, however drainage channels on-site and high permeability soils in areas equally increase the risk to controlled waters. However, the distance to the nearest major surface watercourse limits this risk. Exposure of underground ironstone workings to rising groundwater may generate hydrogen sulphide and introduce potential contaminants to deeper groundwater.
Controlled Waters Run-off/baseflow into Surface Waters	<u>On-site</u> Run-off in areas of impermeable soils Baseflow in areas of permeable soils <u>Off-site:</u> Water Pumping Station (Region 1c, 1h, 2b)	Moderate/Low	

12. Recommendations

12. Preliminary recommendations

12.1 Summary of recommendations

- 12.1.1 Further assessment and investigation are required to confirm the ground conditions, groundwater regime, investigate hazards and to inform the design and construction of the Proposed Development. The below is an outline of recommended further works to further update and refine the risk to the Proposed Development as part of desk-based reporting updates:
- General: Site reconnaissance (walkover) comprising inspection of the site by a suitably qualified and experienced engineering geologist/geotechnical engineer and geo-environmental engineer/scientist to identify any signs of instability/subsidence and contamination (including potential sources, pathways and risks), with specific focus on soft/saturated soils, karst, slope instability and drainage.
 - Historical mining risk: Inspect possible mining features during site reconnaissance, and subject to findings, consider obtaining mine catalogue records and undertake a Mining Risk Assessment (for ironstone mining) to assess the legacy mining risk further.
 - UXO risk: Review awaited Detailed UXO Risk Assessment.
 - Mineral Safeguarding constraints associated with the Lincolnshire Limestone Formation: Consultation with the MPA at the pre-application stage to inform a mineral assessment requirement (including need to incorporate ground investigations to inform this).
- 12.1.2 The following geotechnical and geo-environmental works are recommended:
- Preparation of a Ground Engineering Specification and schedule, outlining the proposed ground engineering methodologies, including non-intrusive surveying, intrusive exploratory test hole drilling, sampling, testing, installations and monitoring activities.
 - Site-specific intrusive ground investigation and subsequent interpretative Ground Investigation Report to confirm the ground and groundwater conditions on the site, investigate and assess anticipated risks, and inform designs and construction.
 - Minerals Assessment relating to safeguarded limestone mineral resource, subject to confirmed requirements of the MPA.
 - Interpretative Ground Investigation Report, Geotechnical Design Report and design specifications, including earthworks, subject to defined nature of the Proposed Development.
- 12.1.3 By undertaking an intrusive ground investigation, an assessment of the ground and groundwater profiles may be carried out along with an assessment of the geotechnical and geo-environmental risks associated with the site. This will allow a refined risk assessment and conceptual site model (CSM) to be developed in accordance with Land Contamination Risk Management (LCRM) methodology. The

ground investigation will allow a quantitative assessment as to whether any of the potential risks identified in this study are present and are of material concern to the development.

12.1.4 Other recommended survey works, if not already considered/planned to date, include:

- Topographical surveys to inform earthwork design.
- Arboricultural surveys to inform heave risk and root protection zones.
- Ecological surveys to inform ground investigation and construction constraints.
- PAS128 Type D, C and B (and A if required) Utility Surveys to inform utility constraints and breaking ground.
- Geophysical surveys to inform geotechnical design.,
- Detailed UXO Risk Assessment, to further inform UXO risk and mitigation.

12.1.5 Further recommendations for ground investigation works are outlined below.

12.2 Outline recommendations for ground investigation

12.2.1 The geotechnical elements of the investigation should be designed with consideration to BS EN 1997-1:2004, BS EN 1997-2:2024 (Eurocode 7: Geotechnical Design- Parts 1 and 2), and BS 5930:2015+A1:2020.

12.2.2 The geo-environmental elements of the investigation should be designed with due consideration of the requirements of BS 10175:2026 (Ref 13.23).

12.2.3 In summary, to effectively inform the design and construction of the Proposed Development, the key objective of the ground investigation is to obtain sufficient, accurate and representative information about the site through the advancement of exploratory holes on the site. Information obtained should include:

- confirmation of ground, groundwater and surface water conditions, including seasonal variations in the latter;
- confirmation of the chemical status of soil for the purpose of risk assessment to human health, groundwater and for preliminary waste classification to inform disposal/storage and chemical status of groundwater and surface water in order to determine risks to controlled waters;
- investigation and verification of geotechnical hazards/constraints, including focus on:
 - compressible deposits
 - shrink-swell clay deposits
 - karst features
 - legacy mining features (subject to further risk refinement)
 - possible slope instabilities
 - aggressivity to buried concrete
- identification of geotechnical design parameters and ground models;

- confirmation of permeability/infiltration characteristics;
- confirmation of excavatability of bedrock;
- assessment of material re-use as part of earthworks and if required, to inform minerals assessment; and,
- ground gas assessment following BS 8485:2015+A1:2019 (Code of practice for the design of protective measures for methane and carbon dioxide). Supported by CL:AIRE RB17 to determine the potential risks to the Proposed Development, surrounding properties, and construction site workers.

12.2.4 It is recommended that the ground investigation be undertaken in accordance with the UK Specification for Ground Investigation 3rd Edition. In brief, the scope of works is generally anticipated to include:

- geophysical survey in advance of intrusive works targeting areas where sub-surface voids are suspected associated with karst features, including around areas of faulting in bedrock. Note, this could also be used to assist with tracing bedrock depth between the confirmed locations provided by the intrusive locations;
- boreholes sunk by cable percussive or dynamic sampling and rotary coring techniques, including in-situ Standard Penetration Testing (SPT);
- trial pitting, including excavation in layers with toothless buckets to help identify relict shear surfaces;
- Cone Penetration Testing (CPT), specifically to delineate changes in thickness of soft soils, such as across alluvial channels/ Tidal Flat Deposits;
- geotechnical and geo-environmental soil, rock and groundwater sampling;
- plate load/in-situ CBR testing to inform pavement foundation design and bearing capacities of shallow soils;
- infiltration and percolation testing to inform drainage;
- installation monitoring wells and programme of monitoring; and,
- geotechnical and geo-environmental laboratory testing (including thermal and electrical resistivity testing).

12.2.5 The findings from the ground investigation should be interpreted within an interpretative Ground Investigation Report. This would also inform successive Geotechnical Design Reports as required as the design progresses.

12.2.6 Liaison with the existing stakeholders, asset owners, landowners, and other relevant parties should be undertaken to confirm their requirements and expectations with regard to the proposed works and developments, alongside any constraints. Liaison with the Environment Agency and other relevant bodies, concerning the need for permits to carry out ground investigation, should be undertaken to confirm their requirements and expectations with regard to the proposed works and developments, alongside any constraints.

- 12.2.7 PAS128 Type D, C and B (and A as required) surveys should be undertaken (prior to intrusive investigations), and ground penetrating radar (GPR) and cable avoidance tools (CAT) used prior to breaking ground. It should be ensured that any existing utilities are identified and fully traced prior to the commencement of intrusive investigations and construction works if near proposed exploratory hole locations. A hand dug inspection pit will be required, dug to at least 1.2m bgl using insulated hand tools, with CAT scanning periodically. Only after this process should mechanical intrusive investigation commence. Procedures to be adopted in the event that underground utilities are encountered must be detailed in the Risk Assessments and Method Statements (RAMS) by the contractor for the intrusive investigation works.
- 12.2.8 At the time of writing AAJV is awaiting further Detailed UXO Risk Assessment information for the site. AAJV recommends that this assessment is undertaken prior to the commencement of any intrusive investigation. This recommendation will be reviewed once further UXO information has been obtained.

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Appendix A

Figures

Appendix A Figures

Figure 1. Site Location Plan

Figure 2. Topography and Slope

Figure 3. Superficial Geology

Figure 4. Bedrock Geology

Figure 5. Hydrogeology

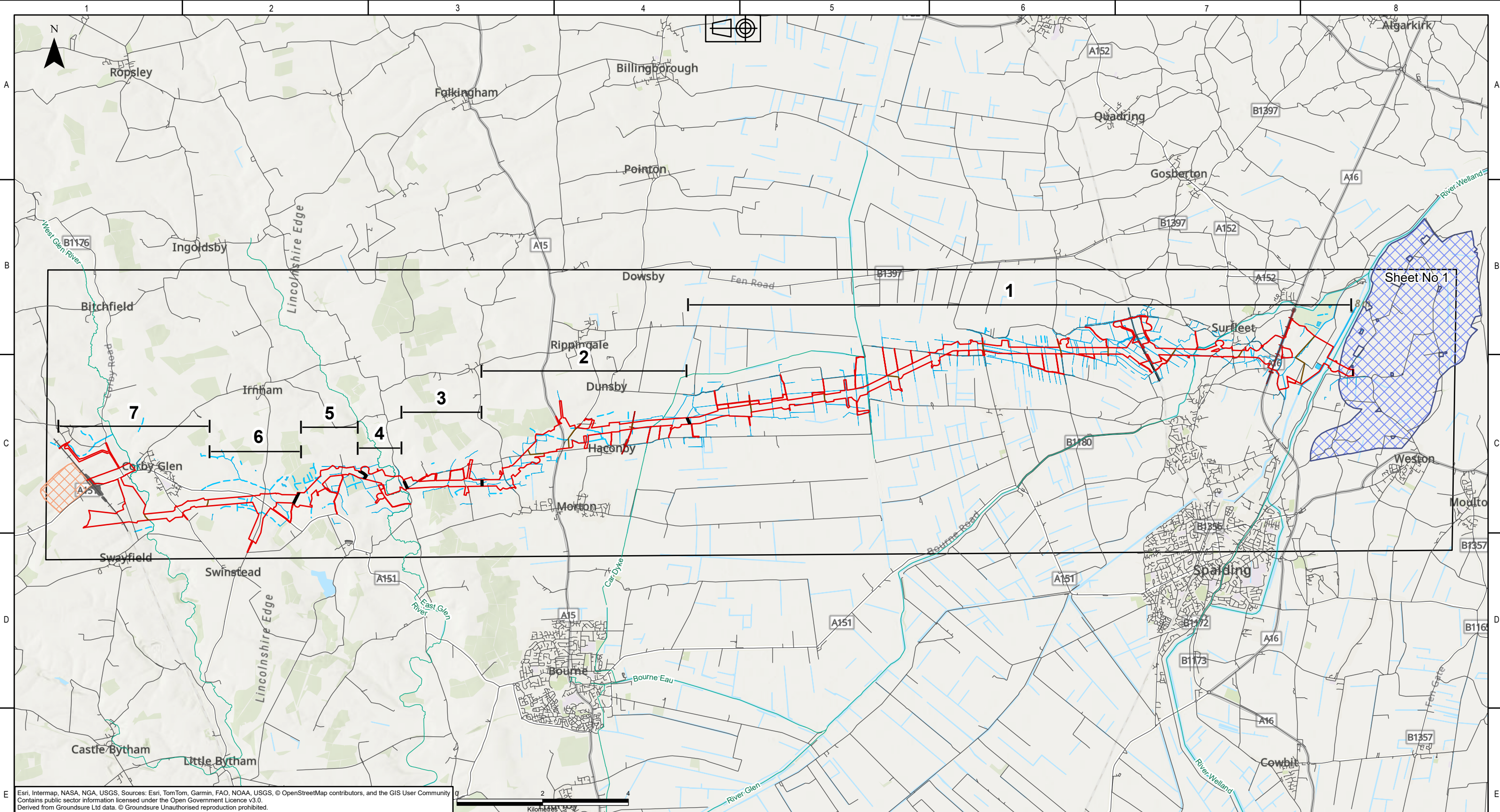
Figure 6. Hydrogeology - Aquifers

Figure 7. Hydrology and Risk of Flooding

Figure 8. Hydrology and Flooding

Figure 9. Licenced waste and industrial land use and hazardous substances

Figure 10. Geohazard Constraints



KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Refined Weston Marsh Substation
- WMEL-A
- EA Main Rivers
- OS Surface Water Features - Lines
- OS Surface Water Features - Areas
- OS Open Roads
- OS Railway Track
- OSM Historical Railway
- Historical Railway Feature LD
- Historical Railway Feature HD

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Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan

Purpose of issue

For Information

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Sheet 1 of 9

Issue A

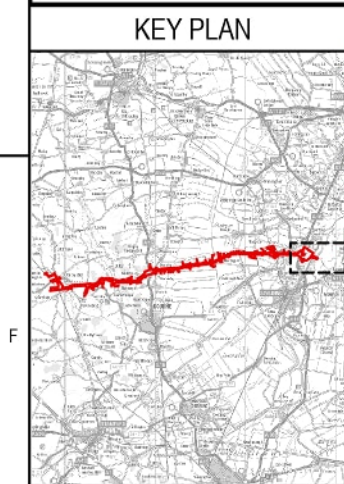
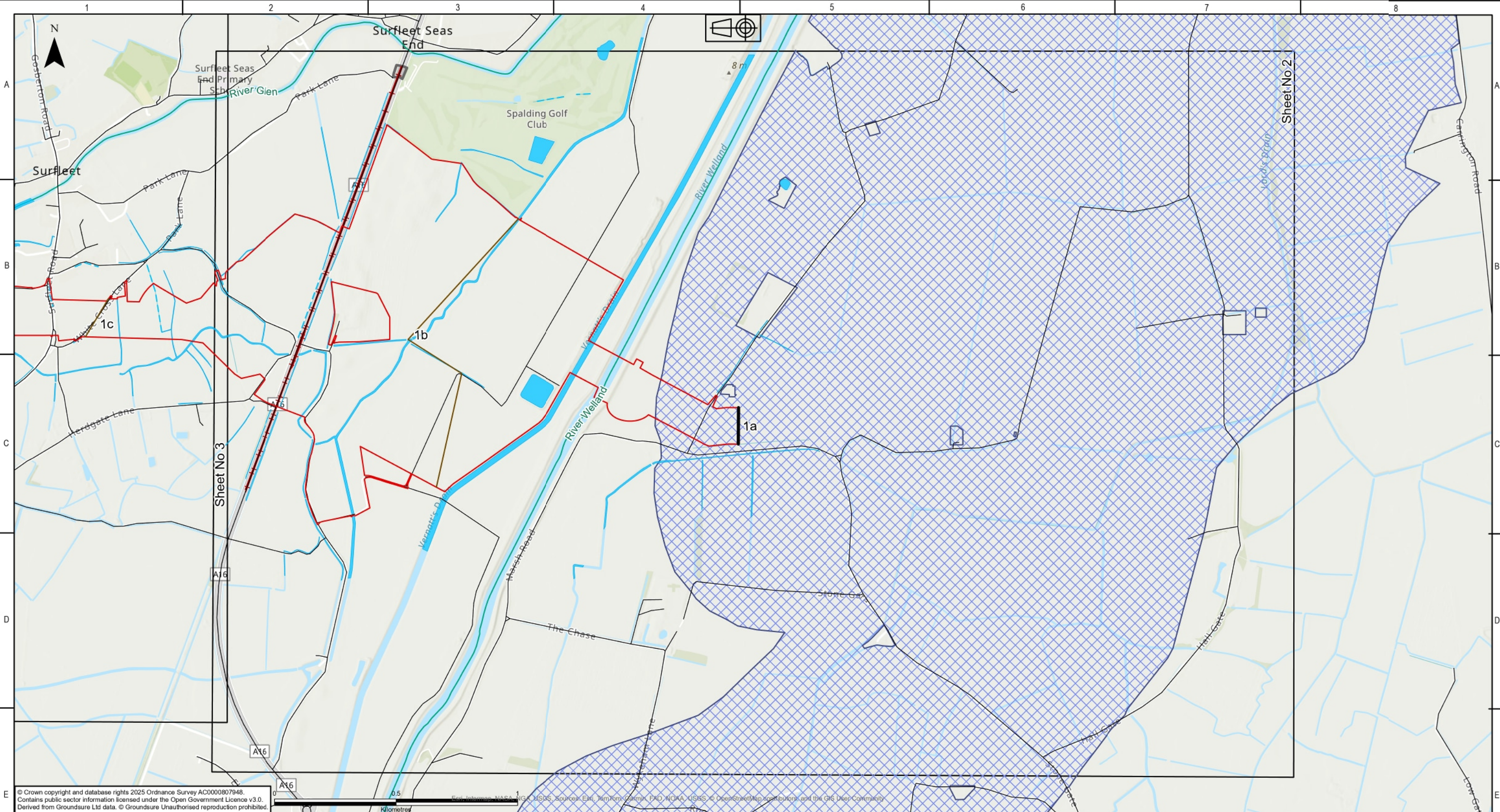
Reviewed C. JOHNSON

Approved J. CHASTNEY

Date 23/06/2026

Scale 1:85,000

Size A3



Legend	
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	Route Regions
	Route Sub-regions
	Refined Weston Marsh Substation
	EA Main Rivers
	OS Surface Water Features - Lines
	OS Surface Water Features - Areas
	OS Open Roads
	OSM Historical Railway
	Historical Railway Feature LD

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Rev.	Date	Comment	Drw by	Check	Rev by	Appr.

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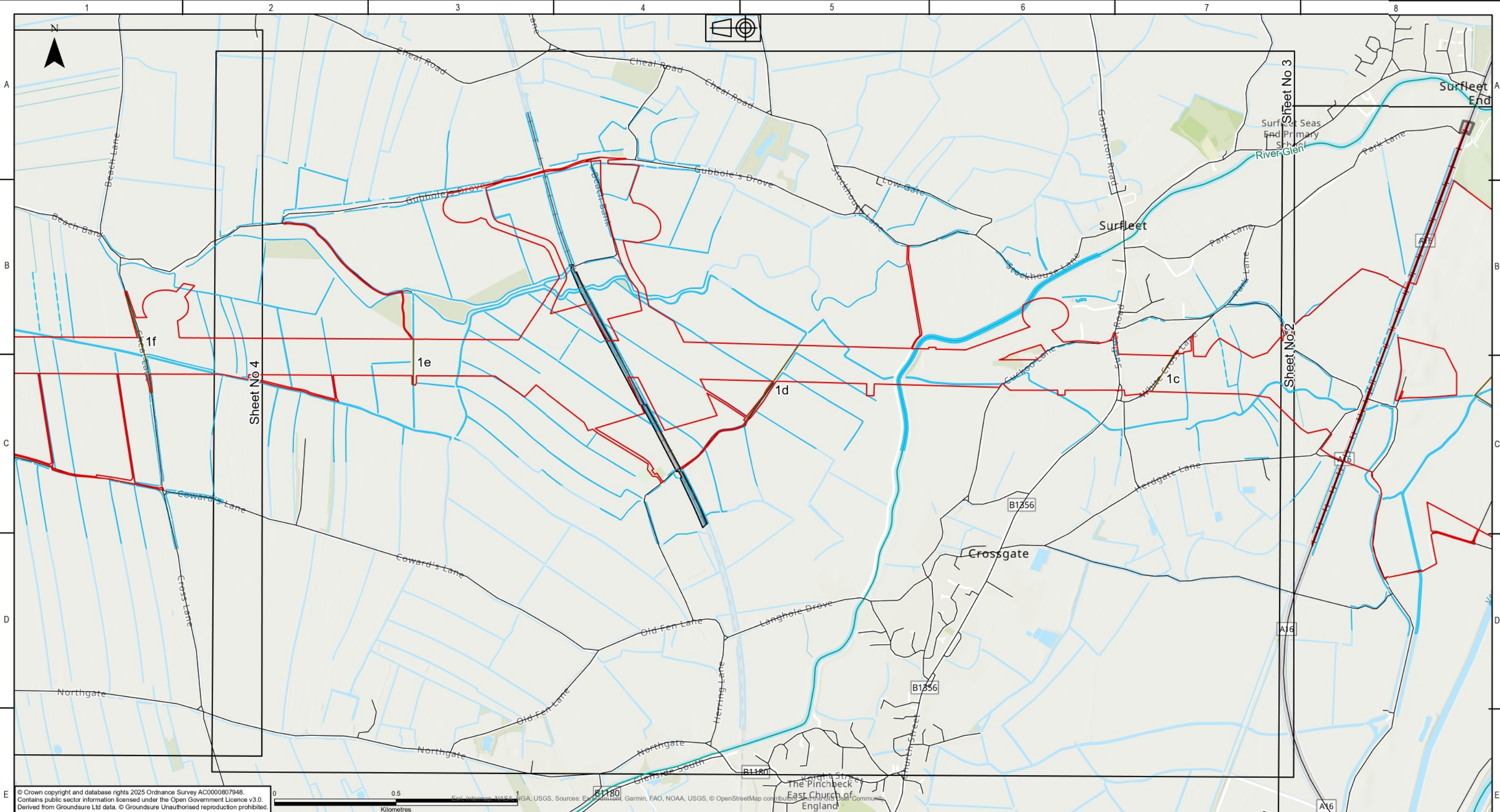
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L. LINE

Checked
S.LUMACA

Site Weston Marsh to East Leicestershire	
Title Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan	
Purpose of issue For Information	Status S3
Contractor Drawing No. WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000013	Revision P03
Customer Drawing No. N/A	Issue A
Reviewed C. JOHNSON	Approved J. CHASTNEY
Date 26/06/2026	Scale 1:15,000
	Size A3



KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- OS Surface Water Features - Lines
- OS Surface Water Features - Areas
- OS Open Roads
- OS Railway Track
- OSM Historical Railway
- Historical Railway Feature LD
- Historical Railway Feature HD

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan

Purpose of issue

For Information

Status

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Revision

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N/A

Sheet 3 of 9

Issue

A

Reviewed

C. JOHNSON

Approved

J. CHASTNEY

Date

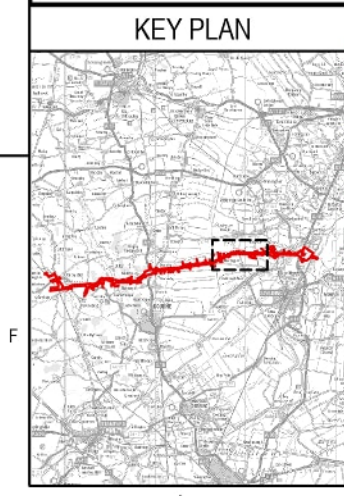
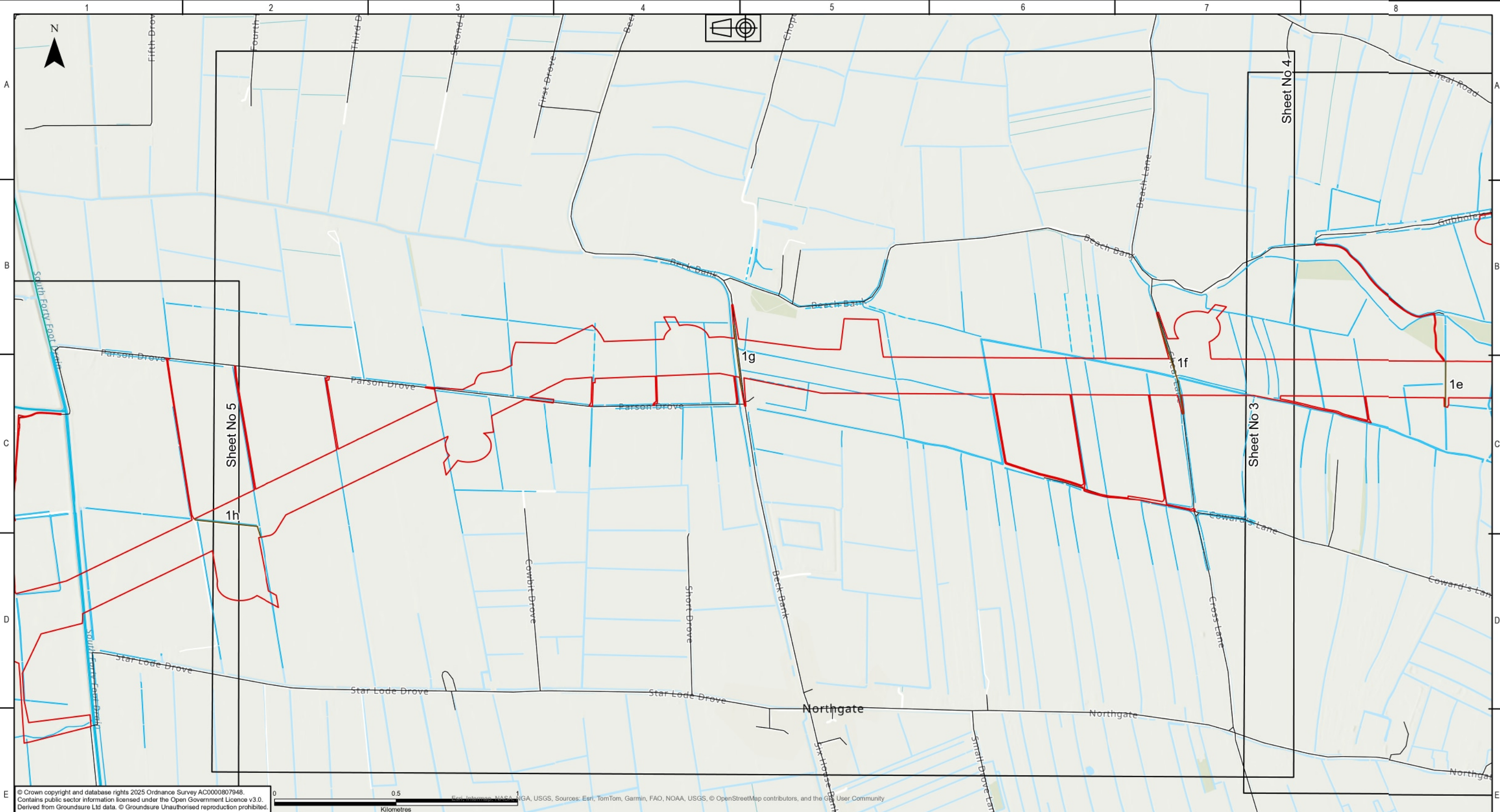
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Legend	
	DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
	Route Regions
	Route Sub-regions
	EA Main Rivers
	OS Surface Water Features - Lines
	OS Surface Water Features - Areas
	OS Open Roads

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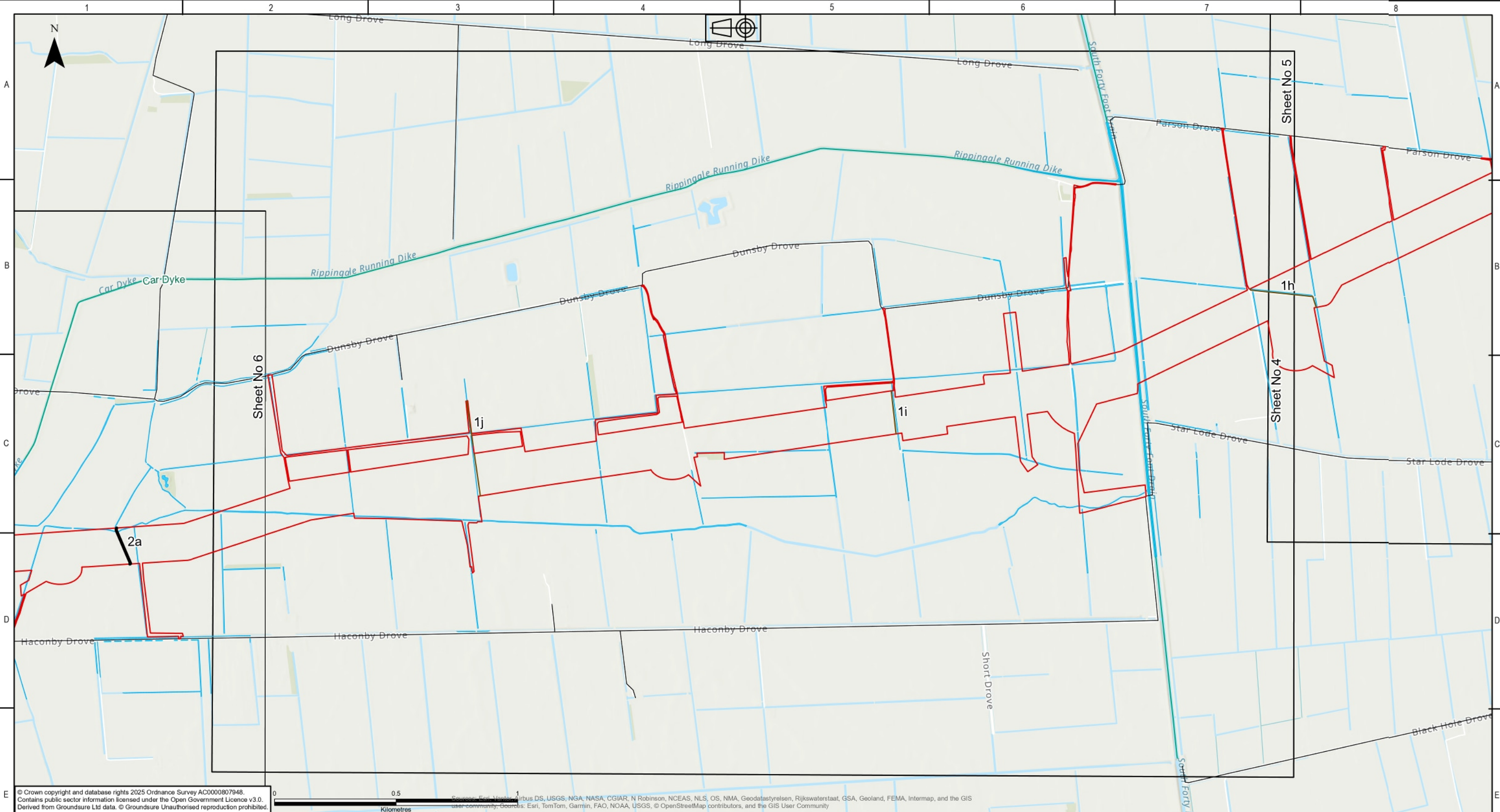
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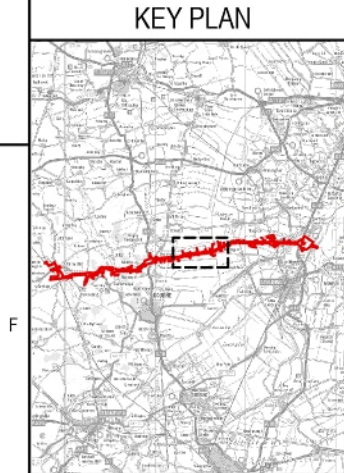
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Title Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan	
Purpose of issue For Information	Status S3
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Customer Drawing No. N/A	Issue A
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Legend	
	DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
	Route Regions
	Route Sub-regions
	EA Main Rivers
	OS Surface Water Features - Lines
	OS Surface Water Features - Areas
	OS Open Roads

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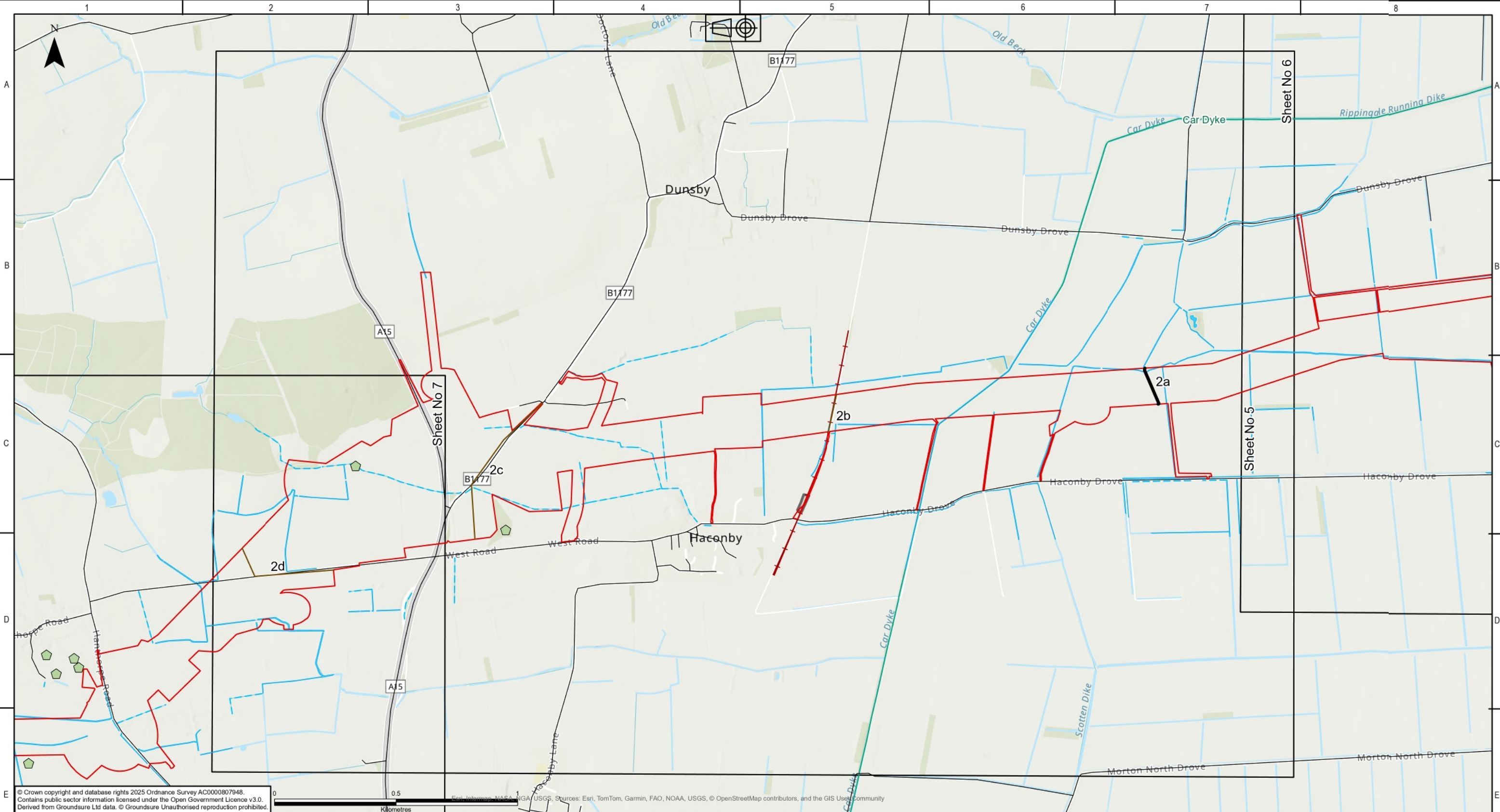
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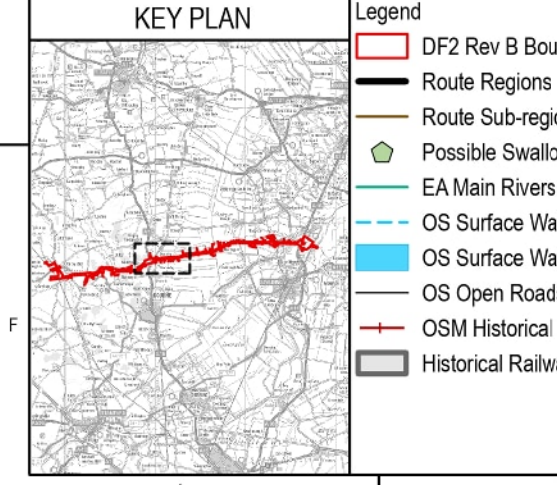
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Checked
S.LUMACA

Site Weston Marsh to East Leicestershire	
Title Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan	
Purpose of issue For Information	Status S3
Contractor Drawing No. WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000013	Revision P03
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- Legend**
- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
 - Route Regions
 - Route Sub-regions
 - Possible Swallow Hole
 - EA Main Rivers
 - OS Surface Water Features - Lines
 - OS Surface Water Features - Areas
 - OS Open Roads
 - OSM Historical Railway
 - Historical Railway Feature LD

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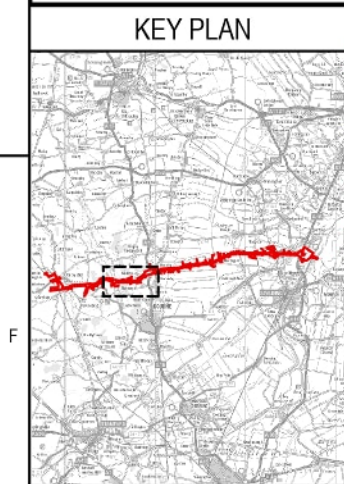
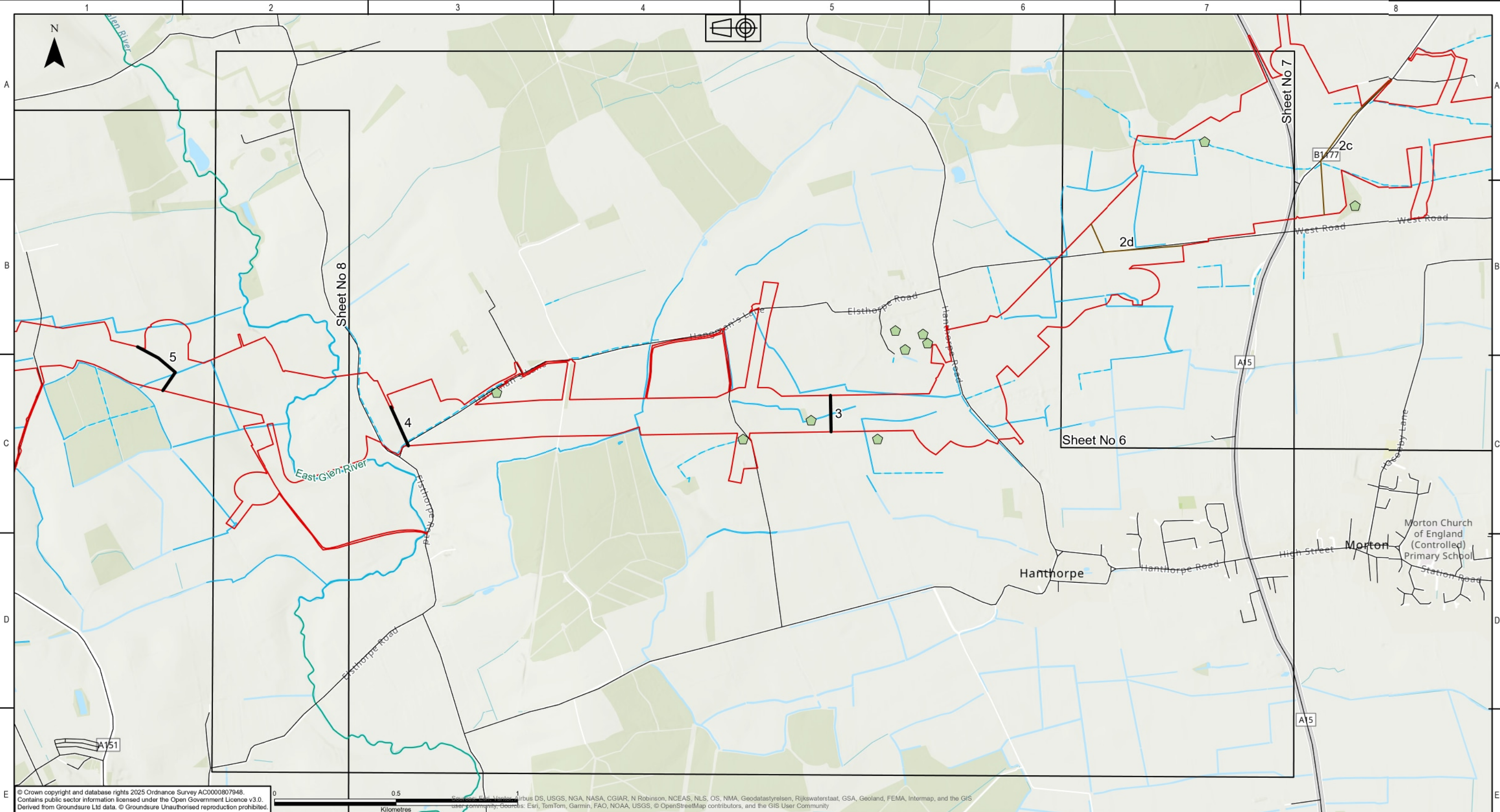
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Site Weston Marsh to East Leicestershire	
Title Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan	
Purpose of issue For Information	Status S3
Contractor Drawing No. WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000013	Revision P03
Customer Drawing No. N/A	Issue A
Reviewed C. JOHNSON	Approved J. CHASTNEY
Date 26/06/2026	Scale 1:15,000
Sheet 6 of 9	Size A3



Legend	
	DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
	Route Regions
	Route Sub-regions
	Possible Swallow Hole
	EA Main Rivers
	OS Surface Water Features - Lines
	OS Surface Water Features - Areas
	OS Open Roads

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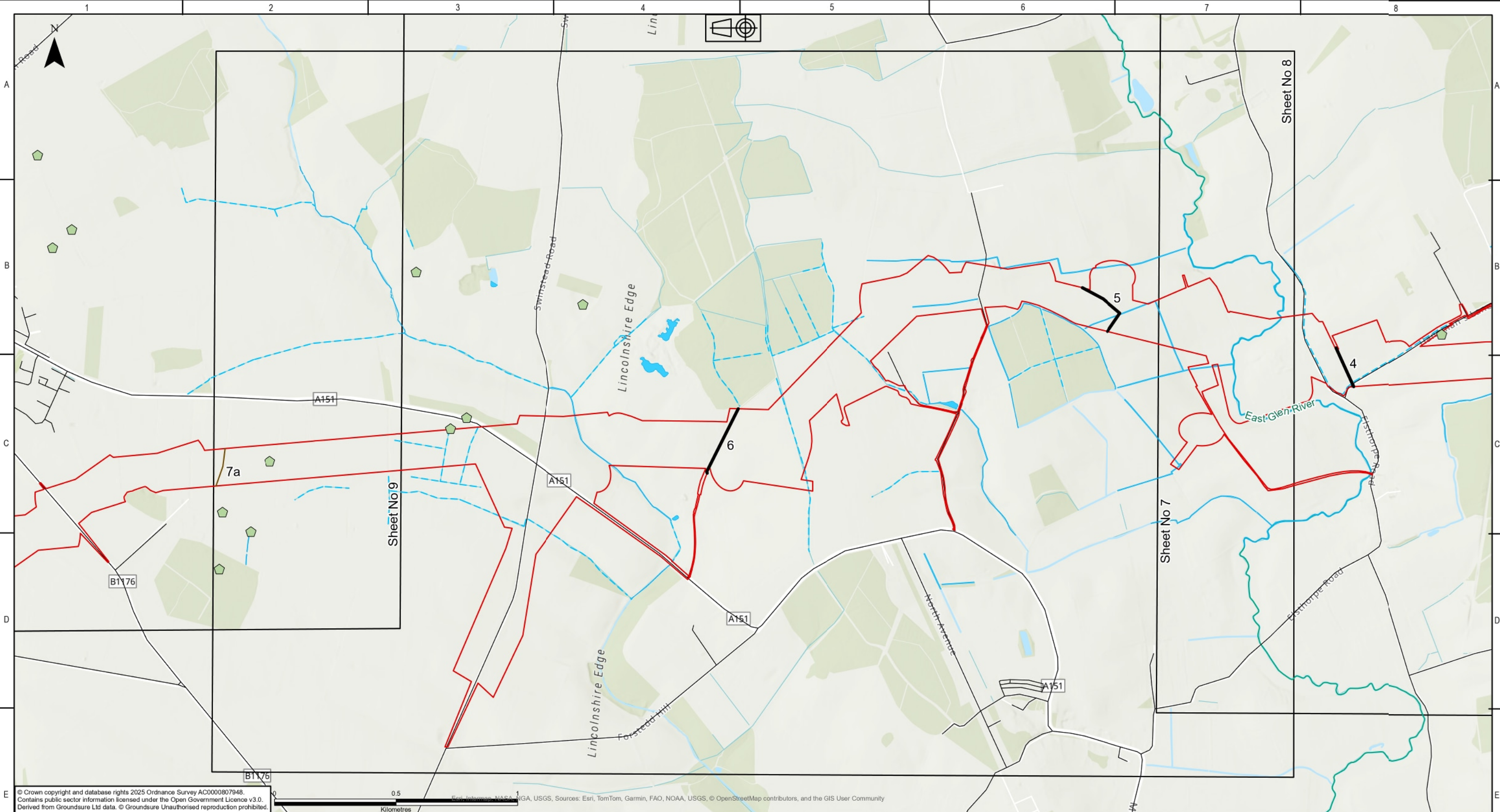
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S.LUMACA

Site Weston Marsh to East Leicestershire	
Title Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan	
Purpose of issue For Information	Status S3
Contractor Drawing No. WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000013	Revision P03
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Date 26/06/2026	Scale 1:15,000
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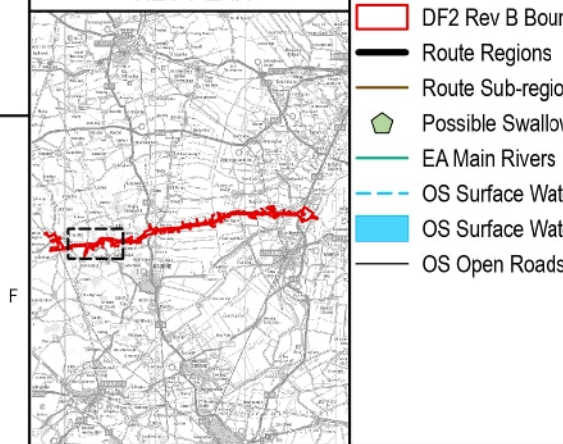


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0 0.5 1 Kilometres

Eastmore Road, A151, NGA, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

KEY PLAN



Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Possible Swallow Hole
- EA Main Rivers
- OS Surface Water Features - Lines
- OS Surface Water Features - Areas
- OS Open Roads

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L. LINE

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 1
Site Location Plan

Purpose of issue
For Information

Status
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Contractor Drawing No.
WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000013

Revision
P03

Customer Drawing No.
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Issue
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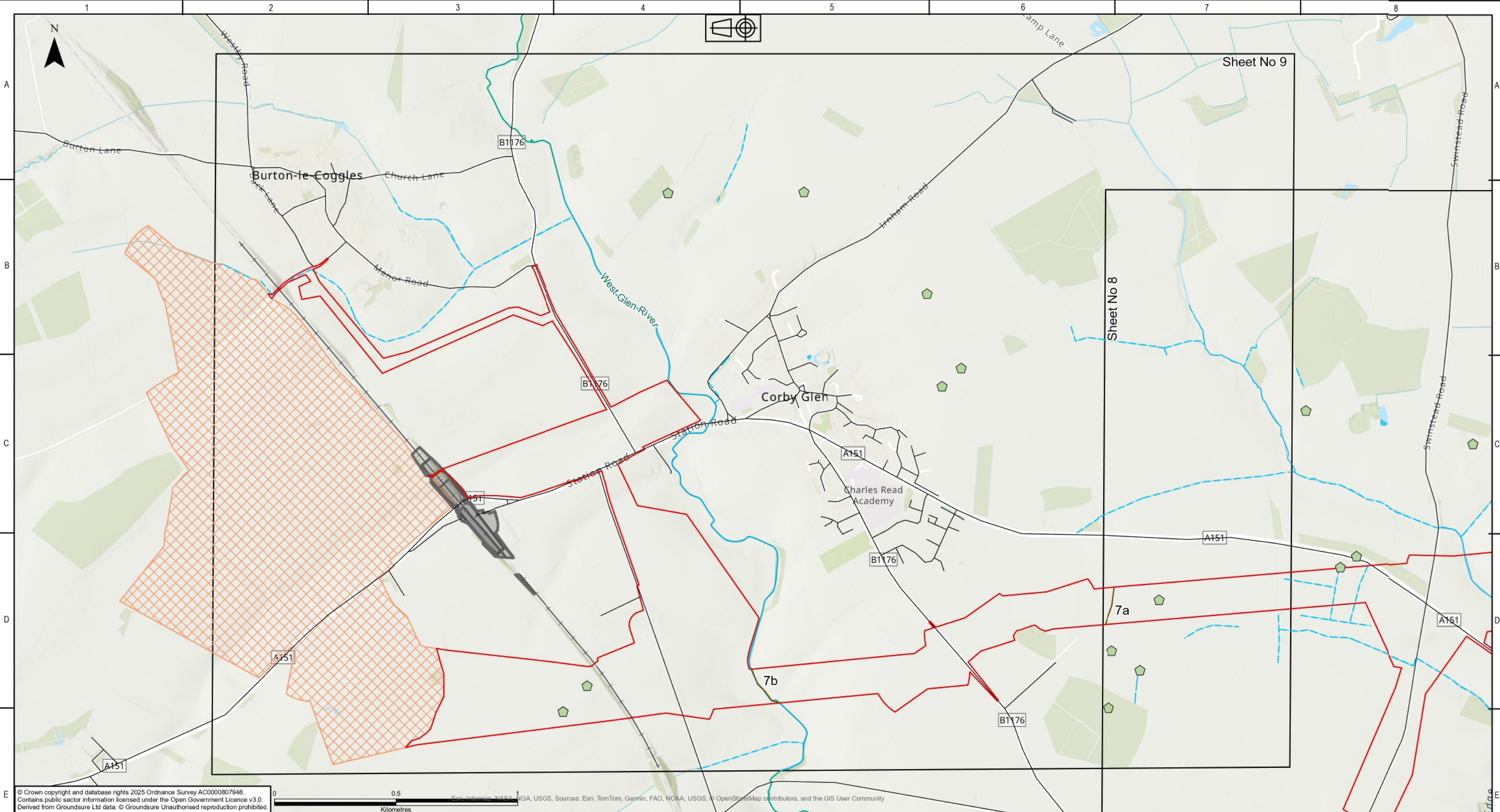
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J. CHASTNEY

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26/06/2026

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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- WMEL-A
- Possible Swallow Hole
- EA Main Rivers
- OS Surface Water Features - Lines
- OS Surface Water Features - Areas
- OS Open Roads
- OS Railway Track
- Historical Railway Feature LD

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 1 Site Location Plan

Purpose of issue

For Information

Status

S3

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Revision

P03

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Issue

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C. JOHNSON

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J. CHASTNEY

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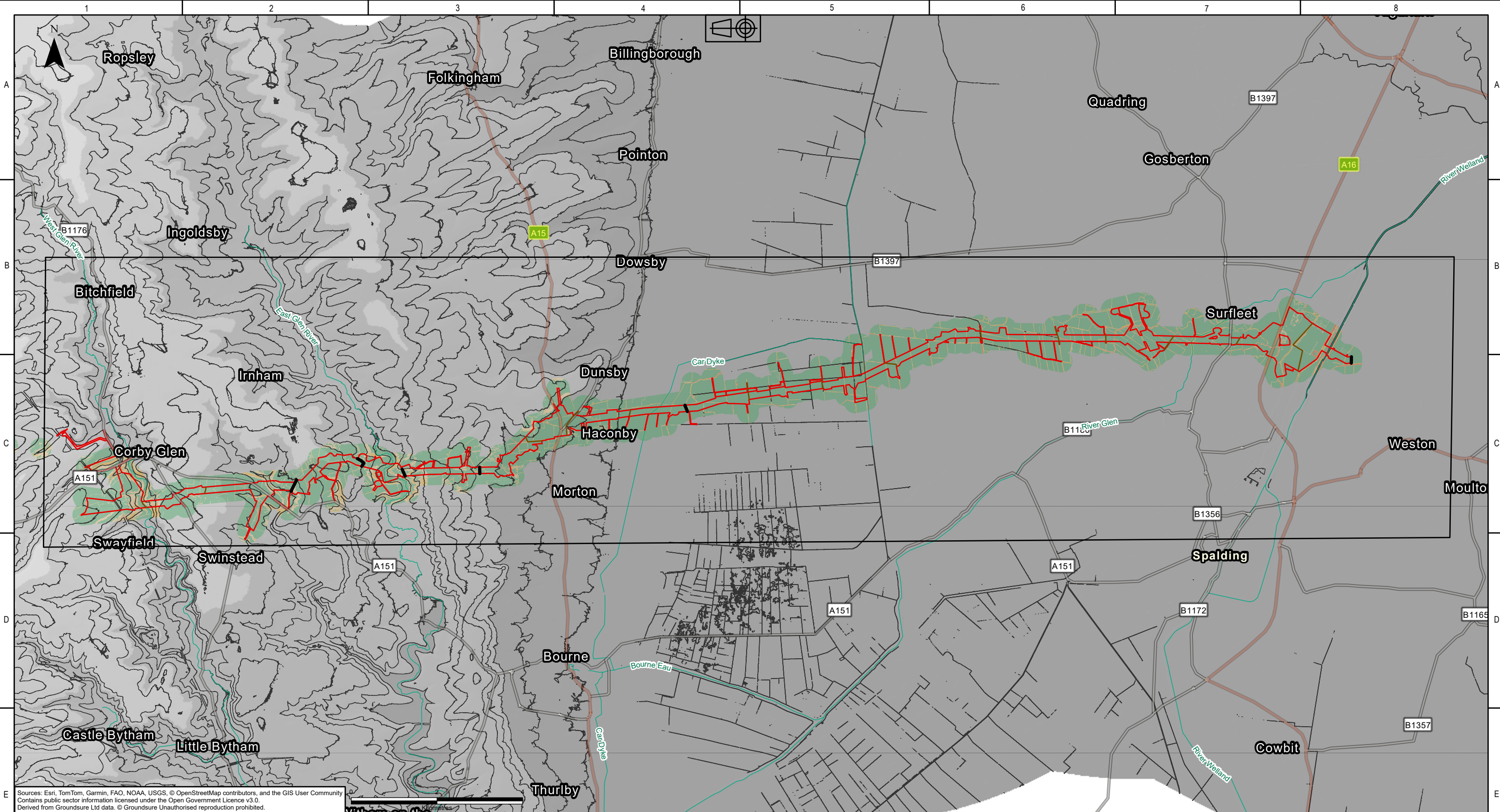
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Sheet No 9

Sheet No 8



KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Contour Lines (10m)
- Less than 3.5*
- 3.5* to 5.7*
- 5.71* to 15*
- Greater than 15*
- Digital Terrain Model LiDAR (1m)
- 2 - 30
- 31 - 75
- 76 - 105
- 106 - 140
- Sheet Grid

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 2 Topography and Slope

Purpose of issue

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Issue

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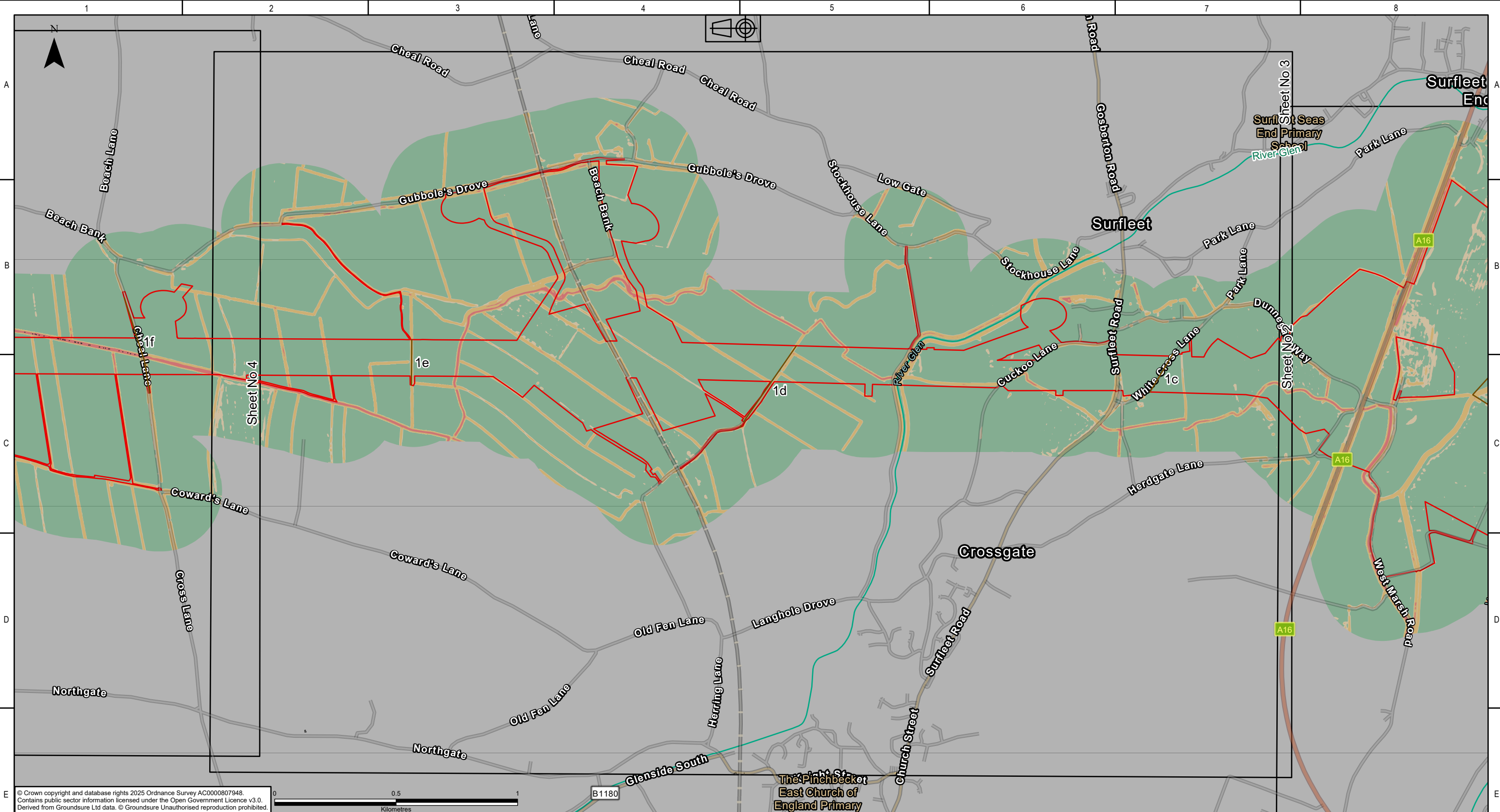
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Contour Lines (10m)
- EA Main Rivers
- Topographic Slope Gradient
 - Less than 3.5°
 - 3.5° to 5.7°
 - 5.71° to 15°
 - Greater than 15°
- Digital Terrain Model LiDAR (1m)
 - 2 - 30

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Site
Weston Marsh to East Leicestershire

Title
Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 2
Topography and Slope

Purpose of issue For Information	Status S3
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Customer Drawing No. N/A	Issue A
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Contour Lines (10m)
- EA Main Rivers
- Topographic Slope Gradient
 - Less than 3.5°
 - 3.5° to 5.7°
 - 5.71° to 15°
 - Greater than 15°
- Digital Terrain Model LiDAR (1m)
 - 2 - 30

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 2 Topography and Slope

Purpose of issue

For Information

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Issue

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N/A

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Date

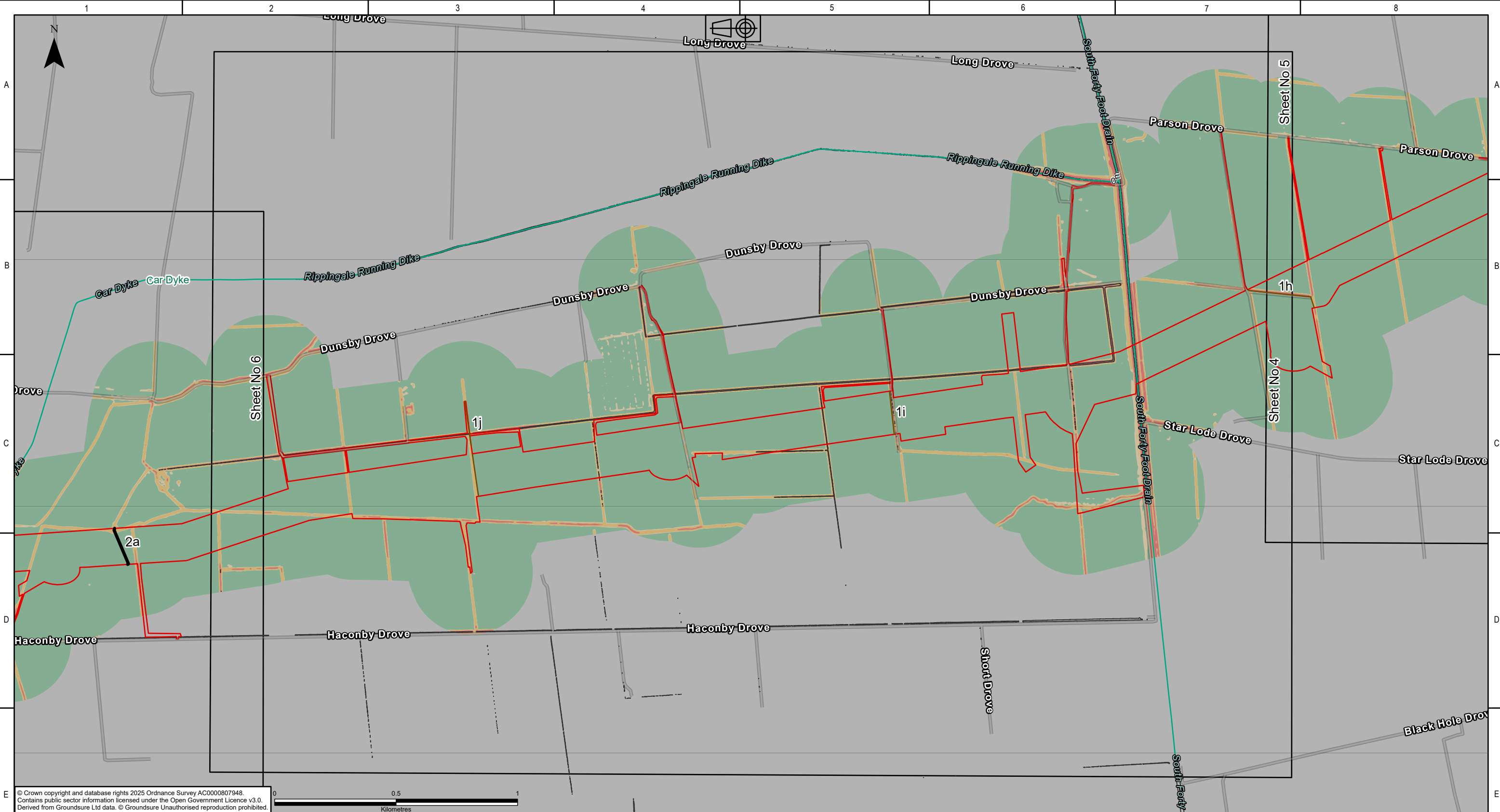
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Contour Lines (10m)
- EA Main Rivers
- Topographic Slope Gradient
 - Less than 3.5°
 - 3.5° to 5.7°
 - 5.71° to 15°
 - Greater than 15°
- Digital Terrain Model LiDAR (1m)
 - 2 - 30

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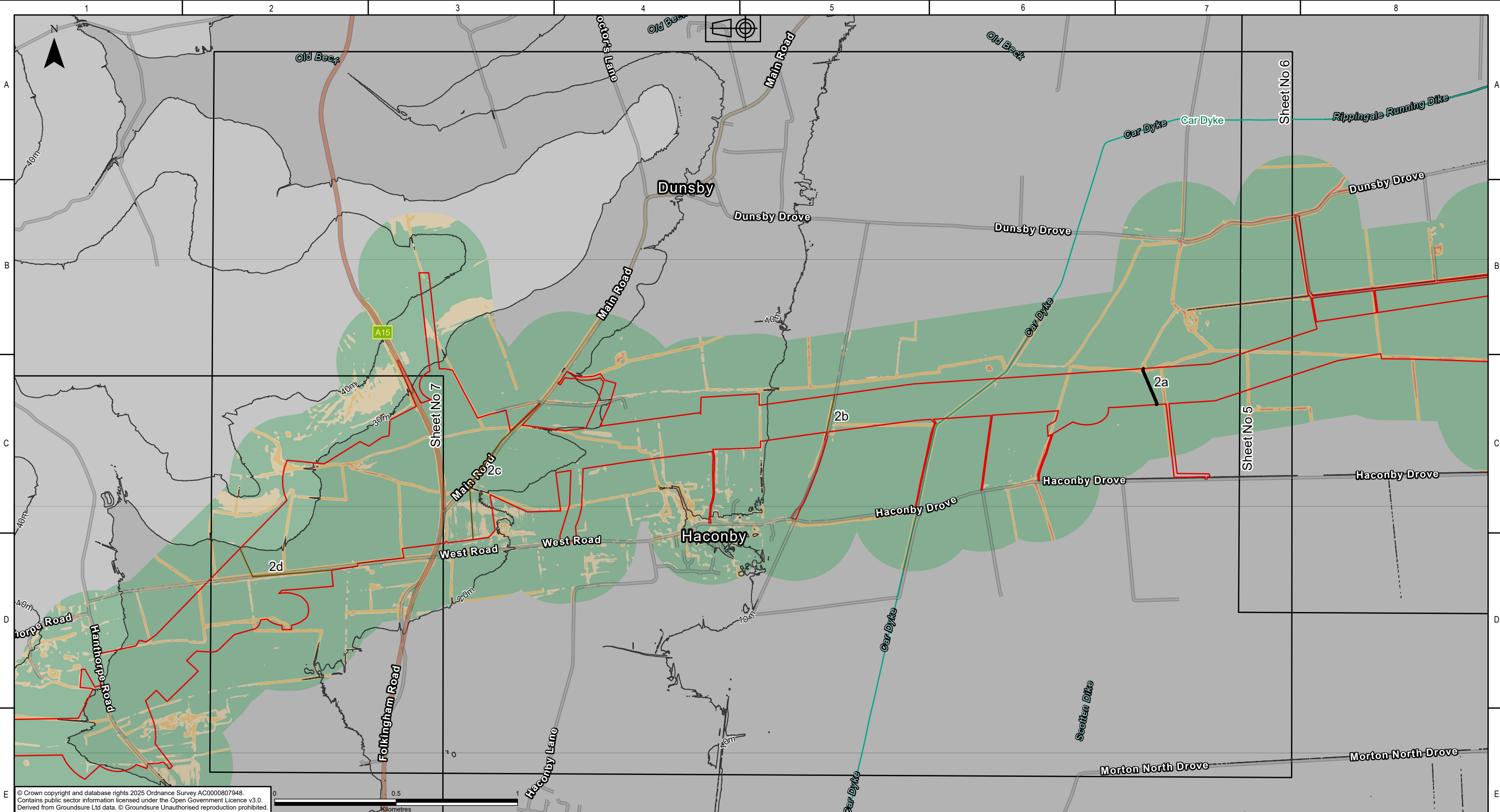
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S.LUMACA

Site
Weston Marsh to East Leicestershire

Title
Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 2
Topography and Slope

Purpose of issue For Information	Status S3
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Reviewed C. JOHNSON	Approved J. CHASTNEY
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Contour Lines (10m)
- EA Main Rivers
- Topographic Slope Gradient
 - Less than 3.5°
 - 3.5° to 5.7°
 - 5.71° to 15°
 - Greater than 15°
- Digital Terrain Model LiDAR (1m)
 - 2 - 30
 - 31 - 75

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Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 2
Topography and Slope

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N/A

Issue

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Date

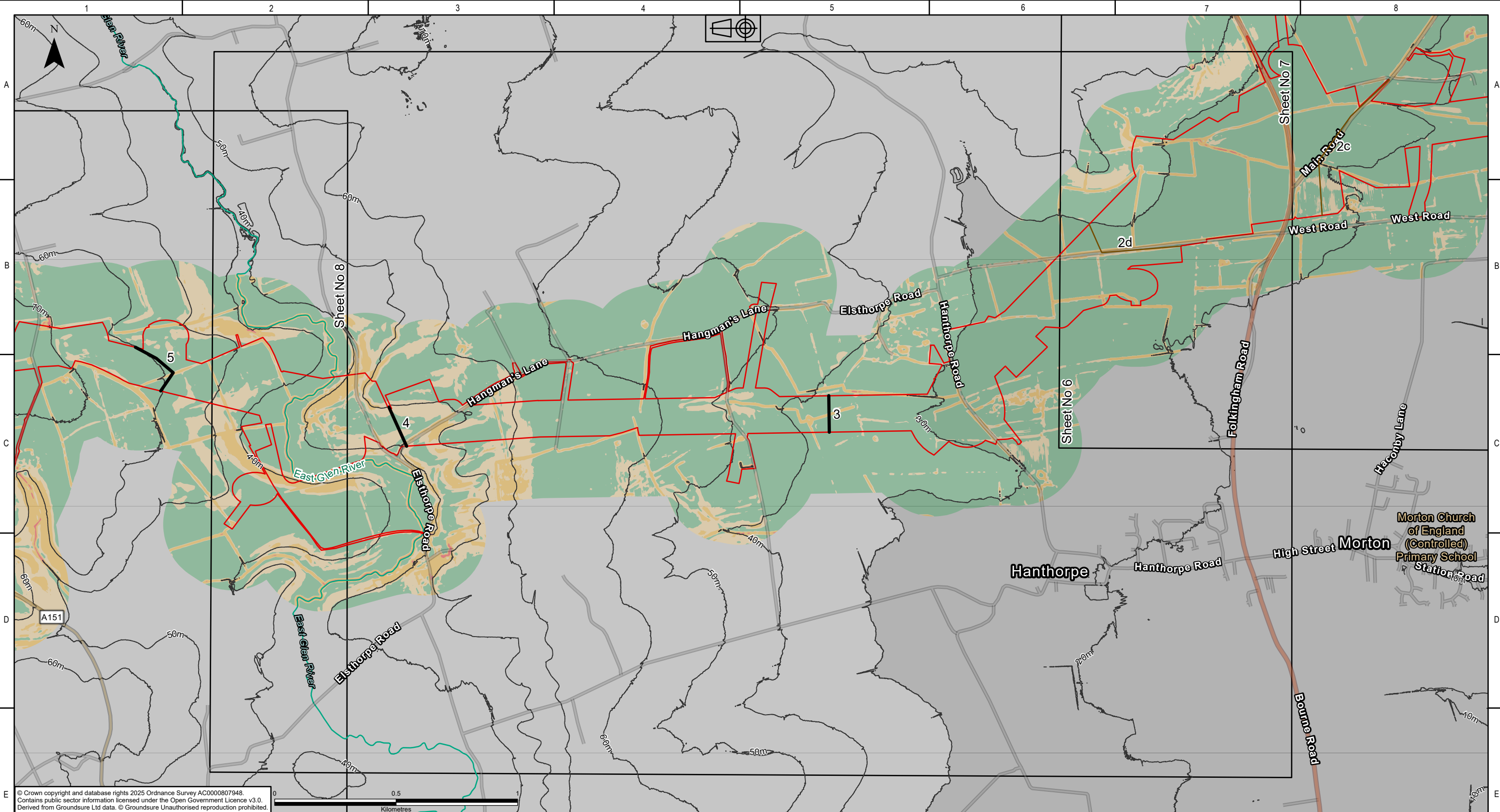
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
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- EA Main Rivers
- Topographic Slope Gradient
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- Digital Terrain Model LiDAR (1m)
 - 2 - 30
 - 31 - 75
 - 76 - 105

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Site

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Title

Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 2 Topography and Slope

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C. JOHNSON

Approved

J. CHASTNEY

Date

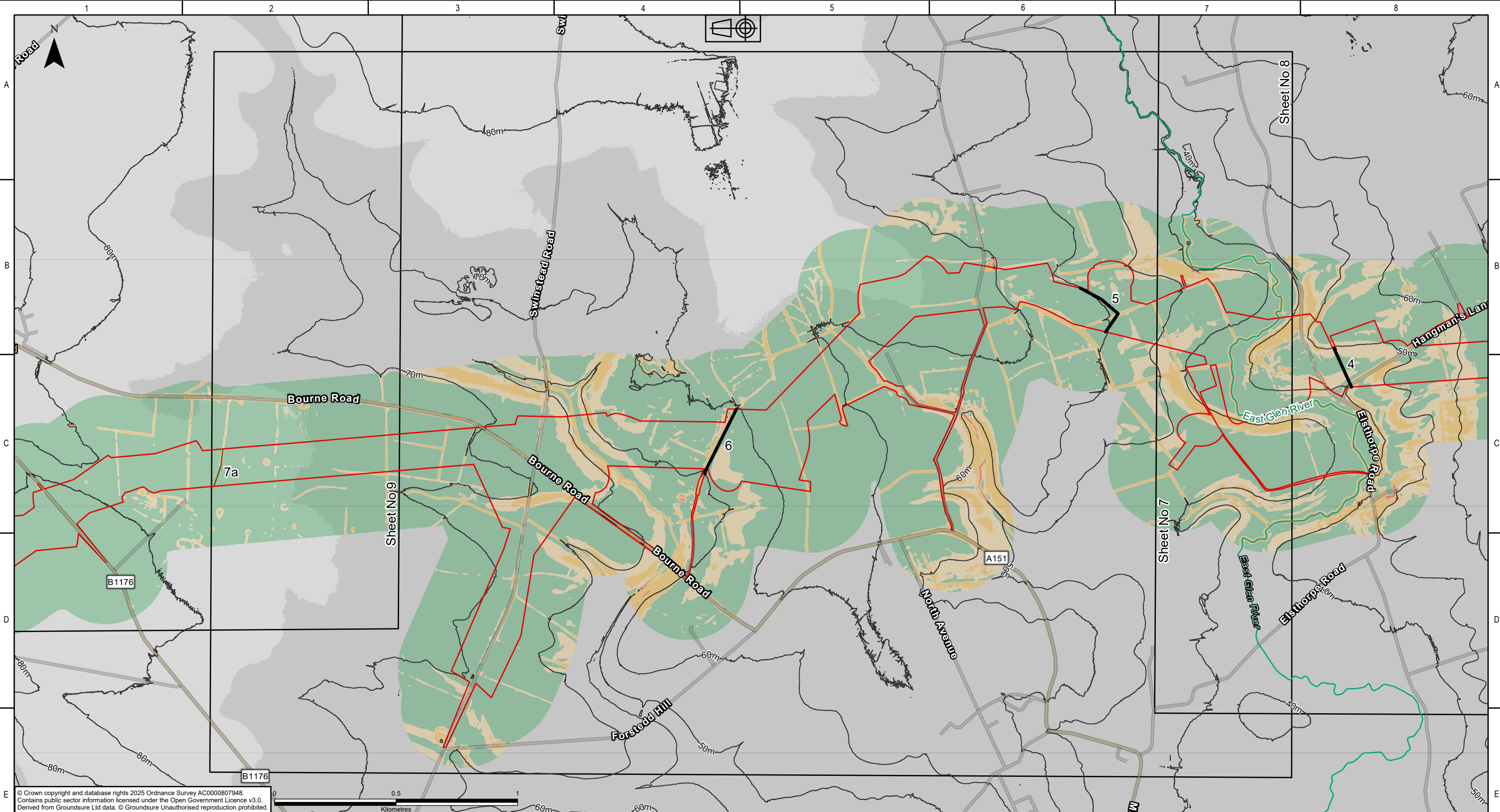
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- Contour Lines (10m)
- EA Main Rivers
- Topographic Slope Gradient
 - Less than 3.5°
 - 3.5° to 5.7°
 - 5.71° to 15°
 - Greater than 15°
- Digital Terrain Model LiDAR (1m)
 - 31 - 75
 - 76 - 105

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S.LUMACA

Site

Weston Marsh to East Leicestershire

Title

Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 2
Topography and Slope

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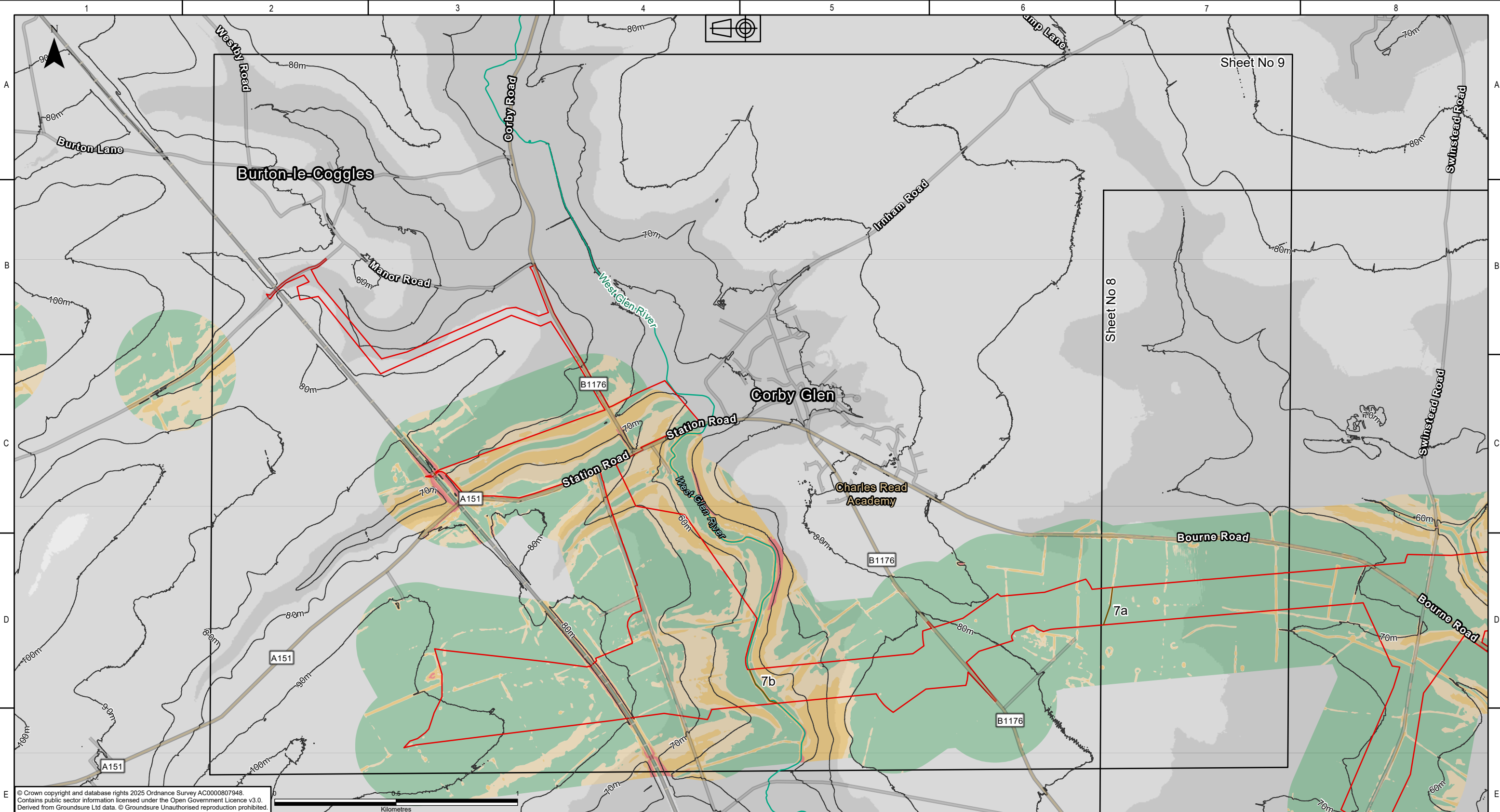
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J. CHASTNEY

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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
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- Contour Lines (10m)
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- Topographic Slope Gradient
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 - 76 - 105
 - 106 - 140

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Phase 1 Geotechnical and Geo-environmental Desktop Study: Figure 2 Topography and Slope

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N/A

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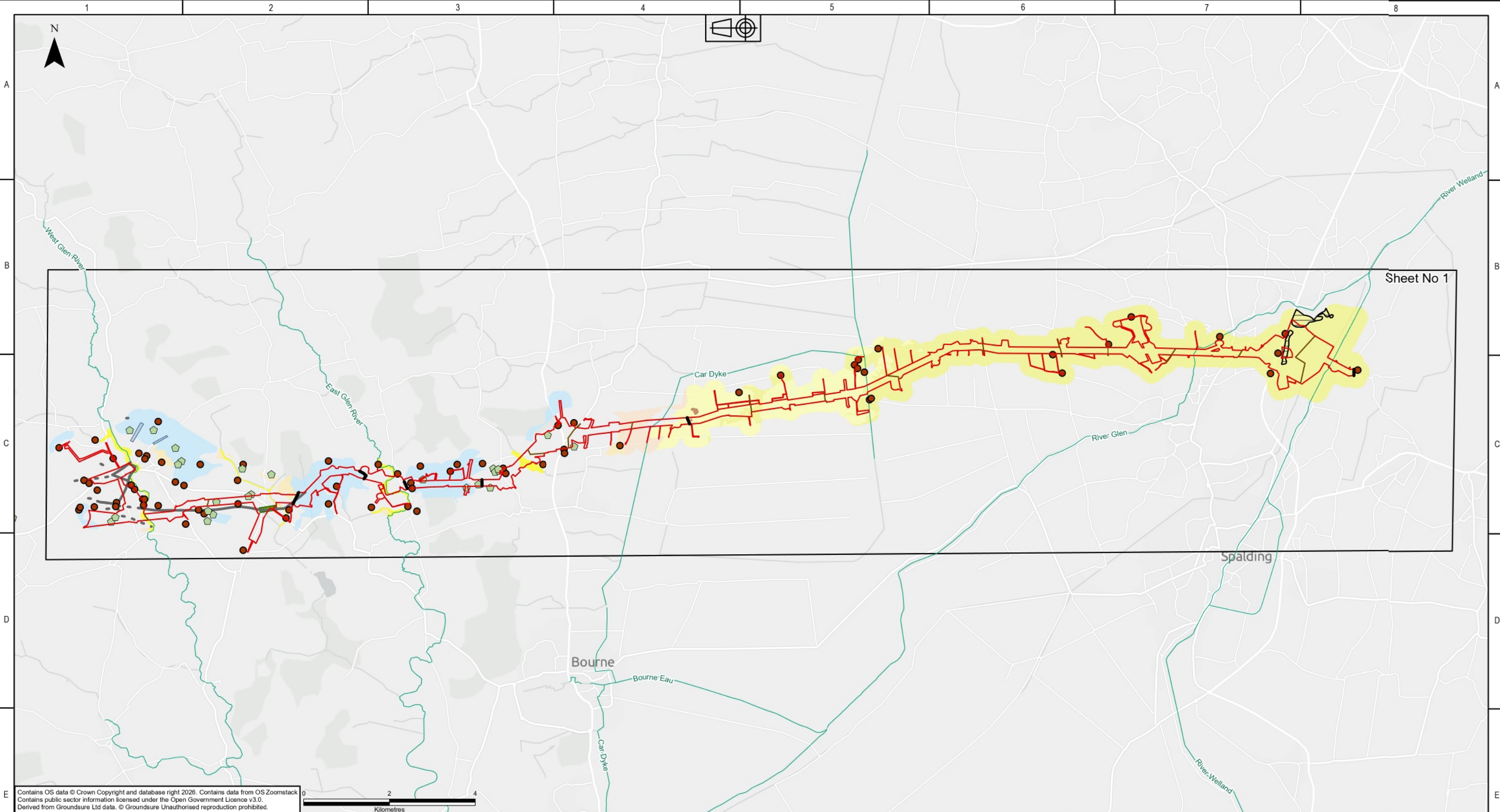
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Sheet 9 of 9



KEY PLAN

Legend

DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A

Route Regions

Route Sub-regions

Possible Swallow Hole

EA Main Rivers

Historical BGS Boreholes

Linear Features 50K

Fault, inferred, crossmark on downthrow side, throw in metres

Fault, observed, crossmark on downthrow side, throw in metres

Artificial Ground 50K

Possible Buried Channel

Woodlands Fault Ridge Line

Superficial Geology 50K

Alluvium-Clay, silt, sand and gravel

Glaciofluvial deposits, Mid Pleistocene-Sand and gravel

Peat-Peat

River Terrace Deposits, 1-Sand and gravel

Tidal flat deposits, 1-Clay and silt

Tidal flat deposits, 1-Sand and silt

Tidal flat deposits-Clay and silt

Till, Mid Pleistocene-Diamicton

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Published Superficial Geology and Artificial Ground

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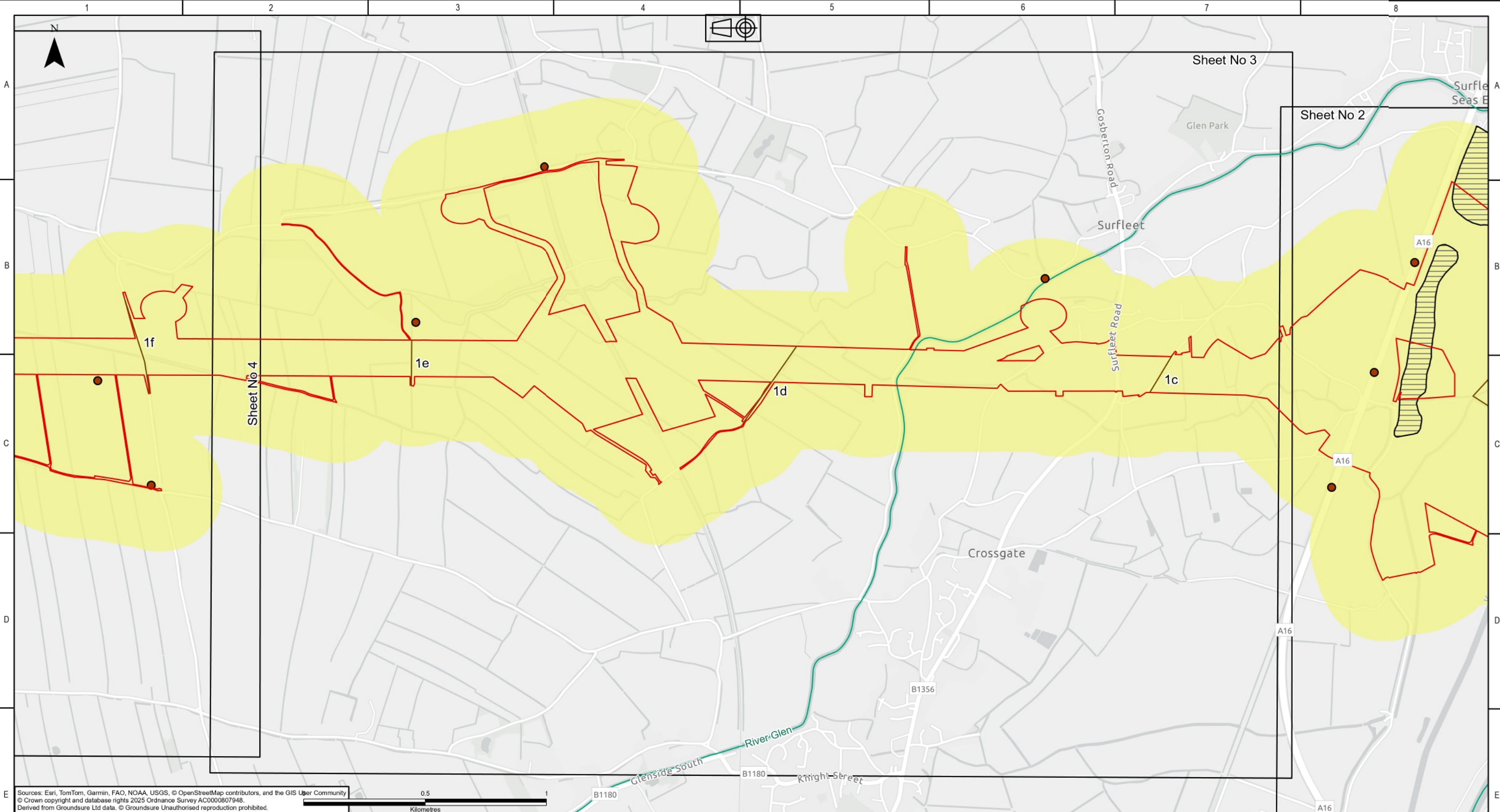
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Artificial Ground 50K
- Superficial Geology 50K
- Tidal flat deposits-Clay and silt

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Sheet 3 of 9

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C. JOHNSON

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J. CHASTNEY

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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Superficial Geology 50K
 - Tidal flat deposits, 1-Clay and silt
 - Tidal flat deposits-Clay and silt

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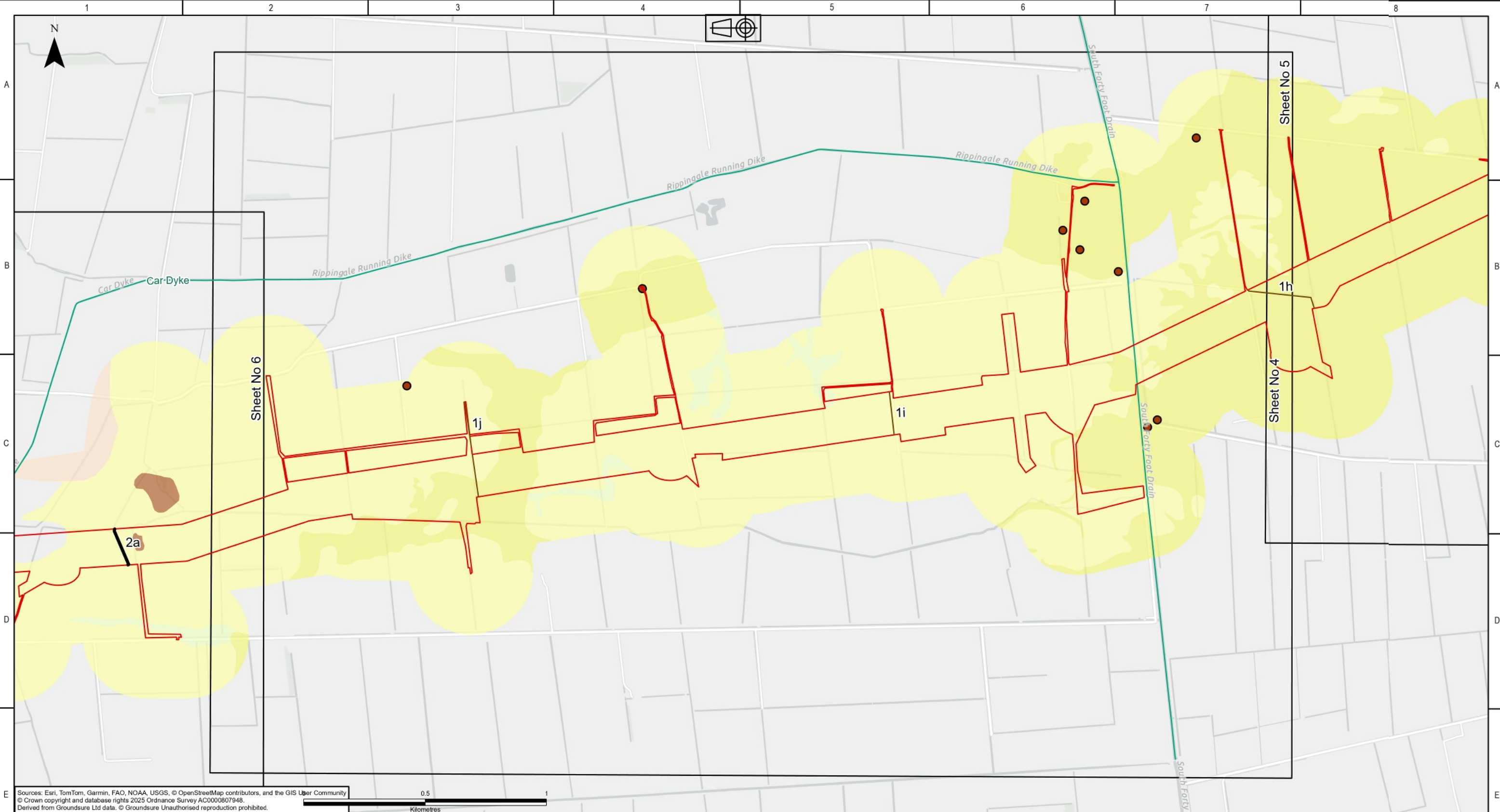
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Phase 1 Geotechnical and Geo-environmental Desktop Study:
Figure 3
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Contractor Drawing No. WMEL-AAJ-ZZZZ-XXXXXX-DRW-GE-000015	Revision P03
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Superficial Geology 50K**
- Peat-Peat
- River Terrace Deposits, 1-Sand and gravel
- Tidal flat deposits, 1-Clay and silt
- Tidal flat deposits, 1-Sand and silt
- Tidal flat deposits-Clay and silt

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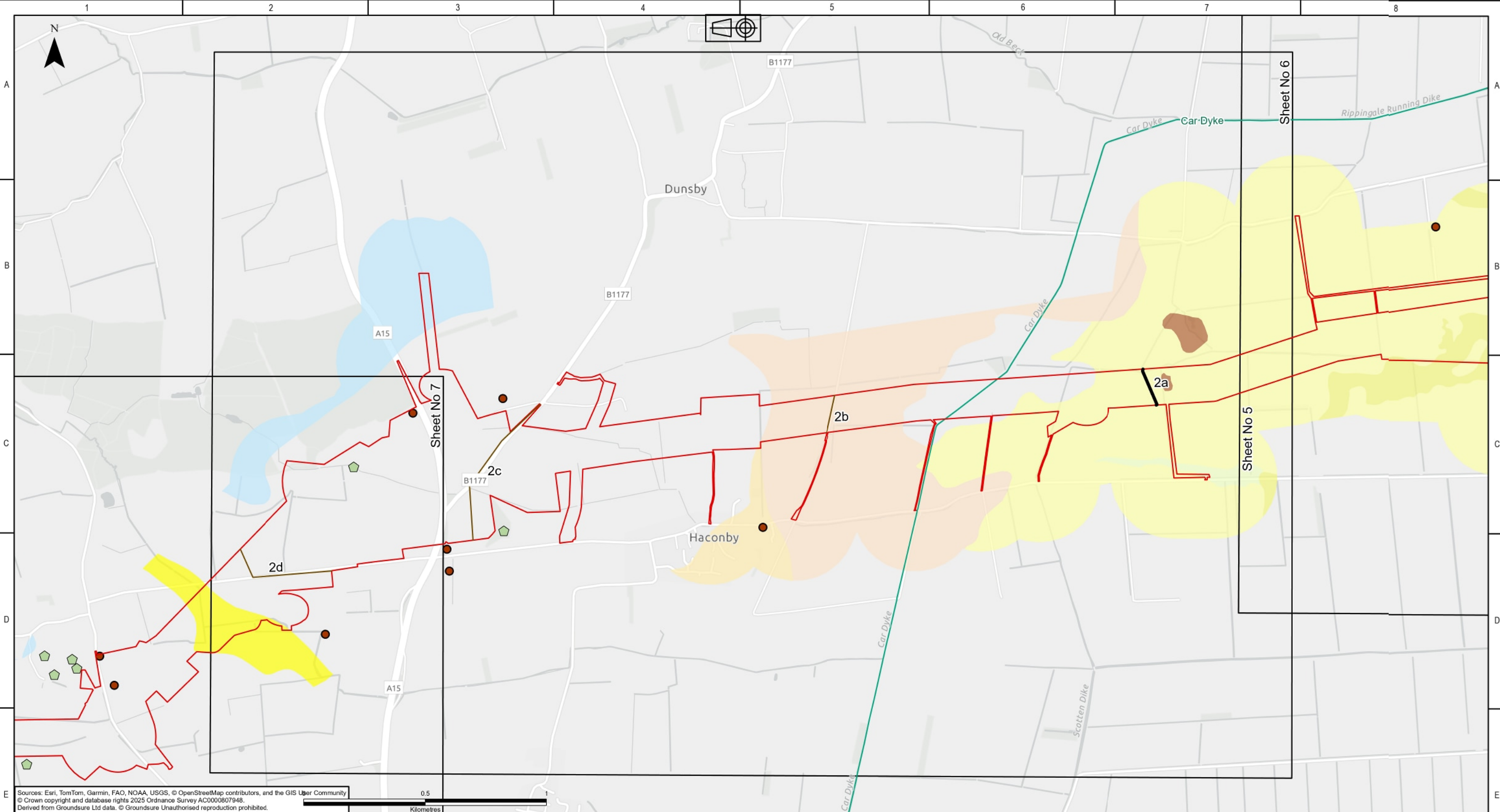
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Possible Swallow Hole
- Superficial Geology 50K
 - Alluvium-Clay, silt, sand and gravel
 - Glaciofluvial deposits, Mid Pleistocene-Sand and gravel
 - Peat-Peat
 - River Terrace Deposits, 1-Sand and gravel
 - Tidal flat deposits, 1-Clay and silt
 - Tidal flat deposits, 1-Sand and silt
 - Tidal flat deposits-Clay and silt
 - Till, Mid Pleistocene-Diamicton

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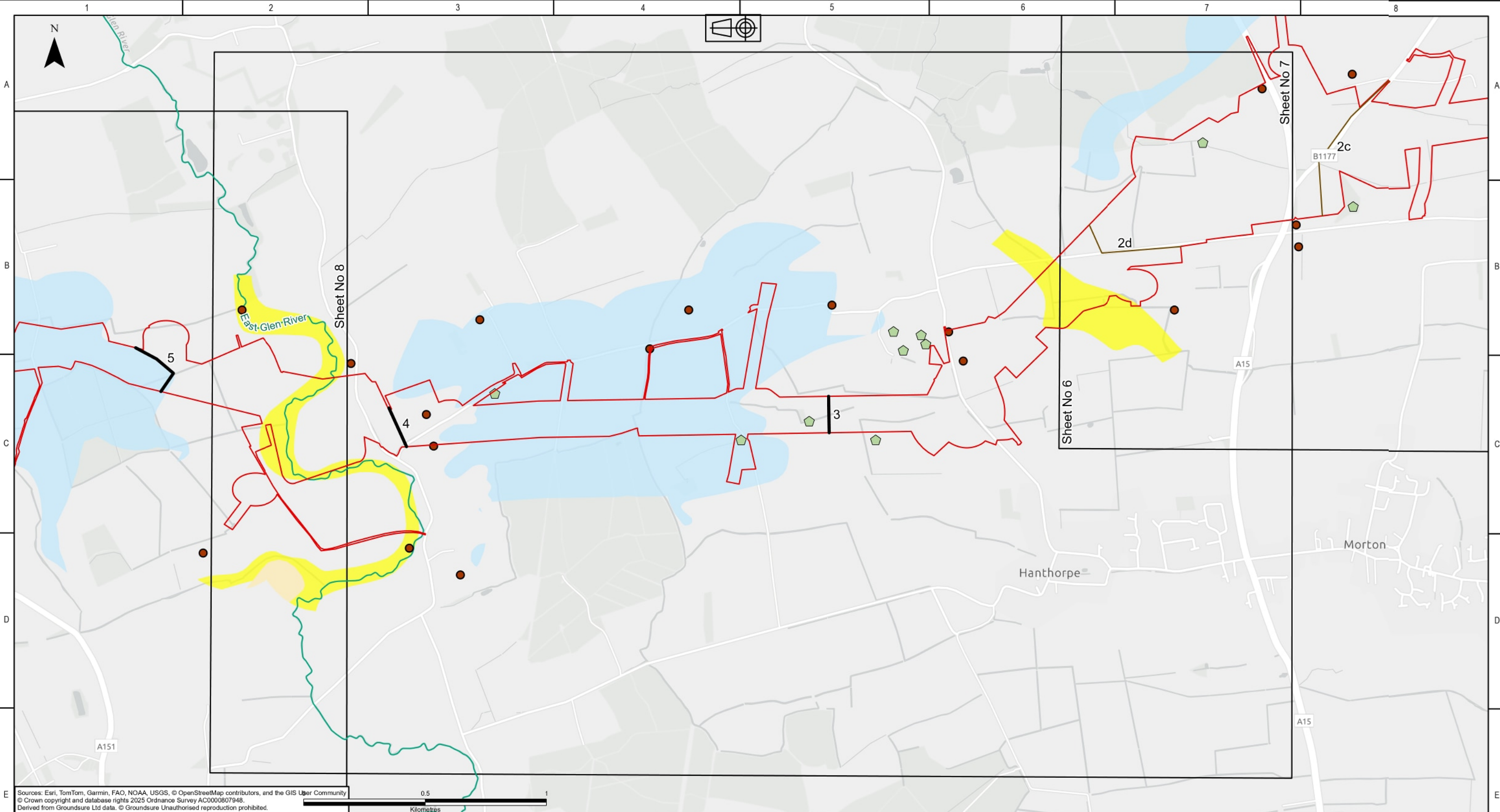
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Possible Swallow Hole
- Superficial Geology 50K
 - Alluvium-Clay, silt, sand and gravel
 - Glaciofluvial deposits, Mid Pleistocene-Sand and gravel
 - Till, Mid Pleistocene-Diamicton

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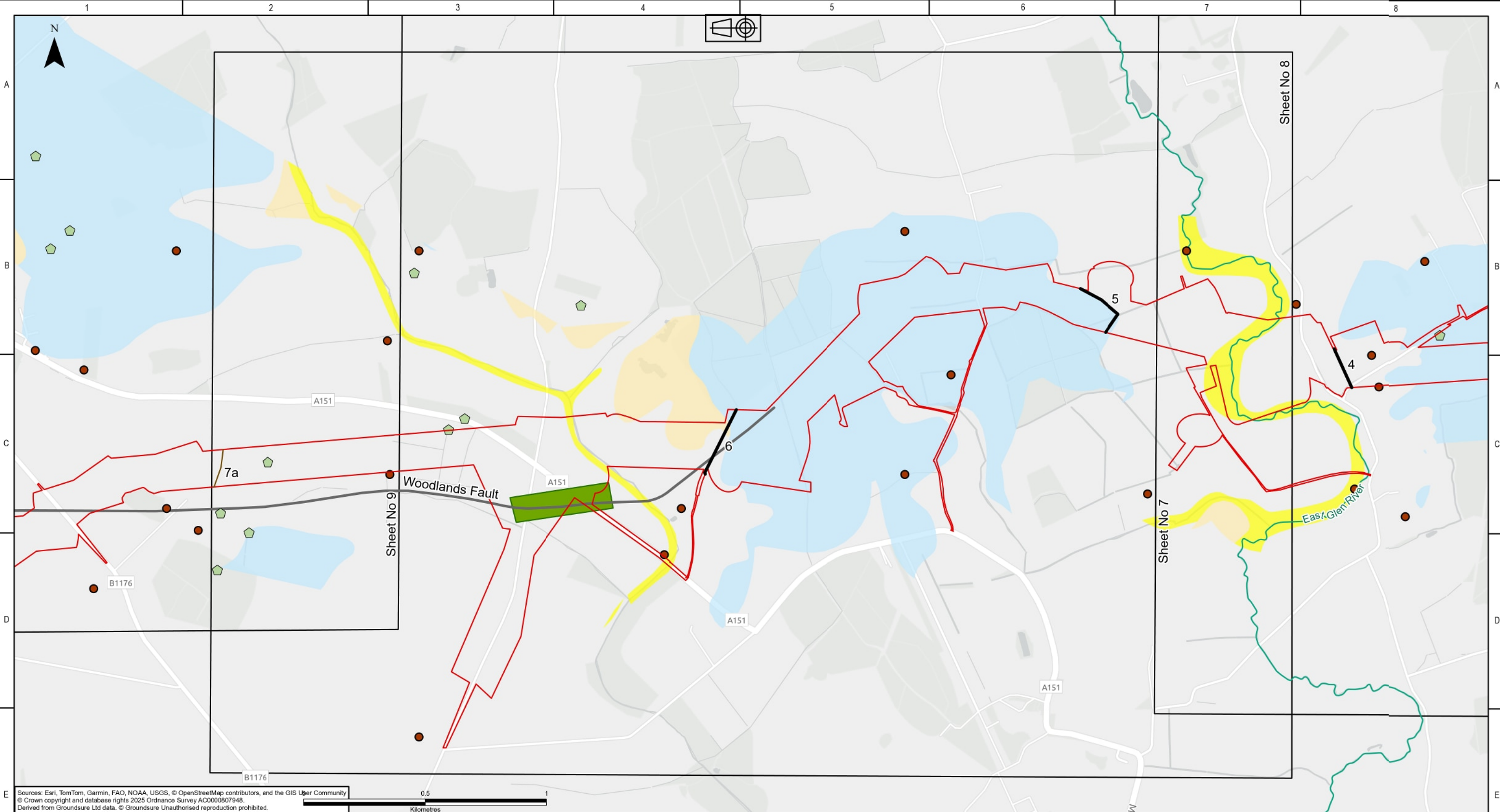
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KEY PLAN

Legend

- DF2 Rev B Boundary - Overhead Line Weston Marsh to WMEL-A
- Route Regions
- Route Sub-regions
- EA Main Rivers
- Historical BGS Boreholes
- Possible Swallow Hole
- Linear Features 50K
 - Fault, inferred, crossmark on downthrow side, throw in metres
 - Woodlands Fault Ridge Line
- Superficial Geology 50K
 - Alluvium-Clay, silt, sand and gravel
 - Glaciofluvial deposits, Mid Pleistocene-Sand and gravel
 - Till, Mid Pleistocene-Diamicton

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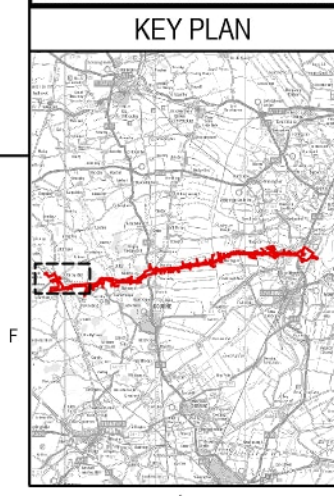
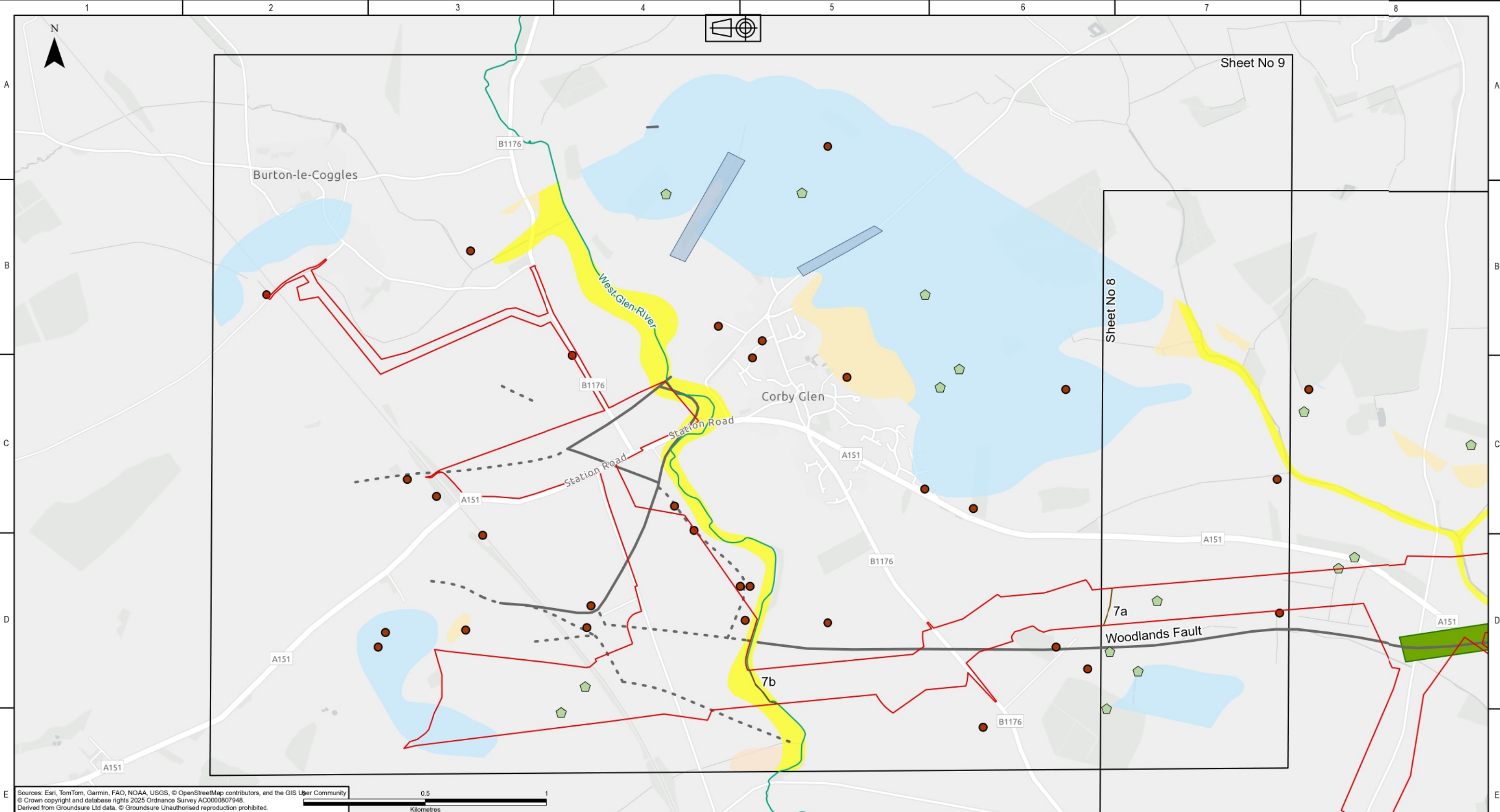
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Legend	
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	Route Regions
	Route Sub-regions
	EA Main Rivers
	Historical BGS Boreholes
	Possible Swallow Hole
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	Fault, observed, crossmark on downthrow side, throw in metres
	Possible Buried Channel
	Woodlands Fault Ridge Line
Superficial Geology 50K	
	Alluvium-Clay, silt, sand and gravel
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	Till, Mid Pleistocene-Diamicton

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