RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

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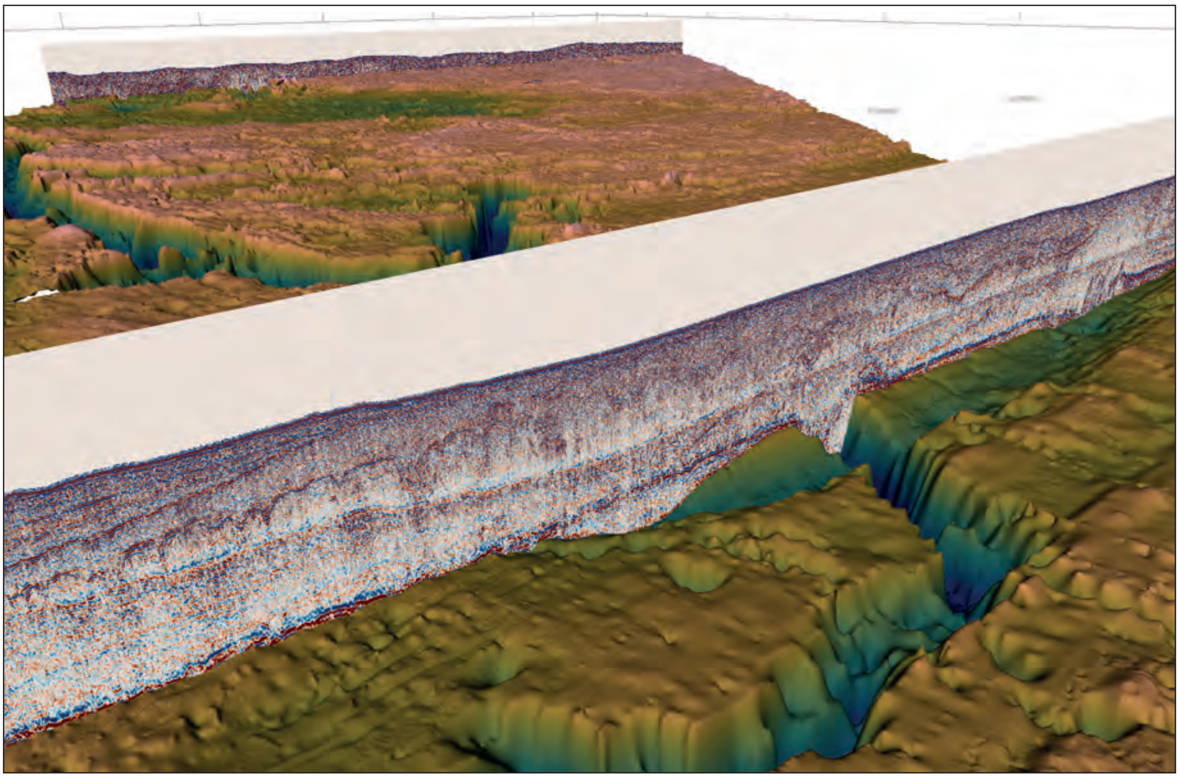
Dogger Bank South OWF Archaeological Assessment of Geophysical Data for EIA

Palaeolandscapes Assessment of 2022 Marine Geophysical Data



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Summary

Wessex Archaeology was commissioned by Royal HaskoningDHV to assess data acquired from the Dogger Bank South Offshore Wind Farm in advance of the proposed development.

This report comprises two phases of assessment. The first is an assessment of the 2022 geophysical data over the Array study area, and the second an assessment of the 2022 geophysical data over the Export Cable Route study area. The study areas for both phases are defined by the client-supplied Dogger Bank South offshore development area shapefile.

This report consists of an assessment of marine geophysical survey data comprising 2D Sparker-sourced seismic data and 2D parametric echosounder sub-bottom profiler data, acquired by Fugro in 2022. The aim of this assessment is to identify any palaeolandscape features of archaeological potential within the two study areas, to further inform the planning process ahead of the proposed development scheme.

The assessment of the geophysical data within the Dogger Bank South Offshore Wind Farm study areas resulted in a total of 171 palaeolandscape features identified as being of possible archaeological interest. There were 155 anomalies identified in the Array study area and 16 anomalies identified in the Export Cable Route study area. These are summarised as follows:

- a total of 122 features in the Array Area and 5 features in the Export Cable Route were assigned a P1 archaeological rating, meaning a feature of probable archaeological interest, either because of its palaeogeography or likelihood for producing palaeoenvironmental material;

- a total of 33 features in the Array Area and 11 features in the Export Cable Route were assigned a P2 archaeological rating, meaning a feature of possible archaeological interest.

These features include channels, basins, areas of bright reflections, mounds, clinoform wedges, cut and fills, fills, acoustic blanking, and erosional surfaces.

As the Dogger Bank area is geologically complicated and the depth of investigation covers multiple glacial/interglacial cycles, it is recommended that further geoarchaeological investigation is undertaken. Detailed stratigraphic, geomorphological, and sedimentological assessment integrating geophysics and geotechnics will help to constrain conceptual models of landscape evolution that in turn inform archaeological potential of palaeolandscape surfaces and features.

For features identified in the nearshore of the Export Cable Route, it is recommended that, should further geotechnical samples be acquired, specific identified features be targeted for archaeological purposes and the samples be made available for archaeological and environmental assessment.

Acknowledgements

This assessment was commissioned by Royal HaskoningDHV. Wessex Archaeology would like to acknowledge the assistance of Victoria Boothby and Claire Mellett of Royal HaskoningDHV throughout the project.

Dogger Bank South OWF Archaeological Assessment of Geophysical Data for EIA

Palaeolandscapes assessment of 2022 Marine Geophysical Data

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Royal HaskoningDHV to undertake an archaeological assessment of geophysical data as part of an Environmental Impact Assessment (EIA).

1.1.2 The Dogger Bank South (DBS) Offshore Wind Farm (OWF) is being developed by RWE and is located in the southern North Sea, offshore from the north-east of England (Figure 1). This work is to be submitted as part of the application for a Development Consent Order for the area. The Array Area (AA) comprises an area covering approximately 1042 km^2. The associated Export Cable Route (ECR) comprises an area covering approximately 351 km^2, and extends from the AA to landfall on the East Yorkshire coast, east of Skipsea.

1.1.3 The study areas for both areas are defined by the client-supplied Dogger Bank South offshore development area shapefile. The report consists of an assessment of geophysical survey data acquired by Fugro in 2022 comprising Sparker-sourced 2D Ultra High Resolution Seismic (UHRS) in the AA, and Parametric sub-bottom profiler (SBP) in the ECR. Parametric sub-bottom profiler data were also acquired in the AA but not assessed due to unsuitable depth of penetration.

1.1.4 This report comprises a palaeolandscape assessment of sub-bottom data, separated into the AA and ECR. In the AA, 3 km x 3 km grid of UHRS data were assessed. In the ECR, an initial centre line of data were assessed, with additional infill lines assessed across the width of the corridor (including both main lines and cross lines) where features of archaeological potential were identified.

1.1.5 The 2022 DBS AA survey data were assessed between August 2023 and September 2023 and the 2022 DBS ECR survey data were assessed between September 2023 and October 2023.

1.1.6 This report is intended to accompany the previously produced archaeological seabed features report for the same areas and development scheme (Wessex Archaeology 2023). No palaeolandscape features were identified or described in the seabed features report.

1.2 Aims and objectives

1.2.1 The aims and objectives of this assessment are:

- identify any buried palaeolandscape features of possible archaeological potential;
- provide recommendations for archaeological mitigation.

1.3 Co-ordinate system

1.3.1 The survey data collected by Fugro over both study areas were acquired in WGS84 UTM31N. The results are presented in WGS84 UTM31N.

2 METHODOLOGY

2.1 Data sources

2.1.1 A number of data sources were consulted during this assessment, including:

- geophysical survey datasets acquired by Fugro;
- client supplied survey reports (Fugro 2022a, b c, d, & e);
- client supplied vibrocore laboratory reports (Fugro 2023);
- Fugro contact lists and interpreted horizons supplied in Kingdom seismic interpretation software format supplied by the client.

2.2 Geophysical data – technical specifications

2.2.1 Geophysical data for the AA were acquired by Fugro in 2022 using the vessels *Fugro Searcher*, *Fugro Frontier* and the *Mainport Geo* (Fugro 2022a, b, c). The *Fugro Searcher* and *Fugro Frontier* collected the majority of data, with the *Mainport Geo* undertaking a coarse grid of data across the area (Fugro 2022b, i).

2.2.2 The AA was split into 31 Blocks for survey data collection (Fugro 2022b, 1). Blocks 1-23 were surveyed in the primary line direction of NNW by SSE and Blocks 24-31 were surveyed as crosslines oriented ENE by WSW (Fugro 2022b, 1). For this report the data will be assessed as one area, Blocks will not be used as subdivisions.

2.2.3 The *Mainport Geo* acquired data between 21 April and 15 May, and surveyed a broad grid of data with 1 km line spacing (Fugro 2022a). The *Fugro Searcher* acquired data between 07 August and 10 September for Blocks 1-5 at a line spacing of 100 m (Fugro 2022b). The *Fugro Frontier* acquired data between 22 May and 23 October for Blocks 6-23 at a line spacing of 100 m (Fugro 2022c). Both the *Fugro Searcher* and the *Fugro Frontier* acquired crosslines in blocks 24-31.

2.2.4 Geophysical data were acquired throughout the offshore ECR study area (Block B, C, E, F) by Fugro onboard the vessel *Fugro Discovery* between 15 June 2022 and 21 July 2022 at a line spacing of approximately 100 m. There were some areas in Blocks B and F that had a line spacing of 65 m due to a change in water depth to ensure complete coverage (Fugro 2022e). Further details on the equipment used is in Table 1.

2.2.5 The nearshore geophysical data covering Block A were acquired by Fugro on board survey vessel *Valkyrie* between 22 June 2022 and 31 July 2022. The line spacing was between 15 and 35 m depending on water depth (Fugro 2022d).

Table 1 Summary of survey equipment

Survey Company	Survey Vessel	Data Type	Equipment	Data Format
Fugro	*Mainport Geo*	UHRS	Fugro Multilevel Stacked Sparker (3 layers 360 tip)	SEG-Y
		Positioning	Fugro StarPack GNSS receiver with Starfix.G4 corrections	N/A
	Fugro Searcher	UHRS	Fugro multi-level stacked Sparker, (360 tip) fitted with Fugro RTKPod with MRU	SEG-Y

Survey Company	Survey Vessel	Data Type	Equipment	Data Format
		Positioning	Fugro StarPack GNSS receiver with Starfix.G4+ corrections	N/A
	Fugro Frontier	UHRS	Fugro Multilevel Stacked Sparker (3 layers 360 tip)	SEG-Y
		Positioning	Fugro StarPack GNSS receiver with StarFix.G2+ corrections	N/A
	Fugro Discovery	SBP	Innomar SES-2000 Medium Parametric sub-bottom profiler	SEG-Y
		Positioning	Fugro StarPack GNSS receiver with StarFix G2+ and XP2 corrections	N/A
	Valkyrie	SBP	Innomar SES-2000 Medium Parametric sub-bottom profiler	SEG-Y
		Positioning	Fugro StarFix DGNSS	N/A

2.3 Geophysical data – interpretation

2.3.1 The following software was used to interpret SBP and UHRS data (Table 2):

Table 2 Software used for geophysical assessment

Dataset	Interpretation Software	Further interpretation
SBP	CodaOctopus Survey Engine v8.6	ArcMap v10.8.1
UHRS	The Kingdom Software 2022	QGIS v3.28 Firenze

2.3.2 The SBP and UHRS data were used as the primary datasets for the palaeolandscape assessment, with additional multibeam echosounder (MBES) data used in the nearshore area (see the associated seabed features report, Wessex Archaeology 2023, for details on the MBES survey and equipment specifications), where some features of palaeogeographic interest were visible at seabed. Elsewhere in the ECR, marine sediments were present at seabed, so no palaeolandscape features were present in the MBES. In the AA, UHRS data were used in a 3 x 3 km grid to interpret palaeolandscape features. Features were interpreted to approximately 70 mBSB (metres below seabed) to account for potential monopile depths. Seismic Two-Way Time (TWT) relative to Lowest Astronomic Tide (LAT) was used to interpret features, as depth conversion of the seismic data is not possible without a velocity model. For shallow sub-bottom (e.g. <5 m), a typical conversion velocity of 1,600 m/s is frequently used. Due to the complicated nature of the geology in this region of the North Sea, a single conversion velocity is overly simple for these depths (Cotterill et al., 2017a), but a velocity of 1,600 m/s was used to give an estimate of depth of the interpreted palaeolandscape features in mBSB in the gazetteer.

2.3.3 SBP data were not interpreted in the AA. The depth of penetration (~5-10 mBSB) is not suitable for interpretation of palaeolandscapes features down to monopile depth (~70 mBSB), and marine sand covers the site in many places. The UHRS data were of good enough quality to allow for interpretation of palaeolandscapes features at all depths, therefore the SBP in the AA was deemed unnecessary.

2.3.4 Palaeolandscape assessment was undertaken independent of Fugro interpretations provided with the dataset. However, interpretation of seismic profiles was guided by horizons already interpreted by Fugro. These horizons were interpreted in a seismic stratigraphic sequence, which does not necessarily correlate to a set of chronostratigraphic landscape surfaces. Whilst these surfaces are a useful guide, the actual palaeolandscape interpretation does not rely on the Fugro-interpreted stratigraphy. For each landscape stage (see section 3.2), an individual horizon was created in Kingdom, and exported for further spatial analysis in QGIS. Key Fugro horizons (e.g. H10, H20, H30, H40, H50) were also exported to guide the spatial analysis and fill in gaps in the interpretation of the 3 x 3 km grid.

2.3.5 In the ECR, SBP data were processed using CodaOctopus Survey Engine Seismic+ software. This software allows the data to be visualised with user selected filters and gain settings in order to optimise the appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting sedimentary boundaries and shallow geological features that might be of archaeological interest.

2.3.6 The SBP data were interpreted with a TWT along the z-axis. In order to convert from TWT to depth, the velocity of the seismic waves was estimated to be 1,600 ms^{-1}. This is a standard estimate for shallow, unconsolidated sediments, and is considered appropriate for assessment of data at shallow depths.

2.3.7 Any palaeogeographic features of archaeological potential were tagged along individual survey lines, and the results exported and viewed in ArcGIS. The final interpretation, comprising mapped extents of the identified features, was created within ArcGIS. The data interpretation was particularly focussed on the upper 5 m of sediment along the ECR, deemed to be a standard maximum depth of sediment disturbance during cable laying.

2.3.8 In addition to the SBP data, the MBES data were visually assessed in ArcGIS and QPS Fledermaus for any exposed and/or underfilled palaeolandscape features in the nearshore area. The extents of any identified features were also mapped in ArcGIS.

2.4 Geophysical data – data quality

2.4.1 Once processed, the geophysical data sets were individually assessed for quality and their suitability for archaeological purposes, and rated using the following criteria (Table 3).

Table 3 Criteria for assigning data quality rating

Data quality	Description
Good	Data which are clear and unaffected or only slightly affected by weather conditions, sea state, background noise or data artefacts. Seabed datasets are suitable for the interpretation of upstanding and partially buried wrecks, debris fields, and small individual anomalies. The structure of wrecks is clear, allowing assessments on wreck condition to be made. Subtle reflectors are clear within SBP data. These data provide the highest probability that anomalies of archaeological potential will be identified.
Average	Data which are moderately affected by weather conditions, sea state and noise. Seabed datasets are suitable for the identification of upstanding and partially buried wrecks, the larger elements of debris fields and dispersed sites, and larger individual anomalies. Dispersed and/or partially buried wrecks may be difficult to identify. Interpretation of continuous reflectors in SBP data is problematic. These data are not considered to be detrimentally affected to a significant degree.
Below Average	Data which are affected by weather conditions, sea state and noise to a significant degree. Seabed datasets are suitable for the identification of relatively intact, upstanding wrecks and large individual anomalies. Dispersed and/or partially buried wrecks, or small isolated anomalies may not be clearly resolved. Small palaeogeographic features, or internal structure may not be resolved in SBP data.
Variable	This category contains datasets where the individual lines range in quality. Confidence of interpretation is subsequently likely to vary within the study area.

2.4.2 The quality of the UHRS data has been rated as 'Good' using the above criteria. Reflections are able to be interpreted to far below the required 70 mBSB depth of investigation. Seabed multiples are present, but have been suppressed during seismic processing. The seabed reflection is strong, but the simple wavelet does not mask the near seabed (<0.5 m), therefore near-seabed features are also well resolved.

2.4.3 The quality of the SBP data has been rated as 'Good' using the above criteria. Penetration of the equipment was relatively limited in some areas, but that is a limitation of the equipment used and the shallow depth of the top of bedrock in places along the ECR. UHRS data were not acquired along the ECR.

2.5 Geophysical data – palaeolandscape feature discrimination

2.5.1 After initial observation and geophysical interpretation of the sub-bottom data, palaeolandscape features are interpreted in a geological and stratigraphic context in order to be assigned an archaeological discrimination. These discriminations are described in Table 4.

Table 4 Criteria discriminating relevance of identified features to proposed scheme

Overview classification	Discrimination	Criteria	Data type
Archaeological	P1	Feature of probable archaeological interest, either because of its palaeogeography or likelihood for producing palaeoenvironmental material	SBP, UHRS, MBES
Archaeological	P2	Feature of possible archaeological interest	SBP, UHRS, MBES

2.5.2 The discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment for further evaluation should more information become available.

3 PALAEOLANDSCAPE ASSESSMENT

3.1 Geological baseline and archaeological potential

3.1.1 This section provides a brief overview of the current knowledge of the geological history of the study area, and any associated archaeological potential. A more in-depth baseline is provided in Cotterill *et al.* 2017b.

3.1.2 The Dogger Bank South development areas are situated on the southern tip of Dogger Bank, a present-day bathymetric high located in the southern North Sea. Unlike many areas of the North Sea, the Dogger Bank South region has not been extensively exploited by the offshore oil and gas industry, and as a result has not been studied in high resolution. The Round 3 Dogger Bank areas to the north (presently Dogger Bank A, B, C and D, and Sofia) have been studied in detail since initial Round 3 surveys in 2010 (e.g. Wessex Archaeology 2013, 2014, 2020, 2022a, 2022b, Cotterill *et al.* 2017b, Phillips *et al.* 2018, 2022, Emery *et al.* 2019a, b, 2020, Roberts *et al.* 2018a). These high-resolution surveys, and studies carried out on the resulting data, have revealed Dogger Bank to be much more geologically complex than was previously thought. Based on these high-resolution surveys associated with the development of the Dogger Bank wind farms, the lithostratigraphic framework for the Dogger Bank region has been updated, and is applicable to the Dogger Bank South region (Cotterill *et al.*, 2017; Table 5).

Table 5 Lithostratigraphy framework for deposits in the Dogger Bank region, modified from Cotterill *et al.* (2017b), Emery et al. (2019a, 2019b, 2020), and Wessex Archaeology (2020, 2022a, 2022b).

Era	Formation	Description/depositional environment	Archaeological potential
Holocene [MIS 1]	Bligh Bank	Modern mobile sands (marine)	Considered of low potential in itself, but possibly contains re-worked artefacts and can cover wreck sites and other cultural heritage
	Indefatigable Grounds	Gravelly sands and sandy gravel, lag deposit (marine)	
	Nieuw Zeeland Gronden Terschellinger Bank	Muddy fine-grained sand and shelly shallow marine sands (marine)	
	Well Hole	Laminated sand and sandy mud, infills depressions (shallow marine)	
	Elbow	Muddy sand and interbedded clay, and basal peat (transitional terrestrial to shallow marine), coastal and shoreface sands, peats, and intertidal muds (coastal)	Potential to contain *in situ* and derived archaeological material, and palaeoenvironmental material
Weichselian [MIS 5d-2]	Botney Cut	Stiff to soft glaciomarine to glaciolacustrine muds (glacial), channel fills, peats, and organic-rich alluvial sediments (terrestrial)	Glaciomarine deposits considered to have low potential. Glaciolacustrine deposits have potential to contain *in situ* and derived archaeological material, and palaeoenvironmental material.
	Volans	Clay with variable silt, sand and gravel content (glacial)	Considered low but has potential to bury deposits of interest or to contain reworked material.
	Bolders Bank	Firm to stiff silty sandy gravelly clay (glacial)	
	Dogger Bank	Very heterogenous deposits. Includes clay with variable silt, sand and gravel content (glacial) and dense sand in areas (aeolian or periglacial). Organic matter and shell	Considered low but has potential to bury deposits of interest or to contain reworked material.

Era	Formation	Description/depositional environment	Archaeological potential
		fragments have been recorded indicating possible sub-aerial exposure. Can contain shell fragments.	
Eemian [MIS 5e]	Eem	Shelly sands, can be muddy in places (marine)	
Saalian [MIS 6]	Tea Kettle Hole	Fine-grained sand with organics (periglacial and aeolian)	Potential to contain *in situ* and derived archaeological material, and palaeoenvironmental material.
	Cleaver Bank	Laminated clays and/or fine-grained sand (marine to proglacial)	Considered low but has potential to bury deposits of interest or to contain reworked material
Holstenian [MIS 11?]	Egmond Ground	Gravelly sands interbedded with silt and clay (marine)	

Pre-Quaternary (>2.5 Ma; >MIS 104)

3.1.3 The North Sea Basin within which Dogger Bank is situated is a multi-stage rift zone, with extensional phases followed by thermal subsidence from the Palaeozoic to the Holocene (Cameron *et al.* 1992). Gradual overall subsidence of this rift zone over time has enabled the accumulation of thick sequences of deposits within the centre of the North Sea (Ottesen *et al.*, 2018). This has resulted in a longer, much more complex geological history being represented in the Dogger Bank region than more nearshore areas.

3.1.4 The pre-Quaternary geology of Dogger Bank comprises Upper Cretaceous chalk overlain by sequences of Tertiary shallow marine sands, silts and clays (Cameron *et al.* 1992). Continued subsidence during the Cenozoic resulted in the deposits of this age being up to 7 km thick in the Dogger Bank area, up to 1 km of which comprise Quaternary sediments (Ottesen *et al.*, 2018).

Lower Pleistocene to Eemian (c. 2.5 Ma – 115 ka; MIS 104 – 5e)

3.1.5 The Quaternary geological history of the southern North Sea is directly linked to glacial/interglacial cycles experienced by the area during the Pleistocene, which resulted in large areas of the southern North Sea being periodically exposed as a terrestrial environment. This is represented in the geological record, with distinct terrestrial landscape features being present, interspersed with deposits of marine and glacially derived sediments.

3.1.6 Due to these fluctuations of glaciations, the corresponding rises and falls in global mean sea level, and major reconfigurations of the landscape during the last million years, the archaeological record is phased between periods of occupation and long periods of hiatus when environmental conditions or high sea levels restricted access to Britain (Figure 2).

Eemian to Last Glacial Maximum (c. 115 ka – 23 ka; MIS 5e – 2)

3.1.7 The formation of Dogger Bank as a topographic high occurred during the last interglacial period, formed of marine sediments deposited in a delta system prograding northwards (Emery *et al.*, 2019a). Eemian (~MIS 5e) interglacial marine deposits, such as shelly sands, are present in the Dogger Bank region underlying the latest phase of glacial sediments. This topographic high was overridden by the ice sheet, and the topography was further raised through deposition of glaciogenic sediments and glaciotectonic activity. This phase of glaciation occurred at a confluence of the British-Irish and Fennoscandian ice sheets at some point between 32 ka BP (Phillips *et al.* 2017; Roberts *et al.* 2018a), and deglaciation, which had occurred in the northern section of Dogger Bank by 23 ka BP (Roberts *et al.*, 2018a; Emery *et al.* 2019a). The Dogger Bank South region is located across the transition from the topographic high of Dogger Bank to the lower elevations to the south and west. In the south and west, less thick accumulations of glaciogenic sediments are anticipated. The DBS region is located at the margin of the fast-flowing North Sea Lobe ice stream that initiated after initial ice advance over Dogger Bank and persisted after ice had retreated northwards from Dogger Bank (Roberts *et al.*, 2018b). The margin of this ice stream may have been the source of intense shearing of previous deposits, potentially reworking previous archaeological sites. However, the persistance of this ice stream to the south of the DBS area may have also formed complicated and frequently-changing drainage networks throughout the DBS area.

3.1.8 Once thought to comprise a single Dogger Bank Formation, it is now known that Dogger Bank is composed of deposits resulting from a number of depositional cycles, including clay till, sandy glacial outwash, and glaciofluvial channel deposits. This cyclic deposition is likely to have been controlled by repeated oscillation of the Weichselian ice front, a process which has also resulted in repeated compression and associated glaciotectonic deformation of the sediments (Cotterill *et al.* 2017b). This has resulted in the formation of a large part of the Dogger Bank that is present today: an isolated, elevated push moraine complex within the generally low-lying Southern North Sea Basin.

Post-Last Glacial Maximum and early Holocene (23,000 – 6000 BP; MIS 2 – 1)

3.1.9 An additional result of the repeated compression and uplift is that Dogger Bank appears to have been a mainly terrestrial environment throughout its formation, even during periods when the surrounding areas may have been submerged or located beneath ice sheets. After deglaciation and retreat of the Weichselian ice sheet, a network of channels developed in a subaerial setting, incising into the underlying glacial deposits. Parts of this channel network were mapped during The North Sea Palaeolandscapes Project (Fitch *et al.* 2005; Gaffney *et al.* 2007, 2009), and have since been mapped in detail by others (Wessex Archaeology 2012; 2013; Emery *et al.* 2020). The channel network formed at some point between deglaciation at 23 ka BP and final marine inundation of Dogger Bank at ca. 8 ka (Emery *et al.*, 2020, Emery *et al.*, in prep).

3.1.10 Pollen taken from the Sofia site indicates a period of Lateglacial tundra vegetation observed in proglacial clay, dominated by sedges and grasses with limited shrubs and trees. The precise age of this vegetation is unknown, but it is likely to have been present shortly after ice sheet retreat (Wessex Archaeology 2022a). Geoarchaeological investigations to the north of DBS have revealed channel networks that were active during the Early Holocene (Wessex Archaeology 2012, 2020, 2022a). The pollen preserved in palaeochannel sediments suggests this Early Holocene landscape was characterised by mixed deciduous woodland with areas of heath and open ground (Wessex Archaeology 2012).

3.1.11 There is also evidence for the preservation of peat deposits on Dogger Bank (Wessex Archaeology 2013, 2022a, 2022b; Russell and Stevens 2014). Peat at the Sofia site was dated to ~12,900-13480 cal BP and found to contain birch, pine, alder, pal, elm, and willow, indicating the establishment of woodlands by this time (Wessex Archaeology 2022a). Pollen preserved in peat deposits recovered during benthic trawling provide evidence for bog, wooded fen, reed marshland/fen, sedge marshland/fen and coastal habitats. In the absence of radiocarbon dated samples, these peat deposits are expected to have formed during the Early Holocene, possibly in and around the margins of an extensive palaeochannel network. Pollen analysis from a channel deposit 32 m below seabed indicates the presence of a terrestrial woodland environment at the site during the Early Holocene, with a similar woodland environment being interpreted during the Mesolithic Period (Wessex Archaeology 2012). During this time, Dogger Bank would have been the northern part of the previously identified Doggerland, an extensive terrestrial plain that covered a large section of the Southern North Sea between south and east England and the continent (Coles 1998; Fitch *et al.* 2005; Gaffney *et al.* 2007, 2009).

3.1.12 Kettle holes are interpreted to have formed on Dogger Bank to the north of the DBS site (Wessex Archaeology 2014, Cotterill et al., 2017). Geoarchaeological investigation of these kettle holes, including pollen studies and radiocarbon dating, shows waterlogged plants and pollen remains (e.g. sedges and rushes) with some shrub and tree species, similar to the pollen assemblages seen at Sofia. These plants were present during the Windermere/Bølling-Allerød Interstadial, radiocarbon dated to 14,890-14,010 cal BP. Similar kettle holes could be present at the DBS site preserving early vegetation remains. Glaciolacustrine units from earlier in the evolutional history of the landscape are currently being studied for plant remains.

3.1.13 The remains of this terrestrial landscape are frequently recovered by dredging and fishing in numerous areas within the Southern North Sea, generally in the form of the remains of extinct megafauna such as mammoths and other large terrestrial mammals. The discovery of actual human artefacts is a rarer occurrence, but some isolated artefacts such as worked flint and antler bone have been recovered from areas in the Southern North Sea (e.g. Area 240, Roberts et al. 2023), but no finds from Dogger Bank itself (NSPRMF 2023).

3.1.14 The palaeochannel and wetland sediments preserved at Dogger Bank have the potential to preserve both archaeological and palaeoenvironmental material and are therefore of archaeological interest. They also represent a significant period of sub aerial exposure when the landscape would have been suitable for hominin occupation. Understanding the palaeolandscape evolution of Dogger Bank in relation to potential pathways of hominin migration into Britain after the Last Glacial Maximum is a key focus of national research agendas (English Heritage 2008; Petters *et al.* 2009, Ransley *et al.* 2013, NSPRMF 2023).

3.1.15 The same archaeological potential of post-glacial features is potentially the case for features at or close to the ECR landfall. Withow Gap at Skipsea, within the coastal landfall study area, is a Site of Special Scientific Interest (SSSI) relating to the late glacial and post glacial history of the area. Skipsea Withow Mere is the remains of a post-glacial mere exposed in the cliffside at Skipsea containing a sequence of preserved peat, logs, gyttja, and minerogenic lake deposits, and has been dated to between 9,880 and 4,500 BP (Hull Geological Society 2011, Humber Archaeology 2013).

3.1.16 There have previously been reports of a bone barbed point being recovered from the area in 1903, and the remains of red deer, potentially a result of human hunting, being discovered associated with the deposits in 2012 (although these two accounts are subject to interpretation) (Cadman *et al.* 2018). Skipsea Withow mere is just one of several present and historic meres in the area, including the archaeological site of Star Carr located approximately 10 km south-west of the proposed landfall. As this part of the coastline is eroding rapidly, there is the potential for the remains of other partially eroded similar features to be present within the nearshore area.

3.1.17 Gradual but continuous relative sea level rise after the last glacial maximum (LGM) eventually inundated all of Doggerland, with the relative topographic high of Dogger Bank being one of the last areas of to be fully submerged. Reconstructed sea level curves combined with recent radiocarbon dates indicate this final inundation is likely to have occurred around 8 ka BP (Shennan and Horton 2002, Wessex Archaeology 2012, Sturt *et al.* 2013, Emery et al., in prep).

3.2 Palaeolandscape assessment results

3.2.1 A number of palaeolandscape features of archaeological potential have been identified across both the DBS AA and ECR. These features are discussed below, individually described in gazetteer format in Appendix 1, and their distribution is illustrated in Figures 3-9.

3.2.2 The identified geology within the study area has been divided into 8 seismic units, as described below:

Table 6 Stratigraphy of the study area up to 70 mBSB, based on lithostratigraphic framework of Stoker *et al.*, 2011 and Cotterill *et al.*, 2017b.

WA unit	WA unit name	Seismic character	Age	Interpreted formation (after Stoker et al., 2011; Cotterill et al., 2017b)
8	Marine	Generally low amplitude to acoustically transparent sheets, with some internal reflections	MIS 1 (Late Holocene)	Bligh Bank
7	Coastal	Thin wedges and sheets of high-amplitude reflections (offshore) Variable potentially preserved coastal and terrestrial deposits associated with erosion surfaces and channel cuts with acoustically layered fills (nearshore)	MIS 1 (Early Holocene)	Nieuw Zeeland Gronden, Terschellinger Bank
6	Alluvial	Variable fills of channel forms, acoustically transparent, low amplitude draped, or high amplitude draped	MIS 2-1 (Late Pleistocene-Holocene)	Botney Cut and unnamed alluvial formations
5	Proglacial outwash	Generally acoustically transparent to low amplitude parallel reflections in wedge form or filling basins in topography formed by previous unit	MIS 2 (Weichselian glacial)	Bolders Bank/Upper Dogger Bank
4	Glacial and subglacial sediments	Chaotic discontinuous reflections with varying amplitude in thick sheets or mounds with irregular top unit topography	MIS 3-2 (Weichselian glacial)	Bolders Bank/Lower Dogger Bank
3	Interglacial marine	High-amplitude, medium frequency continuous parallel reflections with channel forms incised into the unit	MIS 5 (Eemian interglacial)	Eem
2	Tunnel Valley complex	Variable fills of deep channel forms, generally acoustically transparent to low amplitude chaotic fills.	MIS 12-6 (Elsterian to Saalian glacials)	Tea Kettle Hole, Cleaver Bank, Egmond Ground
1	Basement	Low to medium amplitude continuous, low frequency reflections	Pre-MIS 12-6	Yarmouth Roads or older

3.2.3 The features of archaeological potential identified within the different units have also been assigned a landscape stage based on their position within the lithostratigraphic framework. This is to better place the features of interest within a framework of landscape development over time, and is explained below.

3.2.4 Unit 1 forms the basement to the area and is not described in detail here. Unit 1 comprises any formation that the tunnel valleys of Unit 2 are incised into. Unit 1 may have palaeolandscape surfaces of archaeological potential within it but the age of these is unknown and due to their depth below the depth of investigation for this study are considered out of scope. The exception is along sections of ECR, where Unit 1 comprises in places Jurassic sandstone and mudstone and Cretaceous Chalk that is either just below or at seabed. However, these are also too old to be of archaeological potential, but their upper layer may once have provided a palaeolandscape surface.

3.2.5 Unit 2 is a series of deeply incised, generally V-shaped valleys that sit below the parallel reflections of Unit 3. These valleys are interpreted to be subglacial tunnel valleys formed at an earlier stage of glaciation to the Weichselian glaciation. These tunnel valleys may have been partially filled with sediment during a time of subaerial exposure, and therefore may have archaeological potential. These tunnel valleys are assigned Landscape Stage 0 in this study (see Table 7)

3.2.6 Unit 3 is interpreted to represent marine deposits of the Eem Formation deposited during the Eemian interglacial. Unit 3 has channels incised into it, which implies a period of subaerial exposure and is considered to have archaeological potential. The exact timing of this exposure is unknown, but may correlate to sea-level lowstand during MIS 5d, 5a, or 4, assuming the DBS area was ice free during this glacial period. The palaeolandscape features present at this stratigraphic interval are assigned Landscape Stage I in this study (Table 7).

3.2.7 Units 4 and 5 are both glacial units that are considered to have low archaeological potential. However, the top surface of the glacial deposits will have formed a palaeolandscape surface, which is observed in the data as a widespread, distinct erosional reflector, is likely to have represented a terrestrial land surface into which other features (e.g. palaeochannels) are incised, and upon which archaeological material may have been deposited.

3.2.8 Unit 6 represents a phase of fluvial and lacustrine activity that occurred after glacial retreat, assigned Landscape Stage II in this study (Table 7). These are usually found incised into Units 4 and 5, or found in low points in the topography formed at the top surface of Units 4 and 5. This unit has potential to preserve palaeoenvironmental and archaeological material, and are of high archaeological interest.

3.2.9 Unit 7 was deposited onto the former land surface during Holocene marine transgression. Palaeolandscape features formed during this time are assigned Landscape Stage III (Table 7). This unit has high archaeological potential.

3.2.10 Unit 8 represents fully marine sediments deposited after marine transgression, and therefore have low archaeological potential. However, these deposits may protect archaeological sites present on former landscape surfaces from marine erosion.

3.2.11 Table 7 summarises the palaeolandscape features interpreted from the dataset. The number of features observed in the AA and ECR is also given. The individual palaeolandscape features are described in greater detail in the gazetteer in Appendix 1, and summarised by area below.

Table 7 Palaeolandscape features observed and the stratigraphic level they are observed at.

Landscape Stage	WA Unit	Palaeolandscape features observed	Number of features observed	
			AA	ECR
III	7	Mound	19	1
		Clinoform wedges	14	-
		Fill	1	-
		Bright reflection	8	-

Landscape Stage	WA Unit	Palaeolandscape features observed	Number of features observed	
			AA	ECR
		Channel	-	1
		Erosion surface	-	3
		Cut and fill	-	4
		Acoustic blanking	-	1
II	6	Channel	15	2
		Basin	1	-
		Bright reflection	7	-
		Cut and fill	-	4
I	3	Channel	77	-
		Basin	7	
0	2	Channel	5	-
		Total	**153**	16

Array Area palaeolandscape features

<u>Stage 0</u>

3.2.12 Five channel features were interpreted from the datasets at Landscape Stage 0 (Figure 3). These features are generally wide (> 1 km) and deep (10 s to 100 s) with a relatively symmetrical V-shaped profile. There is no single trend of orientation of these valleys, and some features crosscut, implying multiple formational phases. These features are interpreted to be tunnel valleys formed subglacially during a glacial phase prior to MIS 5. The fill patterns of these tunnel valleys are highly stratigraphically complicated, and based on this study of the 3 x 3 km grid it is not possible to determine when the valleys became filled with sediment, nor the sedimentary environment during filling. It is therefore possible that these tunnel valleys became rivers or lakes in a subaerially exposed landscape, but it is not possible without further geoarchaeological investigation to establish at this stage. Because of this, these features have been given a P2 archaeological discrimination as features of possible archaeological interest, especially for those parts of features within foundation depth (Table 4).

3.2.13 Features at Landscape Stage 0 range from 26.4 to 156 mBSB, and are therefore anticipated to be reached by turbine foundations. Shallower sections of features could be penetrated by boreholes for further investigation.

<u>Stage I</u>

3.2.14 Two types of palaeolandscape feature of archaeological interest were interpreted from the datasets at Landscape Stage I, channels and basins. A total of 77 channel features were interpreted as being incised into MIS 5e marine sediments. These form a complicated network, and are seen flowing into or out of the seven basin features.

3.2.15 Three distinct morphologies of channels are observed, a straight, narrow (generally <300 m) set, a sinuous to meandering set (generally 500-1000 m wide), and a very wide (>1 km) relatively straight set. The straight and narrow set (e.g. features **7509, 7510, 7569, 7570, 7536, 7548, 7520**) has multiple orientations across the DBS area. In the west (e.g. features **7506, 7509, 7510, 7514**) these features are oriented approximately north-west to south-east (Fig. 4). In the centre of the area, these features trend approximately east-northeast-west-southwest, and are generally slightly more sinuous than the west set (e.g. features **7570, 7568**). In the southeast of the study area, these straight and narrow channels trend north-east to south-west (e.g. features **7520, 7548, 7550, 7536, 7529**).

3.2.16 The meandering set of features (e.g. **7513, 7521, 7532, 7577**) do not have a single orientation trend. These features crosscut, or are crosscut by, both other channel morphology sets, but it would require further detailed investigation to determine stratigraphic relationships between each channel set.

3.2.17 The third channel feature set, the wide, straight set (e.g. features **7563, 7505, 7518**), is distributed mainly in the centre of the study area, and generally trends east-northeast-west-southwest. The largest of these features, **7563**, splits at its southwestern end, but to be able to tell whether this is a tributive or distributive requires disproportionate work at this stage of the study.

3.2.18 Basin features are generally found in conjunction with the straight, narrow channel set (e.g. features **7583, 7586**), with channels flowing into or out of the basins. One basin, **7587**, appears to be related to the wide, meandering channels **7521** and **7532**, formed at the apparent confluence between these two channels. Basins may have formed as a result of pre-existing topographic lows being expanded by fluvial or lacustrine erosion.

3.2.19 The three differing morphologies of channels and their associated basins implies a potential different sedimentary environment of formation. Given the channels are incised into marine sediments deposited during sea-level highstand at MIS 5e, there is a high likelihood that these channels are subaerial in origin, such as delta-top distributive channels formed during MIS 5, or fluvial channels incised during subsequent subaerial exposure, possibly during relative sea-level lowstands at MIS 5d-5a and during the glacial stage of MIS 4, where ice sheets are anticipated to have been smaller in the North Sea (Carr *et al.*, 2006). Because of this high likelihood of formation during subaerial exposure at a time when there is a possibility of human occupation, the channels and basins have been assigned a P1 discrimination for potential to hold archaeological and palaeoenvironmental material within channels and basins.

3.2.20 A further single feature interpreted as a channel but with a distinct morphology, feature **7533**, has a curvilinear planform and is relatively wide (~500-900 m), increasing towards the north, tapering to a point in the south, and has a planar centreline profile. This morphology is unusual for a channel feature, and may have been formed by iceberg scouring during a phase of relative sea-level highstand, albeit with a source of icebergs close by. However, the width of the scour mark and the likely relatively shallow water depth (~60-70 m) implies a wide, thin iceberg, which may be unfeasible, or may have been floating sea ice or a piece of ice shelf. Although an interesting geological puzzle, this feature is given the archaeological discrimination of P2, as it may still be a feature of archaeological potential if it formed subaerially similar to the above channels.

3.2.21 Features at Landscape Stage I range from 7.2 to 97.6 mBSB, with all but seven channels and basins (**7505, 7513, 7521, 7563, 7578, 7584, 7588**) being entirely within the 70 mBSB turbine foundation depth. The majority of features may be investigated by future borehole campaigns.

<u>Stage II</u>

3.2.22 Three palaeolandscape feature types of interest have been interpreted at Landscape Stage II, channels, a basin, and bright reflections that may represent organic material. This landscape stage is present above glacial deposits, so is anticipated to be younger than c.23 ka BP and therefore has the potential to contain archaeological material.

3.2.23 The channel forms observed at Landscape Stage II are dominated by feature **7589**, a large, north-east to south-west trending, 2-3 km wide channel with a W-shaped profile. This channel sits within a larger basin (feature **7604**) that is formed from the topography of the glacial deposits such as moraines and outwash fans. The seismic facies within the channel imply a stacked sequence of migrating channels and braid bars within the wider channel outline, implying a broad braided river that experienced channel migration and switching events and the aggradation of braid bars, potentially sandy or gravelly, between individual channels. This geomorphology is similar to other channels seen on Dogger Bank to the north that formed as proglacial sandur plain rivers (Emery *et al.*, 2020), so it is interpreted this feature also formed as a proglacial sandur, locally constrained by glacial geomorphology.

3.2.24 The basin that the channel feature **7589** sits in was filled with acoustically transparent or low amplitude reflections that are draped over the previous topography. This seismic facies is also observed on Dogger Bank to the north, where it is interpreted to be a proglacial lake, with the draped reflections implying a distal proglacial setting. A similar setting may be possible for this feature, although a dam would have to form to allow the transition from river to lake. It is possible that this dam may have been formed by the advancing North Sea Lobe ice stream, which flowed south and eastwards around Dogger Bank, and persisted until 17 ka BP (Evans *et al.*, 2016).

3.2.25 The archaeological potential of this river channel and lake basin is assigned a P1 potential. This is based on the fact that these features were subaerially exposed at a time when humans may have been present in the subaerial North Sea prior to its inundation. The exact timing and ages of the river and lake remain unknown, but bright reflections (features **7639**, **7640, 7642, 7645,** and bright reflection feature **7641** on the edge of Stage II channel feature **7590** that forms a tributary to feature **7589**) are present on the edge of the lake basin, which may reflect a period of accumulation of organic matter, and a possible target for chronological and palaeoenvironmental assessment.

3.2.26 Further large channels, such as features **7590, 7593, 7594, 7595,** and **7597**, are tributaries of the main channel feature **7589**. These form networks that locally drain the higher topography of the landscape surface formed by the glacial geomorphology. These features have also been given the P1 discrimination because of their possibility to be of archaeological and palaeoenvironmental interest.

3.2.27 In the east of the study area, a smaller palaeochannel network exists. The main channel is feature **7598**, which is a channel inherited from previous landscape stages of channel activity. Smaller tributary channels, and nearby blind channels that may subsequently have been eroded, are generally straight and narrow (e.g. features **7599, 7600, 7601**). These features may have developed on the landscape surface during a period of subaerial exposure, and so have been assigned P1 potential.

3.2.28 Further bright reflections from Stage II are observed within much smaller channels (e.g. bright reflection feature **7646** within small palaeochannel **7591**). These bright reflections are observed in the base of the channel features, and are interpreted to be gyttja and organic matter accumulating in the base of the channel. These features are ascribed a P1 archaeological potential as they may be useful for geochronology and palaeoenvironmental description.

3.2.29 All features at Landscape Stage II are interpreted to be within both anticipated turbine depth (70 mBSB) and able to be sampled by borehole, ranging from 0.8 to 28 mBSB. Those features less than 6 m from seabed may also be able to be sampled by vibrocore.

Stage III

3.2.30 Four palaeolandscape features were observed at Landscape Stage III, mounds, clinoform wedges, fills, and bright reflections. These features are observed at the stratigraphic boundary between terrestrial and marine deposits, and are largely interpreted to have formed during marine transgression.

3.2.31 A series of mounds is observed to have formed on top of the top glacial surface that forms the palaeolandscape surface. The internal fill of these mounds is generally a series of reflections dipping in one direction subparallel to the mound surface. These features can occur in small areas over a relatively planar substrate (e.g. features **7620, 7621, 7622**). In this case, these features are assigned archaeological discrimination P2 as it is uncertain whether these are coastal features or, more likely, seabed features formed shortly after marine transgression. One mound feature, **7635**, has been interpreted as a potential coastal barrier as it is pinned on a break in slope and the substrate is a dipping surface. It is located on the edge of a topographic high, and is related to clinoform wedge feature **7610**, which may be interpreted as a later phase of overstepped barrier that has undergone subsequent wave ravinement. The mound feature **7635** is interpreted as a potential drowned in place coastal barrier, which may preserve archaeological material, and therefore has been assigned a P1 potential.

3.2.32 Clinoform wedges are observed as sigmoidal to tangential reflections with a subhorizontal top surface that imply progradation into an empty basin. These features are seen both in conjunction with large basins (e.g. features **7605, 7606** prograding into basin feature **7604**), and filling smaller topographic lows in the palaeolandscape surfaces (e.g. features **7608, 7609**). These features are interpreted to be deltas formed during the latest stages of basin filling, possibly during marine transgression as estuarine features. Because of their potential to preserve archaeological material and record palaeoenvironmental change, these features have been assigned a P1 potential.

3.2.33 A single fill feature is interpreted to be the latest stage of fill of the large palaeochannel that feature **7598** is part of. This fill could be alluvial, estuarine, or marine, and further investigation is required to determine whether it could contain archaeological material. Because of this uncertainty, it is assigned P2 archaeological potential.

3.2.34 Some areas of bright reflections, features **7643, 7644, 7645, 7649, 7650, 7652** and **7653**, are observed at the boundary between glacial and marine units, in the form of an increase in amplitude of the boundary reflection. These areas could potentially be organic deposits such as peat formed during subaerial exposure, or salt marsh peat formed in coastal environments. However, these areas could also be high amplitude because they mark deposits of transgressive gravel lag, or areas where glacial sand and gravel has been exposed at the boundary during marine transgression and ravinement. Despite this uncertainty, and the potential for these deposits to contain organic material, these features have been assigned a P1 archaeological potential.

3.2.35 All features at Landscape Stage II are interpreted to be within both anticipated turbine depth (70 mBSB) and able to be sampled by borehole, ranging from 0 to 23.2 mBSB. Those features less than 6 m from seabed may also be able to be sampled by vibrocore.

Export Cable Route palaeolandscape features

3.2.36 The ECR transitions off the top of Dogger Bank at the northern end of both ECR spurs, marked by an abrupt change in bathymetry from around 15 to 30 m below LAT (mLAT) to in excess of 50 mLAT. This is associated with a similarly abrupt change in shallow geology; the difference caused by the lack of the sedimentary sequence that makes up the Dogger

Bank itself. Along the majority of the ECR, the shallow geology is dominated by relatively shallow bedrock overlain by a relatively thin layer of Weichselian till and modern marine sediments.

3.2.37 As such, relatively few palaeogeographic features of archaeological potential have been identified within the ECR. The distribution of these features is illustrated in Figure 12. No features were identified that correspond with Landscape Stages 0 and I as presented in Table 7.

Stage II

3.2.38 Unit 5 is tentatively identified as the basement unit immediately to the west of Dogger Bank, and is potentially incised by two cut and fill features attributed to Landscape Stage II (**7700** and **7701**). Feature **7700** is a complex feature, comprising a lower acoustically layered fill and potentially multiple later acoustically transparent fills. The lower fill was found by Vibrocore DBS_164_VC (Fugro 2023) to comprise soft, silty, sandy clay, which contrasts with the surrounding sand deposits dominant in the area, suggesting it may be a terrestrial feature. Feature **7701**, by contrast, is a simple cut and fill feature with a single phase of generally acoustically transparent fill, suggesting it may be sandier in nature.

3.2.39 Both features are located in an area of mobile seabed sediment and beneath significant sand waves measuring up to a few metres in height. These affected the penetration of the SBP equipment in the area, resulting in a lower confidence of the nature and extents of the features. Due to this lower confidence, these features have been rated as P2 for archaeological potential.

3.2.40 Much closer to the landfall, four other features (two cut and fills and two channels) have been identified associated with Landscape Stage II. The two channels (**7703** and **7705**) cut across the width of the ECR and into the underlying pre-Quaternary bedrock or Weichselian glacial till of the Bolders Bank Formation. Both features are characterised by a distinct, undulating basal reflector and single phase of acoustically layered fill, and are overlain by a thin veneer of modern seabed sediment.

3.2.41 Both are interpreted as possible preserved fluvial channels, and as such are rated as P1 for archaeological potential due to their interpreted depositional environment and likelihood to contain sediments of archaeological interest. Feature **7703** is situated within a broad bathymetric depression trending in the same direction as the interpreted channel, which may suggest the original feature was wider and potentially underfilled, but this is not definitive from the data.

3.2.42 The two cut and fill features (**7704** and **7706**) are smaller, less well-defined features, characterised by poorly defined basal reflectors and acoustically unstructured or weakly layered fill. These are also potentially remnants of fluvial features, but could also be internal features within the underlying Bolders Bank Formation. Due to this uncertainty of interpretation, these have been rated as P2 for archaeological potential.

Stage III

3.2.43 The majority of the palaeogeographic features of archaeological potential within the ECR are located within 9 km of the landfall and are associated with Landscape Stage III. These features record the final nearshore terrestrial landscape development post-LGM, and the eventual Holocene transgression. However, one feature, **7702**, has been identified further offshore. This is a small area of acoustic blanking situated at the top of bedrock below the relatively thin overlying seabed sediment. This is unlikely to represent shallow gas, but may be a localised gravel deposit or other preserved remnant terrestrial material deposited on top of the bedrock, but its exact nature is uncertain. As such, this is considered of P2 archaeological potential.

3.2.44 A total of four cut and fill features have been identified within the nearshore area (**7709**, **7711**, **7712**, and **7715**). These are all relatively discontinuous features cut into the underlying Bolders Bank Formation, and are characterised by a relatively well-defined basal reflector and with a single phase of acoustically unstructured fill. These are potentially the remnants of fluvial or other terrestrial features, but may also represent internal features within the underlying till. As such, they are considered to be of P2 archaeological potential.

3.2.45 The most significant nearshore feature is a distinct, extensive reflector present between the top of the Bolders Bank Formation and base of the modern seabed sediment (**7707**). This has been interpreted as an erosion surface, potentially dating to or just prior to the Holocene marine transgression. The surface contains numerous asymmetric mounds, the origins of which are currently debated. They are currently mapped by BGS as gravel ridges (BGS 2023), but could also represent relict glacial moraine features (Dove *et al*. 2017) or be interpreted as possible sand waves or dunes. The asymmetry direction of these features suggests either a wind, ice, or current direction from offshore to onshore (Fig. 13).Small areas of layered reflectors within the lee of some of these features potentially represent preserved intertidal/transgression deposits (Fig. 13), but these have not been sampled by vibrocore so this is uncertain.

3.2.46 This erosion surface gradually shallows toward landfall, and the features eventually become exposed at seabed. These appear as possible mobile seabed features within the MBES data (Fig. 14), but are in fact relict features and so are likely to be relatively stable. The extents of the current exposure of these features at seabed has been mapped as feature **7708**, but the exact extent is likely to change as the amount of overlying modern sediment naturally varies overtime.

3.2.47 This erosion surface and the associated features is potentially important for recording the final phases of terrestrial landscape development in the nearshore, and as such are considered of P1 archaeological potential.

3.2.48 A distinct, curvilinear mound has been identified within the MBES data extending approximately 1.5 km WNW-ESE across part of the nearshore area (**7713**) (Fig. 14). This is visible in the SBP data as a small seabed mound with an irregular seabed reflection, but it doesn’t appear to have a significant buried component and the extents are more visible within the MBES data.

3.2.49 Based on similar features from other parts of the UK this is interpreted to be the remains of a channel feature, and potentially comprises stiff, fibrous peat/organic and/or other cohesive material that has resisted erosion relative to the surrounding sediment. The result is that the former channel fill now stands proud of the seabed as a mound. This is situated just offshore of the preserved peat deposits of the SSSI of Skipsea Withow Mere (Section 3.1.16), and may be related to the same preserved landscape. As such, feature **7713** is considered of P1 archaeological potential.

3.2.50 A second small, curvilinear mound feature (**7714**) has also been identified within the nearshore area, just to the SSW of channel **7713** (Fig. 14). This may be another similar feature related to **7713**, or may be completely different in nature – this is unclear from the data. As such, **7714** is considered of P2 archaeological potential.

3.2.51 In addition to the tagged features described here, the nearshore 1.5 km of the ECR also contains numerous areas of irregular seabed that differ from the surrounding seabed sand (Fig. 14). These are of an uncertain nature, but their characteristics within the SBP data are similar to that of channel **7713**, and so are tentatively interpreted as possible localised, discontinuous peat deposits. However, they may also represent localised accumulations of coarser seabed sediment. As they are scattered and discontinuous, and their exact locations may change over time due to burial and exposure by seabed sediments, these features have not been individually mapped but their approximate extents are illustrated in Figure 14. Should these be deposits of peat, they would be considered of P1 archaeological potential.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1.1 The assessment of the geophysical data within the study area resulted in a total of 155 features of palaeolandscape interest in the AA and 16 features in the ECR. These are summarised as follows:

- a total of 122 features in the AA and 5 features in the ECR were assigned a P1 archaeological rating;
- a total of 33 features in the AA and 11 features in the ECR were assigned a P2 archaeological rating.

4.1.2 The geological complexity of the Dogger Bank area has resulted in many potential landscape stages of subaerial exposure during the Quaternary. The deposits related to these periods of subaerial exposure may contain important archaeological material and information on palaeoenvironmental conditions. However, the stratigraphic complexity requires further detailed analysis to unravel chronostratigraphic relationships between surfaces and interpreted palaeolandscape features (e.g. channels of uncertain origin).

4.1.3 For the AA and ECR, it is recommended that further, more detailed geophysical and geoarchaeological assessment is undertaken to address the following key questions:

- Is there evidence of exposed land surfaces within the tunnel valley infills, and do any of the deposits infilling them record evidence of subaerial landscapes (e.g. fluvial or lacustrine deposits or organic material)?
- What is the depositional history, age, and evolution of the Landscape Stage I channel networks?
- What is the detailed landscape evolution history of the Landscape Stage II sandur river and lake phases, and when did they form relative to ice sheet retreat and subsequent growth of vegetation as seen on Dogger Bank to the north? What forms the bright reflections observed at this stage, and what chronological, geoarchaeological and palaeoenvironmental information do they contain?
- What was the coastal evolution during marine transgression at Landscape Stage III? How much erosion or deposition was there during this stage? What is the detailed formation history of the asymmetric mounds seen within the ECR?

4.1.4 To assess the above research questions, integration of vibrocore, borehole, and geotechnical logs should be undertaken alongside interpretation of key areas of the Sparker dataset in a denser grid. This will reveal more detailed geomorphological and stratigraphic information that will aid determining landscape evolution at key periods of subaerial exposure throughout the Quaternary.

4.1.5 As such, it is recommended that, should any further geophysical and/or geotechnical investigations be undertaken within the AA, the data are made available to a suitably qualified archaeological contractor for further assessment. This will help further refine the stratigraphic model and the assessment of archaeological potential of the identified units and features.

4.1.6 Within the ECR, the features of highest archaeological potential were mainly identified close to the landfall. In order to further understand the identified features and so ascertain their archaeological potential, it is recommended that, should further geotechnical samples be acquired form the area, a number of samples target specific identified features (particularly channel **7713** and erosion surface **7707**), and that the samples be made available for archaeological and environmental assessment.

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APPENDICES

Appendix I Palaeolandscape features of archaeological potential

Array area

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7500	Channel	P2	53.6	156	0	North-west to south-east trending channel feature that branches in the south of the area. Width ~3 km in main branch, ~1.5 km in smaller branches. Length 21 km main branch, 18 km south branch, 26 km north branch. Channel form varies but mainly symmetrical V-shaped, occasionally u-shaped. Interpreted to be MIS 6 or earlier tunnel valley.
7501	Channel	P2	38.4	115.2	0	East to west trending channel feature with tributive branches. Length 14 km in area. Width ~900 m. Generally V-shaped in cross section. Interpreted to be MIS 6 or earlier tunnel valley.
7502	Channel	P2	44	119.2	0	North-east to south-west trending channel feature that cuts, or is cut by, feature 7500, and joins feature 7500 at southern end. Length 17 km, width 1.5 km. Main body of channel has symmetrical u-shaped profile. Interpreted to be MIS 6 or earlier tunnel valley.
7503	Channel	P2	39.2	68	0	South to north trending channel feature, length 14 km, width 750 m, generally straight. U or w-shaped profile. Interpreted to be MIS 6 or earlier tunnel valley.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7504	Channel	P2	26.4	53.6	0	Separate segments of north-east to south-west trending channel feature, 18 km long, ~500 m wide. U-shaped profile. Interpreted to be MIS 6 or earlier tunnel valley.
7505	Channel	P1	42.4	84	I	Deep, wide channel segment trending NNE-SSW. This segment is 6.5 km long and 1.25 km wide. U-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7506	Channel	P1	12.8	33.6	I	Relatively straight, east to north-west trending channel feature, 14 km long, ~500 m wide. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7507	Channel	P1	10.4	24	I	Small, blind channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7508	Channel	P1	12.32	12.48	I	Potential small channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7509	Channel	P1	12.8	18.4	I	North-west to south-east trending branching channel feature that splits into tributive or distributive network at north-west end. 12 km long, ~250 m wide. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7510	Channel	P1	7.2	26.4	I	North-west to south-east trending narrow, straight channel, 9 km long, ~200 m wide. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7511	Channel	P1	13.6	19.2	I	North to south trending narrow, straight channel, 3 km long, ~200 m wide. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7512	Channel	P1	12.8	25.6	I	North to south trending narrow channel that splits into tributive or distributive network. 4 km long, ~200 m wide. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7513	Channel	P1	17.6	73.6	I	NNE-SSW trending sinuous main channel feature, 20 km long, ~400 m wide. W-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7514	Channel	P1	16	28	I	North-west to south-east trending pair of channels, 8 km long, ~500 m wide, increasing in width in the southernmost channel. V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7515	Channel	P1	28.8	55.2	I	NNE-SSW trending channel segment, 7 km long, ~500 m wide, U-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7516	Channel	P1	22.4	36.8	I	Short channel branches. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7517	Channel	P1	21.6	53.6	I	NNE-SSW trending sinuous channel branches that drain out of or into basin feature 7582. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7518	Channel	P1	33.6	49.6	I	NNE-SSW trending large, wide channel segment, 1.25 km wide, U and W-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7519	Channel	P1	21.6	41.6	I	Channel segment linking features 7518 and 7513. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7520	Channel	P1	18.4	36	I	WSW-ENE trending slightly sinuous channel, 14 km long, ~500 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7521	Channel	P1	13.6	88.8	I	Generally north-west to south-east trending meandering (sinuosity = 1.51) channel, 41 km long, ~800 m wide. V-shaped profile in north, U-shaped profile in S. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7522	Channel	P1	15.2	21.6	I	Small channel segment that possibly links to feature 7545 by cross-cutting/being cross-cut by feature 7520. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7523	Channel	P1	18.4	20	I	Long, linear channel segment that joins feature 7520 at southern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7524	Channel	P1	13.6	18.4	I	Long, linear channel segment that joins feature 7522 at southern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7525	Channel	P1	20	36.8	I	North-east to south-east trending channel segment, ~300 m wide V-shaped. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7526	Channel	P1	31.2	40.8	I	Short channel segment joining feature 7521. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7527	Channel	P1	37.6	45.6	I	ENE - WSW trending channel that joins feature 7521 at WSW end. ~250 m wide, u- and V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7528	Channel	P1	34.4	50.4	I	West to east trending channel feature, ~250 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7529	Channel	P1	24	43.2	I	WSW-ENE trending channel feature, ~200 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7530	Channel	P1	16.8	30.4	I	South-west to north-east trending channel feature that joins feature 7521 at north-eastern end. ~150 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7531	Channel	P1	32	56.8	I	Large north to south trending channel that joins/leaves feature 7505 at northern end. ~500 m wide, u-shaped profile. Course has straight segments separated by acute bends. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7532	Channel	P1	29.6	41.6	I	East to west trending meandering channel flowing into or out of basin feature 7588. ~400 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7533	Channel	P2	30.4	44.8	I	Curvilinear trough, symmetrical V-shaped, that shallows towards south. Base is generally relatively planar. Interpreted to be potential iceberg scour, although very large and would have formed in relatively shallow water. However, formation is uncertain so it has been retained as a feature of possible archaeological or palaeoenvironmental interest.
7534	Channel	P1	36.8	39.2	I	Small channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7535	Channel	P1	25.6	30.4	I	ENE to WSW trending meandering channel that joins feature 7521 at WSW end. ~400 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7536	Channel	P1	37.6	47.2	I	ENE to WSW trending straight channel, ~300 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7537	Channel	P1	37.6	44	I	Small channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7538	Channel	P1	37.6	46.4	I	South-west to north-east branching channel segment that joins basin feature 7588. ~250 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7539	Channel	P1	37.6	44	I	Small branching channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7540	Channel	P1	35.2	43.2	I	Small channel segment that joins feature 7527 at southern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7541	Channel	P1	16.8	20	I	Small channel segment between basin feature 7587 and channel feature 7521. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7542	Channel	P1	16.8	24.8	I	Small channel segment joining basin feature 7586 at west end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.7
7543	Channel	P1	16	22.4	I	Branched channel that joins channel feature 7521 at ENE end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7544	Channel	P1	15.2	25.6	I	Small W-E trending channel segment with branch. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7545	Channel	P1	16.8	32	I	South to north trending channel segment that joins basin feature 7587 at northern end and may join feature 7522 by being cross-cut by/cross-cutting feature 7520. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7546	Channel	P1	14.4	17.6	I	Small ENE to WSW trending channel segment joining basin feature 7587. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7547	Channel	P1	16	19.2	I	Small channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7548	Channel	P1	16.8	24	I	Irregular channel segment connected to basin feature 7586. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.7
7549	Channel	P1	36.8	44.8	I	Small channel segment joining basin feature 7588 at south-western end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7550	Channel	P1	34.4	40	I	ENE to WSW trending channel feature, ~300 m wide, V-shaped profile, joins channel feature 7521 at WSW end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7551	Channel	P1	37.6	42.4	I	Small blind channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7552	Channel	P1	32	36	I	Small north-east to south-west branching channel system that joins channel feature 7531 at SW end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7553	Channel	P1	34.4	36	I	Blind channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7554	Channel	P1	38.4	51.2	I	Two channel branches of a channel segment that joins channel feature 7532 at north-eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7555	Channel	P1	40.8	45.6	I	Short channel segment joining feature 7532 at north-eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7556	Channel	P1	40	52.8	I	ENE-WSW trending channel form ~250 m wide, V-shaped profile, joining channel feature 7532 at ENE end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7557	Channel	P1	22.4	27.2	I	Short ENE to WSW channel segment. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7558	Channel	P1	20	24	I	Short channel segment that joins channel feature 7525 at eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7559	Channel	P1	25.6	36	I	Short NNW-SSE channel segment that joins basin feature 7589 at SSE end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7560	Channel	P1	34.4	52	I	Meandering WNW-ESE channel segment that joins channel features 7563 and 7532. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7561	Channel	P1	37.6	48.8	I	Channel segment with branches that joins channel feature 7563 at western end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7562	Channel	P1	38.4	42.4	I	Short channel segment that joins feature 7532 at southern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7563	Channel	P1	23.2	88.8	I	Large, generally north-east to south-west trending channel network that branches into multiple segments (tributive or distributive) at south-western end. Width varies but generally > 1.25 km, U or W-shaped profile, likely to be an extension of channel feature 7505. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7564	Channel	P1	38.4	48	I	Small channel segment that joins feature 7563 at northern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7565	Channel	P1	36	45.6	I	Small channel segment that joins feature 7563 at north-eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7566	Channel	P1	35.2	39.2	I	Small channel segment that joins features 7505 and 7567. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7567	Channel	P1	34.4	41.6	I	Small channel segment that joins feature 7505 at northern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7568	Channel	P1	31.2	59.2	I	NNE-SSW trending channel feature that joins channel feature 7563 at SSW end, ~300 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7569	Channel	P1	27.2	44	I	South to north trending channel that joins channel feature 7518 at northern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7570	Channel	P1	37.6	49.6	I	North-east to south-west trending meandering channel feature with small branches, ~ 400 m wide, V-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7571	Channel	P1	28	41.6	I	Small channel branch that joins feature 7570 at southern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7572	Channel	P1	22.4	46.4	I	Small channel branch that joins feature 7513 at northern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7573	Channel	P1	32.8	50.4	I	Generally south to north trending meandering channel branch that joins feature 7513 at northern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7574	Channel	P1	30.4	52	I	Small channel segment that joins feature 7570 at eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7575	Channel	P1	38.4	41.6	I	Small channel segment that joins feature 7515 at NNE end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7576	Channel	P1	34.4	44.8	I	North-east to south-west trending channel branch that joins feature 7568 at south-western end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7577	Channel	P1	32.8	54.4	I	Large NNE-SSW trending channel feature that joins channel feature 7563 at SSW end. ~1 km wide, w-shaped profile. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7578	Channel	P1	33.6	78.4	I	Channel segment that joins features 7563 and 7505. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7579	Channel	P1	35.2	47.2	I	Short channel segment that joins feature 7563 at north-eastern end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7580	Channel	P1	35.2	46.4	I	Channel branch that joins feature 7521 at western end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7581	Channel	P1	17.6	22.4	I	Short channel segment that joins basin feature 7587 at ENE end. Interpreted to be ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7582	Channel	P1	18.4	30.4	I	Anastomosing, narrow channel branch oriented W-E, possibly linked to feature 7506. Interpreted to be an ?MIS 4 terrestrial river channel incised into ?MIS 5 marine sediments.
7583	Basin	P1	25.6	65.6	I	Small oval basin, area 3.27 km^2, joined to feature 7517. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7584	Basin	P1	28	72.8	I	Elongated oval basin, area 3.04 km^2, joined to feature 7514. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7585	Basin	P1	20.8	47.2	I	Elongated oval basin 2 km wide, area 2.84 km^2, joined to feature 7585 in north-east and feature 7525 in south-west. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7586	Basin	P1	24	32.8	I	Small basin area 0.5 km^2 joined to feature 7529 in north-east. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7587	Basin	P1	16	30.4	I	Irregular basin with lobes elongated north-east to south-west, area 2.46 km^2, joined to features 7548, 7546 and 7581 on the south-western edge and 7530, 7542 and 7541 in the north-east and feature 7545 in the south-east. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7588	Basin	P1	36.8	97.6	I	Large basin formed at the intersection of features 7521 and 7532, area 4.93 km^2. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7589	Basin	P1	22.4	31.2	I	Small isolated basin joined to feature 7559. Interpreted to be topographic low inherited from previous stratigraphy that may have formed a small lake or marshy area during MIS 4.
7590	Channel	P1	7.2	28	II	Very large north-east to south-west trending channel feature within larger basin feature 7605. 2-3 km wide, w-shaped profile. Interpreted to be MIS 2 proglacial constrained sandur channel, braided, with stacked channels and braid bars.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7591	Channel	P1	5.6	18.4	II	Large tributive channel that joins feature 7590 at western end. Width ~750 m, u-shaped profile. Contains bright reflection feature 7642. Interpreted to be MIS 2 drainage channels joining the main sandur channel.
7592	Channel	P1	2.4	2.4	II	Small blind channel segment. Contains bright reflection feature (possible organics) of feature 7647, 7648 and 7649. Interpreted to be MIS 2 small channel incised into relative topographic high.
7593	Channel	P1	3.2	16	II	Small blind channel segment. Interpreted to be MIS 2 small channel incised into relative topographic high.
7594	Channel	P1	4	19.2	II	Tributive network with w-shaped profile in main branch. Width ~1.5 km in widest part, 600 m in southern branch, 300 m in northern branch, with u-shaped profile in smaller branches. Joins feature 7590 at eastern end. Contains bright reflection feature 7641. Interpreted to be MIS 2 drainage channels joining the main sandur channel.
7595	Channel	P1	7.2	12.8	II	Small branch of tributive network adjacent to feature 7594 that joins feature 7590 at south-eastern end. Contains bright reflection feature 7640. Interpreted to be MIS 2 drainage channels joining the main sandur channel.
7596	Channel	P1	3.2	72	II	Portion of channel network in south-western corner of dataset, w-shaped channel profile with multiple fill stages, which extends beyond the dataset. Interpreted to be potential MIS 2 sandur channel.
7597	Channel	P1	1.6	3.2	II	Small channel segment. Interpreted to be MIS 2 small channel incised into relative topographic high.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7598	Channel	P1	0.8	11.2	II	Tributive network that joins feature 7590 at south-eastern end. V and w-shaped profile. W-shaped channels up to 1 km wide. Interpreted to be MIS 2 drainage channels joining the main sandur channel.
7599	Channel	P1	9.6	44.8	II	Large, deep, incised channel with internal stacked fills, width ~800 m. Interpreted to be potential MIS2 river channel (postglacial terrestrial) inherited from previous stratigraphic stages.
7600	Channel	P1	3.2	16.8	II	South to north trending channel that joins feature 7599 at northern end, width ~250 m. Interpreted to be potential MIS 2 river channel.
7601	Channel	P1	4	2.4	II	Small channel segment that joins feature 7600 at western end. Interpreted to be potential MIS 2 river channel.
7602	Channel	P1	16.8	12	II	Channel segment that joins feature 7600 at western end. Interpreted to be potential MIS 2 river channel.
7603	Channel	P1	4.8	12	II	Small blind channel segments, possibly of individual meanders. Interpreted to be potential MIS 2 river channel.
7604	Channel	P1	2.4	28.8	II	Small channel segment. Interpreted to be potential MIS 2 river channel.
7605	Basin	P1	4.8	28	II	Large basin above palaeochannel feature 7590, bounded by earlier stratigraphy, that contains draped reflections or is acoustically transparent. Contains bright reflection feature 7643. Interpreted to be distal proglacial or non-glacial ribbon lake constrained by glacial geomorphology, likely MIS 2, may contain organics.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7606	Clinoform wedge	P1	0	12	III	Large wedge of clinoforms prograding apparent eastwards into basin feature 7605 as top of basin fill starting at break in slope of the edge of the basin. Interpreted to be delta flowing into palaeolake basin feature 7605.
7607	Clinoform wedge	P1	4.8	9.6	III	Wedge of clinoforms prograding apparent westwards into basin feature 7605 as top of basin fill starting at break in slope of the edge of the basin. Interpreted to be delta flowing into palaeolake basin feature 7605.
7608	Clinoform wedge	P1	4.8	11.2	III	Small wedge of clinoforms prograding apparent westwards into basin feature 7605 as top of basin fill starting at break in slope of the edge of the basin. Interpreted to be delta flowing into palaeolake basin feature 7605.
7609	Clinoform wedge	P1	2.4	3.2	III	Small isolated wedge of clinoforms prograding apparent eastwards. Interpreted to be small, localised fan deposit.
7610	Clinoform wedge	P1	5.6	9.6	III	Small wedge of clinoforms prograding apparent southwards into small basin within surface between glacial and marine units. Interpreted to be small basin fill.
7611	Clinoform wedge	P1	4.8	8	III	Small wedge of clinoforms prograding apparent westwards. Interpreted to be small delta or potential to be overstepped coastal barrier (wave ravinement reworking top section) related to potential barrier mound feature 7636.
7612	Clinoform wedge	P1	1.6	4.8	III	Small wedge of clinoforms prograding apparent northwards into small basin within surface between glacial and marine units. Interpreted to be small basin fill.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7613	Clinoform wedge	P1	0.8	4	III	Small wedge of clinoforms prograding apparent southwards into small basin within surface between glacial and marine units. Interpreted to be small basin fill.
7614	Clinoform wedge	P1	14.4	16	III	Small clinoform wedge prograding eastwards into small basin within surface between glacial and marine units. Interpreted to be small basin fill.
7615	Clinoform wedge	P1	14.4	16.8	III	Small clinoform wedge prograding apparent eastwards into channel fill of channel feature 7599. Interpreted to be small delta deposited on top of channel fill.
7616	Clinoform wedge	P1	14.4	16	III	Small clinoform wedge prograding apparent eastwards into channel fill of channel feature 7599. Interpreted to be small delta deposited on top of channel fill.
7617	Clinoform wedge	P1	4.8	15.2	III	Small isolated clinoform wedge. Interpreted to be small basin fill.
7618	Clinoform wedge	P1	8.8	14.4	III	Small isolated clinoform wedge. Interpreted to be small basin fill.
7619	Clinoform wedge	P1	1.6	4	III	Small isolated clinoform wedge. Interpreted to be small basin fill.
7620	Fill	P2	17.6	23.2	III	Wedge of sediment infilling topographic low above channel feature 7599. Interpreted to be potential marine or terrestrial deposition of sediments filling a topographic low left due to previous partial infilling of palaeochannel 7599.
7621	Mound	P2	10.4	13.6	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7622	Mound	P2	9.6	12.8	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7623	Mound	P2	10.4	12	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7624	Mound	P2	8.8	10.4	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7625	Mound	P2	3.2	5.6	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7626	Mound	P2	1.6	9.6	III	Mound with sigmoidal reflections in seismic facies dipping apparent north-west, asymmetrical elongated profile. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7627	Mound	P2	4.8	6.4	III	Small mound with some sigmoidal reflections. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7628	Mound	P2	4.8	8.8	III	Small mound pair, discontinuous reflections. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7629	Mound	P2	8	9.6	III	Small depression filled with mounded sigmoidal reflections. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7630	Mound	P2	0.8	1.6	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7631	Mound	P2	4	6.4	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7632	Mound	P2	3.2	5.6	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7633	Mound	P2	0.8	3.2	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7634	Mound	P2	8	10.4	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7635	Mound	P2	2.4	2.4	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7636	Mound	P1	10.4	12	III	Small symmetrical mound on break in slope on edge of palaeochannel, appears related to clinoform feature 7611. Interpreted to be potential to be preserved coastal barrier pinned to break in slope.
7637	Mound	P2	3.2	6.4	III	Symmetrical mound with complicated internal reflection geometry. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7638	Mound	P2	4	6.4	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7639	Mound	P2	4	6.4	III	Symmetrical mound with sigmoidal reflections dipping apparent south-east. Interpreted to be likely relict seabed bedform but potential to be coastal barrier.
7640	Bright reflection	P1	7.2	12	II	Area of bright reflections in flat basin and channel-form feature 7595. Interpreted to be potential organic deposits in a channel (gyttja) and/or marshland peat.
7641	Bright reflection	P1	10.4	17.6	II	Bright reflections within channel feature 7594. Interpreted to be potential organic deposits in a channel (gyttja).
7642	Bright reflection	P1	5.6	10.4	II	Bright reflections on edge of channel/basin feature terrace within channel 7591. Interpreted to be organic material buildup during lake filling.
7643	Bright reflection	P1	4	12.8	II	Bright reflections on terrace on edge of channel/basin feature 7590/7605. Interpreted to be organic material buildup during lake filling.
7644	Bright reflection	P1	3.2	4.8	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.
7645	Bright reflection	P1	10.4	12	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7646	Bright reflection	P1	1.6	6.4	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.
7647	Bright reflection	P1	3.2	4.8	II	Bright reflections in a small channel form 7592. Interpreted to be potential organic deposits in a channel (gyttja) and/or marshland peat.
7648	Bright reflection	P1	1.6	3.2	II	Bright reflections in a small channel form 7592. Interpreted to be potential organic deposits in a channel (gyttja) and/or marshland peat.
7649	Bright reflection	P1	2.4	4.8	II	Bright reflections in a small channel form 7592. Interpreted to be potential organic deposits in a channel (gyttja) and/or marshland peat.
7650	Bright reflection	P1	1.6	1.6	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.
7651	Bright reflection	P1	1.6	2.4	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.
7652	Bright reflection	P1	2.4	4	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.

ID	Classification	Archaeological Discrimination	Depth (mBSB)		Landscape stage	Description
			From	To		
7653	Bright reflection	P1	4.8	7.2	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.
7654	Bright reflection	P1	4.8	6.4	III	Area of bright reflections away from channels and at boundary between glacial and marine units. Interpreted to be potential organic deposition in coastal environment, or potential transgressional gravel lag.

Export Cable Route

ID	Classification	Archaeological Discrimination	Depth Range (mBSB)		Landscape stage	Description
			From	To		
7700	Complex cut and fill	P2	1.2	12.0	Stage II	Possible complex cut and fill feature identified cutting into underlying sand/till, overlain by mobile seabed sand waves. The feature is relatively poorly defined, and the extents and internal structure are not clear, but appears to comprise a lower fill of parallel internal reflectors with multiple subsequent cuts with acoustically transparent fill. The lower fill was found by Vibrocore DBS_164_VC to comprise soft, silty, sandy clay. Possible remnants of a terrestrial feature, but exact nature is uncertain.
7701	Simple cut and fill	P2	0.8	11.4	Stage II	Simple cut and fill feature identified on multiple lines cutting into underlying sand/till and overlain by mobile seabed sand waves. Characterised by a relatively well-defined basal reflector and a generally acoustically transparent, but sometimes layered, fill. Possible remnants of a terrestrial feature, but exact nature is uncertain.

ID	Classification	Archaeological Discrimination	Depth Range (mBSB)		Landscape stage	Description
			From	To		
7702	Acoustic blanking	P2	0.6	1.3	Stage III	An area of acoustic blanking located at the top of bedrock and just below a relatively thin layer of seabed sediment. Bedrock at this location is interpreted to be mudstone based on Vibrocore DBS_071_VC. Unlikely to be shallow gas, but may be a localised gravel deposit or other preserved remnant terrestrial material deposited on top of the bedrock, but exact nature is uncertain.
7703	Channel	P1	0.5	4.4	Stage II	Distinct cut and fill feature cut into underlying bedrock, overlain by a thin veneer of seabed sediment. Characterised by a relatively poorly defined, undulating basal reflector and a single phase of acoustically layered fill. The feature crosses the entire route, oriented approximately north-south, and is located within a bathymetric depression along a similar orientation that may be a related underfilled part of the channel, but this is uncertain. Possible preserved fluvial channel.
7704	Simple cut and fill	P2	0.7	2.6	Stage II	Possible very poorly defined cut and fill feature cut into the underlying Bolders Bank Formation. Characterised by a poorly defined basal reflector and weak, acoustically layered fill. Possibly a preserved fluvial channel, but may be an internal till or seabed sediment feature.
7705	Channel	P1	0.5	3.5	Stage II	Broad, relatively shallow cut and fill feature cut into the underlying Bolders Bank Formation. Characterised by a generally well-defined basal reflector and a single phase of acoustically layered fill. Possible preserved fluvial feature.
7706	Simple cut and fill	P2	0.5	1.3	Stage II	Relatively small cut and fill feature cut into the underlying Bolders Bank Formation. Generally characterised by a well-defined packet of basal reflectors and overlying acoustically transparent/unstructured fill. Possible preserved terrestrial feature, maybe fluvial in nature but this is uncertain.

ID	Classification	Archaeological Discrimination	Depth Range (mBSB)		Landscape stage	Description
			From	To		
7707	Erosion surface	P1	0.2	5.1	Stage III	A relatively strong, extensive reflector visible either directly on top of the Bolders Bank Formation, or between the top of the Bolders Bank Formation and the seabed pulse. Vibrocore data (DBS_0003_VC, DBS_002_VC, and DBS_A01_VC) indicate the surface is overlain by a sand unit, probably the modern seabed sediment. The reflector is generally fairly sub-horizontal, but with a number of mounded features that appear to be buried asymmetric dunes, suggesting a current and/or wind direction towards the present-day coast. The sand overlying the erosion surface thickens towards the centre of the feature and then thins rapidly towards the coast. As it thins, the dune features start to protrude above seabed and are visible in the MBES data (these are mapped separately as feature number **7708**). This surface is potentially the post-glacial/pre-transgression land surface, potentially a beach deposit (but this is uncertain). The overlying sand is generally featureless, but there are pockets of basal well-layered areas associated with the dunes that are potentially preserved intertidal deposits dating from the marine transgression.
7708	Erosion surface	P1	-	-	Stage III	An area of possible relict dunes associated with erosion surface **7707** exposed at seabed and mapped using MBES data. The crests of the dune features are generally exposed and trend approximately north-south, whilst the troughs are covered in superficial modern seabed sediment. the overlying sediment likely moves over time, leading to the features being periodically fully buried or more exposed than they are at present. The dunes are asymmetric in nature, suggesting a current/wind direction towards the coast. This surface is potentially the post-glacial/pre-transgression land surface, potentially a beach deposit (but this is uncertain).
7709	Simple cut and fill	P2	1.9	4.3	Stage III	Possible cut and fill feature cut into Bolders Bank Formation and located lower in the stratigraphy than erosion surface **7707**. Characterised by a generally well-defined basal reflector and single phase of acoustically layered or unstructured fill. Could be the remnants of a fluvial feature, or be an internal feature within the till.

ID	Classification	Archaeological Discrimination	Depth Range (mBSB)		Landscape stage	Description
			From	To		
7710	Erosion surface	P2	0.2	0.7	Stage III	Well defined, shallow reflector located between two dune features exposed at seabed. Possible erosion surface, potentially an isolated remnant of feature **7707** but could be the base of modern sediments.
7711	Simple cut and fill	P2	0.3	3.0	Stage III	Small cut and fill feature cut into the Bolders Bank Formation, characterised by a well-defined basal reflector and single phase of acoustically unstructured fill. Possibly the remnants of a fluvial feature, but exact nature is uncertain.
7712	Simple cut and fill	P2	0.3	3.6	Stage III	Distinct cut and fill feature cut into the Bolders Bank Formation. Characterised by a well-defined basal reflector and single phase of acoustically chaotic fill, but only identified on a small number of survey lines. Possible remnants of a mostly eroded fluvial feature.
7713	Channel	P1	-	-	Stage III	A curvilinear mound approximately 1.5 km long trending approximately WNW-ESE across part of the nearshore area. Mapped from the MBES data and does not have a significant buried component, but appears as an irregular mound in cross section in the SBP data. Potentially the remnants of a fluvial channel, possibly comprising stiff, fibrous peat or other cohesive material that has resisted erosion relative to the surrounding sediment (although the feature has not been directly sampled by vibrocore). The south-east end terminates within the exposed dune features of **7708**, but the relationship between the dunes and the channel is difficult to determine from the data.
7714	Mound	P2	-	-	Stage III	An irregular, curvilinear mound approximately 300 m long located approximately 120 m SSW of channel **7713**, also identified from the MBES data only. May indicate an associated terrestrial/fluvial feature, but this is unclear.
7715	Simple cut and fill	P2	0.3	1.9	Stage III	Small cut and fill feature cut into the Bolders Bank Formation, characterised by a well-defined basal reflector and single phase of acoustically unstructured fill. Possibly the remnants of a fluvial feature, but exact nature is uncertain.

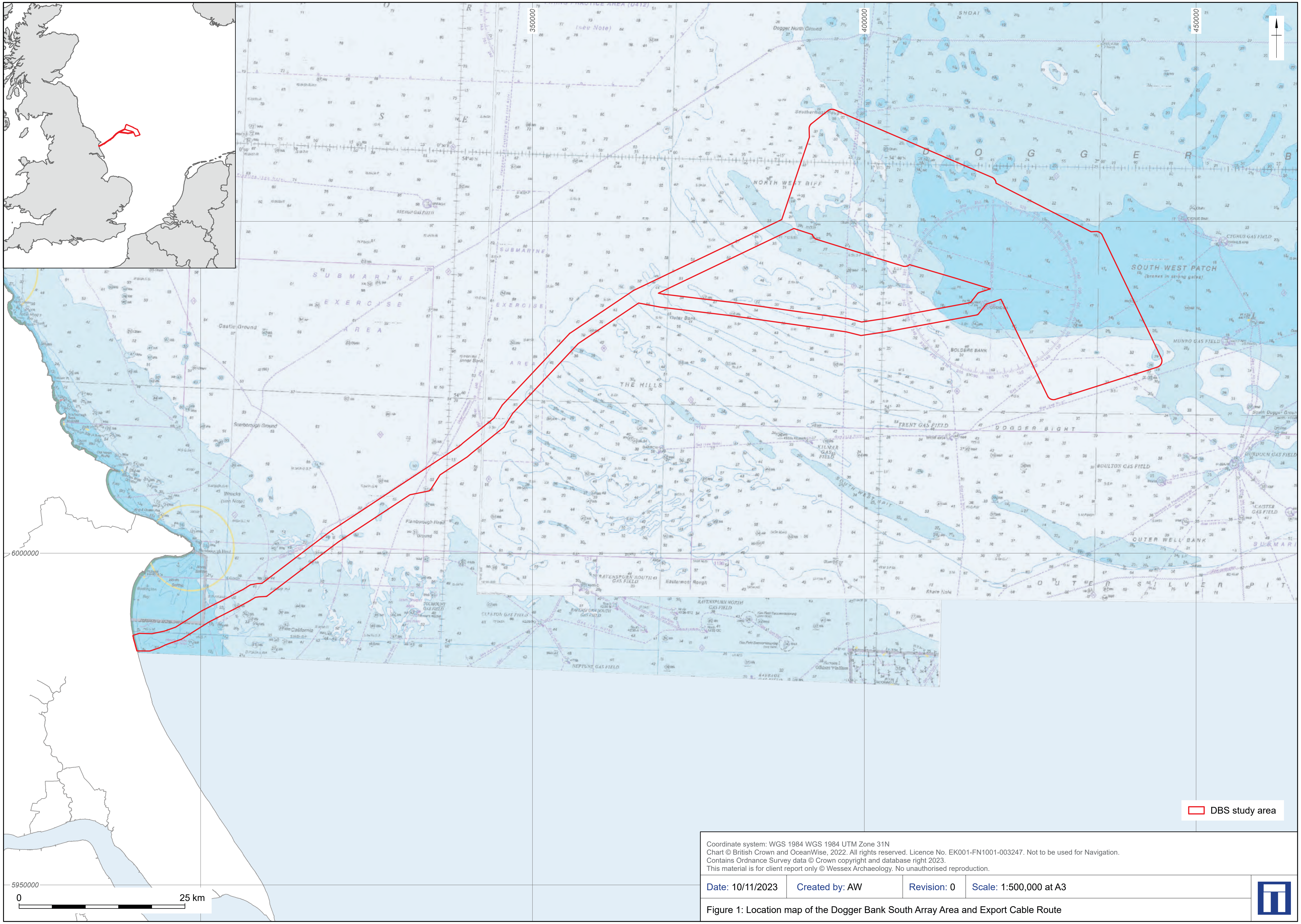
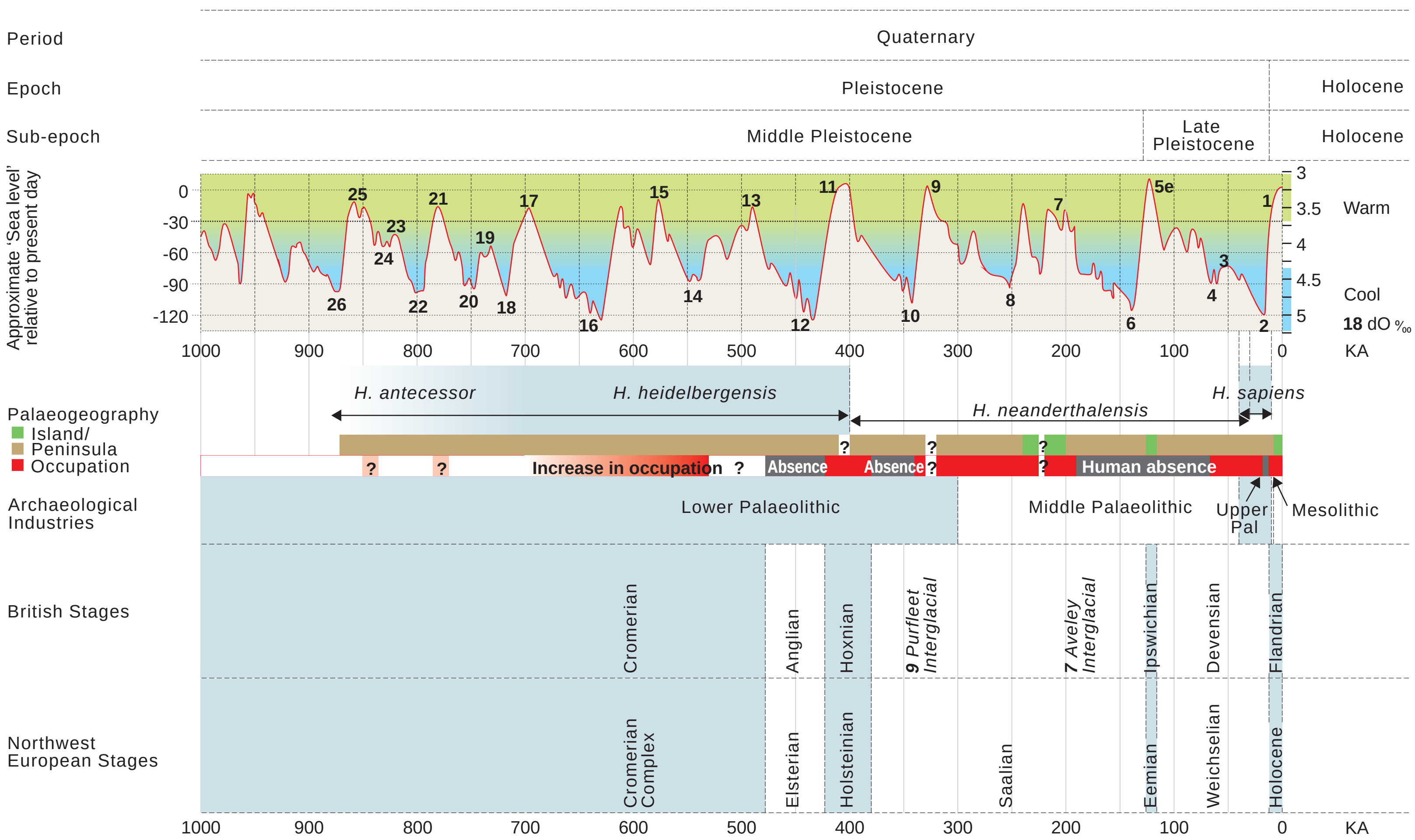


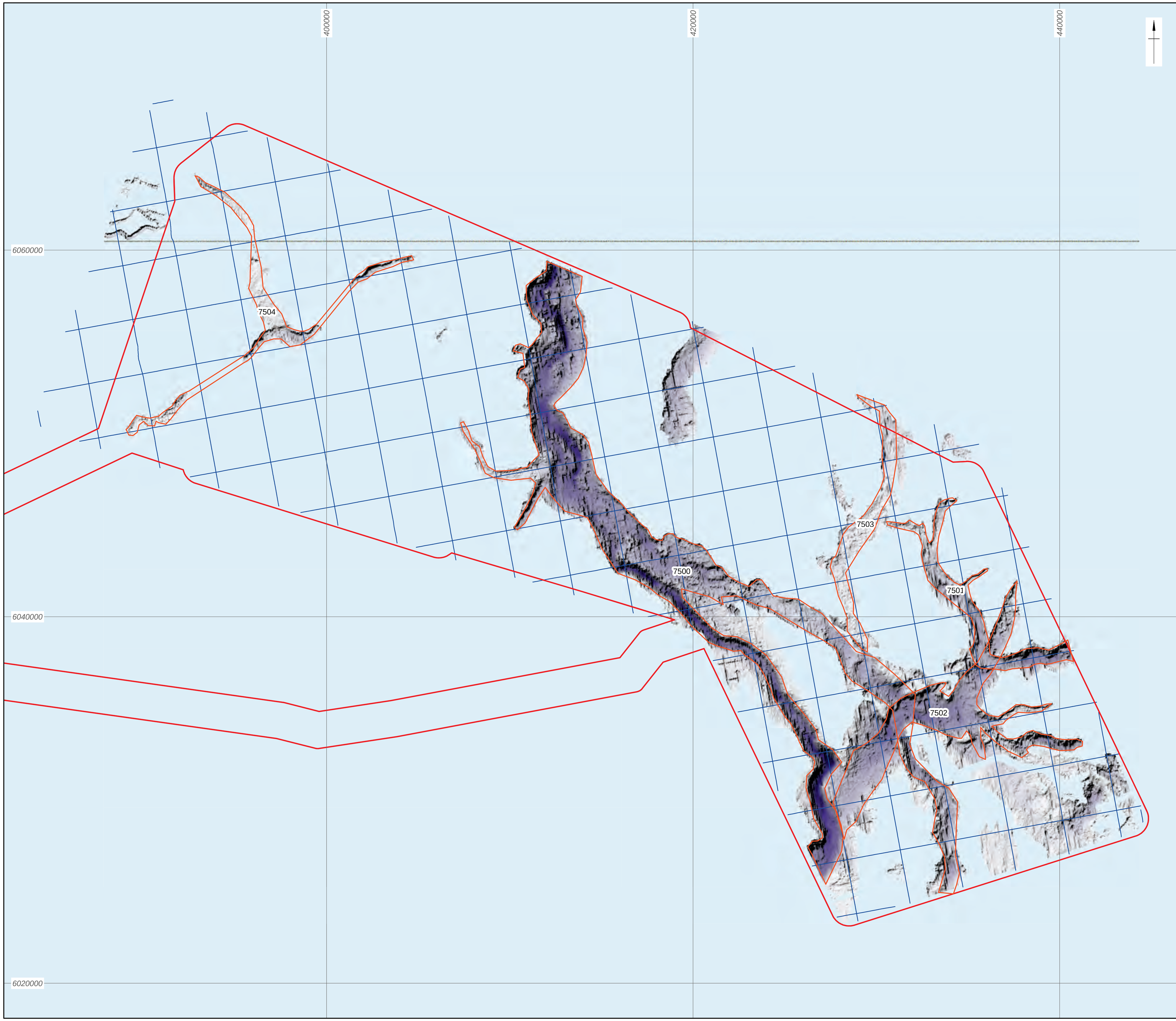
Figure 1: Location map of the Dogger Bank South Array Area and Export Cable Route

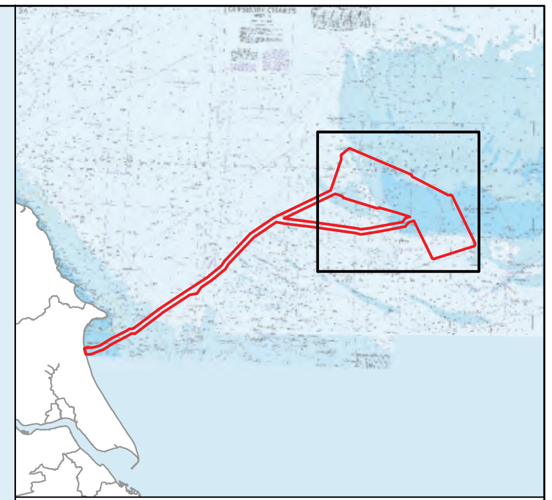


The figure presents information derived from several references: the global sea-level curve is from Lisiecki and Raymo (2005) and Jelgersma (1979). Details on the geology and archaeology were provided by Dix and Westley (2004); Funnel (1995); Gibbard and van Kolfschoten (2004); Kukla et al. (2002); Lee et al. (2006); Lowe and Walker (1997) and Wymer (1999).

Date: 12/10/2023	Created by: KJF	Revision: 0	Scale: NTS at A4

Figure 2: Sea level curve and chronology of the southern North Sea landscape





Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N
Elevation data from Fugro seismic interpretation (Fugro 2023a-e).

Date: 15/11/2023	Created by: AW
Scale: 1:200,000 at A3	Revision: 0

Figure 3: Landscape Stage 0 channel palaeolandscape features

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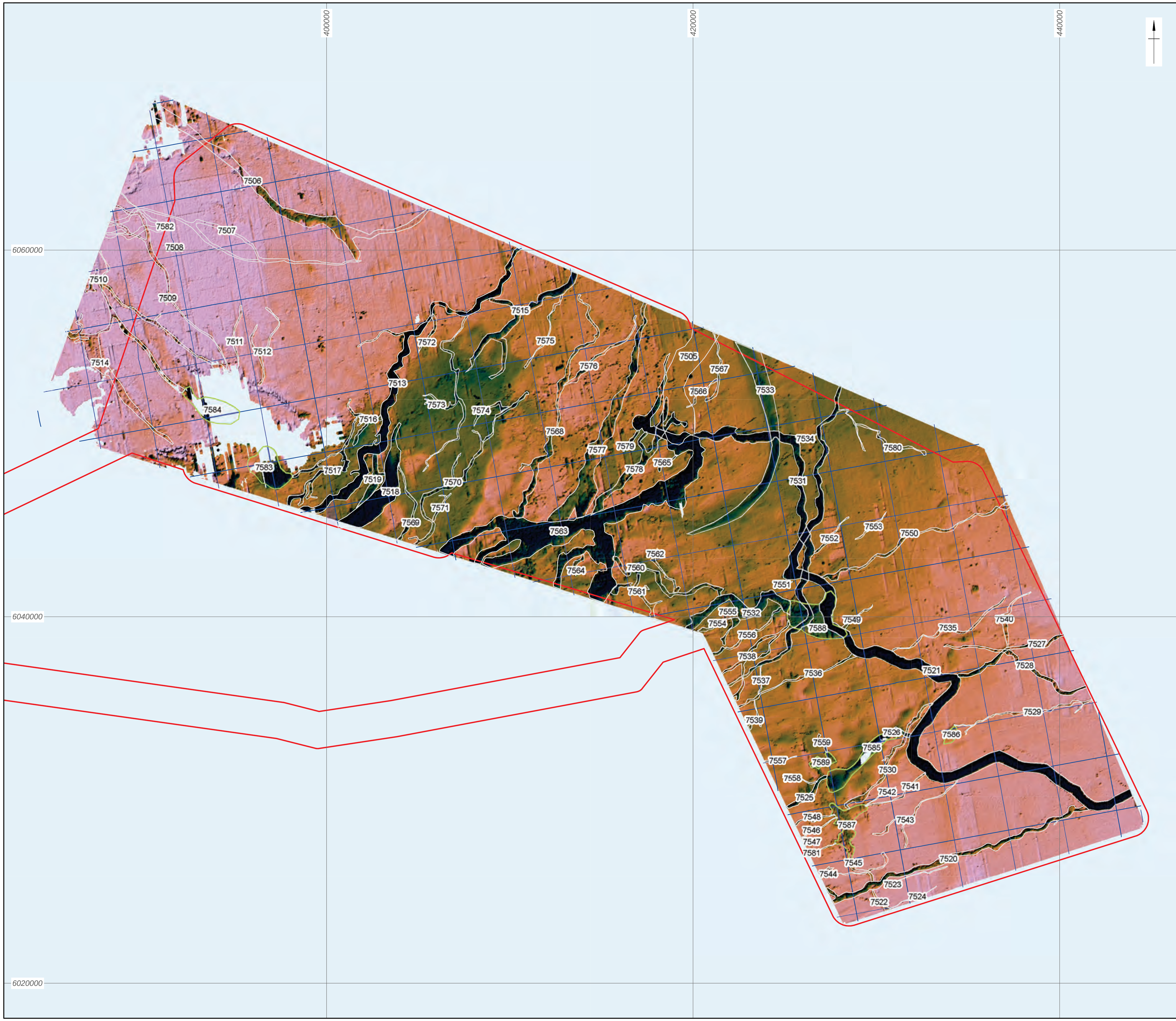

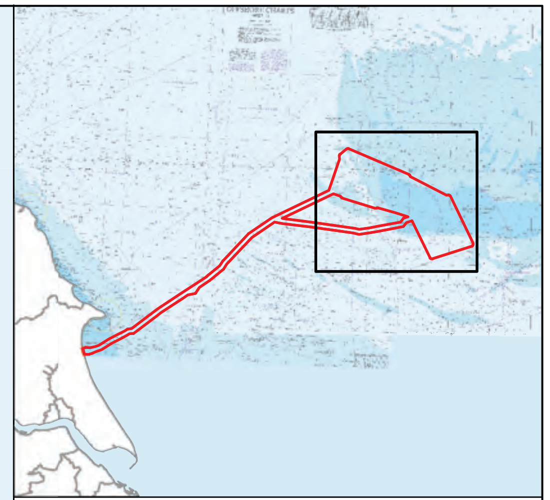

DBS study area
Landscape Stage I channel palaeolandscape features
Landscape Stage I basin palaeolandscape features
Trackplots

Elevation:
-50 m
-80 m

0 10 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N
Elevation data from Fugro seismic interpretation (Fugro 2023a-e).

Date: 17/11/2023	Created by: AW
Scale: 1:200,000 at A3	Revision: 0

Figure 4: Landscape Stage I channel and basin palaeolandscape features

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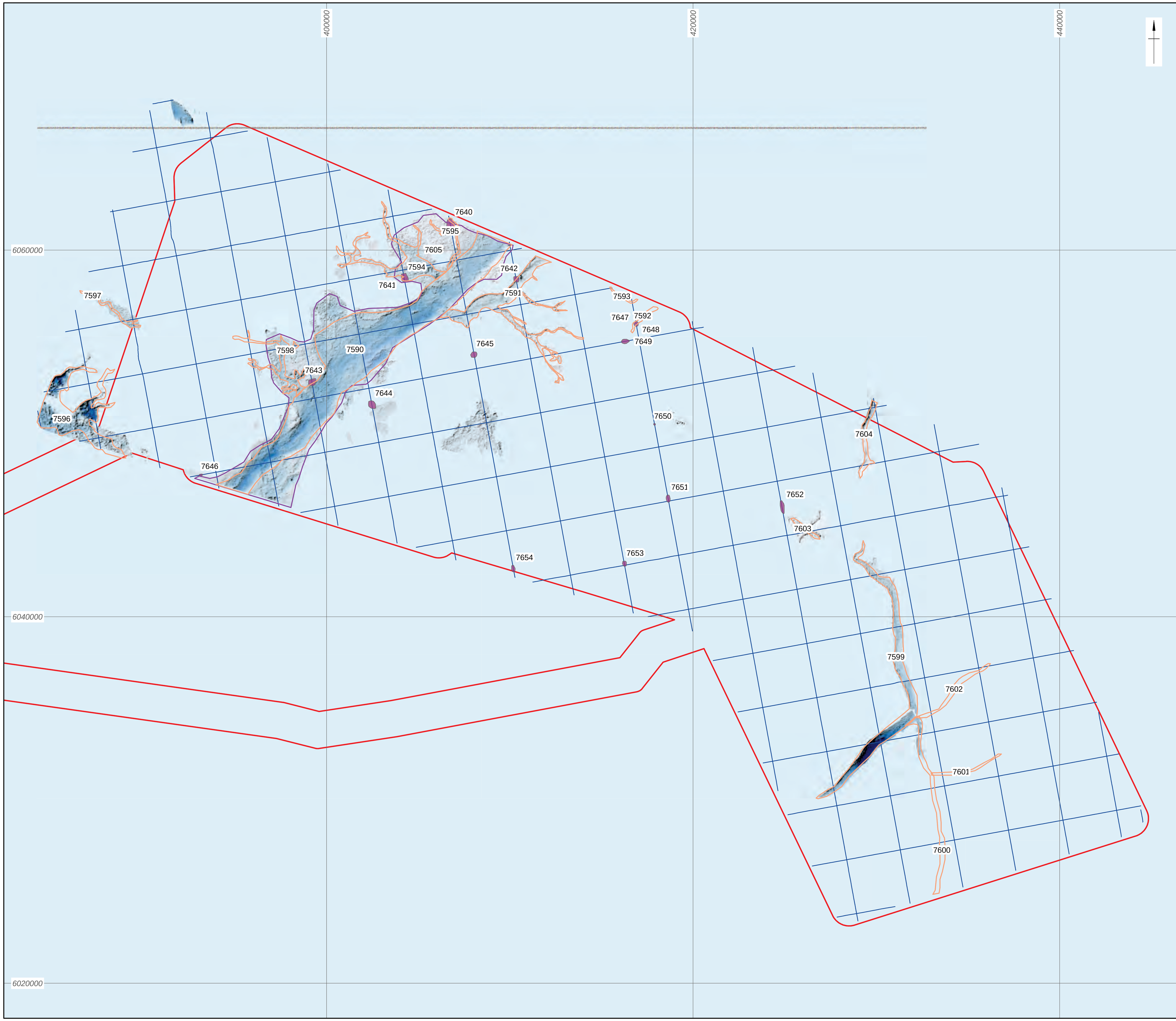
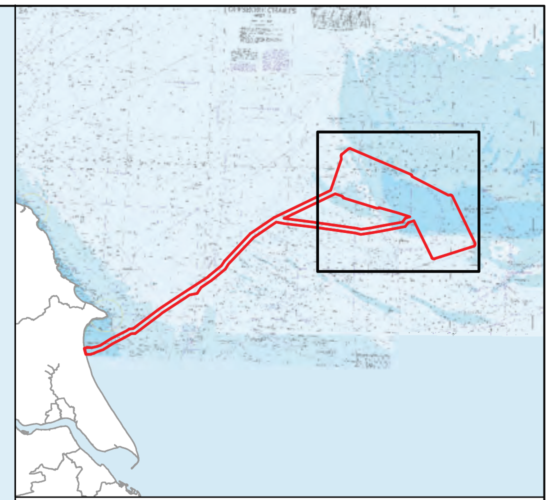




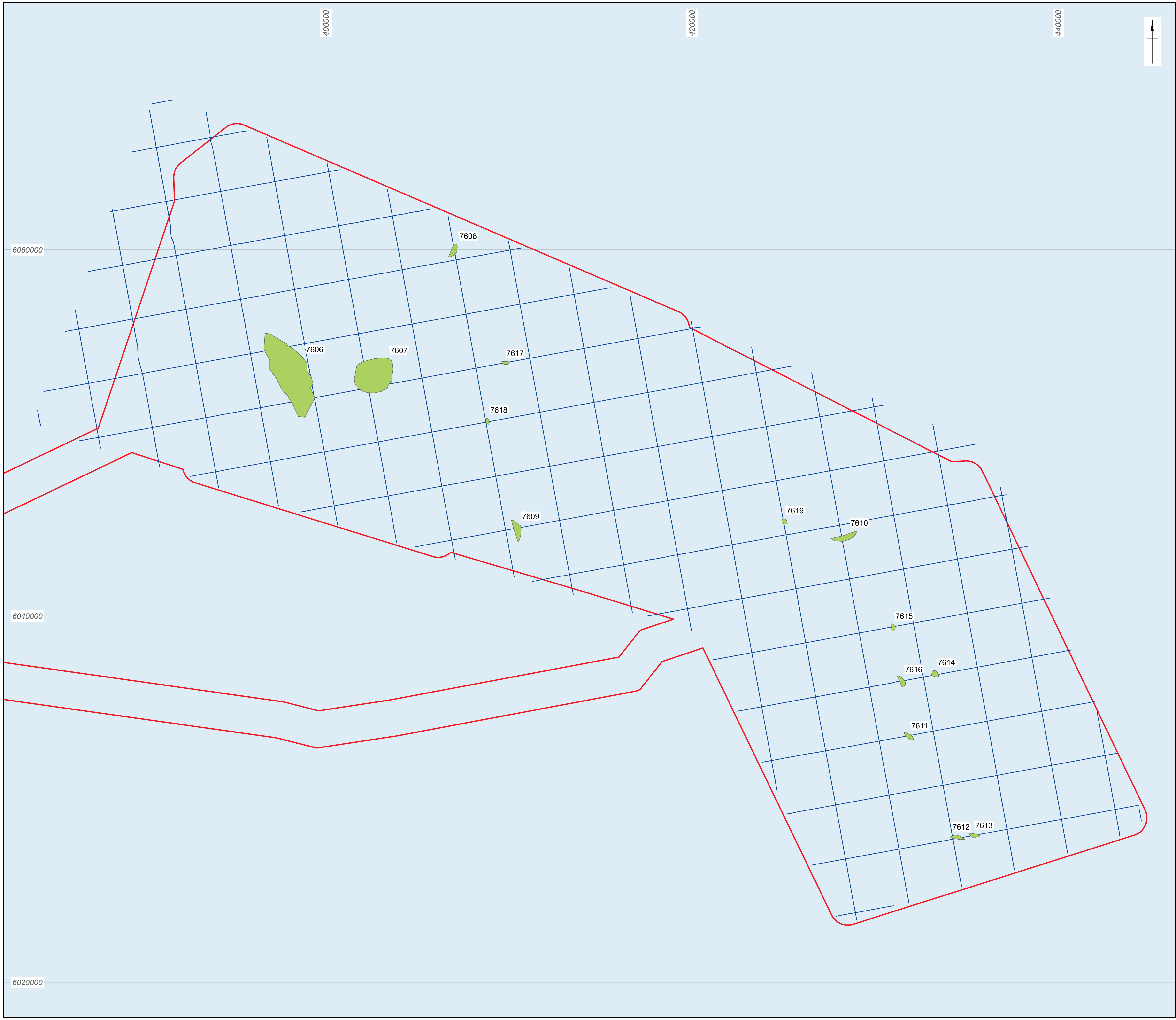
DBS study area
Landscape Stage II channel palaeolandscape features
Landscape Stage II basin palaeolandscape features
Landscape Stage II and III bright reflection palaeolandscape features
Trackplots
Elevation:
-20 m
-70 m

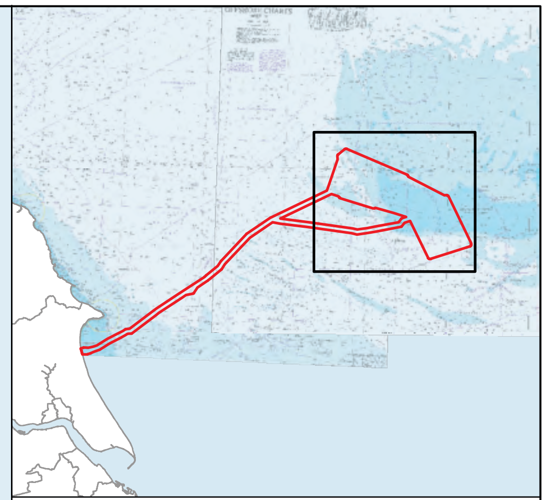
0 10 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N
Elevation data from Fugro seismic interpretation (Fugro 2023a-e).

Date: 15/11/2023	Created by: AW
Scale: 1:200,000 at A3	Revision: 0

Figure 5: Landscape Stage II channel and basin palaeolandscape features





DBS study area
Landscape Stage III clinoform wedge palaeolandscape features
Trackplots

0 10 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 15/11/2023 | Created by: AW
Scale: 1:200,000 at A3 | Revision: 0

Figure 6: Landscape Stage III clinoform wedge palaeolandscape features

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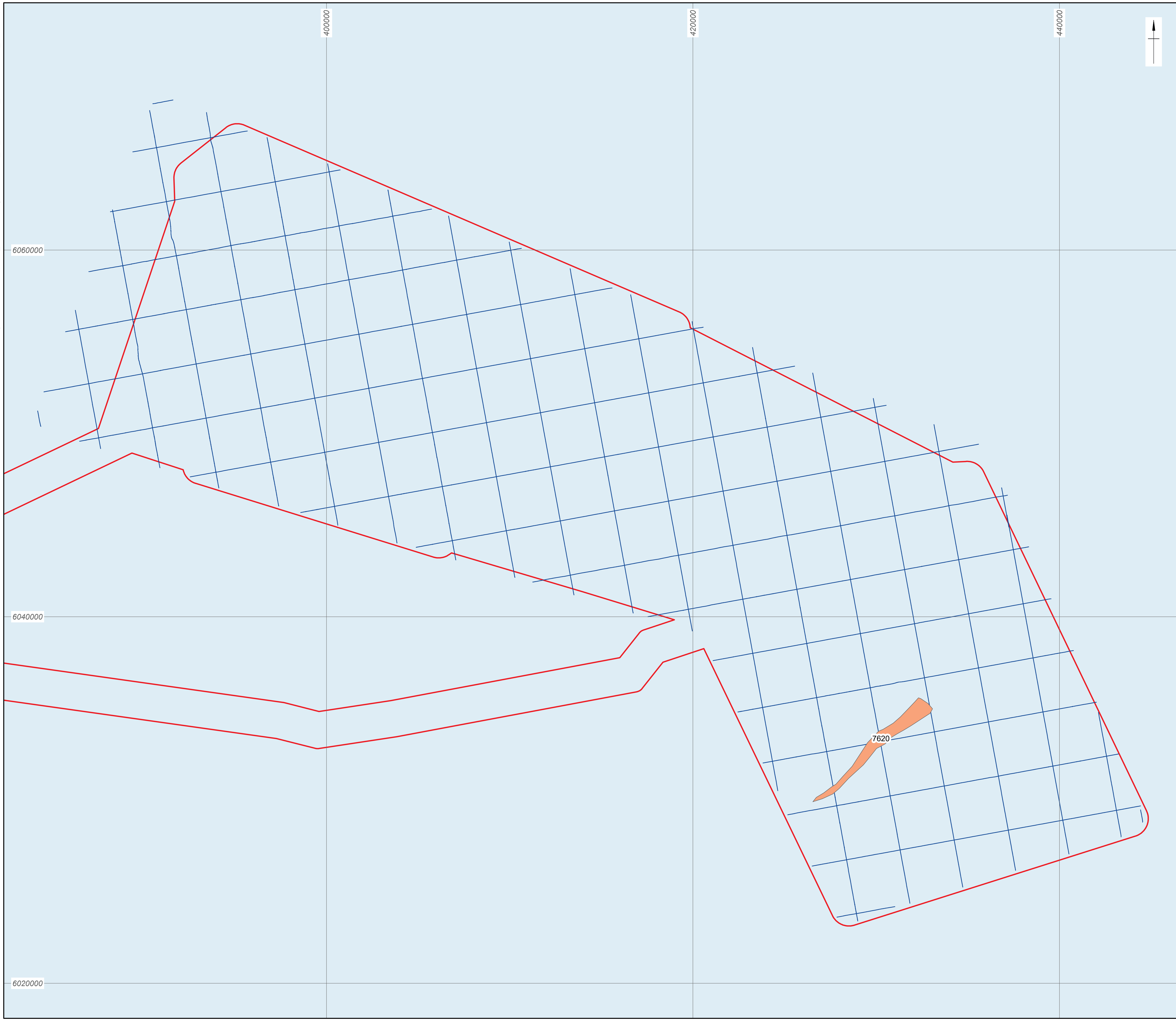

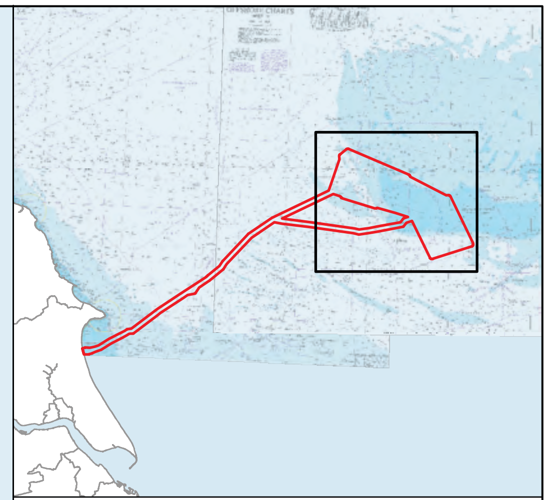

DBS study area
Landscape Stage III fill palaeolandscape features
Trackplots

0 10 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 15/11/2023 | Created by: AW
Scale: 1:200,000 at A3 | Revision: 0

Figure 7: Landscape Stage III fill palaeolandscape features

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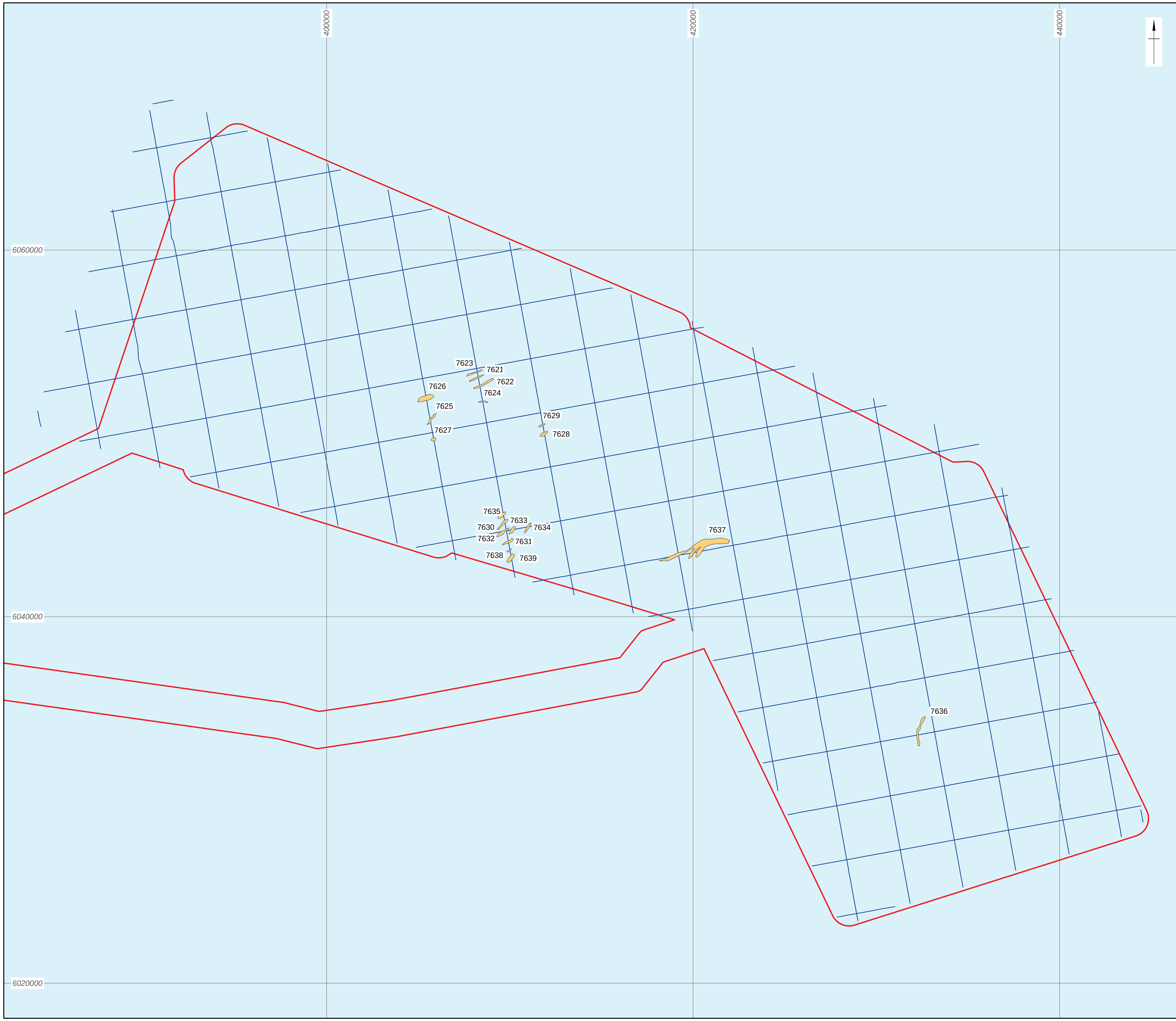

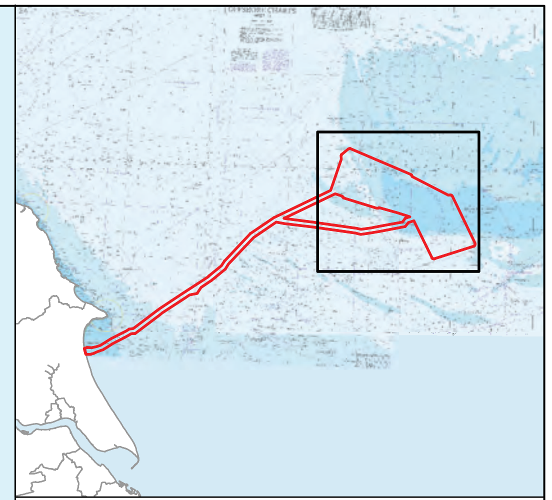

DBS study area
Landscape Stage III mound palaeolandscape features
Trackplots

0 10 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023	Created by: AW
Scale: 1:200,000 at A3	Revision: 0

Figure 8: Landscape Stage III mound palaeolandscape features

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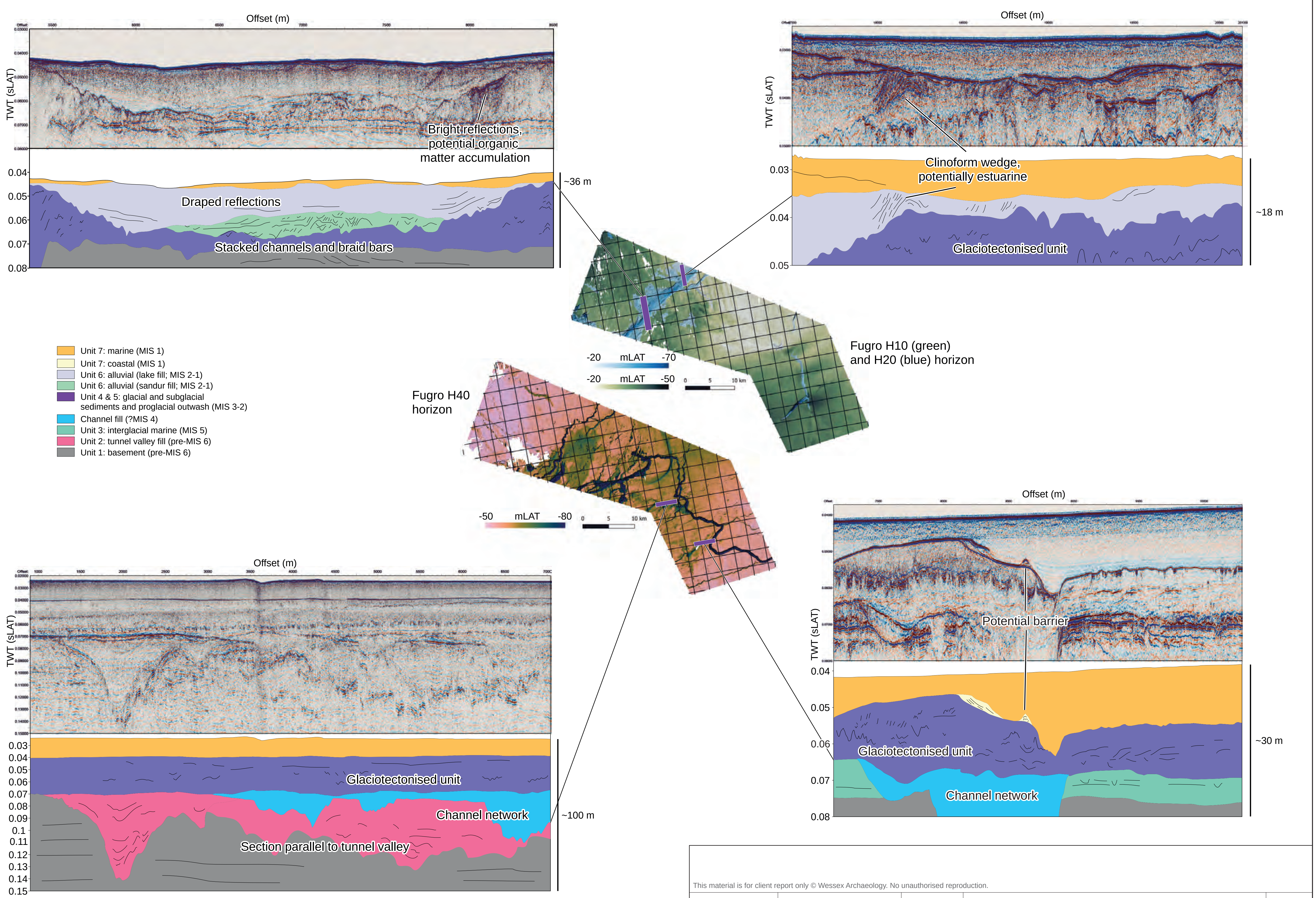
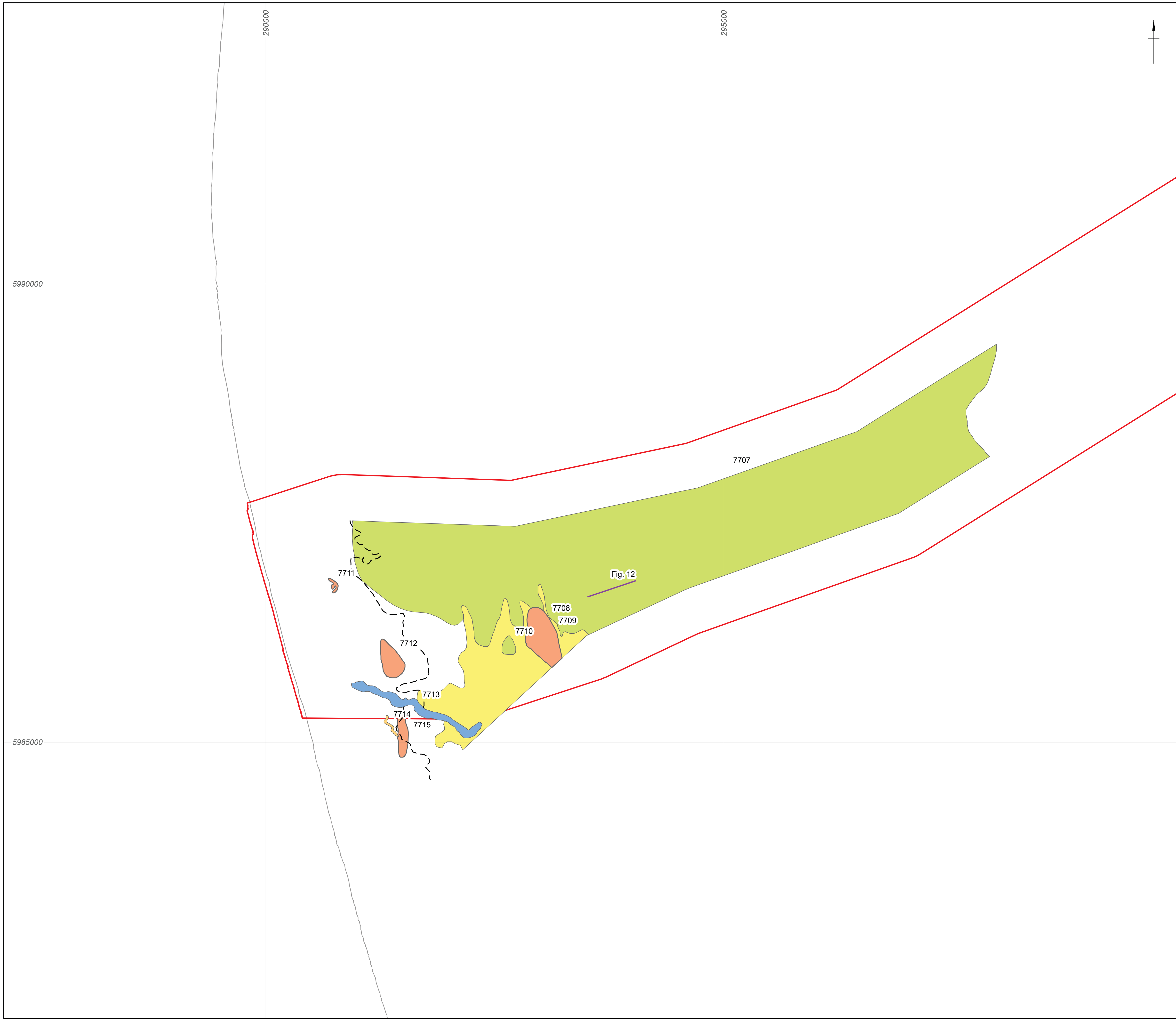
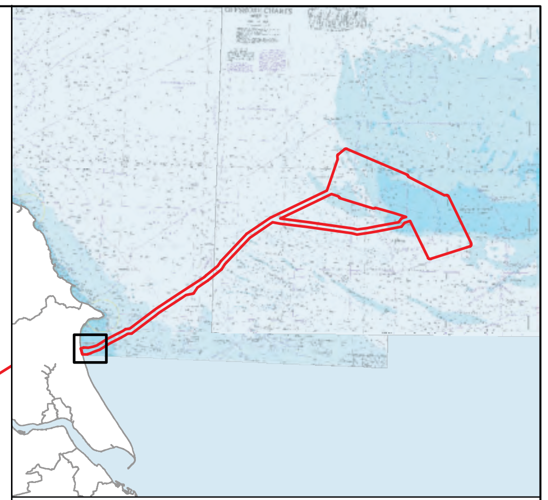


Date: 12/10/2023 | Created by: AE / AW | Revision: 0 | Scale: NTS at A3

Figure 9: Seismic section showing examples of palaeolandscape features observed, along with surfaces used for interpretation of features





DBS study area
SBP Data example locations
Possible nearshore peat extents
Palaeogeographic features of archaeological potential
Channel
Erosion surface
Erosion surface (exposed)
Mound
Simple cut and fill

0 2 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023	Created by: AW
Scale: 1:40,000 at A3	Revision: 0

Figure 10.1: Palaeogeographic features of archaeological potential identified along the ECR

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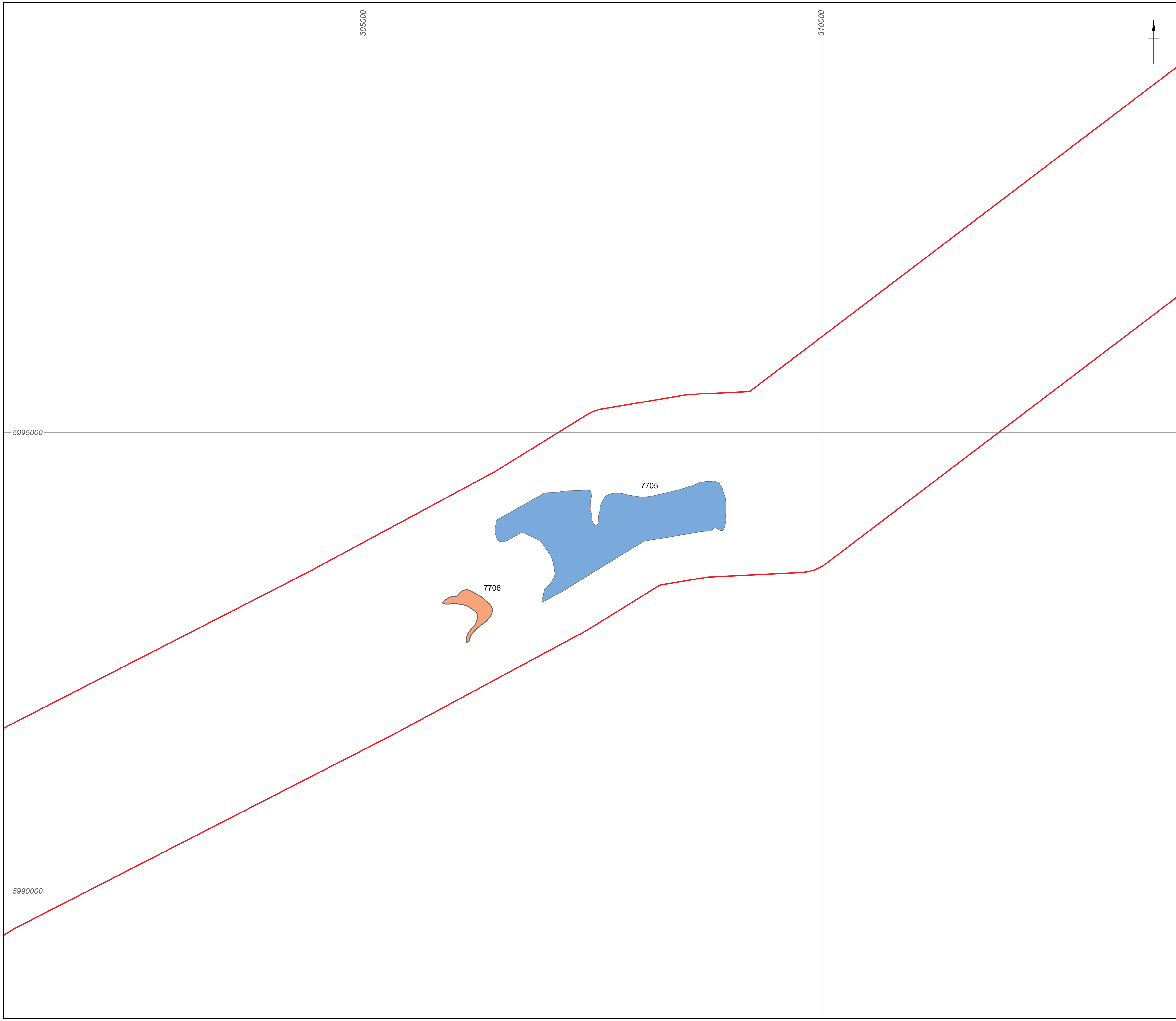
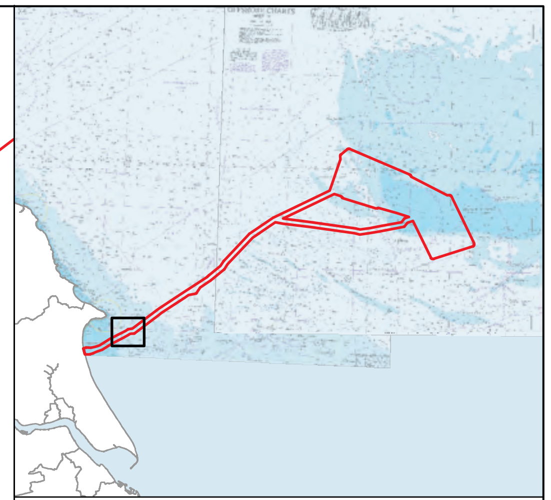




DBS study area

Palaeogeographic features of archaeological potential

Channel

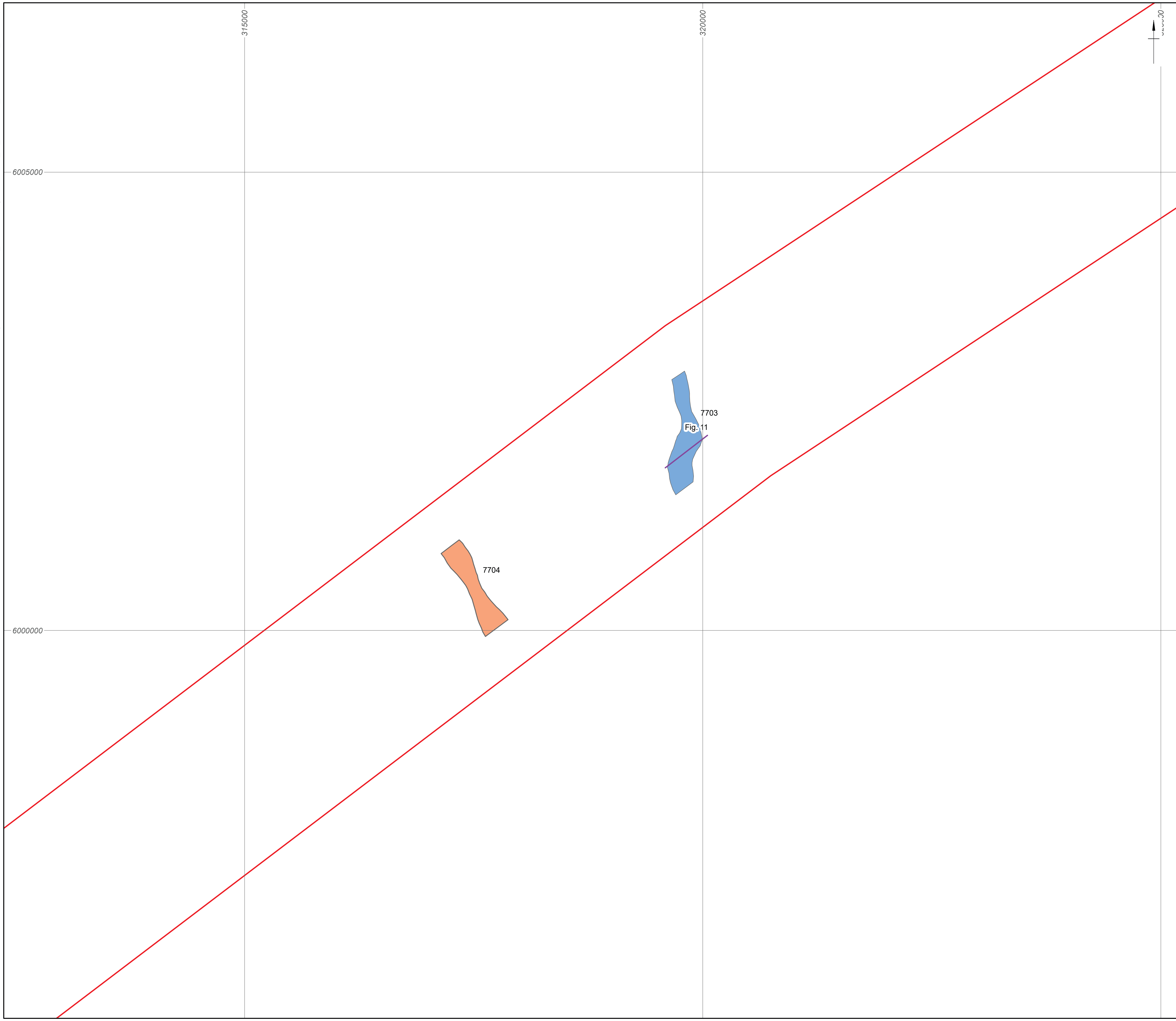
Simple cut and fill

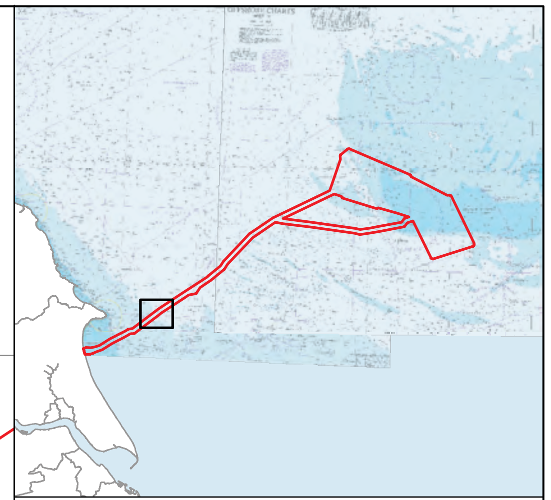
0 2 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023	Created by: AW
Scale: 1:40,000 at A3	Revision: 0

Figure 10.2: Palaeogeographic features of archaeological potential identified along the ECR





DBS study area
SBP Data example locations
Palaeogeographic features of archaeological potential
Channel
Simple cut and fill

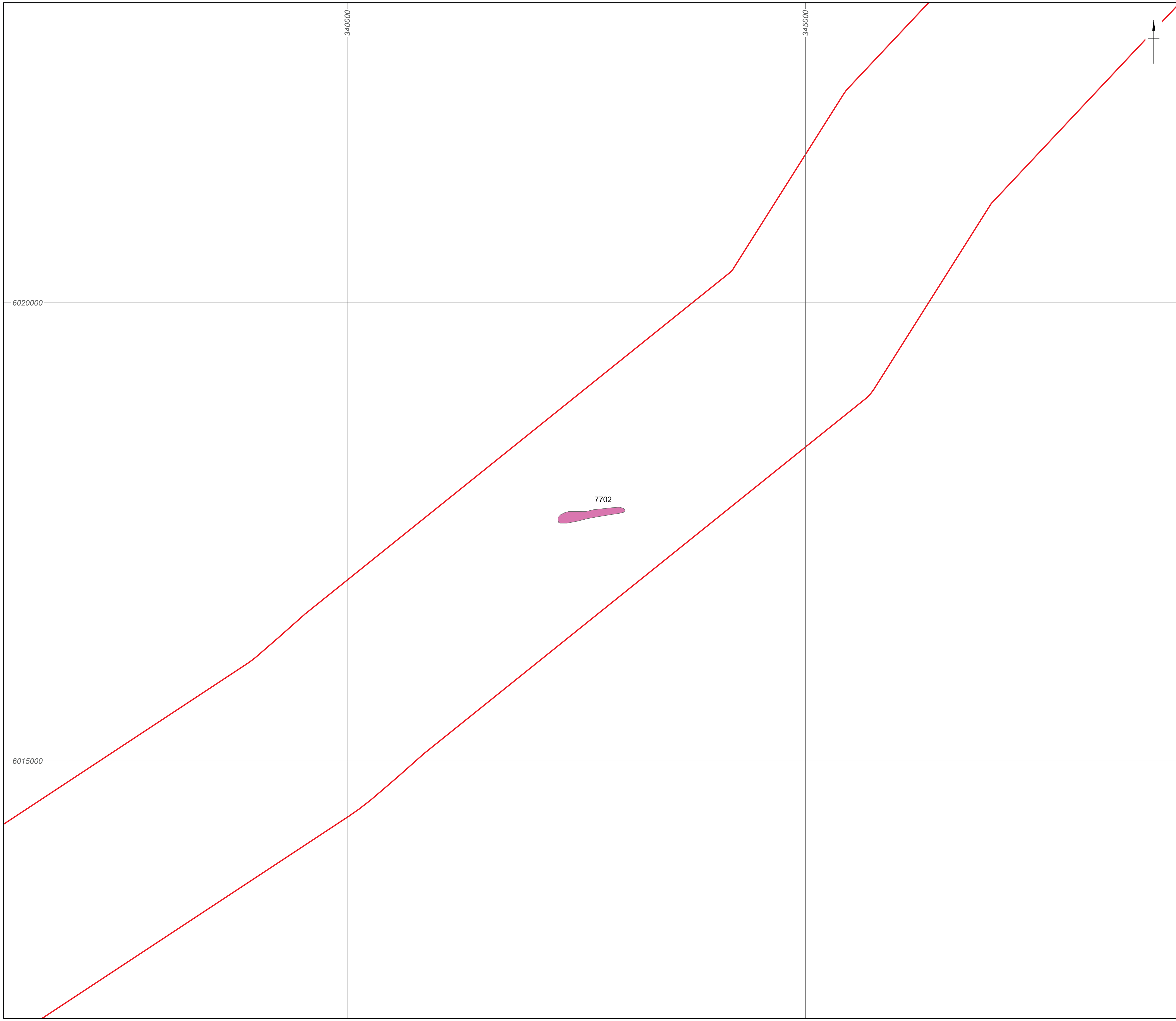
0 2 km

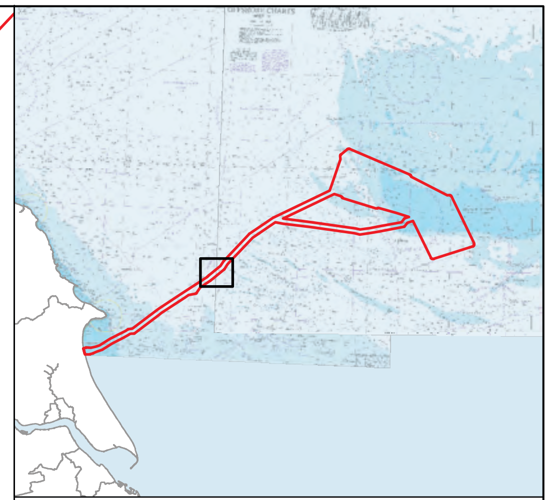
Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023 | Created by: AW

Scale: 1:40,000 at A3 | Revision: 0

Figure 10.3: Palaeogeographic features of archaeological potential identified along the ECR





DBS study area

Palaeogeographic features of archaeological potential

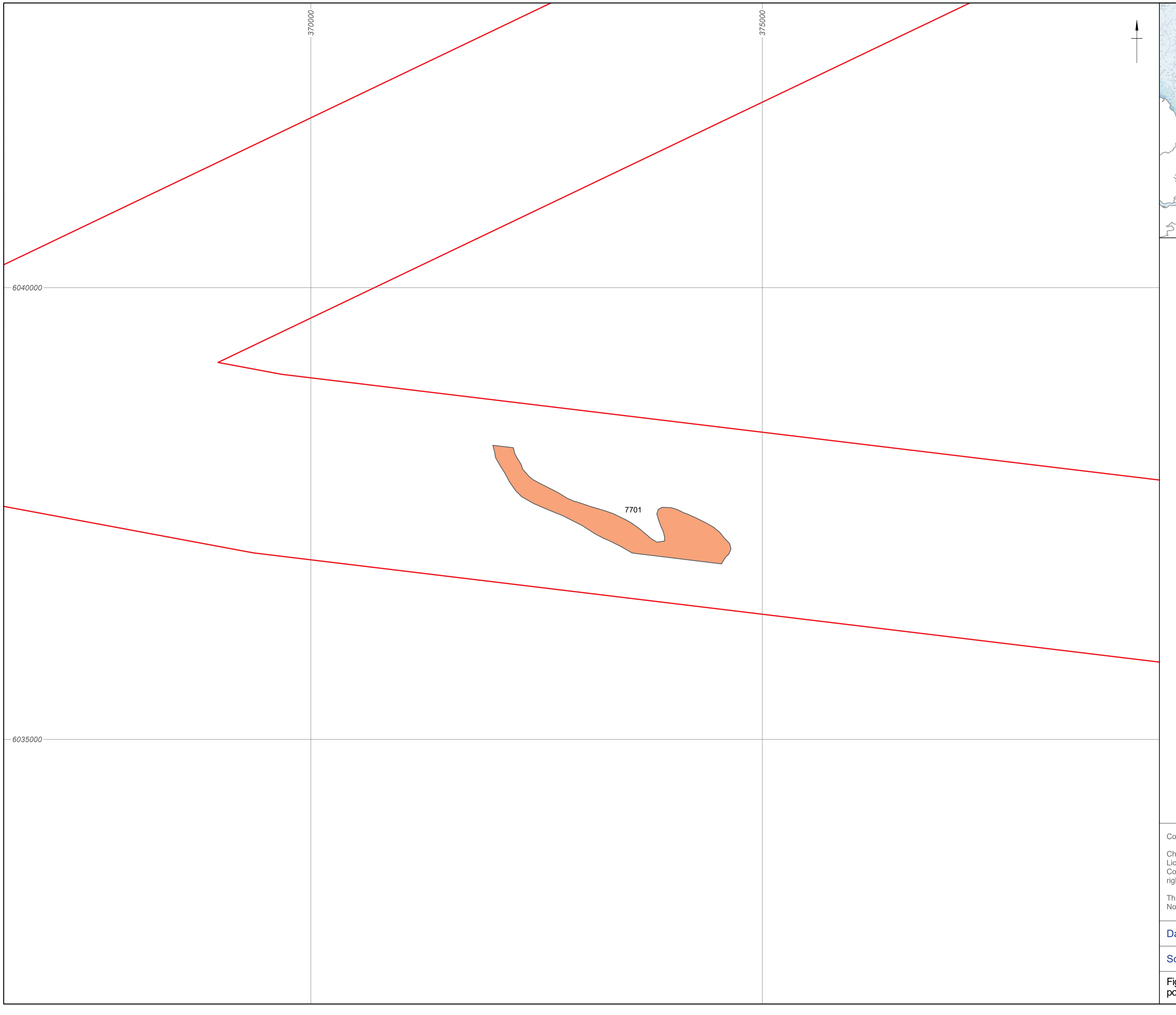
Acoustic blanking

0 2 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023	Created by: AW
Scale: 1:40,000 at A3	Revision: 0

Figure 10.4: Palaeogeographic features of archaeological potential identified along the ECR



Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023 | Created by: AW
Scale: 1:40,000 at A3 | Revision: 0

Figure 10.5: Palaeogeographic features of archaeological potential identified along the ECR

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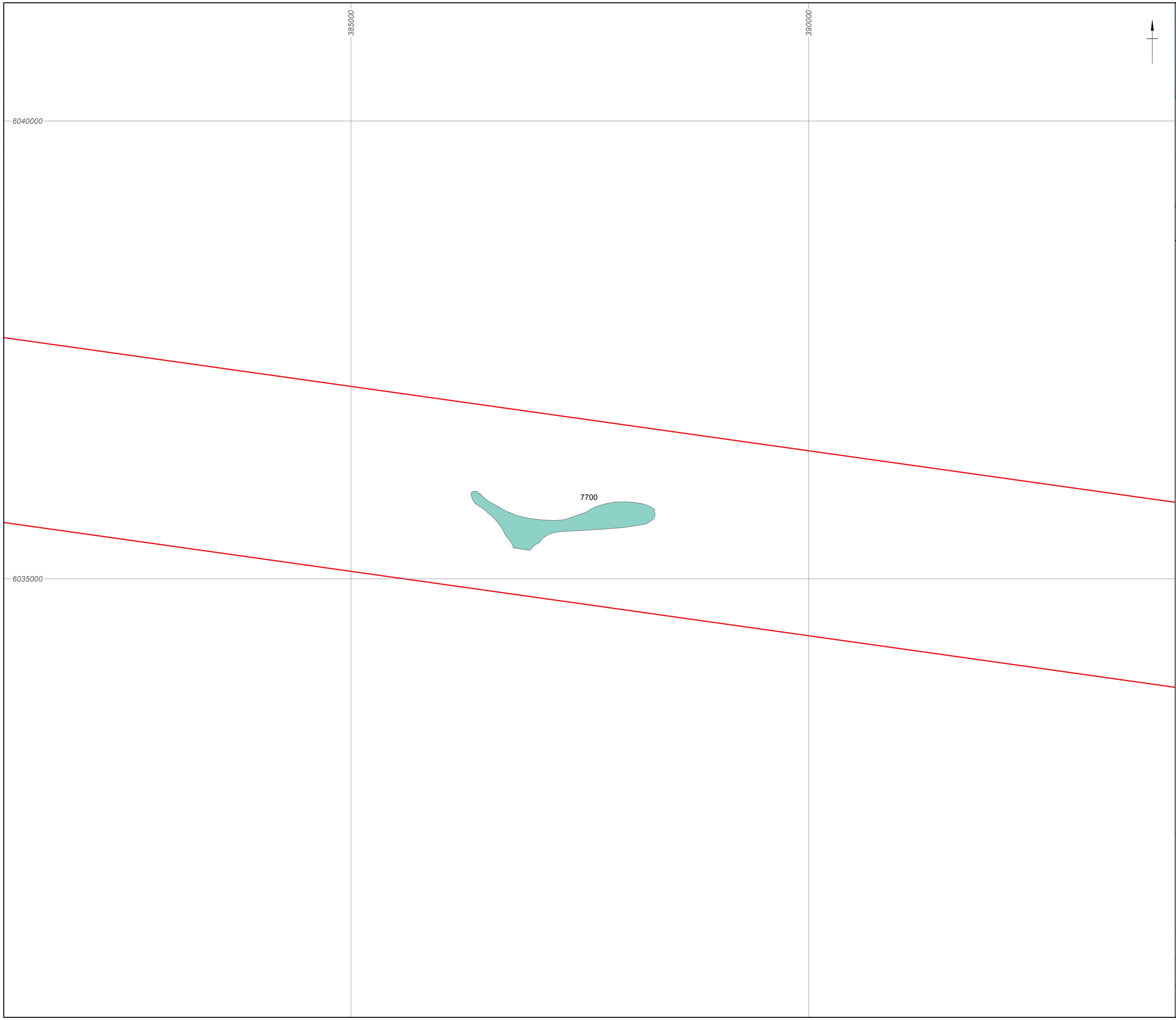

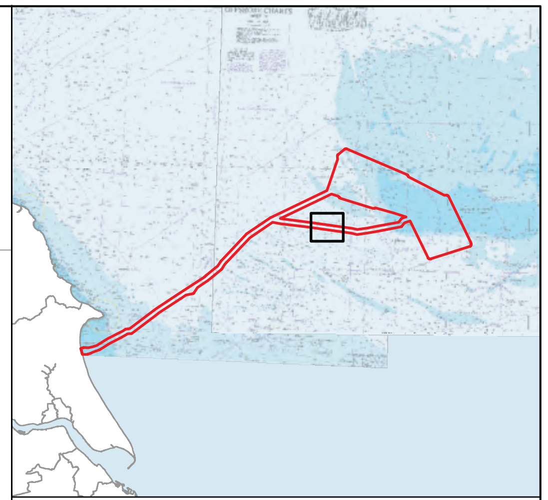

DBS study area
Palaeogeographic features of archaeological potential
Complex cut and fill

0 2 km

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 14/11/2023 | Created by: AW
Scale: 1:40,000 at A3 | Revision: 0

Figure 10.6: Palaeogeographic features of archaeological potential identified along the ECR

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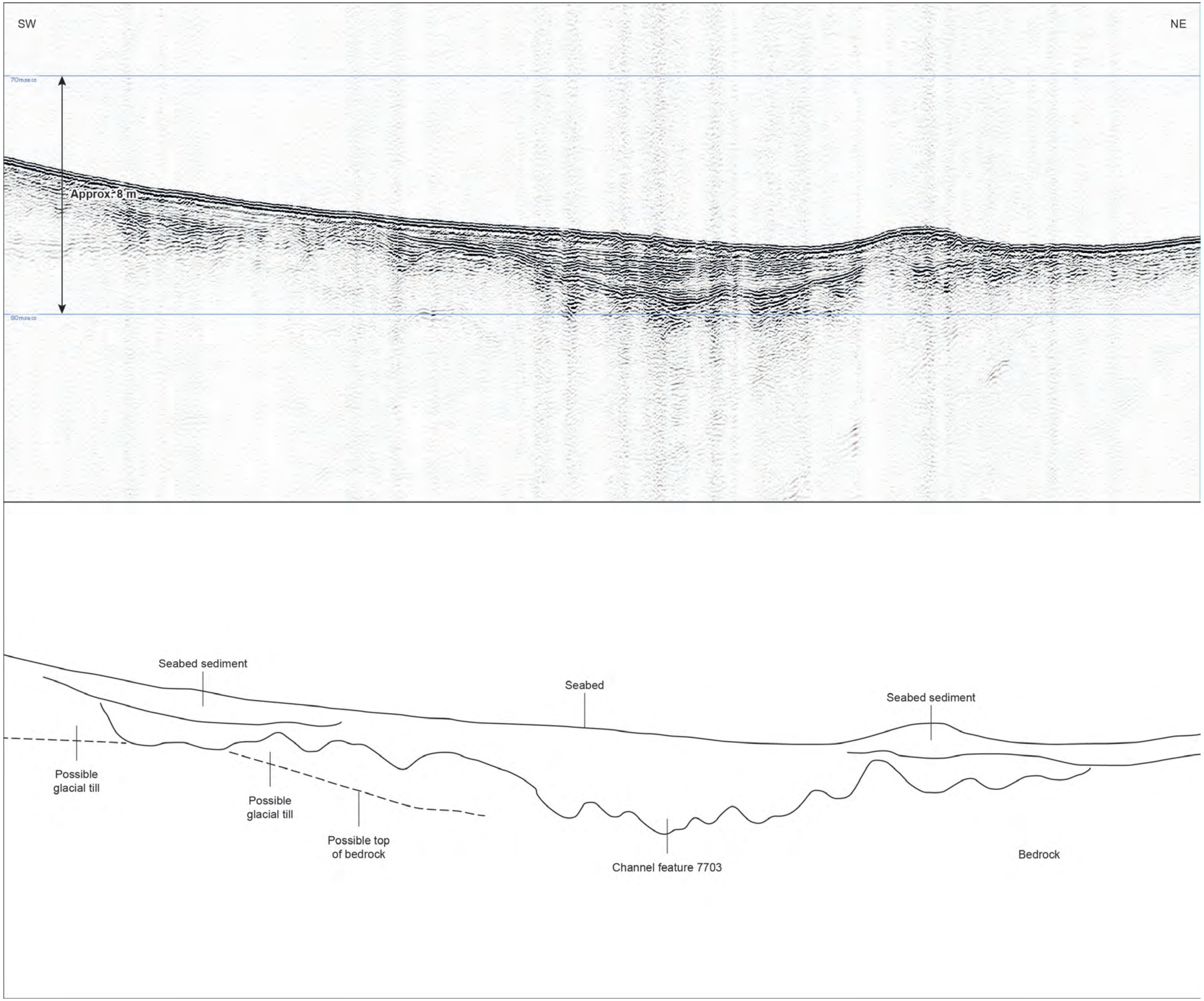

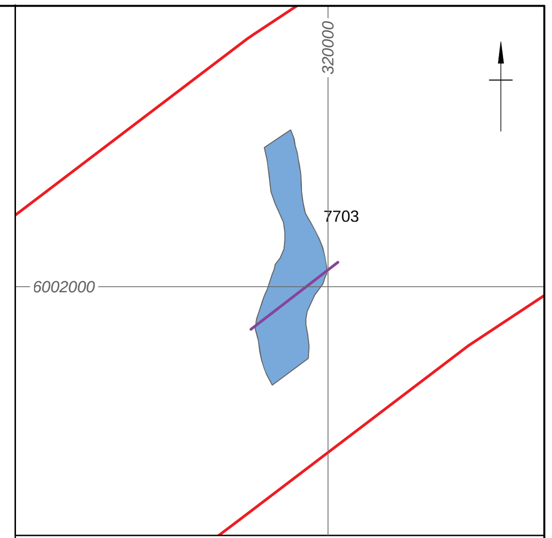

0 2 km

DBS study area
SBP Data example locations
Palaeogeographic features of archaeological potential
Channel

Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 12/10/2023 | Created by: AW

Scale: 1:40,000 at A3 | Revision: 0

Figure 11: SBP data example – channel 7703

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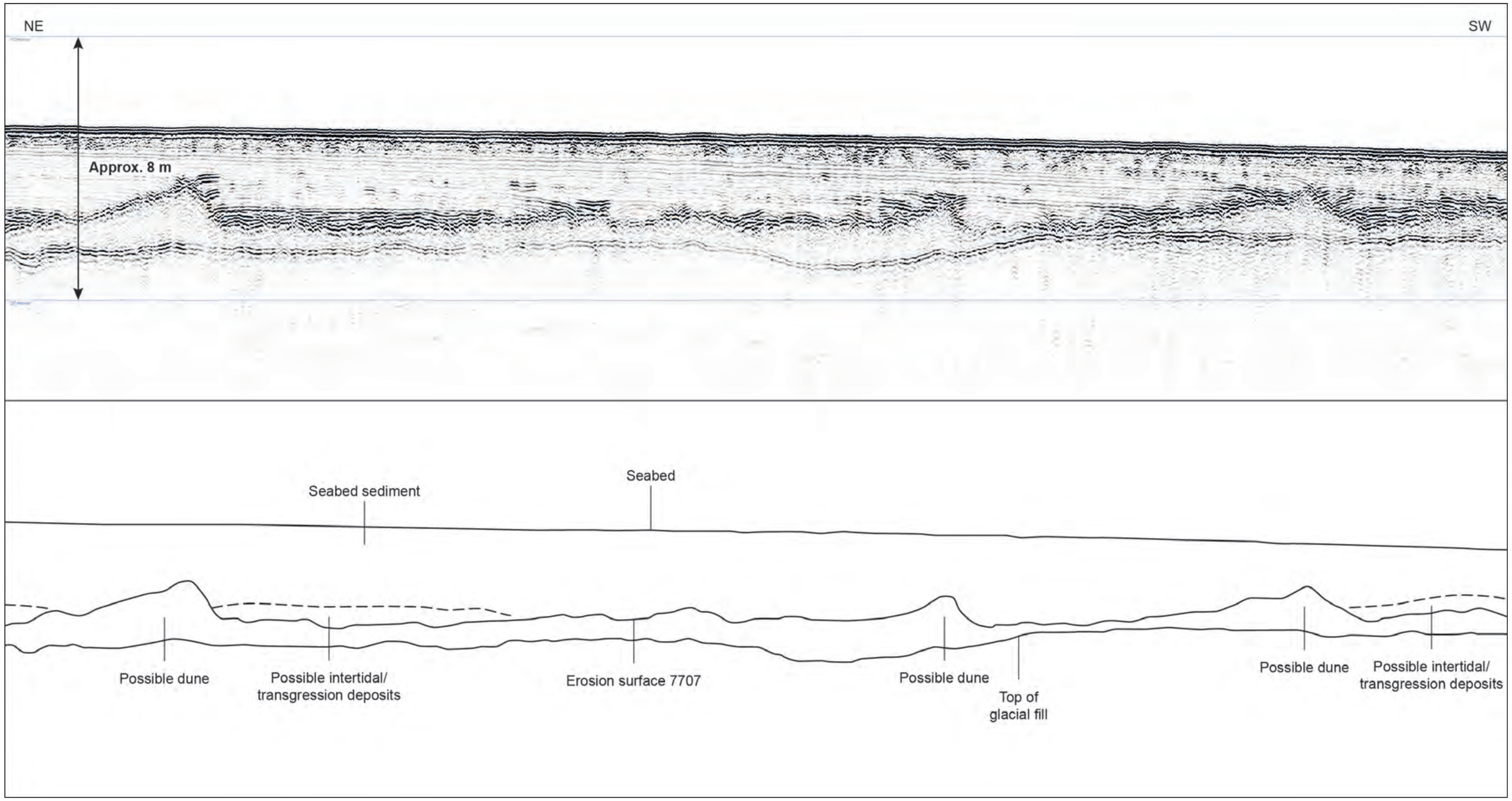
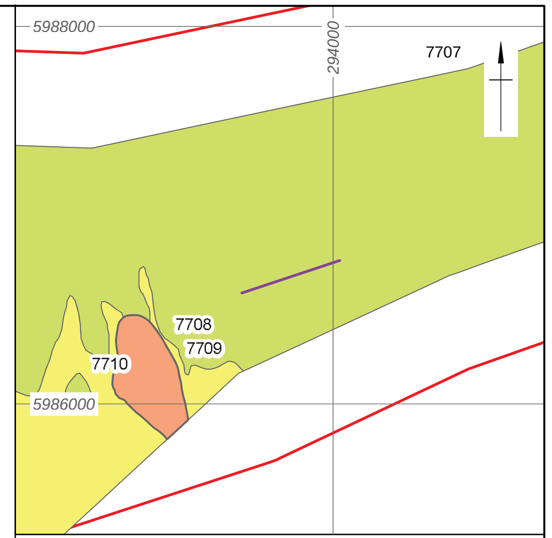




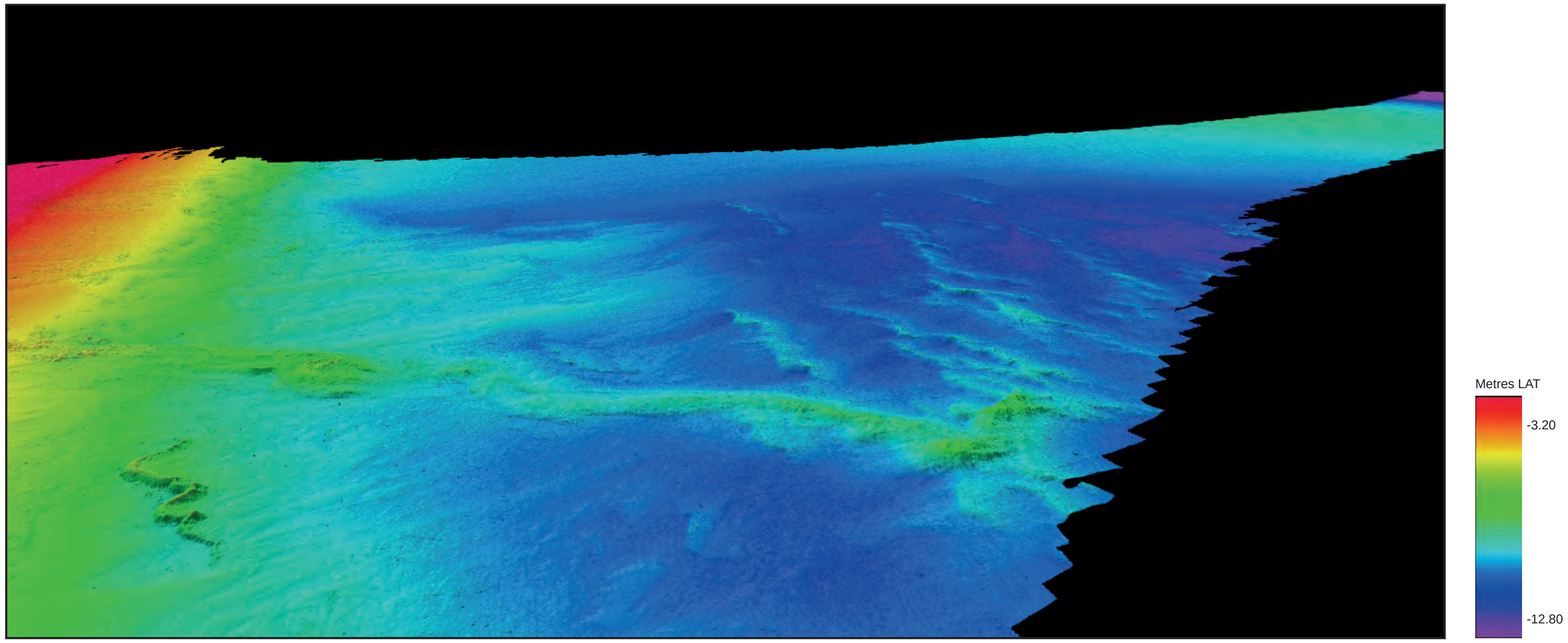
0 2 km

DBS study area
SBP Data example locations
Palaeogeographic features of archaeological potential
Erosion surface
Erosion surface (exposed)
Simple cut and fill

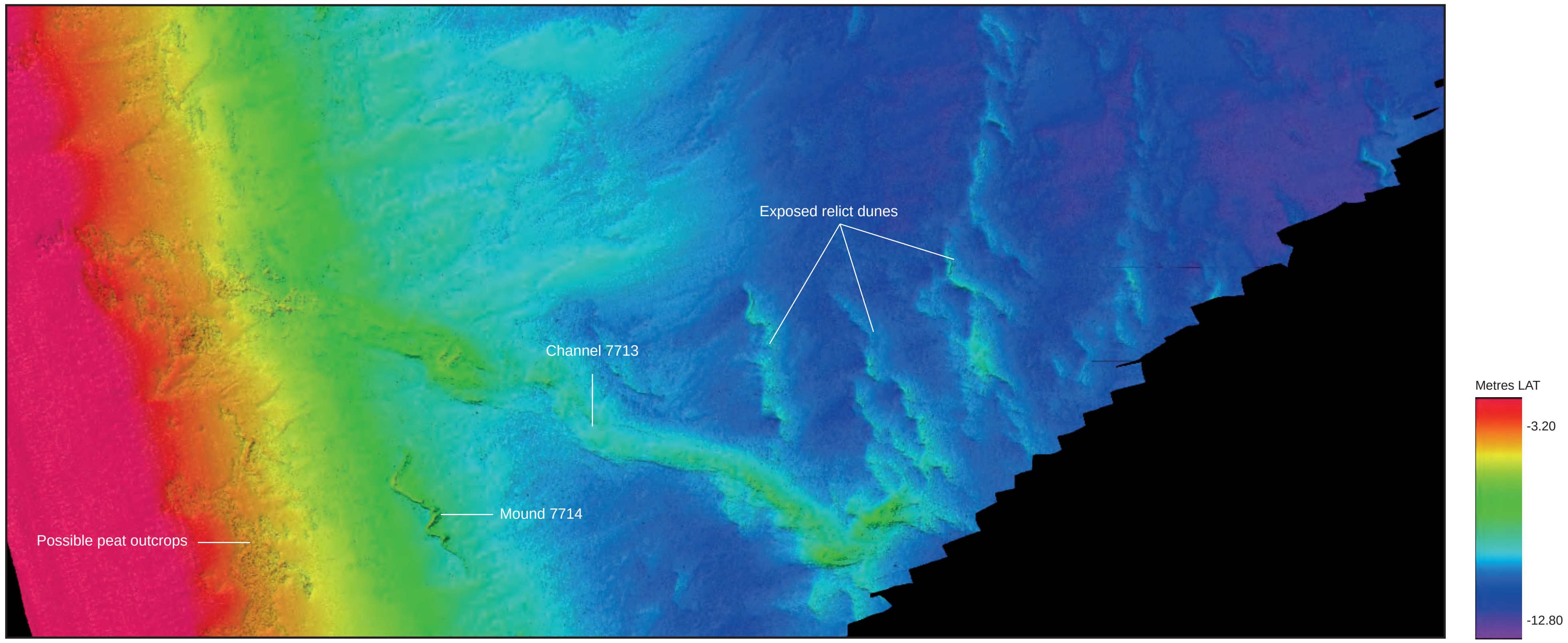
Coordinate system: WGS 1984 WGS 1984 UTM Zone 31N

Date: 12/10/2023	Created by: AW
Scale: 1:40,000 at A3	Revision: 0

Figure 12: SBP data example – erosion surface 7707



MBES image, looking north, x5 vertical exaggeration



MBES image, looking north, x5 vertical exaggeration

Date: 12/10/2023	Created by: AW	Revision: 0	Scale: NTS at A3

Figure 13: MBES data examples – nearshore dune and channel features

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