CHAPTER 07

Geology and Sediment

7. GEOLOGY AND SEDIMENT

This chapter of the ZAP report provides an overview of the geological and sedimentary environment of the ISZ only. No assessment of the impact of developing Potential Development Areas on the geological and sedimentary environment has been undertaken as part of ZAP.

The baseline environment established as part of ZAP has informed other assessments namely, Physical Processes (Chapter 8) and Marine Ecology (Chapter 11).

Impacts associated with the entire lifecycle of projects (construction, operation, decommissioning etc) will assessed as part of subsequent EIAs.

7.1 Introduction

This chapter provides a brief description of the geology and sediments found within the ISZ. The majority of information within this chapter has been obtained from an in-depth geophysical survey that was undertaken between February and August 2010.

Sediment and geology are important physical components of the marine environment. From an engineering perspective the physical properties of ground conditions will influence site selection and foundation type. From an ecological perspective sediments are one of the main physical determinants of marine ecological communities.

7.2 Data sources and guidance

The main source of information which has informed this chapter is data collected as part of a geophysical survey by MMT between the 15th February and 19th August 2010 on the MV Franklin, with additional data obtained between the 13th and 22nd May 2010 on the MV Triad (MMT, 2011).

The dataset consisted of the following:

- Bathymetry – acquired multibeam echo sounder data across the ISZ with a suitable overlap to ensure 100% coverage of the seabed;
- Seabed features – acquire high resolution side scan sonar data over the ISZ to locate and identify debris, wrecks, sediment type, geomorphology and bedrock. Magnetometer data was acquired simultaneously with the side scan sonar; and
- Shallow geology – to acquire seismic data utilising sparker and chirp systems and identify significant boundaries in the shallow geology to the depth of bedrock or to a depth of at least 50 metres.

In addition to the data sources above the DTI Commissioned Report by Holmes and Tappin (2005) on the surficial geology and processes in the Irish Sea has also been used to inform this chapter.

7.3 Regional Irish Sea geological setting

On a regional scale, the Irish Sea has been shaped by large scale geology and is underlain by a number of major sedimentary basins, some of which may contain hydrocarbons, although to date, only the East Irish Sea basin has been commercially developed. Topographically, the region consists of a deeper channel in the west, with shallower embayments in the east. The deep channel is open-ended, connected at both ends to the Atlantic Ocean, in the south via St George's Channel and in the north via the North Channel. The extent of Atlantic inflow to the region varies with changes to large scale circulation patterns in the North-east Atlantic and weather, particularly the strength and direction of the prevailing winds.

The present seabed morphology and sediment distribution of the Irish Sea is due mainly to the interaction of historic glacigenic processes and subsequent exposure to tidal currents, waves and storms. Exposed bedrock and diamicton (mixed sediment) swept clean of sediments (e.g. as found in St George's Channel, north of Anglesey and the Isle of Man, and in the North Channel) characterise the most hydrodynamic seabed environments, with fine muddy sediments restricted to areas with low tidal and wave energy (e.g. the mud belts to the east and west of the Isle of Man). The region contains a range of seabed habitats of conservation interest.

During the last major glacial period (21,000-17,000 years ago), the regional ice sheets had merged across much of the northern British Isles and were flowing south (Lambeck 1995). In areas of the Irish Sea where the ice flow was accelerated, it gouged north-south and north-west-south-east elongated basins. During the waning stages, the ice retreated and deposited diamicton over large areas which it had previously eroded. These areas of diamicton were subsequently resistant to marine erosion. Other relevant glacial features are described in Chapter 8.

In the eastern Irish Sea there is a general transition south-east and east of the Isle of Man towards the coast from coarser-grained gravel and sand to mud (Holmes and Tappin, 2005). To the west and south-west of the Isle of Man, the Western Irish Sea Mud Belt forms an extensive area of muddy sediments. Within sandy and gravelly areas, there are extensive fields of sand ribbons and sand waves as well as barchan (arc shaped) dunes. In St George's Channel and Cardigan Bay there is a dominance of coarser sand and gravel.

7.4 Irish Sea Zone geological setting

The ISZ geological setting has been described from the work undertaken by MMT in 2010 and summarized below. Unsurprisingly given the size and location of the ISZ its geological setting exhibits much of the regional Irish Sea geological setting as described above.

7.4.1 Surface and sub surface sediments

Figure 7.1 provides an overview of the surficial geology found in the ISZ. The surficial sea bed sediments are predominantly comprised of sand and gravel in the west, east and northwestern regions of the ISZ. Most of the central section is comprised of unsorted glacial sediment, occasionally shelly, comprising gravel, cobbles and boulders in a fine grained matrix (commonly referred to as diamicton). Bed rock exposures occur in the central south of the ISZ.

Boulder clays and Tills are present below the gravels and muds, being variable and composed of clay or sand materials. These strata may include cobbles and boulders within the soil matrix as a result of its glacial origin.

Glacial Till deposits in the ISZ are referred by the British Geological Survey as the Cardigan Bay Formation and comprise the upper and lower Till members which were deposited during the beginning of the Quaternary period (approximately 2 million years ago). The upper and lower Till is composed of stiff or hard clays with cobbles and boulders. There are significant variations in the thickness of the various deposits in the ISZ such as depth to Till and depth to bedrock. Initial investigations into depth to Till sediments have identified a range between 0m and 75m. Subsequent geotechnical investigations planned for the ISZ (see section 7.5 below) will improve this interpretation.

Depth to underlying bedrock is also variable across the ISZ with initial geophysical interpretation identifying a range of 0-100m with the largest depths found in the western section of the ISZ (Figure 7.2). Further refinement of this interpretation will occur through geotechnical surveys and cores of the seabed.

The sediments described above overly rock from either the Triassic or Carboniferous periods. Bedrock refers to the pre quaternary strata underlying the glacial Till and the bedrock found in the Irish Sea Zone is believed to be predominantly made up of mudstone occasionally overlain by sandstone.

Chapter 8, Physical Processes, provides more detail on surficial and sub-surface sediment types found across the ISZ.

7.4.2 Seabed morphology

The complex glacial origin of these sediments has led to the formation of drumlins, moraines ridges and mounds with localised steep slopes and iceberg scour forming glacial channels which extend across the central third of the ISZ. Drumlins are streamlined bedform features comprised of glacial debris and are commonly blunted, examples of these drumlins have been found in the centre and to the east of the zone. The diameter of the drumlins range from 50m to 600m and the general heights are approximately 8 metres to 10 metres. Rarely the heights exceed 20m. Issues associated with these topographical features will need further assessment and further interpretation of geophysical data.

Slopes in excess of 40° were measured across plateaus and sand waves in the south west part of the zone. However for the majority of the ISZ slopes were below 4°.

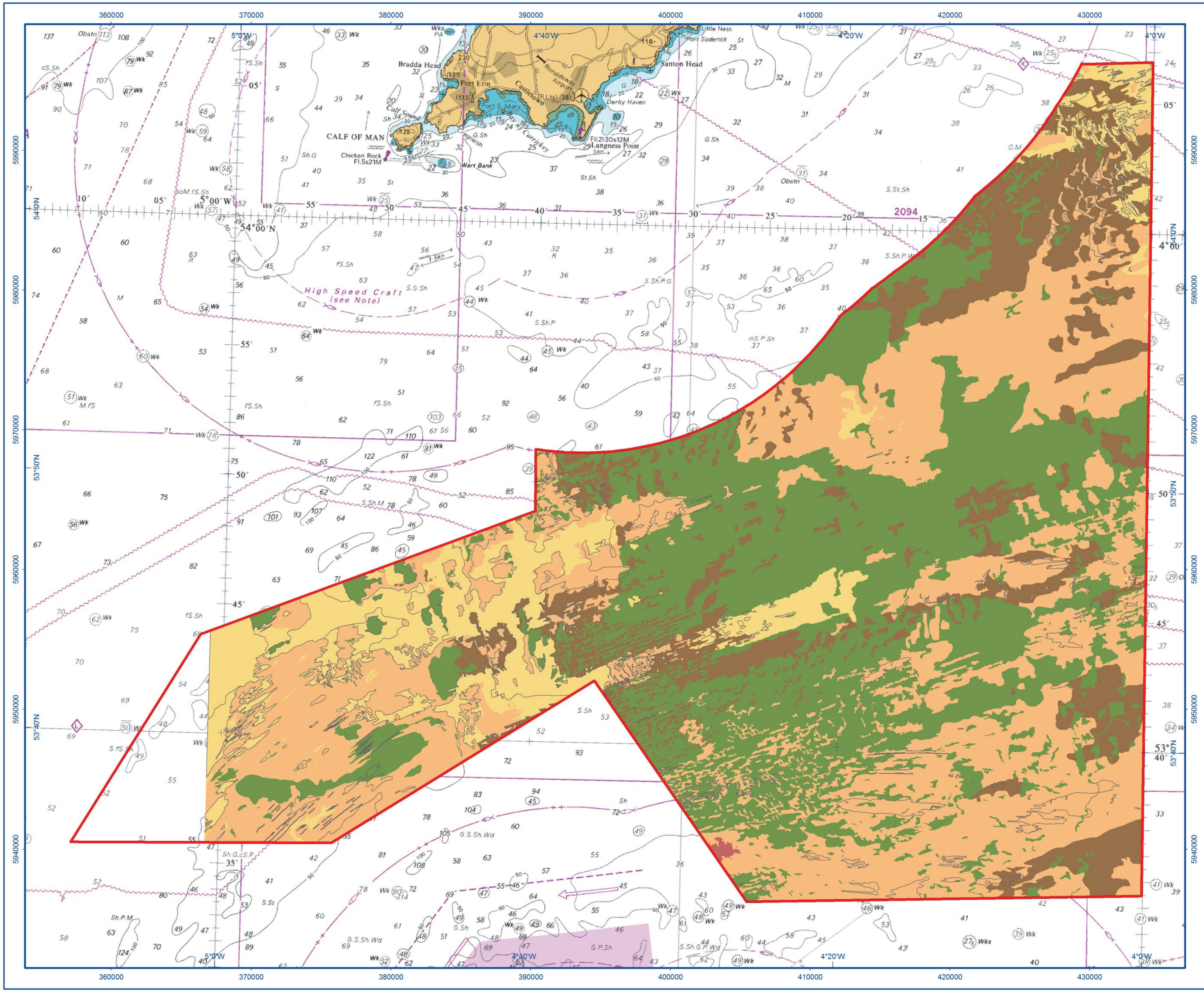
The largest glacial features present in the ISZ are rounded plateaus that vary between 500m and 5000m in diameter and are up to 30m high. Evidence from the geophysical survey indicated that the plateaus are typically flat topped and have gently sloping sides. Several such features have been identified in the ISZ and these are typically associated with the greatest water depths, which occur in the south-west part of the zone. The features are intersected by a series of channels, which reach depths in excess of 90m and are up 2km wide. Superimposed on the flanks of the channels and plateaus are mobile sandwaves of up to 10m high with wavelengths in the region of 600m. The sandwaves are asymmetric and are orientated towards the north-east, which suggests that sediment is transported in this direction across the ISZ.

Other mobile bedforms comprising of arc shaped dunes, megaripples, ripples and sand ribbons are indicative of the strong tidal currents found across the ISZ. The largest sand waves were up to 10m high and with a wavelength of up to 600m. These occurred predominantly in the western and north eastern part of the area.

Chapter 8, Physical Processes, provides more detail on seabed morphology found within the ISZ.

7.4.3 Sediment quality

As part of the environmental survey twenty sites were sampled for chemical analysis. Figure 11.1 shows the locations of the sediment samples collected as part of the environmental survey described in Chapter 11. The chemical analysis showed that all heavy metals analysed were below Cefas Action level 1. However 3 of the samples were just over the action level for arsenic of 20 mg/kg Dry Weight. The higher levels of Arsenic may be caused by number of anthropogenic or natural sources, for example river inputs or industrial activities and chemical dumping. Radionuclides will be investigated as part of project level EIAs.



Irish Sea Zone

Seabed Geology (MMT Survey, 2010)

- Sand
- Sand and Gravel
- Gravel
- Gravel, Cobbles and Boulders in a fine grained matrix
- Bedrock
- MegaRipples and Sandwaves Areas

N

Grid North

0 1 2 3 4 5 6 7 8 9 10 Kilometers

0 1 2 3 4 5 Nautical Miles

PROJECTION	DATUM	PAGE SIZE	SCALE
UTM30N	WGS84	A3	1:250000

ISSUE	DATE	DRN	CHK	APR	ISSUE NOTE
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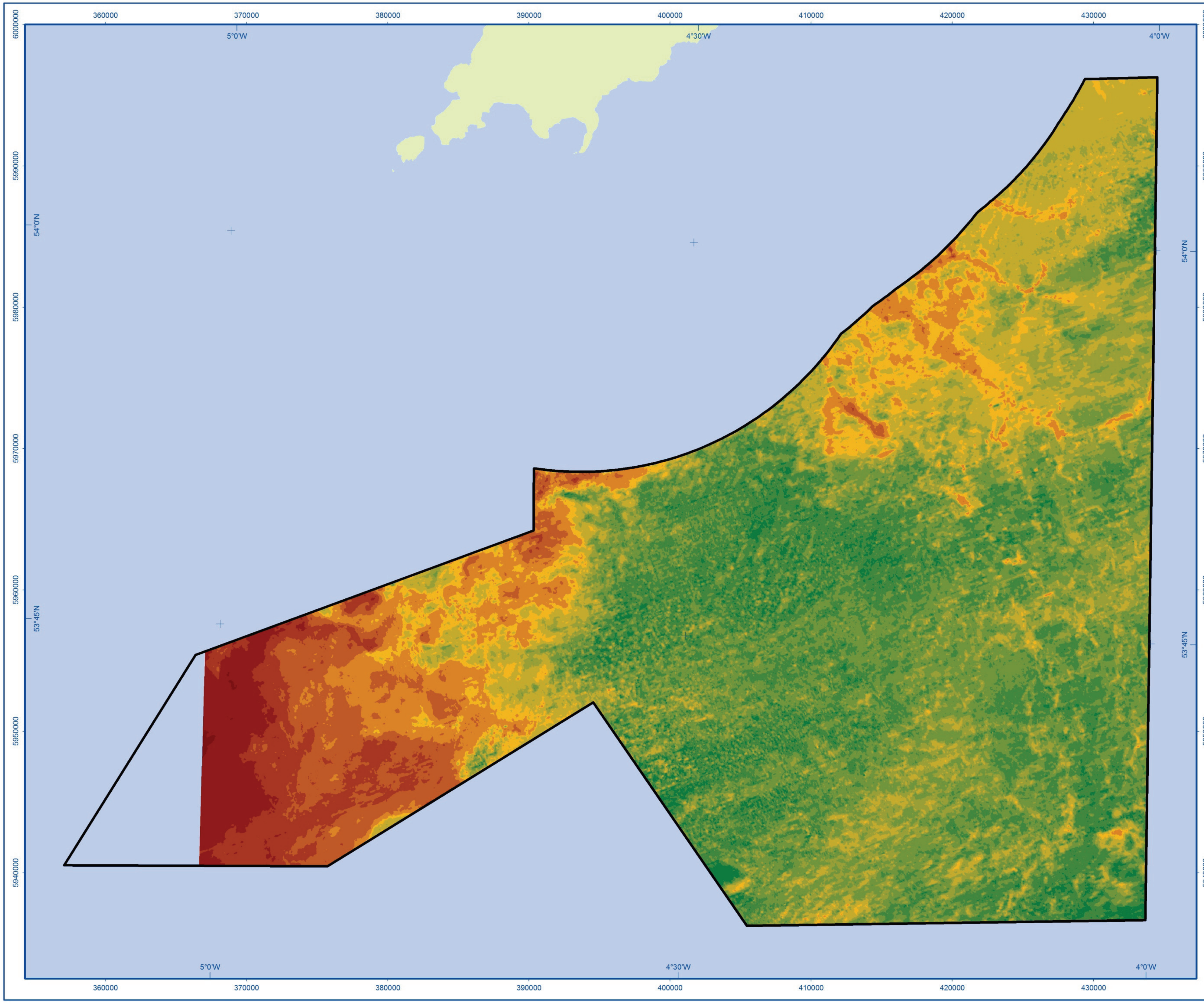
ROUND 3: IRISH SEA ZONE

ZONAL APPRAISAL AND PLANNING (ZAP)
FIGURE: 7.1

Surficial Geology

CENTRICA DOC NO: R3-D-EV-001-0000-000000-059



Irish Sea Zone

Indicative Depth to Bedrock (MMT Survey, 2010)

(Meters)

- 0 - 2.5
- 2.5 - 5
- 5 - 7.5
- 7.5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- 80 - 100

Note: Intervals are uneven.

N

Grid North

0 2.5 5 7.5 10 Kilometers

0 2.5 5 Nautical Miles

PROJECTION	DATUM	PAGE SIZE	SCALE
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ROUND 3: IRISH SEA ZONE

ZONAL APPRAISAL AND PLANNING (ZAP)
FIGURE: 7.2
Indicative Depth to Bedrock

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7.5 Key considerations and next steps

Key considerations such as slope, mobile bedforms, coarse deposits, channels, faults, bedrock and other obstructions will influence the design concept of a number of engineering options including preferred foundation type and cable installation methodologies. The presence of these features has led, in part, to the identification of the Potential Development Areas described in Chapter 5.

The geophysical data collected during the 2010 survey has certain limits and should be considered as preliminary and regional. Further interpretation of the geophysical data will be required at project EIA level. Additional data collection and surveys may be required to provide a more detailed understanding of specific areas leading into project level EIAs. Further work may include detailed geotechnical surveys and evaluation to determine the nature of the bedrock and also to confirm the interpretation of the baseline glacial Till and bedrock boundary. Estimated depths to till and bedrock layers will be confirmed and ground truthed through these surveys which will influence, significantly, preferred foundation concepts. Foundation type and sizes are key criteria when assessing impacts on marine habitats and species. The size of the foundations will influence what area of seabed is disturbed and impacts on marine mammals as a consequence of noise levels during installation.

Additional and more detailed magnetometer surveys may be undertaken so as to identify small, buried debris. Prior to the geotechnical campaign and turbine placement there is also potential to undertake some coring for anomalous areas identified during the 2010 geophysical surveys as well as additional surveys of potential mobile features such as sand waves and other mobile bedforms.

7.6 References

Holmes, R, and Tappin, D R. (2005). DTI Strategic Environmental Assessment Area 6, Irish Sea, seabed and surficial geology and processes. British Geological Survey Commissioned Report, CR/05/057.

Lambeck, K. (1995). Late Devensian and Holocene Shorelines of the British-Isles and North-Sea from Models of Glacio-Hydro-Isostatic Rebound. Journal of the Geological Society, Vol. 152, 437-448.Lambeck 1995.

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