South West of England Regional Development Agency

Wave Hub

Appendix N to the Environmental Statement

June 2006

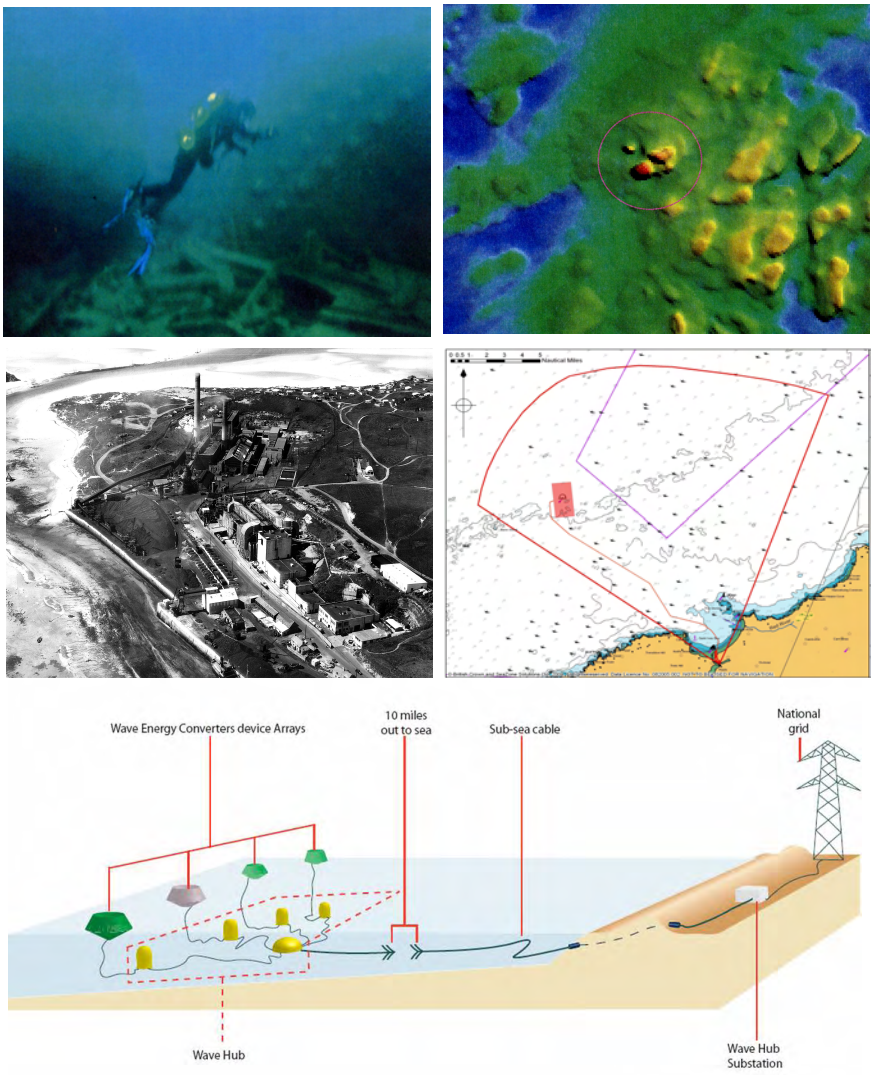
Halcrow

South West *of* England
Regional Development Agency

Report No: 2006R001

South West Wave Hub
Hayle, Cornwall

Archaeological assessment



Historic Environment Service (Projects)

Cornwall County Council

A Report for Halcrow

South West Wave Hub, Hayle, Cornwall

Archaeological assessment

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April 2006

Report No: 2006R001

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Acknowledgements

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Help with the historical research was provided by the Cornish Studies Library, Redruth, Jonathan Holmes and Jeremy Rice of Penlee House Museum, Penzance; Angela Broome of the Royal Institution of Cornwall, Truro and Guy Hannaford of the United Kingdom Hydrographic Office, Taunton. The drawing of the medieval carved slate from Crane Godrevy (Fig 43) is reproduced courtesy of Charles Thomas.

Within the Historic Environment Service, the Project Manager was Charles Johns, who also undertook the terrestrial assessment and walkover survey. Bryn Perry Tapper undertook the GIS mapping, computer generated models and illustrations.

Marine consultants for the project were Kevin Camidge, who interpreted and reported on the marine geophysical survey results and Phillip Rees who provided valuable advice.

The views and recommendations expressed in this report are those of the Historic Environment Service projects team and are presented in good faith on the basis of professional judgement and on information currently available.

Cover illustration

Clockwise; Diver and iron wreck (Kevin Camidge), bathymetric plot of iron wreck site (EGS International Ltd), the Wave Hub study area, schematic diagram of the proposed Wave Hub (Halcrow), Hayle Power Station *c*1950 (courtesy of Penlee House Gallery and Museum)

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Abbreviations

AGLV	Area of Great Landscape Value
AGSV	Area of Great Scientific Value
AONB	Area of Natural Beauty
BP	Before Present
BSG	British Geological Survey
CCCo	Cornish Copper Company
CRO	Cornwall County Record Office
EH	English Heritage
HER	Cornwall and the Isles of Scilly Historic Environment Record
HES	Historic Environment Service, Cornwall County Council
HLC	Historic Landscape Character
ICS	Institute of Cornish Studies Place-Names index (compiled by Oliver Padel, Ann Preston-Jones and Peter rose; copy held at HES)
NGR	National Grid Reference
NMR	National Monument Record, Swindon
OS	Ordnance Survey
PRN	Primary Record Number in Cornwall HER
RIC	Royal Institution of Cornwall
ROV	Remotely Operated Vehicle
UKHO	United Kingdom Hydrographic Office, Taunton
WWI	World War One
WWII	World War Two

1 Summary

This report describes the results of an archaeological and historical assessment of the proposed South-West Wave Hub site off St Ives, Cornwall, carried out by the Historic Environment Service (Projects), Cornwall County Council for the Halcrow Group Limited from July 2005 to January 2006. The project is an innovative study being the first to adopt a seamless approach to the assessment of maritime, inter-tidal and terrestrial archaeological sites incorporating desk-based research, geophysical techniques, and walkover survey.

The proposed scheme consists of three parts: the Wave Hub deployment area measuring 4km by 2km some 25km offshore; a sub-sea high voltage cable running from the deployment area to the shore which will be laid on the seabed apart from within St Ives Bay where it will be buried up to 3m deep in the seabed's sediments; a substation, to be constructed at the site of the former Hayle power station, connecting the cable to existing power lines.

A total of 15 sites were identified in the terrestrial and inter-tidal sections of the study area. Most of these are 19th and 20th century industrial sites including sand and gravel extraction pits, boundary stones, an arsenic works, a power station and chemical factory. There is also a possible Iron Age/Early Medieval round (defended settlement), a 19th century rifle range, a WWII minefield, some 20th century holiday chalets and a modern cricket ground.

A total of 27 wreck sites were identified within 2km of the proposed cable route. Assessment of geophysical data from the main Wave Hub area and cable route revealed a large iron wreck, probably the *Helene*, a steamer torpedoed by a U-boat in 1918. A number of smaller targets may also be of archaeological interest. It is recommended that the cable route should be adjusted to avoid the wreck site and that the smaller targets are further investigated if disturbance to the seabed in their vicinity is envisaged.

In both the inter-tidal and marine sections there is the potential for submerged or buried deposits that may represent paleoenvironmental material, although no specific sites have been identified, excepting a palaeo-channel identified from the sub-bottom profiling data which the line of the proposed cable route, which could contain peat deposits as well as gravels. Provision should be made for monitoring the cable trenching process either by recovering sediment samples or close video inspection by remotely operated vehicle (ROV) and for identification, sampling and specialist analysis of palaeoenvironmental deposits.

Following the completion of the draft archaeological assessment report, it has been proposed to reposition the Wave Hub deployment area approximately 4km ENE of its original position due to commercial shipping movements. It was not possible to make a proper archaeological assessment of the new section of cable route and deployment of area because of incomplete geophysical data. This is discussed in section 7.4 of the report.

Overall, the Wave Hub should be designed to minimise impact on wave climate and coastal processes which might affect archaeological vulnerable, sites such as the Gwithian complex, disturbance to the seabed should be minimised, directional drilling should be used to route the cable through the dunes to avoid any archaeological remains and contaminated ground, the development proposals should take into account the setting of the project area in relation to the historic character of proposed World Heritage Site and the Hayle Conservation Area, and an approved Written Scheme of Investigation (WSI) for further archaeological involvement and recording should be implemented if the development proceeds.

2 Introduction

2.1 Project background

In March 2005 Dr Nigel Thomas of Emu Ltd asked the Historic Environment Service (Projects), Cornwall County Council (HES) to provide a quotation and CVs of key personnel for carrying out an archaeological assessment of the proposed South West Wave Hub development off St Ives on behalf of Halcrow Group Limited. Subsequently a more formal proposal and project design was compiled, based on a scoping document provided Dr Thomas (Thomas 2005) derived from the Environmental Impact Assessment proposal for the Wave Hub (Halcrow 2004, 20-1).

The scope of the project was further clarified by e-mail and in early June Halcrow appointed HES to carry out the assessment of the marine and inter-tidal sections of the Study Area; this was subsequently extended to cover the terrestrial aspects, resulting in a revised project design which was agreed with Halcrow in late June 2005 (Johns 2005).

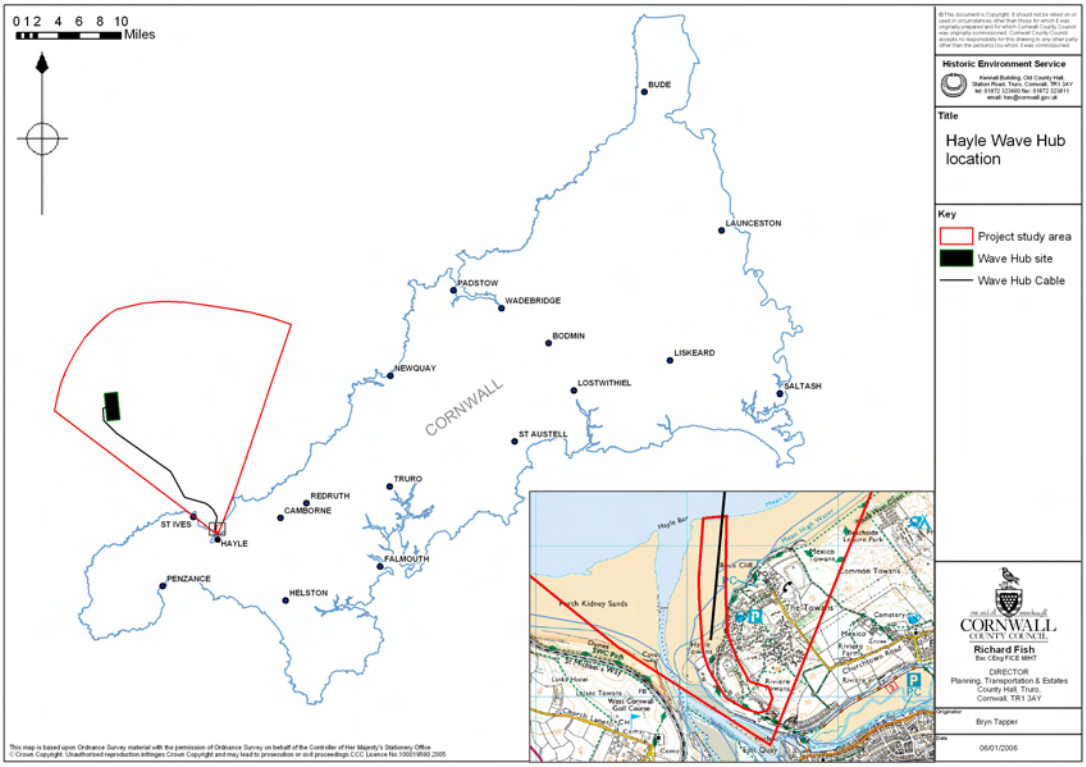

Fig 1 Location map, terrestrial study area inset

2.2 Project extent and scope

The scope of the project includes marine, inter-tidal and terrestrial sections of the Study Area.

The marine section is fan-shaped, extending some 25 kilometres out to sea from an apex at Hayle to a maximum width of approximately 25 kilometres (Fig x).

The inter-tidal section of the study area crosses the sandy beach on the east side of Hayle Bar, approximately 0.2km wide and 0.75km long between mean high water and mean low water.

The terrestrial section extends approximately 0.7 kilometres across Hayle Towans, from Mean High Water to the disused Electric Power Station. The core terrestrial Study Area

extends approximately 100m on either side of the proposed cable route shown on Figure 4 of the Wave Hub Technical Feasibility Study (Halcrow Group Limited 2005). The scope of the terrestrial aspects of the assessment was set out in a letter from English Heritage to Halcrow dated 10/05/05.

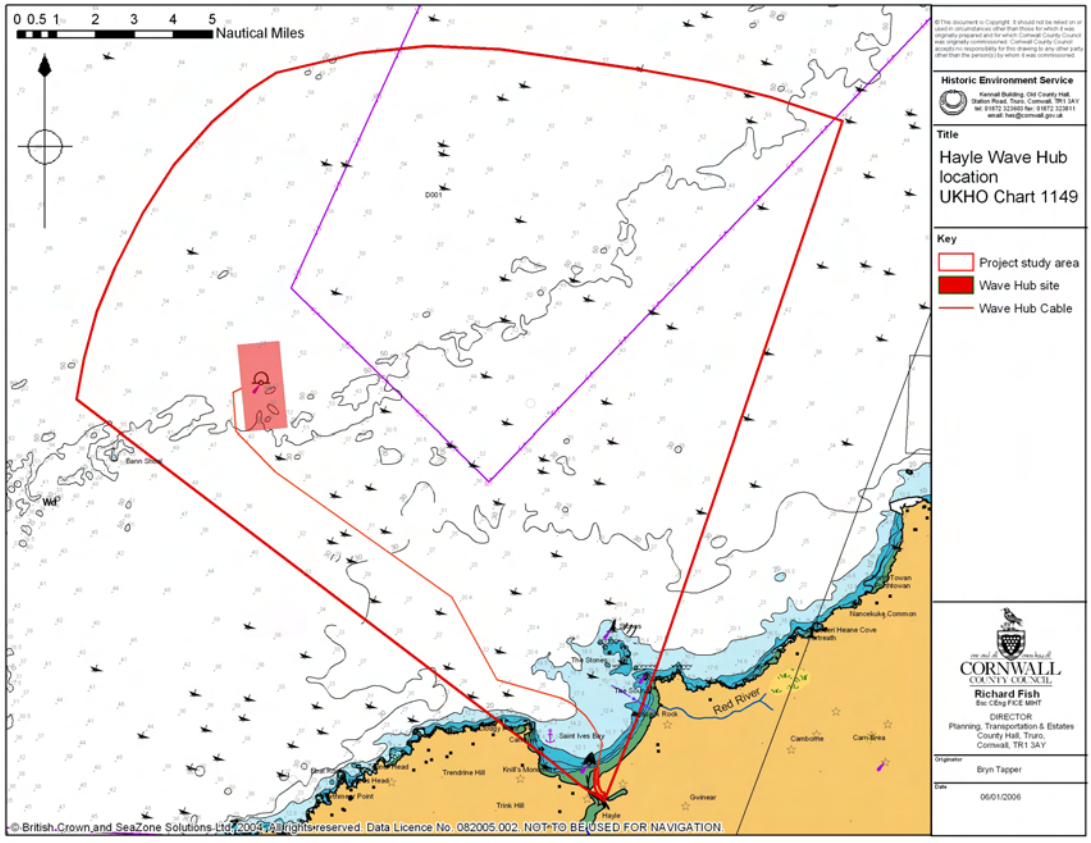

Fig 2 Marine study area

2.3 Standards

The assessment was undertaken according to the Institute of Field Archaeologists' *Standards and Guidance for archaeological desk-based assessments and evaluations* (IFA 1999) and according to the principles and precepts set out in *Planning Policy Guidance Note 16: Archaeology and Planning* (DoE, 1990) and the Joint Nautical Archaeology Policy Committee's *Code of Practice for Seabed Developers* (Hampshire & Wight Trust for Maritime Archaeology 2005).

2.4 Aims

- To identify all known and potential archaeological sites in the Study Area.
- To identify the potential impacts anticipated from the construction of the Wave Hub and the types of archaeological sites affected, including assessment of significant effects.
- To propose appropriate mitigation measures.
- To deliver a project report (paper and digital versions).

3 Methodology

The project involved five main phases of work:

- research and desk-based study;
- walkover survey (inter-tidal/terrestrial);
- database records and GIS mapping;
- assessment of sub-bottom profiling, sidescan sonar, magnetometer and video data;
- report production and dissemination.

3.1 Research and desk–based study

During the research desk-based study historical databases and archives were consulted in order to obtain information about the history of the study area and the structures and features that were likely to survive. The main sources consulted were as follows:

- Cornwall HER
- Cornwall Record Office, Truro
- Royal Institution of Cornwall, Truro
- Cornish Studies Library, Redruth
- National Maritime Museum, Falmouth
- Penlee House Museum, Penzance
- Hayle Library
- UK Hydrographic Office, Taunton
- National Monuments Record, Swindon
- Early maps and photographs (see Section 9.1)
- Published sources (see Section 9.2);

3.2 Walkover survey

The purpose of the walkover survey was:

- To visually examine the inter-tidal and terrestrial parts of the Study Area for possible sites relating to past settlement, environment, land use and sea level change that are not listed in existing records. A 1:2500 scale base map was prepared, annotated with collated information from the desk survey and marked with the line of the proposed cable route corridor. Field information was carefully sketch plotted onto a drafting film overlay taped over the prepared base map and the route of the walkover survey was plotted on GIS;
- To appraise the potential visual impact of the scheme on the proposed World Heritage site (Area 2 Port of Hayle); Hayle Harbour (Conservation Area) and the setting of Scheduled Monuments.

3.3 Database records and GIS mapping

3.3.1 Method

The application of databases and GIS to the South West Wave Hub assessment has aided the collation, collection, interpretation and presentation of archaeological and historical data.

Besides facilitating input, storage, manipulation and output of data, the use of databases and GIS has enabled the generation of an inventory of the assessment results and target areas for potential future investigation. Spatial analyses have enabled the production of distribution maps, sea-level models and identification of areas of likely archaeological potential.

Archaeological sites and wrecks have been located and cross-referenced against the geophysical data resulting in a number of target sites being identified along the proposed Wave Hub route.

3.3.2 CCC HER and NMR

The Cornwall and Isles of Scilly Sites, Monuments and Buildings database (SMR), maintained by the Cornwall and Scilly HER is a well documented and sourced dataset. As part of this assessment marine, coastal and inter-tidal sites were checked, updated, and verified for the study area. New records were created where the SMR did not record known sites and this was the case for all wreck sites.

The archaeological and historical sites were identified and plotted into GIS (ESRI's ArcGIS package) with a linked descriptive (textual) record entered into the SMR (Access 2002). Each record conforms to the minimum heritage information content and coverage specification as advised by the HER including elements such as name, site type, location, period (if known), description, date, and source etc.

Two hundred and eleven wreck records held by the NMR at Swindon were consulted for the study area and cross-referenced against similar records held by the UKHO.

3.3.3 UKHO

Sixty-one wreck and underwater obstruction records held by the UKHO were consulted and referenced against those held by the NMR. Only those wrecks predating 1945 were incorporated into the Cornwall and Scilly HER and cross-referenced against the NMR records. All UKHO wreck locations are, relative to the NMR and reflecting the increased survey sensitivity of sonar sub-bottom profiling, given precisely in OSGB36 longitude and latitude degrees, minutes and decimals of a minute. These were converted to British National Grid eastings and northings using the 'CoordTrans' conversion programme (http://franson.biz/coordtrans/index.asp) and plotted in the GIS.

An important aspect of the project has been the acquisition and use of the digital vector UKHO Admiralty Chart for the area (Chart 1149, Pendeen to Trevose Head). Reprojected in GIS (from WGS84 coordinate system to British National Grid) it has been matched with modern OS maps along the coastline. The vector chart enabled the generation of sea-level models (based on soundings and bathymetric layers).

3.4 Assessment of marine geophysics

The methodology was guided by consultation with English Heritage's Maritime Team and the draft *Guidance notes on assessing, evaluating and recording wreck sites* (prepared for English Heritage by Wessex Archaeology 2005). The final specification was agreed with the

Maritime Team as acceptable for the purposes an archaeological assessment to be undertaken as part of the Environmental Impact Assessment.

EGS collected sub-bottom profiling, sidescan sonar and magnetometer data of the study area, a minimum of 180 line kilometres of data. The results were assessed and interpreted by HES using AutoCAD software, and plotted using Admiralty charts reprojected under licence to the UKHO using Geographic Information Systems (GIS).

The assessment of the sub-bottom data included the recording of all deposits that may relate to the presence of submerged prehistoric land-surfaces. The assessment of the sidescan and magnetometer data included the recording of all features that may relate to wrecks or wreckage. Where possible, such features were cross-linked to the known incidence of wreck sites identified in the UKHO, NMR and HER. Video data was collected where locations of importance have been identified by the geophysical study and the data assessed in order to conduct preliminary ground truthing on any anomalies or areas logged during the earlier stages. Appropriate mitigation recommendations were made for significant anomalies.

Video data was collected by Halcrow where locations of importance were identified by the geophysical study and the data assessed in order to conduct preliminary ground truthing on any anomalies or areas logged during the earlier stages.

Appropriate mitigation recommendations are made for significant anomalies.

3.5 Report production

The main product of the project is this report which is also available digitally in PDF format.

4 Background

4.1 Location and setting

Hayle, and the adjacent area of sea off the north Cornwall coast, was identified as a potential location for the Wave Hub development because it already has a suitable National Grid connection point situated very close to the coast, and because there is a viable route for the cable that does not pass through any nationally designated sites (Fig 1).

The terrestrial section of the study area comprises an area approximately 0.65km long by 0.2km wide encompassing dunes (Harvey's Towans) and the site of a current substation and disused power station at the western end of Riviere Towans (Fig 1). Riviere Towans forms the western end of the three-mile long Hayle-Gwithian system of dunelands which lie to the east of the Hayle estuary, extending as far as Godrevy Point.

4.2 Geology

The geology of the onshore study area is mapped as superficial deposits of blown sand and alluvium overlying Devonian sedimentary bedrock (British Geological Survey (BSG) Sheet 351). The site lies on a Minor Aquifer with soils of high leaching potential (Halcrow 2005, 26).

The existing BSG offshore data shows the seabed of the study area to consist of an intermittent cover of recent 'soft' sediments overlying bedrock; such that exposure of rock at the seabed is likely to be frequent and unpredictable. The seabed sediments are reported to be reworked Quaternary sediments, the deeper sediments trapped within depressions in

the rock surface. The underlying bedrock mainly comprises slates, siltstones, sandstones and limestones (*ibid*, 27-8).

A reported relict cliff line coinciding with the 50m isobath represents a transition beyond which the bedrock surface becomes smother and sediment cover more consistent but generally thinner. It is possible that this change represents the presence of a relict shoreline (*ibid*, 27-8).

4.3 Historic Landscape Character

During 1994, the Cornwall Archaeological Unit (now HES) carried out a map-based historic landscape characterisation (HLC) across the whole of Cornwall, using existing field patterns and early map and place-name evidence to characterise the landscape (Cornwall County Council 1996). This characterisation reflects the historic processes that have shaped the Cornish landscape and involved dividing the county into a series of HLC types, simplified in a second stage into HLC zones, each of which reflects a particular set of historic processes and tends to contain a predictable range of archaeological sites and historic features.

The HLC of the study area is mapped as Recreation because of the adjacent chalet park on Riviere Towans, but when considered in greater detail by this current assessment, is clearly characteristic of the Dunes HLC zone.

The maritime part of the study area was outside the remit of the 1994 assessment.

4.3.1 Zone: Recreation

Recreation land consists of, for the most part, late 19th and 20th century tourism and recreation features. These are mainly coastal chalet or caravan parks, theme parks and golf courses. It is often associated with areas of urban development.

These areas are part of Cornwall's tourism industry, which developed through the 19th century. Until fairly recently these areas have been grouped towards coastal resorts, although there is now a growing demand for inland 'quality' tourism. Most of the chalet and caravan parks consist of 20th century structures, often built out of concrete blocks and occasionally have evolved from wartime camps. A few are of more interest, being early 20th century and with chalets which are almost vernacular (e.g. adjacent to the study area on Riviere Towans and Phillack). All recreation sites have extensive car parks. Theme parks vary in form, but again tend to consist of late 20th century concrete structures. Some golf courses were established by the end of the 19th century, although most are of later 20th century date.

The Zone normally receives no specific protection, although being generally found on the coast, it does often fall within Areas of Natural Beauty (AONBs) or Area of Great Landscape Value (AGLV) designated areas. While contributing significantly to Landscape Character, the zone must be regarded as of low importance in terms of the Historic Landscape.

4.3.2 Zone: Dunes

Dunes are areas of blown sand and shell deposits along low-lying stretches of the Cornish shore, principally on the north coast and are locally called towans. This apparently natural habitat has been influenced and affected by human activity, mainly summer grazing of farm animals, and can be regarded as semi-natural.

Within the Dunes, there are ruined and abandoned industrial complexes, such as Hayle power station and the arsenic works which have altered the landform of these inherently

mobile landscapes. Caravan and chalet parks and golf courses have also spread onto Dunes, considerably altering their character.

An important historical feature of the development of Dunes is the succession of sand movements and stabilization, in places such as Gwithian successive buried land surfaces with their associated settlements and fields can extend from the Early Bronze Age through to the medieval period. Dunes are generally rich in buried archaeological remains and possess considerable potential. Widely protected as SSSIs due to their ecological value, many Dunes also fall within the AONB or other designated areas.

5 Relevant legislation and policy

5.1 Proposed World Heritage Site

The terrestrial part of the study area is adjacent to the proposed Cornish Mining World Heritage Site – Area A2, The Port of Hayle (Fig 3). The formal WHS bid to UNESCO for World heritage site status was submitted in February 2005, the final decision is expected in summer 2006. The proposed World Heritage Site is some 207 hectares in extent, centred at SW 55854 37272. It does not extend below the Mean Low Water Mark (as defined by the United Kingdom Ordnance Survey) as this is the legal limit of statutory planning responsibilities of local authorities (World Heritage Site Bid Partnership 2005, 25-8).

The WHS statement of Outstanding Universal Value states that: '*The Cornwall and West Devon Mining Landscape was transformed during the period 1700-1914 by early industrial development that made a key contribution to the evolution of an industrialised economy and society in the United Kingdom and throughout the world. Its outstanding survival, in a coherent series of highly distinctive cultural landscapes, is testimony to this achievement*' (ibid, 21).

The study area is affected by one of the World Heritage Site key management issues; that of protecting the visual setting and historical context of the Site (Issue 6). Policy 6, arising from this issue, states; 'Developments outside the Site that will affect its outstanding universal value will be resisted' (ibid, 131-2).

5.2 Scheduled Monuments

Statutory protection is extended to archaeological sites and historic structures by scheduling. A Scheduled Monument is one designated by statute as a site of national importance and is protected by The Ancient Monuments and Archaeological Areas Act of 1979, as amended by the National Heritage Act 1983. By law, any proposed work affecting such sites requires Scheduled Monument Consent from the Secretary of State for Culture, Media and Sport.

The 1979 AM&AA Act provided for scheduling to take place anywhere out to the 12 nautical mile limit of UK Territorial Waters, and since the 2002 National Heritage Act has English Heritage has the remit to advise the Government on Schedulings (and other matters pertaining to the historic environment) out to 12 nautical mile limit.

There are no Scheduled Monuments within the study area.

5.3 Listed Buildings

The Secretary of State is required to compile lists of buildings of special architectural or historic interest for the guidance of local planning authorities. Demolition, alterations and extensions to listed buildings require Listed Building consent. Alterations to buildings attached to the main Listed Building or within the curtilege and in existence before 1948 also need Listed Building consent.

Development proposals that will have an impact on Listed Buildings and their setting do not need specific Listed Building consent unless they come into the above categories. However, their impact on the Listed Building is a material consideration in assessing the development.

There are no Listed Buildings within the Study Area. The nearest listed structure is the ruined North Quay office, approximately 400m south-east of the study area

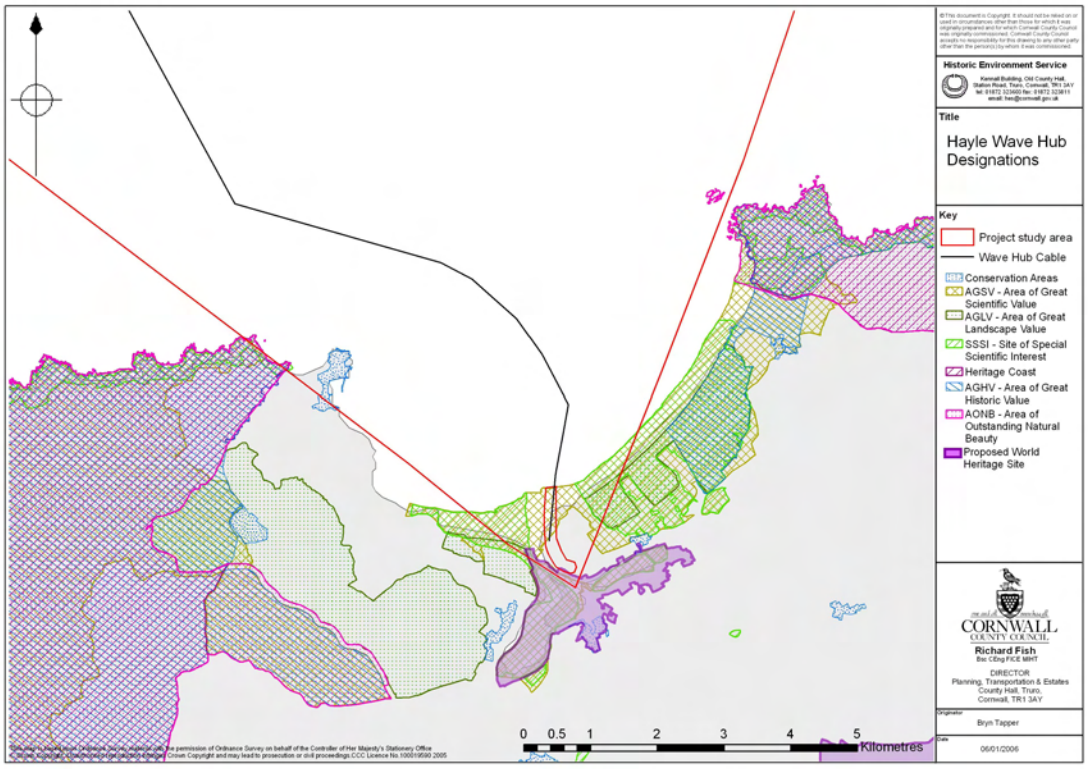

Fig 3 Archaeological and historical designations

5.4 Protected wreck sites

5.4.1 The Protection of Wrecks Act 1973

The Protection of Wrecks Act 1973 (Section 1) is designed to protect wrecks that are of historic, archaeological or artistic importance. It is administered by the Department of Culture, Media and Sport (DCMS) in England, with the assistance of English Heritage since the 2002 National Heritage Act.

A designate order is made by statutory instrument whenever such a site is designated. It identifies a point on the seabed around which an area of seabed is protected; it does not identify the wreck site. Within this area it is an offence without the authority of a licence granted by the Secretary of state to tamper with, damage or remove any part of the wrecked vessel or anything contained or formerly contained within it, to carry out diving or salvage operations, to use diving or salvage equipment or deposit materials so as to obliterate or obstruct access to the site, or to damage the wreck.

Section 2 of the Protection of Wrecks Act concerns vessels designated as dangerous because of their contents. This Section is administered by the Maritime and Coastguard Agency through the Receiver of Wreck.

There are no wreck sites in the study area that are designated under the Protection of Wrecks Act, 1973.

5.4.2 The Protection of Military Remains Act, 1986

The Protection of Military Remains Act deals with military remains of both aircraft and ships. All military aircraft are automatically designated under this legislation which is administered by the Ministry of Defence (RAF for aircraft, Navy for vessels).

Vessels may be designated under this Act either as a Protected Place or a Controlled Site. Divers may visit a Protected Place on a 'look but don't touch' basis. Divers are prohibited from visiting Controlled Sites.

There are no wreck sites in the study area that are designated under the Protection of Military Remains Act, 1986.

5.5 The National Heritage Act 2002

The National Heritage Act 2002 extended English Heritage's remit into the marine zone from the low-water line out to the 12 nautical mile limit of UK territorial waters around England. In particular it:

- extends English Heritage's remit by amending the definition of 'ancient monuments' in the National Heritage Act 1983 and the Ancient Monuments and Archaeological Areas Act 1979 to include sites in, on or under the seabed (including those comprising the remains of vehicles, vessels, aircraft or moveable structures) within the seaward limits of the UK territorial waters adjacent to England;
- enables the Secretary of state to direct English heritage to exercise functions relating to ancient monuments in, on or under the seabed on his behalf; and
- enables English Heritage to defray or contribute to the costs of maintenance of wrecks designated under the Protection of Wrecks Act 1973.

The 2002 Act modified English Heritage's functions to include:

- securing the preservation of ancient monuments in, on or under the seabed; and
- promoting the public's enjoyment of, and advancing their knowledge of ancient monuments, in, on or under the seabed.

As a result of the Act English Heritage have appointed a Maritime Archaeology team, based at the Centre for Archaeology, Fort Cumberland, Portsmouth, to take the lead on all matters pertaining to the management of the maritime archaeological resource. The 2002 Act has a number of other implications that are discussed a length in English Heritage's policy document 'Taking to the Water' (Roberts and Trow 2002, 15-25).

The assessment has identified the following sites, or potential sites, in the maritime section of the study area: 60 magnetic anomalies (one is a large iron wreck, possibly the Helene, sunk by a U-boat in 1918, two others may represent debris on the seabed); 19 sidescan sonar targets; 27 wrecks recorded wrecks within 2km of the wave hub & cable route; 1 palaeo-channel.

5.6 Planning Policy Guidance Notes16 and 20

Planning Policy Guidance Note no 20 *Coastal Planning* (PPG20), deals with, coastal conservation policies and developments. The Government's policy on archaeology is stated in Planning Policy Guidance Note no 16 *Archaeology and Planning'* (PPG16):

'Archaeological remains should be seen as a finite and non-renewable resource, in many cases highly fragile and vulnerable to damage and destruction. Appropriate management is

therefore essential to ensure that they survive in good condition. In particular, care must be taken to ensure that archaeological remains are not needlessly or thoughtlessly destroyed. They can contain irreplaceable information about our past and the potential for an increase in future knowledge. They are part of our sense of national identity and are valuable both for their own sake and their role in education, tourism and leisure'

Although the PPG16 applies to terrestrial sites maritime archaeological sites are equally valuable and the principles and precepts embodied in PPG16 inform the Joint Nautical Archaeological Policy Committee's 'Code of Practice for Seabed Developers' (JNAPC 1998).

5.7 Conservation areas

The study area lies outside the Hayle Conservation area (see Fig 3).

5.8 Local Plans

The area lies within the remit of the Cornwall Structure Plan (October 2004) and Penwith District Plan (Deposit Draft 1998).

5.8.1 Cornwall Structure Plan

The whole estuary including the deep water channel has been designated by the County Council as an Area of Great Scientific Value (AGSV), and is also a Cornwall Nature Conservation Site. Additional Structure Plan Policies of relevance include the following:

Policy 1 Sustainable Development (Principles)

Development should bring about long term and sustainable improvement to Cornwall's economic, social and environmental circumstances without harming future opportunity. Development must be compatible with:

- the conservation and enhancement of Cornwall's character and distinctiveness;
- the prudent use of resources and conservation of natural and historic assets.

Policy 2 Character Areas, Design & Environmental Protection

The quality, character, diversity and local distinctiveness of the natural and built environment of Cornwall will be protected and enhanced. Throughout Cornwall development proposals must respect local character and:

- retain important elements of the local landscape, including natural and semi-natural habitats, hedges, trees, other natural and historic features that add to its distinctiveness;
- contribute to the regeneration, restoration, enhancement or conservation of the area;
- positively relate to townscape and landscape character through siting, design, use of local materials and landscaping.

The conservation and enhancement of sites, areas, or interests, of recognised international or national importance for their landscape, nature conservation, archaeological; or historic importance, including the proposed World Heritage Site, should be given priority in the consideration of development proposals.

Within Areas of Great Landscape Value and other areas or sites of country-wide significance for their biodiversity, geodiversity or historic interest, development proposals will be required to protect those interests.

Policy 3 Use of Resources

Development must be compatible with the prudent use of natural and built resources and energy conservation. Development should:

- give priority to the re-use of previously developed land and buildings to meet development needs including, where appropriate, derelict land reclamation;

Policy 4 Maritime Resources

An integrated and co-ordinated approach to the coast will be taken to support economic importance and conservation value of the marine environment.

Development relating to the coast, estuaries and maritime environment should be considered against the need to ensure the conservation of the environment for its own sake and for the economic importance of fishing and the other activities it supports. Development should avoid pollution of coastal or marine waters and minimise any harmful effects on costal procedures.

Development should be within or well integrated with the existing developed coast and enhance the quality of the environment and economic regeneration of the coastal towns.

The undeveloped coast should be protected.

Local plans should designate coastal zones where appropriate to take account of economic and social opportunity and environmental protection.

5.8.2 Penwith Local Plan Deposit Draft 1998

(incorporating Proposed Modifications 2003)

The following text is extracted directly from the Plan and updated to reflect the proposed modifications

Coast and Countryside

CC1 - Development will not be permitted where it would significantly harm the landscape character, amenity, nature conservation, archaeological, historic and geological values of the coast and countryside of Penwith.

CC2 - Proposals which maintain, enhance and facilitate the enjoyment and understanding of landscape character, amenity, nature conservation, archaeological, historic and geological values in the coast and countryside will be permitted.

CC14 – Proposals for development which would have a significant adverse effect on the shoreline or adjacent coastal waters in terms of its landscape character, amenity, nature conservation, archaeological, historical and geological values will not be permitted.

CC15 – Proposals for development which would damage scheduled ancient monuments and other nationally important archaeological remains or their setting, will not be permitted.

TV15 - Where proposals for re-use of previously developed land, including the reclamation of derelict land, in towns and villages involves sites likely to contain contaminated or toxic materials prior investigations will be required to determine the extent of contamination and, where necessary, measures to avoid pollution during and after implementation will be secured through the use of conditions. Must make a positive contribution to regeneration, and an improvement in attractiveness of built environment, and use be compatible with buildings.

5.8.3 Hayle Estuary Management Plan

A management plan for the Hayle Estuary is currently in preparation by Penwith District Council, the following extract on the Historic Environment are quoted from the draft plan.

Significance of the Historic Environment

The Historic Environment of the Hayle Estuary and its immediate hinterland is of importance for the understanding of how people have used its land and waters over millennia and, in doing so, have helped to shape the landscape of today. It contributes fundamentally to the special sense of place and local identity of the area and to enjoyment of Hayle/Copperhouse and the immediate hinterland. The historic environment here is of international, national and local importance, recognised by its inclusion in the Cornish Mining (candidate) World Heritage Site, and status of individual features as Scheduled Monuments and Listed Buildings.

All features of the Historic Environment are both vulnerable and irreplaceable; their management, and the management of change which may affect them, is critical, as once they are lost they are gone for ever.

Guiding principles

- Ensure, as far as is possible and consistent with other Guiding Principles in this Plan, the protection and enhancement of the historic environment of the estuary and its immediate hinterland, whether statutorily protected or not.
- Ensure that through public awareness and appreciation, the historic environment of the Hayle Estuary, above and below water, is valued and damage is minimised.

Strategic objectives & suggested implementation

Improve understanding of the historic character and constituents of the historic environment of the Estuary.

- *Continue to improve the understanding of the character and extent of the sub-tidal, inter-tidal and immediate shoreline historic environment through survey.*
- *Establish a mechanism for reporting finds and possible snags, hulks and wrecks to the Historic Environment Record, CCC.*

Ensure that key features of the historic environment, including and in addition to those with statutory protection, are protected and managed sustainably.

- *In partnership with the Harbour Authority and local bodies, monitor the condition of the historic environment and review management as necessary.*
- *Through partnership with owners and managers, establish positive management agreements/projects to conserve and enhance sites and features.*
- *In partnership with Penwith District Council and Cornwall County Council Spatial Planning Teams and Historic Environment conservation staff, manage change and protect key features through Development Control.*

Research and review the effects of public access and recreation on key features.

- *Work with the Hayle Harbour Advisory Group and users of water and shore to understand the needs of users and to mitigate any negative impacts.*

Promote public understanding and enjoyment of the historic environment of the Estuary and its immediate hinterland

- *In partnership with The Hayle Harbour Advisory Group, local bodies and the Cornish Mining World Heritage Site Office, develop projects and interpretation strategies to raise awareness and increase understanding of the features, extent and management of the historic environment of the estuary and its hinterland.*
- *In partnership with the WHS Office, raise awareness of the international significance of Hayle/Copperhouse as historic ports and centres of industry.*

Promote understanding of the economic and social benefits provided by the estuary and its immediate hinterland.

- *In partnership with the World Heritage Site Office and other bodies, research and demonstrate the economic and community benefits of the historic environment of the Estuary and its immediate hinterland.*

6 Description of the resource

6.1 Baseline study (geophysical survey)

6.1.1 The survey

The survey was conducted by EGS International Ltd between 28th June and 14th July 2005. Details of the operating procedures and equipment used can be accessed in their report (EGS International Ltd 2005, 3). The scope and methodology of the survey are discussed above in Section 3.4.

6.1.2 The EGS survey report

The report was supplied as a PDF report (Draft final report August 2005 Ref 434r0) in September 2005. The magnetic data was supplied as xyz CSV files. The sidescan sonar data was delivered on a number of DVDs in December 2005 along with a copy of C-View software to enable viewing of the sidescan and SBP files.

6.1.3 Coverage

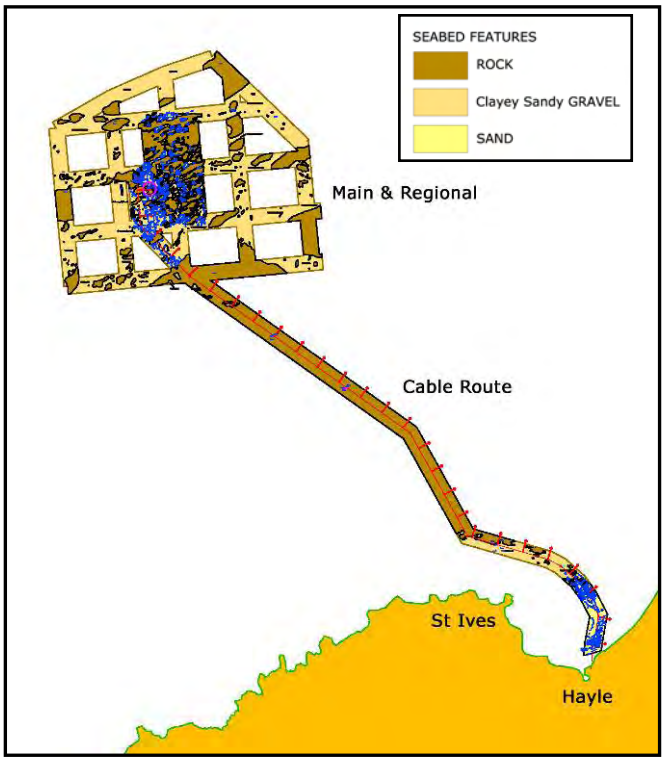

Fig 4 Location of survey tracks

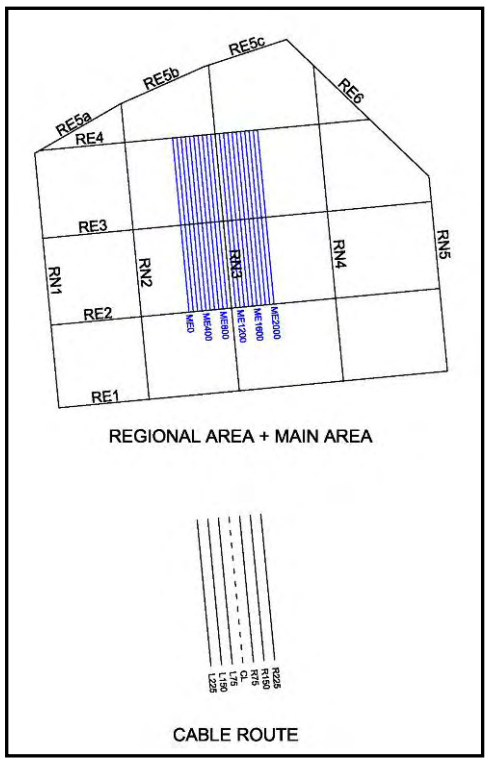

Fig 5 Survey track labels

6.1.4 Survey lines

Cable Route

Seven lines were run along the cable route corridor spaced 75m apart. The lines were named CL (centre line), L75, L150 and L225 to the west and R75, R150 and R225 to the east of the centre line, as shown in Fig 5 above. The length of cable route was divided into sections termed KP1, KP2 etc.

Main Area

A series of 21 north south lines at 100m intervals were run, which were designated ME0 to ME2000.

Regional Area

These lines covered the region around the main area. There were five lines running north to south (RN1 to RN5) and five lines east to west (RE1 to RE5). The distance between these lines was approximately 2 kilometres.

6.1.5 Magnetic survey

The magnetic survey was conducted using a Marine Magnetics SeaSPY marine magnetometer (EGS International Ltd 2005, 3). The magnetic data was supplied as a number of 'xyz' text files. These contained position data in the form of northings and eastings (metric grid co-ordinates – British National Grid), and magnetic values (nT). Unfortunately, there was no associated bathymetric data, nor any timestamp which would have allowed tidal correction to the chart depth known for the given position. This data was requested from EGS but was not available. The depth of the magnetometer fish was apparently recorded but this data was also not available. HES was told to assume a fish depth of 1-3m (Stephen Hayes pers comm).

Given the depth of the magnetometer fish it is possible estimate the minimum mass of iron that could be detected by this equipment in the various water depths of the survey. Because no bathymetric data was associated with the supplied magnetic data files, a number of assumptions had to be made. In the inshore section (less than 5m chart depth) survey at high water has been assumed (EGS International Ltd 2005, Appendix A). Over the rest of the survey mid tide has been assumed. Given the stated fish depth (3m max) and the tidal range in this area (approximately 6m) the fish depth and mid tide height cancel out so that the chart depth is a reasonable approximation of the distance from magnetometer fish to seabed. This assumes the best case scenario where the target lies directly beneath the magnetometer. In practice the object is likely to lie somewhere between the survey lines. This will result in the magnetometer to target distance being somewhat greater than the chart depth used to estimate target mass. In practice this results in the predicted mass of anomalies being an underestimate.

The table of magnetic anomalies (Section 13.1) shows that the chart depths vary from -1 to 59m. The table of minimum mass detectable (below) was constructed using the Hall equations (Hall 1996) as demonstrated by Green (2004, 63-88). Although this is only an approximation due to a number of unknown factors (true distance from fish to target, orientation and shape of the object etc) an indication of the magnitude of the target is very useful in determining the minimum mass of objects this survey could detect.

Depth (m)	Minimum mass detectable (kg)	
	Point source	1:5 source
1	0.2	0.04
5	25	5
10	200	40
15	675	135
20	1600	320
30	5400	1080
40	12800	2560
50	25000	5000
60	43200	8640

Fig 6 Table of likely minimum detectable mass – assuming a 2 nT deflection is the smallest variation readily visible above the background noise. The Hall equation (1996) takes into account the target's length to width ratio as well as its mass; in the minimum detectable mass columns we have considered a symmetrical object (point source) and one with a 5:1length/width ratio

From the above table it is clear that there will be a large variation in the minimum object mass detectable, depending on the depth of water. In the deepest part of this survey (59m) nothing smaller than 9 – 40 tonnes of iron is likely to have been detected. This leaves considerable scope for iron objects to have gone undetected by the magnetometer. For example, an iron cannon of the largest type borne by 18th century British warships (32lb) weighs around 2.5 tonnes; the main bower anchor of a First-rate ship of the same date would weigh about 4 tonnes. From this it is clear that, in parts of this survey, considerable iron objects would not have been detected. To avoid this type of problem the magnetometer tow fish needs to be closer to the seabed in deeper water, thus reducing the fish to seabed distance.

Magnetic anomalies identified by EGS

Three magnetic anomalies were identified in the EGS survey report, Fig 7 below. Target M003 was interpreted as a small fishing vessel of up to 15m in length (EGS International Ltd 2005, 18-19). EGS also state that this target is barely visible on the sidescan sonar record and was only visible on the swath bathymetry after reprocessing of the data (see bathymetric plot p 18). M00 1 and M002 were interpreted as anchors or weights 'relating to fishing activity'.

Anomaly number	Latitude Longitude WGS84	Easting Northing OSGB	KP CL offset	Anomaly Amplitude (nT)	Towfish height above seabed (m)	Possible Causative Body	Associated Sonar Contact
M001	50° 12.295' N 5° 25.731' W	155431.4E 39507.8N	1.146 154m E	7	7	Fishing debris	No
M002	50° 12.454' N 5° 25.696' W	155486.7E 39801.2N	1.445 154m E	16	11	Crab Pots or Fishing debris	SC013 and SC014 within 25m
M003	50° 17.207' N 5° 34.175' W	145829.0E 49078.0N	15.675 20m SW	459	30	Wreck	Feature seen on MBES data Rocky seabed results in sonar contact being hardly visible

Fig 7 Table of magnetic anomalies supplied by EGS (Note: Broad, deep seated geological anomalies not included in this list)

Examination of the magnetic data files

The magnetic data files were examined as profiles by plotting the magnetic magnitude as a series graph. Any anomalies identified were recorded in a table of anomalies, which is reproduced as an appendix to this report (Section 13.1).

The anomalies were plotted on the AutoCAD plan DO4-DO6 (interpreted seabed features) supplied by EGS – note that the contour lines shown on these plans are not seabed depth but are contoured isopachs, showing the depth of unconsolidated sediment.

Examples of the series graphs used to interpret the magnetic data are given in Section 12.2.

Inshore- KP 07

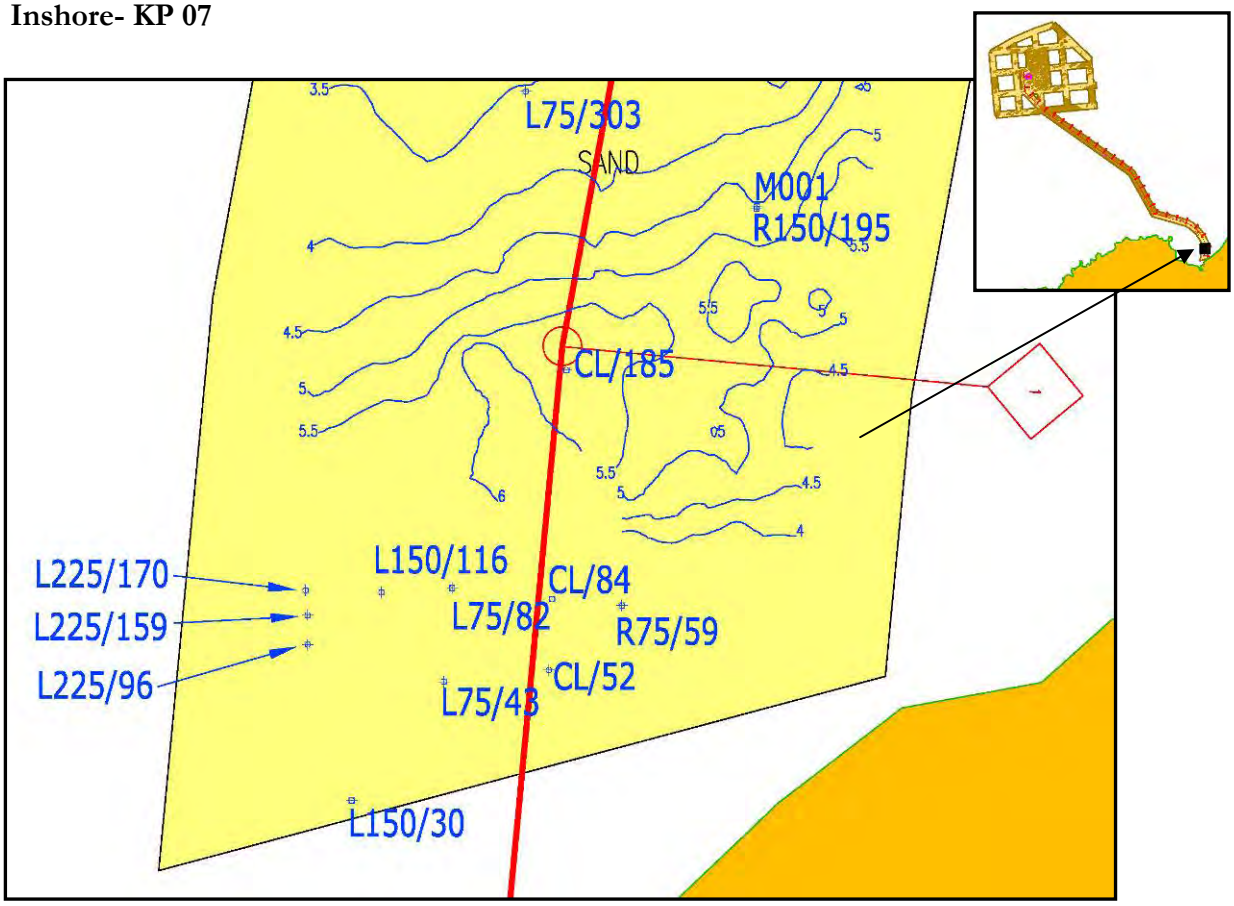

Fig 8 Magnetic anomalies – inshore sections (around KP 1)

These are a cluster of targets in shallow water (-2m to 0m charted depth). The estimated minimum mass of the targets varies from 5 to 50kg. Some of the profiles for these data sets produce convincing anomalies, in particular L225/96, L225/170 and R75/59. As this data was collected in very shallow water it is possible that these anomalies were caused by the magnetometer fish hitting the seabed. However, these anomalies may indicate small iron objects on the seabed – possibly of archaeological significance.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	52	155239.6	39080.6	4	-1	5-25	Spike - Fish bottomed?
	84	155242.5	39146.1	3	0	8-35	Spike
L75	43	155142.7	39070.1	4	-1	5-25	Neg spike - Fish bottomed?
	82	155150.5	39156.3	3	0	8-35	Assm dipole - Fish bottomed?
L150	30	155057.8	38960.6	10	-2	5-27	Neg spike - Fish bottoming?
	116	155085.1	39152.3	20	0	50-250	Spikey dipole - Fish bottoming?
L225	96	155017.3	39104.1	15	0	35-180	Neg spike
	159	155017.2	39131.4	10	0	25-125	Assm dipole
	170	155015.1	39154	18	0	45-225	Dipole
R75	59	155306.8	39140.2	18	-1	20-100	Dipole EOL

Fig 9 Table of inshore magnetic anomalies

Nearshore – KP 1-2

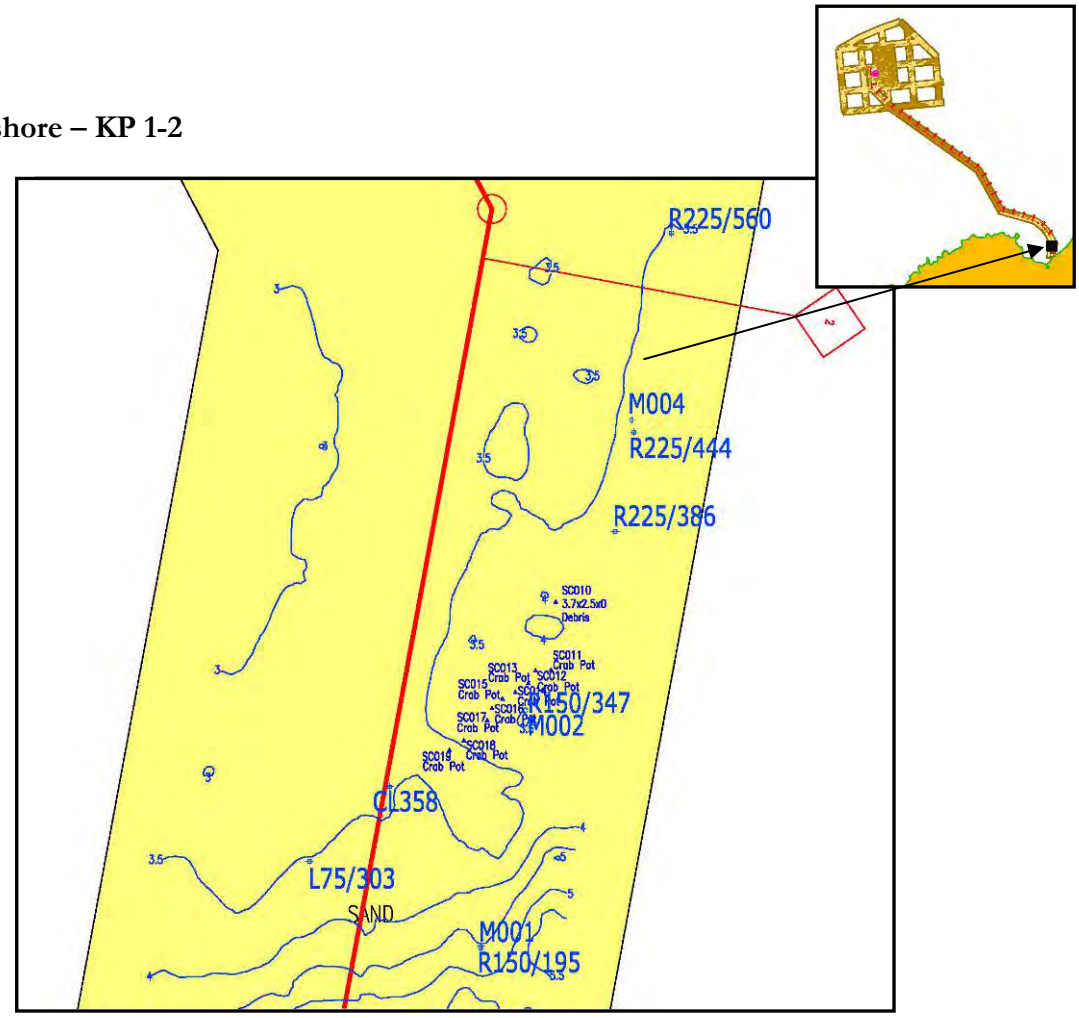

Fig 10 Magnetic anomalies nearshore section (up to KP 2)

This is a group of seven magnetic anomalies, including three identified by EGS: M001 and M002 in their table of magnetic anomalies and a third, 5 nT target, M004, shown only on the alignment chart (drawing 11). R150/195, R150/347 and R225/444 correspond to these EGS targets. Four further magnetic anomalies were identified: L75/303, CL/358, R225/560 and R225/386. These are in the same general area as the sidescan sonar targets SC010 – SC19, which were interpreted by EGS as crab pots. The EGS report refers to these anomalies as possible fishing debris (EGS International Ltd 2005, 18) They may however be archaeological material, and as such warrant further investigation.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	185	155255.8	39356.9	17	3	150-800	Hump - Geological?
	358	155318	39706.1	5	9	70-350	Spike
L75	303	155218.2	39613.5	7	9	100-500	Spikey dipole
R150	195	155430.9	39505.7	7	5	140-700	Spike (EGS M001) Towfish to seabed=7m
	347	155486.7	39801.2	17	9	250-1,200	Assm dipole (EGS M002) Towfish to seabed=11m
R225	386	155597.6	40022.8	5	11	100-650	Spike
	444	155620.9	40146.3	5	12	150-800	Spike (EGS M004)
	560	155667.9	40393.3	2.2	13	100-500	Spike

Fig 11 Table of nearshore magnetic anomalies

Anomalies at KP 7

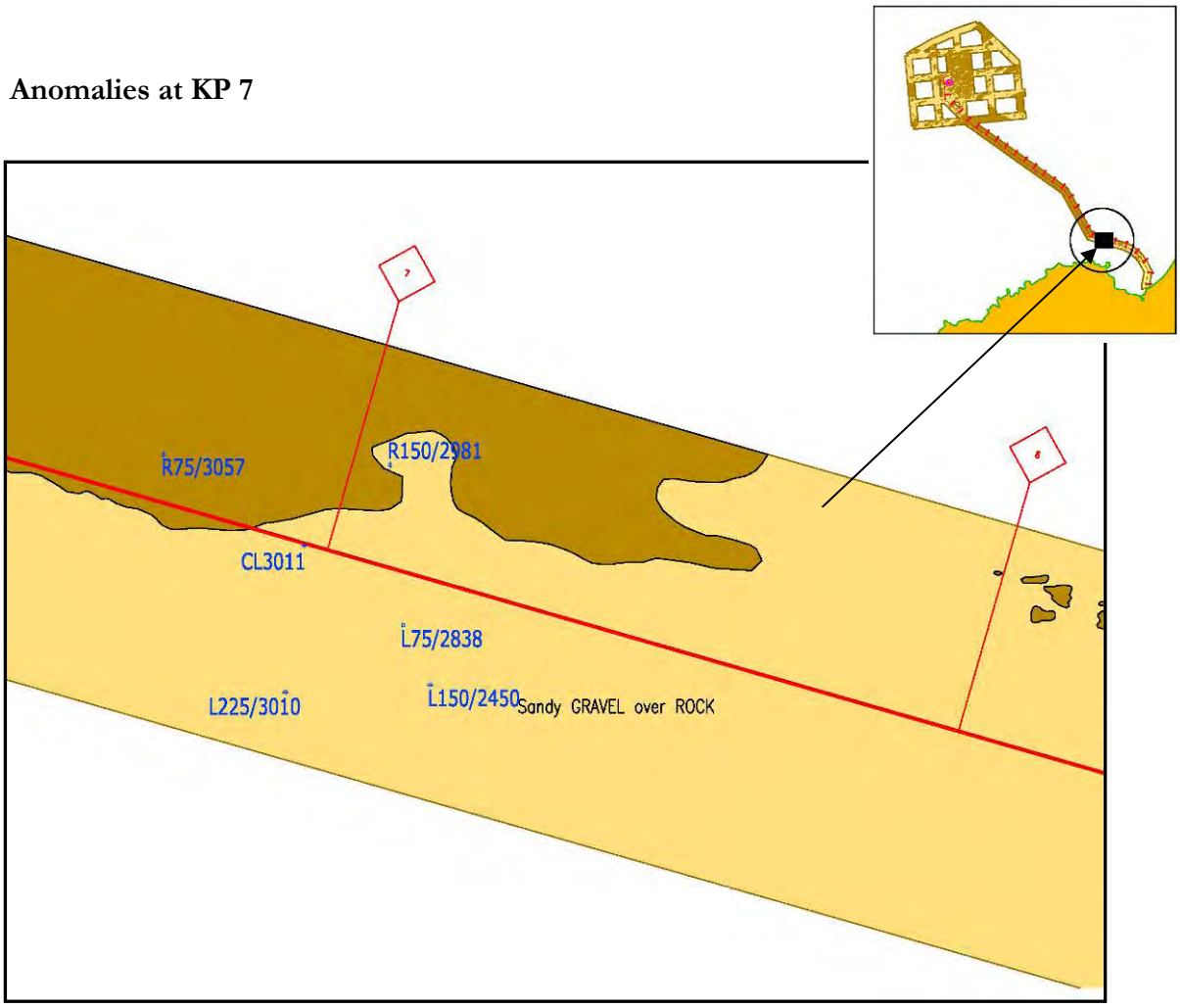

Fig 12 Magnetic anomalies in the region of KP 7

This is a group of six anomalies, with the greatest deflection on anomaly R75/3057. The profiles for all these targets build slowly over a considerable number of readings, suggesting that these anomalies may be caused by geological magnetic features. Investigation of one of the largest - R75/3057 or CL/3011 - would confirm that these anomalies were not caused by archaeological material.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	3011	151565.2	43111.2	28	26	10,000-50,000	Slow spike Geological?
L75	2838	151716	42990	22	25	7,000-35,000	Hump Geological?
L150	2450	151757	42899	18	25	5,000-28,000	Hump Geological?
L225	3010	151536.5	42887.7	20	25	6,000-31,000	Slow dipole
R75	3057	151351	43250	45	26	15,000-80,000	Slow assm dipole Geological?
R150	2981	151696.6	43234	25	26	9,000-45,000	Spike / hump

Fig 13 Table of magnetic anomalies in the region of KP 7

Iron wreck – KP 15.7

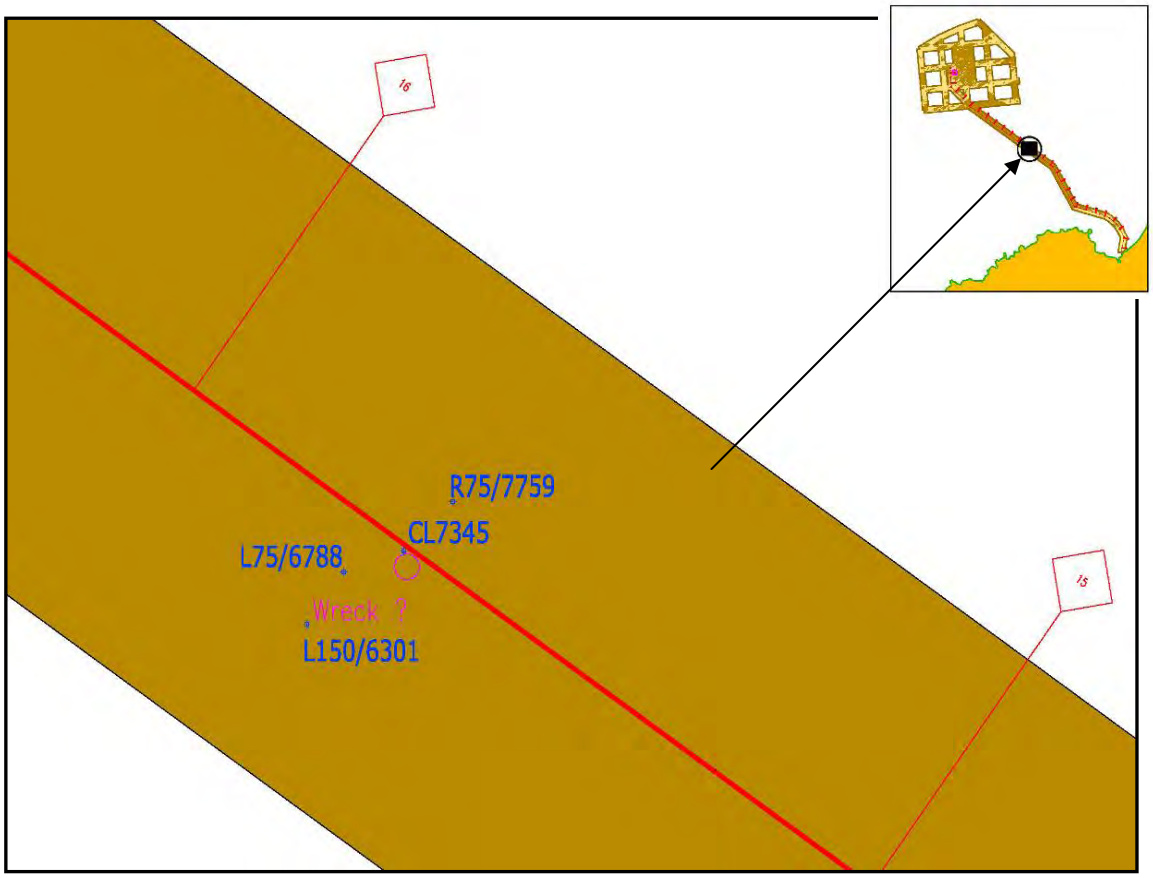

Fig 14 Magnetic anomalies between KP 15 and KP 17

These are four anomalies on adjacent survey lines, all registering the same, substantial target. Anomaly CL/7345 shows the largest deflection at around 460nT, indicating an iron mass of 270 to 1350 tonnes. This would most likely represent a small iron ship – probably built between the mid 19th century and 1940s. As this wreckage is very close to the centre line of the cable-run, some detour around this wreckage will probably be required. Further investigation to establish the date, size and extent of this wreckage should be carried out.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	7345	145825.6	49097	460	31	270,000 – 1350,000	Dipole - EGS M003 Towfish ht = 30m
L75	6788	145753.2	49072	12	32	8,000-40,000	Assm dipole EGS M003
L150	6301	145708.2	49010.3	18	31	10,000-50,000	Assm dipole EGS M003?
R75	7759	145884.1	49154.2	18	31	10,000-50,000	Neg spike

Fig 15 Table of magnetic anomalies between KP 15 and KP 17

Cable route anomaly at KP 19

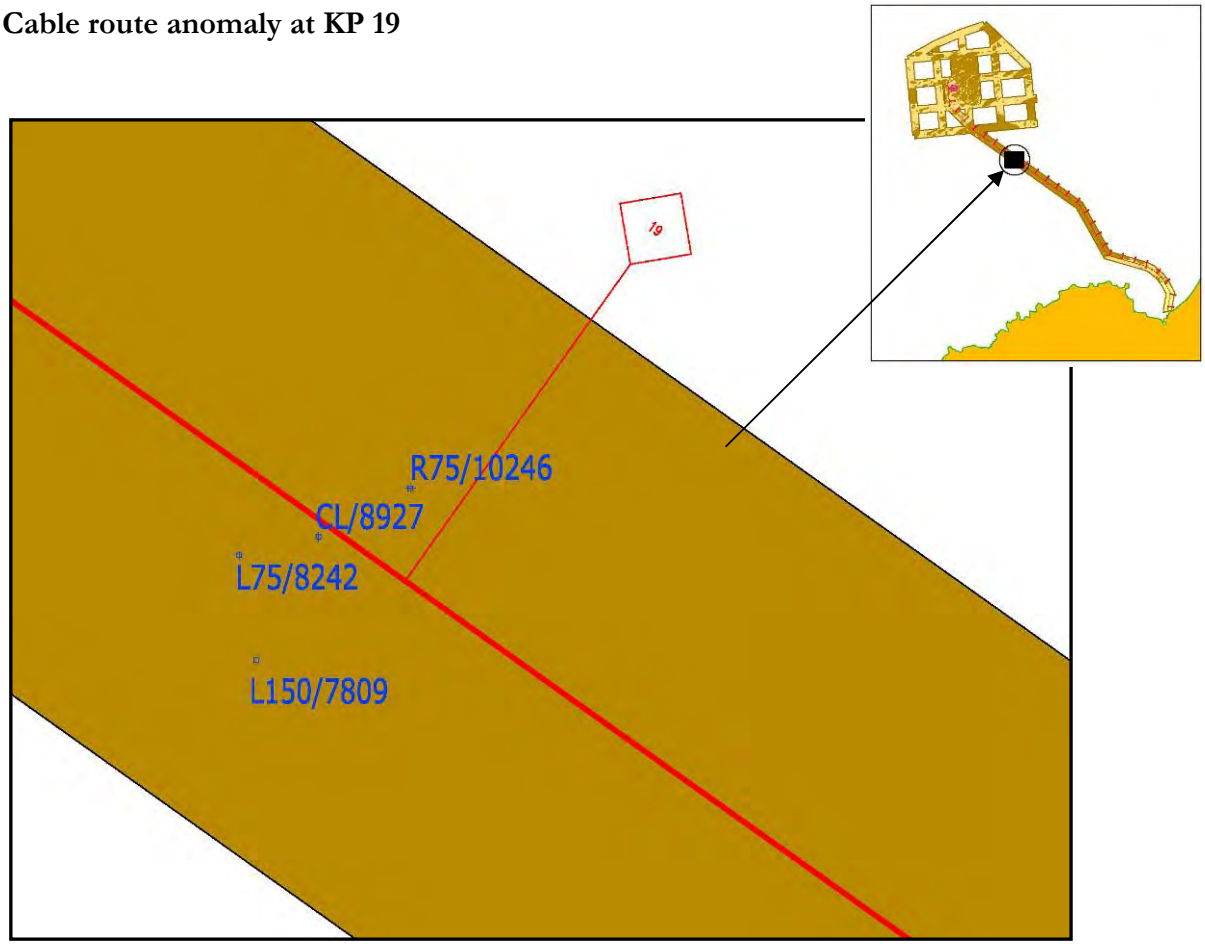

Fig 16 Magnetic anomalies at KP 19

This is a group of four magnetic anomalies on the cable route in the region of KP19. These are all caused by the same anomaly, which is closest to CL/8927 – a dipole target with an estimated mass of between 3.5 and 15 tonnes. This group of targets show some noise in the profile plots and could possibly be geological in origin – but it is difficult to be sure due to the relatively large magnetometer to seabed distance. There is also a uniform decrease in estimated target mass proportional to distance from CL/8927, suggesting a fairly localised source for the anomaly. Further investigation is recommended.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	8927	143040	51067.6	5	33	3,500 – 15000	Dipole Close to L75/8242
L75	8242	142959.5	51049.2	2.6	33	2,000-9,000	Dipole
L150	7809	142977.1	50943	2	33	1,000-7,000	Neg spike
R75	10246	143133.3	51116.8	3	32	2,000-10,000	Assm dipole

Fig 17 Table of magnetic anomalies at KP 19

Regional anomalies

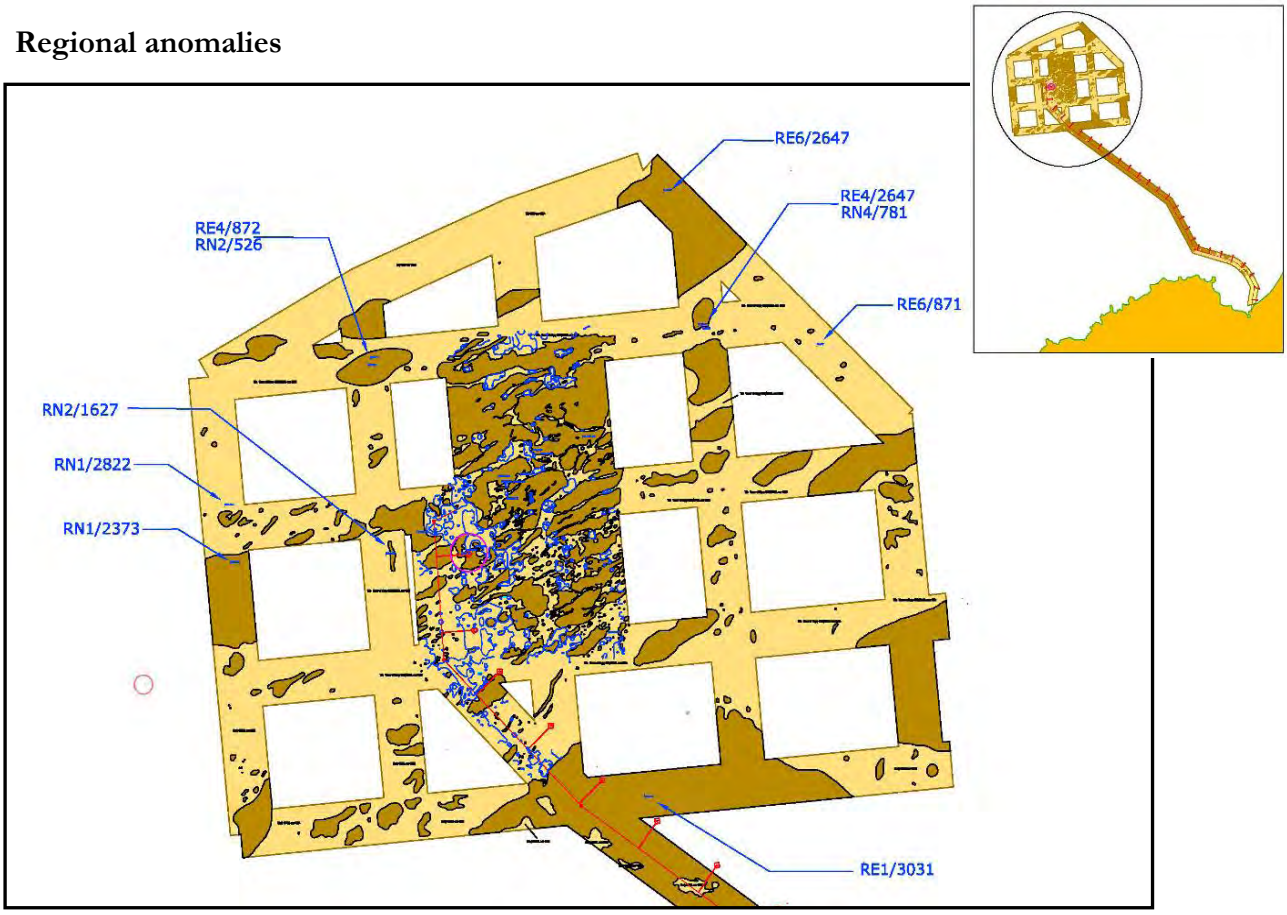

Fig 18 Regional magnetic anomalies

Ten anomalies were identified in the regional survey. The profiles from most of these anomalies were not conclusive, either because they were caused by geological sources or due to the relatively large distance between the magnetometer and the seabed. The exceptions are RE4/872 and RE4/2647 which both have convincing profiles. These hits are confirmed by corresponding anomalies in the readings from the north-south series RN2/526 and RN4/781. These two anomalies warrant further investigation if there is to be any disturbance in these areas.

Two very similar anomalies occur on the regional line RE6. Further investigation shows that in fact exactly the same magnetic values have been presented for this line and for RE4. In a line of over 3000 readings this is incredible and in consequence must be a post-processing artefact. The eastings and northings are consistent with the lines concerned but the magnetic data series are absolutely identical. It is hard to imagine how the same magnetic data set has ended up on two completely different run lines (RE4 and RE6). As the anomalies on RE4 were corroborated by corresponding anomalies on RN2 and RN4, this data has been assumed to be correct and in the right position. The magnetic data for line RE6 should be ignored.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
RE1	3031	140764	53464	1.7	36	1,000-8,000	Neg spike - Doubtful
RE4	872	137024	59193	3.2	57	10,000-60,000	Neg spike - Geological?
	2647	141493	59614	10	57	35,000-180,000	Spike
RE6	871	143115	59359	3.5	56	12,000-60,000	Spike / hump - Geological? NB **data copied from RE4**
	2647	141017	61373	10	56	35,000-175,000	Spike NB **data copied from RE4**
RN1	2373	135118	56498	15	55	50,000-250,000	Dipole
	2822	135036	57252	4	57	15,000-75,000	Spike
RN2	526	136995	59137	3.5	59	14,000-71,000	Hump - Geological?
	1627	137236	56608	15	53	44,000-220,000	Hump - Geological?
RN4	781	141552	59610	2.8	57	10,000-51,000	Spike / hump - Geological?

Fig 19 Table of regional magnetic anomalies

Main area anomalies

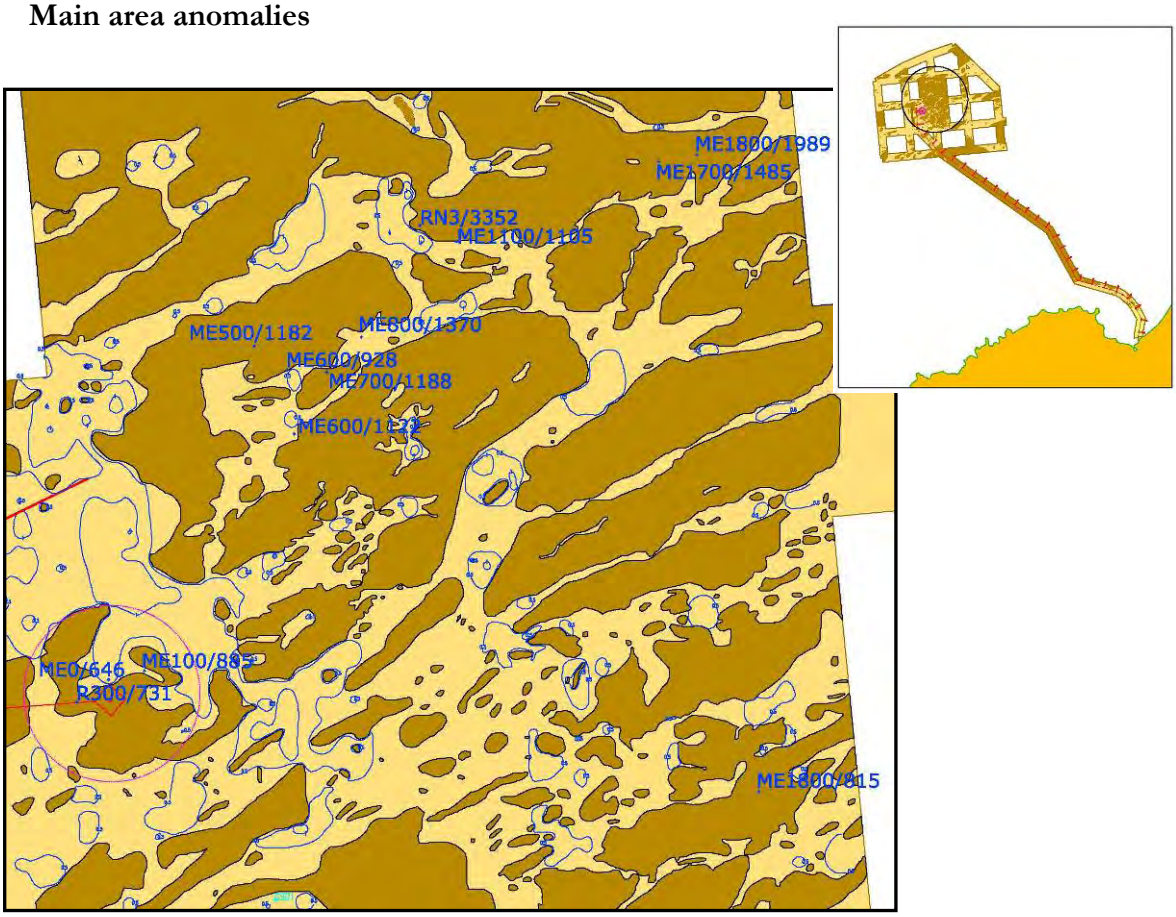

Fig 20 Main area magnetic anomalies

A total of 12 magnetic anomalies in the main area were recorded. One possible target, ME0/646 (estimated weight c.90 tonnes), also registered on adjacent run lines R300/731 and ME100/885. Another, ME1800/1989 (estimated weight 17 to 90 tonnes), also registers on the adjacent line ME1700/1485. These anomalies may be geological in origin but it is not possible to be certain due to the relatively large magnetometer to seabed distances.

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
L225	12926	137667	56938	10	56	35,000-175,000	Slow hump EOL - Geological?
R300	731	138269	56619.1	16	56	5,000-30,000	Slow spike - Geological?
RN3	3352	139242	57972	3.3	57	12,000-60,000	Dipole
ME0	646	138359	56683	25	56	87,000-430,000	Hump - Geological?
ME100	885	138461	56707	16	56	56,000-280,000	Hump - Geological?
ME500	1182	138772	57629	2.8	56	9,000-49,000	Spike
ME600	928	138866	575662	1.8	56	6,000-31,000	Small hump
	1122	138886	57380	2.2	56	7,000-38,000	Hump
ME700	1188	138978	57555	5	56	17,000-87,000	Spike / hump - Geological?
ME800	1370	139076	57655	5	56	17,000-87,000	Spike
ME1100	1105	139345	57925	3	57	11,000-55,000	Spike

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
ME1700	1485	139919	58152	6	56	21,000-105,000	Spike
ME1800	815	140203	56365	6	53	17,000-90,000	Neg Spike
	1989	140027.5	58171.9	7.5	56	26,000-150,000	Spike

Fig 21 Table of main area magnetic anomalies

Magnetic data conclusions

A number of anomalies have been identified and, where appropriate, further investigation of these targets has been recommended in the text above. The largest of the targets located - CL/7345 - was visited on a recreational dive on 27 December 2005. The target proved to be a riveted iron steamer, about 60m in length with twin iron boilers (c. 4m diameter), steam engine and single iron propeller (c.3.7m diameter). These dimensions accord well with the estimated weight (270-1350 tonnes) derived from the magnetic data. However, as the engine, boilers and propeller stand above the surrounding seabed by as much as 4m it is noteworthy that this substantial wreck is not readily apparent on the sidescan sonar survey.

The magnetometer fish was towed at a depth of 1-3m from the surface. As a result, the minimum mass of iron detectable by the survey varies depending on the water depth. In 30m of water the minimum mass detectable is between 1 and 5 tonnes, while in the deepest part of this survey (59m) nothing smaller than 9 – 43 tonnes of iron is likely to have been detected. In consequence, a great deal of archaeological material may have gone undetected in the deeper parts of the magnetic survey. The magnetometer fish needed to be deployed closer to the seabed in order to be able to detect likely archaeological material.

A problem was found in the magnetic data recorded in the regional part of the survey. Two data lines (RE4 and RE6) had exactly the same magnetic data recorded against their respective (and different) x and y positional values. This may have resulted from a post-processing error. This rather odd occurrence calls into question the integrity of the magnetic survey as a whole. Investigation of exactly how this 'error' occurred may help to clarify the overall integrity of this data set.

6.1.6 Sidescan sonar survey

The sidescan sonar system used by EGS International Ltd for the survey was an EdgeTech 260 recorder unit with a 272TD tow fish. The cable route and main area surveys were conducted at 100kHz with a range setting of 100m. The regional survey lines were run with a range of 300m set, 'the extra coverage being obtained with some sacrifice in data resolution' (EGS International Ltd 2005, 7)

The survey report states that the length of cable deployed from the stern of the boat for the sidescan tow fish varied from 5m in shallow water to 70m in the deepest water (*ibid*, 7). The sonar data was recorded digitally by C-View SDMP software on board the survey vessel.

This data was supplied separately, and at a later date than the main survey report. It was produced on five DVD ROMs along with C-View software to enable the sidescan and SBP survey to be viewed(C- View SDMP version 1.50). The data was quite difficult to view using this software and several data files could not be opened at all. Analysis of the sidescan data was further hampered by the fact that the version of C-View supplied had been restricted so that positions and sizes of targets could not be measured. The data was not corrected for layback and the amount of layback was not accessible from the software

supplied. This information was available in the logs made by EGS and it would appear that the amount of layback was variable (Stephen Hayes pers comm). In consequence, the position for any targets identified could only be approximated from the fix points (every 50m) in the sidescan survey.

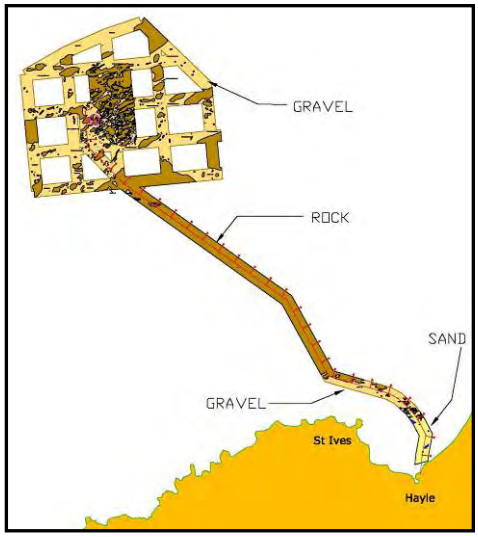

Fig 22 Seabed types

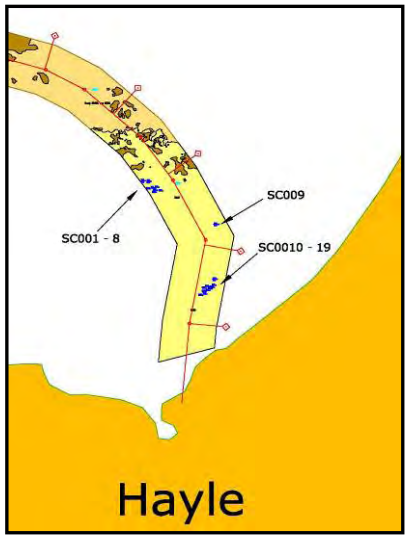

Fig 23 Location of sidescan targets

Contact no	Lat/Long WGS84	Easting / Northing OSGB	KP CL offset	Dimensions (m)	Description	Associated magnetic anomaly
SC001	50° 13.096´N 5° 26.269´ W	154861.0E 41022.0N	2.864 239m SW		Crab pot	No
SC002	50° 13.104´N 5° 26.253´ W	154881.0E 41042.0N	2.872 212m SW		Crab pot	No
SC003	50° 13.119´N 5° 26.313´ W	154810.0E 41066.0N	2.963 259m SW		Crab pot	No
SC004	50° 13.120´N 5° 26.303´W	154822.0E 41068.0N	2.957 248m SW		Crab pot	No
SC005	50° 13.123´N 5° 26.287´ W	154842.0E 41073.0N	2.950 229m SW		Crab pot	No
SC006	50° 13.125´N 5° 26.344´ W	154774.0E 41079.0N	2.994 280m SW		Crab pot	No
SC007	50° 13.166´N 5° 26.380´ W	154735.0E 41157.0N	3.081 267m SW	2.5 x 2.1 x 0 (shown as 5.4 x 2.6 x 0 on EGS drawings 04-06	Crab pot or debris	No

Contact no	Lat/Long WGS84	Easting / Northing OSGB	KP CL offset	Dimensions (m)	Description	Associated magnetic anomaly
SC008	50° 13.167´N 5° 26.439´ W	154665.0E 41163.0N	3.126 320m SW	3.4 x 2.6 x 0 (shown as 5.4 x 2.6 x 0 on EGS drawings 04-0604-06	Crab pot or debris	No
SC009	50° 12.896´N 5° 25.686´ W	155536.0E 40620.0N	2.194 172m SW	2.7 x 1.2 x 0 (shown as 3.7 x 1.2 x 0 on EGS drawings 04-06	Crab pot or debris	No
SC010	50° 12.527´N 5° 25.670´ W	155524.0E 39935.0N	1.597 166m SW	1.5 x 1.0 x 0 (shown as 3.7 x 2.5 x 0 on EGS drawings 04-06	Crab pot or debris	No
SC011	50° 12.481´N 5° 25.672´ W	155518.0E 39851.0N	1.513 176m SW		Crab pot	No
SC012	50° 12.480´N 5° 25.688´ W	155499.0E 39850.0N	1.508 157m SW		Crab pot	No
SC013	50° 12.472´N 5° 25.695´ W	155490.0E 39834.0N	1.491 151m SW		Crab pot	M002 within 25m
SC014	50° 12.465´N 5° 25.708´ W	155474.0E 39823.0N	1.477 138m SW		Crab pot	M002 within 25m
SC015	50° 12.461´N 5° 25.721´ W	155458.0E 39815.0N	1.467 123m SW		Crab pot	No
SC016	50° 12.454´N 5° 25.731´ W	155445.0E 39803.0N	1.452 113m SW		Crab pot	No
SC017	50° 12.445´N 5° 25.736´ W	155439.0E 39788.0N	1.437 110m SW		Crab pot	No
SC018	50° 12.431´N 5° 25.759´ W	155410.0E 39763.0N	1.407 86m SW		Crab pot	No
SC019	50° 12.425´N 5° 25.774´ W	155392.0E 39751.0N	1.392 70m SW		Crab pot	No

Fig 24 List of sidescan targets identified by EGS International Ltd

Sidescan sonar targets SC001 to SC008

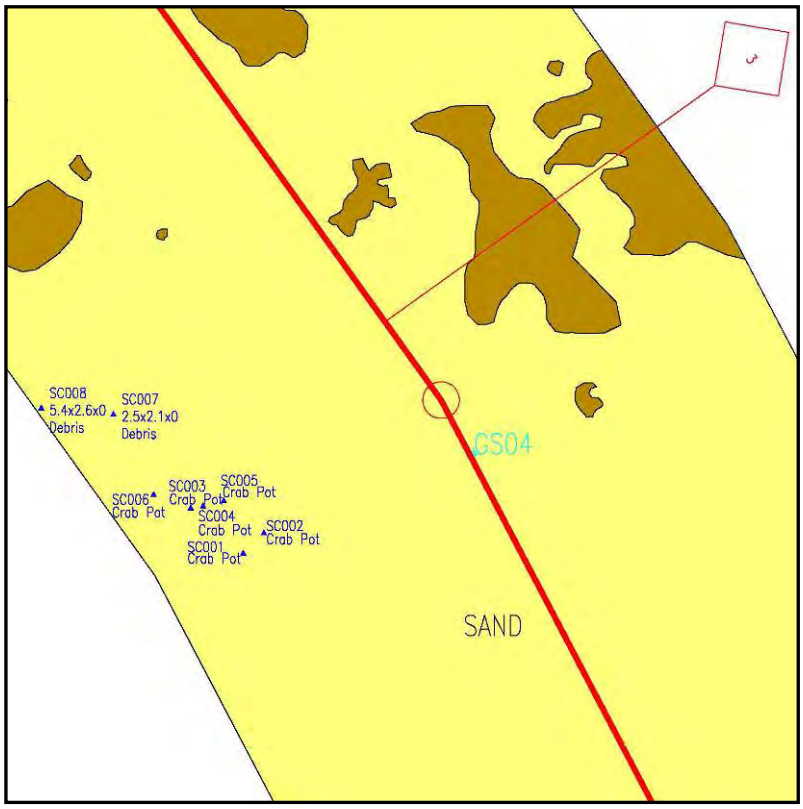

Fig 25 Sidescan sonar targets SC001 to SC008

The sonar targets identified by EGS are all situated on the sandy seabed close to the shore. This may be a function of the visibility of sonar targets on different seabed types rather than a true distribution. The sonar targets form two distinct groups and were interpreted by EGS as crab pots or fishing debris. Where dimensions are given (SC007 to SC010 in the table above) these are considerably larger than the usual dimensions of crab pots in use locally. It should be noted that the dimensions given for these targets in Fig 24 are different from those listed for the same targets on the alignment sheet D11. For this reason, these targets may be of archaeological interest and should be investigated to establish exactly what they were caused by.

The sonar targets SC001 to SC008 are situated at the western edge of the cable route. No magnetic anomalies were detected in this area – suggesting that whatever caused these sidescan targets does not contain any large quantities of iron. The interpretation by EGS of targets SC001 to SC006 as crab pots seems plausible. Although it is customary to secure pot strings with iron weights of about 20 kg at each end, this mass of iron would not have registered on the magnetometer as they are in 15m of water. Reference to the table of minimum detectable mass (Fig 3) shows that at 15m depth the minimum detectable mass of iron is 135 - 575 kg if the fish is towed at 3m below the surface.

Targets SC007 and SC008 are interpreted as fishing debris by EGS. However, the given dimensions (see table above) suggest that these are not crab pots or associated end weights. These two targets should be investigated to establish their exact nature and size.

Sidescan sonar targets SC010 to SC019

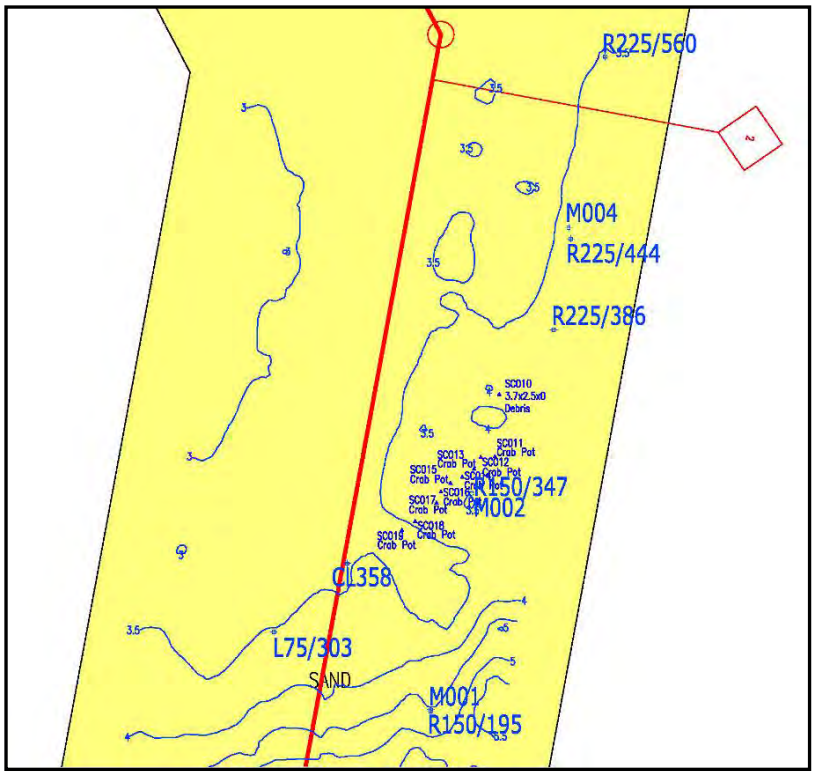

Fig 26 Sidescan sonar targets SC010 to SC019

The other sidescan targets identified are SC010 to SC019. EGS have interpreted targets SC011 to SC019 as crab pots. As fig 15 shows, there is also a magnetic target (R150/347) in amongst these sonar targets. As the estimated weight for this target is 250 – 1200 kg, it is unlikely to be iron weights associated with the crab pots.

SC010 is shown as 3.7m x 2.5m on the SBF 04 drawing accompanying the survey report and is therefore considerably larger than a crab pot. This target warrants further investigation.

SC009 this target is 3.7m x 1.2m on the SBF 04 drawing accompanying the survey report and is therefore considerably larger than a crab pot. This target should be investigated.

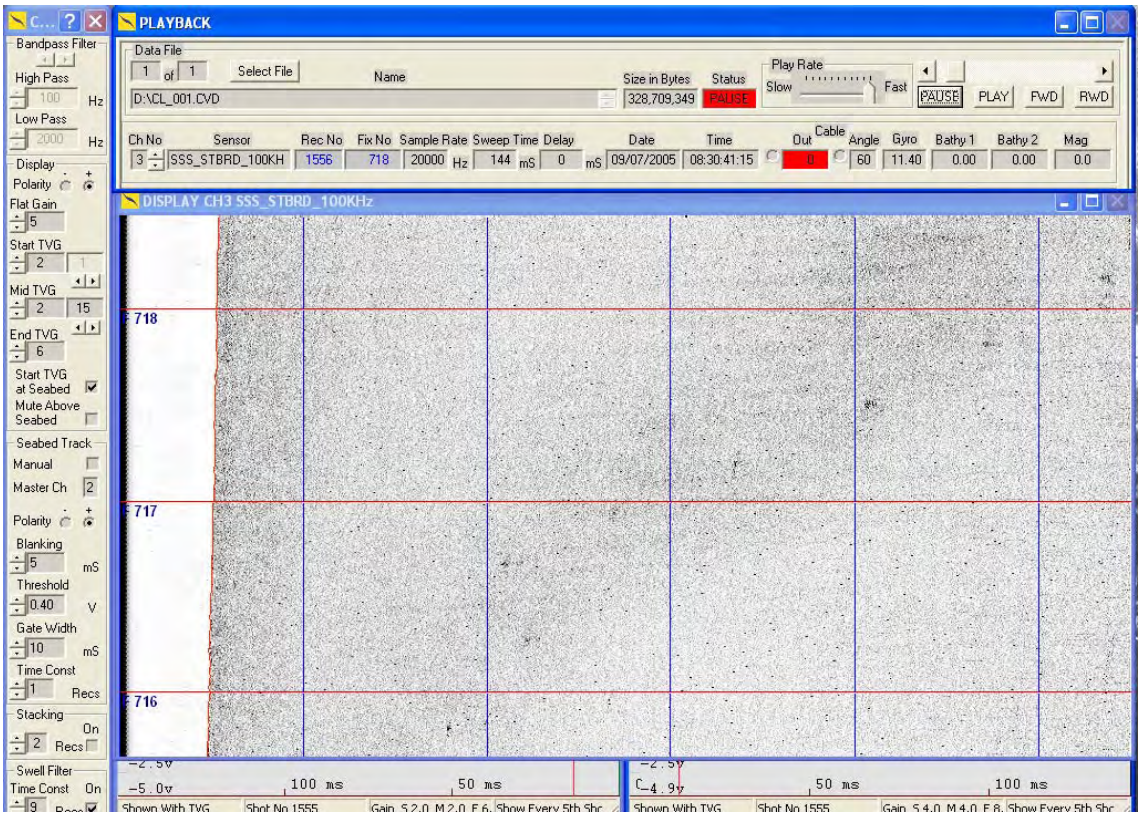

Fig 27 C-View Screenshot – sidescan, starboard side only, possibly showing the start of targets SC010 to SC019

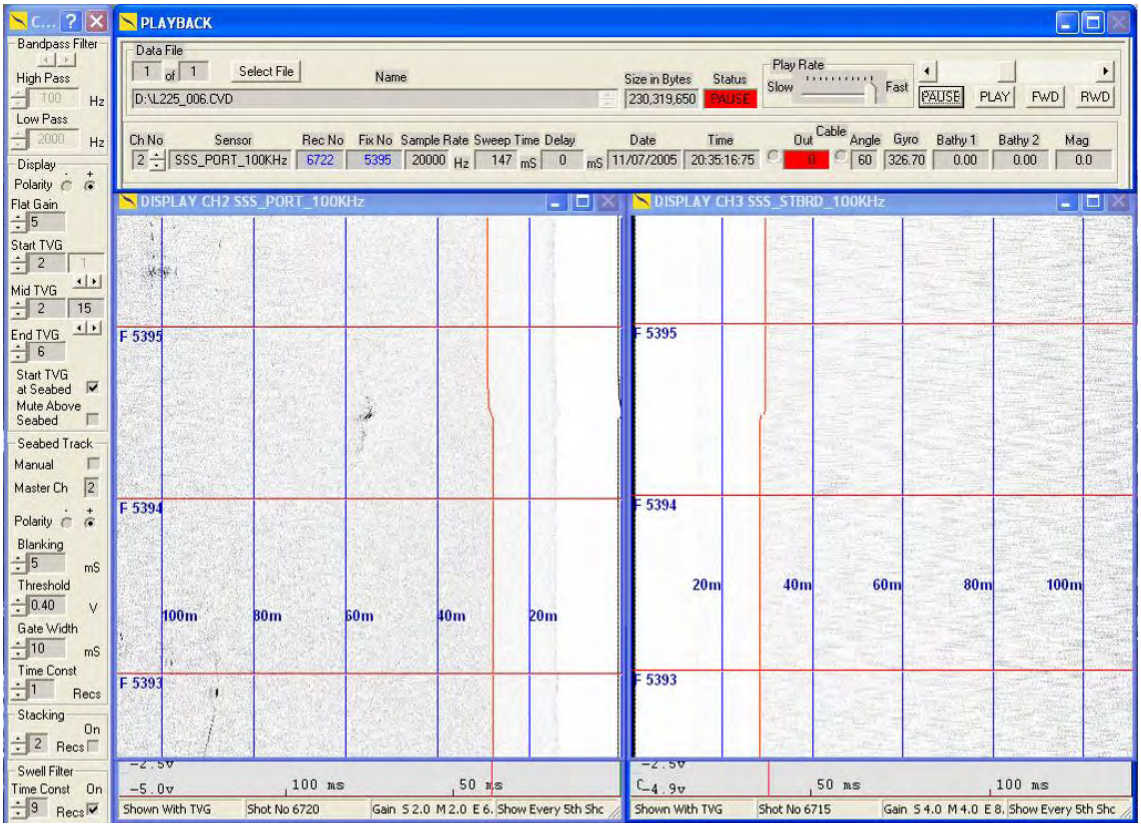

Fig 28 C-View Screenshot showing sidescan targets SC007 to SC008

Additional sidescan targets

The following sidescan targets were detected from the sidescan data supplied by EGS. The amount of layback is not available in the version of the C-View software supplied. For this reason the positions are only approximations and will be in error by at least the distance of the layback. Similarly the dimensions quoted are approximate as the software did not allow target measuring – all dimensions were scaled from the VDU. All sidescan files which could be opened by C-View were examined but the only clear targets detected were on the inshore sandy seabed section (up to KP 3).

Target	File/Fix	Side / distance	Approx position	Comments
SC100	L7501/5348	PORT 100m	154947E 39112N	Long thin hard target – extreme inshore section – some noise or possibly other targets 5 x 0.5m
SC101	CL01/741	STB 31m	155208E 40938N	Hard target with strong shadow on sand 3 x 1m
SC102	CL01/730.1	STB 70m	155492E 40445N	Long thin target (wire?) 10 x 0.2 m
SC103	CL01/731.4	STB 92	155498E 40539N	Long thin hard target 6 x 0.25m

Fig 29 Table of additional sidescan targets

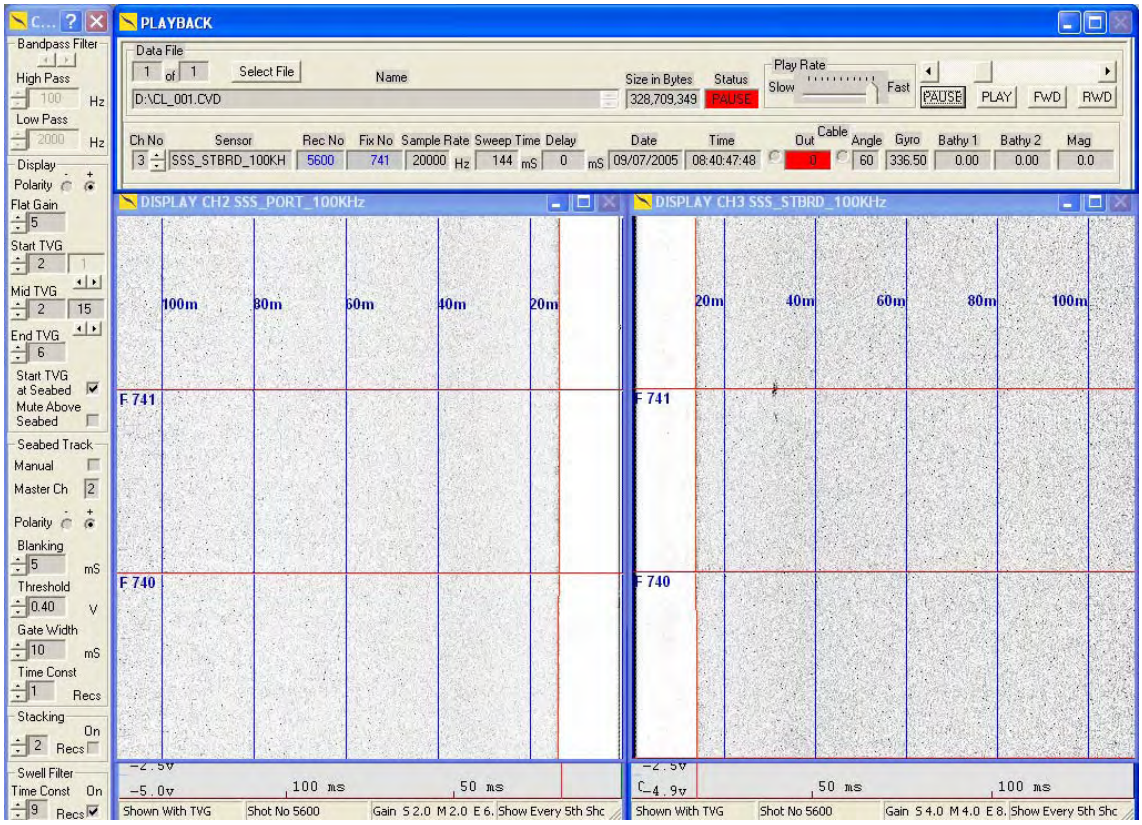

Fig 30 C-View Screenshot showing sidescan target SC101

As is clear from the location plan for these targets (Fig x below), these sonar targets are all situated on the inshore sandy seabed. The areas around all the magnetic targets were searched very carefully in an effort to see the targets concerned. Even where the targets were known to be large (for example the iron steamer which produced magnetic anomaly CL/7345) these could not be detected on the sidescan sonar. One of the reasons for this is probably the very broken nature of the seabed where the rock is exposed.

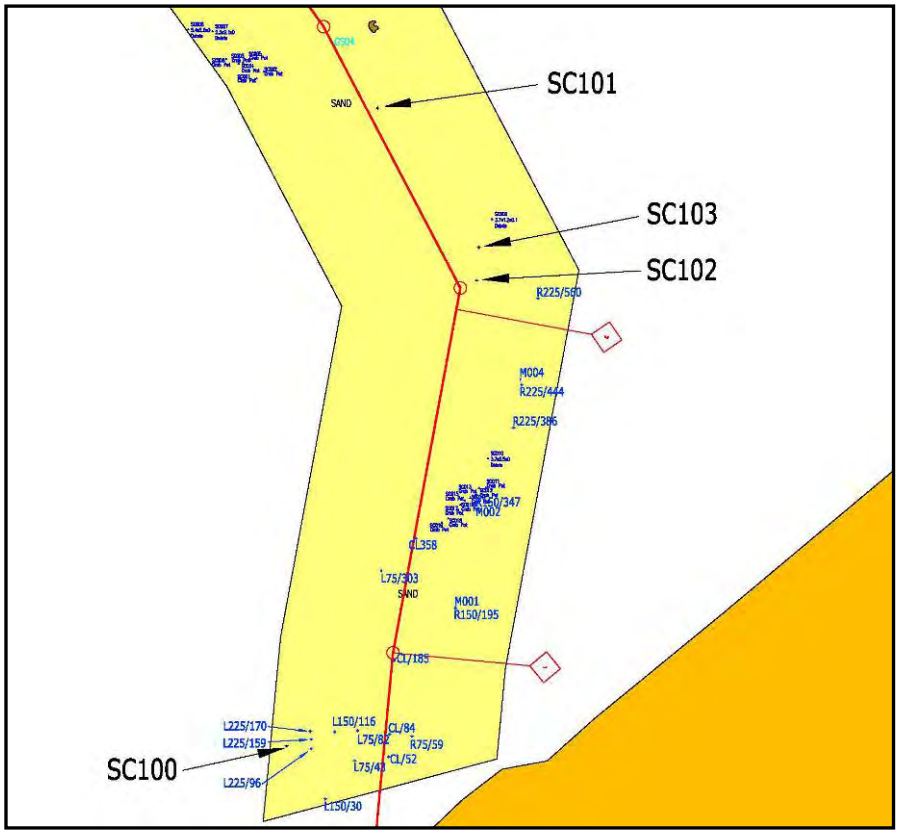

Fig 31 Plan of additional sidescan targets

All the recorded sidescan sonar targets were situated on sandy seabed. However the majority of the area surveyed has an uneven rock seabed, which makes identification of archaeological targets by sidescan sonar very difficult. As an illustration of this phenomenon, the sidescan traces for the iron wreck located on the cable run (CL/7345) were inspected. This wreck is a riveted iron steamer, about 60m in length with twin iron boilers (c. 4m diameter), steam engine and single iron propeller (c.3.7m diameter). However, as the engine, boilers and propeller stand above the surrounding seabed by as much as 4m it is noteworthy that this substantial wreck is not readily apparent on the sidescan sonar survey. If such a substantial target cannot be seen when it is know to be there, then the chances of detecting smaller objects where we have no prior knowledge are highly unlikely.

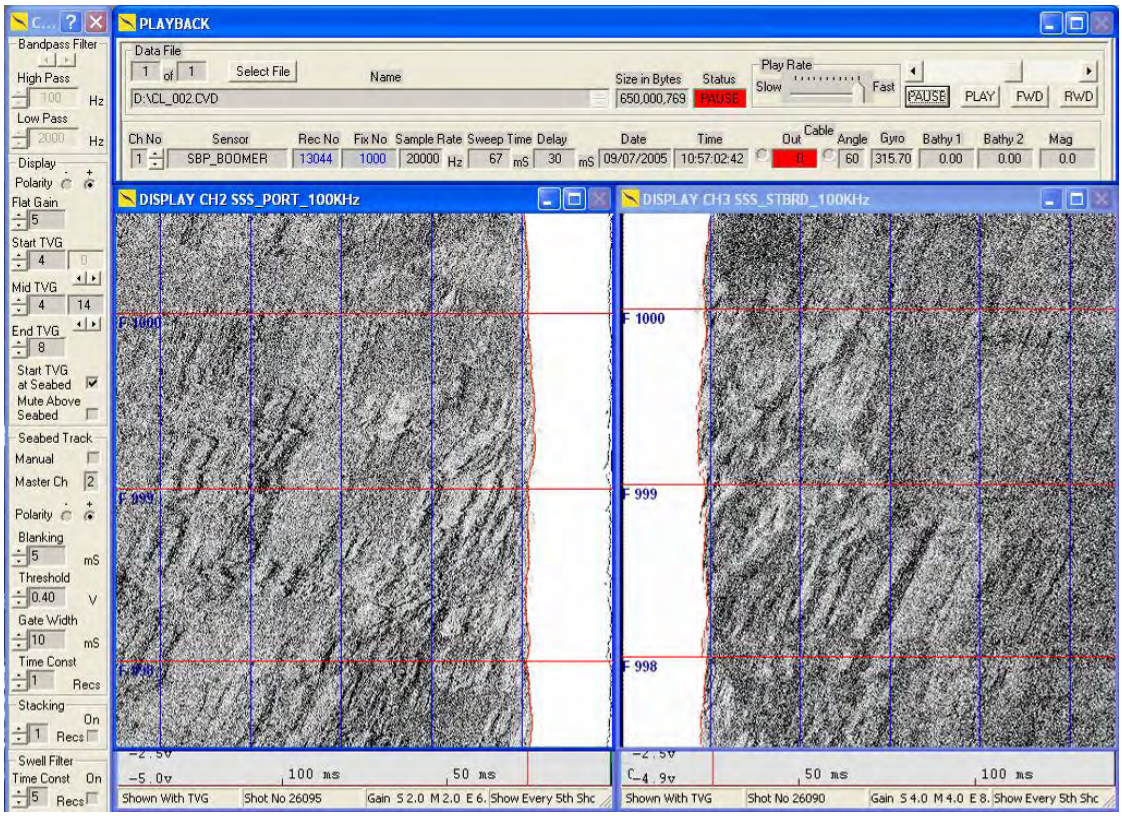

Fig 32 C-View Screenshot CL – sidescan. The wreck should be visible on the port side on the P999 fix line, about 25m out (nb position approximate as layback is unknown)

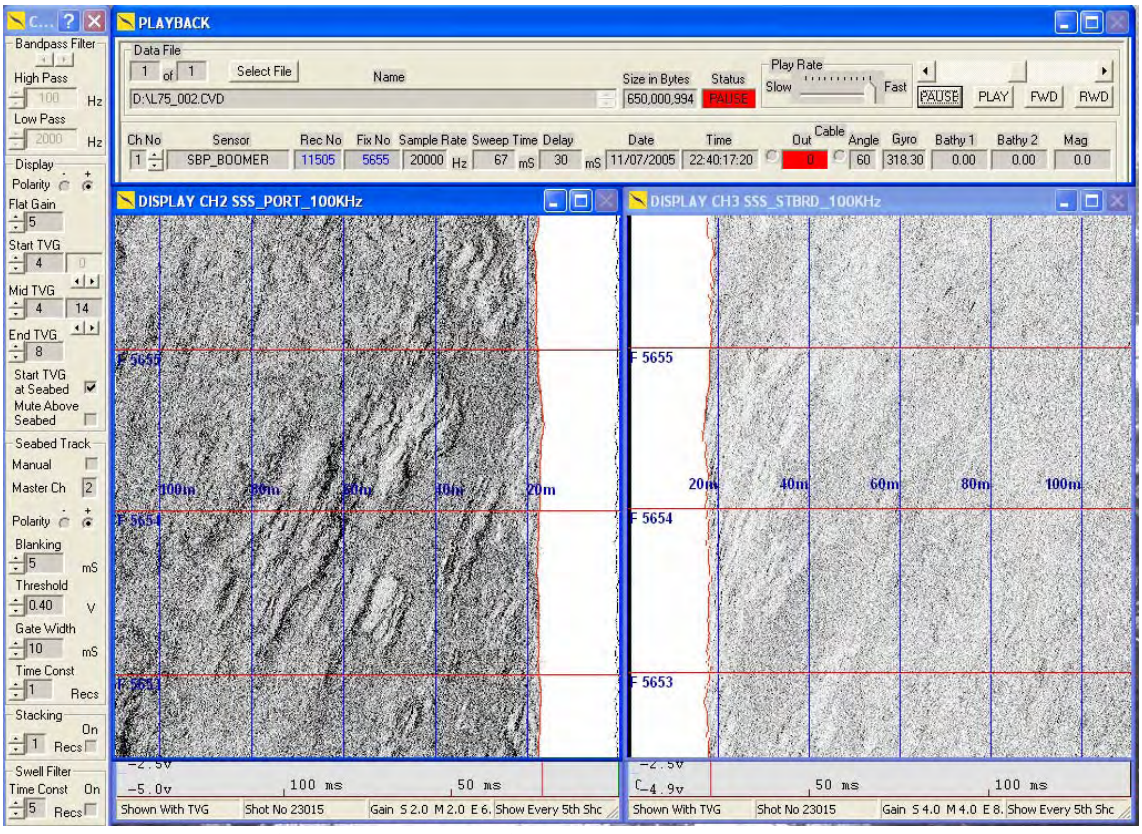

Fig 33 C-View Screenshot L75 – sidescan. The wreck should be visible on the starboard side on the F5654 fix line and 60m out (nb position approximate as layback unknown)

6.1.7 Sub-bottom profile survey

This section of the report reviews the sub-bottom profile data with regard to the nature and character of the palaeoenvironment along the line of the proposed cable route and main site for the wave hub project.

The sub bottom profile data was acquired using an EGS C-Boom low voltage boomer which together with an "eel" hydrophone was towed behind the vessel. This type of system is very weather dependant and it is noticeable that on the early part of the survey programme the data was adversely affected by poor sea state conditions. This includes segments 2 – 6 on line R75, and segment 7 on lines R225 and R150.

Cable Route

The sub-bottom profile data was run along seven parallel lines, comprising the centre line and three wing lines at 75m line spacing. The inshore area was surveyed as a single entity in the period over HW on 11 July 2005 in good sea state conditions in order to provide survey coverage to mean sea level. These inshore survey lines are approximately 500m long, from KP 0.60 to KP 1.10, and covered the sandy section of the near shore areas forming the east side of the Hayle Bar.

The sub-bottom profile record show that the depth of surfical sand overlying bedrock in this section decreases from a maximum depth of sand cover of more than 6m at KP 0.90 to less than 4.0m at KP 1.1, all of which overlies a sequence of coarser grained material. At least the upper 3m of this surficial sand is mobile and subject to changes in levels due to seasonal variations.

In the winter period the wave action causes the sand to accumulate further offshore in the form of offshore bars. During periods of calmer weather the sand bar tends to migrate shoreward and by early summer usually forms a sand berm at the high water mark.

This cyclic process can have a significant influence on the distribution of any wrecks or artefactual material lost on the seabed. This will largely depend on the depth of water and the bed sheer stress acting on the seabed which can cause higher density materials to become buried at depth in the unconsolidated sub bottom where the material is less likely to become disturbed over time.

In this instance the shore approaches at Hayle provide the conditions in which artefactual material may have become preserved at the interface between the mobile sand layer and the underlying sequence of coarser grained material. However, no artefactual material was reported or could be observed from the sub-bottom profile records.

The sequence of surficial sand has been "mapped" on the alignment sheets as an isopachyte which indicates the presence of an "infill" erosion valley which is a palaeo feature of the Hayle River estuary formed at a lowering of sea level during the Mesolithic period when sea level was some 40 m lower than the present day.

Whereas it is not possible to identify the full extent of the old drainage pattern, it is possible to identify where parts of the old river system cross over the line of the proposed cable route in K 1. It is quite conceivable that the central areas of the infill erosion valley could contain peat deposits as well as gravels and hence could provide information on the climate and sea level rise during the Flandrian transgression.

There is also evidence in this area that below the surficial sand, there is an underlying sequence of coarser grained material comprising gravels and cobble layers which is "masked" by the first "multiple" in the near shore areas due to the effect of shallow water.

This underlying coarser sequence which forms a "basal conglomerate overlying consolidated bedrock appears to be more variable in character and gradually reduces in thickness further offshore and eventually "pinches out" at KP 1.70 on the centre line.

There is some evidence to suggest that some of these relic features are "raised" beaches which have been formed at a stand of sea level below the present day sea level. Other sources indicate that these "raised" beaches are not necessarily formed during the most recent interglacial period (Holocene) but may have been formed from stands in sea level from an earlier interglacial periods (ie Hoxnian).

It is noticeable that from the area around KP 1.2 to KP 3.2, the cover of surfical sand remains fairly constant at between 3.5 and 4m but thereafter it begins to reduce gradually in depth and between KP 3.4 and KP 3.6 thins from less than 2m to a almost zero.

For the remainder of the cable route, the seabed profile remains "broken" with thin veneer of shelly gravels overlying a consolidated bedrock of foliated Devonian metamorphosed slates. Periodically these slates form reefs aligned in a SW/NE alignment which extend across the cable route.

The areas for which there is some surficial sediment cover is limited to of an area of unconsolidated surficial sediment up to 1m thick from KP 20.9 to KP 21.3 consisting of sandy gravel overlying bedrock.

There is an abrupt change in the seabed profile at KP 22.15.where a prominent "reef" extends across the line of the cable route.

The 40m contour is considered to be the limit of the Mesolithic shoreline in the period 10000 to 4000 years BP when sea levels were continuing to rise from the end of the last Ice Age, known as the Flandrian Transgression.

Description of Main Site

The deployment area occupies an area of 4 km long by some 2km wide, orientated NNW/SSE. A total of 21 survey lines were run at nominal 100m spacing.

Within the main area of the Wave Hub site the sea floor varies in depth from 50m to 60m with a localized shoal reef area some 8m high giving a least depth of 43m in the south of the area.

The interpreted seabed features and isopachyte to the base of recent marine sediments is depicted on dwg WHUB D06. This drawing shows that the area to the north consists mainly of exposed rock with channels of surficial sediment aligned in an approximate SSW/NNE direction.

This distribution of surfical sediment is considered to relate to the main structural trends in the folding and foliation in the metamorphosed Devonian slates.

Apart from large structures such as wrecks, no artefact material has been reported. Any artefactual material is most likely to have been preserved in the channels formed between the exposed rock outcrops and in the areas where surfical sediment has accumulated to a depth of up to 1m in the south and west of the main site.

6.1.8 Seabed sediments

Three basic sediment types were identified by the EGS survey. These were rock, gravel and sand. The seabed surface distribution of these is shown below.

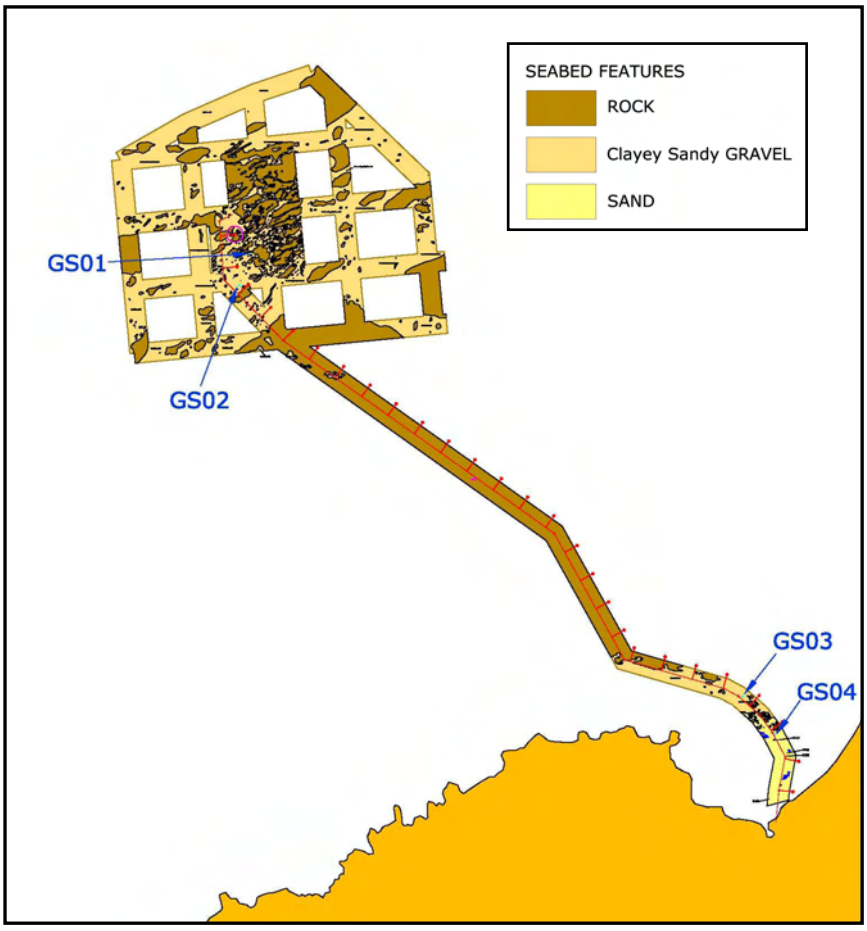

Fig 34 Location of grab samples

Four grab samples of seabed sediment were taken. These are detailed in the EGS report appendix H. The results are summarised below in Fig 35. It is worth noting that grab sample 3 (GS03) is recorded as fine sand, while on the seabed features plan this area is shown as gravel.

Sample	Description
GS01	Clayey sandy medium to coarse GRAVEL
GS02	Slightly clayey shelly GRAVEL
GS03	Fine sand
GS04	Coarse SAND/GRAVEL with cobbles

Fig 35 Grab sample results

From the sub bottom profile data it is clear that the sand overlies the gravel deposits which in turn overly the rock.

Archaeological material is more likely to have survived buried within the sand and gravel deposits than on the rocky areas of seabed. Organic material will probably be subject to decay and dispersal on the rocky areas of seabed. However non organic remains may have survived especially if trapped in fissures within the rock. Objects of iron will often survive on rock, and will tend to become attached to the rock by their corrosion products.

6.1.9 Video data

The underwater video was supplied in late December 2005. The only video supplied consisted of just over 2 minutes of underwater footage (see screenshots below, Figs 36-38). The footage was obviously taken in difficult conditions and much of it is very dark. What is clear is that there is considerable iron wreckage on the seabed on this part of the cable route. The underwater photograph (Fig 39 below) shows the two boilers of the wreck, each of which is approximately 4m in diameter. The boilers, engine and propeller of the wreck are all situated at the stern of the wreck, where the position shown on the video footage suggests these pictures were taken. The wreck is some 60m in length.

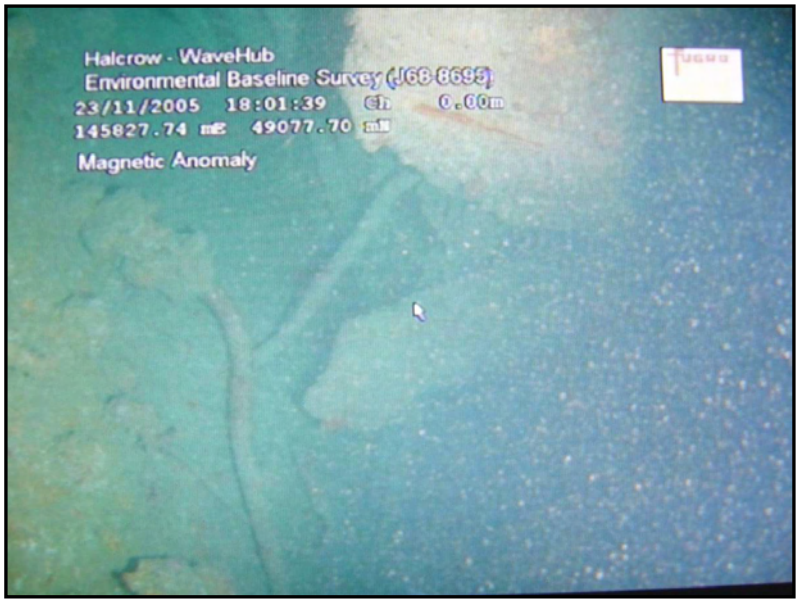

Fig 36 Screenshot from underwater video (magnetic target M003)

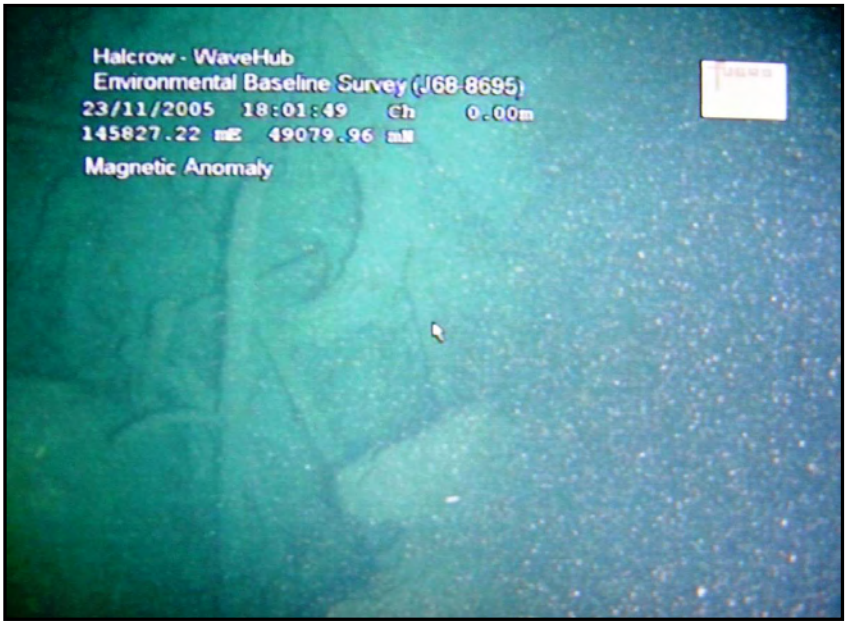

Fig 37 Screenshot from underwater video (magnetic target M003)

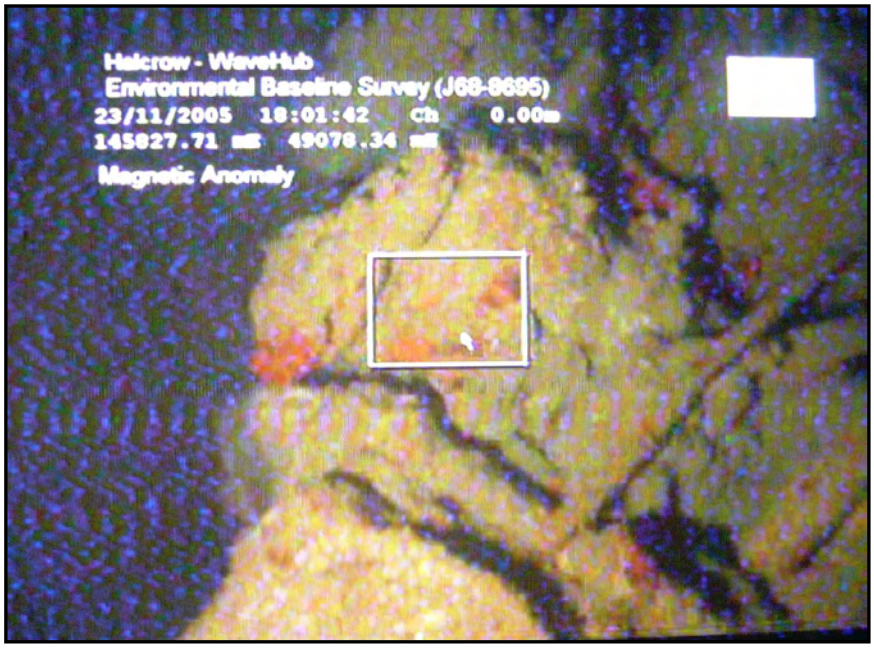

Fig 38 Screenshot from underwater video (magnetic target M003)

Fig 39 Underwater photograph of the wreck taken 27 December 2005 showing the two boilers, wreckage and diver (photo: Kevin Camidge)

6.2 Known and potential terrestrial archaeology

6.2.1 The archaeological and historical background

The Hayle-Gwithian Towans sand dune complex is the second largest in Cornwall and is recognised as having an extremely archaeological and historical dimension. Work by Professor Charles Thomas at Gwithian and Godrevy in the 1950s and 1960s has shown how a succession of episodic sand inundations can preserve a series of old land surfaces ranging in date from the Mesolithic to the medieval periods. Such buried land surfaces may include field boundaries and their associated settlements. The alkaline nature of the dunes is important as it permits the survival of bone which is unusual in Cornwall where bone rarely survives because of the general acidic soil conditions. Where cemeteries survive the Cornish sand dune systems provide the best chance for the study and analysis of osteoarchaeological remains from different periods.

At Gwithian two main excavations revealed a Bronze Age site with three major occupation horizons, evidence for wooden buildings, cremation burials, pottery manufacture, exploitation of marine resources, agriculture in the form of plough and spade marks, and a post-Roman site with major occupation horizons, each associated with different forms of 'Gwithian-style' pottery dating to the 5th to 9th centuries AD.

6.2.2 Sites

The earliest site identified in the study area is Riviere Castle, **site 1**, which in folklore or tradition was the stronghold of Teudar, a semi-legendary petty king of Cornwall in the late 5th to 6th century AD. The HER describes the site as a possible 'round' (a defended settlement of Iron Age date). The NGR, given in the NMR and HER, centres the round within the 19th century sand extraction pit, **site 2**, and early 20th century power station, **site 9** (Fig 40).

During the medieval period the study area was part of the Riviere Estate owned in 1522 by George de Vere, Earl of Oxford. It passed to the Arundells, from whom it was acquired by the Cornwall Copper Company in 1811. Neither Joel Gascoynes's map of 1699 nor Thomas Martyn's map of 1748 indicate any features in the study area.

The 1842 Tithe Award map for the parish of Phillack records the major part of the study area as Riviere Towan (Tithe Apportionment, 1680), owned by the Cornwall Copper Company (CCCo) under the firm of Carne, Sandys and Vivian and occupied by Matthew Trewhela. The land use is described as coarse pasture and this is likely to have been the primary land use of the area throughout prehistory and most of the historic era, until the mid-19th century, when its use became predominantly industrial.

The beginnings of a sand extraction pit, **site 2**, served by railway line, **site 3**, are shown on the Tithe Award map. The 1888 and 1907 OS maps show the sand pit and railway gradually extending northwards. By 1888 there was also a gravel pit, **site 4**, which was disused by the time of the 1907 OS map, with the Pentowan Calcining Works (arsenic works), **site 7**, established in its north-west corner. Between 1917 and 1925, the arsenic works were re-used as a glassworks known as the Pentowan Glass Bottle Works, **site 8**.

The 1888 OS map, shows a rifle range, **site 5**, crossing the sand pit and railway line. By the time of the 1907 OS map the rifle range has been moved to the east, with butts to the north of the sand pit. The site of 'Old Targets' are marked on the northern edge of the sand pit. The rifle range has disappeared by the time of the 1936-8 OS map.

There are six boundary stones, **site 6**, in the study area dating to 1867, which mark the bounds between Harvey's property and the remnant of the Copper Company lands which was by then in the hands of the receivers (Pascoe 1981, 120).

Hayle Power Station, **site 9**, was built by 1910 on the site of the mid-19th century sand pit, and remained in operation until 1977. A large bromine producing plant, **site 10**, was built in 1939-40 occupying part of the site of the former arsenic works and glassworks, continuing in production until 1973.

The other sites are a modern coal yard, **site 12**, electricity substation, **site 13**, holiday chalets dating from the 1930s onwards, **site 14**, and a modern cricket ground, **site 15**.

In addition there is potential for buried palaeoenvironmental and archaeological material to be buried below the dunes, including the remnants of WWII defences (cf Halcrow 2005, Appendix E, 6).

A contaminated land desk study has been carried out (Halcrow 2005, Appendix E to report 4D) which points out that the former power station, land filling/fly tipping, WWII ordnance, the rifle range and the arsenic/glass/bromide works are all potential sources of contamination.

Note: The sites are described in the Gazetteer and Inventory at the end of the report.

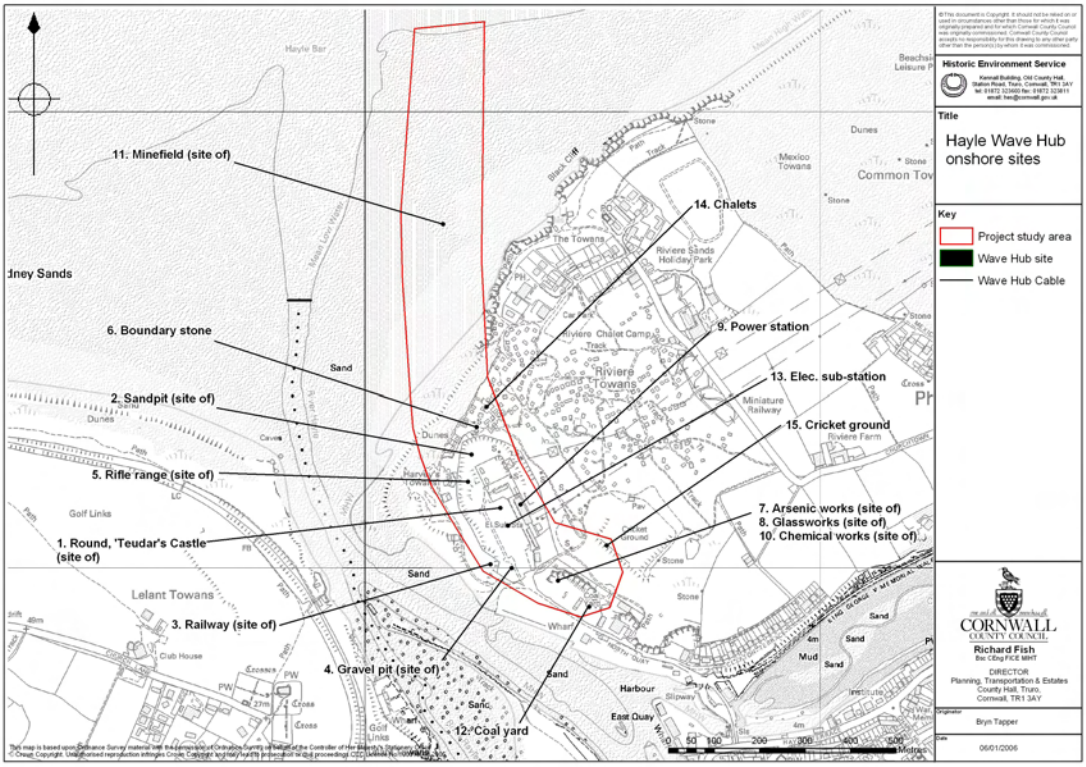

Fig 40 Location of terrestrial sites

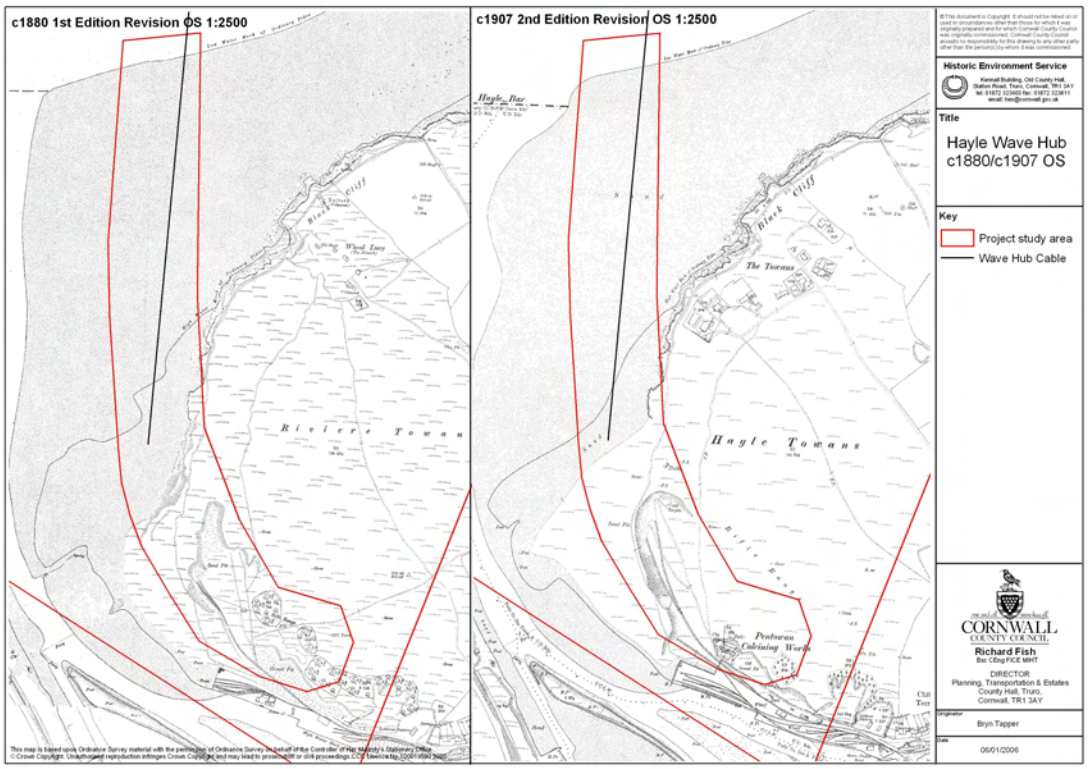

Fig 41 Extracts from the c1880 and 1907 OS maps

Fig 42 Aerial view of Hayle Power Station, ***site 10****, c1950 (courtesy of Penlee House Gallery and Museum)*

6.3 Known and potential inter-tidal archaeology

6.3.1 The archaeological and historical background

A submerged forest lies in the Hayle Estuary at Trewinnard (NGR 55500 37500), consisting of organic deposits covered by marine deposits. This suggests that at one time, possibly the Mesolithic Period, the area was dry land and became a tidal estuary a result of marine transgression. The tidal estuary was much bigger than the one we see today, and that Penwith was almost an island, separate from the rest of Cornwall. By the medieval period the estuary was reduced to little more than a stream by shifting sea sand and silt from inland mining works and agricultural activity. The while of the land locked water was hen known as the port of Lelant (Pearse 1963, 117; Johnson and David 1982, 97).

Two isolated archaeological finds have been made in the inter-tidal zone bordering the study area: a Bronze object, suggested to be a late Bronze Age razor was found on the beach to the west (Wessex Archaeology 1999, no 1035) and a Carthaginian coin in the channel through Hayle Bar (*ibid*, no 1211).

6.3.2 Sites

Although there are no known *in situ* or derived sites or artefacts of prehistoric date within the study area there is the potential for paleoenvironmental material or evidence of prehistoric human activity to survive below the sands of the Hayle Estuary.

The minefield, **site 11**, defending the eastern beach approaches of the Hayle Estuary was cleared after the war, although thirty mines are reputed to be unaccounted for. Other debris from WWII defences maybe buried below the sands.

6.4 Known and potential maritime archaeology

6.4.1 The archaeological and historical background

Prehistoric to medieval periods

Pottery recovered from the Gwithian sites and elsewhere along the Towans indicate that Hayle was an important haven on the Atlantic trading route, one of the few harbours on the north Cornish coast, particularly in the post-Roman period when pottery was being imported along the seaways from the Mediterranean to Tintagel.

The place-name Hayle is derived from the Cornish **heyl** 'estuary' (Padel 1985, 127-8) and is first recorded in 1260. The medieval carved slate from Crane Godrevy showing two moored cogs in a reed bed is likely to represent a ship that the artist actually saw riding at anchor, perhaps in the Hayle estuary or the mouth of the Red River (Fig 43). So, although no prehistoric, Roman-period, or medieval wrecks sites have been identified in the study area there is potential for an early wreck site to be preserved below the sands and mud of the Hayle estuary.

The Tudor Period

Some of the earliest recorded Cornish wrecks are in St Ives Bay, described in detail in the Penheleg manuscript, an 18th century copy of an original document dating to 1580. Thomas Penheleg (Penhellick) was the bailiff to the Arundell family who, as Lords of the Manor of Connerton, overlooking Hayle, claimed right of wreck from Cudden Point in Mount's Bay, around Land's End up to Godrevy Point. This right was exercised as far as a '*Hamborowghe* barrel' could be seen floating on a calm day with good visibility (Carter 1970, 57; Pool 1959, 173).

The manuscript describes twelve wrecks from the Tudor period in St Ives Bay, as recalled by eye witnesses who were by then old men. The first entry is a Spanish vessel with a cargo

of '…broad cloths and scarlet with divers other wares…' driven ashore on Porth Kidney Sands (the western side of Hayle Estuary) in 1514. In 1516 seven ships and barks were lost between Lelant water and St Ives with '…divers wares as iron pans and cloth and other wares…'. In 1547 two French fishing vessels were seized by Sir John Arundell, France and England then being at war. In 1556-7 two joists from a wrecked ship were recovered from Lelant Bar. In 1575 a barque '…coming out of Ireland loaden with white herring came into the bay of St Ives and there by foul weather was driven to land at Porthreptor the ship all broken…'. In the same year a ship of Southampton laden with fish from Newfoundland was lost on Candlemas Day and a ship from Normandy carrying coal from Wales were lost in the bay (Pool 1959, 186-200).

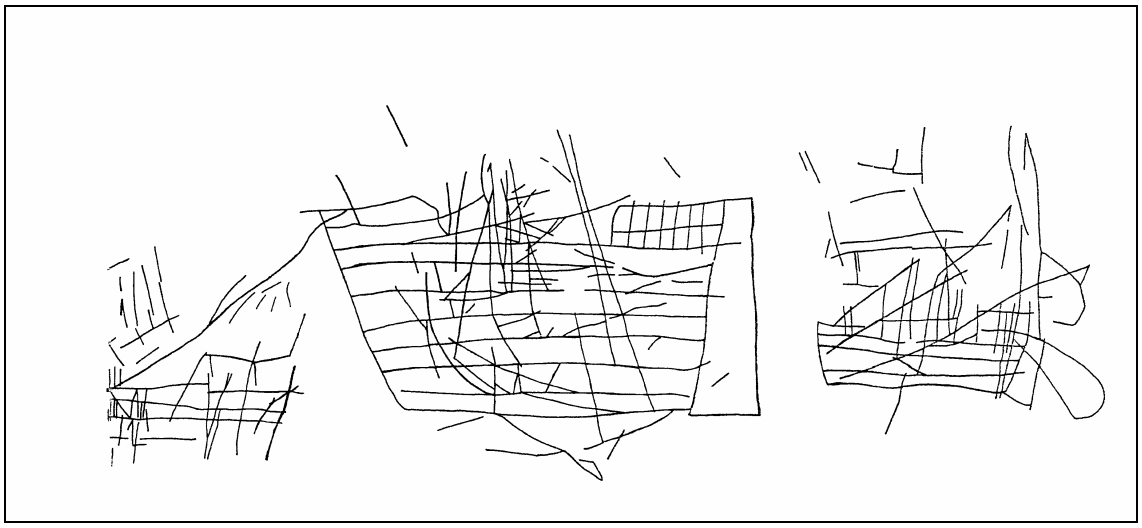

Fig 43 Medieval slate carving from Crane Godrevy apparently showing a moored cog (drawn by Carl Thorpe and reproduced courtesy of Charles Thomas)

The 17th century

On 31 January 1649 the *Garland* of Topsham, carrying the wardrobe of the Prince of Wales, later King Charles II, was wrecked on Godrevy Island (Carter 1970, 70-1).

The 18th century

There were many wrecks in St Ives Bay during the 18th century. The privateer *Boscawen* was lost in 1745. Thirteen ships were wrecked between St Ives Island and Godrevy during a sudden gale in August 1752 including the *Daniel*, the *William and John*, the *Unity*, the *Rondell*, the *Two Brothers* and the *Wilmington*. The *Rainbow* was lost neat Hayle Bar in March 1756. The medieval pier at St Ives was replaced by a larger granite structure in 1770 providing a larger, moderately well-sheltered harbour, although it still dried out at low tide and the approach remained dangerous. The *Exeter Flying Post* was wrecked on Hayle bar in November 1782, the *Plymouth* off Hayle in January 1788 (Carter 1970, 58-65).

The 19th century

From the late 18th century the port of Hayle became one of the major outlets for the great copper mines of west Cornwall. In the 1830s more improvements were made to the harbour, Hayle was linked to Bristol by a weekly packet service and the Hayle railway was opened in 1837. The copper mines declined in the 1860s but Hayle continued to prosper and Harvey's iron foundry branched into shipbuilding (Carter 1970, 56).

The coastal trade flourished but St Ives Bay could be hazardous to shipping. It provided reasonable shelter from southerly gales, but if a storm veered northwards the approaches to St Ives and Hayle became a lee shore. St Ives harbour was inaccessible around low tide when a long sandbank called the Ridge was exposed. Approaches to Hayle could be difficult, with the western cliffs, Porth Kidney and Lelant sands and Hayle bar, three miles

There were many wrecks during the 19th century, probably the most famous was *The Nile*, an iron screw-steamer belonging to the Irish Steam Company was lost on the Stones Reef off Godrevy in thick and tempestuous weather in December 1854; the passengers and crew all perished. She was one of a series of wrecks on the reef, including the schooner *Reward* in 1845, the schooner *Expedition* in 1848, the sloop *Hope* in 1852, the schooner *Mount Charles* in 1853, a *chasse marée* in 1856, the schooner *Mary Welsh* in 1857, that prompted the construction of Godrevy Lighthouse which was first lit in March 1859 (Carter 1970 71-3).

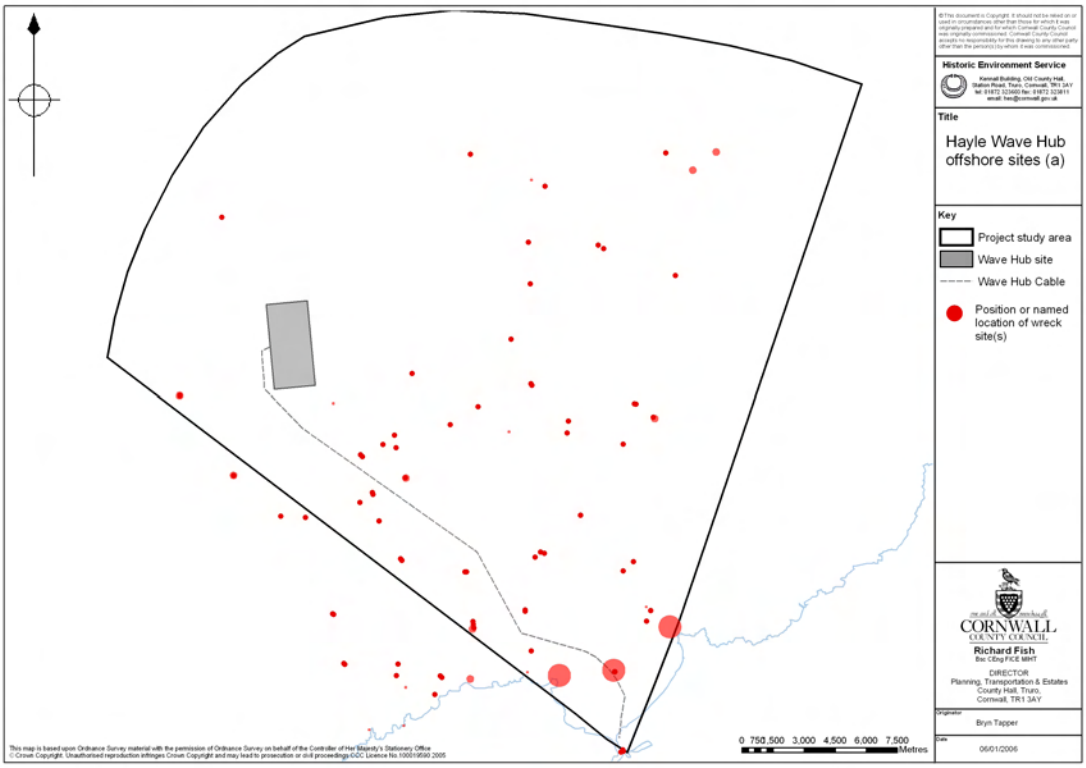

Fig 44 Distribution of recorded wreck sites

The 20th century

About twenty large steamers sank around the Stones during WW1 including the *Hamilton*, the *Veghstroom*, the *Sten*, the *Mayflower*, the *Dux*, the *Gemini*, the *Prince*, the *Lutece*, and the *St Chamond*; all torpedoed between January 1917 and September 1918. The largest WWI sinking was the 4,616-ton Blue Funnel steamer *Kintuck*, torpedoed eight miles north-west by north of Godrevy light in December 1917. The Norwegian steamer *Noorlands* and the steamer *Jason* were wrecked in May 1918. The last big wreck on the Stones was the London screw steamer *Eleanor* in December 1922 (Carter 1970, 75-6).

The steam-coaster *Marena* was almost wrecked on Hayle Bar several times, the Panamanian motor vessel *Alba* was wrecked on Porthmeor beach in January 1938 as was the Goole coaster *Sandrunner* in fog in May 1950. During WWII the Dutch coaster *Reigher* was beached at Carbis Bay, the naval trawler HMS *Breeze* on Lelant beach in January 1945. In 1946 the steamer *Flowergate* beached off Porthminster. Since WWII most of the casualties

on Hayle bar have been motor coasters, but none have been wrecked. The last serious stranding on Hayle Bar was the coaster *Kindrence*, which floated off after a week (Carter 1970, 88-91).

6.4.2 Recorded wreck sites

The data on known wrecks was collected from the HER, NMR, UKHO and Larn and Larn 1995.

There are a number of known wrecks within the vicinity of the proposed wave hub. Those with recorded positions within 2 km of the cable route and wave hub have been listed in Fig 45 below. These recorded wrecks are also shown on Fig 44.

There are a number of recorded wrecks lying within 1000 metres of the centre line of the proposed cable route. These should be taken into account if there are any adjustments made to the intended position of the cable route. Further details about these wrecks are recorded in Fig 45 below.

Recorded wreck name	**Distance from centre line (m)**
Alster	670
Dageid	500
Dux	900
Gemini	600
St Chamond	660
War Baron	900

Fig 45 Recorded wrecks within 1km of the centre line of the proposed cable route

Near shore

Reports exist of the loss of a number of vessels in the vicinity of the near shore section of the cable route. For the most part, these records are fragmentary and do not offer any precise location for the wrecks, which are the potential sources of the small scale debris indicated by the magnetic survey in the inshore section of the cable route. These records include:

HER 172009

HER 172010

HER 172017

HER 172020

HER 172022

Magnetic anomaly RE4/2647

This magnetic target was indicated by anomalies on two adjacent magnetic survey lines. The targets were RE4/2647 and RN/781. A reported fishing fastening, NMR 766752, is within 350m of this target. This suggests that there may be debris on the seabed at this point and as such warrants further investigation if any disturbance of the seabed is likely in this area.

Identification of Iron Wreck (KP 15.7)

Magnetometer target CL/7345 indicated a large iron mass at approximately KP15.7, close to the centre line of the cable route. The estimated weight of iron from the magnetometer survey was 270 – 1350 tonnes. A short video of the seabed in the vicinity of EGS magnetometer target M003 showed iron machinery consistent with a small iron vessel on the seabed. A recreational dive at the position indicated by the magnetic anomaly CL/7345 located an iron wreck approximately 60m in length with two boilers, a compound steam engine and a single propeller shaft with iron screw still attached.

The three nearest known wrecks to the position of magnetic anomaly CL/7345 are HER171423 *War Baron*, HER171452 *Helene* and HER171457 *Veghtstroon*. The recorded position for the *War Baron* is 2.2 km from the magnetic anomaly and according to the UKHO record is precisely known. The record also shows that the *War Baron* had three boilers and was 125m in length. The position of the *Veghtstroom* is also recorded by the UKHO as precisely known, and some 2.3 km from the magnetometer target. We can therefore rule out these two wrecks. The third wreck, *Helene*, is shown in the UKHO record as position approximate. Furthermore, the record states that a magnetometer search of the recorded position in 1973 failed to locate any significant anomalies. This would indicate that the position of this wreck is not precise.

The Helene was built in 1896 and was sunk by UB86 in 1918. She was 73m in length, had twin boilers and a single screw. Her gross tonnage was 1567 (Larn and Larn 1995). All the known data fits with the observed wreckage seen at the site of magnetic anomaly CL/7345. There is a possibility that the wreck lying on the seabed close to the centre line of the cable route is the wreck of the *Helene*, and the UKHO have been notified of this. Further investigation of the wreckage should help to clarify this tentative identification.

6.4.3 Other marine sites

The geophysical survey has identified a palaeo-channel in K1. As with the inter-tidal zone there potential for so far unidentified paleoenvironmental material to survive below the seabed.

6.5 Assessment of effect of sea level change from *c*500,000 BP

6.5.1 Context

In order to place the site into its geographical, archaeological and environmental context an attempt has been made to present and model the landscape evolution of the area particularly through the analysis of sea-level rise.

Between 80,000 and 125,000 years ago the sea around Cornwall stood two to three metres above its present level with a coastline not markedly different to that of today. From 80,000 years ago extensive global glaciation led to sea-levels falling well below the present level exposing the sea-floor around Cornwall as a wide lowland plateau (as much of the continental shelf was exposed). About 18,000 years ago the sea was at least 120m below the present level but as the climate warmed and the ice sheets began to melt sea-levels rose, a process known as the Late Quaternary or Flandrian marine transgression (Bird 1998). Despite the isostatic readjustment of the land the sea-level continued to rise, rapidly at first but easing off until by 4500 BC it was only 5m below that of today, and by 1500 BC within 1-2m of current levels (Johnson and David 1982).

Buried organic-rich sediments have been recorded at a number of coastal sites in Cornwall including several from the north coast of relevance to this study (Hayle Copperhouse, Reskajeage, Portreath, Porthtowan, Perranporth, Widemouth Bay, Porth Beach (St

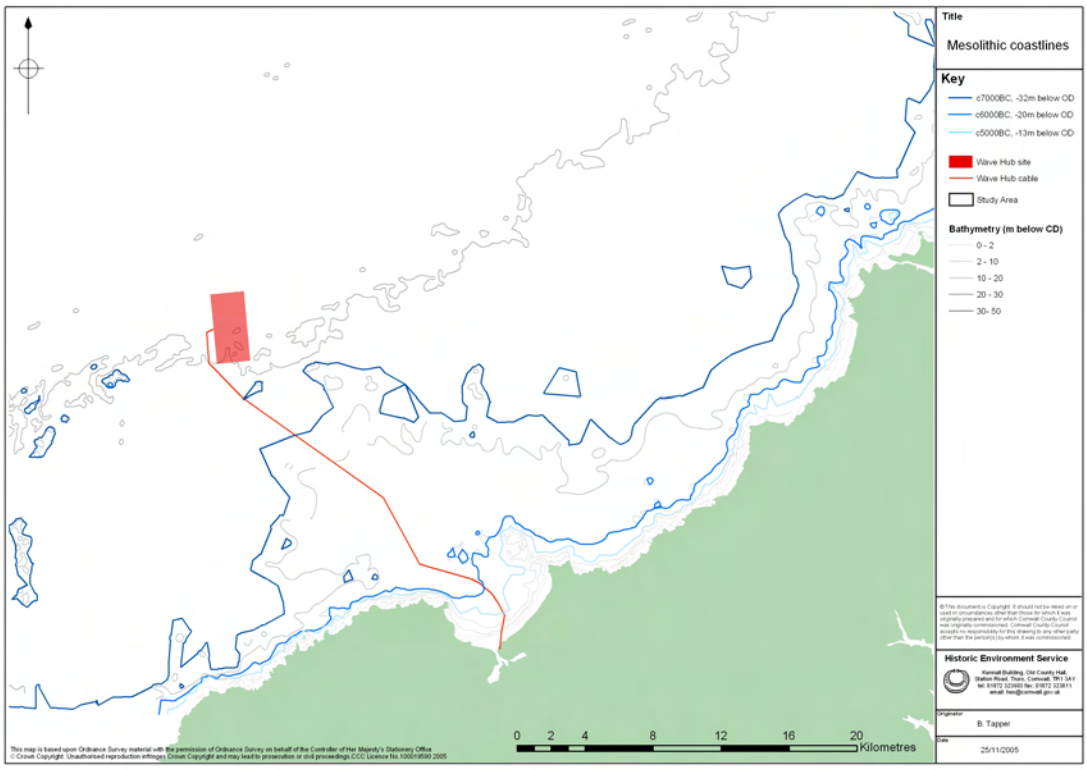

Fig 46 Projected coastline in the Mesolithic period (c7000 BC – c4000 BC)

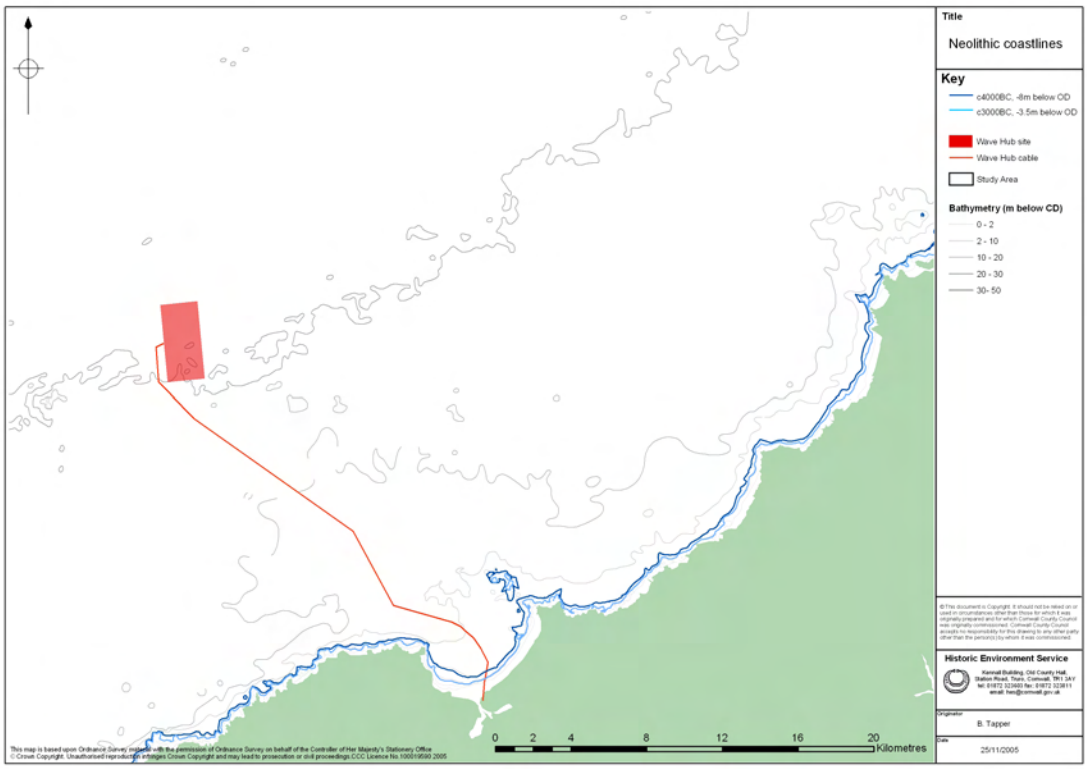

Fig 47 Projected coastline in the Neolithic period (c4000 BC – c2500 BC)

Columb), Porthmissen Beach and Harbour Cove (Padstow), Porthmear (St Eval), Daymer Bay and Crooklets Beach (Bude). Generically referred to as 'submerged forests' these deposits also reveal a wider spectrum of organic material beyond the fallen tree trucks, protruding stumps, branches and root systems to include peat exposures. These 'submerged forest' deposits have been used to present reconstructed models of past coastal and sea-level behaviour and positions (Heyworth 1978; 1986). Healey (1995) builds on and refines these earlier models using palaeoenvironmental data gathered from sites in west Cornwall with results pointing to greater local variation in sea-level rise and indicating episodic marine transgressions during the Holocene (post-glacial) period than had previously been recorded.

6.5.2 Sea level models

A submergence model has been rendered for the purposes of this study. Based on and crudely extrapolated from the sea-level curve 'Line E', modelling the Bristol Channel, it represents the best approximation of a regional sea-level curve for south-west England (Heyworth and Kidson 1982). More recent analysis of lithostratigraphy and biostratigraphy undertaken by Healey (1995) at a number of sites in west Cornwall (including Hayle Copperhouse) has however refined and qualified these models suggesting that coastal morphodynamics also controlled the impact and timing of relative sea-level rise. Healey's emphasis seeks to reconstruct local and site-specific conditions and the results for Hayle, based on the radiocarbon date results that he sets out in Table 2 (sample Q-2773) and the Time/Altitude plot fig 6a , give a sea-level -1.59m below OD (as adjusted to MHWST) at about 5317-4987 years before present (BP), considerably higher than the regional curve suggests.

Healey also notes that the morphology and angle of slope over which changes of relative sea-level rise occur is important particularly when considering short timescales and unexpected marine conditions such as rapid wave surges which when allied with local factors such as coastal topography (headland/bay configurations) and long shore sediment movement can determine unique local patterns of coastal evolution. The embayed environment (produced by a protective barrier structure, such as blown sand dunes) he suggests for Marazion Marsh is a scenario that could be entertained for the Hayle Estuary and the results he received from that site point to a main marine transgression phase (which corresponds well with other sites in East Anglia, Essex and Dorset) occurring broadly 4500 years BP.

In order to tentatively visualise the submergence model of the north coast throughout (pre)history it has been possible to merge digital Ordnance Survey contour data with UKHO chart soundings and bathymetry to produce a seamless DEM (digital elevation model) incorporating both terrestrial heights and maritime depths. OS heights are relative to Mean Sea Level (MSL) or OS Datum, as taken at Newlyn harbour. Digital UKHO Chart 1149 soundings were used as they depict Lowest Astronomical Tide (LAT), which serves as Chart Datum (0m) for maritime craft. OS datum represents a height difference of 2.39m with Chart Datum as taken at Newlyn. To join the soundings with OS heights 2.39m was added to all depth (soundings) values. This has meant that during interpolation of these points to a 3D surface model (TIN) a straight line has been inferred between 0m (MSL) and -2.39m (Chart Datum).

Considering the sensitivity of Healey's model (especially his results from Hayle Copperhouse) this may represent a coarse interpretation of the inter-tidal zone particularly considering the shallow gradient of St Ives Bay. However using the submergence gradient at the regional level has enabled sea-level heights to be calculated and displayed in the GIS producing tentative maps depicting suggested MSL for the Mesolithic and Neolithic

periods of prehistory for this stretch of the north coast. This indicates likely areas that may have been used by Mesolithic hunter-gatherers and the first farmers of the Neolithic. Later prehistoric models have not been created since sea-levels seem to reach their current levels (or thereabouts) by the Late Bronze Age/Early Iron Age.

The DEM against which the sea-level rise ('Line E') was projected integrated interpolated 10cm grid resolution where converted from UKHO data ie below CD, with interpolated 5m grid resolution above OS datum with the intervening 2.39m being interpolated between the two. This undoubtedly limits its use when considering sub-metre variation in sea-level.

7 Assessment of impact and recommendations for mitigation

The potential impacts of the scheme on the archaeological and historical resource are:

7.1 Coastal processes

7.1.1 Potential impact

- Changes to coastal processes and/or the wave climate which could have a range of ongoing impacts on archaeological and historical sites, in particular affecting sand deposition/erosion around these sites. Of particular concern would be a change in sediment dynamics leading to the burial / exposure of archaeological and historical sites.

7.1.2 Appraisal of impact

- Given the seabed deployment of the Wave Hub's offshore infrastructure, wave energy device moorings and the cable, the relatively small area of sea to be covered by the deployment area, and the fact that the deployment area is a considerable distance offshore, it is considered unlikely that the proposed development will have impact on coastal processes, waves or currents. This appraisal is given against the considerable seasonal variation in beach levels that occurs as a natural response to storms and other sea conditions.

7.1.3 Suggested mitigation

- No mitigation measures are required to directly address the potential impact, however, it is recommended that the Wave Hub project should be designed to minimise the impact on the processes that affect sediment dynamics at the coast.

7.2 Visual setting and historical context

7.2.1 Potential impact

- The development could affect the visual setting and historical context of the proposed World Heritage Site (Area A2 The Port of Hayle).
- The development could affect the visual setting and historical context of Hayle Harbour Conservation Area.
- The development could affect the visual setting and historical context of Scheduled Monuments in the vicinity.
- Re-use of disused power station could contribute to the erosion of the character and setting of the harbour, the town, listed buildings and structures.

7.2.2 Appraisal of impact

- The former power station site, a contaminated wasteland, is situated in an old sand pit screened by high dunes to the north and west. The new substation will be built within the dunes and will not be visible from the proposed World Heritage Site or the Hayle Harbour Conservation Area and will not affect its setting within the disused power station site. Providing the suggested mitigation measures are fulfilled the development will have a positive impact on the setting of the harbour and town by improving the environment.

- The nearest Scheduled Monuments are the early Christian crosses [PRN 31814, SM 906a], [PRN 31815, SM 906b], [PRN 31859, SM 392] inscribed stone [PRN 31822, SM 906c] in and around Phillack churchyard, approximately 1km east of the study area and the Cunaide Stone [PRN 31978, SM 30] at Carnsew, approximately 1km south of the study area. About 1.4km south-east of the Study area are two scheduled bridges, the 1811 road bridge across Copperhouse Creek – 'the Black Bridge' [PRN 31974 SM 986] and the early railway bridge [PRN 31832.03, SM 987, which carried the Hayle Railway (1837) across the same creek. The proposed development is not inter-visible with any Scheduled Monuments and will not impact on their settings.

7.2.3 Suggested mitigation

- Development proposals should take into account the setting of the project area in relation to the historic character of proposed World Heritage Site and the Conservation Area; this should involve retention of historic fabric where possible and design proposals that minimise visual impact and are of a high quality that respect the setting. However, it is recognised that the new substation will be built adjacent to the existing substation complex (operated by Western Power Distribution) and will be designed in accordance with its functional requirements. Visually, this is likely to mean that the substation building will be a modern structure surrounded by the same type of palisade fencing that surrounds the existing substation in order to provide the necessary level of security and health and safety. Also, it is likely that site clearance will be limited to removing some scrub vegetation and tipped rubble, and it is unlikely that this will reveal any historic fabric.

7.3 Damage to archaeological sites

7.3.1 Potential impact

- Deployment of the Wave Hub's offshore infrastructure and the wave energy devices (including their moorings) and ploughing and laying for the cable could damage completely submerged marine structures and deposits, some of which have been identified by the geophysical surveys and others that have not.

- Ploughing for the cable across the beach could affect archaeological sites and deposits in the inter-tidal zone.

- Directional drilling for the cable through the dunes and limited excavation for the construction of on shore infrastructure such as the new substation building could destroy buried terrestrial archaeological remains.

7.3.2 Appraisal of impact

- Although all previous planning of the cable route has sought to avoid known wreck sites and allowed a 500m buffer zone for wreck fields, geophysical survey indicates that the types of maritime sites along the cable route that could be affected ranges from a large iron wreck (originally marked on a chart in a different position) to smaller iron objects, including a number of small anomalies are too large to be fishing debris and may represent material of archaeological interest. Known and unknown archaeological sites could be affected by seabed disturbance associated with cable laying and deployment of the Wave Hub's offshore infrastructure, wave energy devices and moorings.

- In both the marine and inter-tidal zones there is the potential for currently unidentified buried palaeoenvironmental material and for chance finds. Although the WWII minefield on the beach was cleared after the war thirty mines are reputed to be unaccounted for. Other remnants of WWII defences could also be affected by directional drilling and cable laying.

- The main type of terrestrial sites which might be affected are 19th or 20th century industrial sites, which are of local importance but which are contaminated and decrepit. Other sites which existed historically are no longer extant and are unlikely to have any surviving remains. The new substation will be built within the old power station and existing access roads will be used so the development will not have an impact on terrestrial archaeological sites.

7.3.3 Suggested mitigation

- Careful planning of the cable route to avoid identified maritime sites such as the iron wreck identified in the geophysical survey (KP 15.7) and leaving a 500m buffer zone around them. This measure has been used to plan the proposed cable route and will continue as far as the design progresses. In addition, there will be an inspection after laying to check that seabed features do not affect the cable (e.g. wreckage, rock ledges). If any features do affect the cable, the affected part of the cable will be re-positioned to avoid the feature.

- Minimise disturbance to the seabed.

- Geophysical and/or metal detector survey of the beach and dunes to detect any buried WWII ordnance or other defences. However, it is recognised that this type of measure is likely to be included under the performance specification for the construction works which will mean that the decision to undertake a pre-construction survey will be taken by the appointed contractor;

- Use directional drilling to route the cable through the dunes, thus avoiding any archaeological remains and contaminated ground. This measure is part of the proposed construction process for installing the cable.

- An agreed programme of archaeological recording should be put in place and a Written Scheme of Investigation (WSI) approved by the Historic Environment Planning Advice Manager, CCC and the Inspector of Ancient Monuments, English Heritage. This should include the following:

    - Provision for archaeological assessment of any further geophysical survey of geotechnical investigations of the main deployment area;

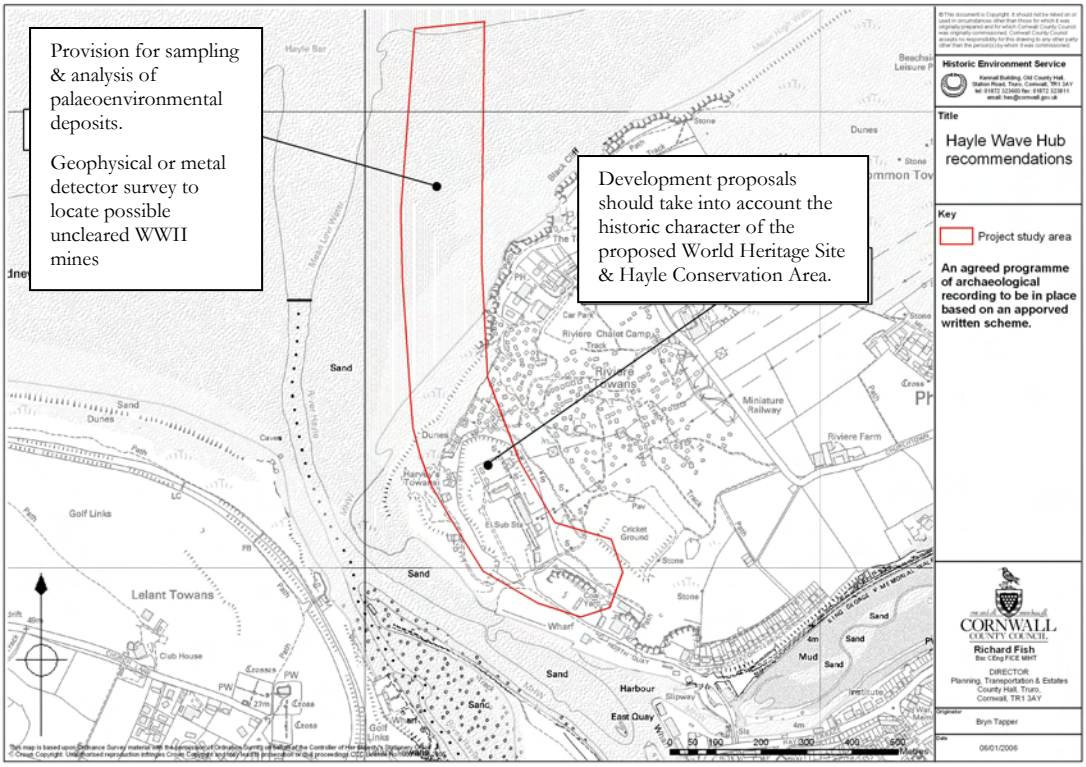

Fig 48 Summary recommendations for inter-tidal and terrestrial sites

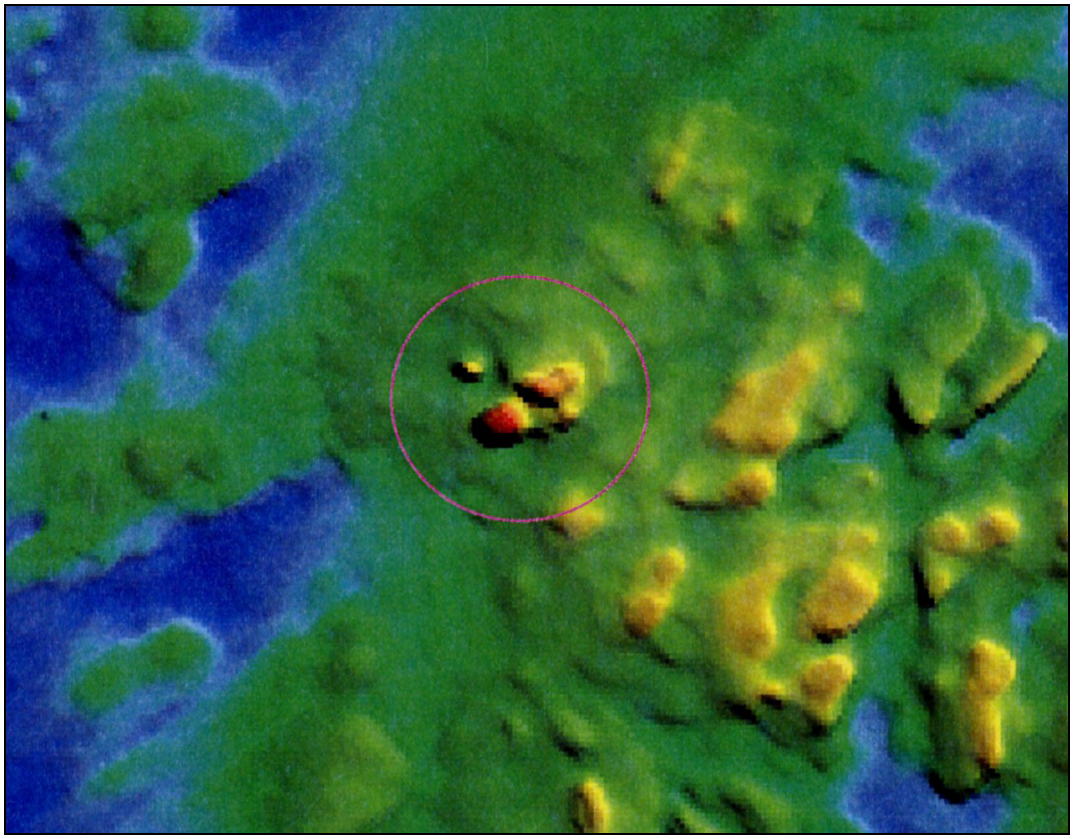

Fig 49 Bathymetric survey of the iron wreck site, possibly the Helene sunk by a U-boat in 1918 (EGS International Ltd

- Provision for further archaeological investigation in the event of any disturbance to the seabed in the vicinity of smaller geophysical targets;
- Provision for archaeological involvement in subsequent diver investigations;
- Provision for monitoring the cable trenching process either by recovering sediment samples or close video inspection by ROV;
- Contingency for sampling and specialist analysis of identified submarine or inter-tidal palaeoenvironmental deposits.

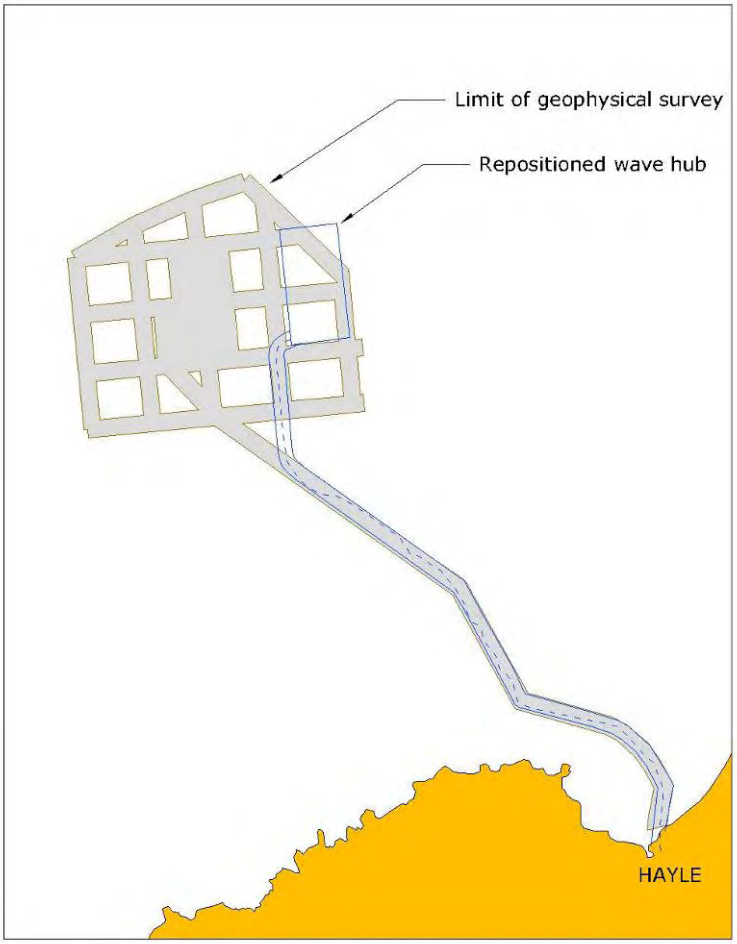

Fig 50 The area covered by the original EGS geophysical survey is shown in grey. The outline of the proposed repositioned Wave Hub is shown in blue

7.4 The proposed new deployment area

The repositioned wave hub was discussed at a meeting between HES and Steve Challinor of Halcrow in Truro on 24th March 2006. This new position (shown on Fig 50) has not yet been finalised and it is possible that it may change again.

7.4.1 Implications for the archaeological assessment

Cable route

The new cable route follows the area of the survey until KP20, after which it diverges to the north. From this point (KP20) there are approximately 4km of new cable route. Of this approx 1.7km is over ground with no geophysical survey. The remaining 2.3km coincides

with regional survey line RN4. This survey line includes sidescan, magnetometer and multibeam data, but for a single run line only.

Deployment area

The new wave hub area covers approximately 8 square km. Approximately half of this (about 4 sq km) has some geophysical data from the regional survey lines RE3, RE6 & RN5. About half of it has no geophysical data at all.

7.4.2 Recommendations

It is not possible to make a proper archaeological assessment of the new section of cable route and the new deployment area without adequate geophysical data. Provision should be made in the WSI for archaeological assessment of any further geophysical survey or geotechnical investigations associated with the new deployment area.

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9 Project archive

The HES project number is **2005034**

The project's documentary, photographic and drawn archive is housed at the offices of the Historic Environment Service, Cornwall County Council, Kennall Building, Old County Hall, Station Road, Truro, TR1 3AY. The contents of this archive are as listed below:

1. A project file containing site records and notes, project correspondence, administration and containing copies of documentary/cartographic source material (file no 2005034).
2. Electronic drawings and maps stored in the directory L:\CAU\HE Projects\Sites H\Hayle Wave Hub 2005034
3. Digital photographs stored in the directory R:Images\HE Images\Maritime\South West Wave Hub 2005034
4. This report held in digital form as: G:\CAU\HE PROJECTS\SITES\MARITIME\SOUTH WEST WAVE HUB 2005034\WAVE HUB ASSESSMENT REPORT.DOC

10 Gazetteers

10.1 Gazetteer of terrestrial and inter-tidal sites

10.1.1 Definition of significance criteria

The following grades are used in the Cornwall HER and have been used to guide this report:

S Scheduled Monument (none identified within the study area)

L Listed Building (none identified within the study area)

A Site of potential National Importance

B Site of Regional Importance

C Site of Local Importance

D Natural feature or non-antiquity

Site No	PRN	Name	Site type	Condition	Period	Source	Status	Grade	NGR (SW)
1	139295	Riviere Castle	Round, site of	Unknown	Iron Age	Trad.	None	A?	55300 38090
2	-	Riviere Towans	Sand pit	Destroyed	19th century	1888/ 1907 OS	None	C	55340 38100
3	-	Riviere Towans	Railway	Destroyed	19th century	1888/ 1907 OS	None	C	55340 38100
4	-	Riviere Towans	Gravel pit	Destroyed	19th century	1888/ 1907 OS	None	C	55340 38100
5	-	Riviere Towans	Rifle range	Destroyed	19th / early 20th	1888 OS	None	C	553

Site No	PRN	Name	Site type	Condition	Period	Source	Status	Grade	NGR (SW)
					century				381
6	40378	Riviere Towans	Boundary stone	Extant	1867	OS maps	None	C	55460 38040, 55255 38120, 55295 38259, 55340 38240, 55315 38200.
7	40378	Hayle Arsenic Works	Calciner	Part survives	?	HER	None	C	55340 38100
8	-	Pentowan Glass Bottle Co	Glassworks	Part survives	1917-25	Acton 1992, 64	None	C	55340 38100
9	141059	Hayle Power Station	Power Station	Destroyed	20th century	HER	None	C	55340 38100
10	-	-	Chemical works	Part survives	WWII	Acton 1992, 64	None	C	55340 38100
11	167098	-	Minefield	Cleared?	WWII	HER	None	C	55170 38130
12	-	-	Coal yard	Extant?	20th century	Mod. OS	None	C	55340 38100
13	-	-	Substation	Extant	20th century	Mod. OS	None	D	5534 3810
14		Riviere Towans	Chalets (generic)	Extant	20th century	Mod. OS	None	C	5525 3814
15		Riviere Rowans	Cricket ground	Extant	Late 20th century	Modern OS	None	D	55650 38100

10.2 Gazetteer of recorded wrecks within 2km of the cable route

Name	Date	Source	Proximity	Distance from CL	Position (DD MM.MM)	Details
Thomas	1823	HER 172009	Near shore		50 13.39N 005 26.20W	
Unknown	1802	HER 172020	Near shore		50 13.39N 005 26.20W	Two vessels
Nosso Senhora Do Carmo	1782	HER 172017	Near shore		50 13.39N 005 26.20W	Position approx.
Brunswick	1823	HER 172022	Near shore		50 13.39N 005 26.20W	Position approx
Beckford Jenson	1799	HER 172010	Near Shore		50 13.39N 005 26.20W	Five vessels Position approx
Alster	b 1867 w 1885	HER 171467 UKHO 16395	Cable route	0.67 km	50 13.806N 005 29.568W	2 boilers Compound engine 1 screw Position known precisely
St Chamond	b 1913 w 1918	HER 171460 UKHO 16404	Cable route	0.66 km	50 14.901N 005 29.960W	Cargo of railway engines and iron Popular dive site with recreational divers
Veghtstroom	b 1901 w 1918	HER 171457 UKHO 16413	Cable route		50 16.046N 005 35.051W	Sunk by UB47 Length 70m 2 boilers Triple exp engine Single shaft Position precisely known
Lutice	b 1893 w 1918	HER 171465 UKHO 16400	Cable route	1.7 km	50 14.500N 005 32.000W	
Kintuck	b 1895 w 1918	HER 171466 UKHO 16398	Cable route	1.8 km	50 14.425N 005 31.978W	
Dux	b 1904 w 1918	HER 191458 UKHO 16409	Cable route	0.9 km	50 15.817N 005 32.415W	
Nile	b 1849 w 1854	HER 171456 UKHO 16414	Cable route	2.3 km	50 16.284N 005 25.660W	Position precisely known
Zone	b 1903 w 1917	HER 171455 UKHO 16415	Cable route	2.6 km	50 16.426N 005 29.452W	Position precisely known
Helene	b 1896 w 1918	HER 171452 UKHO 16417	Cable route	1.5 km	50 17.034N 005 36.060W	Sunk by UB86 Length 73m 2 boilers GT 1567

Name	Date	Source	Proximity	Distance from CL	Position (DD MM.MM)	Details
						Position approx
War Baron	b 1917 w 1918	HER 171423 UKHO 16476	Cable route	0.9 km	50 23.385N 005 23.684W	Sunk by UM55 Length 125m 3 boilers Position precisely known
Gemini	b 1892 w 1918	HER 171443 UKHO 16423	Cable route	0.6 km	50 17.715N 005 36.360W	
Unknown		HER 171445 UKHO 16421	Cable route	1.3 km	50 17.500N 005 36.800W	Length 83m 2 boilers engine & single prop
Dageid	b 1904 w 1918	HER 171428 UKHO 16461	Cable route	0.5 km	50 21.384N 005 26.171W	2 boilers, engine, anchors and cable
Stabil	b 1906 w 1917	HER 171435 UKHO 16434	Cable route	1.6 km	50 19.034N 005 36.060W	Sunk by U46 Position approx
Dundee	b 1906 w 1917	HER 171429 UKHO 16462	Regional (E)		50 20.904N 005 35.007W	Sunk by UB55 2 boilers Triple exp engine Prop shaft Anchors
Unknown		NMR 766753	Regional (NE)		50 23.07N 005 36.20W	Reported fishing fastener 1979 Decca position
Unknown		NMR 766752	Regional		50 22.90N 005 38.35W	Reported fishing fastener 1979 Decca position Close to Magnetometer targets RE4/2647 and RN4/781
Cato	w 1899	HER 172018	Regional (W)		50 20.00N 005 44.36W	
Unknown		NMR 766748	Regional (SW)		50 19.03N 005 42.83W	Reported fishing fastener 1979 Decca position
Unknown		NMR 766749	Regional		50 19.65N 005 40.85W	Reported fishing fastener 1979 Decca position
Mary Orr	b 1868 w 1917	HER 171438 UKHO 16427	Regional (SW)		50 18.034N 005 42.059W	Length 25m Position approx
Cheerful	b 1874 w 1885	HER 171420 UKHO 16507	Regional (N)		50 24.724N 005 43.054W	Length 68m Compound engine Single shaft Position precisely known

11 Inventory of terrestrial and inter-tidal sites

Site 1 Round, alleged site **SW 55303 38090**

Cornwall HER, PRN 139295

Grade A

Riviere Towans, overlooking the Hayle estuary, is traditionally the site of Riviere Castle, stronghold of Teudar, a semi-legendary petty king of Cornwall in the late 5th to 6th century AD.

The place-name is first recorded in 1259 as *Ruviere* (Gover 1948, 612), being derived from the Norman-French for 'at the river' (ICS), although it has been suggested that the name derives from the Cornish elements **roy veor** meaning 'great king' (Pascoe 1985, 41).

The site is first recorded as Riviere Castle by Thomas Leland in *c*1537 , '…*almost at the est part of the mouth of Hayle river on the North Se, now as sum think, drounid in sand. This was Theodore's Castelle*' (in Chope 1918, 21). According to Lysons the site of the castle was buried by sand in 1814. The actual site of the castle and derivation of the place-name has been the subject of some scholarly speculation (cf Pascoe 1985); Henderson noted that the site of Teudar's castle was '…*at Riviere behind the present church* [Phillack]' (Henderson 1925, 164).

The grid reference given in the NMR (Unique Identifier 424723) and the Cornwall HER places the site of the round within 19th century sand pit, **site 2**, and the early 20th century power station, **site 9**; in which case it would have been mostly destroyed.

Site 2 Sand pit **SW 55340 38100**

Grade C

The beginnings of a sand extraction pit, served by railway line, **site 3**, are shown on the 1842 Tithe Award Map for the parish of Phillack. The 1880 and 1907 OS maps show the sand pit is gradually extending northwards. The power station was built within the sand pit by 1910.

Site 3 Railway **SW 55340 38100**

Grade C

A railway line serving the sand extraction pit is first shown on the 1842 Tithe Award map for the parish of Phillack (the Hayle railway had opened in 1837). The railway line is extended as the sand pit enlarges as is indicated on the 1888 and 1907 OS maps. The Tithe Award and OS maps shoe a railway terminus located to the south of the gravel pit, **site 4**, on a wharf adjacent to the River Hayle. The railway line serving the sand pit is likely to have been removed when the power station, **site 9**, was built in *c*1910.

Site 4 Gravel pit **SW 55340 38100**

Grade C

A gravel pit, crossed by railway line **3**, is first shown on the 1888 OS map. On the 1907 OS map it is marled as 'Old Gravel Pit' and the Pentowan Calcining Works, **site 7**, has been established in its north-west corner.

Site 5 Rifle range **SW 553 381**

Grade C

A 300 yard-long rifle range is first shown on the 1880 OS map, orientated north-west to south-east, crossing the sand pit and railway line. By the time of the 1907 OS map the rifle range has been moved to the east, with butts to the north of the sand pit. The site of 'Old Targets' are marked on the northern edge of the sand pit. The rifle range has disappeared by the time of the 1936-8 OS map.

Site 6 Boundary stone **SW 55460 38040**
Cornwall HER, PRN 140139

Grade C

A round headed boundary stone dated 1867, marking the bounds between Harvey's Towans and Riviere Towans (Cornish Copper Company). Inscribed on the north-east side 'CCC', on the south-east side 'H'. One of a series of such boundary stones marking the line across the Towans and around the waterside marking the bounds between Harvey's newly acquired property on the sale of the Copper Company's quays etc., and the remnant of the Copper Company lands in the hands of the receivers (Pascoe 1981, 120). Within the study area, there are four more within the former power station, **site 9** at SW 55255 38120, 55295 38259, 55340 38240, 55315 38200 and fifth to the south-east at 55458 38080

Site 7 Arsenic works **SW 55340 38100**

Cornwall HER, PRN 40378

Grade C

Pentowan Calcining Works was established between 1888 and 1907 on the site of the mid-late 19th century gravel pit, **site 4**. The works is shown on a plan of *c*1910 (Unknown 1969, CRO, AL, 3, 2). A round masonry stack remains with a flue opening on the east side.

Site 8 Glassworks **SW 55340 38100**

Grade C

The stack and the site of the arsenic works were re-used for a glassworks known as the Pentowan Glass Bottle Works between 1917-25; the only one of its kind in Cornwall (Acton 1992, 64). Apparently it took the Company only two months to prepare for production, including the setting up of a furnace capable of holding 10 tons of glass, with an output of 300 gross of 12oz bottles per week, and plant for utilising broken glass as raw material. The intention was to produce a pale glass for the manufacture of jam jars, medicine and sauce bottles. but it ran into financial difficulties and had to close (Bliss 1978, 37).

Site 9 Power station **SW 55340 38100**

Cornwall HER, PRN 141049

Grade C

Hayle Power Station was built on the site of the mid-19th century sand pit, **site 2**, and late 19th /early 20thcentury rifle range, **site 3**, and possibly Riviere Castle, **site 1**.

The Cornwall Electricity Power Company leased the land at Hayle from Harvey's to enable them to transfer their generating station from Carn Brea to save on the cost of transporting coal overland.

The power station began operating in 1910 and closed in 1977. Originally it contained a 900W 25 cycle alternator, but its capacity increased to meet demand. In 1933 it changed over to 50 cycle operation and was connected to the National Grid in 1934 remaining Cornwall's only National Grid power station (Unknown, 1912, SME Soc. Rep JM, 31-34; Noall 1985; Acton 1992, 64). Details from the late 1930's are given by Hamilton Jenkin (Unknown, 1973, Newsletter of the Trevithick Society, No. 2, 11). In 1949 capacity had risen to 47.5MW but it was gradually run down in the early 1970s and production ceased in 1976. Its two tall chimneys were demolished on 24 June 1981 and most of the remainder was partly demolished in December of that year (Noall 1985) - nothing now survives of the original early 20th century construction, although there are substantial remains still standing of the mid 20th century supply points and substations, large buildings built of concrete block, the elevations enlivened by a series of buttresses, and with a plain parapet.

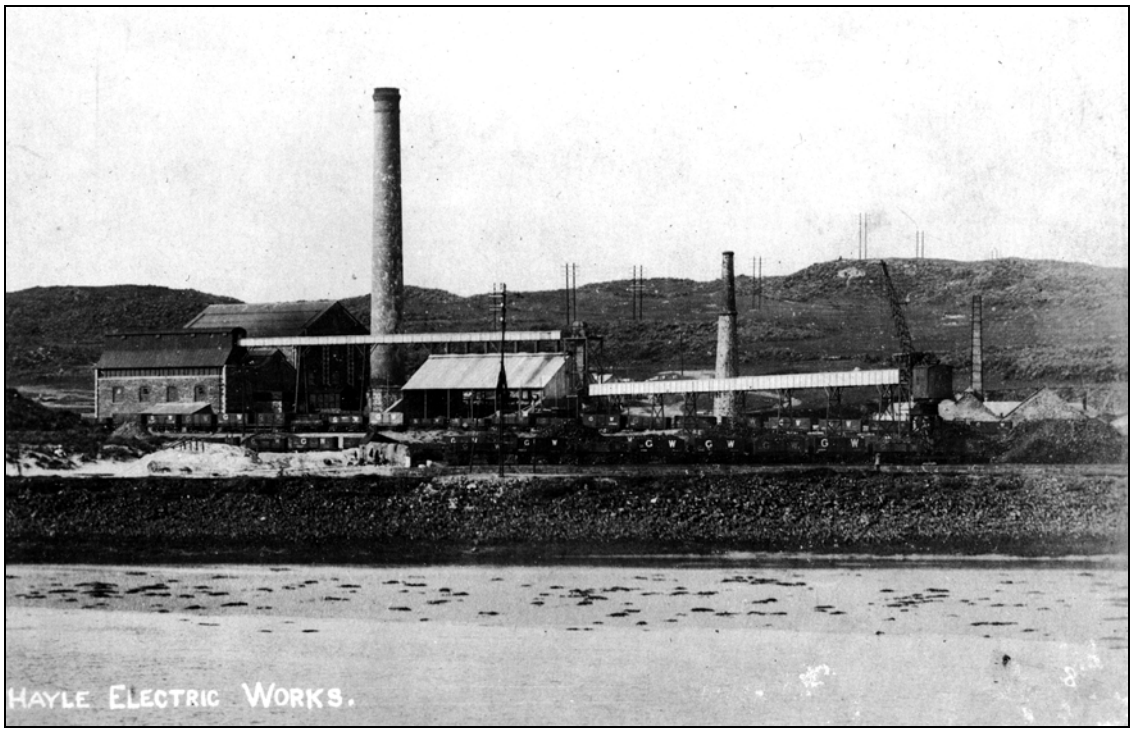


Fig 51 Undated photograph of Hayle Electric Works (courtesy of Penlee House Gallery and Museum)

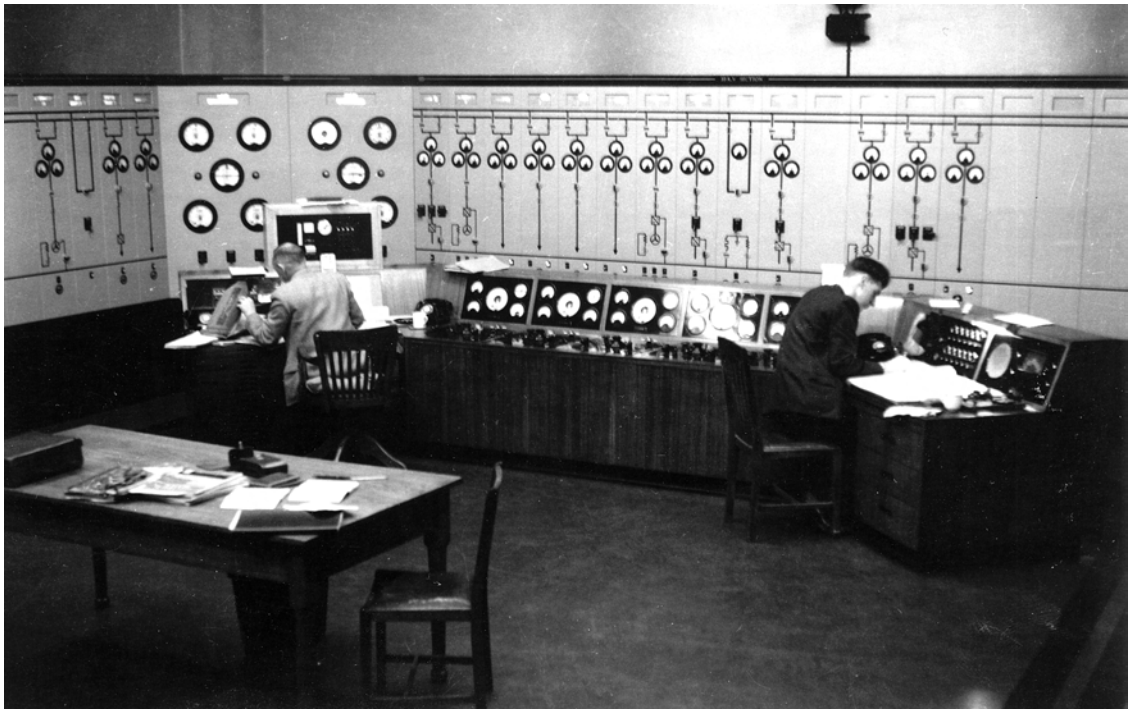
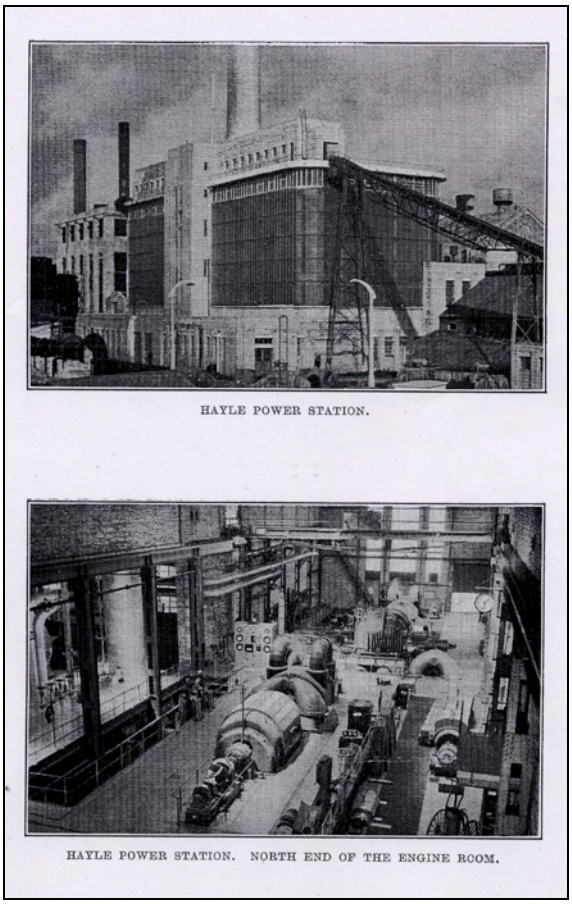


Fig 52 The interior of Hayle Power Station c1950 (courtesy of Penlee House Art Gallery and Museum)



HAYLE POWER STATION.

HAYLE POWER STATION. NORTH END OF THE ENGINE ROOM.

Fig 53 Images of the power station from the Cornwall Electric Power Company's Christmas 1947 souvenir magazine

Site 10 Chemical works **SW 55340 38100**

HER PRN 40363

Grade C

A large bromine producing plant was built in 1939-40 by ICI for the British Ethyl Corporation, sponsored by the Air Ministry, occupying part of the site of the former arsenic works and glassworks (**sites 7 and 8**). It was realised that the RAF depended on imported lead anti-knock additives that improved aviation fuel. Because of the supply of sea water needed for its production and the good rail transport links in a remote location, Hayle was chosen as the site for the plant. Also the power station could provide cooling water. The building contractors were John Mowlem & Co., civil engineers and the plant was known as GC3 (Government Contract 3). In 1940 it produced 579 tons of bromine and by 1942 it produced 798 tons per year. It was one of only a few such plants producing bromine and because of the importance of bromine to the war effort there was much security at the site. However, German intelligence never discovered it. After the war the demand for anti-knock compounds fell, then rose again with an increase in civil demand for the product, but the site at Hayle was too small and the plant could not be expanded. It continued producing bromine until 1973 when it was closed. Most of the plant was demolished and all that survives is the office, medical centre and laboratory buildings at the south-east end of the site (outside the Study Area) (Cahill 2000, Vol 2, 23).

Site 11 Minefield **SW 55170 38130**

Cornwall HER, PRN 167098

Grade C

A minefield was sited to cover the eastern beach approaches of Hayle estuary during WWII. Because of the power station, **site 9**, and the chemical works, **site 10**, the area was heavily defended by the minefield and by several pillboxes and bofors guns (not in the Study Area). The minefield was cleared after the war, although thirty mines are reputed to be unaccounted for.

Site 12 Coal yard **SW 55340 38100**

Cornwall HER, PRN 40378

Grade C

Coal yard occupying the northern part of the former chemical works, **site 10**, shown on the modern OS map but now apparently operating as a soil transfer site.

Site 13 Substation **SW 55340 38100**

Cornwall HER, PRN 40378

Grade D

Modern electricity substation built on the former power station site, **site 9**. Dating from *c*1989, still operational. To be re-used.

Site 14 Chalets (generic) **SW 55250 38140**

Grade C

The study area includes about twenty 20th century holiday chalets, known locally as bungalows. These are first shown on the 1936-8 OS map. Of interest, because of their vernacular nature, it is presumed that the development will not affect these buildings.

Site 15 Cricket ground **SW 55650 38100**

Grade D

Modern cricket ground, clipped by the eastern edge of the study area. It is presumed that the development will not impinge on this site.

12 Appendices

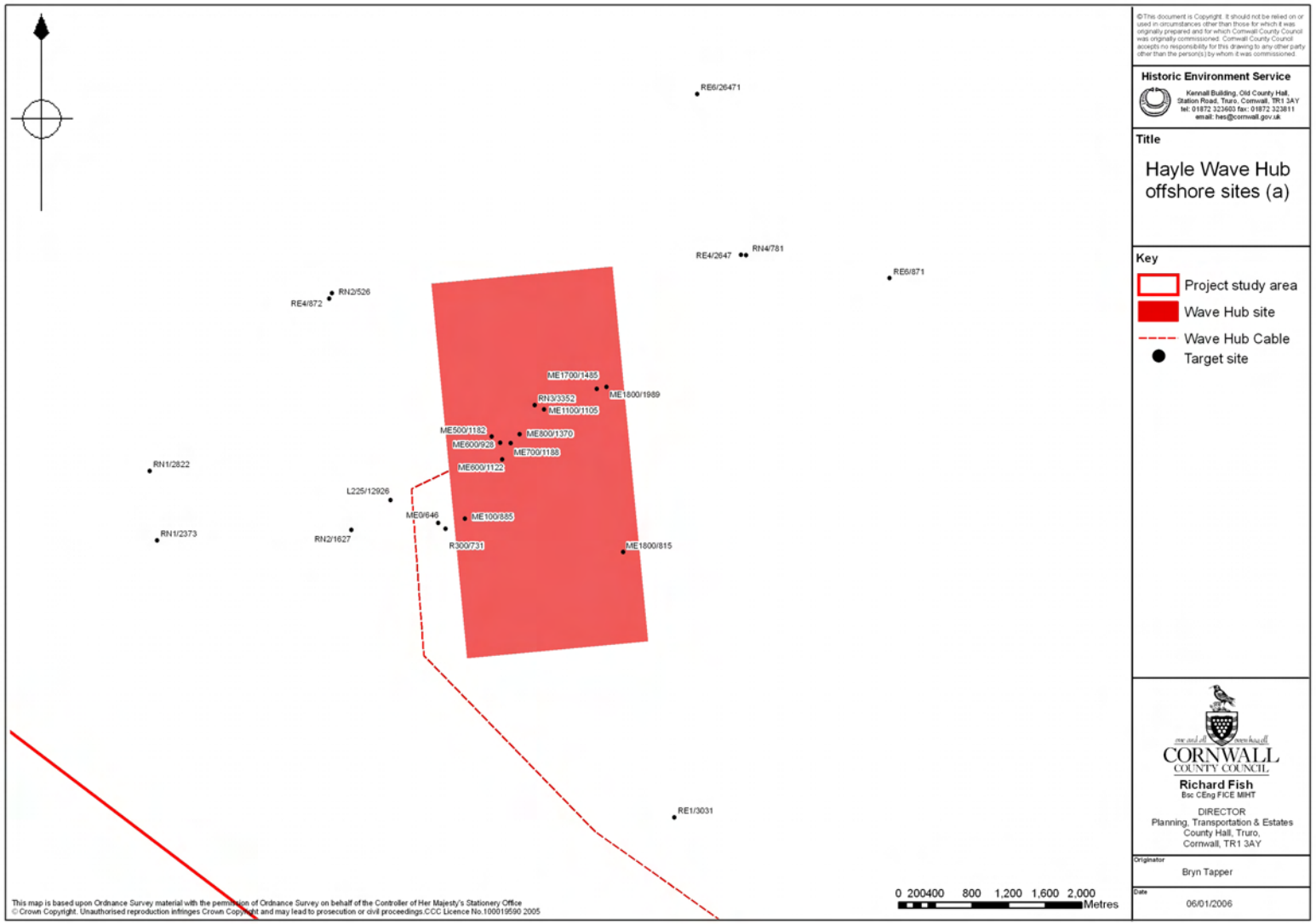
12.1 Table of magnetic anomalies

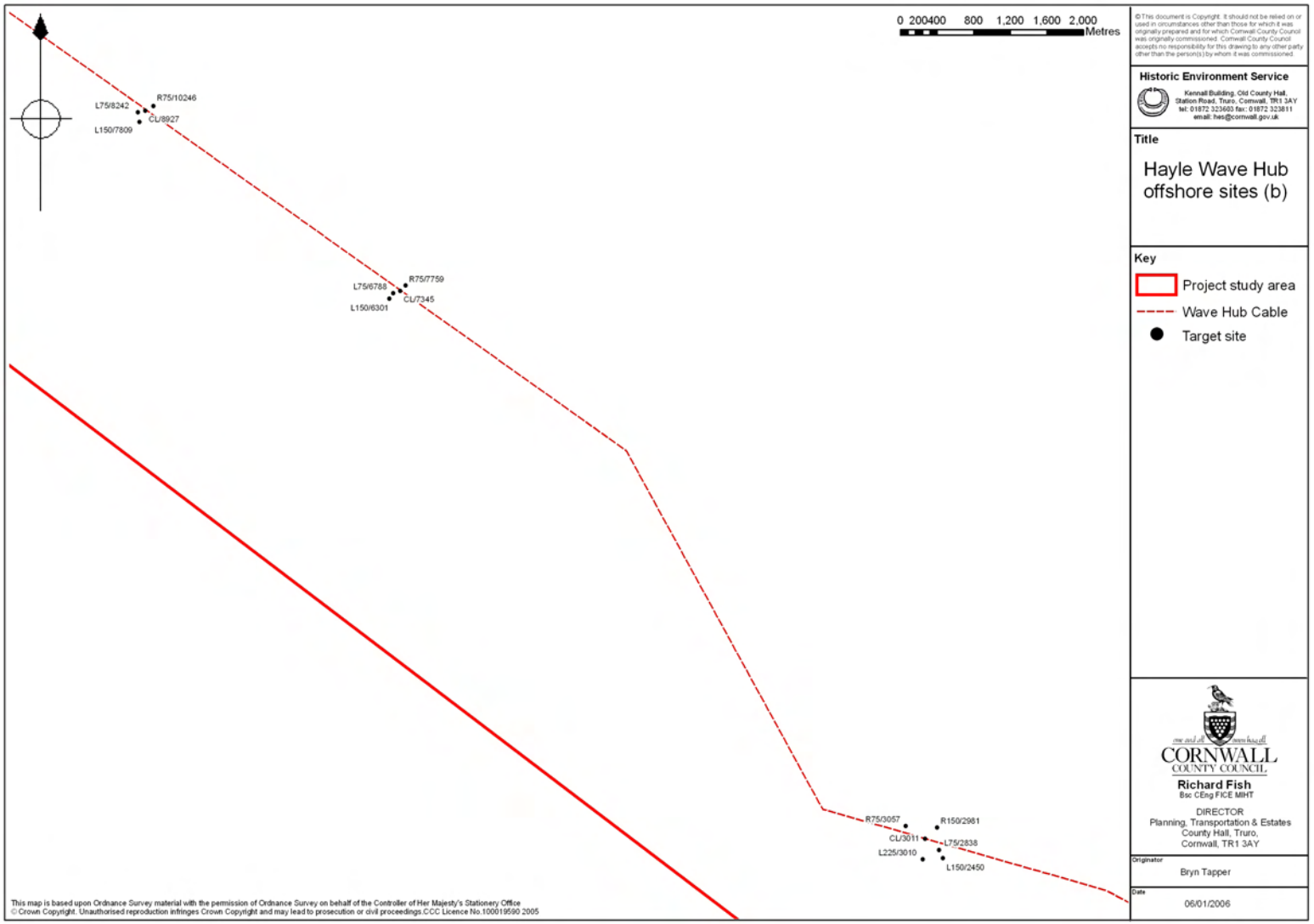
File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
CL	52	155239.6	39080.6	4	-1	5-25	Spike Fish bottomed?
	84	155242.5	39146.1	3	0	8-35	Spike
	185	155255.8	39356.9	17	3	150-800	Hump Geological?
	358	155318	39706.1	5	9	70-350	Spike
	3011	151565.2	43111.2	28	26	10,000-50,000	Slow spike Geological?
	7345	145825.6	49097	459	31	270,000 – 1350,000	Dipole EGS M003 Towfish ht = 30m
	8927	143040	51067.6	5	33	3,500 – 15000	Dipole Close to L75/8242
L75	43	155142.7	39070.1	4	-1	5-25	Neg spike Fish bottomed?
	82	155150.5	39156.3	3	0	8-35	Assm dipole Fish bottomed?
	303	155218.2	39613.5	7	9	100-500	Spikey dipole
	2838	151716	42990	22	25	7,000-35,000	Hump Geological?
	6788	145753.2	49072	12	32	8,000-40,000	Assm dipole EGS M003
	8242	142959.5	51049.2	2.6	33	2,000-9,000	Dipole
L150	30	155057.8	38960.6	10	-2	5-27	Neg spike Fish bottoming?
	116	155085.1	39152.3	20	0	50-250	Spikey dipole Fish bottoming?
	2450	151757	42899	18	25	5,000-28,000	Hump Geological?

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
	6301	145708.2	49010.3	18	31	10,000-50,000	Assm dipole EGS M003?
	7809	142977.1	50943	2	33	1,000-7,000	Neg spike
L225	96	155017.3	39104.1	15	0	35-180	Neg spike
	159	155017.2	39131.4	10	0	25-125	Assm dipole
	170	155015.1	39154	18	0	45-225	Dipole
	3010	151536.5	42887.7	20	25	6,000-31,000	Slow dipole
L225	12926	137667	56938	10	56	35,000-175,000	Slow hump EOL Geological?
R75	59	155306.8	39140.2	18	-1	20-100	Dipole EOL
	3057	151351	43250	45	26	15,000-80,000	Slow assm dipole Geological?
	7759	145884.1	49154.2	18	31	10,000-50,000	Neg spike
	10246	143133.3	51116.8	3	32	2,000-10,000	Assm dipole
R150	195	155430.9	39505.7	7	5	140-700	Spike EGS M001 Towfish ht=7m
	347	155486.7	39801.2	17	9	250-1,200	Assm dipole EGS M002 Towfish ht=11m
	2981	151696.6	43234	25	26	9,000-45,000	Spike / hump
R225	386	155597.6	40022.8	5	11	100-650	Spike
	444	155620.9	40146.3	5	12	150-800	Spike
	560	155667.9	40393.3	2.2	13	100-500	Spike
R300	731	138269	56619.1	16	56	5,000-30,000	Slow spike Geological?
RE1	3031	140764	53464	1.7	36	1,000-8,000	Neg spike Doubtful
RE4	872	137024	59193	3.2	57	10,000-60,000	Neg spike Geological?
	2647	141493	59614	10	57	35,000-180,000	Spike
RE6	871	143115	59359	3.5	56	12,000-60,000	Spike / hump Geological?
	2647	141017	61373	10	56	35,000-175,000	Spike
RN1	2373	135118	56498	15	55	50,000-250,000	Dipole
	2822	135036	57252	4	57	15,000-75,000	Spike
RN2	526	136995	59137	3.5	59	14,000-71,000	Hump Geological?
	1627	137236	56608	15	53	44,000-220,000	Hump Geological?
RN3	3352	139242	57972	3.3	57	12,000-60,000	Dipole
RN4	781	141552	59610	2.8	57	10,000-51,000	Spike / hump Geological?

File	Data Point	Easting	Northing	Mag (nT)	Chart Depth	Est Wt (kg)	Comments
ME0	646	138359	56683	25	56	87,000-430,000	Hump Geological?
ME100	885	138461	56707	16	56	56,000-280,000	Hump Geological?
ME500	1182	138772	57629	2.8	56	9,000-49,000	Spike
ME600	928	138866	575662	1.8	56	6,000-31,000	Small hump
	1122	138886	57380	2.2	56	7,000-38,000	hump
ME700	1188	138978	57555	5	56	17,000-87,000	Spike / hump Geological?
ME800	1370	139076	57655	5	56	17,000-87,000	Spike
ME1100	1105	139345	57925	3	57	11,000-55,000	Spike
ME1700	1485	139919	58152	6	56	21,000-105,000	Spike
ME1800	815	140203	56365	6	53	17,000-90,000	Neg Spike
	1989	140027.5	58171.9	7.5	56	26,000-150,000	Spike

12.2 Location of magnetic anomalies (3 maps)

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R75/10246
CL/8927
L150/7809
L75/6788
R75/7759
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L150/6301
R75/3057
R150/2981
CL/3011
L75/2838
L225/3010
L150/2450
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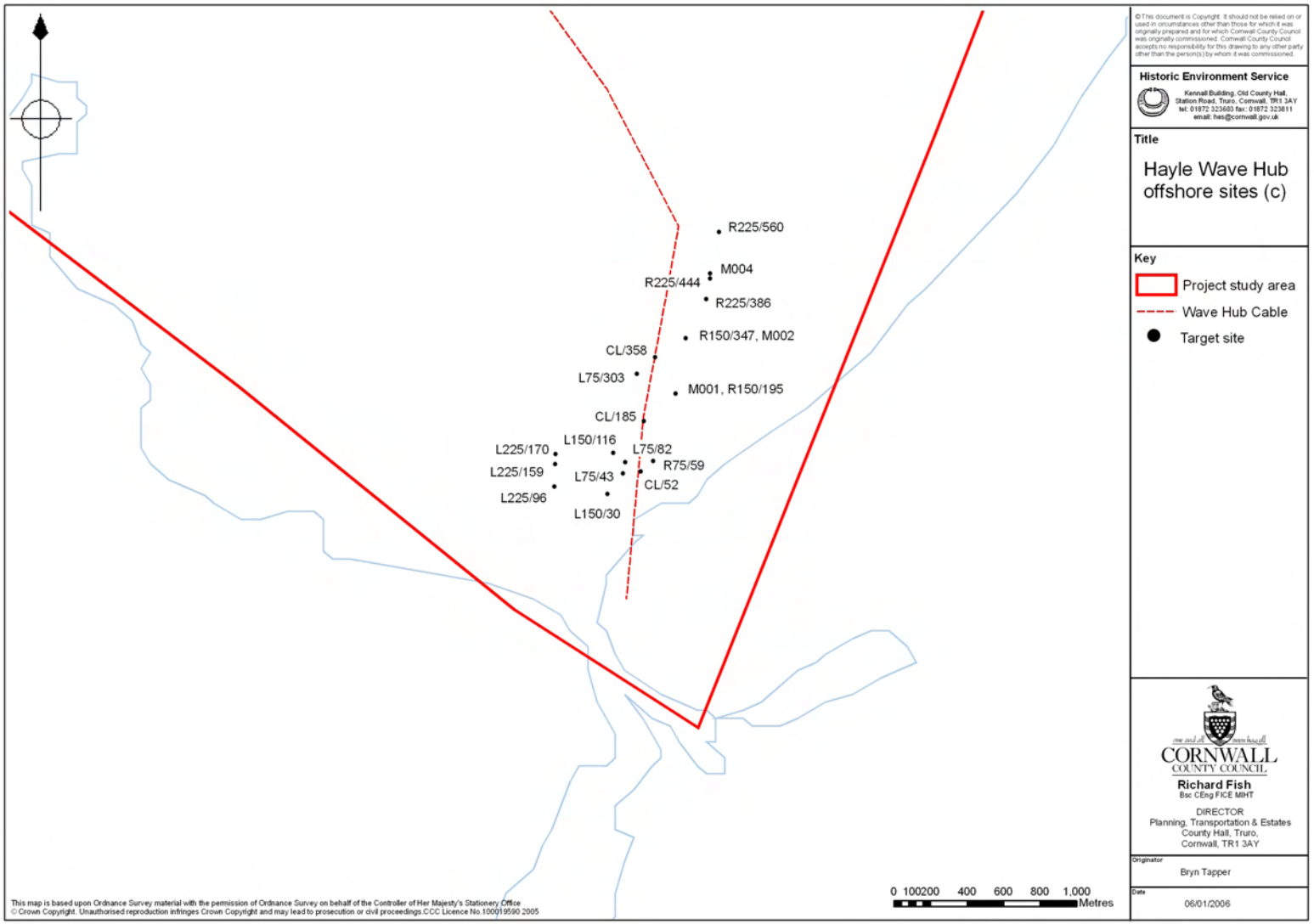
Kennall Building, Old County Hall, Station Road, Truro, Cornwall, TR1 3AY
tel: 01872 323603 fax: 01872 323811
email: hes@cornwall.gov.uk
Title
Hayle Wave Hub offshore sites (b)
Key
Project study area
Wave Hub Cable
Target site
CORNWALL COUNTY COUNCIL
Richard Fish
Bsc CEng FICE MIHT
DIRECTOR
Planning, Transportation & Estates
County Hall, Truro,
Cornwall, TR1 3AY
Originator
Bryn Tapper
Date
06/01/2006


R225/560
M004
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R225/386
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CL/358
L75/303
M001, R150/195
CL/185
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L75/82
R75/59
L225/159
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CL/52
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0 100200 400 600 800 1,000
Metres
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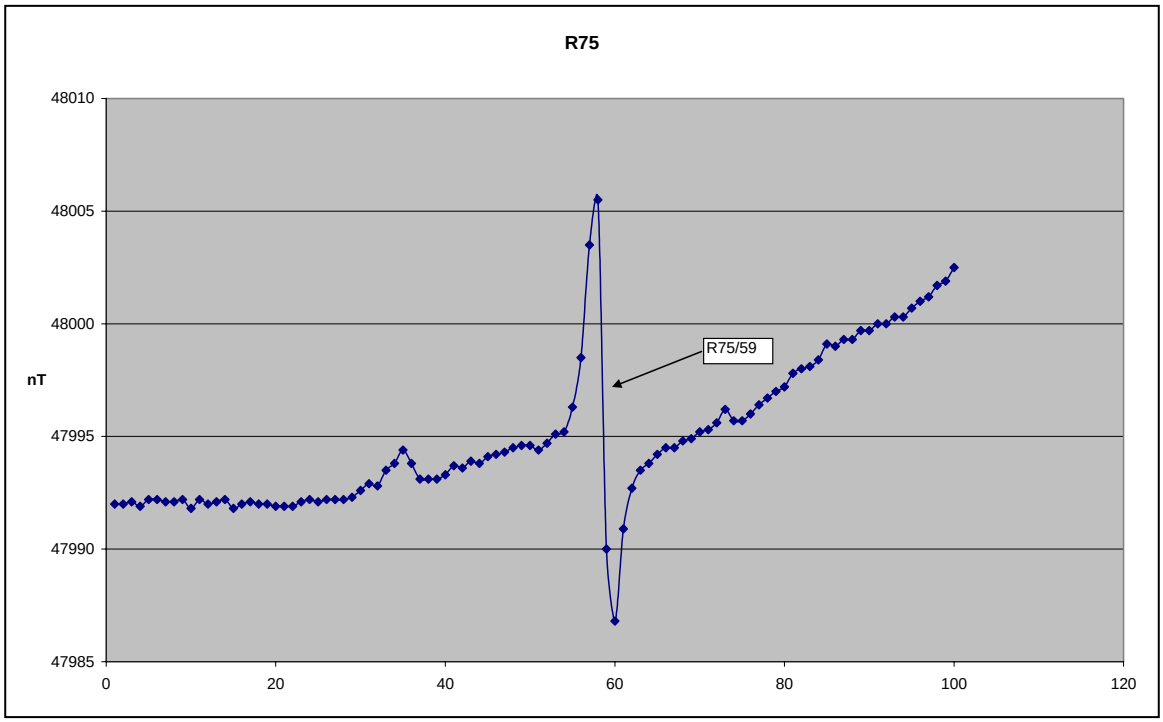
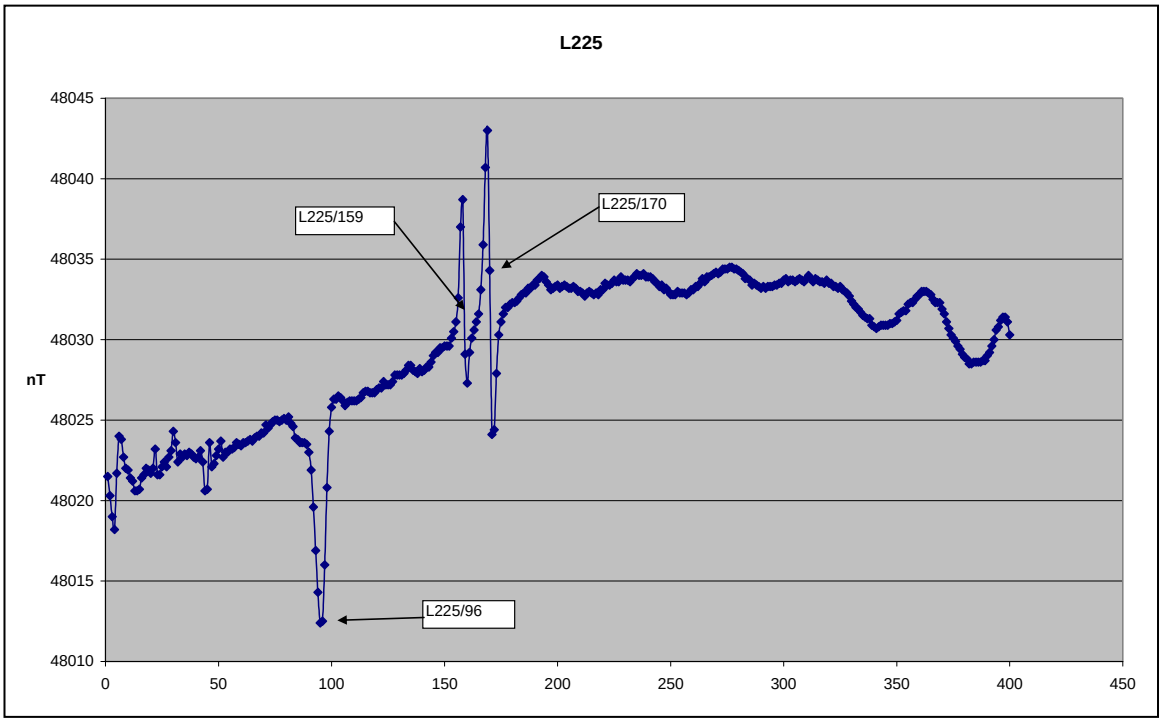
Historic Environment Service
Kennall Building, Old County Hall, Station Road, Truro, Cornwall, TR1 3AY
tel: 01872 323603 fax: 01872 323811
email: hes@cornwall.gov.uk
Title
Hayle Wave Hub offshore sites (c)
Key
Project study area
Wave Hub Cable
Target site
CORNWALL COUNTY COUNCIL
Richard Fish
Bsc CEng FICE MIHT
DIRECTOR
Planning, Transportation & Estates
County Hall, Truro,
Cornwall, TR1 3AY
Originator
Bryn Tapper
Date
06/01/2006

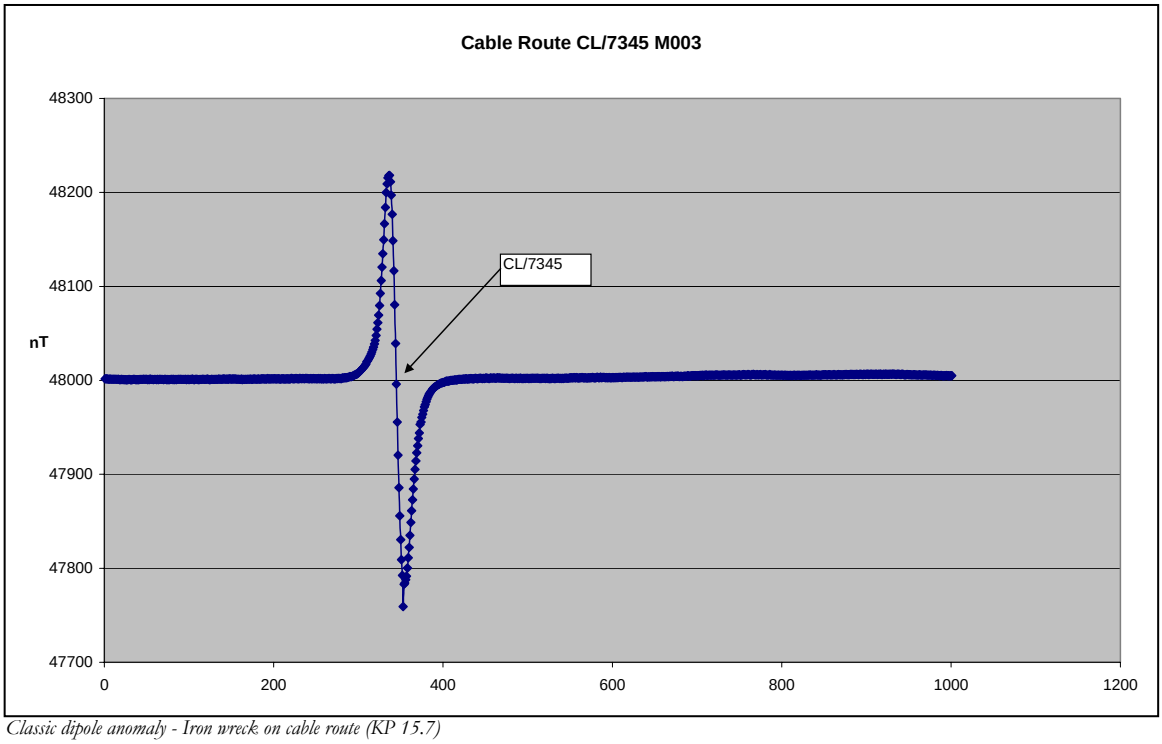
12.3 Examples of magnetic profile graphs



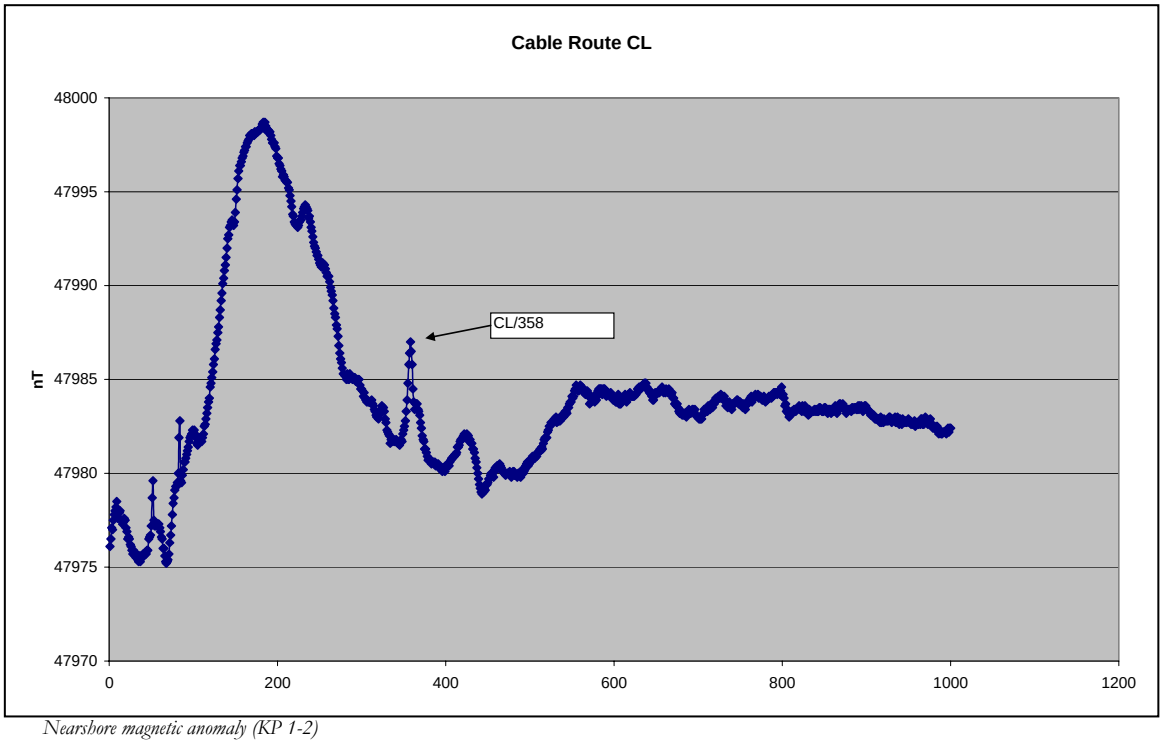
Inshore magnetic targets



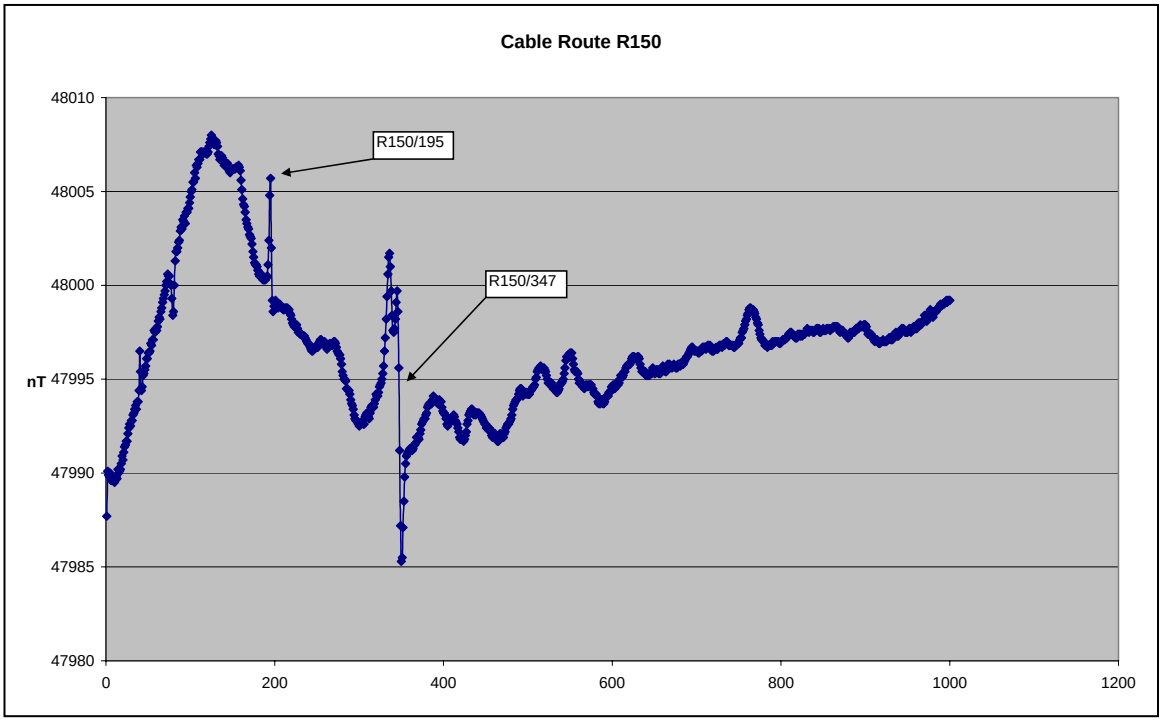
Inshore magnetic target



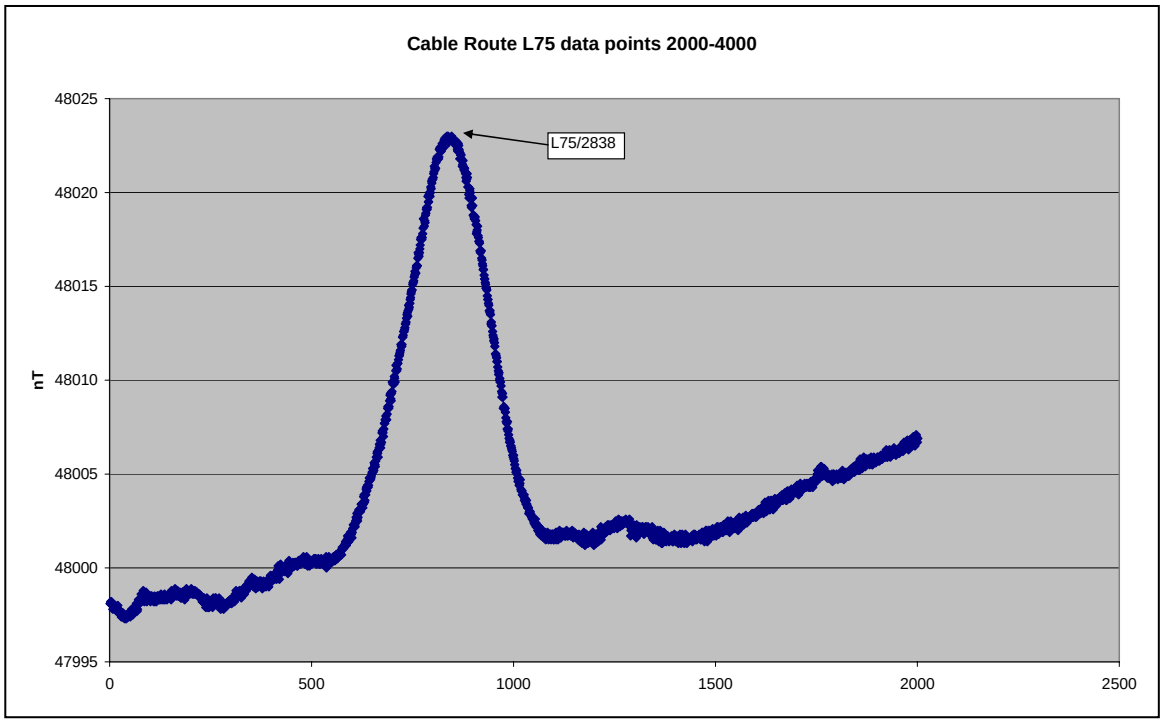
Classic dipole anomaly - Iron wreck on cable route (KP 15.7)



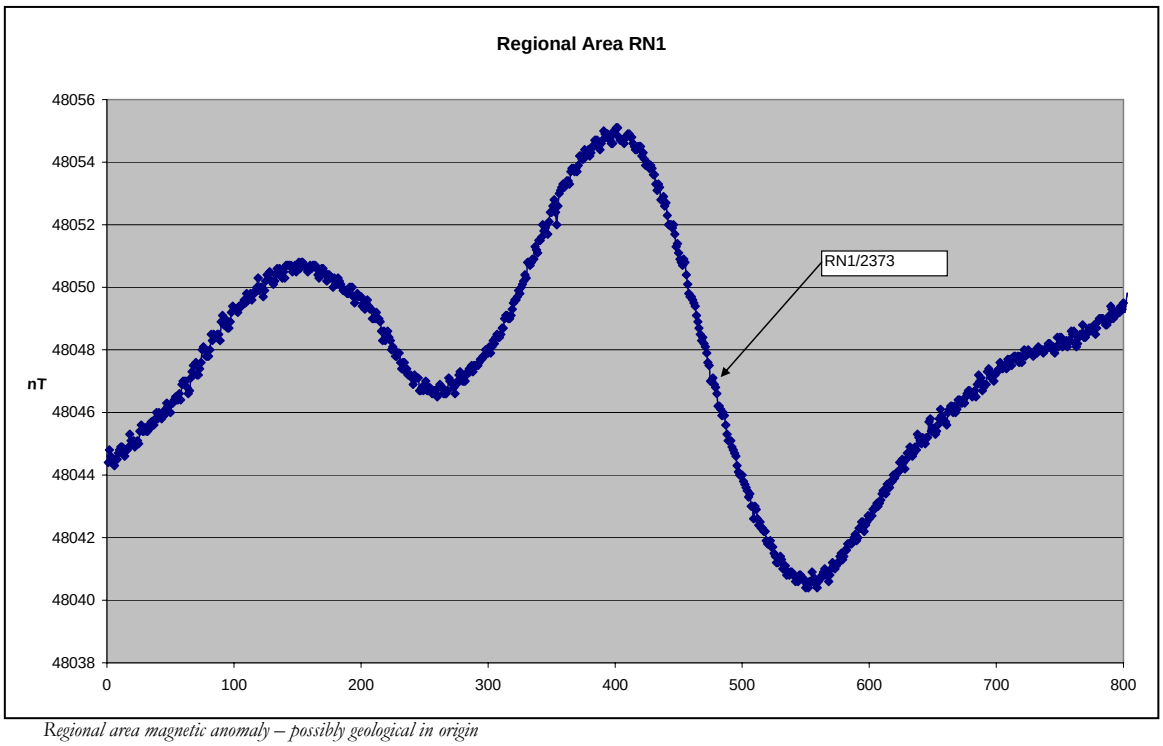
Nearshore magnetic anomaly (KP 1-2)



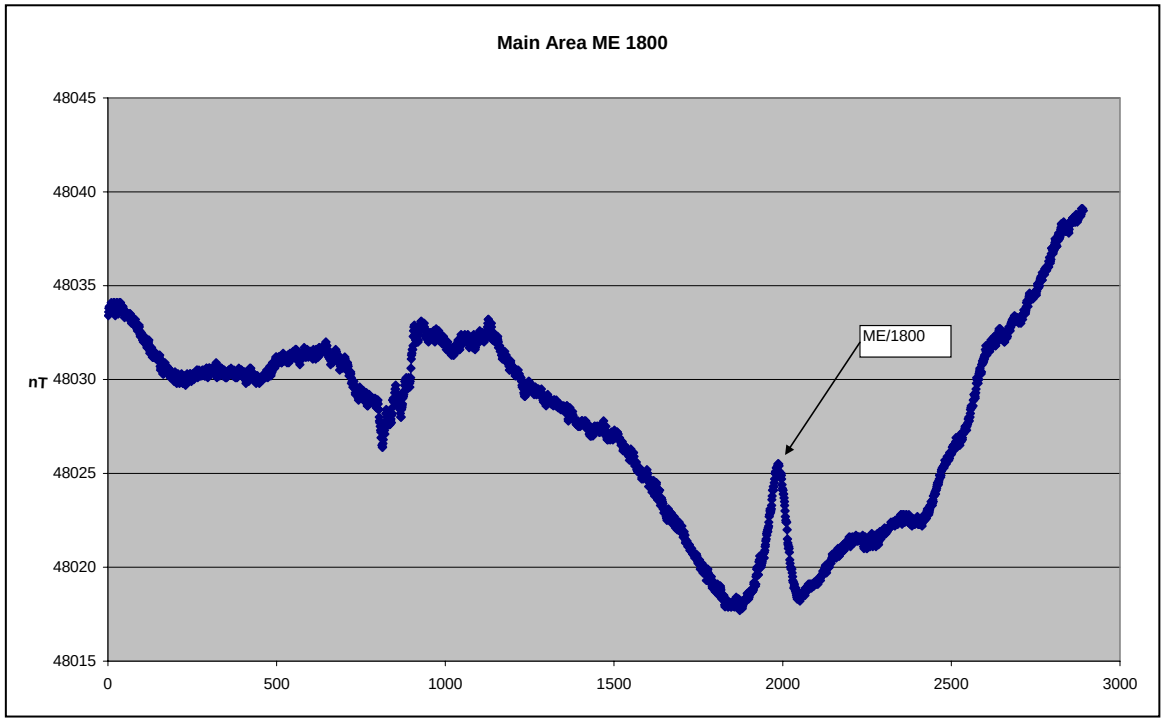
Nearshore magnetic anomalies (KP 1-2)



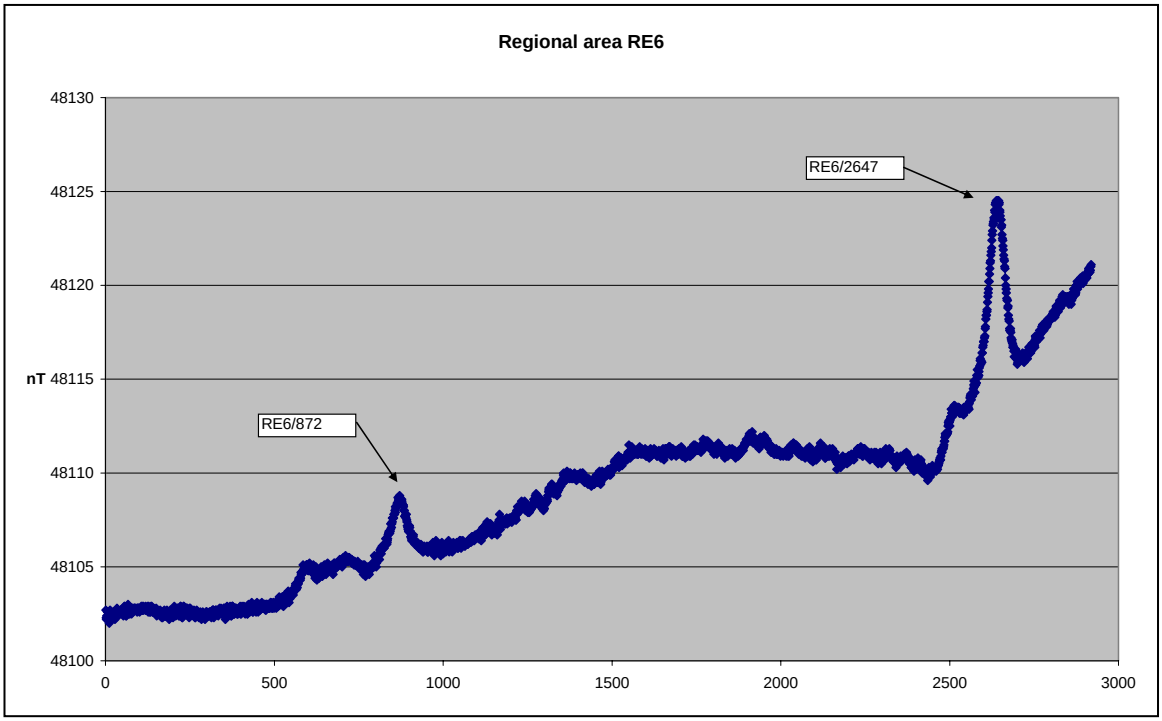
Possible geological anomaly (KP7)

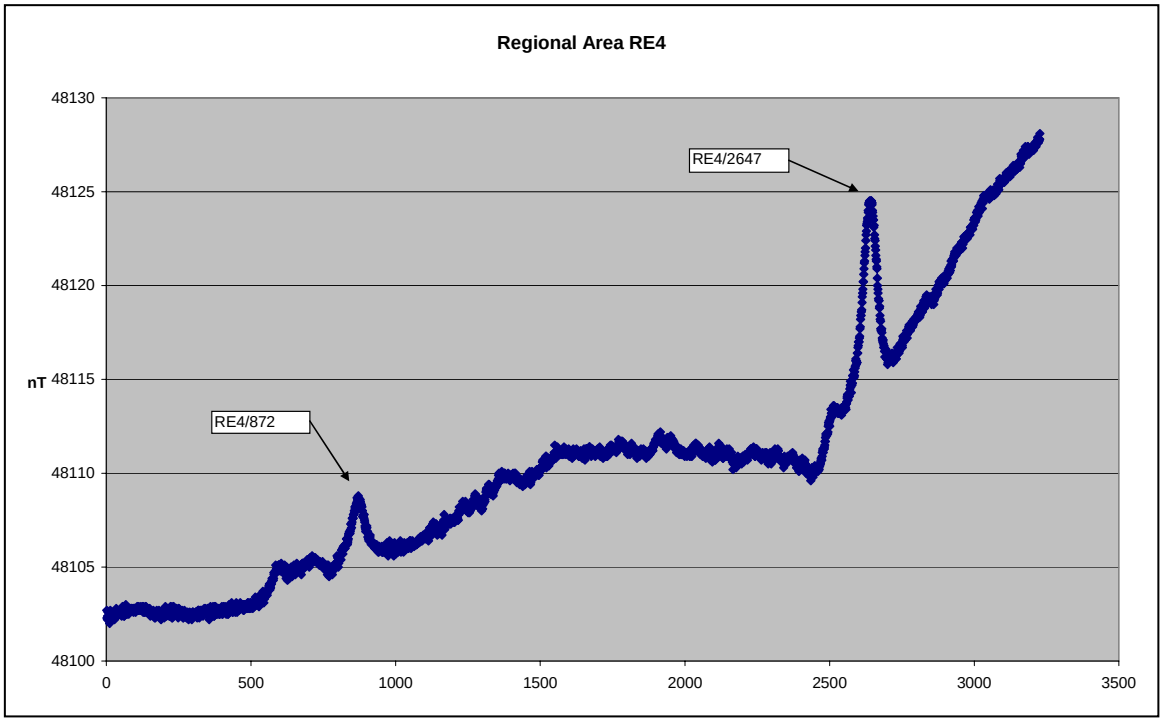


Regional area magnetic anomaly – possibly geological in origin



Main area magnetic anomoly





Magnetic profiles for regional lines RE4 and RE6. Note that these are identical apart from the last few data points, which have been trimmed off to make the longer series from RE4 fit that for

13 The Wave Hub

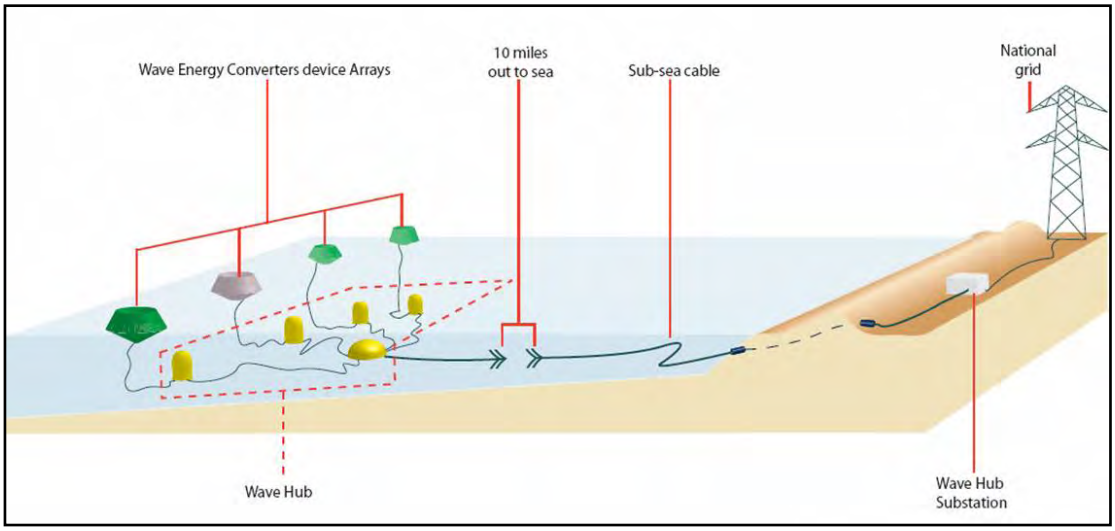


Fig 54 Schematic diagram of the proposed Wave Hub (Halcrow)

The Wave Hub application is for up to four power connection units (PCUs) to be located on the sea bed in approximately 50 metres of water, to which wave energy converter (WEC) units or interconnected arrays of WECs will be connected. The PCUs will be spread across the sea bed within a 4km x 2km Deployment Area and each connected back to a termination and distribution unit (TDU).

WEC units may take a number of forms, with varying outputs, operating ranges, numbers in an array, and spacings. Different device developers would each be able to connect either large scale devices or arrays of devices to a PCU (a PCU Array) at any one time. Developers would be able to build up the number of WECs in a PCU Array and to replace WECs with larger scale devices. The Wave Hub will have a maximum output of 20MW.

All devices would be floating or semi-submersible connected to the Wave Hub by cable and moored on the seabed. The main types of device will be oscillating water columns (partially submerged), buoyant moored devices (floating on or just below the surface of the sea), or hinged contour devices (floating on the surface of the sea).

The Wave Hub is intended to provide device developers with a facility where devices can be tested and improved over a number of years. Devices will be encouraged to remain connected to the Wave Hub for a limited duration and then be removed from the site to enable other devices to be connected. The required time duration is not known at this stage but should become clearer during the development process and from discussions within the industry.

Electricity generated at the site will be transmitted from the TDU via a sub-sea high voltage cable to land and via onshore underground cable to a proposed onshore substation adjacent to the existing Hayle substation. The cable will be laid on the seabed apart from within St Ives Bay where it will be buried up to 3m deep in the seabed's sediment. The cable will also be laid up to 3m deep where it crosses the beach (Hayle Towans) and will pass beneath the dunes via a pipe (pre-installed by directional drilling) to the new

substation. The new substation will in turn be connected by underground cable to the 33 kv bulk electricity system of Western Power Distribution (WPD).

In summary, the proposal seeks development consent for a Wave Hub of 20 MW maximum generating capacity which comprises the following works:

- up to 24 WECs attached to each PCU
- a maximum generating capacity of 5 MW per PCU array
- up to four power connection units
- the associated interconnecting cable array
- a termination and distribution unit
- the undersea cable to shore and onshore connection
- the onshore electricity substation, car park and access road together with associated works.