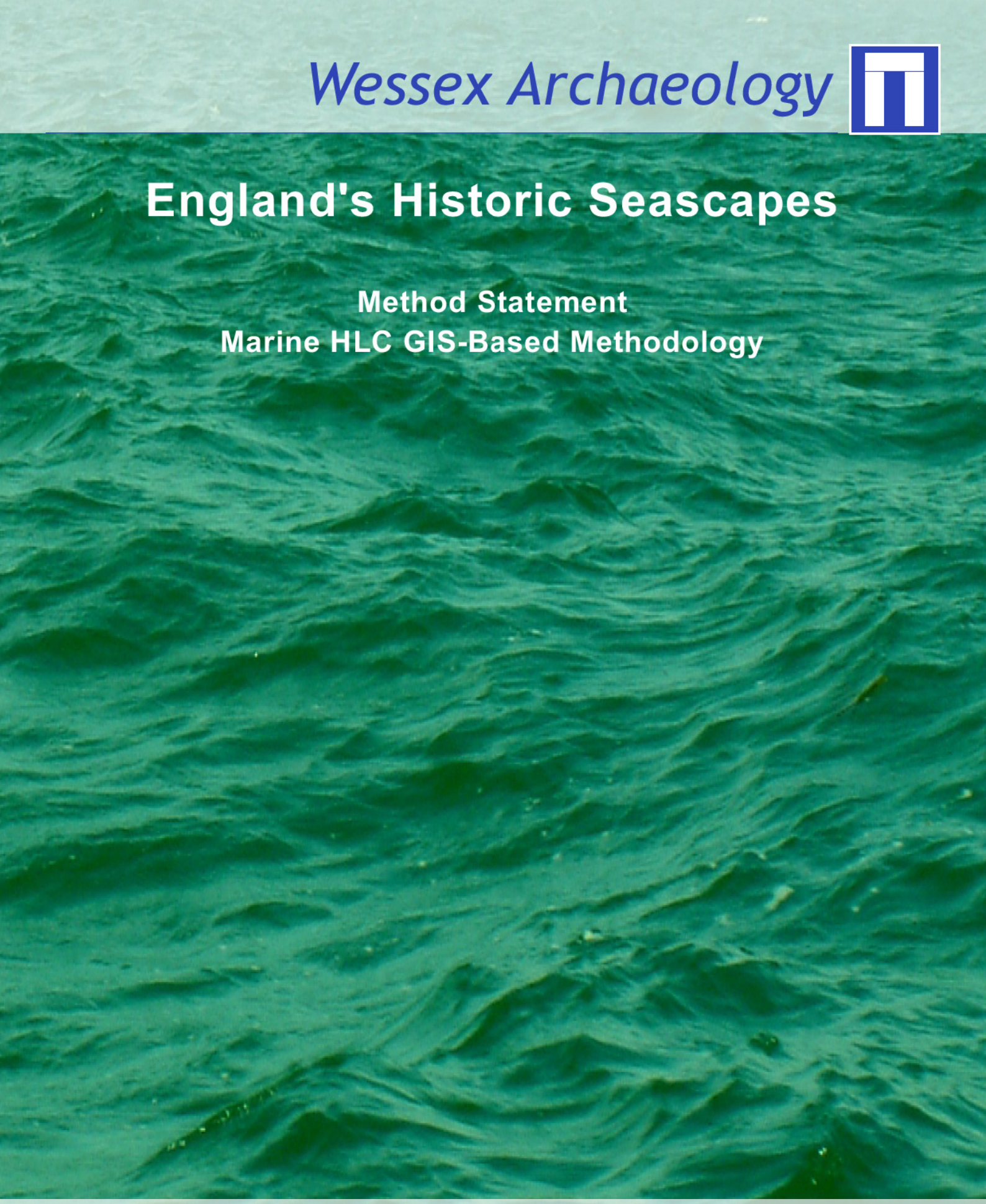
Wessex Archaeology

England's Historic Seascapes

Method Statement
Marine HLC GIS-Based Methodology



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ENGLAND'S HISTORIC SEASCAPES

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MARINE HLC GIS-BASED METHODOLOGY

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ABBREVIATIONS

BGS	British Geological Survey
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
DEFRA	Department for Environment Food and Rural Affairs
DEM	Digital Elevation Model
DTI	Department of Trade and Industry
EA	Environment Agency
EH	English Heritage
EN	English Nature
GIS	Geographical Information Systems
HBSMR	Historic Buildings and Site Monument Records
HER	Historic Environment Record
HLC	Historic Landscape Characterisation
ISO	International Organisation for Standarisation
JNCC	Joint Nature Conservation Committee
MHLC	Maritime Historic Landscape Characterisation
MHW	Mean High Water
NLO	Named Location
NM	Nautical Miles
MLW	Mean Low Water
NMR	National Monument Record
OS	Ordnance Survey
POL	Proudman Oceanographic Laboratory
RNLI	Royal National Lifeboat Institution
SOC	Southampton Oceanographic Centre
UKHO	United Kingdom Hydrographic Office
WA	Wessex Archaeology

ENGLAND'S HISTORIC SEASCAPES

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CONTENTS

1. INTRODUCTION

The purpose of this document is to describe the methods of GIS development and data manipulation methods that have been utilised by Wessex Archaeology (WA) during the development of England's Historic Seascapes Liverpool Bay and Fylde Pilot Project, a project commissioned by English Heritage (EH) and funded by the Aggregate Levy Sustainability Fund.

England's Historic Seascapes Liverpool Bay and Fylde Pilot Project aims to improve our understanding of natural processes and human activities that have shaped the seabed and intertidal zones as they are represented and experienced today through the application of the historic landscape characterisation (HLC) process. Historic landscape characterisation is a methodology designed to provide a landscape-scale understanding of the historic dimension of our environment. England's Historic Seascapes is a programme to extend the principles of HLC into England's intertidal and marine zones. The project was designed to have a particular application in contextualising responses to marine aggregates extraction and licence area applications for future extraction.

The *Guidelines for EH projects involving GIS* recommends that a record of the methodology of data capture is explained, including details of pre-processing, methods of geo-coding and classification (English Heritage 2004). This document aims to fulfil these requirements, and reflects WA's experience of finding solutions to the particular problems associated with extending methods of terrestrial HLC projects to offshore and intertidal areas.

1.1. HISTORIC LANDSCAPE CHARACTERISATION

Characterisation is a new way of managing change in the historic landscape. HLC comprises spatial historic analysis in terms of the 'historic environment' and 'heritage' and how to manage the 'historic environment' (Clark et al 2004). The spatial component is controlled and visually displayed within GIS. Therefore, HLC is a GIS-based methodology for mapping and defining the historic and archaeological dimensions of the present day landscape or seascape.

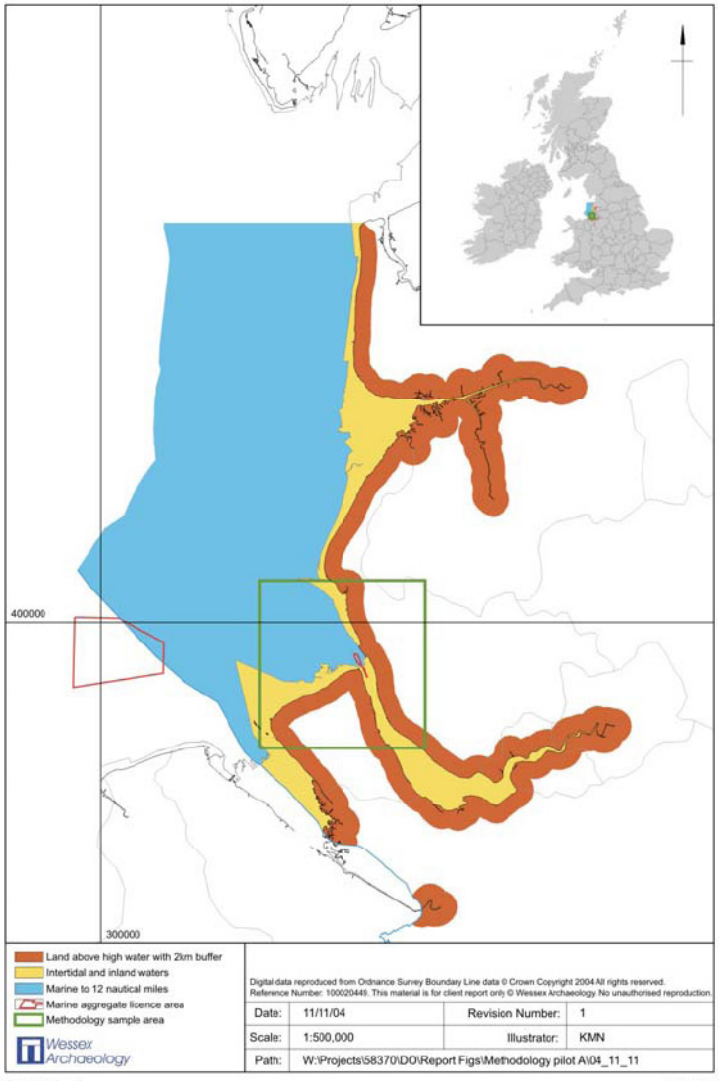
Methods developed and used widely for terrestrial characterisation are useful guides to characterising the near shore, but cannot always be directly transferred to offshore areas. Some of the problems associated with the latter include:

- *Working without fixed boundaries*: in terrestrial contexts field boundaries, roads, railways, patterns of land ownership, amongst others create divisions of the landscape which discretely contain different types of human activity. In offshore and intertidal areas, divisions reflecting zones of human activity are much more diffuse and very rarely have hard or defined boundaries.
- *The sea has three vertical zones which can influence the character areas*: the seabed, the sea surface, and the water column form the three offshore zones of interest. However, in the intertidal and coastal areas there is a single land surface. WA has focussed primarily on the seabed and sea surface in offshore areas during the characterisation process.
- *Dynamic marine environment*: the natural environment of the intertidal and marine zone is predominantly dynamic and constantly changing due to natural processes such as currents, tidal range and sediment mobility. Hence, evidence of human activity in this type of environment can be easily eroded. Evidence can also be covered and

uncovered, and even transported from distant locations by the natural marine dynamics.

1.2. ENGLAND'S HISTORIC SEASCAPES LIVERPOOL BAY AND FYLDE PILOT PROJECT

The project area initially focuses in north-west England (Pilot Area) comprising Liverpool Bay and waters off the Fylde, with a small test area defined at the mouth of the Mersey (Figure 1 below).



Pilot Area A Figure 1

The Pilot Area A comprises Liverpool Bay and waters off the Fylde and has been mapped provisionally by WA on the basis of the following boundaries:

landward boundary	Mean High Water (MHW), up to the Normal Tidal Limit of rivers, as mapped by Ordnance Survey (OS) (Boundary-Line dataset, 1:10 000).
seaward boundary	12 nautical mile (nm) limit of UK territorial waters, calculated as a 12 nm buffer to the Extent of Realm (Mean Low Water (MLW) and seaward local authority boundary extensions) mapped by the OS (Boundary-Line dataset, 1:10 000).
south-western boundary	The line between the territorial waters adjacent to England and Wales extending from the Dee Estuary, as defined in The National Heritage Act (Territorial Waters Adjacent to England) Order 2002 (Statutory Instrument 2002 No. 2427).
northern boundary	A line perpendicular to the general lie of coast at the point at Rossall Point, Fleetwood, out to the 12 nm limit.

In accordance with the EH's Project Brief, MHW has not been taken as an arbitrary landward line to truncate character polygons. WA has included a strip of coastal land above high water, calculated as a 2 km buffer landward of MHW utilised for data capture and bibliographic searches with a view to gaining a greater understanding coastal activities that may have a direct bearing on the character of intertidal and marine areas.

1.3. THE MARITIME HISTORY AND ARCHAEOLOGY OF LIVERPOOL BAY

Liverpool Bay has a rich and varied maritime history, as well as a wide range of planning and management issues which maritime historic landscape characterisation can help to address.

In terms of prehistory, Liverpool Bay has clear potential for human occupation of landscapes that are now inundated. Palaeoenvironmental evidence, in the form of submerged forests, is found on the coasts of both Lancashire and Cheshire. Moreover, animal footprints from the Neolithic or early Bronze Age survive in the intertidal zones in Merseyside (Cox 1895; Roberts et al 1996; Waddell 1993). Into periods encompassed by written history, large numbers of Roman and Medieval finds are known in the intertidal area of the Wirral (Greenwood 1999; Stammers 1994). Their location, in areas that were formerly terrestrial, provides evidence for sea-level rise and the continuity of coastal change into modern times.

Liverpool Bay has seen maritime activity from at least the Roman period. Ocean-going vessels navigated the Dee and Irish Sea to and from the Roman town of *Deva,* now Chester (Boult unknown-a, b). Place-names such as Formby and Fylde show Viking activity in the region (Griffiths 2001). By the Middle Ages, Chester and Liverpool were used as maritime bases for military campaigns in Wales and Ireland (Mannering 1997).

In the Medieval and Post-Medieval periods, Liverpool grew as a port becoming a centre for trade with the New World colonies, including slave trading known as Triangular Trade (Fryer

1984; Rawley & Behrendt 2005; Snelgrave 1971). In the eighteenth century, an extensive new dock system was built to facilitate further expansion in trade. By then, Liverpool became one of the world's most powerful maritime cities, second only to London in importance, and the second city of the British Empire (Aughton 2003). After the abolition of slavery, Liverpool remained a busy port exporting coal, salt and textiles. Other ports in the pilot area such as Southport and Fleetwood remained active in coastal trade and fishing and they never challenged Liverpool in exports and imports (Aughton 2003; Foster 1995). Other towns on the coast like Blackpool developed greatly due to the growth of tourism in the nineteenth century bringing further prosperity to the region (Mannering 1997).

The offshore pilot area contains valuable resources such as Lennox Oil and Gas Fields and Hamilton Gas Field which are extensively exploited. Growing modern interest in renewable energy sources has led to the selection of parts of the pilot area for the construction of offshore wind farms. Moreover, maritime aggregate extraction has occurred at the entrance of the Mersey (areas 175/1-2, 193/1-2 and 195/1-2), to the east of the study area (areas 392 and 393) and at the mouth of the Ribble. These developments form part of the pressing management and sustainability issues currently facing curators.

1.4. ENGLAND'S HISTORIC SEASCAPES LIVERPOOL BAY AND FYLDE PILOT PROJECT AIMS AND OBJECTIVES

The aims of the proposed pilot project, as set out in the Project Brief, were as follows:

A1 To define, test in the Liverpool Bay and Fylde pilot area, review and finalise a desk-based methodology for extending historic landscape characterisation to the present landscape in the intertidal and marine zone of England to the limit of UK Territorial Waters.
A2 To create a GIS-based characterisation of the historic and archaeological dimension in the present landscape of the intertidal and marine zones of England to the limit of UK Territorial Waters.
A3 To contribute to government agendas in favour of integrated spatial planning of the intertidal and marine zones by creating a historic environment GIS database for the project area which will readily integrate with analogous databases for the natural environment.
A4 To create a framework of understanding which will structure and promote well-informed decision-making relating to the sustainable management of change and conservation planning affecting the historic environment in the intertidal and marine zones.
A5 To enhance and contextualise the Maritime Record of the National Monuments Record (NMR) and those Local Authority Historic Environment Records (HER) working within the project area.
A6 To inform, structure, and stimulate future research programmes and agendas relating to the project area.
A7 To improve the awareness, understanding and appreciation of the historic dimension of the project area to professional and non-professional users of the database.
A8 To be a demonstration project and specifically to produce a model for extending its methodology to further project areas encompassing a greater diversity of environmental and management conditions.

The project's key objectives, as set out in the Project Brief, were as follows:

O1 To produce a GIS-database structure capable of accommodating the distinctive qualities of the project area while retaining compatibility of that database with the interfacing or partly overlapping terrestrial characterisation databases.
O2 To produce a GIS-based HLC characterising the project area's landscapes in historic and archaeological terms by means of:

- identifying and gaining access to the range of data sources relevant to understanding the historic and archaeological dimension of the project area, placing greatest emphasis on sources with consistent national coverage;
- using GIS polygons to define areas sharing similar historic character;
- defining polygons on the basis of combined shared values of dominant character attributes, with secondary attributes recorded in a consistent, structured manner;
- identifying trends and recurrent groupings among the attributes to define historic landscape types that will together encompass all of the polygons and reflect the differing historical processes in their information.

O3 To record the sources and datasets supporting each stage of characterisation, to meet the needs of transparency and assist future updates against the initial benchmark characterisation.
O4 To analyse and interpret the HLC to produce preliminary syntheses from it.
O5 To produce a Project Design for applying the project's HLC methodology to a further four areas in subsequent projects which will validate that methodology against major contrasts in coastal and marine environmental and management context.
O6 To assess present uses and potential for the HLC in informing sustainable management of change and spatial planning issues surrounding marine aggregates extraction in the project area.
O7 To assess present uses and potential for the HLC in informing broader sustainable management of change, spatial planning, outreach and research programmes.
O8 To produce an archive and a report reviewing the methodological development and practical application of HLC in the project area and assessing the benefits of extending such characterisation more widely to the historic environment in the intertidal and marine zones to the limit of UK territorial waters.
O9 To disseminate information on the progress and results of the project through professional and popular publications and other media.

1.5. Practical Applications of Maritime HLC

Potential applications of maritime HLC (MHLC) have been identified. The following are likely to be the main immediate uses:

- Sea Use Planning: especially informing strategic planning, contributing to supplementary planning guidance and providing context for archaeological development control decisions.
- Conservation: particularly in conjunction with curatorial staff from EH and from Local Authorities who were identified among the potential end-users of the MHLC.
- Public Outreach and Research: MHLC will stimulate research at regional and national level to enhance our understanding of intertidal and marine landscapes.

It is anticipated that the primary end-users of MHLC are likely to be the following:

- Curators: processing offshore or coastal planning applications and contributing to SEAs and EIAs
- Regional authorities: assisting with strategic regional planning initiatives, for example, the archaeological component of shoreline management plans
- Central government strategic planning: contributing particularly to marine spatial planning initiatives, licensing process and consents units of the Department for Environment, Food and Rural Affairs (DEFRA), Department of Trade and Industry (DTI)
- Maritime researchers: exploring a wide variety of historical and prehistoric maritime themes
- Lecturers and teachers: assisting to develop schools projects linked to environment and archaeology
- Developers: concerned with coastal and offshore projects, needing to anticipate the impacts of their proposals to ensure compliance with environmental legislation.

2. CORE DATASETS

The following table summarises the core and supplementary data utilised during England's Historic Seascapes Pilot Project.

Core data	**Format**	**Location**
Modern charts	Hard copy	United Kingdom Hydrographic Office (UKHO)
Historic charts	Hard copy	UKHO
Bathymetry/topography	Digital	SeaZone Solutions Ltd
Modern OS maps	Digital	EH
OS 1st edition maps	Digital	EH
Supplementary Data	**Format**	**Location**
NMR	Digital and hard copy	National Monuments Record (NMR) database
Cheshire HER	Digital	Cheshire County Council dataset
Merseyside HER	Digital	Merseyside Archaeological Services dataset
Cheshire HLC	Digital	Cheshire County Council HLC polygons
Lancashire HLC	Digital	Lancashire County Council HLC polygons
Merseyside HLC	Digital	Merseyside Archaeological Services HLC polygons
Offshore industry	Digital	Joint Nature Conservation Committee (JNCC) + SeaZone Ltd. offshore developments
Coastal industry	Digital	Modern Ordnance Survey (OS) maps (EH)
Fisheries data	Digital	JNCC
Wrecks and obstructions	Digital	SeaZone
Offshore installations	Digital	SeaZone
Dumping grounds	Digital	SeaZone
Bathymetry	Digital	SeaZone
Seabed sediments	Digital	British Geological Survey (BGS)
Offshore solid geology	Digital	BGS
Tidal range	Digital	DTI
Environmental	Digital	English Nature (EN)

2.1 PRACTICAL APPLICATIONS OF MARITIME HLC

Data Licensing and usage

The following section explores the issues surrounding using external data for offshore zones where licencing and usages agreements are essentially different from those in place for terrestrial HLC which primarily uses OS mapping. Some of the differences between OS licencing and other data providers are explored below.

Note: the following is an interpretive view with particular relevance to experience of Liverpool Bay and Fylde Pilot Project. Marine HLC developers should seek specific advice from each data provider and refer to individual licences and usage agreements.

The Liverpool Bay and Fylde Pilot Project has utilised digital data which has been generated or collated by external organisations. The organisations primarily concerned are BGS, Seazone Solutions Ltd, UKHO and the Ordnance Survey. Due to licensing constraints, some data could not be reproduced as attributes in the final GIS attributes table transferred for archiving to the NMR. As a consequence, while some of these datasets were kept in the project GIS particularly to inform the character narratives that were compiled near the end of the project they were then removed.

Ordnance Survey

The extracts of historic Ordnance Survey mapping shown in **Section 6** of this document are subject to the licencing agreement between English Heritage and Ordnance Survey under a Pan-Government Agreement (PGA). The agreement between the OS and EH includes specific reference to allowing simple derived data to be digitised from OS mapping (e.g. polygons). With regard to ownership in Intellectual Property Rights, Schedule 5 Contractor Licence for the Use of Ordnance Survey Digital Mapping Products includes a clause (5.1.) which states that *'The Contractor will not retain any Intellectual Property Rights in material created using Ordnance Survey Digital Mapping products and agrees to assign any rights created to the Sublicensor or Ordnance Survey as requested by the Sub Licensor or Ordnance Survey'*. Hence the 'intellectual property rights' of polygons generated using OS base mapping can be assigned to the Sub-Licensor (i.e. English Heritage).

The above agreement requests that all extracts of Ordnance Survey mapping must acknowledge the source of mapping through the reproduction of the following copyright statement:

In addition, Wessex Archaeology has utilised its own licences for Ordnance survey for the reproduction of modern mapping and the utilisation of digital coastline data in the GIS. Essentially, the licences restrict the transfer of the data in any form other than non-editable .pdf.

The following acknowledgment for the use of modern mapping data applies:

The following acknowledgement for the use of digital coastline data applies:

SeaZone Solutions Ltd Data

The SeaZone data acquired by WA was used to explore present sea use as a component of overall character. The Seazone data was altered substantially in the creation of character types, but some compromises had to be made regarding the shape of some final character polygons to ensure derivation.

With EH unable to supply digital charting data and having the facility to provide a Contractor's Licence for the use of such data (i.e. similar to that allowed by the OS stating that contractors do not retain any intellectual property rights in material created using the mapping product, etc,), a standard SeaZone Solutions Ltd data licence between Wessex Archaeology and SeaZone Solutions Ltd operated for this project.

A copy of the SeaZone Solutions Ltd licence is included in the project archive. The clauses it contains, for example, request the licensee to acknowledge that Intellectual Property Rights are the Licensor's and no licence or rights are granted in favour of the licensee in relation to Intellectual Property Rights (4.1). The ability to create simple derived data from the base mapping is not specifically mentioned. The licence restricts the placing of data on a computer that is accessible to third parties; permits the production of up to 500 A4 or A3 size paper of non-editable electronic copies (e.g. .pdfs) for non commercial purposes; and requests that on each and every reproduction the following statement should be readily apparent:

The material derived from Seazone Solutions Ltd is subject to licence and conditions on End-Users and Third Parties contained therein.

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All rights Reserved. NOT TO BE USED FOR NAVIGATION.

An agreement was reached between WA and SeaZone Solutions Ltd and permission was granted for the resulting GIS project to be transferred to EH and to the NMR for archiving.

United Kingdom Hydrographic Office (UKHO) Charts

Both modern and historic UKHO charts were used to obtain data on present and past sea use as components of overall character. WA used UKHO charts to mark charted features and inform characterisation narratives. The data from these sources was used in the creation of character types, but some compromises had to be made regarding the shape of some final character polygons where it was felt they followed elements of the UKHO data (current charts in copyright) too closely. Historic charts over 50 years old are out of copyright.

With EH being unable to supply rasterised modern charts and having the facility to provide a Contractor's Licence for the use of such data (i.e. similar to that allowed by the OS stating that contractors do not retain any intellectual property rights in material created using the mapping product, etc), Wessex Archaeology's own agreement with the UKHO with regard to scanned and rasterised modern charting was used for this project. The agreement includes clauses which state that 'copyright and all other intellectual property rights in the Copyright Material, including were incorporated into the Reproduced Material or the Outputs of the Reproduced Material, shall remain at all times the property of the Crown, the UKHO or its licensors.' The ability to create simple derived data from the base mapping is not specifically mentioned.

The inclusion of charting extracts in this document invokes the above agreement and essentially restricts this document to internal use only; transmittal only as a non-editable .pdf in digital form; and restricts the number of hard copies which can be produced to 500.

A separate copyright licence 984 has been agreed between the UKHO and WA which allows the transference of the GIS to English Heritage and reproduction of the material to authorised users on the internet, but requests the protection of the material from unauthorised copying by

using a secure file format with the image grabbing-features turned off. A copy of this licence is included in the project archive.

The following acknowledgement for the general use of modern charting as rasterised data applies:

The digital use of Charts 1978, 1981, 2010, and 3490 was made under licence (re. HO 820/020220/11). The following notice applies:

> This product has been derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationary Office (www.ukho.gov.uk). All rights reserved.
>
> NOT TO BE USED FOR NAVIGATION.
>
> WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction or any modifications made thereafter.

Charts 1978, 1981, 2010 and 3490 have been added to Schedule 1 Annex A of the above licence.

British Geographical Survey (BGS) Data

The BGS data acquired was purchased under licence and used to inform the description and interpretation of the physical environment as components of overall character. WA used seabed sediment data, and used BGS paper charts to inform character narratives before removing attributes derived from this data from the GIS transferred to EH/NMR.

After incorporation in the final GIS polygon layer, the overall patterning of the seabed sediment data was still largely preserved through gridding and the unions approach to defining polygons. In discussion with BGS, the key question with regard to BGS copyright interests was whether the data could be re-engineered. As it was thought possible that, through dissolving and merging polygons/grids squares, an approximation of the original mapping might be produced the decision was made to remove the attribute. Copies of the licence are included in the project archive.

The following acknowledgement applies:

Derived from 1:250,000 scale BGS Digital Data under Licence No 2004/167. British Geological Survey © NERC.

2.2. BASE MAPPING

As a member of the Ordnance Survey (OS) Pan-Government agreement, EH has an organisation-wide licence to provide OS digital base mapping for projects funded by them. OS digital data was used for terrestrial base mapping during the project.

Digital chart data (e.g. bathymetry, topography, wrecks) was acquired from SeaZone Solutions Ltd to provide coastal and offshore base mapping. These could therefore be loaded directly into the GIS project.

Hard copies of historic charts were gathered from the archives of UKHO. These were individually scanned and geo-referenced to British National Grid (OSGB 36) at WA.

Hard copies of modern charts were collated from WA library resources. These were individually scanned and geo-referenced to British National Grid (OSGB 36) at WA.

2.3. BIBLIOGRAPHIC AND OTHER DOCUMENTARY SOURCES

WA performed an initial project bibliography review to gather sources on general historic, archaeological, contemporary and environmental data on the project study area. Following the bibliographic search, WA staff undertook visits to Warrington, Merseyside, Preston, Chester, Southampton and London to collect maps and written sources from local libraries, museum collections, record offices and archives.

2.4. MODEL OF SEA-LEVEL CHANGE

A model of sea-level change was generated for England's Historic Seascapes to enhance our understanding of the archaeological potential of Liverpool Bay. The model was based on SeaZone bathymetric data using six datasets: soundings E, F and G, and bathymetric polylines E, F, and G (the alphabetic notations relate to scales of digitised Admiralty chart; e.g. E_Coastal = 1:50,000, F_Approaches = 1:15,000 and G_Harbour = 1:5,000).

The more accurate or reliable data was kept and overlapping data was removed. This dataset was then adjusted to the OS datum Formby -4.93 metres. This point dataset was then run through Surface Terrain Modelling Software (Surfer, using krigging on a grid density 400x328=every 240m) to create a digital elevation model (DEM). The following sea-levels were attributed to different periods:

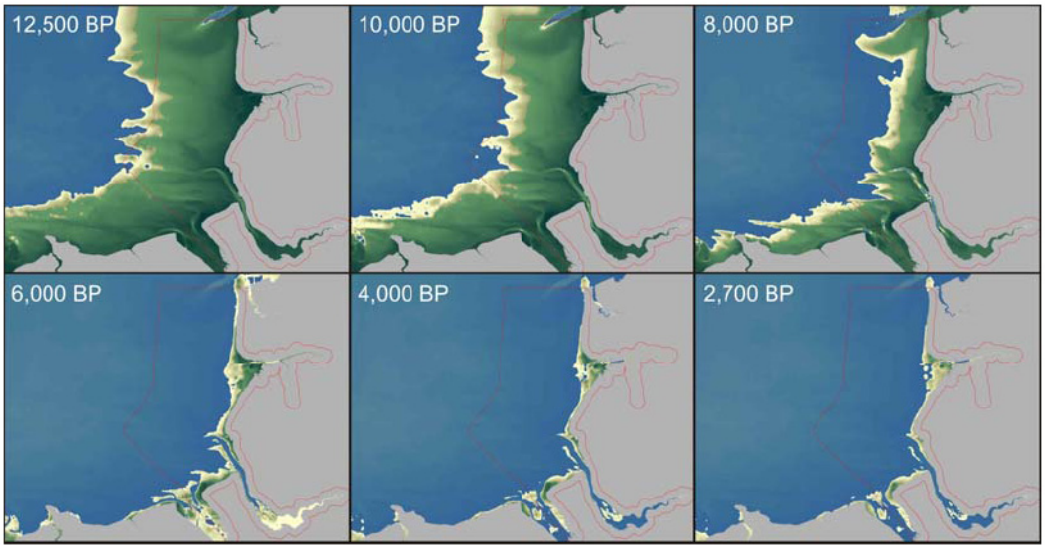
Late Upper Palaeolithic 12,500BP	-28m mean, intertidal range 5m
Early Mesolithic 10,000BP	-23m mean, intertidal range 5m
Late Mesolithic 8,000BP	-14m mean, intertidal range 4m
Neolithic 6,000BP	-3m mean, intertidal range 4m
Bronze Age 4,000BP	-1m mean, intertidal range 4m
Iron Age 2,700BP	0m mean, intertidal range 5m

Establishing intertidal range example:

Late Upper Palaeolithic = intertidal range 5m.
Hence highwater -25.5m, low water -30.5m = mean of tidal range -28m.

Note: The modern day tidal range across Liverpool Bay is 7ms plus. However the tidal range from these earlier periods is unknown, hence estimations have been utilised based upon a mean of the higher ranges experienced around the coast of England.

The results of the sea-level model are illustrated below, the yellow areas representing the intertidal zone and the green areas representing the land surface:



The sea-levels attributed to differing periods (relative sea-levels or RSLs) were obtained from bibliographic sources, primarily Lambeck 1991; but also Plater et al 1999.

The trends for Liverpool Bay show a rapid rise in the sea-level between 8,000BP and 6,000BP. This interpretation is supported by evidence collected from the sediments of Downholland Moss (Tooley 1978) and Morecambe Bay (Zong & Tooley 1996).

Caveats to the use of the model:

- The model uses modern bathymetry – in order to gain a more realistic model it would be necessary to remove the depths of overlying Holocene deposits associated with marine transgression for which there is little data (e.g. one transect published for the area within BGS seabed sediment mapping).
- The model does not make allowances for what may be fairly localised trends of erosion, deposition and isostatic change - sediment transport systems and coastal geomorphological processes are relatively poorly understood and have not been included in the modelling

Although the type of data used for this sea-level model is speculative, it is a useful way to generate a first impression of coastal change. This basic model was then used as an aid in the interpretation of prehistoric data and other appropriate datasets for inclusion into the characterisations. For example, for chronological reference for palaeoenvironmental evidence such as peat bed exposures.

The polygons generated were created from the high and low water marks for all the date ranges. These were then overlaid and made into one seamless set of polygons in AutoCAD. The polygons generated reflect the approximate millennium during which the landsurfaces were inundated.

The fields contained in this layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
TIME_PERIOD: approximate millennium during which the submerged landsurface is most likely to have been inundated
INTERTIDE: intertidal (period in which that polygon was intertidal area)
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

2.5. STANDARDS

The England's Historic Seascapes Liverpool Bay and Fylde Pilot Project has adhered to the *Guidelines for English Heritage projects involving GIS* (English Heritage 2004). Standards applied particularly to England's Historic Seascapes Liverpool Bay and Fylde Pilot Project include:

- The scale of data capture for England's Historic Seascapes is 1:25,000 and therefore the spatial resolution of the final character layer(s) is approximately 13 metres.
- England's Historic Seascapes intermediate and final character layers are in British National Grid and all measurements are in metres.
- The terms used for the Attribute names when possible were defined using the EH online thesauri. For datasets obtained from other sources such as UKHO, JNCC and BGS amongst others, their own definitions have been utilised and adapted.
- England's Historic Seascapes has used the International Organisation for Standarisation (ISO) metadata standards contained in ESRI ArcCatalog metadata editor (see **Section 6**).

2.6. SOFTWARE

The characterisation process undertaken for the England's Historic Seascapes Liverpool Bay and Fylde Pilot Project used ESRI ArcGIS 9.0, ArcInfo licence level.

The multimedia component within England's Historic Seascapes Liverpool Bay and Fylde Pilot Project offers a deeper, closer and illustrative insight to the characterisation of the historic environment for marine and intertidal zones. The .HTML offline pages were generated using the software Rapidweaver. The videos included in this multi-media package were edited using the programme iMovie. 360º panorama images were generated utilising ArcSoft Panorama Maker 3.0.

3. APPROACHES TO SEASCAPE CHARACTERISATION

The methodological development, trialling of different approaches, and the detailed philosophical approach to characterising coastal and marine historic landscapes are described in the main report for the project (**WA ref. 58370.06**). In this section, the 'multi-mode' approach is described, which is the approach pursued by WA for extensive trailing (see 'Flow Diagram' on p16).

The 'multi-mode' approach is where attributes and terms are initially undecided. The creation of themed mapping is undertaken utilising the power of GIS to query and undertake spatial analysis to generate the final data structure and mapping.

3.1. ATTRIBUTE ANALYSIS AND CHARACTER AREA ANALYSIS

During the analysis of common data structures (i.e. tables, attributes and terms) amongst more recent terrestrial HLC initiatives, WA's review identified two levels of characterisation, referred to hereafter as 'Character Analysis' and 'Character Area Analysis'.

The 'Character Analysis' level represents an analysis of landscape or seascape feature (e.g. field boundary patterns and human usage of individual parcels of land) and included three groupings of attributes:

- Observations of features (e.g. morphology, settlement pattern)
- Interpretation (e.g. origin of landscape features linked to an historic period or specific edition of mapping)
- System Administrative (e.g. unique identification number for polygon, recorder's identity)

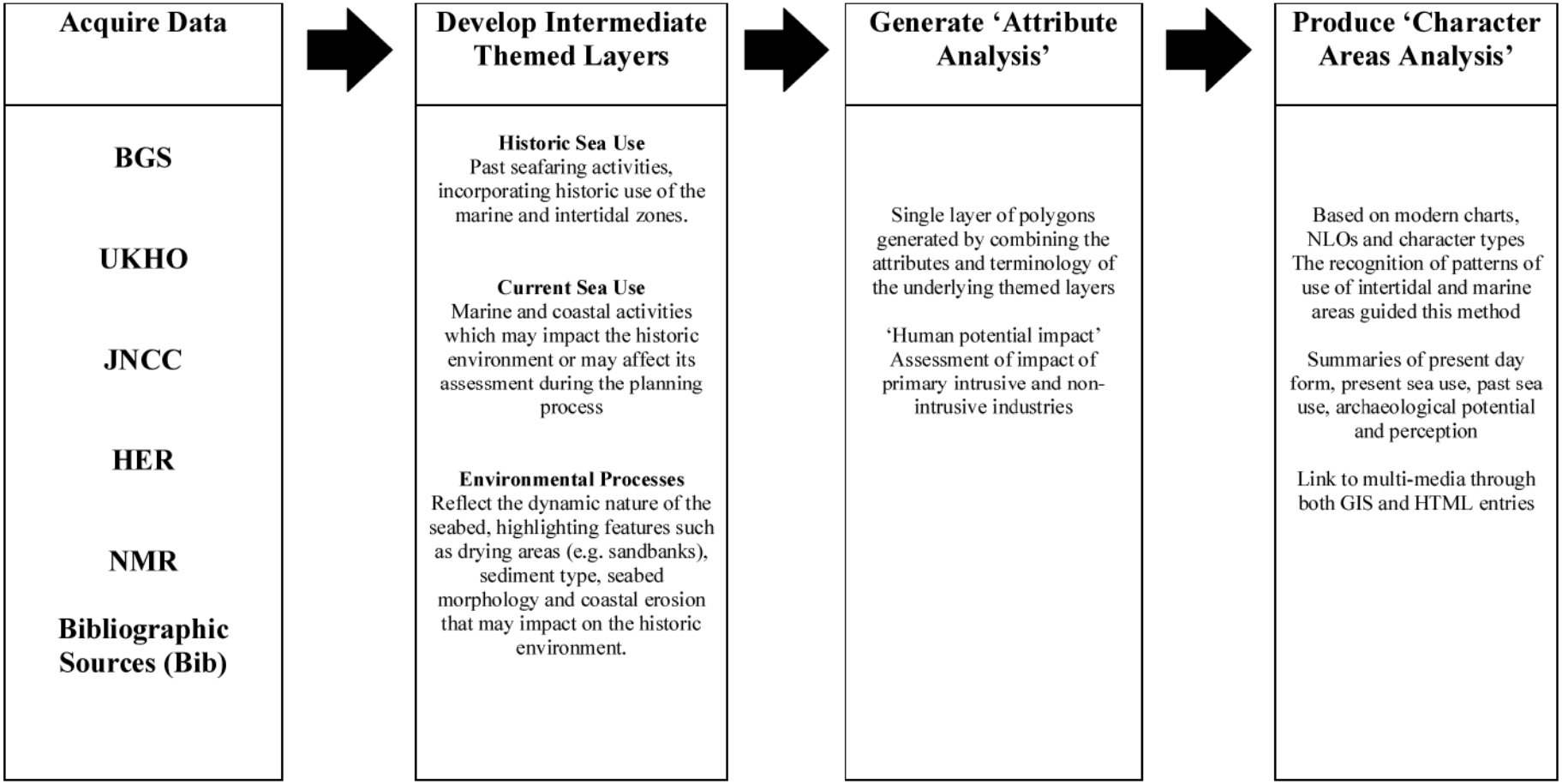
For example, if we consider the feature 'active historic channel' at the entrance of the Mersey, we can observe the following features:

- Sediment: sand (marine sediment)
- Morphology: variable seabed, subdued slopes
- Habitat: fine sediment plains
- Location: marine

An example of interpretation is the consideration of 'period'. The seabed was last exposed as dry land during the Neolithic, hence we can hypothesise that there is potential for archaeological remains from that period.

The 'Character Area Analysis' represents an amalgam of 'Character Analysis' level polygons with similar characteristics, incorporated in a descriptive text and relevant illustrative examples of multimedia with an estimation of the human potential impact of large-scale development.

Flow diagram of the 'Multi-mode' approach to creating marine and intertidal HLC



3.2. METHODOLOGICAL PRACTICALITIES

Many of the datasets obtained for England's Historic Seascapes have required processing, cleaning and formatting to make them usable resources. The methodology described below outlines the general approach adopted by WA to format individual datasets to generate attributes and to control terminology.

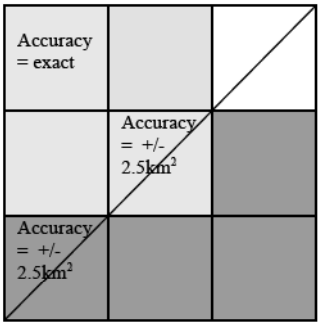
External data has been provided in different formats including vector data (points, polygons and polylines) and raster data (images in .TIFF, .JPG, .GIF, .BMP and .PNG file extensions). Each dataset has been approached as an independent entity in order to convert it to a format that is compatible with other datasets and which retains the attributes required during the characterisation process.

In some cases, datasets were subdivided to highlight the difference between the data types. For example, NMR documentary shipwreck losses with only general places of loss were separated from the known or precisely located known wreck sites with accurate coordinates and casualties.

Where necessary, data plotted as points was processed to convert the representation of points into polygons. Hence, it can later be combined with other polygon vector layers. The attributes provided with the external datasets used have been edited to reduce the dataset to the components needed for characterisation.

A vector grid system was utilised to process the environmental datasets such as BGS Seabed Sediments and the model of coastal change (1 grid square = $5km^2$). Sampling trials suggested that a grid of large resolution ($>5km^2$) made the spatial definition of the data largely meaningless, whilst a grid of smaller resolution ($<5km^{2)}$ might suggest an accuracy that was unwarranted given the summary nature of the data. These gridded layers could then be combined by joining the data by location to produce a layer where each grid cell contains the data of the layers combined.

The accuracy of the grid can be exact (where the whole area of the grid square coincides with a single value in the underlying dataset). However, where the boundaries between two or more polygons in the underlying data source are encompassed by a grid square, a decision has to be made by the compiler with regard to which is predominant. This is value which is then assigned for that particular attribute attached to the grid square. Hence the accuracy can vary as much as 2.5 km^2 (or half the total area of the square).



	$5km^2$ grid square overlying a dataset which features a boundary between two potential 'character types' for one attribute, i.e. light grey and dark grey
	'Character' of grid square manually attributed to what is judged to be the dominant 'character type', i.e. light grey. Hence dark grey loses $2.5km^2$ of its total area
	'Character' of grid square manually attributed to what is judged to be the dominant 'character type' i.e. dark grey. Hence light grey loses $2.5km^2$ of its total area

Data was divided into three themes:

- Historic Sea Use
- Modern Sea Use
- Environmental Processes

By combining the layers one at a time, WA could maintain the visual identification of trends and hence the process contributed to the interpretation of character areas.

The following table outlines the grouping of the intermediate themed mapping.

Historic Sea Use	Maritime features Historic anchorages Historic Channels Quarantine grounds NMR monument data NLO polygons Terrestrial HER data Terrestrial HLC
Modern Sea Use	Modern channels Industry Mariculture Modern Fisheries Recreation and settlement Shipwrecks and Obstructions
Environmental Processes	Palaeoenvironmental data Historic Drying areas and sandbanks Modern drying areas and sandbanks Geological data (solid and seabed sediment) Bathymetry Ecological data (natural habitats) Marine habitats Coastal geomorphology

Following the *Guidelines for English Heritage Projects involving* GIS, the attributes names are in capital letters, no spaces were used, underscore was used instead. ArcGIS imposes a character limit on attribute names, hence some names have been shortened (the abbreviations are explained within the metadata below). No alias' were used.

3.2.1. EVIDENCE FOR HISTORIC SEA USE

Several potentially useful datasets for historic sea use were identified from a review of historic charts, including anchorages, natural and maintained shipping channels, and maritime coastal monuments. An extensive programme of digitisation was undertaken to harness information about these features from individual charts. The data type for each chart was recorded separately to maintain its flexibility during later phases of data processing.

Maritime Features 1st Edition OS

The attributes associated with maritime features were recorded from 1st Edition OS maps.

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
SEASCAPE: broad description or character type referring to, for example, whether the feature is related to navigation, industry, recreation, etc
FEATURE_TY: feature type e.g. dock, buoy, landmark, etc
FEATURE_NA: feature name refers to the placename associated with the feature type if known
MAP_REF: map reference where the data was recorded from

Historic Anchorages

Anchorages were initially mapped as points on historic charts, although they represent an area of activity. The data was converted to polygons to reflect the role of anchorages as areas of maritime activity and to prepare the data for querying with other vector polygons. The centre points of the anchorages were digitised and a 500m buffer was created utilising the buffer option in the Editor tool.

The attributes associated with the historic anchorages layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
POLY_TYPE: type of polygon, in this case anchorage
PERIOD: represented by the centuries during which the anchorage was in use (generated from chart edition date)
CHART_DATE: chart date or reference where the data was obtained from since historic charts have been organised per date as reference
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Historic Channels

Shipping channels are named on historic charts although their limits, if defined, tend to be roughly demarcated by buoyage rather than by continuous lines. The dynamic nature of the seabed means that these shipping channels move spatially and, in some cases, fall out of use altogether (e.g. when they can no longer cater for larger, more modern ships). They have therefore been digitised for each chart by chart date so they can later be summarised as areas taking into account spatial change and period of use.

The attributes associated with historic channels layer are as follows:

OBJECTID: default number generated by GIS

SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
POLY_TYPE: type of polygon, in this case historical channels
PERIOD: representing the centuries during which the channel was in use (generated from the chart edition date).
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Quarantine Grounds

Quarantine grounds are anchorages where vessels coming from foreign ports and suspected of carrying disease can be isolated. A quarantine ground was identified on the lower Mersey. This quarantine ground was mapped as a point. The point was then converted to polygons to reflect the role of quarantine grounds as anchorages/areas of maritime activity and to prepare the data for querying with other vector polygons. A 500m buffer was created around the digitised centre point of the quarantine ground, utilising the buffer option in the Editor tool.

The attributes associated with the quarantine grounds layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
FEATURE_TY: feature type, in this case quarantine area
PERIOD: represented by centuries the quarantine ground was in use (generated from chart edition date). In this case, 19th century since the data was recorded from a historic chart dated 1875.
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

NMR Monument data

NMR monument dataset was provided as a single digital point layer containing both terrestrial and maritime point data. In the first instance, the data was queried to extract the maritime monuments. The attributes of the data were then cleaned to remove any information that was not necessary for the characterisation process and to format the attributes. This data was reviewed with SeaZone wreck data to identify and remove any duplicates before combining them as a single layer.

NMR terrestrial and maritime features were selected from the original dataset. The fields contained in this dataset have not been modified. Terrestrial and maritime features were selected by using the 'select by location' tool and copied into a new layer.

Since the attribute list for NMR records is extensive, only the most relevant attributes for characterisation are shown below:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
GDO_GID
PREFIX
ID_NUMBER
VERSION
MARITIME / TERRESTRIAL
NAME
SUMMARY
PARENT_UID
COORDINATE
MON_PREUD
CURRENT_BA
CURRENT_CA
X_VALUE
Y_VALUE
SOURCE

Named Location Casualty Records

The inclusion of documentary reference to ship losses in the marine and intertidal zones enhances the assessment of information concerning the archaeological potential of an area. The NMR defines 'casualties' as records of shipping losses where there is no corresponding evidence from hydrographic survey or diver inspection of an actual shipwreck surviving on the seabed.

'Named Locations' are a recording practice developed by the NMR to allow historical references to shipping losses to be incorporated into the Maritime Record. These losses are attributed to a nominal point or polygon on a chart or map generated to represent the presumed place or area of loss. This centre point co-ordinate/polygon is given the designation 'Named Location' or 'NLO' as its precision qualifier and usually a topographic name such as 'Burbo Bank' or 'Off Formby'. The same centre point co-ordinate/polygon is then associated again and again with other casualties which give the same area/feature as their location of their loss.

For example, a typical NLO record might contain the following information: '*Pikovaya Dama*, Russian Brigantine, Master Korolev, sank off Formby in heavy swell, Lancashire, carrying a cargo of gin and cotton, 1756. All the crew were saved'. From this information, the only inference that can be made is that the vessel could be anywhere off Formby coast. As a consequence the shipping loss would be assigned to the NLO 'Off Formby' to illustrate that archaeological evidence for the wreck may remain in the general vicinity of the Formby Channel and Formby Point.

NLOs were included as a data source in the characterisation project as they give some indication of the potential for undiscovered vessel remains in the study area. NLOs take their names mostly from topographic features such as sandbanks. Unfortunately,

the NMR data did not include the position qualifier attribute giving the name of the NLO and hence the name of the topographic feature in general that it represents. The data only included a polygon buffer around the centre point co-ordinate. It was therefore necessary to review the casualties assigned to the NLO to access the most likely name of the NLO.

The second step in adapting NMR NLOs for use in characterisation required a review of the name of NLO and its location. For example, does the name 'Wallasey' and the location of the Wallasey polygon accurately illustrate the descriptions of losses of the casualties attached the NLO? Do the casualty records mostly refer to a feature that can be represented by a new polygon?

Where discrete features like sandbanks have been identified as topographic features represented by the NLO, it is necessary to decide how to represent them within a polygon. Finding the edge of such features is often difficult as they are represented on charts by isobath bathymetric contours. Whilst care was taken not to replicate contours in the digitisation process, in a few cases contours were used as an approximate guide to extents. Using this technique, polygons with a direct relationship to the feature named in the NLO record were created for most of the inshore areas of the study area.

For example, there are sandbanks at the mouth of the Mersey represented on the chart as one large bank named Great Burbo Bank. However, the bathymetry shows that there is an extensive area of shallow water around this bank and upon further examination of the area, features marked as Great Burbo Flats and Little Burbo are recorded. The NLO records for this area mostly refer to Burbo, or Burbo Bank or Burbo Banks. This indicates that there may have been confusion when the loss was recorded as to what part of Burbo it refers to. In addition, it raises the possibility that errors may have been made in allocating the loss to a particular NLO. To reflect this uncertainty, a decision was made incorporating all of these features into one polygon named 'Burbo Bank'.

NLOs also include references to areas where there are no easily distinguishable topographic features, for example 'Liverpool Bay', 'Off the Lancashire Coast' and 'Off Southport'.

To represent the uncertainty of these NLOs records, large buffers of 10km and 20km diameter centred on the centre point co-ordinates were created using the buffer option in the Editor tool. The study area polygon was used to erase the parts of these buffers that lay over the land using the ET Geo Wizard 'erase' tool (http://www.ian-ko.com/ET_GeoWizards/gw_register.htm), so that they fit exactly against the coastline. This made it possible to create large polygons for NLOs like 'Blackpool' and 'Lytham' that extended into inshore waters. So although these polygons do not follow any natural features, they do perhaps provide a better representation of the possible areas of loss (e.g. the original polygons for NLOs, such as Blackpool, were located on land).

The resulting NLO polygons are abutting and compiled to form a continuous layer, with no overlaps. The attribute tables of these polygons could then be edited to

include data such as polygon name, a unique ID number and, if appropriate, the number of casualties the polygon was supposed to represent.

Therefore, attributes contained in the NLO polygon layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
NAME: name of the NLO area obtained from NMR original dataset
CASUALTIES: number of casualties contained in that area
EARLIEST_D: earliest date of recorded casualty
LATEST_DAT: latest date of recorded casualty
SHAPE_LENGTH: auto-generated by GIS; unit in m
SHAPE_AREA: auto-generated by GIS; unit in square m

Terrestrial HER Data

HER records were obtained from Lancashire and Cheshire County Councils and Merseyside Archaeological Services from the data structure of Historic Buildings and Site Monument Records (HBSMR) software developed by ExeGesIS. These records were cross-referenced with NMR terrestrial records to remove duplicates.

HER records were reviewed to identify sites and monuments in the 2km terrestrial buffer zone of the project area. The aim was to obtain archaeological evidence of settlements and activities that may have a bearing on the final attributes to be included in the intertidal and marine zone character areas. The data was also used to assess the archaeological potential of the coastal area and trace its time-depth.

Terrestrial NMR records were first separated from the maritime records using the ArcMap 'select by attributes' function. These were then saved as a separate NMR Maritime and Terrestrial shapefiles in the GIS, with both sets retaining their original attributes. Terrestrial data has been cleaned so the attributes remaining provide information on the monument type, period, listing, NMR ID and HER ID.

Terrestrial Historic Landscape Characterisation

Copies of the terrestrial HLCs datasets from Lancashire, Merseyside and Cheshire were obtained. The polygons within the Liverpool Bay and Fylde pilot 2km coastal buffer were reviewed to provide an initial guide to the size and shape that Seascapes polygons might take, and also to gauge the best way to create the join the terrestrial, intertidal and marine HLC polygons.

Where possible, WA has used the coastal character areas already created. The attributes associated with these shapes were altered to reflect the Seascapes data structure, yet retaining the HLC unique identifier (populating HLC_Ref) and HLC character type (populating ‘Sub Char’).

3.2.2. EVIDENCE FOR MODERN SEA USE

Modern Channels

Modern charts were used to gather information about channels, drying areas, navigational beacons, anchorages and fisheries. The same methodology followed for digitising historic maps and charts was applied to digitise modern features.

For example, modern channels were digitised from modern charts and the attributes associated with this layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
SEASCAPE: broad definition such as navigation
POLY_TYPE: type of polygon, in this case modern channel
PERIOD: representing the centuries during which the channel was in use (generated from the chart edition date)
MAP_REF: map reference
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Industry

SeaZone digital chart data provided many details of modern sea use such as spoil grounds, dredging and oil and gas installations. Other sources include JNCC data which includes information on relative fishing intensity, dredge disposal sites, and coast protection structures. These sources are summarised below:

Data	Format	Location	Status
Dredge disposal sites	Convert data and import to ArcGIS 8	DEFRA	Received from JNCC
Coastal development	Compiled through contract with BMT Cordah	Data sourced from JNCC Coastal Directories and Centre for Environment, Fisheries and Aquaculture Science (CEFAS)	Received from JNCC
Conservation Areas	GIS Geodatabase	SeaZone	Received from SeaZone
Offshore Developments	GIS Geodatabase	SeaZone	Received from SeaZone
Marine Aggregate Extraction Licence Areas	GIS Geodatabase	SeaZone	Received from SeaZone
Marine Aggregate Extraction Licence Areas Active Areas	Paper List	Crown Estate/BMAPA	BMAPA website (updated over the project's duration)

Note: the establishment of 'label' terms in the hierarchical relationship between 'Sub-Char', 'Char_Type' and 'Broad_Char' contributed to identifying whether the industry was intrusive or non-intrusive in the final characterisation layer.

In the creation of the offshore industry layer, data was copied directly from SeaZone.

The attributes of this layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
LABEL: defined by SeaZone
IND_TYPE: related to type of industry (e.g. gas field, dumping ground, etc.)
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Note: there are licencing and copyright constraints associated with this data layer.

Note: information with regard to commercial or primary shipping routes was collated from JNCC Irish Sea Pilot and local sailing directions. These were compared to routes defined for England's Historic Shipping Project and incorporated manually by sub-dividing polygons after initial population.

Note: the definition of coastal industries which extended above the MHW was driven by the data provided by neighbouring terrestrial HLC projects.

Mariculture

The term 'mariculture' is associated with fish farming, oyster beds, mussel scalps and cockling where the beds are 'seeded' and 'cultivated' with young mussels/oysters which are managed over several seasons until they are big enough to harvest. 'Fish traps' are more related to a form of 'fishing' but they have been included by WA under this heading.

Data was digitised from modern maps as lines. They were then converted into polygons using a 100m buffer utilising the buffer option in the Editor tool. These polygons were then integrated into the industry polygon layer since they offer valuable information in relation to fishing and cockling industries.

The attributes associated with mariculture layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
SEASCAPE: broad description or character type it refers to, in this case maritime culture
POLY_TYPE: type of polyline, in this case fish traps
POLY_NAME: name of the poly_type if known
PERIOD: represented by centuries according to the chart date where the data was obtained from

MAP_REF: chart number and edition
SHAPE_LENGTH: auto-generated by GIS; unit in metres

Modern Fisheries

Data related to modern fisheries obtained from JNCC was at a scale or resolution for the Irish Sea as a whole.

The attributes in the modern fisheries layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
IND_TYPE: industry type
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Note: The JNCC, reflecting the scale of the Irish Sea Pilot, class the whole of the Liverpool Bay area simply as 'modern fisheries'.

Recreation and Settlement

The polygons attributed to recreation and coastal settlement were queried/extracted from the terrestrial HLC data supplied by Cheshire, Lancashire and Merseyside. The querying process was undertaken using the selection tool 'select by attribute'. This data was used to populate the sub-character attribute in the 'near level' polygon layer. Hence, WA retained continuity of interpretation from terrestrial HLC projects for the 2km buffer zone within England's Historic Seascapes.

The attributes represented in the coastal recreation and settlement layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
TYPE: general description (e.g. settlement or recreation)
SUB_TYPE: more specific description (e.g. marine lake, post-medieval fields, etc)
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Shipwreck and Obstruction Data

Data on wrecks and obstructions are sourced from UKHO wreck and obstruction digital dataset provided by SeaZone Solutions Ltd and from NMR maritime monument data as well as from secondary bibliographic sources.

The wrecks and obstructions dataset provided by SeaZone was cleaned to remove fields from the attributes that were not relevant to the characterisation. The wrecks and obstructions were queried separately to show the densities of DEAD, LIVE and LIFT wrecks. Ultimately, only LIVE wrecks and obstructions were added into the final polygon layer because they provide relevant data to assess the archaeological

potential of the area as well as for management purposes. The selected data was then saved into a separate layer.

Note: there are licencing and copyright constraints associated with this data.

3.2.3. ENVIRONMENTAL DATASETS

A wide variety of environmental data was identified during the review of historic and modern charts, which are exemplified below.

Paleoenvironmental data

Historic charts were found to represent one of the primary sources of mapped palaeoenvironmental data for the intertidal zone in that exposed peat deposits were shown. Historic peat exposures were digitised as a separate layer noting the source chart edition and date. This layer was reviewed in conjunction with palaeoenvironmental data from secondary sources.

The attributes of the palaeoenvironmental attributes are represented as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
POLY_TYPE: feature type (e.g. peat bed, prehistoric footprints, etc)
CHART_DATE: chart edition date
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Historic Drying Areas or Sandbanks

The seabed environment within the Mersey Basin is known to be extremely dynamic. Historic charts show the detail of drying areas or sandbanks as surveyed at the time the chart was produced. Drying areas of each chart were digitised, and copied and pasted into a single layer. These were then dissolved to produce a layer called historic drying areas. This layer provides an overall layer showing historic unstable seabed areas inshore.
The attributes recorded for this layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
POLY_TYPE: type of polygon, in this case historical drying area
PERIOD: representing the century encompassing the chart edition date
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Note: care was taken to not digitise bathymetric contours as a basis for defining channels to ensure the intermediate themed mapping layer was sufficiently derived from the original chart source.

Modern Drying Areas or Sandbanks

Modern drying areas were also digitised from modern Admiralty charts following the same procedure used for historic drying areas.

The attributes associated with this layer are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
SEASCAPE: broad description it refers to, in this case navigational hazard
POLY_TYPE: type of polygon, in this case historical drying area
MAP_REF: Admiralty chart number
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

Note: care was taken to not digitise bathymetric contours as a basis for defining channels to ensure the intermediate themed mapping layer was sufficiently derived from the original chart source.

Note: there are licencing and copyright constraints associated with this data.

Geological Data

Solid geology and seabed sediment data was acquired from BGS and loaded into the GIS project. BGS data has been used as baseline environmental data to obtain information on the material components of the seabed. Sediment data is relevant to assessments of potential preservation state. For example, clay sediments will offer an anaerobic environment (lack of oxygen) which facilitates the preservation of organic archaeological remains.

The primary attribute of interest is associated with seabed sediment data is the field called ROCK_D which defines the type of sediment.

Note: there are licencing and copyright constraints associated with this data.

Bathymetry

Bathymetry was acquired from SeaZone Solutions Ltd to gain an overall record of water depth. The data was provided in three qualities of resolution as reflected in available paper charts for the study area (SeaZone chart scales E_Coastal = 1:50,000, F_Approaches = 1:15,000 and G_Harbour = 1:5,000). The data provided water depth polygons and sounding points.

Note: there are licencing and copyright constraints associated with this data.

Ecological Data

The ecological datasets sourced and requested are as follows:

Data	Format	Location	Status
Natural Habitats	GIS shapefiles	English Nature (EN)	Received from EN
Seabed slope	Created by JNCC from BGS digital bathymetry	JNCC	Received from JNCC
Protected sites	Imported from other GIS. Conservation objectives will be added	JNCC and country agencies	Received from JNCC (download from www.jncc.gov.uk)
Fishery closed areas	Digitised from co-ordinates and imported into ArcGIS 8 (CEFAS)	UK Government	Received from JNCC
Marine habitats /landscapes	Hard copy (Irish Sea Pilot Project)	JNCC	Received from JNCC
Coastal morphology	Digital	FutureCoast CD	CD of data available for the updating of shoreline management plans distributed by DEFRA.

This ecological data was used to identify the physical character of an area, and also to correlate particular marine habitats with human activities. For example, in the Irish Sea the most productive fisheries are found in association with the fine sediment plains; (Golding et al 2004; Vincent et al 2004). This type of data can therefore provide an extra tool to assess potential human impact on the marine and intertidal zones.

Geomorphology

Coastal morphology and stability information was obtained from the FutureCOAST CD. This data was extracted and copied into a new polygon layer and used in conjunction with information on drying areas to explore the relative stability of the environment. The terminology used by FutureCOAST was maintained from the original dataset.

The attributes in this dataset are as follows:

OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
GEOMORPH_B (e.g. dune, lowland, cliff)
GEOMORPH_F (e.g. sand, mud/clay, rock)
FUT_CHANGE: scale relating to the magnitude of potential erosion processes
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

4 GIS APPROACH TO CHARACTERISATION.

The following sections provide an overview of the steps taken in the construction of the final, seamless, 'attribute analysis' layer containing the characterisation information for the study area. The workflow presented should provide the reader with a framework for understanding the process and enable the methodological approach to be applied elsewhere.

The stages are presented as generic GIS processes which can be adopted across both hardware and software platforms and not restricted to ESRI software products. It is assumed that the reader is familiar with GIS practices, software and terminology and a working knowledge of coordinate systems and transformations.

4.1 GIS WORKFLOW

All spatial features and attribute data have been stored in a personal geodatabase (GDB). This has the advantage of holding all the spatial data in a single location but also adds additional processing capabilities that have been utilised during the project, such as the application of topological rules to maintain a seamless polygon layer.

STEP 1 – DATA INTEGRITY

Prior to data processing and/or capture, all sources require checking to ensure that they have the same coordinate system and projection and units. These should be agreed in early project phases and clearly stated.

The spatial reference and domain extent of the GDB were set for British National Grid. All digitisation was carried out in British National Grid and all received digital data, where necessary, was either transformed or projected to this prior to processing.

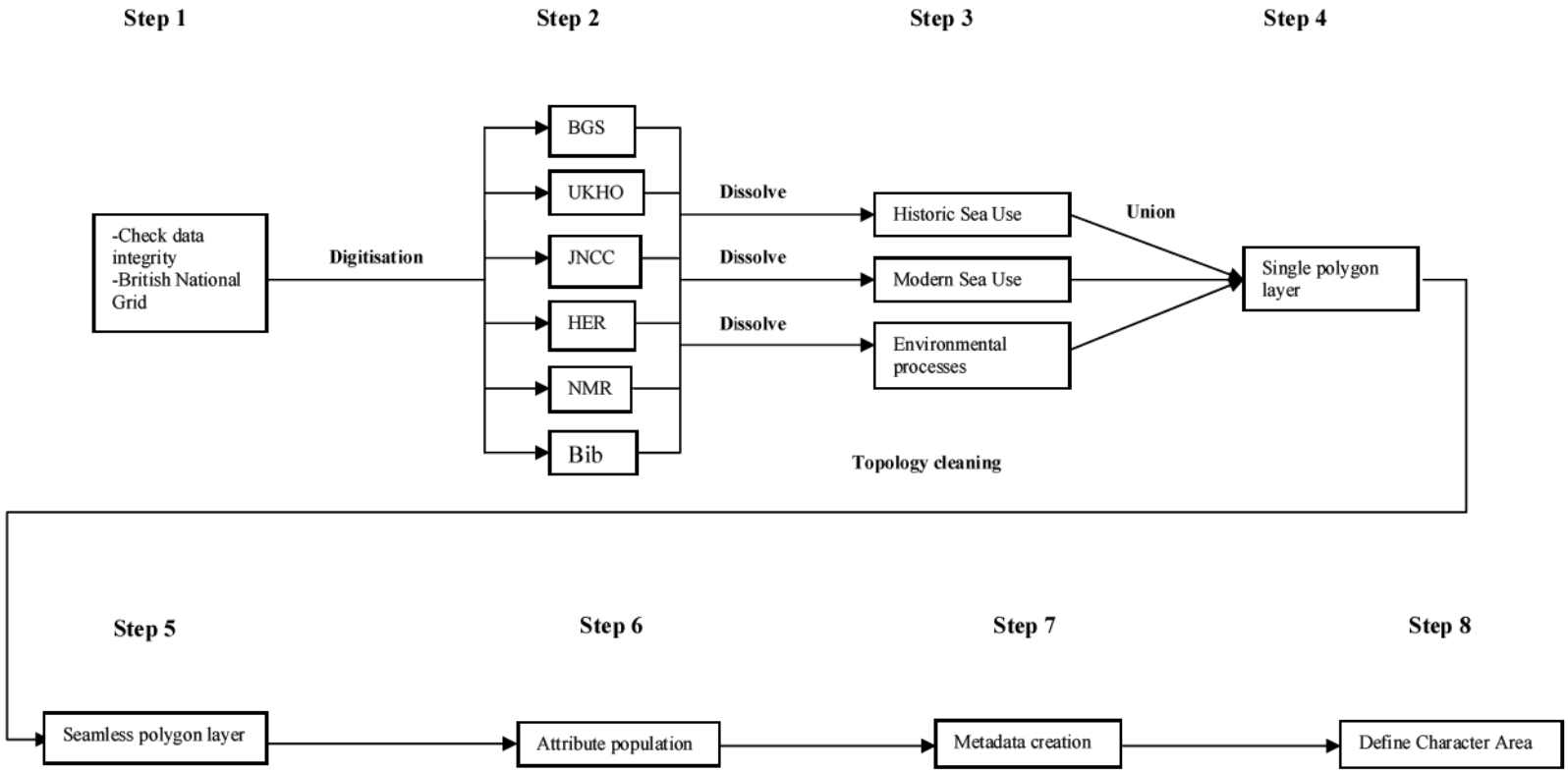
STEP 2 – DATA CAPTURE

Heads-up digitisation of hardcopy maps was carried out at 1:25,000. Digital data sources acquired externally, or captured through the digitisation process in point or line format, were converted to polygonal format through a process of buffering or identifying spatial extent of features from base mapping. Details of this are presented in Section 3.2.

A 5km^2 polygon grid was used to sample proprietary data sets for Geological Data and Modern Fisheries data where no other character polygons could be generated. This area was predominantly located offshore to the north of the Seascapes Pilot area.

Data capture was undertaken under three theme headings; Historic Sea Use, Modern Sea Use and Environmental Processes (as presented in section 3.2).

Simple GIS workflow model for England's Historic Seascapes Liverpool Bay and Fylde Pilot Project



STEP 3 – COMBINING DATA SETS

Captured data was combined into the three themed data sets, described in Stage 2, using the GIS 'Dissolve' function. The dissolve function removes boundaries between adjacent polygons having the same value for a specific attribute. This process removed polygonal overlaps within themes.

STEP 4 – DATA UNION

The three themed polygonal data sets were merged together using the GIS 'Union' function. The union function is a topological overlay of two polygonal spatial datasets which preserves features from both coverages, both feature geometry and attributes.

STEP 5 – POLYGON CLEANING

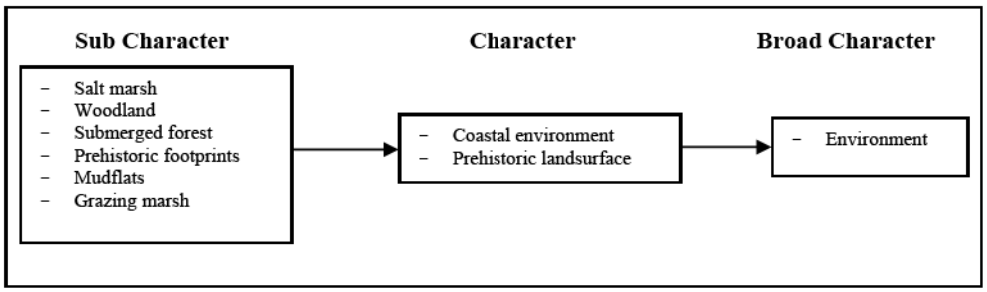
The union function will generate a single polygonal 'layer' that has attributes for all the component data sets. However, due to variation in the base data and the disparate data sources utilised, this layer will require cleaning. This has been achieved by applying topological rules defined as 'No Overlaps' and 'No Gaps'. A cluster tolerance, also known as fuzzy tolerance, of 5m has been applied during this process meaning that boundaries within this distance would automatically be snapped together. Areas which do not conform to the topological rules, and are outside the cluster tolerance, are identified and manually corrected.

STEP 6 – ATTRIBUTE POPULATION

The attribute fields were populated by means of an attribute query. The table below outlines the intermediate mapping source for the final layer of polygons.

Attribute	Population method
HLC_ref	Auto populated from terrestrial HLC attributes
Broad_character	Auto populated by character_type_1 via database
character_type	Auto populated by character_type_2 via database
HLC_character_type	Auto populated from terrestrial HLC attributes
Primary_Intrusive_industry	Auto populated from industry map
NLO_area	Auto populated from NLO map
Sediment	Auto populated using BGS
Morphology	Auto populated using a morphology map
Tidal_range	Auto populated using a tidal range map
Sea-level_exposure	Auto populated from map produced from sea-level model
Location	Auto populated from location map

The Sub Character types attribute was populated manually based upon the source data sets employed as part of the Seascapes project. The Broad Character Type and Character Type attribute fields were populated by means of a two stage attribute query. Firstly, features were selected based upon the Sub Character type then the attribute fields for Broad Character and Character Type were auto-filled. This process is outlined below.



After completion of the initial population, character maps based on each attribute were displayed, visually checked and corrections made where needed.

STEP 7 – METADATA

WA reviewed EH's guidelines for GIS metadata and, in consultation with EH, established that the ISO metadata editor integrated in ESRI ArcGIS 9.0 should be used to record Seascapes metadata. EH specify that metadata should conform to the UKGEMINI standard which is itself based upon ISO 19115.

An example of the metadata generated for one of the intermediate themed mapping layers is presented below:

NLO_polygons

Data format: Personal GeoDatabase Feature Class

Coordinate system: British_National_Grid

Location: file://\\Mciserver\Wessex\Projects\58370 seascapes\GIS\Final_product_Nov2005\Geodatabase\Seascapes_final_geodatabase.mdb

Abstract: Polygons drawn converting NLO points to a polygonised representation of casualty losses. The casualties losses data was obtained from the NMR. Polygons were based on features, mainly sandbanks, with similar location names. Several NLO points sometimes were included within one polygon. This method was very subjective when drawing the polygons but it has given an idea of casualties (and potential wrecks) in a specific area. Application: reference and attribute population Source: NMR (casualties losses point data)

Metadata Information

*__Metadata language:__ English
*__Metadata character set:__ utf8 - 8 bit UCS Transfer Format

*__Last update:__ 20051114

__Metadata contact:__
__Individual's name:__ Dr Virginia Dellino-Musgrave
__Organization's name:__ Wessex Archaeology
__Contact's role:__ originator

*__Scope of the data described by the metadata:__ dataset
*__Scope name:__ dataset

*__Name of the metadata standard used:__ ISO 19115 Geographic Information - Metadata
*__Version of the metadata standard:__ DIS_ESRI1.0

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Resource Identification Information:

Citation:

*__Title:__ NLO_polygons

Reference date:

__Date:__ 200507
__Type of date:__ creation

*__Presentation format:__ digital map

Party responsible for the resource:

__Individual's name:__ English Heritage
__Organization's name:__ English Heritage
__Contact's role:__ owner

Themes or categories of the resource: society

Abstract:

Polygons drawn converting NLO points to a polygonised representation of casualty losses. The casualties losses data was obtained from the NMR. Polygons were based on features, mainly sandbanks, with similar location names. Several NLO points sometimes were included within one polygon. This method was very subjective when drawing the polygons but it has given an idea of casualties (and potential wrecks) in a specific area.
Application: reference and attribute population
Source: NMR (casualties losses point data)

*__Dataset language:__ English

Resource constraints:

Legal constraints:

__Access constraints:__ copyright, other restrictions

__Use constraints:__ copyright, other restrictions

__Other constraints:__

Copyright under Englsih Heritage

*__Spatial representation type:__ vector

*__Processing environment:__ Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.0.0.535

Resource's bounding rectangle:

*__Extent type:__ Full extent in decimal degrees
*__Extent contains the resource:__ Yes
*__West longitude:__ -3.565997
*__East longitude:__ -2.574075
*__North latitude:__ 53.926515
*__South latitude:__ 53.257457

Other extent information:

Geographic extent:

Bounding rectangle:

*__Extent type:__ Full extent in the data's coordinate system
*__Extent contains the resource:__ Yes
*__West longitude:__ 297161.16359
*__East longitude:__ 361714.69901
*__North latitude:__ 447999.99764
*__South latitude:__ 374523.246084

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Spatial Representation - Vector:

*Level of topology for this dataset: geometry only
Geometric objects:
*Name: NLO_polygons
*Object type: complexes
*Object count: 37

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Reference System Information:

Reference system identifier:
*Value: British_National_Grid

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Data Quality Information:

Scope of quality information:
Level of the data: dataset

Lineage:
Lineage statement:
The fields contained in this feature class are as follows:
OBJECTID: default number generated by GIS
SHAPE: auto-generated by GIS (information in relation to whether it is a polygon, polyline or point)
NAME: name of the NLO area obtained from NMR original dataset
CASUALTIES: number of casualties contained in that area
EARLIEST_D: earliest date of recorded casualty
LATEST_DAT: latest date of recorded casualty
SHAPE_LENGTH: auto-generated by GIS; unit in metres
SHAPE_AREA: auto-generated by GIS; unit in square metres

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Distribution Information:

Distributor:
Contact information:
Individual's name: English Heritage
Organization's name: English Heritage
Contact's role: distributor

Available format:
*Format name: Personal GeoDatabase Feature Class
Format version: ESRI-ArcGIS9

Transfer options:
Online source:
*Online location (URL): file://\\Mciserver\Wessex\Projects\58370 seascapes\GIS\Final_product_Nov2005 \Geodatabase\Seascapes_final_geodatabase.mdb
*Connection protocol: Local Area Network
Description: Downloadable Data

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Geoprocessing History:

Process:
***Process name:** Create Feature Class
***Date:** 20050727
***Time:** 091020
***Tool location:** C:\Program Files\ArcGIS\ArcToolbox\Toolboxes\Data Management Tools.tbx\CreateFeatureclass
***Command issued:** CreateFeatureclass "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05\Seascapes_May05.mdb" NLO_polygons # NLO_Polygon_Layer SAME_AS_TEMPLATE SAME_AS_TEMPLATE "PROJCS ['British_National_Grid',GEOGCS['GCS_OSGB_1936',DATUM['D_OSGB_1936',SPHEROID ['Airy_1830',6377563.396,299.3249646]],PRIMEM['Greenwich',0.0],UNIT ['Degree',0.0174532925199433]],PROJECTION['Transverse_Mercator'],PARAMETER ['False_Easting',400000.0],PARAMETER['False_Northing',-100000.0],PARAMETER ['Central_Meridian',-2.0],PARAMETER['Scale_Factor',0.999601272],PARAMETER ['Latitude_Of_Origin',49.0],UNIT['Meter',1.0]];191998.977764 273822.668326 7812.499993;0.000000 100000.000000;0.000000 100000.000000" # 0 0 0 "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05 \Seascapes_May05.mdb\NLO_polygons"

Process:
***Process name:** Append
***Date:** 20050727
***Time:** 091021
***Tool location:** C:\Program Files\ArcGIS\ArcToolbox\Toolboxes\Data Management Tools.tbx\Append
***Command issued:** Append NLO_Polygon_Layer "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05\Seascapes_May05.mdb\NLO_polygons" TEST "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05 \Seascapes_May05.mdb\NLO_polygons"

Process:
***Process name:** FeatureClassToFeatureClass_1
***Date:** 20050727
***Time:** 091022
***Tool location:** C:\Program Files\ArcGIS\ArcToolbox\Toolboxes\Conversion Tools.tbx\FeatureClassToFeatureClass
***Command issued:** FeatureClassToFeatureClass "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05\Brian_NLO\NLO_Polygon.shp" "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05\Seascapes_May05.mdb" NLO_polygons # "METHOD_ID METHOD_ID VISIBLE;NAME NAME VISIBLE;CASUALTIES CASUALTIES VISIBLE;EARLIEST_D EARLIEST_D VISIBLE;LATEST_DAT LATEST_DAT VISIBLE" SAME_AS_TEMPLATE SAME_AS_TEMPLATE # 0 "W:\Projects\58370 seascapes\GIS\Geodatabase_05_05 \Seascapes_May05.mdb\NLO_polygons"

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STEP 8 – CHARACTER AREA DEFINITION

The purpose of the Seascapes 'character area' layer is to summarise and spatially define areas where polygons with similar attributes are found in close spatial

WA have utilised the following principles for the creation of 'character areas':

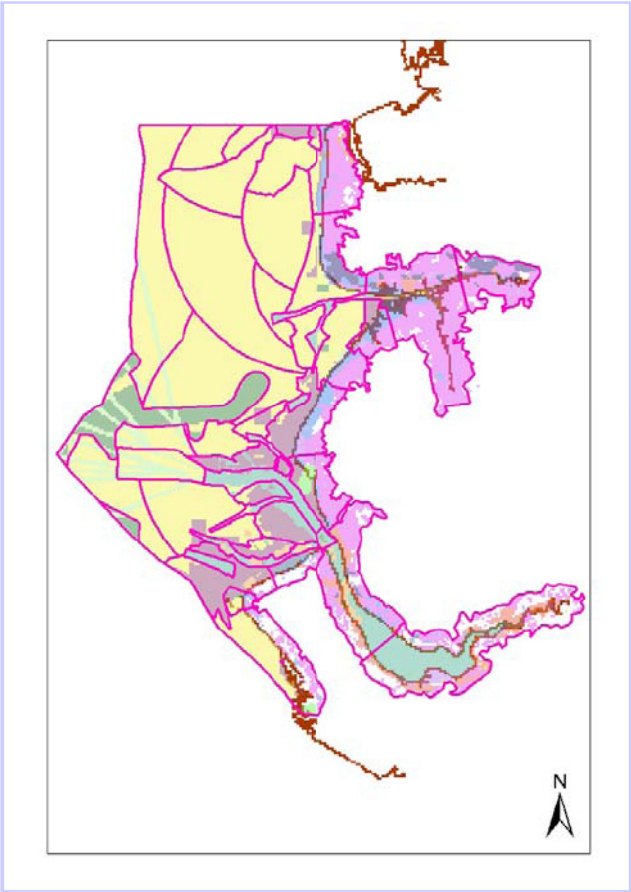
Primary:

- Based on the visual identification of human activity patterns observed on displaying the final attribute analysis polygon layer by 'character type'. Hence, character areas are created from amalgams of 'sub-character' types.

Secondary (where large 'homogenous' offshore areas exist and no other differentiation is possible):

- Place names featured in documentary sources and on modern admiralty charts, such as deeps or fishing grounds;
- Where a place name or natural feature could not be identified, NLOs polygon boundaries have been used.

Forty-three character areas were therefore defined for Liverpool Bay area. The image below illustrates the pink lines that represent the 'character area' polygon layer.



STEP 9 – DEVELOPING THE MULTIMEDIA RESOURCE

The 'character area' polygons were given a hyperlink to an offline HTML page. The pages display the descriptive text, sensitivity analysis and multimedia resources including video footage and interactive 360 degree panoramas. Hyperlinks to images illustrating a particular point discussed in the text were created. Historic images were obtained from the NMR's online photo catalogue (Viewfinder), British Library, Peabody Essex Museum and modern images were taken by WA staff to illustrate particular features of the modern landscape or seascape. The descriptive data for each image has been composed following the NMR online photo collection protocol. A full screen version of the image can also be downloaded from the offline HTML page.

An offline HTML introductory page was developed, including an interactive map, to facilitate the user being able to access the pages as a stand-a-lone application if required.

The descriptive text for each character area was generated using a wide variety of sources, from historic written sources, to point data of recorded losses. To clearly present the information the following headings were devised:

- Present Day Form;
- Sea Use: present;
- Sea Use: past;
- Archaeological Potential;
- Character Perceptions;
- References.

Present Day Form is a short synthesis of the characteristics of the modern sea area. This comprises a description of the water column and topography and composition of the seabed and shore in the area. Major physical characteristics and the primary sea use of the area are also described.

Sea Use: Present discusses what activities are noted to take place in the sea, seabed and shore in the area and any physical marks they leave. This includes recreational, industrial and biological information. Any known activities planned for the future are also mentioned.

Sea Use: Past examines the pattern of maritime activity in earlier periods and discusses what is known about the submerged landscape. When considering the submerged landscape the sea-level change model, created from modern charts and bathymetry, and any existing archaeological data from the area and its surroundings was taken into account.

*Archaeological Potentia*l aims to provide some assessment of the likely survival of any archaeological deposits. This includes a summary of known archaeology usually in the form of wrecks and other maritime debris.

Character Perceptions judges how the area is perceived by the local community, visitors and mariners, and how past sea use has influenced today's perception.

References lists the key sources utilised to generate that descriptive text. In some cases this includes web pages, hyperlinked for the user to access, if online.

The text generated for the North Shore Character Area is shown below.

Character Area: North Shore **WA ID:** 26

Present Day Form

The North Shore character is delineated by the character areas of Rossall Point, Rossall Oyster Grounds and Blackpool to the west and Crusader Bank to the south. The area is represented as both an area of fisheries and mariculture, exemplified by the offshore fishing grounds where plaice is exploited; and as a navigational hazard, exemplified by the sand and mudflats which are historic and modern drying areas. There are also two environmental areas in the form prehistoric land surfaces exemplified by submerged forests and peat deposits in the drying areas in Blackpool and Shell Wharf. The North Shore also has recreational uses, being adjacent to the town of Blackpool and containing popular sandy beaches that run much of the length of the Fylde coast. In addition, the area has substantial areas of coastal settlement with a strong recreational character exemplified by facilities such as boating areas and golf courses. The intertidal area also has a series of coastal defences running from Cleveleys to Fleetwood. The sediment is represented by sand (marine sediment) and the habitat includes fine sediment plains.

The tidal range is large and in nearby Morecambe Bay, the tide can expose up to 100 square miles of drying banks during the ebb. On the flood tide the water surges into the bay extremely rapidly. Tidal currents are predominantly set in a northerly direction during the flood and in a southerly direction on the ebb. The primary losses of sediment are longshore and are wave driven with major movements immediately in front of the coastal defence structures to

30 to 50 metres offshore during storm events (Posner, 2004; 18). Promontories exist on the west-facing frontage at Rossall and Larkholme with the adjacent sections exhibiting higher beach levels. This dynamic tidal system contributes to coastal erosion which shows a marked increase during bad weather periods. There is the potential for archaeological deposits to be exposed through erosion, as a result the situation should be monitored.

The foreshore of the North Shore consists of sandy beaches, which in contrast to the wide expanses of sand and mud banks of the shorelines south of the Ribble are relatively narrow and seldom dry to a height of 3 metres. Much of the shoreline is lined with groynes to halt the removal of the sandy deposits which make the beaches of Blackpool so popular to visitors.

SEA USE: PRESENT

The area is developed, with Blackpool to the south east and Fleetwood to the north east. The sea is used primarily for fishing in the areas furthest from the shore. The Joint Nature Conservation Committee have recorded the area as plaice habitat, and this resource is exploited by boats from the harbour at Fleetwood and from fishing ports along the north east coast as well as from the coast of continental Europe. The fishing fleet at Fleetwood has recently diminished due to the loss of most of its fleet following the Icelandic Cod Wars in the 1970s and the cutbacks in fishing quotas during the 1980s and 1990s (Anon, 2002).

The character area also has a strong recreational aspect with beaches, a sailing area near Blackpool and a golf course near Fleetwood. Cleveleys also offers seaside entertainment with amusement arcades and bingo halls. The town of Fleetwood has suffered damage from tidal floods since its foundation (Curtis, 1986; 109-115). At present there are a series of coastal defences running from Cleveleys to Fleetwood along most of the shoreline of the North Shore area.

The surrounding area also has a navigational use, with three lighthouses situated just outside the character area at Fleetwood. The spires of churches in the built up areas along most of the coastline and the tower at Blackpool also provide useful landmarks for seafarers.

SEA USE: PAST

The North Shore area's current appearance has been shaped by thousands of years of dynamic marine transgressions. The coastline has therefore shifted dramatically since the earliest evidence for human activity. According to bathymetric data and the sea level change model produced from it, this area is likely to have been dry land until the Late Mesolithic period and in some areas into the Neolithic. The coastline had assumed an approximation of its current appearance by the Bronze Age. Before that, the area both intertidal and marine, would have been dry land and exploited by prehistoric settlers. The earliest archaeological evidence from the Lancashire coast dates to the Upper Palaeolithic. Evidence for prehistoric land use in areas that are now coastal zones is discussed in *Archaeological Potential*, below.

Substantial marine traffic between the west coast of Lancashire and the Isle of Man from the Bronze Age onwards is suggested by material culture found on the island (Bowen, 1970; 25-27). This may have been an important trade route in pre and proto-historic times.

There may have been a substantial harbour near the modern town of Fleetwood in pre-Roman times. Ptolemy's Geography lists a Portus Setantiorum at the southern edge of Morecambe Bay. The name suggests it was a seaport controlled or used by the Setantii, a sub-tribe of the powerful Brigantes tribe known to have lived in Lancashire. No archaeological evidence for this port has been found, although it may have existed north of Fleetwood and subsequently became lost to the sea. There is evidence that an important settlement of some sort existed in this part of the Fylde, as the main Roman road from the Ribchester to the coast had an offshoot going north in the direction of Fleetwood (Anon, 2005). There is also the suggestion that a pre-Roman harbour existed at Rossall rather than Fleetwood (Curtis, 1986; 8-11).

There is sparse archaeological evidence for the early Medieval period in the vicinity of the character area. Some place-names in the area are of Anglo-Saxon origin, such as Lytham from the Old English *hlip*, meaning 'slope'. Further north along the coast there are many Scandinavian place-names, but there are none in the immediate vicinity of the character area. It is however likely that the area would have seen Viking marine traffic, given the large influx of Vikings into Lancashire from the Isle of Man in the 10th and 11th centuries, reflected in the frequency of Viking place-names along the coast. The area would have been important for navigation, being part of the main approach to Morecambe Bay and the River Wyre.

The recreational use of the shore by Blackpool is recorded in the 18th century when Blackpool itself did not 'merit the name of a village, because they [its houses] are scattered to the extent of a mile.' (Hutton, 1789; 5). Hutton's 18th century account notes that with the rise of the land at Blackpool the 'principal object is the sea' and that the vessels on the seas surface '..generally from one to six, afford a continual source of amusement' (ibid; 12). Hutton notes that at low tide, the sands of the foreshore at Blackpool are well 'adapted for a gentleman to sport an

equipage' (ibid; 15). Hutton makes an interesting observation of the limitations of the use of this sandy shoreline, noting that 'the water is more barren than the land; it produces but few fish' and that 'sea excursions are but little known, and fishing is not one of the pleasures at Blackpool. From the flatness of the ground no vessel can approach the shore; nay, we cannot enter the smallest boat without wading' (ibid; 16).

The coast of Lancashire was virtually uninhabited at the beginning of the 19th century. Liverpool and Lancaster were the only towns of any importance and between them were scattered just a few villages; Southport, Lytham and Blackpool. Before the development of Blackpool and the founding of Fleetwood it is likely that the sea would only have been exploited by fishermen from the coastal towns and villages.

The 19th century saw the intensification of sea use in the character area with the development of Blackpool as a major centre for recreation. Blackpool's new status as a recreational destination resulted in smaller towns such as Lytham and Cleveleys also promoting themselves as seaside destinations. Fleetwood's foundation would also have had a great impact on the sea use in the character area. Sir Peter Hesketh-Fleetwood originally intended to found a holiday town, but included port facilities to support the town during the winter. Three lighthouses were built, including the Wyre Light, secured in the river entrance using a newly patented system of screw piles (Curtis, 1986; 68). The town rapidly grew into one of the busiest ports in the region and it became the third biggest fishing station in the kingdom during the steam trawler era (Stammers, 1997; 204). Cod, haddock, hake and oyster were exploited from small inshore craft as well as large deep sea steam trawlers. The character area would have seen an enormous amount of marine traffic, from small fishing smacks to large steamers importing goods from all over the world. Construction of a fully equipped dock commenced in 1869 and was finished in 1877 and by 1892 the dock was so busy that one vessel had to leave before another could be admitted (Curtis, 1986; 74). The decline of the port of Fleetwood corresponded with the opening of the Albert Dock at Preston followed by the opening of the Manchester Ship Canal in 1894 (Curtis, 1986; 76).

There was also a military firing range to the North of the area in the late 19th century, the ranges at Rossall Point being very extensive, including four 800 yard ranges and an associated camp, 'the Hutments' (Ede & Darlington, 2002; 6).

Archaeological Potential

There were 24 reported casualties in the North Shore character area between 1701 and 1940. There is one 'live' wreck listed by the UK Hydrographics Office. The barque *Abana*, a Norwegian steam vessel was built in 1874 by the Halyard Brothers at New Brunswick, at the time of its loss it was owned by Llarsen Sunde, in Norway. Travelling from Liverpool, *Abana* was bound for Sapelo in America on the 21st of December 1894 when it was stranded and lost in a south-westerly gale force 11. The *Abana*'s wooden ribs can still be seen 150 yards offshore from Blackpool Promenade.

According to bathymetric data and the sea level change model produced from it, the character area was inundated by the Neolithic period. The earliest evidence for human activity from the Lancashire coast is from nearby Poulton-le-Fylde where an elk skeleton containing barbed points was discovered in lake deposits in a peaty hollow, dating to the Upper Palaeolithic, 10,400 ± 300 BC (Cowell, 1996; 21). The character area may have experienced prehistoric land use during this period and may have been exploited as an intertidal zone in later periods. The character area also includes two areas of submerged prehistoric forest. These peat beds at Rossall and Cleveleys are basal organic deposits from kettle holes (Tooley, 1977; 78).

The historical evidence from Ptolemy's Geography combined with the archaeological evidence of the Roman road directed towards Fleetwood also raises the possibility of a Roman or pre-Roman settlement or port in the area. No evidence for this settlement was reported during the construction of Fleetwood in the 19th century and the settlement, if it exists, could be situated in the intertidal zone. The town of Fleetwood has a history of tidal flooding so a historic port in this area could have been lost to the sea. Any submerged archaeological remains present in this area would be highly susceptible to natural marine dynamics as well as intrusive human activities such as trawling, also performed in the area.

Perceptions

The outer parts of the character area are perceived as a navigational hazard, the sand and mudflats in the intertidal zone having been marked on charts since 1842. There is also a fishing ground in the western part of the area, although local exploitation of this resource has diminished since the setbacks suffered by the Fleetwood fishing fleet. The character area also has areas of environmental interest, exemplified by the submerged forest deposits. Public awareness of palaeo-environmental areas such as these is likely to be heightened since the discovery of prehistoric footprints on the Formby coast. Most of the coastline between the Ribble estuary and Fleetwood also has an emphasis on recreation, with Blackpool, Cleveleys and Fleetwood being popular seaside destinations.

The beaches and towns that run along the inshore part of the North Shore character area are strongly perceived as recreational. Visitors crowd the beaches and seaside amusements of Blackpool, Cleveleys and Lytham St. Annes in the summer tourist season and events such as the Blackpool Illuminations emphasises the importance Blackpool places on its reputation as a place of entertainment. Large recreational piers, sculpture and promenades line the

coast along the entire length of the North Shore combining to create a shoreline that bustles and is highly visible from a great distance.

The strong recreational element of the shore and beaches of the North Shore area is offset by the maritime perspective of the wide expansive drying area along this shoreline. The area is one avoided by mariners and the absence of any substantial port or landing place in this area makes the drying area unattractive to any vessels unsuitable for beaching, a fact noted since the 18th century, hence the area is largely considered a navigational hazard for most vessels.

References

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Cowell, R. 1996, 'The Upper Palaeolithic and Mesolithic' Newman, R. (ed.), *The Archaeology of Lancashire: Present State and Future Priorities*, pp. 19-34, Lancaster University Archaeological Unit, Lancaster

Curtis, B. 1986, *Fleetwood: A Town is Born*, Terence Dalton Ltd. Lavenham

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Stammers, M. 1997, 'The Northwest Coast', Mannering, J. (ed.), *The Chatham Directory of Inshore Craft: Traditional Working Vessels of the British Isles*, pp. 204-215, Chatham Publishing, London

Tooley, M. J. 1977, 'Theories of Coastal Change in North-West England', Thompson, F. H. (ed.), *Archaeology and Coastal Change*, pp. 74-86, The Society of Antiquaries of London, London

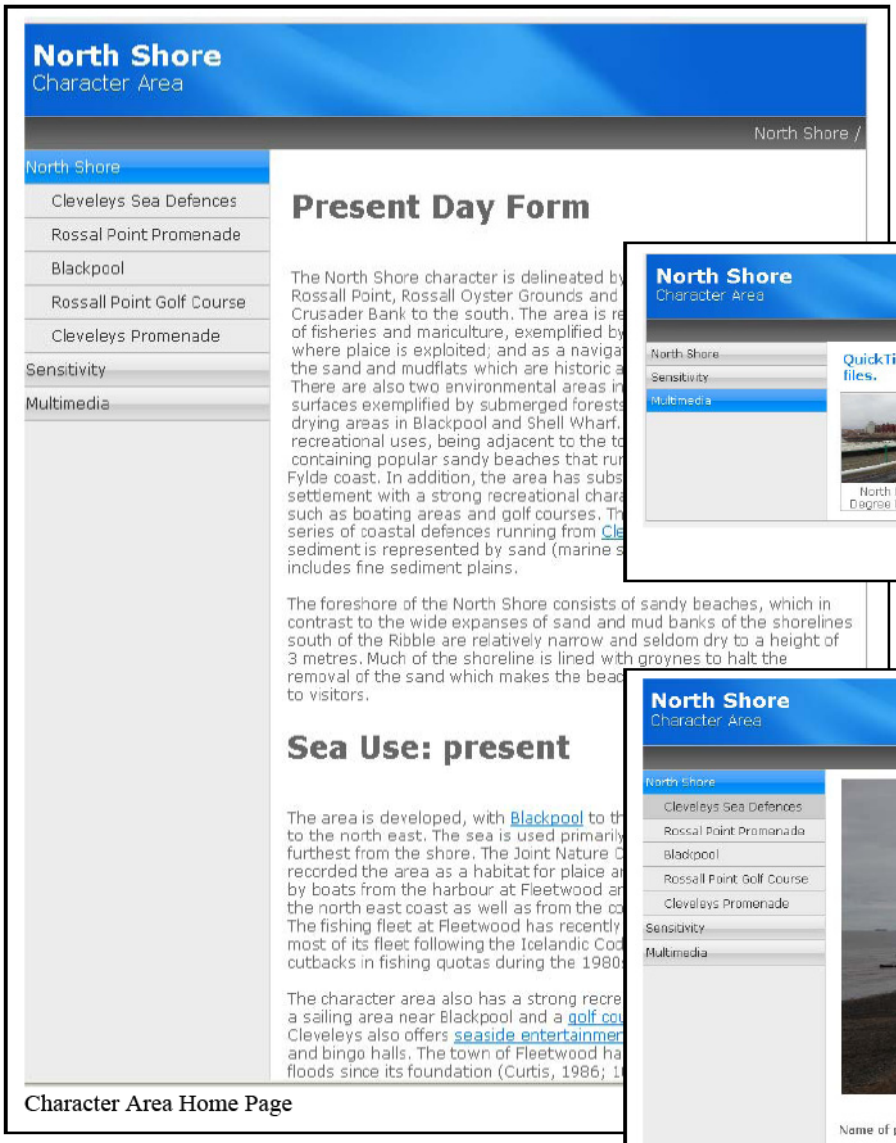
Robert Posner, March 20004, *Wyre Flood and Coastal Defence Strategy Plan*, Wyre Borough Council, Lancashire

Online Sources

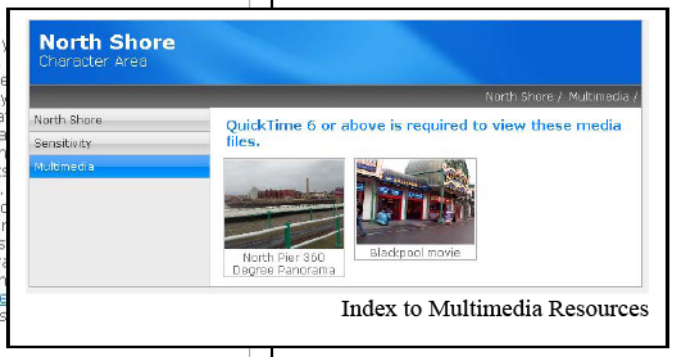
Anon, 2002, 'Fleetwood: the town', *e:Nation*, Fleetwood
Main site: http://www.enation.co.uk/
Page referenced: www.enation.co.uk/fleetwood_town.htm

Anon, 2005, 'Portvs setantiorvm; Romano-British Seaport near Fleetwood, Lancashire', *www.Roman-Britain.ORG*
Main site: http://www.roman-britain.org/
Page referenced: http://www.roman-britain.org/places/portus_setantiorum.htm

An example of the various components of a single character area offline html page can be seen overleaf.



Character Area Home Page



Index to Multimedia Resources

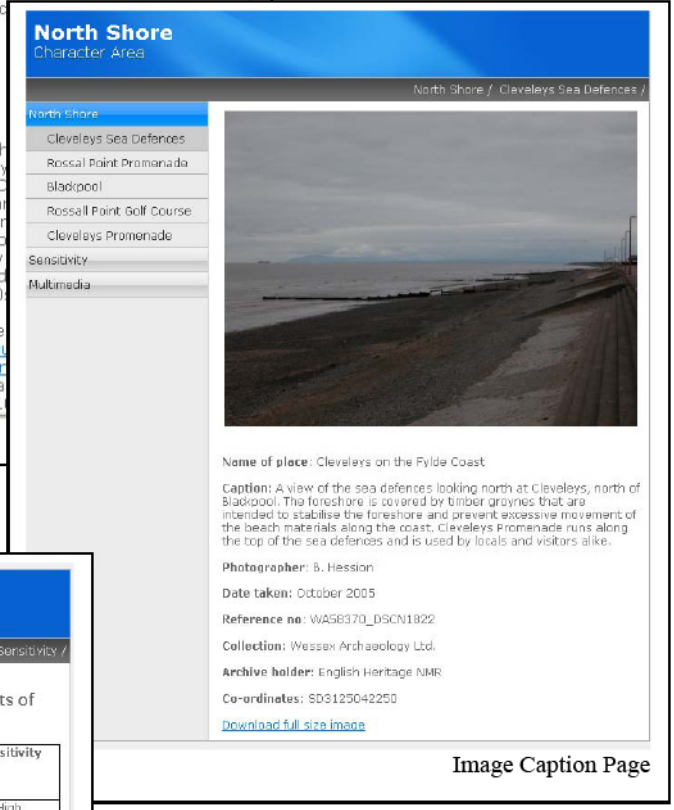
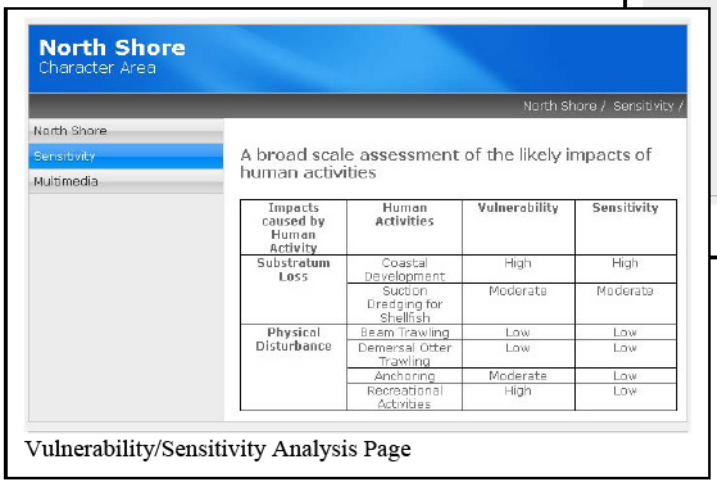


Image Caption Page



Vulnerability/Sensitivity Analysis Page

STEP 10 – SENSITIVITY ANALYSIS

An analysis of vulnerability and sensitivity was undertaken for each Character Area, assessing the significance of the archaeological resources in relation to the potential scale and effect of likely impacts. The matrix (utilising a very similar approach to that developed by the JNCC Irish Sea Pilot) measures the impacts of human activities by whether the area is currently or likely to be effected by them in the near future and the potential scale of those impacts to estimate 'vulnerability'.

A measure of 'sensitivity' is achieved by assessing a combination of the importance of the archaeological potential of the area and vulnerability to achieve an estimate of the significance of the effect.

Scale and potential impact of development (vulnerability)
+
Importance of archaeology

= Significance of effect (sensitivity)

Scales of 'high', 'moderate', 'low' and 'insufficient data' have been used for both vulnerability and sensitivity.

Note: If a particular human activity or industry is not noted or unlikely to occur in a particular Character Area, it has not been included in the matrix (e.g. coastal development in an area several miles off the coast).

An example of the full matrix is given below:

A broad scale assessment of the likely impacts of human activities:			
Potential impacts on archaeological resources	Human Activities	Vulnerability	Sensitivity
Substratum Loss	Coastal Development	e.g. High	e.g. Moderate
	Offshore Development		
	Aggregate Extraction		
	Capital/Maintenance Dredging		
	Tractor dredging for Shellfish		
	Suction Dredging for Shellfish		
	Coastal Erosion		
Physical Disturbance	Capital/Maintenance Dredging		
	Tractor Dredging for Shellfish		
	Suction Dredging for Shellfish		
	Beam Trawling		
	Scallop Dredging		
	Demersal Otter Trawling		
	Anchoring		
	Mussel/Cockle Harvesting		
	Recreational Activities		
	Wreck Clearance		
	Bait digging		
	Coastal Erosion		
Smothering	Deposition of Spoil		
	Coastal accretion		

5 RELATIONSHIPS BETWEEN CHARACTER LEVELS

The table below summarises the hierarchical relationship between 'Broad_Character', 'Character_Type' and 'Sub_Character'.

For example, a polygon, given the sub-character 'active historic channel', has the character type 'navigation feature' and the broad character 'navigation'.

BROAD_CHARACTER	CHARACTER_TYPE	SUB_CHARACTER
NAVIGATION	Navigation feature	Active historic channel
		Active modern channel
		Disused buried historical channel
		Disused historical channel
	Navigation activity	Disused historical anchorage
		Ferry
		Historical anchorage
		Historical anchorage in active historic channel
		Historical anchorage in active modern channel
		Historical anchorage in disused buried channel
		Historical canal
		Historical port quarantine area
		Waterway
	Navigational hazard	Historical drying area
		Maritime debris
		Modern drying area
		Shipwreck cluster
		Rocky outcrop
INDUSTRY	Intrusive offshore industry	Aggregate dredging
		Capital dredging
		Dumping ground
		Gas installation
		Maintenance dredging
		Oil and gas installation
		Oil terminal
		Submarine cable
	Ports, docks and harbours	Boatbuilding yard
		Dock and port related industry
		Shipbuilding yard
	Fisheries and Mariculture	Cockling area
		Historic fisheries
		Modern fisheries
	Coastal Industry	Brickworks
		Gas works
		Kiln
		Modern industry
		Pottery works
		Renewable energy installations
		Reservoir
		Sewage works
		Warehouse
	Non-intrusive offshore industry	Commercial shipping

BROAD_CHARACTER	CHARACTER_TYPE	SUB_CHARACTER
RECREATION	Coastal Recreation	Beach
		Coastal golf course
		Coastal parkland
		Coastal recreation
		Coastal way
		Marina
		Marine lake
		Marine reserve
		Nature reserve
		Protected recreation area
		Sailing club
		Seaside entertainment
		Sports ground
		Water park
	Offshore recreation	Dive site
		Leisure fishing area
		Offshore recreation
		Offshore sailing area
ENVIRONMENT	Coastal Environment	Grazing marsh
		Mudflats
		Salt marsh area
		Sand dunes
		Rocky outcrop
		Woodland
	Offshore Environment	Coarse sediment plains
		Fine sediment plains
	Prehistoric land surface	Palaeochannel
		Peat bed
		Prehistoric footprints in modern drying area
		Submerged forest in modern drying area
SETTLEMENT	Coastal Settlement	Ancient field systems
		Coastal settlement
		Coastal village
		Historic field systems
		Historic town
		Historic settlement
		Medieval townfields
		Modern field systems
	Maritime Safety	Coastguard installations
		Lifeboat stations
		Lifeguard area
		Navigation aid
MILITARY	Coastal Military	Army base
		Military area
		Military fort
		Military practice area
	Naval Activity	Naval dockyard
		Navy base
		Submarine exercise area

6 ATTRIBUTE DEFINITIONS AND TERMINOLOGY

Where possible, England's Historic Seascapes Liverpool Bay and Fylde Pilot Project has used terminology and definitions which will be familiar to both maritime archaeologists and to marine industries and sciences. In cases, where a relevant definition could not be found in national reference terminology lists (e.g. *Inscription* thesauri, UKHO Admiralty Chart Key), the Oxford Dictionary has been utilised.

The attribute information follows EH recommendations for recording attributes.

- Each spatial feature has been assigned a unique reference code.
- All Attribute names are in BLOCK CAPITALS. Attribute names do not contain spaces, UNDERSCORES_WERE_USED_INSTEAD. Due to character limit within ArcCatalog, the names of some attributes were abbreviated. In the following pages, the full 'spoken name' of the field and its abbreviation are shown overleaf and in brackets after the attribute name.
- WA has avoided using abbreviations, codes and acronyms. The particular thesauri or source of terminology which has been utilised is recorded in the metadata. The terminology which has been utilised is defined in the following pages.

6.1 CHARACTER ANALYSIS MAP DATA STRUCTURE

The final 'Character Analysis' map contains the following attributes:

Attribute Name	Abbreviated Name used in GIS	Population method
Object_ID	OBJECTID	System generated
WAID	WA_ID	System generated
HLC_ref	HLC_REF	Auto populated from terrestrial HLCs
Broad_character	BROAD_CHAR	Auto populated by character_type via database
Character_type	CHAR_TY	Auto populated by sub_character via database
Sub-character	SUB_CHAR	Manual entry
HLC_character_type	HLC_CHA_TY	Auto populated
Period	PERIOD	Manual entry
Primary_attribute	PRIM_ATTR	Auto populated
Primary Landscape	PRI_LNDSC	Manual entry
Other Landscape	OTHER_LAND	Manual entry
Primary_Intrusive_industry	PR_INT_IND	Auto populated
Primary_Non-intrusive_industry	NO_INT_IND	Auto populated
NLO_area	NLO_AREA	Auto populated
Sediment	SEDIMENT	Auto populated
Morphology	MORPHOLOGY	Auto populated
Habitat	HABITAT	Auto populated
Tidal_range	TIDAL_RANG	Auto populated
Sea_level	SEA_LEVEL	Auto populated
Impact	P_IMPACT	Manual entry
Location	LOCATION	Auto populated
Confidence	CONFIDENCE	Manual entry

Checked_By	CHECK_BY	Manual entry
Shape_Length	Shape_length	System generated
Shape_Area	Shape_area	System generated

6.2 CHARACTER ANALYSIS MAP ATTRIBUTE DEFINTIONS AND TERMINOLOGY

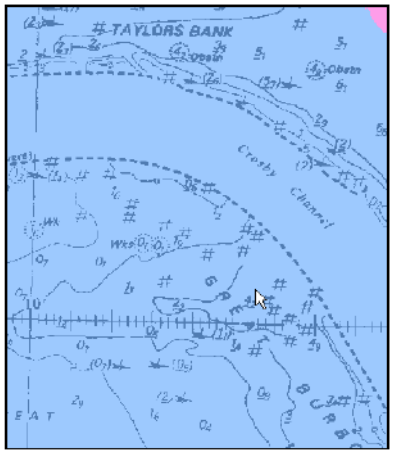
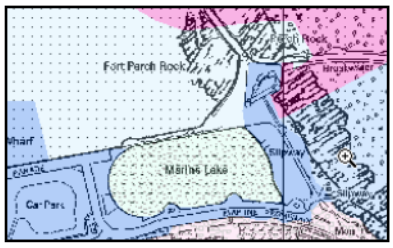
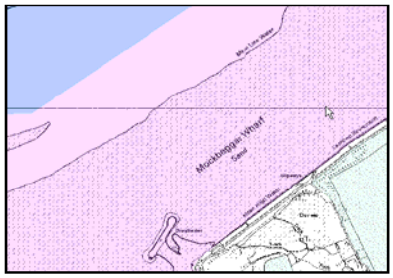
The following section defines the attributes and the terminology used:

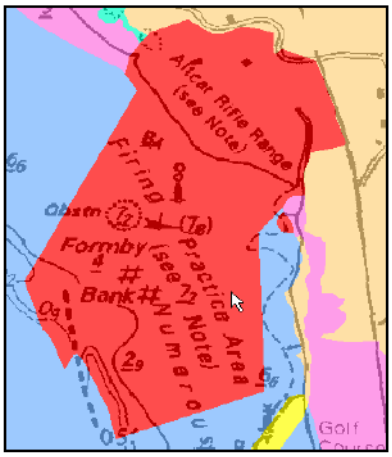
Attribute name: OBJECTID
Definition: default number generated by GIS
Controls: auto generated by ArcGIS
Sample data: 1, 2, 3, 4, 5, 6, 7, etc.

Attribute name: WAID
Definition: unique ID for each new polygon (WA reference number)
Controls: auto generated system controlled
Sample data: 1, 2, 3, 4, 5, 6, 7, etc.

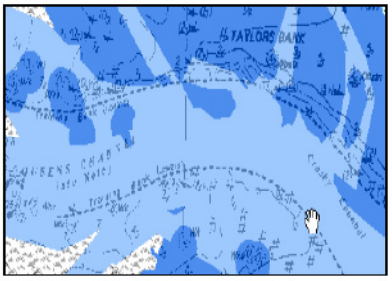
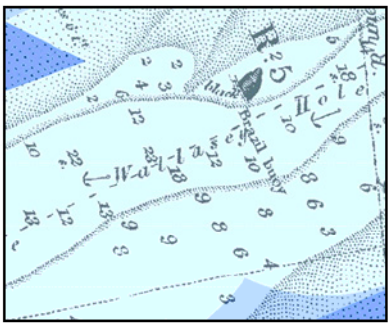
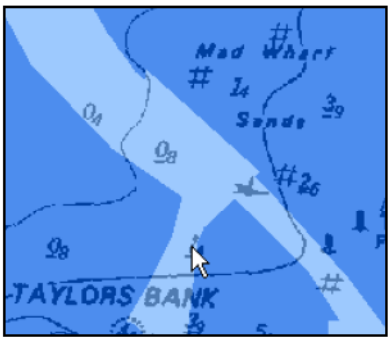
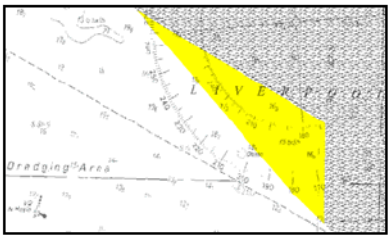
Attribute name: HLC_REF
Definition: unique ID for each new polygon according to HLC polygon data from Cheshire, Merseyside and Lancashire
Controls: auto generated system controlled
Sample data: 3, 43, 50, 54, 56, 57, 69, 70, etc.

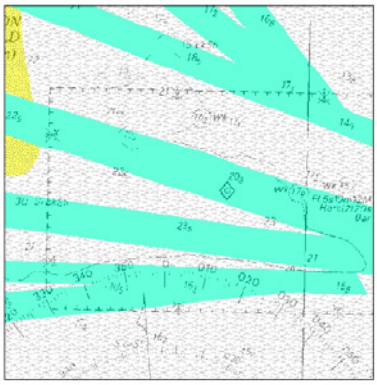
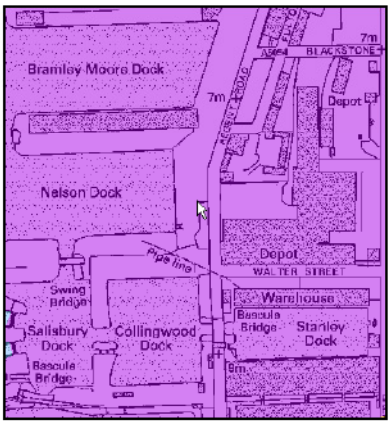
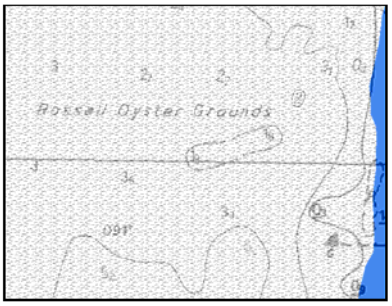
Attribute name: BROAD_CHAR (BROAD_CHARACTER)
Definition: broadest level of characterisation
Controls: auto-populated controlled system based on SUB_CHAR (SUB_CHARACTER)
Sample data: (begins overleaf)

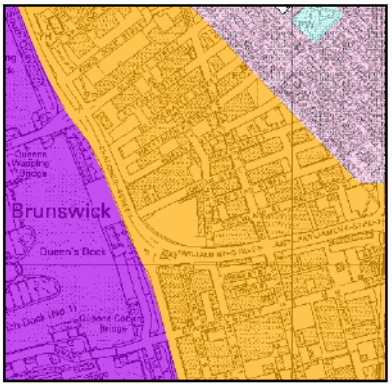
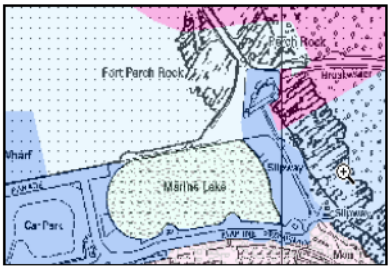
Navigation	Related to the action or practice of travelling on water in a ship or other vessel (Oxford Dictionary). This broad character includes character types such as active historic channels, active modern channels, disused historical anchorages, historical canal, and ferry amongst others (e.g. main channel approach to Mersey river). This data was primarily derived from the digitisation of modern and historic charts.	
Industry	This category is relevant where industrial activity is or has been the dominant influence on the character of the seascape (e.g. oil and gas installations associated with the Lennox gas field, aggregate dredging). Derived primarily from SeaZone offshore developments and JNCC data.	
Recreation	This category is relevant in areas where human activities are undertaken for pleasure or amusement. This type includes public parks, tourist attractions, sports grounds, playing fields, sailing and boating areas, marinas, marines reserves, marine lakes and beaches. Derived primarily from historic and modern OS maps.	
Environment	Defines a seascape where the predominant character is un-developed and has a strong tendency to be dominated by natural processes. This includes prehistoric land surface, mudflats, salt marsh areas, sand dunes and estuarine areas, and may also include areas of offshore deep water. Derived primarily from historic charts, JNCC and EN data.	

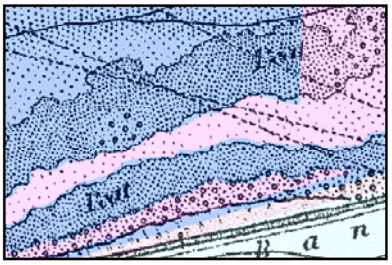
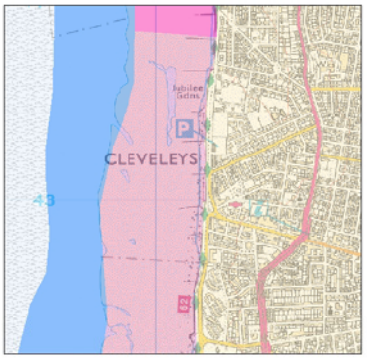
Settlement	Nucleated areas of built environment interest, where people live including historic, medieval and modern towns, coastal villages, coastguard installations, navigation aids (e.g. lighthouses), lifeguard areas and lifeboat stations. Derived from modern OS maps and terrestrial HLC	
Military	Used by or connected with the army or navy for defence, operational bases, or for supply and provisioning Includes firing ranges, practice areas, coastal batteries, ordnance factories, navy dockyards, etc. Derived primarily from historic and modern OS maps.	

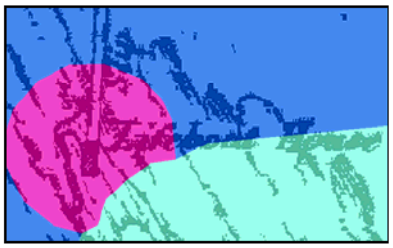
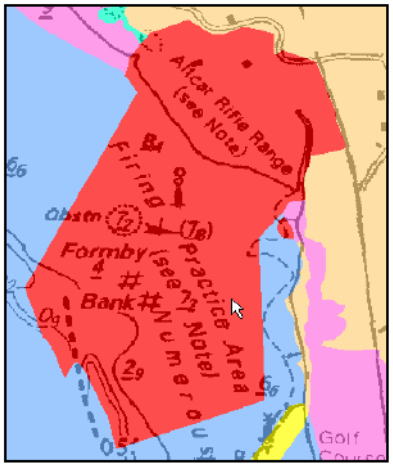
Attribute name: CHARA_TY (CHARACTER_TYPE)
Definition: more specific level of characterisation compared to BROAD_CHAR but yet still maintaining a level of generalisation
Controls: auto-populated controlled system based on SUB_CHAR
Sample data:

(Navigation) Navigation feature	Distinctive navigational aspect mainly related to passage of shipping traffic such as active historic channel, active modern channel, disused historical channel and disused buried historical channel.	
(Navigation) Navigation activity	Related to the human activities linked to navigation such as historical anchorages, historical anchorage in active historic channel, historical anchorage in active modern channel, historic anchorage in disused historical channel (e.g. Wallasey Hole, adjacent to Rock Channel), disused historical anchorage, historical canal, historical port quarantine area, and waterway.	
(Navigation) Navigational hazard	Features that represent a risk of collision, stranding, etc. leading to damage or total loss of a vessel such as historical drying areas and modern drying areas (e.g. Mad Wharf Sands)	
(Industry) Intrusive offshore industry	Referring to any industrial activity at sea that continuously disrupts and impacts on the marine environment (particularly the seabed) through time. For example, aggregate dredging, trawling, oil and gas installations, amongst others. The image illustrates the dredging area (in yellow) in Liverpool Bay that falls into the edge of England's Historic Seascapes study area.	

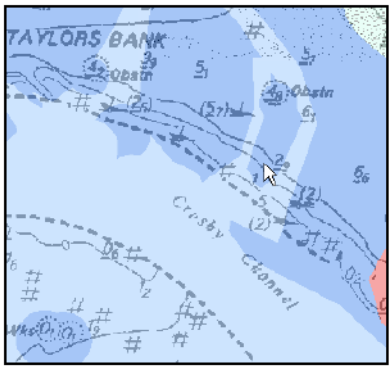
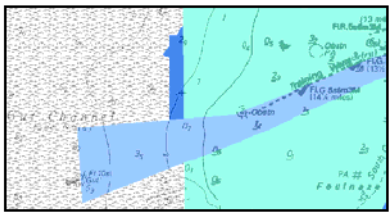
(Industry) Non-intrusive offshore Industry	Referring to any industrial activity at sea that does not have a continuous and incremental intrusive impact on the seabed such as commercial shipping, illustrated here as green areas on the map.	
(Industry) Ports, docks and harbours	Related to functioning of ports, docks and harbours such as dock and port related industry, industrial port area, industrial dock area, historic dock, and historic harbour amongst others. For example, the dock complex along the Mersey at Liverpool.	
(Industry) Fisheries and mariculture	Activities associated with the business, occupation, or industry of harvesting or cultivating fish and shellfish from the sea or rivers such as modern fisheries and historic fisheries amongst others, illustrated in grey on the image.	

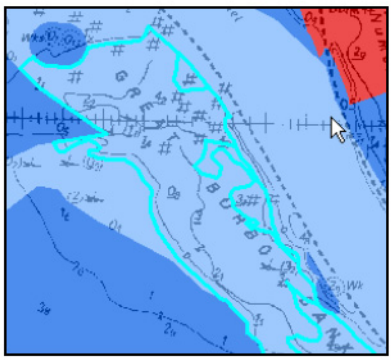
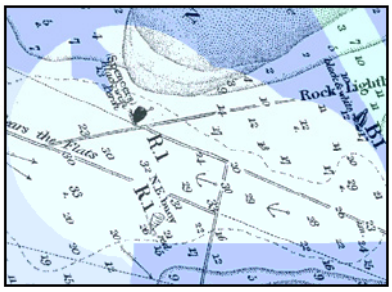
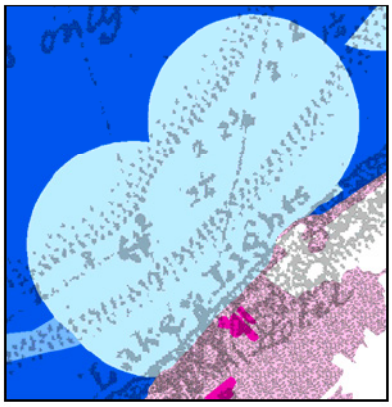
(Industry) Coastal industry	Any industrial activity undertaken along the coast such as historic salt-making, water extraction, boat and shipbuilding yards, coastal quarries, brickworks, sewage works, etc. For example, the image's orange area by Queens Dock (data taken from terrestrial HLC).	
(Recreation) Coastal recreation	Areas accessible to the general public for the pursuit of leisure and recreational activities. This seascape character type includes golf courses, sports grounds, parklands, sailing and boating areas, marine lakes, water parks, etc.	
(Recreation) Offshore recreation	Areas of sea associated with activities undertaken by the general public during leisure time, including dive sites, leisure fishing areas, sailing areas, etc. The pink area on the map shows an area of offshore recreation off the Blackpool coast.	

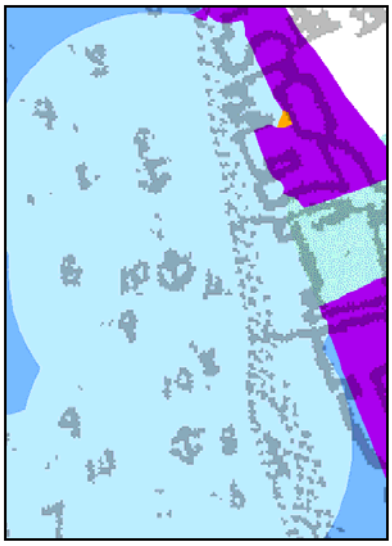
(Environment) Coastal environment	This type includes undeveloped mudflats, salt marsh areas, sand dunes and estuarine areas. For example, the salt marsh area by the River Ribble	
(Environment) Prehistoric land surface	Currently submerged land which may retain evidence of prehistoric human usage, such as areas of prehistoric foot prints, palaeochannels, submerged forests and peat exposures shown in blue in this example.	
(Environment) Offshore Environment	This type describes submerged offshore environments. Types currently include fine sediment plains and coarse sediment plains. The human dimension of such area may be the occasional isolated wreck, but the predominant overall character is defined by natural processes.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project).
(Settlement) Coastal settlement	Nucleated occupation areas predominately characterised by the built environment, including historic and modern towns, coastal villages, etc. This concept has been already applied by terrestrial HLC initiatives and integrated in England's Historic Seascapes. For example, the coastal settlement at Cleveleys.	

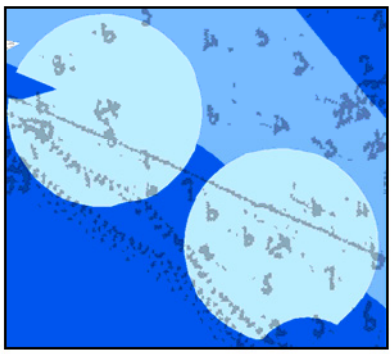
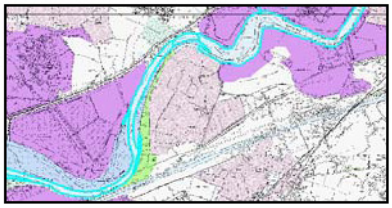
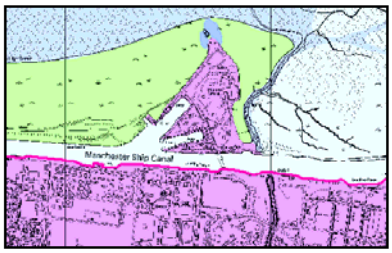
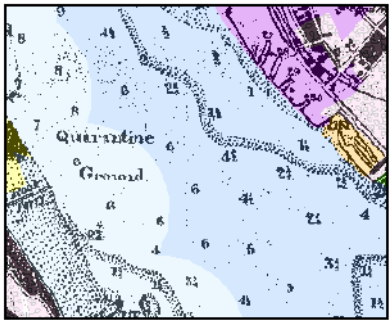
(Settlement) Maritime safety	Installations, associated with local Port Authorities, Royal National Lifeboat Institution (RNLI) or seafarers' co-operatives, to assist safe navigation. These installations include navigation aids (e.g. lighthouses), coastguard and lifeboat stations, and boat and watch houses.	
(Military) Coastal military	Used by or connected with the army including coastal batteries, ordnance factories, artillery or rockets testing ranges, etc.	
(Military) Naval activity	Used by or connected with the navy including navy dockyards, navy bases, submarine practice areas, etc.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project).

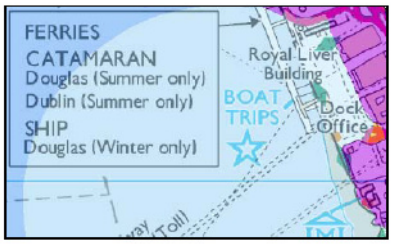
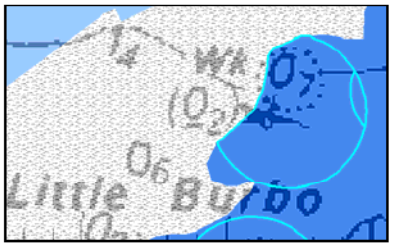
Attribute name: SUB_CHAR (SUB_CHARACTER)
Definition: more specific level of characterisation compared to CHAR_TYPE
Controls: manually populated by observation and data gathering from NMR, HER, JNNC, Historical charts, OS maps.
Sample data:

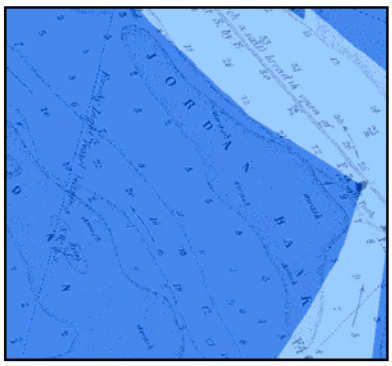
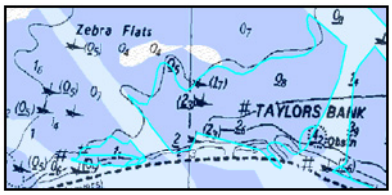
(Navigation feature) Active historic channel	Navigational watercourse or channel used in the past and which is currently in use by modern commercial traffic. Often defined by buoyage and training walls. For example, Crosby Channel as illustrated in the image.	
(Navigation feature) Active modern channel	Navigational watercourse or channel that is currently in use with no evidence of usage in before modern times (1900s onwards). An example is Gut Channel (represented in light blue) at the entrance of the River Ribble.	
(Navigation feature) Disused historical channel	Navigational watercourse or channel used in the past but which is not currently used for modern commercial traffic such as the disused historic channel by Burbo Bank represented in light blue on the image.	

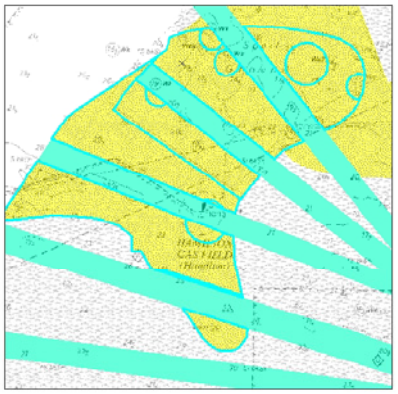
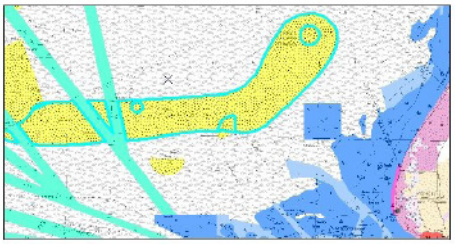
(Navigation feature) Disused buried historical channel	Navigational watercourse or channel used in the past, which is currently buried and therefore it is not currently in use. For example the disused buried historical channel by Great Burbo.	
(Navigation activity) Historical anchorage in disused buried channel	An area of sea or coast where ships anchored in the past, located in a historical navigational watercourse or channel which has been buried and is therefore not currently used by modern commercial traffic. For example, those by Hoyle Bank as illustrated in the image	
(Navigation activity) Historical anchorage	An area of sea, often providing sheltered conditions by the topography of the nearby coast, where ships used to anchor in the past. For example, those by Hoylake as illustrated in the image.	

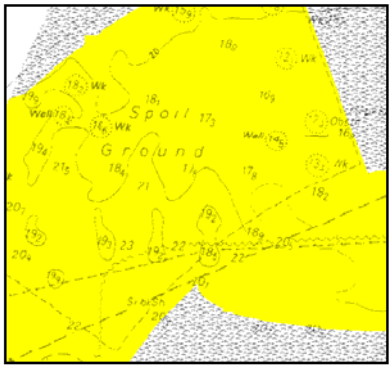
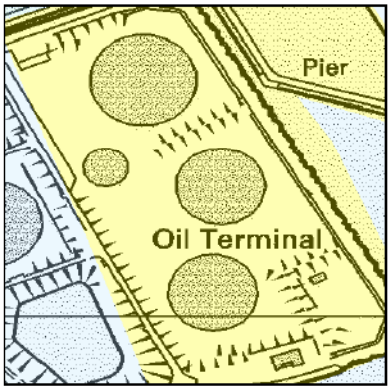
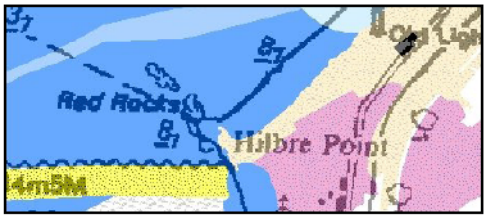
(Navigation activity) Historical anchorage in active historic channel	An area of sea, where ships used to anchor in the past, located in a navigational watercourse or channel used in the past and which is currently in use. For example, those by Perch Rock (in light blue) at the entrance on the Mersey, cut by a dredging area illustrated in yellow on the image.	
(Navigation activity) Historical anchorage in active modern channel	An area of sea or coast where ships used to anchor in the past located in a currently used modern channel. For example, those on the Mersey (represented in light blue) by the Merseyside Maritime Museum and Albert Docks (represented in purple).	

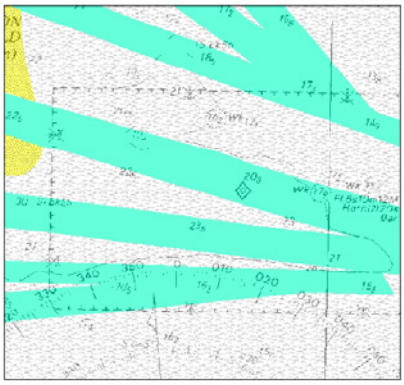
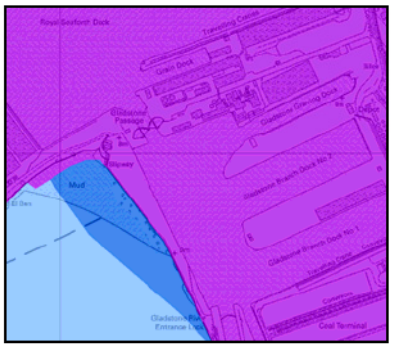
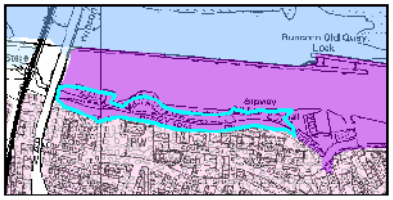
(Navigation activity) Disused historical anchorage	An area of sea or coast where ships used to anchor in the past that it is currently not in use by modern commercial shipping. For example, those by East Hoyle Spit represented in light blue.	
(Navigation activity) Waterway	A natural passage of water related to any navigational practice such as the one on the Upper Mersey.	
(Navigation activity) Historical canal	An artificial navigable waterway used for the transportation of goods (e.g. Manchester Ship Canal). (http://thesaurus.english-heritage.org.uk).	
(Navigation activity) Historical port quarantine area	A historical area generally linked to a port where a period of detention was imposed on travellers or voyagers before they are allowed to enter a country or town, and mix with the inhabitants. Commonly, quarantine is also defined as the period during which a ship, capable of carrying contagion, is kept isolated on its arrival at a port. Historic charting notes which of the anchorages on the western bank of the Mersey was formerly used as a quarantine ground.	

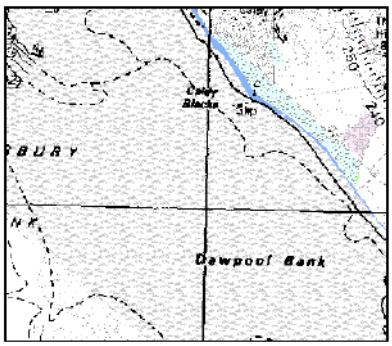
(Navigation activity) Ferry	Related to a route across river or lake or an area of port, dock or harbour often including buildings for passport control and customs where passengers and vehicles using ferry services can embark/disembark and where supplies can be taken on board (http://thesaurus.english-heritage.org.uk). For example, the ferry area at the Mersey highlighted in light blue.	
(Navigational hazard) Rocky outcrop	Area dominated by submerged rocks rising above the general level of the seabed which poses a risk for navigation, such as the one by Taylors Bank.	
(Navigational hazard) Shipwreck Cluster	An area dominated by submerged wrecks representing a hazard or risk for navigation. Dangerous wrecks in shallow water are those either exposed and/or found above 10 m below the sea-level (based on UKHO definition). For example, the ones in Little Burbo.	
(Navigational hazard) Maritime Debris	An area dominated by obstructions and fouls which may not necessarily be associated with a wreck (based on UKHO definition).	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project).

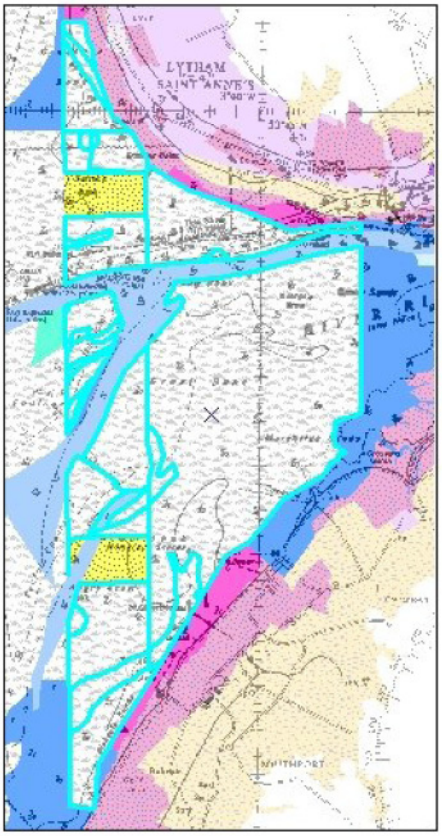
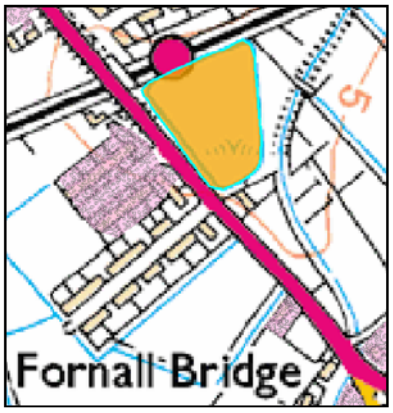
(Navigational hazard) Historical drying area	Sandbanks exposed in the past such as Jordan Bank and Jordan Flats represented on the image in dark blue.	
(Navigational hazard) Modern drying area	Areas subject to change and exposure at low tide due to the mobility of sediments, includes sandbanks such as Taylors Bank	
(Intrusive offshore industry) Aggregate dredging	Often implies sand and gravel removal. More specifically, this industry comprises activities engaged in the mining and quarrying of sand, gravel, clays, ceramic and refractory minerals, and/or the beneficiation by washing, screening, and otherwise preparing the mined sand, gravel and clays. The principal activity of this industry is the production of sand and gravel for use as aggregates in the construction of buildings and infrastructure (e.g. highways). The yellow areas on the map represent areas of aggregate extraction at the mouth of the Mersey river.	
(Intrusive offshore industry) Capital dredging	Related to the excavation of material to deepen or create navigational channels and berths to provide additional harbour infrastructure or provide access for deeper draught vessels. The difference between capital and maintenance dredging is that capital dredging reduces the seabed to a level (relative to Ordnance Datum) lower than it has been at anytime during the preceding 10 years (Source: http://www.mceu.gov.uk/MCEU_LOCAL/FEPA/FEPA-capital.htm)	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

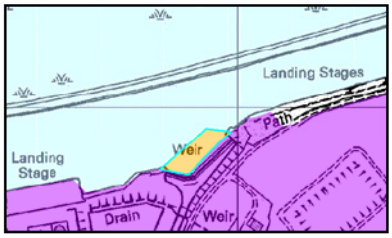
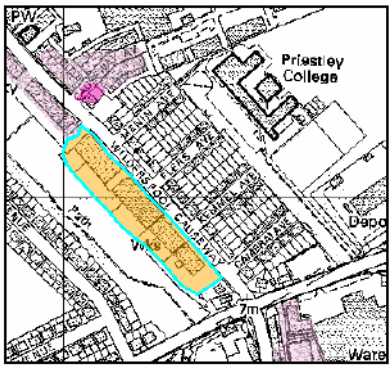
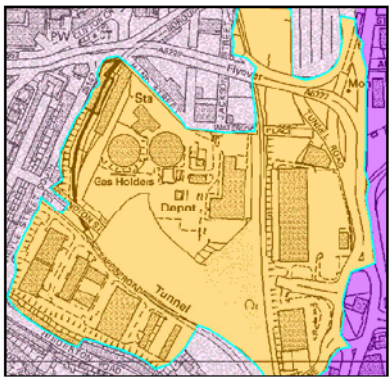
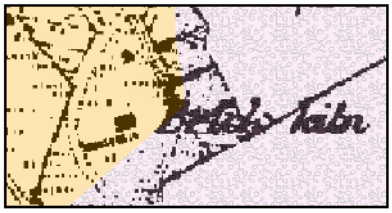
(Intrusive offshore industry) Maintenance dredging	Referring to the removal of accumulated sediments from harbour channels and berths to ensure a safe depth of water for navigational purposes; or similar maintenance works to remove sediment to restore an adequate flow of water to mitigate risk of flooding or protect a sensitive habitat (sometimes referred to as environmental dredging). The difference between maintenance and capital dredging is that maintenance dredging will not reduce the seabed (relative to Ordnance Datum) to level any lower than it has been at any time during the preceding 10 years. (Source: http://www.mceu.gov.uk/MCEU_LOCAL/FEPA/fepa-maintenance.htm)	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Intrusive offshore industry) Gas installation	An installation involved in the extraction of natural gas. Associated structures would include pipelines, platforms, warning signals and lights. Unauthorised navigation is prohibited within 500 m of all such structures. For example, the gas installation and surrounding Hamilton gas field shown as a yellow area highlighted in light green.	
(Intrusive offshore industry) Oil and gas installation	An installation involved in the extraction of oil and natural gas. Associated structures would include pipelines, platforms, tanker moorings, storage containers, warning signals and lights. Unauthorised navigation is prohibited within 500 m of all such structures. For example, the oil and gas installation and surrounding Lennox oil and gas field shown as a yellow area highlighted in light green.	

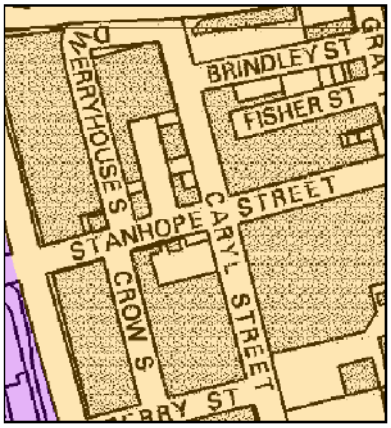
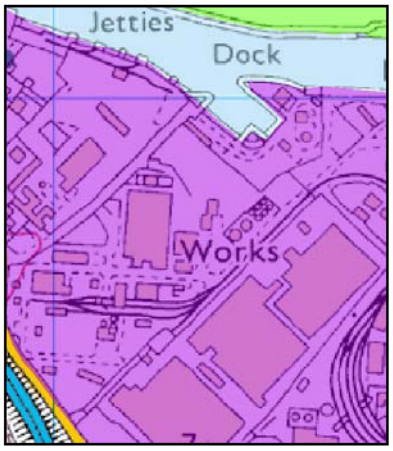
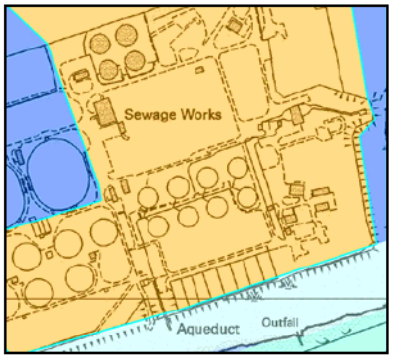
(Intrusive offshore industry) Dumping ground	Used for dumping or depositing loads of dredging spoil, drilling waste and possible treated sewage and other terrestrial waste. For example, the dumping ground above Hamilton Gas Field.	
(Intrusive offshore industry) Oil terminal	A building or structure that deals with oil. For example, the oil terminal at Birkenhead on the Mersey River.	
(Intrusive offshore industry) Submarine cable	Cables or pipes used to transmit (a message, news, etc.), or communicate, by submarine telegraph. For example, the submarine telegraph (shown in yellow) off Hilbre Point	

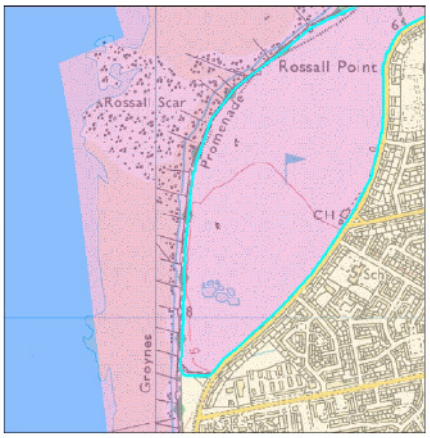
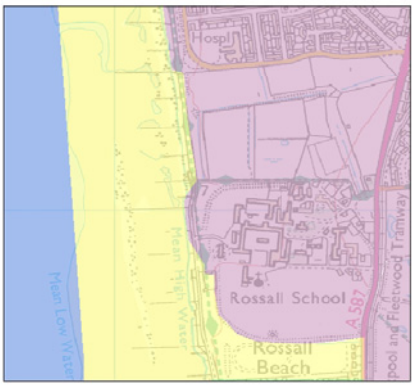
(Non-intrusive offshore industry) Commercial shipping	Area where ships travelling through are principally related to commerce or trade. For example the commercial shipping area in Liverpool Bay represented on the image in light green.	
(Ports, docks and harbours) Dock and port related industry	Buildings or structures that combine dock, harbour and terminal facilities at the interface between land and water transportation systems. These areas also involve receiving ships for purposes of shelter from storms, loading and unloading and/or building, maintaining and repairing ships (http://thesaurus.english-heritage.org.uk). For example, the Royal Seaforth Dock and Gladstone Dock (represented on the image in purple) at the entrance of the River Mersey.	
(Ports, docks and harbours) Shipbuilding yard	Relating to dockyard or shipyard involving the business or art of building and repairing ships	
(Ports, docks and harbours) Boatbuilding yard	A place where boats are built and stored (http://thesaurus.english-heritage.org.uk).	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

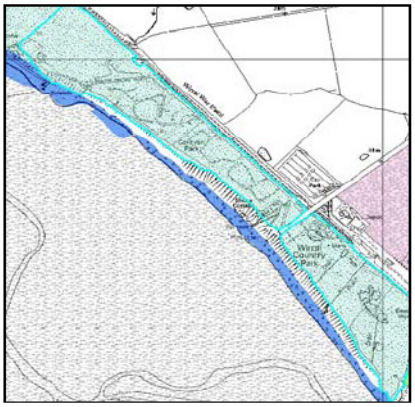
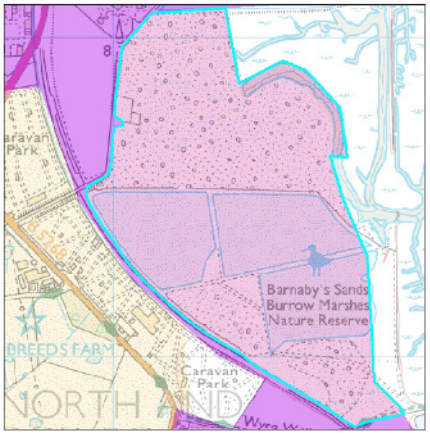
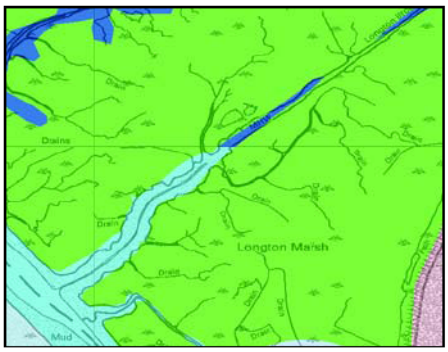
(Fisheries and mariculture) Modern fisheries	Broad definition for areas related to modern fishing industry. For example, the modern fisheries on the Upper Dee represented on the image in grey.	
(Fisheries and mariculture) Historic fisheries	Broad definition for fishing areas utilised in the past. The oyster grounds noted off Rossall Point are likely to have some antiquity and other historic fisheries have been identified through secondary sources in Southport (Foster 1998; Harrop 1982, 1985, forthcoming). None of the latter were mappable. However the information was used as part of the characterisation process.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

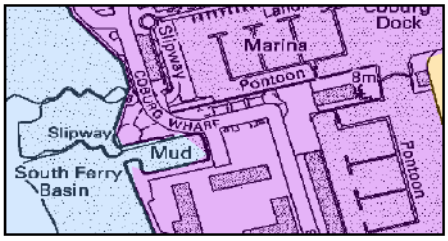
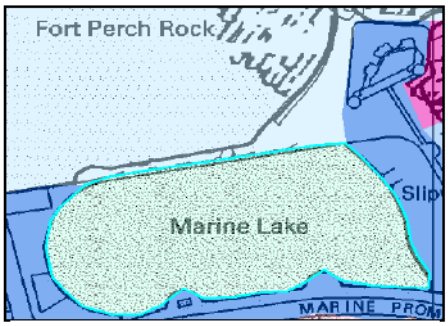
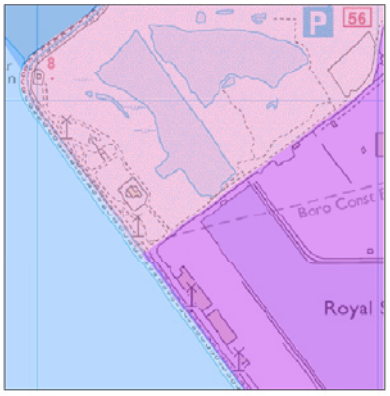
(Fisheries and mariculture) Cockling area	An area where bivalve molluscs are exploited. For example, the cockling area at the River Ribble highlighted on the image in light green.	
(Coastal industry) Reservoir	A large natural or artificial body of water sometimes covered, used to collect and store water for a particular function, e.g. industrial or public use (http://thesaurus.english-heritage.org.uk). For example, the reservoir at Meols by Fornall Bridge represented on the image in orange Data taken from terrestrial HLC.	

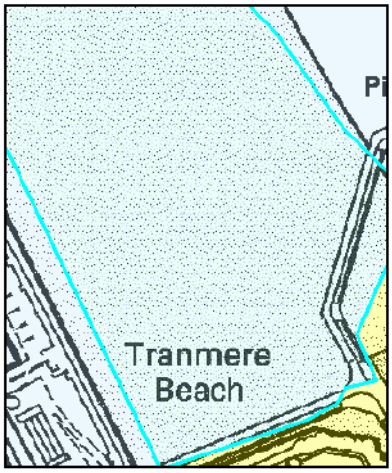
(Coastal industry) Renewable energy installations	Especially built installations to generate energy from natural resources such as wind or water (Oxford Dictionary). For example, the renewable energy installations by the Manchester Ship Canal (Upper Mersey) represented on the image in orange.	
(Coastal industry) Gas works	An industrial storage complex concerned with the manufacture of gas for domestic use (http://thesaurus.english-heritage.org.uk). For example, the gas works by Warrington (Upper Mersey) represented on the image in orange. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal industry) Modern industry	Includes those industrial areas that are active today as represented on modern maps. For example, the modern industry area by Tranmere, highlighted on the image in orange. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal industry) Kilns	A furnace or oven for burning, baking, or drying, of which various kinds are used in different industrial processes (e.g. lime-kiln, charcoal, tiles, or clay vessels, etc) (http://thesaurus.english-heritage.org.uk; Oxford Dictionary). Definition and area spatial definition taken from neighbouring terrestrial HLC.	

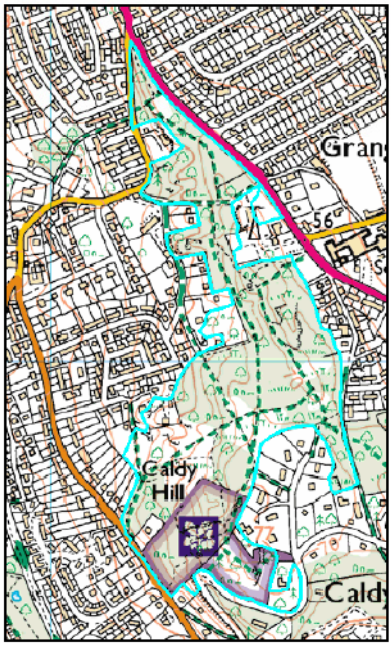
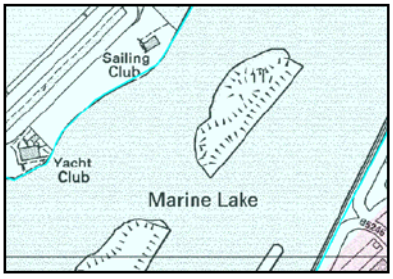
(Coastal industry) Warehouses	A building or part of a building used for the storage of goods and merchandise (http://thesaurus.english-heritage.org.uk). For example, the warehouses by Queen's Dock (Liverpool), represented on the image in orange. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal industry) Brickworks	An industrial manufacturing complex producing bricks (http://thesaurus.english-heritage.org.uk). For example, the brickworks along the Manchester Ship Canal by Ellesmere Port. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal industry) Sewage works	A group of buildings in which local sewage is filtered and purified in large rectangular or circular tanks (http://thesaurus.english-heritage.org.uk). For example, the sewage works on the Upper Ribble illustrated on the image in orange. Definition and area spatial definition taken from neighbouring terrestrial HLC.	

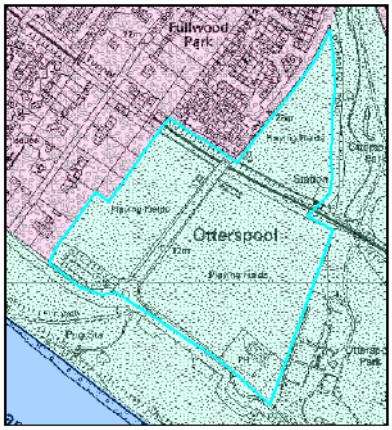
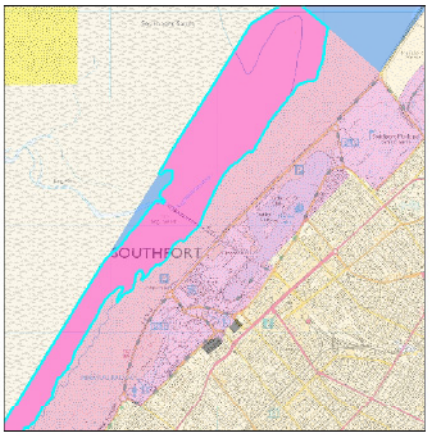
(Coastal industry) Pottery works	A complex of buildings used for the manufacture of pottery (http://thesaurus.english-heritage.org.uk). For example, the one located by the Manchester Ship Canal. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal recreation) Coastal golf course	A prepared area of ground located on the coast used to play golf games (http://thesaurus.english-heritage.org.uk). For example, the coastal golf course at Rossall Point. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal recreation) Coastal recreation	Areas used for recreation and leisure activities. Definition and area spatial definition taken from neighbouring terrestrial HLC.	

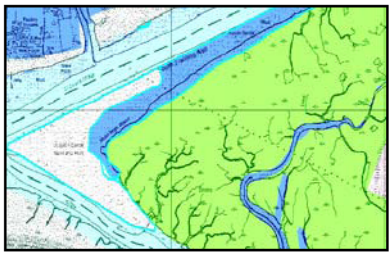
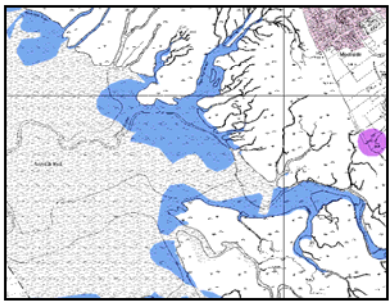
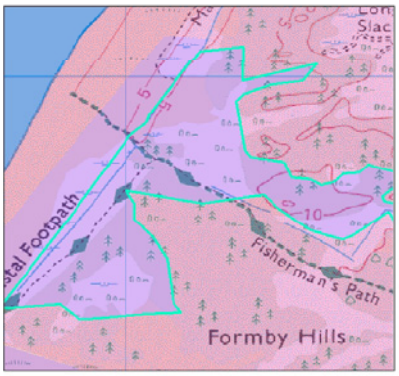
(Coastal recreation) Coastal parkland	An enclosed piece of land, generally large in area, used for hunting, the cultivation of trees, for grazing sheep and cattle or visual enjoyment (http://thesaurus.english-heritage.org.uk). Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal recreation) Nature reserve	An area of land protected and managed to preserve its flora and fauna, used by the public as a recreational area for the appreciation of the natural environment and for activities such as walking and hiking. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal recreation) Marine Reserve	An area of the marine environment which is completely protected from extractive activities such as fishing and cockling, presenting what is perceived as a wild environment for the general public to appreciate. These reserves are a focus for recreational activities such as walking and bird watching. An example of this is the marshside along the Ribble. This sub-character includes all marine reserves, and although no Marine Protected Areas exist in the study area, they could be included under this sub-character in areas where they do occur.	

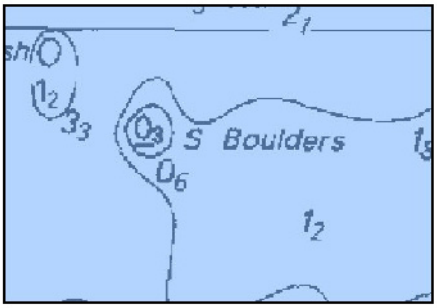
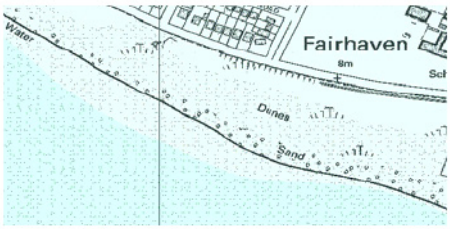
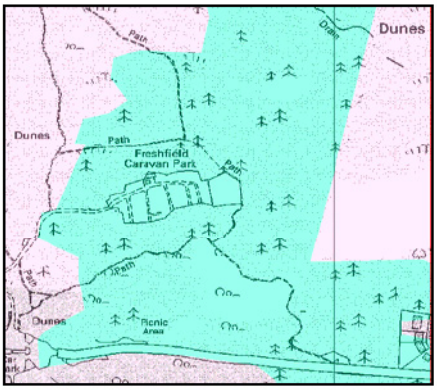
(Coastal recreation) Marina	A place providing mooring, storage, maintenance and other facilities for boats which in many occasions also includes leisure activities centred on such a mooring area. For example, the marina by Queen's Dock by the South Ferry Basin (Liverpool).	
(Coastal recreation) Marine lake	A large body of water generally located in the intertidal zones filled in by tidal saltwater, connected with recreational marine activities such as sailing and rowing. For example, the marine lake at Perch Rock.	
(Coastal recreation) Water park	Amusement parks in which activities are centred around recreational settings involving water, such as this example adjacent to Royal Seaforth dock	

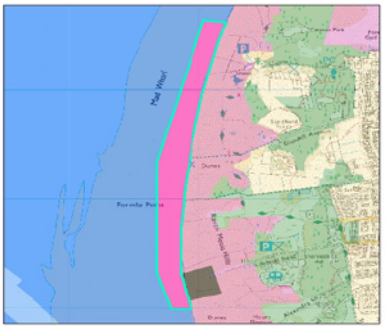
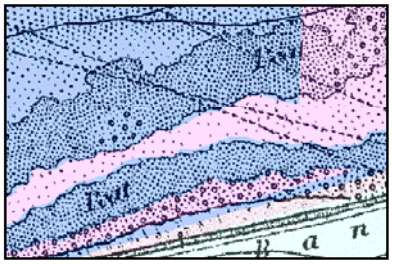
(Coastal recreation) Beach	The gently sloping accumulation of material (shingle, sand, mud) between mean low water springs tides and the highest point reached by storm waves, primarily used for recreational purposes, such as Tranmere Beach, Mersey.	
(Coastal recreation) Seaside entertainment	A recreational area located close to the sea where the general public can have access to a variety of leisure activities such as pleasure piers used a promenades and amusement parks, and seaside areas with cinemas, museums, restaurants, etc. For example, the seaside entertainment area of Blackpool pleasure beach.	

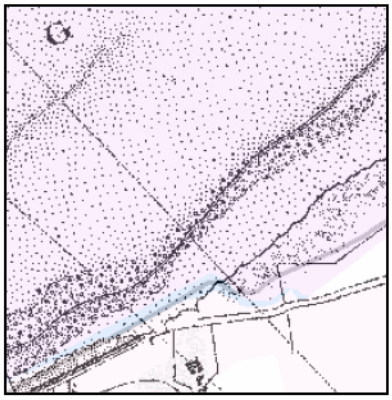
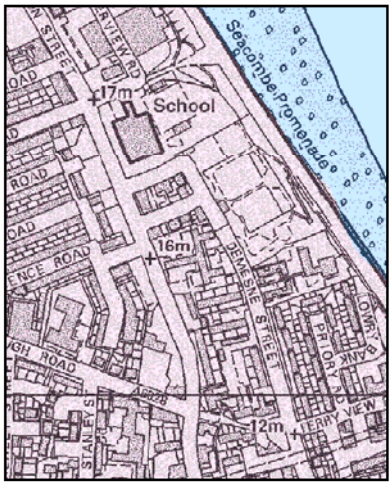
(Coastal recreation) Protected recreation area	A recreational area that is generally under the National Trust ownership. For example, the protected recreation area at Caldy Hill. Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Coastal recreation) Sailing club	An area, buildings or structures related to the sport of rowing and sailing. For example, the sailing club adjacent to the marine lake at Southport illustrated on the image.	

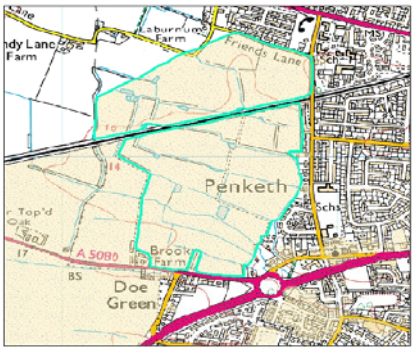
(Coastal recreation) Sports ground	Buildings, sites and structures associated with sporting activities Definition and area spatial definition taken from neighbouring terrestrial HLC.	
(Offshore recreation) Offshore recreation	Areas of sea associated with activities undertaken by the general public during leisure time. An example of this is the area off Southport Pleasure Beach, highlighted in pink on the map.	
(Offshore recreation) Leisure fishing area	An area, buildings, sites and structures associated with fishing activities for leisure purposes only. Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future similar projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Offshore recreation) Dive site	An area, buildings, sites and structures associated with the sport of diving. Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future similar projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

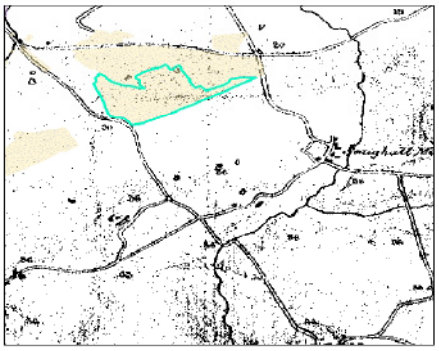
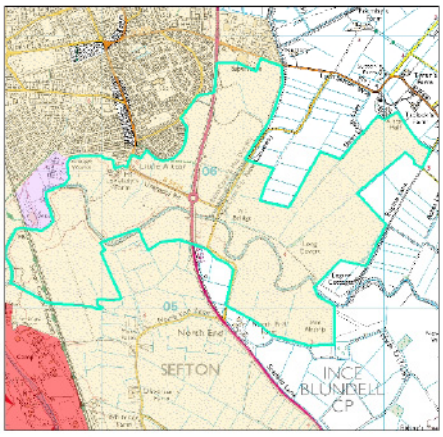
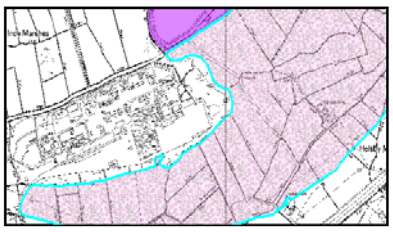
(Offshore recreation) Offshore Sailing area	An offshore area related to the sport of rowing and sailing. Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future similar projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Coastal environment) Mudflats	An expanse of mud or muddy sediment in the intertidal zone (May & Hansom 2003). Mudflats are predominantly composed by clay, silt and to a lesser extent very fine sand (www.ukmarinesac.org.uk). The image on the right illustrates the mudflats along the Ribble marsh area.	
(Coastal environment) Salt marsh	An area of alluvial or peat deposits, colonised by herbaceous and small shrubby terrestrial vascular plants, almost permanently wet and frequently inundated with saline waters (May & Hansom 2003). For example, the Dee marsh area near Parkgate and Neston.	
(Coastal environment) Grazing marsh	Areas of periodically inundated pasture, or meadow with ditches containing fresh water or standing brackish water. The ditches can be rich in plants and invertebrate fauna. These areas are grazed and some are cut for hay or silage (www.ukbap.org.uk). The example, highlighted in blue, is an area of grazing marsh on the Formby coast.	

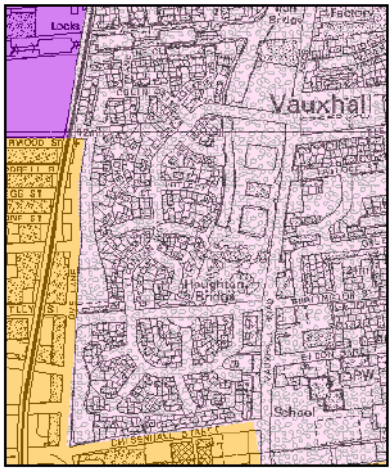
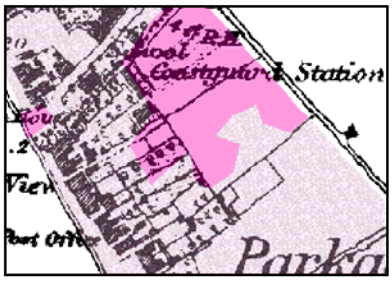
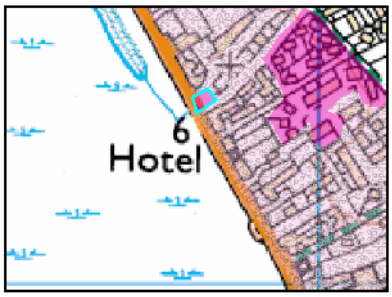
(Coastal environment) Rocky outcrop	Area dominated by submerged rocks rising above the general level of the seabed which pose a risk for safe navigation, such as the boulders defining a change in seabed at Rossall Patches.	
(Coastal environment) Sand dunes	A mound or ridge of unconsolidated windblown sediment such as the sand dunes on the foreshore near Lytham St. Annes.	
(Coastal environment) Woodland	Coastal area of land cover with trees usually smaller and less wild than a forest, which includes planted woods and woods associated with parklands. An example is the woodland area close to Mad Wharf, represented on the image in green. Definition and area spatial definition taken from neighbouring terrestrial HLC	
(Offshore environment) Fine sediment plains	Large areas of seabed containing predominantly different grades of sand and very low silt and clay content. These areas do not encompass normal commercial shipping routes and any fishing activity is extremely diffuse. The predominant archaeological interest is likely to be isolated wrecks and an as yet undetermined potential for submerged landscapes to be preserved underneath the later Holocene deposits.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

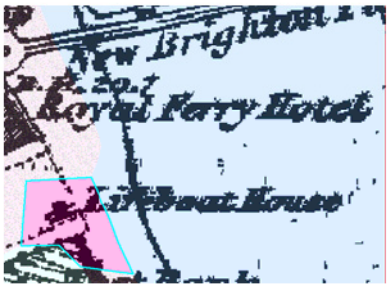
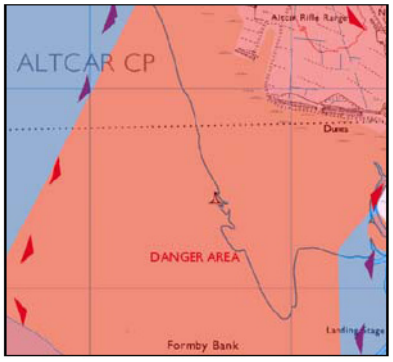
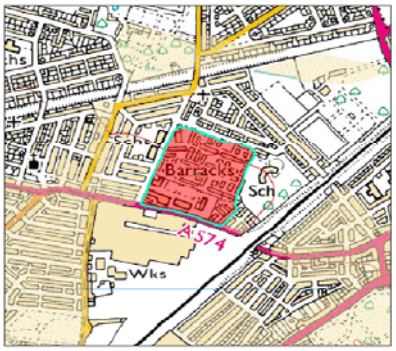
Offshore environment) Coarse sediment plains	Large area of seabed containing predominantly different grades of pebbles, rocks, boulders and glacial eratics, with lower sand and very low silt and clay contents. These areas do not encompass normal commercial shipping routes and any fishing activity is extremely diffuse. The predominant archaeological interest is likely to be isolated wrecks, and an as yet undetermined potential for submerged landscapes to be preserved underneath the later Holocene deposits.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Prehistoric land surface) Prehistoric footprints in modern drying area	A site where prehistoric footprints have been discovered in now fossilised mud or sand. For example, the prehistoric footprints at Formby Point, illustrated in pink on the map.	
(Prehistoric land surface) Peat bed	Exposures of unconsolidated deposits of semi-carbonised plant remains formed in freshwater-saturated environments (May & Hansom 2003). Peat only forms in freshwater wetlands and at the coast, just above or at sea-level. Example depicted in the intertidal zone on historical charts.	

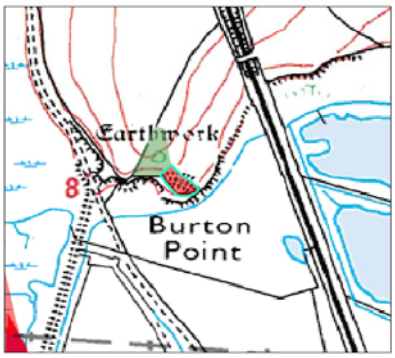
(Prehistoric land surface) Submerged forest	Tracks of submerged land with evidence of forests and undergrowth. Submerged forests contain crucial information related to past environments and human action. Areas of submerged forests are represented on historical charts by continuous black dots such as those along Mockbeggar Wharf.	
(Prehistoric land surface) Palaeochannel	An ancient or fossil stream channel preserved in the geologic record. Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future similar projects, where bibliographic sources either map extents or available sub-bottom profiling data facilitates their definition.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Coastal settlement) Historic town	A historic assemblage of public and private buildings larger than a village and having more complete and independent local government. Origins can be traced back to references, for example, in the Domesday Book. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example is the historic town by Seacombe Ferry.	

(Coastal settlement) Coastal settlement	A general description to identify a coastal settlement where no further information has been found. Hence, coastal settlements include towns, villages and farms. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example is the coastal settlement of Egremont on the Wirral.	
(Coastal settlement) Ancient field systems	An ancient group or complex of fields which appear to form a coherent whole. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. The example shown is the ancient field system at Penketh (Upper Mersey).	
(Coastal settlement) Historic settlement	A general description for a historic assemblage of public and private buildings. Origins can be traced back to references, for example, in the Domesday Book. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example is the historic settlement at Seacombe.	

(Coastal settlement) Medieval townfields	A medieval group or complex of fields, particularly exemplified by urban based agricultural enclosures. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example of this is the medieval townfield systems at Meols.	
(Coastal settlement) Modern field systems	A modern group or complex of fields which appear to form a coherent whole. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. The example shown is the modern field system at Altcar, Sefton.	
(Coastal settlement) Historic field systems	A historic group or complex of fields which appear to form a coherent whole. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example is the historic field systems by Ince Marsh (Upper Mersey).	

(Coastal settlement) Coastal village	A collection of dwelling-houses and other buildings located on the coast, usually larger than a hamlet but smaller than a town with a simpler organisation and administration than the latter. This type of data has been obtained from Lancashire, Cheshire and Merseyside terrestrial HLCs. An example is the coastal village at Vauxhall represented on the image in pink.	
(Maritime safety) Coastguard installations	A building or group of buildings situated close to the sea used by coastguards to enable them to monitor the coastline (http://thesaurus.english-heritage.org.uk). An example is the coastguard station at Parkgate represented on the image in pink.	
(Maritime safety) Navigation aid	Towers or structures with powerful lights usually erected at an important or dangerous point on or near the sea-coast for the warning and guidance of mariners, but can also be erected inland for the guidance of travellers (e.g. lighthouses, land-marks) (http://thesaurus.english-heritage.org.uk). An example is the lighthouse at Hoylake represented on the image in green.	
(Maritime safety) Lifeguard area	Buildings or structures from which observation is kept of the approach of danger (e.g. boat and watch house) (http://thesaurus.english-heritage.org.uk). Lifeguard areas are often associated with holiday areas where guards monitor over the safety of holidaymakers, such as the Parade at Parkgate (area highlighted in light green).	

(Maritime safety) Lifeboat stations	Buildings designed to house a lifeboat, usually with a stone ramp to launch the boat into the sea (e.g. lifeboat house) (http://thesaurus.english-heritage.org.uk). For example, the lifeboat house by the Royal Ferry Hotel at Perch Rock.	
(Coastal military) Military practice area	An area containing buildings, structures and sites for the training of military personnel (http://thesaurus.english-heritage.org.uk). An example is the military practice area at Formby Bank represented on the image in red.	
(Coastal military) Army base	Army or military base: a building or group of buildings often surrounded by a system of fortifications used as residential and training site by members of a military land-based force (http://thesaurus.english-heritage.org.uk). For example, the barracks near Warrington.	
(Coastal military) Military area	A term included for the generic description of any area area used to defend the populace from enemy shipping and invasion attempts, for example coastal batteries. (http://thesaurus.english-heritage.org.uk).	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

(Coastal military) Military fort	A fortified place capable of containing a large force and usually located in an area to defend against enemy shipping or invasion attempts (http://thesaurus.english-heritage.org.uk). For example, the military fort at Burton Point, represented as a red area highlighted in light green.	
(Naval activity) Naval dockyard	A naval place that builds, repairs, docks or converts warships and is manned by civilian engineers and workers and administered by engineer duty officers (http://thesaurus.english-heritage.org.uk). Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Naval activity) Navy base	A naval building or group of buildings often surrounded by a system of fortifications used as residential and training site by members of a naval force (http://thesaurus.english-heritage.org.uk). Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)
(Naval Activity) Submarine Exercise Area	Areas where mariners are advised that naval submarines are likely to be operating below the surface. Although there are no examples for England's Historic Seascapes Pilot Area, WA is aware that such category exists and it is important to define for future projects.	Not utilised for England's Historic Seascapes (Liverpool Bay Pilot Project)

Attribute name: HLC_CHA_TY (HLC_CHARACTER_TYPE)
Definition: terrestrial HLC character types from neighbouring county initiatives (e.g. Cheshire, Lancashire and Merseyside)
Controls: extracted and auto-populated for the retained terrestrial HLC polygons in the 2km coastal buffer.
Sample data:

Allotment gardens
Ancient and post-medieval ornamental
Ancient and post-medieval settlement
Ancient and post-medieval woodland
Ancient enclosure
Ancient field systems
Ancient woodland
C19th field systems
C20th century agricultural improvement
C20th artificial water body
C20th communication
C20th field systems
C20th golf course
C20th industry
C20th ornamental parkland
C20th recreation
C20th settlement
Civil
Coastal rough land
Commercial
Communications
Dock and port related
Dunes
Gold course
Late post-medieval agricultural improvement
Manufacturing industry
Maritime commercial area
Medieval townfields
Modern communications
Modern enclosure
Modern industry
Modern military
Modern recreation
Modern settlement
Modern woodland
Municipal works
Natural water bodies
Not applicable
Other artificial water bodies
Other military
Other woodland
Post-medieval communications
Post-medieval enclosure
Post-medieval industry
Post-medieval ornamental parkland
Post-medieval other woodland
Post-medieval plantation
Post-medieval recreation
Post-medieval settlement
Public park
Recreational and ornamental
Residential
Saltmarsh
Sand and mudflats
Unimproved land coastal
Water

Attribute name: PERIOD
Definition: reflects time-depth. 'Period' has been defined by combining two factors for each polygon:

- The broad periods suggested by the model of sea-level change (see **Section 2.4**) to assess when the seabed was last exposed as dry land during the last marine transgression.

- Dates and periods recorded in documentary and secondary sources, as well as periods/dates associated with the polygons from the Lancashire, Cheshire and Merseyside terrestrial HLCs.

Controls: manually populated. For coastal areas, terrestrial HLC 'periods' were used. For offshore, an estimate of when the polygon began to adopt its particular 'sub_character' has been implemented.
Date ranges from MIDAS/INSCRIPTION word lists (http://www.fish-forum.info)
Examples:

- A 'historic channel' noted on a charting dating to 1838 - the model of sea-level change suggests that the channel may have formed as a natural feature and become available for 'navigation' around 6000BP hence the channel is assigned to the period Bronze Age.
- A 'modern channel' – despite having being in existence from prehistoric period, where a channel is significantly straightened and dredged to develop its current profile and has had stone training walls installed to maintain the definition of its edges, this example takes on the period of the implementation of the aforementioned works, e.g. training bank of Formby channel installed in 1910, hence Formby Channel assigned to the 'modern' period.
- The date of inception of offshore industries provides the date for the 'sub-character, Lennex oil and gas field exploration began in 1970s and hence assigned to 'Modern'
- As the present seascape character of the offshore areas of Liverpool Bay proved to be chiefly navigation and modern fisheries, in many areas time depth correspond to the date of marine transgression.

Sample data:

Late Glacial/Late Upper Palaeolithic	13000 to 10000 BC
Mesolithic	10000 to 4000 BC
Early Mesolithic	10000 to 7000 BC
Late Mesolithic	7000 to 4000 BC
Neolithic	4000 to 2200 BC
Early Neolithic	4000 to 3000 BC
Middle Neolithic	3500 to 2700 BC
Late Neolithic	3000 to 2200 BC
Bronze Age	2500 to 700 BC
Iron Age	800 BC to AD 43
Roman	AD 43 to AD 410
Saxon	410 to 1065
Medieval	1066 to 1540
Post-medieval	1540 to 1901
Modern	1901 to present

Attribute name: PRI_LNDSC_ (PRIMARY_LANDSCAPE_FEATURE)
Definition: Provision has been made to record the most salient man-made feature of the seascape.
Controls: manually populated.
Sample data: (continued over)

Active historic channel	Boating area
Active modern channel	Botanic gardens
Aggregate dredging	Brickworks
Boat and watch house	Canal
Boat house	Coastal golf course

Coastal recreation
Coastal village
Coastal way
Coastguard station
Cockling area
Commercial area
Dam
Dangerous wreck
Disused buried historical channel
Disused historical anchorage
Disused historical channel
Dock and port related industry
Dock area
Dock area and dry dock
Dock area and dock offices
Dock basin
Dockyard
Dumping ground
Ferry office
Ferry pier
Ferry port
Ferry route
Ferry terminal
Ferry
Field systems
Fish trap in modern drying area
Fishing area
Gas installation
Gas works
Golf club
Golf course
Grazing marsh
Historical anchorage
Historical canal
Historical drying area
Historical military fort
Human and animal footprints
Industrial dock area
Industrial harbour area
Industrial manufacture area
Industrial port area
Kiln
Leading mark
Leisure area
Lifeboat station
Malt kiln
Managed woodlands
Marine lake
Medieval townfields
Military area
Modern drying area
Modern fisheries protection area
Modern industry
Mooring posts
Natural reserve
Maritime debris or foul ground
Oil and gas installation
Oil terminal
Old quay works
Old works
Oyster ground
Offshore recreation
Parkland
Post-medieval fieldsystems
Post-medieval recreation
Pottery works
Public park
Quay
Recreation in dock area
Recreation
Reservoir
Riffle range
Sailing club
Sand extraction
Settlement
Sewage works
Shipbuilding yard
Sports ground
Submarine cable
Submarine telegraph
Training camp
Warehouse
Watch house
Water park
Waterway
Wharf
Wire works

Attribute name: OTHER_LAND (OTHER_LANDSCAPE_FEATURE)
Definition: since some polygons can encompass several characters, the attribute allows the recoding of additional features/characters. These secondary attributes contain relevant information for the overall Character Area descriptions.
Controls: manually populated. For this field, secondary information was combined from different sources: HER and NMR data, Lancashire, Merseyside and Cheshire terrestrial HLCs, and environmental data
Sample data: (continued over)

Active historic channel
Active modern channel
Allotment gardens
Ancient and post-medieval ornamental
Ancient and post-medieval settlement
Ancient and post-medieval wood

Ancient enclosure
Ancient field systems
Ancient woodland
Boat house in historic canal
Boating area
Boating lake
Brickworks in ancient field systems
C19th field systems and C20th century golf course
C19th field systems and in unimproved land coastal
C19th field systems
C19th panned enclosure
C20th communication
C20th industrial activity
C20th industry
C20th recreation
C20th recreation, post-medieval parkland
Coastal parkland in coastal settlement
Coastal parkland in modern drying area
Coastal parkland
Coastal recreation
Coastal settlement
Commercial shipping
Dangerous wreck
Dangerous wreck in active historic channel
Dangerous wreck in restricted navigation area
Disused historical channel
Dock and port related industry
Dock area
Dock offices
Dock
Drying area
Dumping ground
Estuarine area
Exercise area in modern field systems
Exercise area
Ferry office
Ferry pier
Ferry port
Ferry
Fishing area
Gas works
Historic settlement
Historical anchorage in active historic channel
Historical anchorage in active modern channel
Historical anchorage
Historical canal in modern drying area
Historical drying area
Historical port quarantine area
Industrial manufacture area
Lake in historical drying area
Late post-medieval agriculture improvement
Leisure area
Marina in mudflat area
Marine lake in modern drying area
Maritime commercial in estuarine areas
Maritime commercial area
Maritime debris or foul ground
Medieval deer park
Medieval townfields
Medieval townfields, post medieval industry
Modern channel
Modern communications
Modern drying area in disused buried hist channel
Modern drying area, dunes
Modern drying area, modern settlement
Modern drying area, mooring posts
Modern drying area, sand and mud flats
Modern field systems in saltmarsh area
Modern fisheries
Modern industry, mudflats
Modern recreation and woodlands
Modern woodland
Mudflats
Mussel bed
Natural water bodies
Navigation aid in modern drying area
Navigation aid in post medieval settlement
Navigation company's works
Not applicable
Old works
Peat bed
Planned enclosure of marsh
Post-medieval agricultural improvement
Post-medieval communications
Post-medieval detached housing
Post-medieval enclosed parkland
Post-medieval enclosure
Post-medieval field systems
Post medieaval field systems in salt marsh area
Post-medieval gold course, unimproved land coastal
Post-medieval ornamental parkland
Post-medieval settlement
Post-medieval woodland
Protected area
Public park
Public park, recreational and ornamental
Recreation ground in coastal settlement
Recreation in historical drying area
Recreation in modern drying area
Recreational and ornamental
Renewable energy installations
Residential
Restricted anchoring area
Restricted anchoring area, dumping ground
Saltmarsh
Sand and mudflats
Sand dunes
Sand extraction area
Settlement
Sports ground
Unimproved land coastal
Warehouse
Waterway
Woodland

Attribute name: PRI_INT_IND (PRIMARY_INTRUSIVE_INDUSTRY)
Definition: attribute recording main intrusive industrial activities that represent continuous and incremental impact on the marine and intertidal zones
Controls: auto-populated combining character types and sub-characters as well as SeaZone offshore development data, JNCC data and terrestrial HLC polygons
Sample data:
Aggregate dredging
Dumping ground
Gas installations
Not applicable
Oil and gas installation
Oil terminal
Modern fisheries
Unknown

Attribute name: NO_INT_IND (NON_INTRUSIVE_INDUSTRY)
Definition: attribute recording intrusive industrial activities not presenting a continuous and incremental impact on the seabed.
Controls: manually derived and populated from a combination of JNCC data, nautical almanacs and routes derived from England's Historic Shipping projects.
Sample data:

Commercial shipping

Attribute name: NLO_AREA
Definition: named Locations' or NLOs are a recording practice developed by the NMR to allow historical references to shipping losses to be incorporated into the Maritime Record. These losses are attributed to an arbitrary point or polygon on a chart or map that is near of the presumed area of loss or 'named location' (NLO), e.g. 'Burbo Banks' or 'Off Formby Point' (see **Section 3.2.1**). These NLO losses and groundings are very generally located in an area rather than a specific location. This attribute records the NLO polygon encompassing the near level polygon.
Controls: auto-populated from NLO polygons map
Sample data:

Ainsdale
Blackpool
Bootle Bay
Burbo Bank
Crosby Channel
Crusaders Bank
Formby Bank
Formby Light
Formby Point
Heswall
Hilbre Island
Hoyle
Jordan Spit
Liverpool bay
Lytham
Mockbeggars wharf
Near Preston
North bank
Not applicable
Off Blackpool
Off Formby
Off Southport
Parkgate
Queens Channel
River Mersey and Docks
River Ribble
Rock Cut
Salisbury Bank
Salters Bank
Shell Wharf
Southport
Spencers spit
St George's Bank
Taylor
West Hoyle
West Kirby
Zebra Flat

Attribute name: SEDIMENT
Definition: loose material derived from the weathering and erosion of pre-existing rocks or from biological activity (e.g. shells or organic matter) or from chemical precipitation. Note: licence restrictions.
Controls: auto-populated. Polygons created from BGS data. Terminology is as BGS original data. Deleted from attribute analysis layer on transfer to NMR.
Sample data: (continued over)

Coastal area
Gravelly muddy sand [marine sediment]
Gravelly sand [marine sediment]
Muddy sand [marine sediment]
Muddy sandy gravel [marine sediment]
Sand [marine sediment]
Slightly gravelly muddy sand [marine sediment]
Slightly gravelly sand [marine sediment]
Undifferentiated bedrock lithology
No data

Attribute name: MORPHOLOGY
Definition: the form and structure of the seafloor. This type of information, integrated with sediment data, contributes to an assessment of the general environment and preservation potential. Note: licence restrictions.
Controls: bedforms shown in various publications (derived from BGS) and FutureCOAST morphology data.
Sample data:

Dunes, mud/clay foreshore
Dunes, rock foreshore
Dunes, shingle foreshore
Estuarine
Lowland, mud/clay foreshore
Lowland, sandy foreshore
Sand dunes
Sand ribbon
Sandwave field
Sandy beach ridge
Sandy cliff
Sandy lowland
Smooth bedform
Variable seabed, subdued slopes
No data

Attribute name: HABITAT
Definition: a combination of geophysical and hydrographical data to obtain biological information to classify marine habitats and to set marine nature conservation priorities (Vincent et al 2004).
Controls: JNCC data for the Irish Sea Pilot Project. Terminology is as JNCC original data.
Sample data:

Coastal sediment	Water depth: intertidal-50m; substratum: mud, sands and gravels; bed stress/current: variable; topography and additional criteria: adjacent to coastline (Vincent et al 2004: 36)
Estuary	Water depth: 0-30m; substratum: mixed; bed stress/current: variable; topography and additional criteria: variable (Vincent et al 2004: 36)
Fine sediment plains:	Variable water depth; substratum: sand and muddy sands; bed stress/current: weak currents; topography and additional criteria: negligible slopes (Vincent et al 2004: 36)

Low-bed stress coarse sediment plains:	Variable water depth; substratum: cobbles, pebbles and muddy gravels; bed stress/current: low bed-stress; topography and additional criteria: negligible slopes (Vincent et al 2004: 36)

Attribute name: TIDAL_RANG (TIDAL_RANGE)
Definition: the range of tidal variation between mean low water (MLW) and mean high water (MHW).
Controls: DTI data.
Sample data:

High (7-8m)
Medium (6-7m)
Terrestrial area

Attribute name: SEALEVEL (SEALEVEL)
Definition: reflects the approximate period or millennium during which the landscape was inundated during the most recent phase of marine transgression.
Controls: polygons created from sea-level change model (**Section 2.4**).
Sample data:

12500 – 10000BP
10000 - 8000BP
8000 - 6000BP
6000 - 4000BP
4000 -2700BP
2700BP - present day
Current

Attribute name: P_IMPACT (POTENTIAL_IMPACT)
Definition: a broad scale assessment of the impact of modern human activities on the marine environment and which consequently also have the potentially to disturb archaeological deposits.
Controls: data combined from habitats and industry polygons.
Sample data:

High	Areas where human activities are likely to have highly disturbed the marine and intertidal environment, such as dredging activities. These types of activities therefore have the potential to a high impact on archaeological remains.
Moderate	Human activities that moderately disturb the marine and intertidal environment, such as fishing. These types of activities therefore have the potential to have a moderate impact on archaeological remains.
Low	Human activities that have a low impact on the marine and intertidal environment, such as some forms of recreation. These types of activities therefore have a low impact on archaeological remains.

Not applicable

Attribute name: LOCATION
Definition: refers to broad area where polygons are located
Controls: Auto-populated from 'location' layer.
Sample data:

Coastal	The coast is where the land and water meet (Fulford et al 1997: 22). This definition rises many different definitions and for this reason EH considers the concept of coastal zone more appropriate (*ibid.*) The coastal zone is an environment of ecological economic contrasts and dynamism reflecting the interplay of fluctuating terrestrial and maritime influences (Fulford et al 1997: 57). Therefore, the coastal zone is the landward area susceptible to damage from coastal processes which begins where the intertidal zone ends.
Estuarine	Low energy environment characterised by an inlet of the sea reaching into a river valley as far as the upper limit of tidal rise (Fulford et al 1997; May & Hansom 2003).
Intertidal	The intertidal zone is part of the coastal zone but specifically it is the area exposed at low water or the zone between high tide and low tide (McErlean et al 2002).
Marine	The marine zone is the area where the intertidal zone ends and the sea begins. It is that zone relating to or characteristic of the sea; existing, originating, or found in the sea; produced by the sea; inhabiting or growing in the sea. Source: Online Oxford Dictionary (http://dictionary.oed.com/).

Attribute name: CONFIDENCE
Definition: This field represents the degree of certainty assigned to the complete coding used for each polygon.
Controls: manually populated
Sample data:

Certain
High likelihood of certainty
Good basis for certainty
Probable

Attribute name: CHECKED_BY
Definition: initials of the person checking the information contained within the attributes for each polygon.
Controls: manually populated
Sample data: NC

Attribute name: Shape_Length
Definition: field auto-generated by GIS
Controls: autogenerated by ArcGIS
Sample data: 7134.95325703214

Shape: Shape_Area
Definition: field auto-generated by GIS
Controls: autogenerated by ArcGIS
Sample data: 2790691.82795003

6.3 CHARACTER AREA MAP DATA STRUCTURE

The final 'Character Area' map has the following data structure:

Attribute Name	Population method
Object_ID	System generated
WA ID	System generated
AREA_NAME	Manually
URL	Manually
Shape_length	System generated
Shape_area	System generated

6.4 CHARACTER AREA MAP ATTRIBUTE DEFINITIONS AND TERMINOLOGY

The Character Area Map has the following attributes:

Attribute name: OBJECTID
Definition: default number generated by GIS
Controls: autogenerated by ArcGIS
Sample data: 1, 2, 3, 4, 5, 6, 7, etc.

Attribute name: WAID
Definition: unique ID for each new polygon (WA reference number)
Controls: autogenerated system controlled
Sample data: 1, 2, 3, 4, 5, 6, 7, etc.

Attribute name: AREA_NAME
Definition: name of each Character Area
Controls: generated from the observation of patterning from displaying the Character Type map, and from the inclusion of place names and NLO polygons
Sample data:

Blackpool
Bootle Bay
Burbo Bank
Crosby Channel
Crusadar Bank
Dee Estuary
East Hoyle Bank
East Hoyle Spit
Formby Bank
Formby Light
Formby Spit
Great Bank
Great Burbo Flats
Gut Channel
Hamilton Gas Field
Hilbre Swash
Jordan Spit
Lime Wharf
Little Burbo
Liverpool Dredging Area
Liverpool Bay
Lune Deep
Mad Wharf Sands
Marshside Sands
Mockbeggar Wharf
Morecambe Light
North Bank
North Shore
Off Blackpool
Off Formby
Off Heysham
Off Southport
River Mersey and Docks
River Ribble
Rossall Oyster Ground
Rossall Patches
Rossall Point
Shell Flat
South Channel
South Gut
Tailors Bank
Upper Mersey
Upper Ribble
Zebra Flats

Attribute name: URL
Definition: hyperlink to the .html pages relating to the character area
Controls: name of page and location of page in overall project file structure.
Sample data:

html/Blackpool/index.html
html/Bootle_Bay/index.html
html/Burbo_Bank/index.html
etc.

Attribute name: Shape_length
Definition: field auto-generated by GIS
Controls: autogenerated by ArcGIS
Sample data: 7134.95325703214

Shape: Shape_area
Definition: field auto-generated by GIS
Controls: autogenerated by ArcGIS
Sample data: 2790691.82795003

7. DELIVERING THE FINAL PRODUCT TO NMR

As noted in section 2.1 the restrictions of copyright and usage agreements with the external data suppliers necessitated the deletion some of intermediate themed mapping and attributes from character analysis map submitted to the NMR for curation.

Deleted intermediate themed mapping:

- Industry
- Geological Data
- Geomorphology

Deleted attributes from character analysis map:

- Sediment
- Morphology
- Tidal Range

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Useful Web Links

www.esri.com
http://dictionary.oed.com
http://thesaurus.english-heritage.org.uk
www.enchantedlearning.com/Iisfor.shtml
www.mbayaq.org/efc/efc_eqf/glossary_gl.html
www.horseshoecrab.org/misc/glossary.html
www.sitesalive.com/oil/tg/private/oiltgglossary.html
www.botany.uwc.ac.za/presents/seashore1/glossary.htm
www.ukmarinesac.org.uk
http://www.dti.gov.uk/energy/renewables/publications/pdfs/meanspringtidalrange.pdf
www.english-heritage.org.uk/characterisation

GLOSSARY

ArcGIS Spatial Analyst
An ArcGIS extension that provides spatial modelling and analysis features. It allows the creation, querying, mapping, and analysis of cell-based raster data and integrated vector.

ArcInfo workspace
A file-based collection of coverages, grids, TINs, or shapefiles stored as a directory of folders in the file system.

ArcToolbox
A user interface in ArcGIS used for accessing and organizing a collection of geoprocessing tools, models, and scripts. ArcToolbox and ModelBuilder are used in concert to perform geoprocessing.

Attribute
Information about a geographic feature in a GIS, usually stored in a table and linked to the feature by a unique identifier. For example, attributes of a river might include its name, length, and average depth.
In raster datasets, information associated with each unique value of raster cells.
Cartographic information that specifies how features are displayed and labelled on a map; the cartographic attributes of a river might include line thickness, line length, colour, and font.

Attribute query
A request that selects features or records from a database containing information about a geographic feature in a GIS, generally stored in a table and linked to the feature by a unique identifier.

Attribute table
A database or tabular file containing information about a set of geographic features, usually arranged so that each row represents a feature and each column represents one feature attribute. In raster datasets, each row of an attribute table corresponds to a certain zone of cells having the same value. In a GIS, attribute tables are often joined or related to spatial data layers, and the attribute values they contain can be used to find, query, and symbolize features or raster cells.

Bathymetry
The science of measuring and charting the depths of water bodies to determine the topography of a lake bed, seafloor, or ocean bottom.

Bedforms
Features on the seabed (e.g. sandwaves, ripples) resulting from the movement of sediment over it, from seabed erosion, from deposition of stable sediment

CAD
Computer-aided design. A computer-based system for the design, drafting, and display of graphical information. Also known as computer-aided drafting, such

systems are most commonly used to support engineering, planning, and illustrating activities.

Centroid
The geometric centre of a feature. Of a line, it is the midpoint; of a polygon, the centre of area; of a three-dimensional figure, the centre of volume.

Characterisation
Characterisation is a method of informing the management of change in the historic environment by tracing the imprint of history on the present landscape. Piecing together information from maps new and historic, from aerial photos, and from the wealth of data that we already have about archaeology and buildings, it builds up area-based pictures of how places in town and country have developed over time. Using GIS-based map techniques, it shows how the past exists within today's world.

Cleaning
Improving the appearance of scanned or digitized data by correcting overshoots and undershoots, making lines thicker or thinner, closing polygons, and so forth.

Clip
In ArcInfo, a command that extracts the features from one coverage that reside entirely within a boundary defined by features in another coverage (called the clip coverage).

Coordinate system
A reference system used to measure horizontal and vertical distances on a planimetric map. A coordinate system is usually defined by a map projection, spheroid of reference, a datum, one or more standard parallels, a central meridian, and possible shifts in the x- and y- directions to locate x,y positions of point, line and area features
An item in ArcCatalog representing a projection file, which contains the param defining a coordinate system. The contents of the projection file can either be in the format defined by ArcWorkstation or in the format defined by ArcCatalog.

Database
One or more structured sets of persistent data, managed and stored as a unit and generally associated with software to update and query the data. A simple database might be a single file with many records, each of which references the same set of fields. A GIS database includes data about the spatial locations and shapes of geographic features recorded as points, lines, areas, pixels, grid cells, or TINs, as well as their attributes.

Data standard
Data standard allows you to describe your digital assets with consistency as well as establishing the use of a common terminology that can be readable both by people and machines.

Datum
In the most general sense, any set of numeric or geometric constants from which other quantities, such as coordinate systems, can be defined. A datum defines a reference

surface. There are many types of datums, but most fall into two categories: horizontal and vertical.

Dissolve
A geoprocessing command that removes boundaries between adjacent polygons that have the same value for a specified attribute.

Dissolve route events
In linear referencing, a procedure that combines event records in tables where there are events on the same route that have the same value for specified fields. The Dissolve Route Events tool combines events when there is measure overlap, and is available for both line and point event tables.

Feature
A representation of a real-world object on a map. Features can be represented in a GIS as vector data (points, lines, or polygons) or as cells in a raster data format. To be displayed in a GIS, features must have geometry and locational information.
A group of spatial elements that together represent a real-world entity. A complex feature is made up of more than one group of spatial elements: for example, a set of line elements with the common theme of roads representing a road network.

Feature class
A collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." In a geodatabase, feature classes can also store annotation and dimensions.

Geodatabase
A collection of geographic datasets for use by ArcGIS. There are various types of geographic datasets, including feature classes, attribute tables, raster datasets, network datasets, topologies, and many others.

Geodatabase data model
The schema for the various geographic datasets and tables in an instance of a geodatabase. The schema defines the GIS objects, rules, and relationships used to add GIS behaviour and integrity to the datasets in a collection.

Geodatabase feature dataset
In a geodatabase, a collection of feature classes stored together so they can participate in topological relationships with one another. All the feature classes in a feature dataset must share the same spatial reference; that is, they must have the same coordinate system and their features must fall within a common geographic area. Feature classes with different geometry types may be stored in a feature dataset. In ArcGIS, feature classes that participate in a geometric network must be placed in a feature dataset.

Georeferencing
Aligning geographic data to a known coordinate system so it can be viewed, queried, and analyzed with other geographic data. Georeferencing may involve shifting, rotating, scaling, skewing, and in some cases warping or rubber sheeting the data.

Grid
In cartography, any network of parallel and perpendicular lines superimposed on a map and used for reference.

HTML
Hypertext markup language. An HTML file contains text and tags instructing an Internet browser application on how to present the text.

Input data
Data that is entered into a computer, device, program, or process.

ISO
Acronym for *International Organization for Standardization*. A federation of national standards institutes from 145 countries that works with international organizations, governments, industries, businesses, and consumer representatives to define and maintain criteria for international standards.

Isobath
Lines joining points of similar value on a vertical axis (e.g. land heights and water depths).

Layer
The visual representation of a geographic dataset in any digital map environment. Conceptually, a layer is a slice or stratum of the geographic reality in a particular area, and is more or less equivalent to a legend item on a paper map. On a road map, for example, roads, national parks, political boundaries and rivers are examples of different layers.
In ArcGIS, a reference to a data source, such as a coverage, geodatabase feature class, raster, and so on, that defines how the data should be symbolized on a map. Layers can also define additional properties, such as which features from the data source are included. Layers can be stored in map documents (.mxd) or saved individually as layer files (.lyr). Layers are conceptually similar to themes in ArcView 3.x.

Map topology
A temporary set of topological relationships between coincident parts of simple features on a map, used to edit shared parts of multiple features.

Mean sea-level
The average height of the surface of the sea for all stages of the tide over a nineteen-year period, usually determined by averaging hourly height readings from a fixed level of reference.

Merge policy
In geodatabases, rules that dictate what happens to the respective attributes of features that are merged together during editing in ArcMap. A merge policy can be set to

assign a default value to the new attribute, summarize the values of the merged attributes, or create a weighted average from the merged attributes.

Merging
Combining input features from multiple input data sources of the same data type into a single, new, output feature class.

Metadata
Information that describes the content, quality, condition, origin, and other characteristics of data or other pieces of information. Metadata for spatial data may document its subject matter; how, when, where, and by whom the data was collected; availability and distribution information; its projection, scale, resolution, and accuracy; and its reliability with regard to some standard. Metadata consists of properties and documentation. Properties are derived from the data source (for example, the coordinate system and projection of the data), while documentation is entered by a person (for example, keywords used to describe the data).

Morphology
The structure, form and arrangement of rocks in relation to the development of landforms.

Point
A geometric element defined by a pair of x,y coordinates.

Polygon
On a map, a closed shape defined by a connected sequence of x,y coordinate pairs, where the first and last coordinate pair are the same and all other pairs are unique.

Polyline
In ArcGIS software, a shape defined by one or more paths, where a path is a series of connected segments. If a polyline has more than one path (a multipart polyline) the paths may either branch or be discontinuous.

Projected coordinate system
A reference system used to locate x, y, and z positions of point, line, and area features in two or three dimensions. A projected coordinate system is defined by a geographic coordinate system, a map projection, any param needed by the map projection, and a linear unit of measure.

Projection
A method by which the curved surface of the earth is portrayed on a flat surface. This generally requires a systematic mathematical transformation of the earth's graticule of lines of longitude and latitude onto a plane. It can be visualized as a transparent globe with a light bulb at its centre casting lines of latitude and longitude onto a sheet of paper. Generally, the paper is either flat and placed tangent to the globe (a planar or azimuthal projection) or formed into a cone or cylinder and placed over the globe (cylindrical and conical projections). Every map projection distorts distance, area, shape, direction, or some combination thereof.

Query
A request that selects features or records from a database. A query is often written as a statement or logical expression.

Raster
A spatial data model that defines space as an array of equally sized cells arranged in rows and columns (e.g. images in .TIFF, .JPG, .GIF, .BMP and .PNG file extensions). Each cell contains an attribute value and location coordinates. Unlike a vector structure, which stores coordinates explicitly, raster coordinates are contained in the ordering of the matrix. Groups of cells that share the same value represent the same type of geographic feature.

Reference data source
In ArcGIS, a spatial data layer that a geocoding service uses to perform address geocoding. A reference data source can be any point, line, or polygon feature class that contains the necessary address attributes. Each address component is stored as a separate attribute. The address attributes can be contained in the reference data source itself or in a table joined to it.

Relational database
A data structure where collections of tables are logically associated with each other by shared attributes. Any data element can be found in a relation by knowing the name of the table, the attribute (column) name, and the value of the primary key.

Relationship
An association or link between two objects in a geodatabase. Relationships can exist between spatial objects (features in feature classes), between nonspatial objects (rows in a table), or between spatial and nonspatial objects.

Reference system
A method for identifying positions on the globe. This is often constructed with a grid that either refers to the earth's latitude and longitude (graticule), or a planar equivalent that divides grid lines by a fixed length from a predefined point of origin.

Sediment
Particulate matter derived from rock, minerals or biogenic matter.

Shapefile
A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

Topology
In geodatabases, the arrangement that constrains how point, line, and polygon features share geometry. For example, street centerlines and census blocks share geometry, and adjacent soil polygons share geometry. Topology defines and enforces data integrity rules (for example, there should be no gaps between polygons). It supports topological relationship queries and navigation (for example, navigating feature adjacency or connectivity), supports sophisticated editing tools, and allows feature

construction from unstructured geometry (for example, constructing polygons from lines).

Vector
A coordinate-based data model that represents geographic features as points, lines, and polygons. Each point feature is represented as a single coordinate pair, while line and polygon features are represented as ordered lists of vertices. Attributes are associated with each feature, as opposed to a raster data model, which associates attributes with grid cells.

Union
A topological overlay of two or more polygon spatial datasets that preserves the features that fall within the spatial extent of either input dataset; that is, all features from both datasets are retained and extracted into a new polygon dataset.

Workspace
A container for geographic data. A workspace can be a folder that contains shapefiles, a geodatabase, a feature dataset or an ArcInfo workspace. Other multidimensional datasets like netCDF or HDF can also be considered workspaces, and are often treated in this manner within GIS software packages.

XML
Acronym for *Extensible Markup Language*. Developed by the World Wide Web Consortium (W3C), XML is a standardized general purpose markup language for designing text formats that facilitates the interchange of data between computer applications. XML is a set of rules for creating standard information formats using customized tags and sharing both the format and the data across applications.

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