Vattenfall Wind Power Ltd
1st Floor
1 Tudor Street
London
EC4Y 0AH

Kate Mignano
Temple Quay House
2 The Square
Bristol
BS1 6PN

Date: 02/01/2019
Contact: Daniel Bates (Consents Manager)
E-mail: Daniel.bates@vattenfall.com
Phone: 07976 783478

Thanet Extension Offshore Wind Farm – EN010084

Submission of Nemolink Interconnector planning documents

Dear Ms Mignano,

As requested by the Examining Authority (ExA) in Annex E of the rule 6 letter, enclosed is a USB drive containing the publicly available planning and environmental documents including the planning consent for the Nemolink Interconnector.

I would like to confirm that these documents have been submitted purely on the request of the ExA and that the Applicant does not rely on or refer to these documents in the Application and does not intend to (unless requested) during the examination.

Kind regards

[redacted]

Daniel Bates
Consents Manager – Thanet Extension Offshore Wind Farm
Vattenfall Wind Power Ltd

Nemo Link®

Development of an Interconnector between the United Kingdom and Belgium

February 2013

Elia
Boulevard de l'Empereur 20
B-1000 Brussels

National Grid Nemo Link Limited
1 – 3 Strand
London
WC2N 5EH

Nemo Link is a registered Trade Mark

Development of an Interconnector between the United Kingdom and Belgium

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1 Introduction

1.1 A 1000MW subsea electricity interconnector is being jointly developed by National Grid Nemo Link Limited ("NGNLL")[2] and the Belgian transmission company Elia (together referred to as the Nemo Consortium). The project, known as the Nemo Link, will connect the UK and Belgian electricity transmission systems by means of subsea cables between Richborough, Kent and West Zeebrugge in Belgium. It is proposed that the Nemo Link will become operational in 2018.

1.3 This report explains the need for an electricity interconnector linking the UK with Belgium and describes the role that interconnectors can play in the efficient operation of electricity markets and in supporting renewable energy and security of supply.

1.4 This document and other information regarding the Nemo Link can be found on the project website

http://www.nemo-link.com

2 Background

The Electricity Market in Great Britain

2.1 A single electricity market serves the whole of Great Britain. The market comprises competing generators and suppliers. Generators produce electricity from a variety of fuel sources, including coal, gas, nuclear and wind, and sell into the electricity wholesale market.

2.2 Supply companies purchase electricity in the wholesale market and supply to end customers. Transmission and distribution companies, which are licensed monopolies in their respective areas, carry bulk supplies of electricity from power stations, and distribute supplies to end customers. National Grid

[2] National Grid Nemo Link Limited is a subsidiary company of National Grid plc for the development of the Nemo Link. More information about the Nemo Consortium companies is provided in Appendix 1.

Electricity Transmission plc ("NGET") is the operator of the high-voltage transmission system for the whole of Great Britain and the owner of the high voltage transmission network in England & Wales[3].

2.3 Annual electricity demand in Great Britain is around 310 Terra Watt hours. This value represents the total amount of electrical energy used in one year and is equivalent to 310m heaters rated at 1000 Watts all operating for 1 hour. The peak electricity demand occurs in winter and is over 60 GW. The minimum demand occurs in summer and is approximately 40% of peak (~24GW).

2.4 The combined capacity of all the generators is greater than peak demand. The excess of generation capacity over maximum demand, known as the "Plant Margin", is needed to ensure that maximum demand can be met, allowing for fluctuations in the levels of maximum demand and available generating capacity.

2.5 The electricity industry in Great Britain is undergoing unprecedented change. In the next few years, 12GW of coal-fired power stations will close, as they cannot meet the new requirements of European emissions legislation. At the same time, around 7.5GW of nuclear capacity will come to the end of its operating life. This reduction in existing generating capacity, and consequent reduction in Plant Margin, means a huge investment in new generating capacity is needed including investment in new interconnection between the UK and Europe and Scandinavia. Furthermore, the need to tackle climate change requires a major investment in generation from low-carbon sources, such as wind, nuclear and efficient gas-fired plant.

Climate Change Targets

2.6 The UK has two key environmental targets relating to renewable energy and greenhouse gas emissions. The first of these targets is part of the European Union's (EU) integrated energy/climate change proposal. This proposal sets a target of 20% of European Energy (including electricity, heat & transport) to come from renewable sources by 2020 (known as the EU 20/20/20 vision)[4]. The Renewable Energy Strategy[5] (published in July 2009) identified that, for

[3] The transmission network in Scotland is owned by Scottish Power Transmission Limited in southern and central Scotland and by Scottish Hydro-Electric Transmission Limited in the north of Scotland.

[4] http://www.energy.eu/directives/com2008_0030en01.pdf

[5] **http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx**

the UK to meet its share of the EU target (UK's share is 15% of energy sources including electricity, heat and transport), 30% of the UK's electricity would have to come from renewable sources.

2.7 The second target is incorporated in the Climate Change Act 2008 [6]. This goes further than the EU 20/20/20 vision, and sets a target of 80% reduction in UK greenhouse gas emissions from 1990 levels by 2050. This equates to a 34% reduction in greenhouse gas emissions by 2020 as specified by the Climate Change Committee[7].

The Legislative and Licensing Framework

2.8 Generation, Supply and Transmission of electricity are all licensable activities in Great Britain under the Electricity Act 1989 (as amended) ("the Electricity Act"). The development and operation of an Interconnector is a separate licensable activity under the Electricity Act.

2.9 The Electricity Act requires that the holder of an Interconnector Licence (or its subsidiaries) cannot also hold a Generation, Supply or Transmission Licence. As National Grid Electricity Transmission plc ("NGET") holds a Transmission Licence in respect of its operation of the transmission system in Great Britain, the Nemo Link is being developed (with Elia) by a separate National Grid company, National Grid Nemo Link Limited ("NGNLL"). NGNLL has applied for an Interconnector Licence for the Nemo Link.

3 The Role of Interconnectors

Concept

3.1 Interconnectors connect a transmission system in one country with another. Where a border is land based the interconnector will typically take the form of an overhead line or cable and will appear no different to that of the domestic transmission system. The transmission systems in Great Britain and mainland Europe operate at a frequency of 50Hz and, where two transmission systems are linked, they both have to operate at the same frequency.

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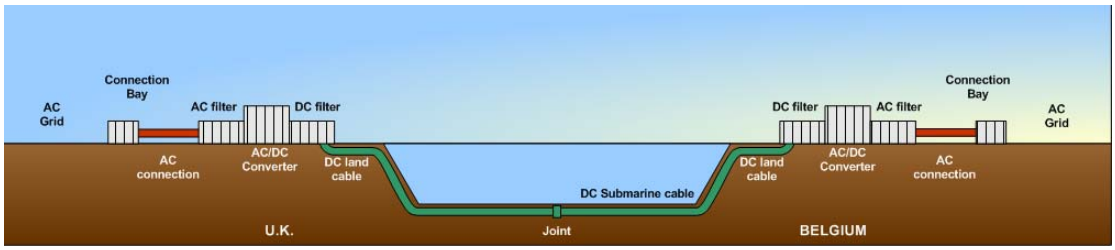
http://www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/Energy%20mix/Renewable%20energy/Renewable%20Energy%20Strategy/1_20090717120647_e_@@_TheUKRenewableEnergyStrategy2009.pdf

[6] http://www.opsi.gov.uk/acts/acts2008/ukpga_20080027_en_1

[7] http://www.theccc.org.uk/

3.2 Where national electricity transmission systems are separated by sea it is only possible to use sub-sea cables to connect the two systems. If the distance across the sea is greater than ~50km then High Voltage Direct Current (HVDC) technology is more cost effective than AC undersea cable. The shortest distance between the UK and Belgium is over 100km, and therefore an HVDC interconnector between the two countries is preferred. The use of HVDC also avoids the necessity to synchronise the two interconnected AC networks. A typical HVDC interconnector configuration is shown in the illustration below.



A typical HVDC interconnector configuration

3.3 The configuration consists of two converter stations (one in each country connected to its respective high voltage transmission systems) connected through HVDC subsea cables. The link operates by taking AC power from one system and converting it from AC to DC. The electricity, in DC form, is then transported via the subsea cables to the receiving converter station where it is then converted back from DC to AC for use on the receiving system.

3.5 Interconnectors can therefore provide power to or from a transmission system, thereby acting as either a source of generation or demand within the system.

Interconnectors and Electricity Prices

3.6 The direction of flow on an interconnector is largely determined by any price differential between the two systems. Power will be bought in the lower priced country and sold in the higher priced country. The price differential between the two countries is referred to as the arbitrage. Where the arbitrage is large, it is likely that the interconnector will flow to its maximum capacity. For example, where wholesale electricity prices in the UK are higher than in Europe, the interconnector would allow power to be bought in Europe and sold in the UK wholesale market. Conversely, where power prices were higher in Europe than in UK, power would be bought in the UK and sold into the European markets. Physical power flows on the interconnector reflect the direction of trade.

3.7 Belgium is heavily interconnected with central Europe, so a UK-Belgium link provides further opportunities to trade power between the wider Continental European power markets and the UK, thereby further contributing to downward pressure on wholesale prices.

3.8 Interconnectors also tend to reduce the frequency and severity of high price spikes in both interconnected markets.

Supporting Renewable Energy and Security of Supply

3.9 The UK's current generation portfolio comprises of mainly thermal plants such as nuclear, coal and gas fired power stations where each fuel source contributes to around one third of the total used to generate electricity. Coal is regarded as a heavily polluting fossil fuel. Gas is used for both power generation and domestic and industrial heating. Whilst the UK has enjoyed an abundance of natural gas from the North Sea Continental Shelf (NSCS), these supplies are reducing and the UK is increasing its reliance for gas from overseas either piped directly to the UK or shipped in the form of Liquefied Natural Gas to an importation terminal. As a result of securing gas from non-indigenous sources, its availability is increasingly subject to international supply and demand pressures including geopolitical issues.

3.10 As a consequence of the Large Combustion Plant Directive, 12GW of coal fired generation plant is due to be decommissioned by 2016. Additionally, 7.5GW of aged nuclear reactors are due to be decommissioned by 2020 as they reach the end of their service lives. The anticipation is that it will take around 15 years to plan and build new nuclear generation facilities. Personal energy consumption is increasing as a result of changing lifestyles and a growing population. There is therefore, an increasing need to satisfy demand whilst the UK moves to new forms of generation.

3.11 The UK Government's vision to ensure safe, secure and affordable supplies for the future involves the construction of a new fleet of nuclear generation, rapid expansion of renewable energy (mainly through offshore wind), and the development of interconnector projects. Specifically, the UK is committed to the European Commission's 3rd energy package which states that 15% of the UK's demand for energy needs to be generated from renewable sources by 2020. To meet this target, the UK will need an energy portfolio of 34% wind generating capacity by 2020, rapidly building on 4% wind capacity of today. The vast majority of this wind capacity is expected to be obtained from the

Crown Estate's licensed Round 3 Development Zones which has the aim to install 25 GW of offshore wind capacity by 2020. This huge investment into the UK Renewables sector is part of an aspiration to develop a large-scale green industry to boost the UK economy and create jobs.

3.12 By its nature, wind generation is intermittent. It is therefore necessary to have plant and equipment that can respond to rapid changes in generating output. Interconnectors, such as the one proposed between the UK and Belgium, provide an effective way to manage these fluctuations in supply and demand.

4 Policy Support for Interconnectors

European Context

4.1 European strategy recognises the urgent need to upgrade Europe's energy infrastructure and to interconnect networks across borders to meet the EU's core energy policy objectives of competitiveness, sustainability and security of supply[8].

4.2 These objectives are supported by European policy which facilitates the urgent upgrading and extension of electricity networks, including interconnectors, to maintain existing levels of security of supply and, in particular, to transport and balance electricity from renewable sources, which is expected to more than double in the period 2007 to 2020.

4.3 Interconnectors enable power to flow between member state transmission networks and are vital for ensuring a competitive and well-functioning integrated market for energy. Despite the existence of common rules for the internal market in electricity, the European Commission has recognised that the internal market remains fragmented due to insufficient interconnections between national energy networks.

4.4 In 2002 the EU Council set a target for all Member States to have electricity interconnections equivalent to at least 10% of their installed production capacity by 2005. The UK is still failing to meet this target. Total UK interconnection capacity amounts to 3.5GW which represents just over 4% of the 85 GW of installed generation capacity.

[8] "Europe 2020" EC Communication (2010) 2020.

4.5 In December 2009 the UK and Belgium both became signatories to the North Seas Countries Offshore Grid Initiative (NSCOGI) with the objective to coordinate offshore wind and infrastructure developments in the North Sea. Interconnection between countries is a prerequisite to achieving this ambition.

4.6 This initiative was endorsed by the European Commission in its Communication dated 17th November 2010 titled "Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network". That document called for a new EU energy infrastructure policy to co-ordinate and optimise network development at a European level. As part of the implementation of this policy, the Commission has identified a limited number of trans-European priority corridors for which EU action is most warranted. The list of priority corridors in the electricity sectors includes the offshore grid in the North Sea[9].

4.7 Development of an interconnector of 1000MW between the UK and Belgium will contribute towards achieving the UK's interconnection capacity target set by the European Council whilst establishing infrastructure identified as a pre-requisite to the development of the NSCOGI.

United Kingdom Context

4.8 Currently, the UK has three interconnectors providing a total of up to 3,500MW of power transfer capability:

- UK – France: Known as IFA (Interconnexion France Angleterre), this is a 2000MW HVDC connection commissioned in 1986. It is jointly owned and operated by National Grid Interconnectors Limited and Reseau de Transport d'Electricite.

- UK – Netherlands: Known as BritNed, this is a 1000MW HVDC connection commissioned in 2011. It is owned and operated by BritNed Development Limited which is a joint venture of Dutch Transmission System Operator TenneT and National Grid Holdings One Plc, a subsidiary of National Grid Plc.

- Scotland – Northern Ireland: Known as the Moyle interconnector, this is a 500MW connection between Scotland and Northern Ireland. It was

[9] See Proposal for a Regulation of the European Parliament and Council on guidelines for trans-European energy infrastructure and repealing Decision No. 1364/2006/EC (2011/0300 (COD))

commissioned in 2001 and is operated by SONI (System Operator Northern Ireland) on behalf of Northern Ireland Energy Holdings.

4.9 The 7th Report of the Energy and Climate Change Parliamentary Committee which looks at the case for a European Supergrid refers to the role of interconnectors in realising such a prospect. With the increasing deployment of intermittent renewable generation the Committee noted in its report that intermittency poses two problems:

- it will increase price volatility; and
- it will damage grid stability, increasing the challenge of system balancing and system reliability.

4.10 The report also noted that renewable energy has prompted additional demand for reserve and response operations in order to balance out unpredictable peaks and troughs in supply. This will be expensive and present challenges in terms of achieving adequate supply when it is needed. This trend will get worse as EU member states increase the deployment of wind power and other intermittent renewable energy sources to deliver the 20% renewable target formulated in the European Renewables Directive of 2009.

4.11 Importantly, the report acknowledged that increased interconnection with European and Scandinavian transmission systems could offer scope for flexibility.

Regulatory Context

4.12 In January 2010, the energy regulator Ofgem (Office of Gas and Electricity Markets) published a consultation on Electricity Interconnector Policy. The target audience was electricity traders, transmission companies, interconnector developers, generators and suppliers, customer representatives and other interested parties across the UK and Europe.

4.13 It was acknowledged in this consultation that:

"The GB electricity market currently has limited interconnection with other markets but this is expected to increase significantly in the decade ahead. In part, this reflects the expectation that increased interconnection will help

accommodate the expected huge increase in intermittent wind generation and will contribute to security of supply".

4.14 To date in Great Britain, interconnectors have been developed as stand-alone projects outside the price-controlled transmission business. By contrast, in other European Member States, it is more common for interconnection to be developed by national transmission companies with revenues underwritten by consumers. Amongst other matters, the Ofgem consultation proposed and sought views on the regulatory treatment of interconnector investment.

4.15 Responses to the consultation were received from 21 organisations and interested parties. As part of the next steps from this consultation, Ofgem demonstrated its support for the proposed UK – Belgium Interconnector in proposing to develop a regulatory investment model for the project by working with its regulatory counterpart in Belgium, CREG (Commission de Régulation de l'Électricité et du Gaz) and the Nemo consortium which could be used as an alternative model for this and future interconnector investment.

4.16 Details of the consultations can be found at

http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=2&refer=Europe

http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=67&refer=Europe

4.17 An industry consultation carried out by National Grid Interconnectors Ltd, Elia and RTE in [2008] concluded that there was significant demand for new interconnection between Great Britain and Continental Europe.

4.18 Respondents considered interconnection to be an important means to:

- respond to intermittency of wind generation, which varies according to the strength of the wind;
- respond to periods of excess power, specifically when wind generation is greater than electricity demand;
- help meet the challenge of retiring fossil fuel and nuclear plants in UK; and

- support neighbouring wholesale and supply markets and, in the case of DC interconnectors, the provision of balancing and ancillary services.

4.19 The proposed interconnector between the UK and Belgium is one of a small number of interconnector projects currently under development/construction. Other projects include:

- Republic of Ireland – UK, 500MW interconnector, known as the East – West Interconnector, linking the Republic of Ireland (RoI) with Deeside, North Wales. This project is currently under construction and is being developed by Eirgrid, the Transmission System Operator for the RoI.

- UK – Norway: Approx 1400MW interconnector linking the north east of England with Norway. This project is jointly being developed by National Grid International and Statnett, the Transmission System Operator for Norway.

4.20 Taking into account these other projects, the UK – Belgium interconnector provides further diversity to the UK's interconnection portfolio and will contribute 15% of total interconnection capacity of 6.4GW which in turn represents 7.5% of installed generation capacity.

5 Need for the Nemo Link

Energy market and policy drivers

5.1 This report has explained the challenges facing the UK's electricity sector over the next few years and the essential role that interconnectors play in meeting those challenges.

- The closure of 12 GW of coal-fired generating plant by 2016, combined with the closure of up to 7.5 GW of nuclear power stations by 2020, means that investment in new interconnectors is essential for the ongoing provision of a secure electricity supply.

- Interconnectors are needed to manage fluctuations in supply and demand brought about by the increased deployment of intermittent renewable power generation. They also contribute to the functioning of an effective electricity market.

- Significant levels of additional interconnector capacity are needed for the UK to meet the EU Council's target for member states to have interconnectors equivalent to at least 10% of their installed production capacity.

5.2 A number of new interconnector projects are underway in the UK to help meet this need, including connections to Norway and the Republic of Ireland. National Grid Nemo Link Ltd considers that additional connections to mainland Europe are needed to enhance the diversity of supply and ensure the UK is not overly dependent on the limited number of existing interconnectors.

Project location

5.3 A UK-Belgium interconnector is regarded as the best way to meet this need. Belgium is particularly suitable for a new interconnector not only because of its geographical proximity to the UK, but also because its electricity transmission system is highly connected to Central Europe. A UK-Belgium interconnector will therefore provide enhanced opportunities for the UK to trade with wider European power markets. There is no existing connection between the UK and Belgian transmission systems, so the construction of a new connection is required to achieve these objectives. The proposal to build an interconnector to Belgium is based on:

- risk mitigation: it is prudent to interconnect the UK to different parts of the European Continent. Building all interconnection to a single point reduces security of supply in case of grid problems at that single point.

- cost: a subsea cable route to Belgium is the obvious next best choice after France to minimize the cable route length. France is however already interconnected through the Channel and therefore less suitable from a risk perspective, as explained above.

5.4 The construction of a UK–Belgium interconnector is also needed to achieve the objectives agreed by the two countries as signatories to the 2009 North Sea Countries Offshore Grid Initiative.

5.7 A separate document "Development of an Interconnector between the UK and Belgium: Review of Options" explains the process by which the preferred location for the UK converter station has been determined.

Project specification

5.8 The 1000MW capacity of the Nemo Link has been carefully determined having regard to the technical requirements of the UK and Belgian transmission systems and to make optimum use of available marine cable and converter technology. A higher capacity could lead to power system stability issues in the existing AC transmission systems which must be able to withstand the sudden failure of the link. To date the GB transmission system has been designed and operated to accommodate a maximum interconnector loss of 1000 MW[10] A lower capacity, however, would drive up the cost per MW and therefore make the investment less favourable from an economic point of view. A capacity of 1000 MW therefore strikes the right balance between system stability and cost per MW.

5.9 The UK's current interconnection capacity only amounts to around 4% of total installed generation capacity; well short of the 10% target set by the EU Council in 2002. A new 1000MW interconnector with Belgium, combined with the other new interconnectors being developed, will increase UK interconnection capacity to approximately 7.5% of the UK's installed generation.

5.10 The choice of converter technology for the Nemo Link has been carefully considered by the Nemo Consortium.

5.11 There are two types of converter technology currently deployed in modern HVDC interconnector applications. These are line-commutated current source converters (CSC), and the more recently-developed voltage source converters (VSC).

5.12 Initially, the Nemo Consortium submitted a Connection Application to NGET for a CSC-based interconnector. By 2010, however, the Nemo Consortium had satisfied itself that the VSC technology had evolved sufficiently that it could be reliably used with a subsea interconnector of 1000MW capacity by the time the project places supply and installation contracts.

5.13 VSC offers greater operational flexibility than its CSC counterpart and requires fewer consequential reinforcements to the transmission system compared to CSC-based converters.

[10] Although the IFA (Interconnexion France Angleterre), is a 2000MW HVDC connection it is a bipole configuration of 2 x 1000 MW. The GB transmission system must be secure for loss of one bipole i.e. 1000 MW.

Project timing

5.14 The urgency of the need for the Nemo Link is driven partly by the energy market and policy drivers described above, and partly by factors which are specific to the project.

5.15 The imminent changes to the UK energy market and the targets established by climate change legislation, require new interconnection capacity to be established as a matter of urgency. Much of the UK's coal-fired and nuclear generating capacity will go offline by 2020, to be partly replaced by intermittent renewable sources. It is important that increased interconnection capacity is in place by this date to manage fluctuations in supply and demand and to provide the UK with access to additional sources of power generation.

5.16 In addition to these factors, the Nemo Consortium consider that the benefits of the Nemo Link can only be realised if the interconnector is commissioned by 2018. 2018 is the earliest date by which NGET could offer a connection to the high voltage transmission system.

Regulatory support

5.17 The energy regulator, Ofgem, is supportive of the Nemo Link and is working with its counterparts in Belgium to seek a regulatory investment model that will shape how future regulation will apply to new interconnector projects.

Glossary of Terms

AC	Alternating current
CSC	Current source converter
DC	Direct current
GW	Gigawatt (1000 million Watts)
HVDC	High voltage direct current
kV	Kilovolt (1000 Volts)
km	Kilometre
MW	Megawatt (1 Million Watts)
NGET	National Grid Electricity Transmission plc
NSCOGI	North Sea Countries Offshore Grid Initiative
NGNLL	National Grid Nemo Link Limited
Ofgem	Office of the Gas and Electricity Markets
TWh	Terawatt Hour (1 billion Kilowatt Hours)
VSC	Voltage source converter

Appendix 1

Nemo Consortium

Company Information

National Grid Group

National Grid Nemo Link Limited is a subsidiary of National Grid plc, and has been established specifically for the development of the Nemo Link.

National Grid plc, is one of the largest investor-owned utilities in the world. It is a low-risk international electricity and gas company with 95% of its activities in regulated businesses. It is the largest utility in the UK and the second largest utility in the US.

A separate subsidiary, National Grid Electricity Transmission plc (NGET) owns the high-voltage electricity transmission system in England and Wales and operates the system across Great Britain.

National Grid plc also has a number of businesses operating in related areas such as liquefied natural gas importation, land remediation and metering.

Elia Group

Elia System Operator SA is Belgium's transmission system operator and is responsible for the transmission of electricity in that country. Electricity is transmitted over the high-voltage grid from electricity generators to the distribution system operators and large industrial consumers. As system operator, Elia System Operator organises transparent, objective and non-discriminatory access to the grid.

Elia Asset SA is a subsidiary of Elia System Operator SA and owner of most of the Belgian grid. Elia Asset's principal mission is to develop, modernise and maintain the Belgian high-voltage grid and be responsible for the operational management of the system, under exclusive instruction of Elia System Operator.

Together, Elia System Operator and Elia Asset operate under the brand name "Elia", carrying out the regulated activities described in the Belgian Federal and Regional

Electricity Acts. The relationship between both companies is also established in these Acts.

Elia has recently expanded its activities on a broader European level and, following its acquisition of German TSO 50Hertz and in cooperation with Industry Funds Management (IFM), is now one of the top five transmission system operators in Europe.

Nemo Link®

Environmental Statement Volume I

Environmental Statement and Figures

February 2013

UK Environmental Statement

The Nemo Link

February 2013

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Content	Environmental Consultant	Christine Grant	2012-08-08	[redacted]
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Signatures in this approval box have checked this document in line with the requirements of QP16

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Abbreviations

1DV	One-dimensional vertical
µT	Microtesla
AC	Alternating current
AD	Anno Domini
AIS	Automatic Identification System
AONB	Area of Outstanding Natural Beauty
BAI	Broad Areas of Interest
BC	Before Christ
BGS	British Geological Society
BP	Before Present
BT	British Telecom
CALDOVREP	CNIS Mandatory Reporting System
CD	Capital Dredgings
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CLBs	Cable Lay Barges
CLV	Cable Laying Vessel
CNIS	Channel Navigation Information Service
COLREGS	International Regulations for Preventing Collisions at Sea, 1972 (as amended)
dB re 1µPa	Decibels relative to one micropascal
DAS	Days at sea
DC	Direct current
DECC	Department for Energy and Climate Change
dMCZ	Draft Marine Conservation Zone
DoRIS	Department of Research and Information Services
E	East
EEC	European Economic Community
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic fields
EOD	Explosives and Ordnance Disposal
EQS	Environmental Quality Standards
ERCoP	Emergency Response Coordination Plan
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
FLO	Fisheries Liaison Officer
FOCI	Feature of Conservation Interest
GB	Great British
GT	Gross Tonnage
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HVAC	High Voltage Alternating Current
HVDC	High voltage direct current
IBA	Important Bird Area
IFA	UK-France Interconnector

IMO	International Maritime Organisation
IRC	Integrated Return Conductor
JNCC	Joint Nature Conservation Committee
ICES	International Council for the Exploration of the Sea
KESFC	Kent and Essex Sea Fisheries Committee
KISCA	Kingfisher Cable Awareness Charts
km	Kilometres
KWT	Kent Wildlife Trust
LAT	Lowest Astronomical Tide
LNR	Local Nature Reserve
m	metres
MAGIC	Multi Agency Geographical Information for the Countryside
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MD	Maintenance Dredgings
MESH	Mapping European Seabed Habitats
MGN	Marine Guidance Note
MHWS	Mean High Water Spring
MI	Mass Impregnated
MLW	Mean Low Water
MLWS	Mean Low Water Spring
MMO	Marine Management Organisation
MPA	Marine Protected Area
ms	Milli-seconds
MUMM	Management Unit of the North Sea Mathematical Models
N	North
NAVTEX	Navigational Telex Reports
NE	North East
NEQ	Net Explosive Quantity
NM	Nautical Miles
NMR	National Monuments Record
NNR	National Nature Reserve
OFTO	Offshore Transmission Operator
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PLB	Post Lay Burial
PLGR	Pre-lay Grapnel Run
PMSS	Project Management Support Services Limited
PSA	Particle Size Analysis
RAF	Royal Air Force
ROEP	Rise of Earth Potential
ROV	Remote Operated Vehicle
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SPA	Special Protected Area
SSS	Side-scan Sonar
SSSI	Site of Special Scientific Interest
SW	South West
TAC	Total allowable catch
TFA	Thanet Fishermen’s Association

THLS	Trinity House Lighthouse Service
TJP	Transition Jointing Pit
TSHD	Trailer suction hopper dredgers
TSS	Traffic Separation Scheme
TTS	Temporary threshold shift
UK	United Kingdom
UKCPC	UK Cable Protection Committee
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded Ordnance
VHF	Very High Frequency Radio
VMS	Vessel Monitoring System
VTS	Vessel Traffic Services
WFD	Water Framework Directive
WWI	World War I
WWII	World War II
XLPE	Cross Linked Polyethylene

1. Introduction

1.1. Purpose of this report

This Environmental Statement has been produced to support the consent applications for the UK marine aspects of the Nemo Link.

1.2. Project overview

The Nemo Link (the Project) is a proposed electrical interconnector, with an approximate capacity of 1000 MW, which will allow transfer of electrical power between the high voltage grid systems of Belgium and the United Kingdom. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. The proposed cable route would run from Richborough in Kent in the UK to Zeebrugge in Belgium, passing through English, French and Belgian waters. Figures A and B in Appendix 2 – Route Position List provide an overview of the location of the proposed cable route and the landfall location.

1.2.1. Scheme promoters

The Nemo Link is being developed by a consortium made up of National Grid Nemo Link Ltd and Elia Asset S.A., which is part of the national transmission company in Belgium. The companies are jointly referred to in this Environmental Statement as “the Nemo Consortium”.

1.3. Environmental Statement objectives

This Environmental Statement covers the UK marine cable elements of the Project, from the mean high water spring (MHWS) tide mark at Pegwell Bay in Kent out to the median line between England and France. The UK marine elements of the Project are referred to in this Environmental Statement as “the proposed development “.

The proposed development does not fall within the types of development specified in Annex I or Annex II of the EIA Directive (Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the impacts of certain public and private projects on the environment). Therefore it does not constitute EIA (EIA) development under the relevant UK regulations (The Marine Works (EIA) Regulations 2007). This was confirmed by the Marine Management Organisation in response to a request for a joint screening and scoping opinion (Appendix 3). However, the Nemo Consortium has chosen to submit this Environmental Statement voluntarily.

The proposed development requires several consents under other legislation for construction and operation. Details of the legislative and regulatory framework and the consenting requirements are detailed in Section 3 below.

This Environmental Statement provides details of the environmental data and information used to inform the Project development, the baseline environment of the area where the cable system will be installed, and details of the predicted environmental impacts of the proposed development. The information in the Environmental Statement has been collated to both inform the applications for the required consents and/or to allow the United Kingdom regulators (primarily the Marine Management Organisation (MMO)) to satisfy their statutory obligations.

The objectives of this document are therefore to:

- Enable the Nemo Consortium to comply with best environmental practice by delivering voluntary Environmental Impact Assessment (EIA) to a high standard
- Provide environmental information and data to inform the relevant consent applications as required by law and to allow the United Kingdom regulators to satisfy their obligations under European law (in particular in respect of the requirements for Appropriate Assessment under the Habitats Directive)

1.3.1. Other elements of the Project

In addition to the UK marine components which are the subject of this Environmental Statement, the Project includes the following elements:

- The UK onshore elements: the construction of an electricity converter station and substation on the site of the former Richborough power station, comprising buildings, outdoor electrical equipment and internal access roads, and the installation of underground electricity cables from low water at Pegwell Bay to the converter station.

- The Belgian onshore elements: the construction of an electricity converter station and substation at Zeebrugge, comprising buildings, outdoor electrical equipment and internal access roads, and the installation of underground electricity cables from low water to the converter station.

- The offshore elements in French and Belgian waters: the installation of a marine electricity cable from the median line between England and France to the landfall at Zeebrugge.

The appropriate consents for these other elements of the Project will be sought independently of, but in parallel to, the UK marine components, and Environmental Impact Assessments have been undertaken in respect of each element.

The likely significant effects of the other elements of the Project are summarised in section 10.

1.4. Environmental Statement structure

The structure of this report is as follows:-

Section	Title
Volume I: Environmental Statement	
1	Introduction
2	Project Background
3	Legislative Framework
4	Description of Proposed Development
5	EIA Method
6	Physical Environment
6.1	Geology and Bathymetry
6.2	Sediment transport and bedload
6.3	Water quality and suspended sediments
7	Biological environment
7.1	Conservation designations
7.2	Ornithology
7.3	Marine mammals
7.4	Benthic and intertidal ecology
7.5	Fish and shellfish ecology

8	Human environment
8.1	Commercial fisheries
8.2	Shipping and navigation
8.3	Archaeology and cultural heritage
8.4	Cables and pipelines
8.5	Military and other sea users
8.6	UXO
8.7	Tourism, recreation and amenity
9	Cumulative Effects
10	Effects of other Project elements
11	Conclusions
Appendix 1	Figures
Volume II: Technical Appendix	
Appendix 1	Route Position List
Appendix 2	Scoping Response Matrix
Appendix 3	MMO Scoping Response Letter
Appendix 4	Legislative Framework
Appendix 5	Habitats Regulations Assessment Signposting
Appendix 6	Assessment of Impact Significance
Appendix 7	HR Wallingford Technical Report
Appendix 8	Winter Bird Survey
Appendix 9	Inter-tidal sediment and invertebrate surveys
Appendix 10	Breeding Bird and Redshank Nesting Survey
Appendix 11	Benthic Survey Report
Appendix 12	Archaeological EIA
Appendix 13	Offshore French Non-Technical Summary
Appendix 14	Offshore Belgian Non-Technical Summary
Appendix 15	UK Onshore Non-Technical Summary
Appendix 16	Belgian Onshore Non-Technical Summary

1.5. References

- CEFAS (2004). Guidance notes for EIA in respect of FEPA/CPA requirements. (Version 2 - June 2004).
- HM Government et al, 2010 HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government (2010) Draft UK Marine Policy Statement: The Appraisal of Sustainability report http://www.defra.gov.uk/corporate/consult/marine-policy/100721-marine-policy-appraisal-ofsustainabilty.pdf [Accessed: 09/08/2010]
- Kalmijn, A. J. 1974. The detection of electric fields from inanimate and animate sources other than electric organs. In: Handbook of Sensory Physiology (Ed. by Fessard, A.), pp. 147-200. New York: Springer Verlag.
- Pals, N., Peters, R. C. & Schoenhage, A. A. C. 1982b. Local geo-electric fields at the bottom of the sea and their relevance for electrosensitive fish. Netherlands Journal of Zoology, 32, 495-512.

2. Project Background

2.1. Project justification

It is European Union (EU) policy to increase the transmission capacity between countries, with the stated wish to see each member state establish an interconnector capacity of around 10% of installed generation capacity. The reasons for this policy are to allow a more efficient energy market within the EU and facilitate the sustainable development of the electricity sector by increasing opportunities for clean and efficient generation and by making it easier to exploit intermittent renewable electricity resources in the UK and Continental Europe. The Nemo Link is consistent with these policy objectives.

Further information regarding the rationale behind the Project can be found on the project website available at the following link:

http://www.nationalgrid.com/uk/Interconnectors/Belgium/Nemo+interconnector/

2.2. Project definition process and alternatives considered

In order to identify an optimal project solution, the Nemo Consortium has undertaken a series of feasibility assessments and an ongoing route engineering study to address several connection and routing options.

2.2.1. Discussion of Belgian onshore options

Several onshore connection location options in Belgium were considered including Zeebrugge, Oostende and Koksijde. A connection point and landfall in Zeebrugge was selected for technical, economic and environmental reasons. A key reason for the selection of this landfall and connection point is that the Project will be able to make use of the increased grid capacity that will be offered by the Stevin project which will upgrade Elia's 380 kV electrical grid between Zomergem and Zeebrugge. The Stevin project is required to allow the planned offshore wind farms in Belgian waters to connect to the Belgian transmission system, facilitate the connection of this project and accommodate the increasing power requirements of the Port of Zeebrugge. Further details of the project can be found on the Elia website available at the following link:

http://www.elia.be/en/projects/grid-projects/stevin

The specific environmental reasons for selection of Zeebrugge for the onshore connection to the grid and the associated landfall are as follows:

- Reinforcement of the Belgian electricity transmission system to enable connection of the Project in Zeebrugge would need the least amount of overhead line in coastal areas in comparison to the other potential landfall locations
- The selection of Zeebrugge as the connection point for the Project minimises negative environmental effects on features such as visual amenity and ornithology.

2.2.2. UK Converter Station

The physical size of the converter station is dependent on a number of factors including the following examples:

- Power rating of the link;
- Operating voltage;
- Operating arrangements;

- Connection point on the transmission system; and
- Conversion technology

The initial study area in which the converter station was considered in the UK included a large area of land in southeast England in which the following parameters were identified:

- Possible onshore cables route from a cable landfall with a feasible and practical route offshore to the Belgian coast;
- A site where land was available and where a converter station could be deemed acceptable; and
- A potential connection to a robust connection point on the high voltage electricity transmission system.

With respect to the cable landfall and offshore cable route between the UK and Belgium a series of feasibility studies were undertaken (which are discussed further in Section 2.2.3). The initial feasibility work carried out highlighted Richborough to Zeebrugge as the preferable route following consideration of a number of environmental and technical factors such as:

- Other commercial offshore developments and sea users (e.g. offshore wind, aggregates, disposal sites, oil and gas, port development and dredging)
- Bathymetry and geology
- Military use
- Existing and potential conservation designations
- Fishing

In relation to the suitability of the onshore location, the following onshore factors were considered:

- Land availability in relation to the footprint of the converter station;
- Land designation and use (i.e. existing/planned use and setting as well as landscape, heritage and nature conservation designations);
- Feasibility of an appropriate AC connection to the grid system; and
- Environmental sensitivity of the site (e.g. existing visual amenity, noise, traffic levels etc.).

Ten locations were considered as potential converter stations, each having a direct current (DC) cable connection to a suitable subsea cable landfall area (Figure 2-1). The availability of land for a converter station, the suitability of planning policy and existing land uses, and the difficulty of the alternating current (AC) connection from the converter station to the transmission system, were all taken into account.

The following locations were investigated:

- Sizewell
- Bramford (near Ipswich)
- Bradwell
- Rayleigh (Essex)
- Shellhaven
- Grain
- Kemsley
- Cleve Hill
- Richborough
- Sellindge

The investigation into these options is presented in the report entitled Nemo Link: Development of an electricity interconnector between UK and Belgium - Review of Options which is available on the Project website following the link below:

http://www.nemo-link.com/

Initial investigations indicated that the most favoured sites were at Shellhaven, Kemsley and Richborough which were subject to further investigation. The site at Shellhaven became the 'Thames Gateway' development proposal which included dredging of the dock and plans to keep this and a channel to the open sea at appropriate depths with maintenance dredging if required. This precluded the location as a viable option due to the level of disturbance and potentially high risk of damage to the cables in that environment.

Detailed assessment and discussion with planning authorities, Environment Agency, Natural England and Kent Wildlife Trust focused on sites at Kemsley and the nearby Ridham Dock on the River Swale, Richborough and in the vicinity of Canterbury.

In relation to existing land use, Richborough Power Station was considered a strong candidate site as there have been long-held local aspirations for positive use of the dis-used station as a catalyst for clearance of the site. Kemsley and Ridham Dock also have a number of large industrial buildings in the vicinity, although there is also land with modern housing and other land held by housing developers. There is limited land available and concerns were expressed from consultation regarding the effects of development on the adjacent wildlife sites including European sites. Sites in the vicinity of Canterbury were generally deemed unsuitable for a converter station due to land conditions and possible effects on the setting of the World Heritage Site of the city.

The Richborough Power Station site for the converter station therefore offered the optimal balance between a feasible subsea cable route and a landfall to which a reasonable connection could be implemented, i.e. a suitable and available converter station site, and reasonable prospects for a connection to the high voltage transmission system without giving rise to unacceptable environmental effects (due to existing land use and a lower environmental sensitivity to this type of development in comparison to the other sites shortlisted).

No other offshore factors contributed to the siting of the converter station other than distance from a viable landfall option. However, the marine feasibility assessment involved an assessment of each of the possible marine routes based upon a comparative cost analysis and a review of environmental constraints and impacts and consent requirements. This assessment identified significant advantage (in terms of land availability, cable route length and permitting and consenting issues) of the route between Richborough and West Zeebrugge. A route between Richborough and West Zeebrugge is the shortest cable route option at 130 km and therefore minimises the extent and duration of environmental effects.

2.2.3. Preliminary Offshore cable route engineering study

Based upon the initial feasibility work a preliminary route engineering study was undertaken to assess alternatives and which identified the optimal offshore cable route between Richborough and Zeebrugge.

The following broad criteria were used to inform the route selection.

Category	Criteria
Physical environment	Available seabed sediment data were reviewed to assess the potential for successful burial of the cable. Where possible, areas of rock, boulder clay and sand waves were avoided as these factors could create difficulties in burying the cable.
Biological environment	The following designated conservation areas were considered in route development. Special Areas of Conservation

Category	Criteria
	Special Protection Areas Ramsar Sites National Nature Reserves Sites of Special Scientific Interest Local Nature Reserves Marine development (including the laying and operation of submarine cables) is not prohibited in any of these sites and therefore protected sites were not considered "no go" areas for cable routeing. Instead, the routing took into account available information on the designated sites. In the absence of available information on the precise locations of sensitivities within protected sites, the shortest route across these areas was taken where possible to minimise disturbance.
Human Environment	All anchorage areas, dredging areas, existing marine disposal areas, oil and gas infrastructure and existing offshore wind farms were avoided. An angle as close to 90° as possible was sought in making cable and pipeline crossings. Disused marine disposal sites and military practice areas were crossed with caution, taking into account available information on what they are used for. All known wrecks were avoided.

Table 2-1: Route selection criteria

The specific marine, intertidal and coastal factors taken into account were as follows:

- Coastal geology
- Coastal processes
- Beach gradient
- Rivers and watercourses
- Existing infrastructure
- Access
- Proximity to residential areas
- Landing technique
- Conservation designations

A summary of the landfall areas near to Richborough considered is detailed below:

1. Service Station North – This is an area to the north of the petrol station located at the west of Pegwell Bay on the A256. The Thanet Offshore Wind Farm cable makes landfall in this area and therefore it is expected that installation of the cables is technically feasible using similar open cut trenching methods as used by the Thanet Project. This landfall location is slightly less sensitive in ecological terms than other areas of the bay as it would involve minimal crossing of saltmarsh. The area to the north, Cliff End Beach is important for a population of turnstone, the area to the south west has extensive areas of salt marsh, the area to the south of the river mouth – Sandwich Flats – has sensitivities including ancient dune pasture and is also a sand lizard re-introduction area. This landfall would however require crossing the Thanet Offshore Wind Farm cables both offshore and onshore.

2. Service Station South – This is an area to the south of the petrol station located at the west of Pegwell Bay on the A256. This location shares the benefits of the Service Station North landfall noted above. An offshore crossing of the Thanet Offshore Wind Farm cables would not be required for this option. It is understood however from anecdotal evidence (pers comm, Kent Wildlife Trust, 19 January 2011) that there may be hydrocarbon contamination in the area directly to the south of the service station that will need to be taken into account during

installation. This area is above mean high water and will therefore be addressed in more detail in the onshore Environmental Statement.

3. Cliff End Beach – This area is in the northern part of Pegwell Bay. Cable installation would require Horizontal Directional Drilling (HDD) through the cliffs at the back of the bay which may disturb a population of the protected bird species Turnstone (for which Thanet Coast and Sandwich Bay SPA is designated). An offshore crossing of the Thanet Offshore Wind Farm cables would also be required for this option.

4. Sandwich Flats – This landfall is located to the southern extent of the bay, south of the mouth of the River Stour. There are considerable disadvantages with this landfall owing to its remoteness, access issues, ecological sensitivities including the presence of ancient dune pasture and the adjacent sand lizard re-introduction area.

5. Country Park – This landfall is located in the southern extent of the bay, north of the mouth of the River Stour. It is understood that this area is a former landfill site for which records are incomplete. This option would present considerable engineering challenges to minimise any discharges from the landfall and may give the developers unacceptable levels of project and liability risk.

6. River Stour – This would involve installation of the cable in the mouth of the River Stour, making landfall at Richborough Port. The width of the river channel and estuarine environment present considerable risk to the environment and the project.

Based upon technical and environmental assessments of the alternatives detailed above, the proposed cable landfall is Service Station South. Due to a current lack of site specific topographic, geophysical and geotechnical data a landfall area (rather than a specific location) has been defined for this Environmental Statement and the associated consent and licence applications. The final cable route, within the intertidal zone, will be within this area. The extent of this 400m wide area is detailed in Figure 2-2.

In 2012, following the initial phase of feasibility work in 2006, a further study was undertaken to take account of further designations that had been put in place or potential designations such as the Marine Conservation Zones and Reference Areas. Additionally, there were further route options previously not considered, however these were deemed to be unacceptable on the grounds of constraints posed by technical or 3rd party and environmental factors (primarily designated sites that the routes crossed). Therefore the results of these feasibility studies were that the Richborough route with the Pegwell Bay landfall was the most environmentally and technically viable option.

2.3. Consultation

Consultation with stakeholders has been undertaken through the route selection and definition process, and comments were received from statutory and key consultees on the scope of EIA required for the proposed development via a Scoping Report circulated to consultees in October 2010. Appendix 2 – Scoping Response Matrix provides a summary of the responses received and the sections of this report that address these comments. Responses were received from the following organisations:

- The Marine Management Organisation
- Natural England
- English Heritage
- JNCC
- The Crown Estate

- The Maritime and Coastguard Agency
- The Royal Yachting Association
- Trinity House Lighthouse Service
- Port of Ramsgate
- Thanet District Council
- Kent Wildlife Trust

2.4. Sources of data and information

The following primary sources of data have been used to inform the project specific specialist studies and this Environmental Statement.

Survey/study	Extent of data	Data collected	Date of survey
Cable Route Geophysical Survey	Low water mark in the UK to low water mark in Belgium. 500m wide corridor surveyed.	Sidescan sonar, multibeam bathymetry, sub bottom profiler, magnetometer.	August 2010
Cable Route Benthic Survey	Low water mark in the UK to low water mark in Belgium.	Sidescan sonar and multibeam data examined to inform benthic sampling locations and locations for trawl survey.	September 2010
Cable Route Geotechnical survey	Low water mark in the UK to low water mark in Belgium.	Vibrocore samples taken to a depth of 5m and cone penetrometer tests undertaken.	September 2010
Wintering bird survey	Pegwell Bay	Details of the numbers and species of wintering birds present (see Section 7.2 – Ornithology for further details)	November 2008 – March 2009 and May 2009
Breeding bird survey	Pegwell Bay	Details of the numbers and species of breeding birds present (see Section 7.2 – Ornithology for further details)	May – June 2009
Invertebrate survey	Pegwell Bay	Sediment cores, biotope survey and survey of invertebrate communities and species abundance. Also includes a brief discussion on predator prey relationships especially in relation to bird species.	August 2009
Marine Archaeology Study	Marine cable route from high water mark in the UK to high water mark in Belgium	The archaeological consultants input to the scope of geophysical and geotechnical survey and reviewed all data to determine archaeological potential along the cable route.	July – December 2010
Sandwave and sediment modelling	Marine cable route from high water mark in the UK to high water mark in Belgium	The study drew upon the geophysical and geotechnical survey data to model the sediment mobility along the cable route to inform impact assessment and cable burial specification.	November 2010 – February 2011
Sediment plume dispersal modelling	Specific locations along the cable route selected to give an overview of the potential plume dispersal from installation along the cable route.	The study drew upon the geophysical and geotechnical survey data to model plume dispersal along the cable route to inform impact assessment and cable burial specification.	November 2010 – February 2011

Table 2-2 : Primary data sources and project specific studies undertaken to inform the Environmental Statement

3. Legislative Framework

As discussed above there is no specific legislative provision which requires the proposed development to undergo EIA. However, a number of policies and laws require decision makers to consider the environmental impacts of projects. The main relevant provisions are set out in the table at Appendix 4 – Legislative Framework.

It is understood that relevant licences, consents or permissions will be required under the following legislation for the proposed development:

- Marine and Coastal Access Act 2009
- Town and Country Planning Act 1990 (a separate Environmental Statement will be prepared for the UK onshore aspects of the Project covering all those aspects located above the mean low water spring (MLWS) tide mark)
- Environment Act 1995
- Land Drainage Act 1991
- Water Resources Act 1991

It should be noted that under the Marine and Coastal Access Act 2009, a licence is required for the following aspects of the proposed development:

- Laying and burial of cable from the Mean High Water Spring (MHWS) tide mark to 12 nautical miles (NM)
- Dredging and disposal required to pre-sweep sand waves
- Rock/concrete mattress placement in one location in the UK
- Horizontal directional drilling (HDD)

A Habitats Regulations Screening Assessment under The Conservation of Habitats and Species Regulations 2010 (as amended) is required for crossing both Special Area of Conservation (SAC) and Special Protection Area (SPA) designations at the cable landfall. (see The Nemo Link: Pegwell Bay – Assessment of Likely Significant Effects Report). Information relevant to this assessment within this Environmental Statement is highlighted within Appendix 5 – Habitats Regulations Assessment Signposting.

4. Description of Proposed Development

4.1. Introduction

This section presents the details of the UK marine elements of the Project which are the subject of this Environmental Statement. The installation, operation, maintenance and decommissioning phases are described in terms of the likely component options and their installation and use.

4.2. Project overview

The Nemo Link is a proposed electrical interconnector with an approximate capacity of 1000 MW, which will allow transfer of power between the high voltage grid systems of Belgium and the United Kingdom. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. The proposed cable route would run from Richborough in Kent in the UK to Zeebrugge in Belgium.

The use of High Voltage Direct Current (HVDC) provides the most efficient and effective means to transport electricity over this distance.

The high voltage grid systems in the UK and Belgium operate using high voltage alternating current (HVAC). To transport electricity from one country to the other first requires the HVAC to be converted to HVDC at the transmitting end and after traversing the seabeds of the UK, France and Belgium by means of HVDC cables then needs to be converted from HVDC to HVAC at the receiving end. This conversion process is carried out at converter stations which will be located at the former power station at Richborough in Kent and at Zeebrugge in Belgium.

A direct HVAC connection is not feasible due to inefficiencies resulting from the distances involved and from the fact that while both the UK and Belgium transmission systems operate at 50Hz an HVDC system allows for any discrepancies in synchronisation between the two systems.

The subsea cable system is jointed to its corresponding land cable in a joint pit located above mean high water mark and does not form part of this application. The consent for this will form part of the application for onshore consent.

4.3. Marine cable route description

4.3.1. Marine cable route

The route derived from preliminary cable route engineering and survey is shown in Figure A (Appendix 1). The description below outlines the key constraints that were considered in the cable route identification and selection. To aid this description, kilometre points have been assigned to the route running from Zeebrugge in Belgium to Richborough in the UK.

Route section	Key Constraints
Kilometre point 55 - 100	Route continues on an east/west alignment taking a similar route to the Tangerine telecoms cable. Route crosses the Dover Straits traffic separation scheme and deep water route before continuing along the West Hinder Traffic Separation Scheme. The Tangerine telecoms cable takes a similar route in this area. Between KP 82 and 59 the cable route passes through French waters, before entering Belgian waters.
Kilometre point 100	Crosses South Falls sand bank where water depth may be less than 10 m.

Route section	Key Constraints
	Bank is over 30 km long, meaning a substantial detour would be needed for the route to go around it.
Kilometre point 100 - 115	Local deviations to avoid known wreck locations. Hard ground may be encountered in this area. Project experience in this area suggests that burial in the chalk can be achieved with a rock cutting type plough. The alternative of protection through surface lay together with rock or mattress protection is likely to be more expensive and have a greater environmental impact. Further assessment of this will be undertaken based on survey data when available.
Kilometre point 115 - 124	Route crosses to the north of Goodwin Sands, an area of shallow water, shifting sands and known wrecks.
Kilometre point 124	Cable route avoids a marine spoil ground.
Kilometre point 128	Cable exits Pegwell Bay
Cable landfall UK/Intertidal Area (Richborough) Kilometre point 130	Port of Ramsgate to the north. Spoil ground and Cross Ledge Shoal to the south. *NB The marine approach of the cable route to Pegwell Bay has been confirmed via geophysical and geotechnical survey. Geophysical and geotechnical survey of the intertidal and associated landfall area (as indicated on Figure 4-1) was undertaken in August 2011. This data will be used to inform the precise alignment of the cable in the intertidal area.*

Table 4-1: Marine cable route high level description

4.4. Outline description of cable system

4.4.1. System options

As described in Section 4.2 the cable system will be HVDC. No decision has been taken to date on the type and voltage of submarine cable to be deployed, and this will be considered prior to any contract being awarded for cable design and installation. The cable will be rated at between 350 kV and 400 kV.

HVDC Interconnectors can be configured either as monopole or bipole systems.

4.4.1.1. Bipole system

Bipole systems transmit power via a closed circuit of two HVDC submarine cables installed alongside each other. Bipolar systems transmit power through two high voltage conductors of opposite polarity (e.g. +500 kV and — 500 kV).

Typically these are installed in a bundled configuration, with no separation between cables, however in some circumstances these cables may be installed in an unbundled format with cables installed in the same trench.

4.4.1.2. Monopole system

Monopole systems have a single high-voltage conductor, at either negative or positive polarity connected to a single converter at each end. The return path may be through the earth (and sea) itself or via a second cable. Using an earth return requires large copper electrodes to be placed near each

end of the link to feed the return current into the earth and sea. Although monopole interconnecton with earth returns operate successfully in a number of locations without adverse effects on local environments, concern has sometimes been expressed in respect of recent possible similar installations. These concerns generally relate to the effects on the marine environment of electrolysis products from the electrodes and the possible effects on metallic structures (such as pipelines) of stray currents.

Monopole systems may also use a metallic sheath around the main conductor as the return path.

4.4.2. Cable technology options

The Project is considering the use of one of two cable types available for HVDC application; Cross Linked Polyethylene (XLPE) and Mass Impregnated (MI).

4.4.2.1. XLPE cable

Extruded HVDC cables use XLPE for their insulation. The insulation is extruded over a copper or aluminium conductor (copper has a lower resistance and thus a higher power density, although it is heavier and more expensive than aluminium) and is covered with a water tight sheath, usually of extruded seamless lead for submarine cables or aluminium laminate for land cables, and a further protective plastic coating. Cables intended for submarine use have an additional layer of galvanised steel wire armour to increase the cable's tensile strength so it can better withstand the stresses of submarine installation. This is usually a single layer of wires, helically wound around the cable (although in deeper waters or over rocky sea beds this may be a double layer), and covered in a sleeve of bitumen impregnated polypropylene yarn to inhibit corrosion.

4.4.2.2. MI cable

MI type cable is a proven technology and has been widely used on major interconnector projects in service to date including but not limited to:-

- UK-France interconnector (IFA)
- BritNed, linking the UK and the Netherlands,
- Basslink, linking Australia with Tasmania
- NorNed, linking Norway with the Netherlands

The MI cable is a stranded type single copper core cable that has paper insulation impregnated with high viscosity mineral oil. This cable type is not pressurised like a fluid (low viscosity oil) filled cable and has no free oil to leak out in the event of a cable sheath rupture.

A typical section of an MI cable is shown in Figure 4-A below. The MI cable core has a concentric construction comprising a central stranded low resistivity copper conductor with a screen, mass impregnated paper insulation layers, and an outer dielectric screen made of semi-conducting paper. The core is contained in a lead sheath to protect the insulation from water ingress and a polyethylene sheath is extruded over this to protect it from corrosion. One, and sometimes two, layers of galvanised steel armour wires are applied in a helix to provide mechanical strength during cable handling and installation and protection from external damage. The armour wires are bedded into a layer of bituminised jute strings and a layer of polypropylene string is applied over them to bind them in and provide abrasion resistance and to improve handling.

Figure 4-A : Mass Impregnated Cable

4.4.2.3. Cable oil and coating

The presence of oil in the cable and any possible consequences of this are avoided by using an MI or XLPE cable in which no liquid occurs. Some types of cable (oil filled cables) contain liquid oil that is used for electrical insulation. In the case of cable rupture, this oil could leak into the marine environment or into the ground. These types of cable are not being considered for the Nemo Link.

4.4.2.4. System assumed for the purposes of EIA

This Environmenal Statement has been prepared on the basis that the cable configuration for the proposed 1000MW Nemo Link, will be a bipolar HVDC system, with a pair of single core, MI cables bundled together in the same trench.

4.5. Cable installation

The sections below give an outline description of operations involved in installing the cables.

4.5.1. Route preparation

Two significant preparation activities are likely to be undertaken prior to installation of the cable system. These are:

- Clearance of out-of-service telecommunications cables that cross the cable route using a grapnel hook dragged across the seabed to pick up the cables and cutting equipment to cut away the relevant section.
- Preparation and deposit of bridging and separation structures over any cables and pipelines that the Nemo Link cable route crosses. Typically crossing designs involve the placement of crushed rock on the seabed above the crossed asset by a specialist vessel, utilising a fall pipe that precisely guides the rock onto the seabed. The exact design will be agreed with the crossed party through a formal crossing agreement process and may, as an alternative, use concrete “link-lock” type mattresses.

It is also possible that areas of seabed where bed rock is present, likely to be chalk, may be prepared by the cutting of a trench that the cables will then be installed into. An alternative approach in these chalk areas, would be to use a specialist rock cutting plough, which may provide a more effective solution.

4.5.2. Cable route clearance

Prior to the start of marine operation it is essential to ensure the cable route is clear of obstructions that may hinder the operation.

Seabed debris such as scrap trawler warps or ships' crane wires that may have been jettisoned by vessels onto the seabed, abandoned communications cables and other debris can be detrimental to the burial machine. Before the start of cable laying operations the cable route is surveyed using a magnetometer to identify wires and cables so they can be removed.

To clear the route of detected and any undetected debris, a small vessel will be mobilised to remove them during an operation known as a 'pre-lay grapnel run' (PLGR). The PLGR vessel tows a wire with a specially designed hook, or grapnel, along the centreline of the cable route until it encounters debris. The tow winch is fitted with a strain gauge which will detect the rise in tension as an object is hooked. Most old cable and scrap wire is normally found at, or just below, the seabed. The PLGR grapnel will be designed to penetrate the seabed to a depth of approximately 1 m. The grapnel will have a maximum width of approximately 200 mm.

Any debris encountered will be recovered to the deck of the vessel for appropriate licensed disposal ashore. Should any unexploded ordnance be discovered during this process, a registered Explosives and Ordnance Disposal (EOD) specialist will be available during the installation process to identify any suspicious items and provide advice on the appropriate remediation. Abandoned communications cables may be kilometres long. The vessel will cut out and recover a section of the cable to open a gap through which the burial machine can pass. The two cut ends of the cable at either side of the gap will be fitted with weights to secure them against movement before they are returned to the seabed.

Cable installation may be carried out in a number of campaigns, the length of which is related to the cable carrying capacity of the main lay vessel. The PLGR operation may be phased to ensure that the route is clear of any recently dumped debris before each campaign.

4.5.3. Route preparation in sandwaves (pre-sweeping)

Sandwaves are known to be present on the sea bed along the cable route in the Eastern English Channel. They inhibit burial equipment and, if they are mobile, decrease the efficacy of burial.

Installation equipment can generally work on long inclines of up to 10-20°. However, sandwaves with crest lines on an oblique angle to the cable line can present major difficulties for both towed and self propelled machines.

Where sandwaves are mobile a cable buried into the upper part of a sandwave may become exposed if subsequently a trough moves through the location.

Pre-sweeping by dredging can be used to reduce the height of the sandwaves along the cables route and produce a flatter path for the installation equipment to move along. This also allows for greater control of the burial depth of the cables. It also makes the protection afforded by burial more resistant to sandwave mobility and therefore more durable over time.

Pre-sweeping is normally carried out by trailing suction hopper dredgers (TSHD) that shave off the crest lines of sandwaves and create a flatter path for a burial machine to move along. Path width will vary depending on the shape and size of each feature but may be 10m to 20m.

If adopted, pre-sweeping will be undertaken just a few days in advance of cable laying operations to ensure the dredged path remains open for the installation to take place. The TSHD would operate mainly as a discrete vessel detached from the cable laying spread, except if remedial work is considered necessary during cable laying. Dredgers are generally agile and not so restricted as a Cable Laying Vessel (CLV) or burial support vessel in their ability to manoeuvre.

The spoil volumes resulting from pre-sweeping are typical of dredging operations for channel or port maintenance and therefore relatively small. It is assumed that the spoil will be deposited back on the seabed in the immediate vicinity of the pre-sweeping activity.

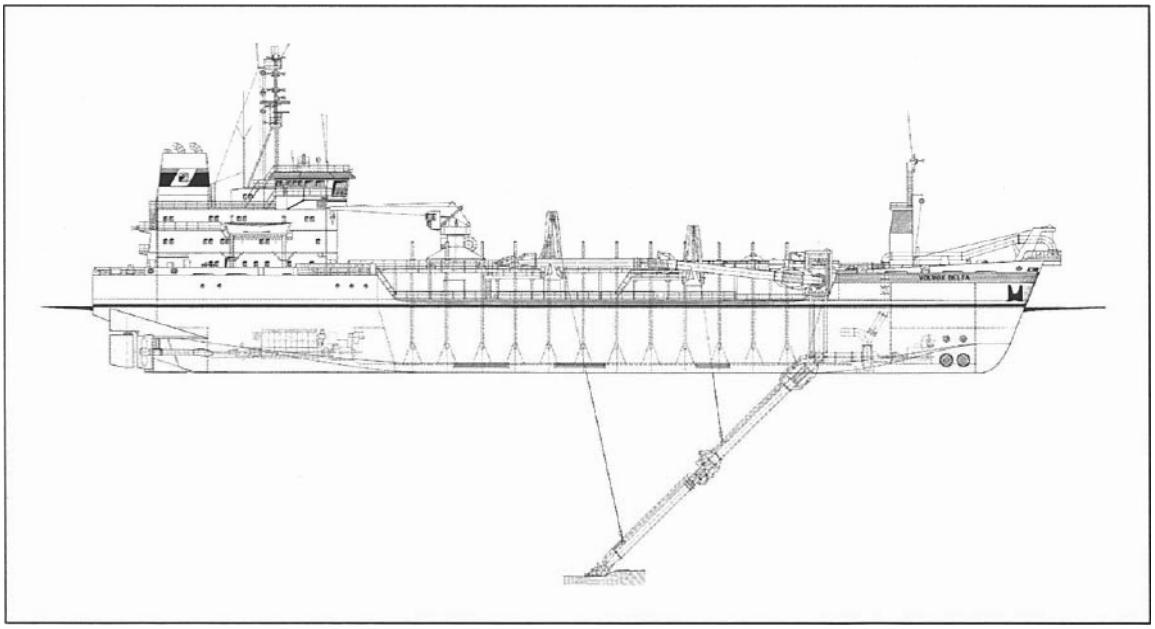

Figure 4-B : Trailing suction hopper dredger

The sediments along the UK route sector have been assessed relative to a 1:50 year storm event (i.e. a period which encompasses the expected engineering lifespan of the interconnector).

In addition to the pre-sweeping areas determined to allow target burial depths to be achieved, a number of locations have been identified where seabed slopes exceed the nominal 10-20° capability of burial machinery. These areas will require the local sediment slope angle to be modified to allow access for burial machinery. All locations where dredging of seabed slopes was identified coincide with the pre-sweeping areas as the sandwave crests tend to be the areas with the greatest slope angle. No further dredging areas were therefore identified as a result of the slope analysis. The table below presents the pre-sweeping locations and approximate volumes of material extracted, assuming a 40m pre-sweep corridor width (i.e. a 20m trench with sides of 1/5 gradient).

KP	Longitude	Latitude	Volume (m^3)	Purpose
26 - 29	2.77979	51.35257	38273	Mobility
29.25 - 29.35	2.75559	51.34716	743	Veneer
30.05 - 30.15	2.74507	51.34426	33	Veneer
31.5 - 34	2.70636	51.34514	10829	Mobility - Large Sandwave features, some presweep likely required
37.5 - 41.25	2.61177	51.34873	20479	Mobility
42.8 - 43	2.56172	51.35095	482	Veneer
54 - 57	2.40024	51.34705	27899	Mobility - Note cable crossing at 56.7
61.8 - 63	2.30903	51.32294	48491	Veneer
63 - 65.4	2.28503	51.31696	21330	Mobility
68.5 - 69.2	2.21952	51.32001	4593	Veneer
69.2 - 73.6	2.18433	51.32437	60249	Mobility
74.5 - 77.5	2.11854	51.32572	32614	Mobility - Assumes bedform type C is soft
82.3 - 87	1.99369	51.32529	24470	Mobility
99 - 100.75	1.77564	51.32706	93138	Mobility - South Falls sand bank
123 -123.5	1.44542	51.30614	1170	Veneer

Table 4-2: Proposed pre-sweeping locations and approximate extraction dredging

4.5.4. Offshore operations

4.5.4.1. Offshore resources

The use of particular resources, CLVs or cable lay barges (CLBs), is dependent on the company that secures the installation contract and the availability of vessels. The present situation is that installation resources are in great demand and there is unlikely to be any decrease in this demand in the foreseeable future. It is impossible at this stage to make a forecast as to the available resources which could be deployed for the Project, since this is subject to market forces. The following presents a description of resources presently being deployed or proposed for installations of the size and character required for the Project.

The installation services typically being offered in the market for offshore work are based on either long standing installation resources such as the CLVs “Team Oman” and the “Giulio Verne” or relatively new entrants such as the CLVs “Stemat Spirit”, “NorthOcean 102”, the CLB “Atalanti” or the new build CLV “Aker Connector”. Available pictures of these vessels are provided in Figure 4-C below.

Team Oman

Stemat Spirit

North Ocean 102

Aker Connector

Giulio Verne

Figure 4-C : Cable laying vessels in the market

All the vessels mentioned are, in principle, capable of deploying burial equipment for simultaneous lay and burial and could therefore install all of the system between the 10 m depth contours on each side. The “Team Oman”, “Stemat Spirit” and the “Atalanti” also have some capability in waters shallower than 10m.

There may be limitations with respect to the amount of cable that can be carried if a vessel also has to deploy cable burial equipment. These limitations might affect the length of cable that can be installed during a single campaign and therefore the number of campaigns needed to install the complete system.

The larger CLVs are not normally worked inshore of the 10m isobath but may do so dependent on the environmental conditions, tidal range, weather etc., and the willingness of the operators to take the vessel closer in.

4.5.4.2. Shallow water working

The water depths on the route determine to a large degree the installation vessels and planning.

If the main CLV cannot approach close enough to the beach to directly land the cables, i.e. within a maximum of around 2km, a separate shallow water spread may be needed to install the cables.

Shallow water spreads are normally based upon flat-top pontoon barges that are mobilised on an *ad hoc* basis for cable work. They will be fitted with all necessary cable storage and working gear and a four to six point mooring system, which is used to manoeuvre the barge during cable work. Occasionally two barges are combined into a single spread, with one providing storage and deck working space and another providing motive power by use of anchors or thrusters.

Figures 4-D and 4-E below show the shallow water spread used for the installation of a landfall section of cable.

Figure 4-D : BritNed inshore installation spread – the Fetsy L multi-role and Stemat 81 flat barge

Figure 4-E : Fetsy L multi-role barge

4.5.4.3. Operational footprint

The footprint of a cable installation spread will depend on whether there is to be simultaneous lay and burial or post-lay burial. In the former case the lay vessel may deploy the burial equipment or this may be deployed by another vessel navigating close behind, creating effectively a single large spread. In the latter case the post lay burial (PLB) vessel may be some physical distance, or indeed some days, behind the lay vessel, so there are two discrete operations separated physically and in time.

The physical foot print will be that of the vessel, or vessels if working in concert, and also the surrounding navigational precautionary zone, commensurate with being a “vessel restricted in its ability to manoeuvre”. Typically a large CLV will be up to 150 m in length and will sit within a 500 m radius precautionary zone. This radius will be larger (potentially up to 2km) if the CLV has anchors.

The temporal impact of the spread will be dependent on the slowest moving element, usually the burial spread, which will most likely be moving at less than half a knot. This, in terms of other shipping will appear to be effectively stationary.

The more significant impact of the spread with respect to interference with general navigation is the precautionary zone as other vessels may need to alter course or speed to avoid this zone. The greatest significance will be within traffic separation schemes (TSS) where vessels are already constrained to navigate in defined areas and directions.

The greatest impact will be in the situation where the lay vessel is closely trailed by a burial vessel. In this case the precautionary zones may link together creating a single zone 500m by 1000m.

Interaction with other shipping traffic is managed in the first instance by broadcasting information regarding the location, direction and speed of the spread through normal marine channels, such as “Notices to Mariners”, and on vhf radio. In the second instance guard vessels are deployed with the spread to monitor and, if necessary, intercept approaching shipping to avoid hazardous situations developing.

In shallow waters the footprint of the spread will also be dependent on whether anchors are used. The anchors may be placed hundreds of metres from the vessel. The same precautions are necessary with respect to the vessel and the anchor pattern although there is inherently less risk of interaction with large volumes of shipping traffic in shallow water. The anchor handling vessels will in this case normally also act as guard vessels for the spread.

Project activity	Area concerned	Footprint
Cable installation at landfall	From approximately the low water mark to the transition joint pit which will be located above the mean high water springs line at the back of the beach.	Cable installation trench will be approximately 1 – 2 m wide. The cable will be buried to a target depth of circa 2-3 m. Mechanical excavators will be used to bury the cable. Potential for use of coffer dam
Shallow water cable installation	From approximately the low water mark out to 10 m water depth.	Seabed Anchors may be used to maintain the position of the vessel during installation of the landfall and shallow water section of cable system. It is expected that four anchors would be required and they would be approximately 100 m from the vessel. The cable will be buried to a target depth of circa 2 -3m Based on current burial technology it is estimated that the maximum footprint of the burial machine will be 10m and the footprint of the trench will be between 1 – 5 m. Sea surface The cable lay barge (CLB) will sit within a 500 m radius precautionary zone. If the lay vessel is closely trailed by a burial vessel the precautionary zones may link together creating a single zone 500 m by 1000 m. This radius will be larger (potentially up to 2 km) if the CLB has anchors.
Deep water cable installation	Water depths greater than 10 m	The cable will be buried to a target depth of circa 2 -3m. Based on current burial technology it is estimated that the maximum footprint of the burial machine will be 10 m and the footprint of the trench will be between 1 – 5 m. Pre-sweeping path width will vary depending the shape and size of each feature but may be 10 m to 20 m. Sea surface Typically a large Cable Lay Vessel (CLV) will be up to 150 m in length and will sit within a 500 m radius precautionary zone. If the lay vessel is closely trailed by a burial vessel the precautionary zones may link together creating a single zone 500 m by 1000 m. This radius will be larger (potentially up to 2 km) if the CLV has anchors.

Table 4-3 : Project installation footprint

4.5.5. Cable installation methods

A number of alternative methods are available for cable burial; however, the options are determined by the characteristics of the seabed into which the cables are to be buried.

The cables will be buried into the seabed either by a plough or trenching machine deployed by the main laying vessel directly or by a support vessel following behind. To ensure cable protection is immediate, operations may be simultaneous with burial equipment being deployed by either the cable layer or the support vessel. Alternatively cables may be buried in a 'post-lay burial' (PLB) operation, where a burial machine may be deployed days or even weeks later by a separate vessel.

There are three generic types of equipment for installing cables into the seabed:

- ploughs (towed),
- jetting machines (towed, free swimming or tracked)
- mechanical trenchers (tracked).

Ploughs
Ploughs are towed machines generally used for simultaneous lay and burial operations where the cable vessel controls cable laying speed to match plough performance and residual tension targets.

Although they are essentially passive, ploughs can be steered, and plough penetration (and hence cable depth) is controlled remotely from the surface via an umbilical cable.

There are two principal types of cable plough: displacement ploughs and non-displacement ploughs. Both types of plough are towed either by the cable vessel or an auxiliary vessel moving along closely behind the cable vessel.

Displacement ploughs

Displacement ploughs create an open v-shaped trench into which the cable is laid.

This type of plough is typically used for pipeline installations and generally requires high pulling forces (bollard pull), possibly 200 tonnes or higher, as a large amount of seabed material is displaced. A displacement plough is suitable for most types of sediment including rock. The trench may be back filled by the use of back fill blades at the rear of the machine or left to backfill naturally.

The displacement plough can make a trench of up to 5 m or more in width and the footprint of the plough itself may be more than 10 m. The equipment can only be used in water depths of greater than 10 m due to its large size and is therefore not suitable for shallow water installation.

The action of the displacement plough causes a relatively large amount of ground disturbance, because, as the name suggests sea bed material is displaced and piled up at either side of the produced trench. The sea bed footprint is greater than that of other machines and the spread foot print on the sea surface may be large owing to the size of vessel needed to pull this large equipment.

Non-displacement ploughs

This type of plough is the one most commonly used for the installation of telecommunications cables and is also used for power cables, umbilicals and other flexible products.

Figure 4-F : Modular Cable Plough in use on Isle of Man interconnector

A non-displacement plough uses a thin blade-like share that slices through sedimentary seabed material without creating an open trench. This type of plough often causes minimal disturbance to the seabed surface and the passage line can sometimes be difficult to detect during subsequent surveys. The cable runs through the heel of the share and is installed below soil that is relatively un-weakened by the process. Pulling forces for this type of plough are generally less than for the displacement plough but can still be in the order of 150 to 200 tonnes.

The footprint of the plough is typically 5 - 10 m wide depending on the size of the equipment.

A non-displacement plough performs well in most sediment types but is not optimal for use in sandy sediments where frictional forces and wear rates are high.

A development of the basic non-displacement plough is the jetting plough, which uses water jets to lubricate the passage of the share, thereby overcoming some of the affects of friction. The jetting plough has good performance in all sediment types including sand and requires less bollard pull to achieve the same burial depth as a conventional plough.

Non-displacement plough design has advanced over recent years and machines have been produced with capability in very hard materials including high strength clays, i.e. London Clay, and also chalk. These are typically called “rock ripping” ploughs and have similar operational characteristics to other non-displacement ploughs.

Another development of the non-displacement plough type is the vibro-plough which utilises vibration to reduce friction on the share. It has been shown to be particularly effective in glacial till (‘boulder clay’). This type of plough is generally only available for inshore works and is usually mounted directly on a barge or tracked vehicle. Although very effective in the inter-tidal area this type of equipment has not so far been developed for use on large cables in greater water depths. The footprint of the plough is 3 - 4 m.

Jet trenchers

Jet trenching machines use water jets to fluidise the seabed underneath the cable, forming a trench full of fluidised material.

Figure 4-G : Canyon T750 tracked jet trencher

The cable sinks into the trench through the fluidised material under its own weight or is directed into it by a stinger or depressor. The jetting action may be augmented in some cases by eductors that suck

disrupted material out of the trench and deposit it to the side. The trench created may be partially or completely filled by reconsolidation of the fluidised material with the previous seabed level recovering over time through natural sedimentation.

Open sword jetting machines may be deployed directly behind the cable vessel or onto a cable that has been laid previously. Those with a cable depressor or stinger can only be deployed in simultaneous mode for the first pass on a cable. Figure 4-H shows the Prysmian Hydroplow jetting machine with stinger, currently being offered in the European market.

Figure 4-H : Prysmian Hydroplow jetting machine

Using water jets results in slightly more turbidity than that created by a non-displacement plough. Jetting is a viable technique in a wide range of sediments but performance decreases with:

- increase in sediment shear strength and cohesiveness (e.g. contents of clay),
- increase of organic content (peat) and;
- increase of particle size (gravel, cobbles)

Mechanical trenchers

Mechanical trenchers are usually mounted on tracked vehicles and use chain saws or wheels armed with tungsten carbide teeth to cut a defined trench. These machines can work in virtually all sediments, including those with high shear strength and even bedrock. These are often large machines and work in very soft mud or loose ground conditions, though it can be difficult in mobile sands. They may also have difficulty in certain types of rock (eg chalk with flints) or in glacial till or “boulder clays” (where the loose cobbles may cause problems with teeth/additional wear).

Figure 4-I : Canyon i-Trencher (BritNed)

Some spoil is ejected from the trench by the cutting action and the cable is guided into the trench base by a depressor arm. The mechanical action may be augmented in some cases by water jetting and/or by eductors that suck disrupted material out of the trench and deposit it to the side.

The trench opened during mechanical trenching can be back filled or left to refill naturally. A mechanical trencher will make trench of 0.5 m to 1.0 m in width and the footprint of a mechanical trencher will be 5 to 10 m, depending on the particular machine.

Trenchers may be used for simultaneous lay and burial operations, where the cable vessel controls laying speed to match machine performance, and also for post-lay burial of cable or burial of repaired

sections. They normally cannot be used for a second pass on an already buried cable as the cable cannot be located and loaded into the machine.

Mechanical trenching is a viable technique in a wide range of sediments but is not usually deployed unless sediment shear strengths are known to be very high. This is because of the complexity of these machines, which have many moving parts, high wear rates and relatively slow installation speeds. These factors can potentially result in higher costs and possible delays during installation.

4.5.6. Cable joints

As a cable lay vessel or barge cannot carry the entire quantity of cable required for the marine cable route, it will be necessary to install the cable in several sections. Joints will be required to join each section of cable. It is expected that up to five offshore joints will be required for the Project however it will not be possible to determine the precise number or location of cable joints until an installation contractor has been appointed. Appointment of an installation contractor will not take place until consents for installation and operation of the project have been secured.

Cable joints will be made on board the cable lay vessel or barge and will take up to a week to complete. In this time the vessel is likely to anchor to maintain position. Once the cable joint has been made on board the vessel the cable lay will continue as normal.

4.5.7. Cable and pipeline crossings

Crossing agreements will be made with parties owning cables and pipelines which the project will cross in line with UK Cable Protection Committee (UKCPC) guidance. All parties have been informed about the potential for a cable crossing. These agreements detail the physical design of the crossing, and outline the rights and responsibilities of both parties to ensure the ongoing integrity of the assets. Indicative diagrams of typical methods of cable crossing are shown in Figures 4-J and 4-K. The footprint of cable crossings will be circa 100 m (rock or concrete mattress along the Nemo Interconnector cable) by 30 m (width of bridge over existing cable).

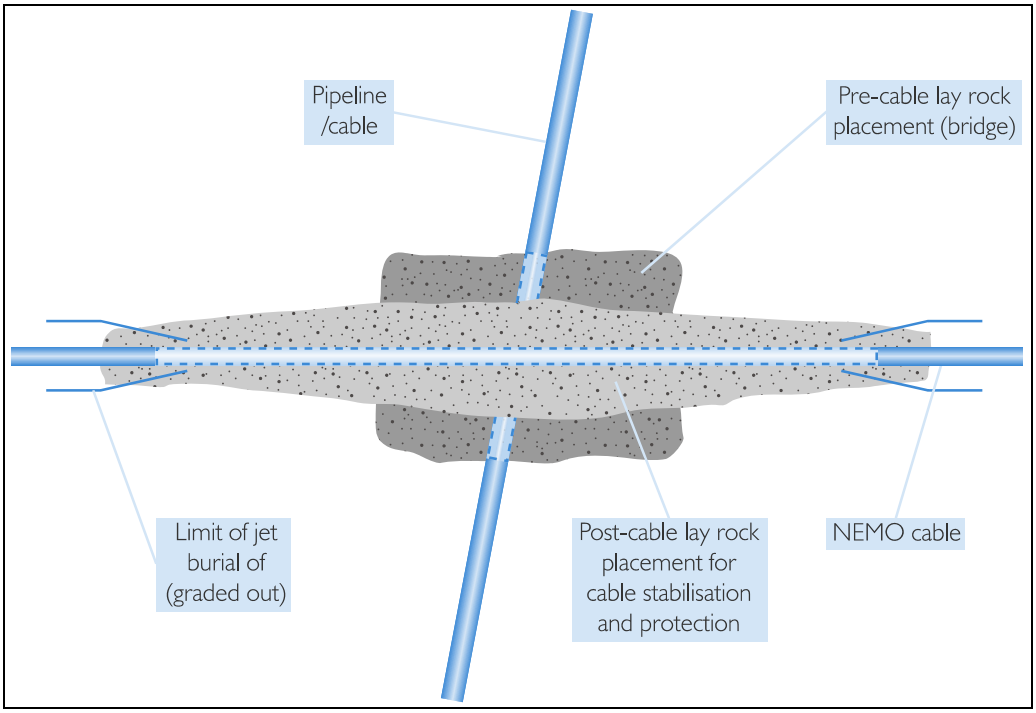

Figure 4-J : Cable crossing over buried/semi buried infrastructure

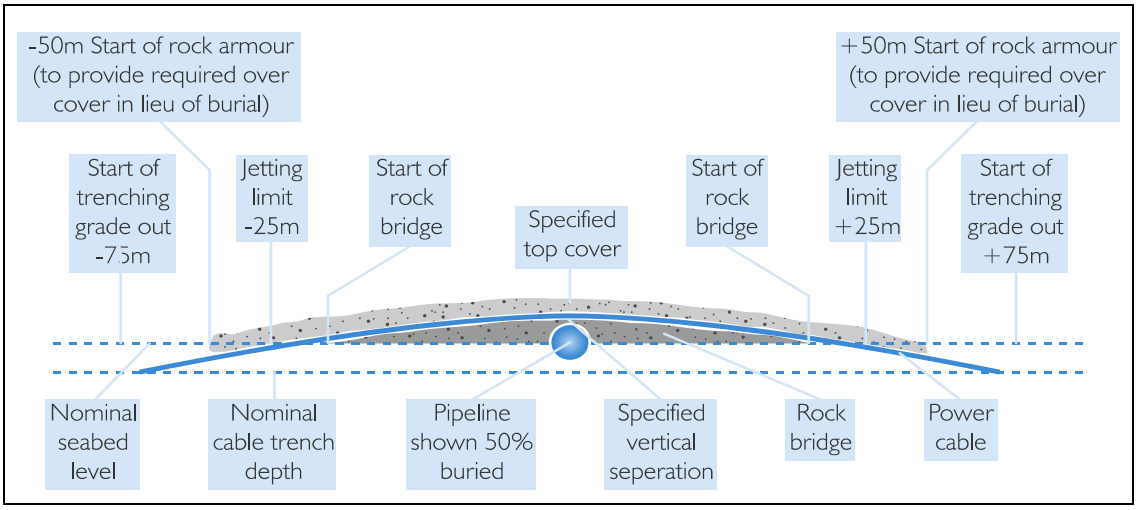

Figure 4-K : Cable crossing over buried/semi buried infrastructure – elevation

4.5.8. Landfall installation

In the case of Richborough, consideration of the Thanet Offshore Wind Farm operations suggests that marine burial of the cable will be possible between 1.5 km and 2.0 km from the beach. Inshore of this, the Thanet cables were mostly buried using the land based spider plough, with the last 100 m to 200 m being trenched with tracked excavators.

The landfall installation work relates to the construction of the Transition Jointing Pit (TJP) and the intertidal cable installation. The TJP will contain the joint between marine and land cables. The TJP, which will be described in the corresponding onshore planning application, will be constructed from reinforced-concrete and will be situated below ground level. It must be completed well in advance of the cable landing to avoid any delays to the landing operation. It will be necessary to agree temporary access routes to areas such as the beach for installation work to be completed. It is expected that the installation will use similar methods to those used for the Thanet Offshore Wind Farm cables as outlined above.

For the Nemo Link the proposed installation is via open cut trenching, possibly with the requirement for a cofferdam, which is similar to open cut but with sheet piling used to support the trench walls

For open trenching, a trench will be constructed using a conventional excavator and rollers will be used in the base of the trench to pull the cable along it. The trench will be approximately 1 – 2 m wide and the cables will be buried at a target depth of 2-3 m. Mechanical excavators will then be used to bury the cable. Some soil conditions may dictate that the cable should be laid on sand (or another suitable backfill) for protection. Top soil and subsoil from the trench will be removed and stored separately. In some areas it may also be necessary to provide protection to the topsoil in the surrounding work area through the use of wooden ‘bog-mats’ or possibly by removing the topsoil and storing it away from the construction area. Some conditions may require the use of cofferdams and in some open areas, such as the beach, it will be necessary to fence off the trench area in advance of installation.

A temporary working area of approximately 30m x 30m will be established as a works compound. The working assumption for this is the lay-by adjacent to the Service Station at Pegwell Bay.

4.5.9. Hours of work

As marine operations are dependent on weather conditions, installation work will be conducted on a 24-hour basis.

For inter-tidal cable work, site preparation work will be undertaken between 07:00 and 19:00 hrs Monday to Friday and 07:00 to 13:00 hrs on a Saturday. Within these times, one hour at either end of the working day has been allowed for start-up and shut down procedures. These hours of work may vary in extraordinary circumstances. Since the cable installation work is linked to offshore working, the installation work may require 24-hour working.

4.6. Installation programme

Cable installation schedules are dependent on a number of factors such as the delivery of cable, the availability of cable and the other commitments of the installer.

The Project route is relatively straightforward with approximately 20km of shallow water (< 10mCD) on the UK side, a deep water (> 10mCD) section of some 100 km (that crosses UK, French and Belgian waters) and a shallow water section at the Belgian end of approximately 10 km.

Figure 4-L below provides an indication of the installation programme for the marine aspects of the project. The programme for the commencement of installation has not yet been agreed but it is likely that installation will begin between 2014 and 2016. In general, installations in European waters are undertaken in the summer season, broadly between April and October. This period is determined primarily by the high probability of adverse weather occurring outside of this period. The schedule will also be affected by factors such as the requirement for ecological mitigation, cable delivery and the availability of vessels.

		Month				
Activity	**Description**	**1**	**2**	**3**	**4**	**5**
C1a UK shore end installation	Route clearance, laying and post lay burial of cable					
C1b Belgian shore end installation	Route clearance, laying and post lay burial of cable					
C2 Offshore installation UK	Pre-sweeping of sand waves, route clearance, cable jointing, simultaneous lay and burial of cable					
C3 Offshore installation France and Belgium	Pre-sweeping of sand waves, route clearance, cable jointing, simultaneous lay and burial of cable					

Figure 4-L : Installation programme for the marine aspects of the project

Installation work in the intertidal areas in the UK and Belgium is expected to take less than one week. It is expected that up to five marine cable joints will be required on the entire cable system and each jointing operation will take approximately five days.

4.7. Cable operation

4.7.1. Overview

Following installation, routine maintenance work to the cables is not anticipated. However, some work may be required to maintain the burial of the cable to protect it from adverse interactions with other sea users and marine processes which might damage it. The cable and its installation will be designed to minimise any maintenance requirements.

4.7.2. In-service survey operations

Routine survey of a correctly installed and protected marine cable is not normally required as the subsea cables will be designed to require minimum maintenance. However, in areas of high seabed mobility, or if post-installation changes in the natural or manmade environment are perceived to have occurred (for example through an increase in adjacent dredging activity), survey of specific areas of the Nemo Link cables may be initiated. Regular survey of pipeline crossings may also be a requirement of a particular pipeline crossing agreement. Periodic inspections may be undertaken to identify cable exposures or spanning.

If required, a survey in shallow waters, 10m depth or less, will be carried out by divers or an ROV using cable tracking and video equipment and operating from a barge or small vessel. A survey in deeper water, 10m or more, will be carried out from a survey vessel using side-scan sonar (SSS) and ROV deployed instruments, such as cable trackers and video cameras.

4.7.3. Emissions from operating cable

There are a number of emissions which may occur to varying degrees during installation or operation of the interconnector. Such emissions include:

- electric and magnetic fields
- heat
- noise
- stray currents
- rise of earth potential (ROEP)

Several studies are referred to in order to assess the impact of the Nemo Link:

Study	Author
Electrotechnical studies and effects on the marine ecosystem for the BritNed connector (June 2003)	SwedPower
Seabed temperature profiles (September 2003)	KEMA
Two Part Report: Heating and magnetic issues and specific magnetic conditions within the Port of London (October 2003)	SwedPower
Magnetic and electric field strengths around HVDC cable (December 2003)	SwedPower

Table 4-4 : Operating cable emissions studies

4.7.3.1. Electric and magnetic field (EMF)

Background magnetic and electric fields
The geo-magnetic field forms the background which man-made magnetic fields interact with and against which they can be assessed. A desk study undertaken specifically for the BritNed interconnector estimated the geo-magnetic field in the vicinity of the marine section of the cables to be approximately 48 μT (Swedpower, 2003a). This is assumed to be similar to that for the Nemo Link. This is supported by data from the world magnetic model. There are however likely to be very small local variations in the geo-magnetic field, which exist due to differences in the magnetic characteristics of the underlying geology from place to place.

The geo-magnetic field is thought to play a part in the navigation of marine fauna and is also used by man to navigate, by the use of the magnetic compass. The magnetic field has both magnitude and direction, which vary from place to place. Ships' compasses are adjusted to compensate for the difference between magnetic and true north, the declination.

Electric fields are induced in the sea water as it passes through the geo-magnetic field. The strength of these fields is dependent on the geo-magnetic field strength and also sea water chemistry, viscosity and its flow velocity and direction relative to the lines of magnetic flux.

Naturally occurring induced electric fields have been estimated for the North Sea and have been measured at 35 μV/cm (Pals *et al*., 1982). In 1974, Kalmijn estimated electric fields in the English Channel to reach 25μV/cm twice a day. However, the strength of the electric field in the sea varies continuously because of the varying speeds and directions of the water flow that are consequences of the tides and weather conditions, but it is essentially a static field.

Some species of marine fauna are known to utilize electric fields to detect prey and mates. It is also thought that some species are able to utilize the background electric field to orientate themselves and to navigate.

Magnetic fields associated with the marine cables
The system will produce a static magnetic field with a low-level time-varying magnetic field superimposed on to it.

The predicted line current on the Nemo Link produces a static magnetic field of a magnitude that is substantially the same as the geo-magnetic field. In theory, a cable type called the Integrated Return Conductor (IRC) will have a greatly diminished, or even no, magnetic field as both conductors are centred on the same axis of the cable. This type of cable may be considered ideal in respect of its magnetic signature and has been used for a twin monopole HVDC link between Scotland and Northern Ireland. However, the IRC cable type is not currently available for transmitting the level of power proposed for the Nemo Link, which will use instead a bipole system with two cables of opposite electrical polarity.

The Nemo Link cables will be installed in a bundled configuration, with nominal separation of 0.2 m. The resultant magnetic fields will be very low due to mutual cancellation of the positive and negative poles, and the time-varying component has been calculated to be insignificant.

Electric fields associated with marine cables
The HVDC voltage on the conductors of the Nemo Link cables produces a static electric field. The marine environment is shielded from this electric field by the lead sheath and other external metallic components of the cables, which are bonded to earth. For this reason, electric fields directly caused by the cable conductor voltages external to the cable will be insignificant.

Static and low-level, time-varying, electric fields are produced in the sea water around the cables by induction, principally by the sea water passing through the cables' static magnetic field in the same way as it does through the geo-magnetic field.

Very small electric fields are also produced in the water by the time-varying magnetic field resulting from the electrical 'noise' on the cables. The effects of these low-level fields are not considered to be significant.

The electric field situation is complex as the field strength around the cables is dependent on the cables' magnetic field strength and orientation, in absolute terms and relative to the geo-magnetic field, and time variable environmental factors such as water chemistry, viscosity and flow velocities. The time-varying fields will also serve to influence, however minimally, the resultant strength of the field.

The electric field produced in the cable's magnetic field will also be influenced by the natural electric field induced in the water by virtue of the earth's magnetic field at the same location. It is not possible

to accurately describe the electric field strength at a given location without a full understanding of the local environmental conditions. A study to estimate electric fields produced by the BritNed (SwedPower, December 2003) cable system (a similar system to the Nemo Link) was based on a maximal water flow parallel to a surface laid cable, which produces the greatest induction, and ignores any interactions with natural fields. The estimated field strengths are therefore based on ideal conditions for induction, which may rarely be achieved in the natural environment. Furthermore, these figures are for cables laid on the seabed. The magnetic field strength at the seabed will be reduced for the buried cables and the maximum possible electric fields strengths will be reduced proportionally.

The Nemo Link cable design eliminates direct electric field generation and, by minimizing the magnetic field generated by the Interconnector, the system configuration also minimizes electric fields induced in the marine environment.

Estimated magnetic and electric field strengths

Expected electric and magnetic fields from the Nemo Link have been confirmed by calculation as similar to those from BritNed, which were modelled for several different cable configurations (SwedPower, December 2003). The results of this work are summarized in Table 4-5. As can be seen from the table, both electric and magnetic fields are substantially reduced by bundling the cables together. Bundling is the “base case” cable configuration. Information on electric and magnetic field strengths are also given for 2m separation of cables, for comparison, although it is very unlikely that this cable configuration will be used. Absolute field strengths at 1m and 5m horizontal distance from the central axis of the cables along the seabed are presented for each cable configuration.

Cable configuration	Electric field strength (μV/m)		Magnetic field strength (μT)	
	1 m from cable	5 m from cable	1 m from cable	5 m from cable
Bundled (0.2 m separation)	61	1.9	72	2.2
Separated (2 m separation)	260	18	310	21

Table 4-5 : Electric and magnetic fields from BritNed.
Source: Swepower, December 2003

Note: The values above are calculated to be the maximum possible electric and magnetic fields to be produced by BritNed. Calculations are based on a sea water current speed of 0.85m/s, and a cable electrical current of 1,320 A.

Consideration has been given to the distance from the cables that the electric and magnetic fields generated by the cables can no longer be detected against the natural background fields. The electric and magnetic field contributions from each conductor decay by a factor equal to the reciprocal of the distance from the conductor. The net magnetic field at each point is the sum of magnetic field contributions from each conductor and the background earth’s geomagnetic field. For example, for the “base case” option (bundled cables), the magnetic field strength reduces to 0.5 μT at 8 m from the cables, representing only 1% of the typical strength of the earth’s magnetic field. This figure is for cables laid on the seabed; however, the magnetic field strength at the seabed will reduce proportionately as the cables are buried to greater depths.

Cable configuration	Electric field strength (μV/m)		Magnetic field strength (μT)	
	1 m from cable	5 m from cable	1 m from cable	5 m from cable
Bundled (0.2 m separation)	53	2.0	62	2.4
Separated (2 m separation)	266	21	313	25

Table 4-6 : Expected maximum electric and magnetic fields from the Nemo Link submarine cable.

Note: The values above are calculated to be the maximum possible electric and magnetic fields to be produced by the Nemo Link submarine cable. Calculations are based on a sea water current speed of 0.85m/s, 1 GW power transfer, +320 kV positive pole voltage, -320 kV negative pole voltage, a cable electrical current of 1,563 A, a burial depth of 1m and a seabed relative permeability of unity.

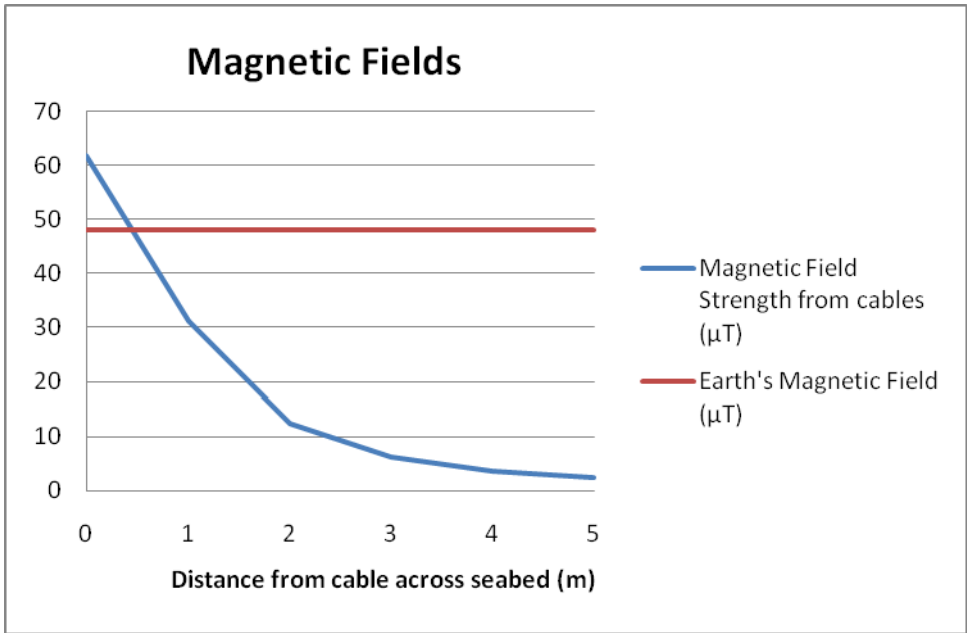

Figure 4-M : Maximum magnetic fields at seabed versus distance from the Nemo Link cable

4.7.3.2. Heat

In transporting DC electrical energy, losses occur as a consequence of the internal resistance in the conductor. This resistance is proportional to the length of the cables and inversely proportional to the cross-sectional area of the conductor (i.e. in this case the copper cable core). The energy that is lost is converted primarily into heat.

A study for the Nemo Link was undertaken in 2011 which uses thermal resistivity data collected during geotechnical survey of the cables route to calculate the impact of cable operation on the seabed temperature. In doing this, the following basic assumptions were used:

- Two bundled cables with a conductor cross-sectional area of 1440mm²;
- The temperature of the seabed is 17°C in the summer and 5°C in the winter;
- The heat production of the cables amounts to 70W/m in summer (with a conductor temperature of 70°C) and 66W/m in winter (with a conductor temperature of 55°C);
- Cable burial depth of 2.5m.

The calculations indicate the following:

- At a depth of 30cm below the seabed, localized heating directly above the cables amounts to a rise of 1.2 °C,
- At a depth of 10cm below the seabed, localized heating directly above the cables amounts to a rise of 0.7°C,

The 2.5m burial values detailed above could equate to a local rise in the seabed temperature in the topmost 30cm of sediment to a maximum of 18.2°C in the summer and 6.2°C in the winter. This is compared with a background summer maximum of approximately 17°C and a winter maximum of approximately 5°C. This heating effect would be very localised, only occurring in the sediment immediately surrounding the buried cables, and furthermore the seawater would be at background temperatures very close to the seabed surface.

4.7.3.3. Noise

No noise will be produced during operation of the cables; however, there are three main elements of the marine cable installation which will involve a degree of noise production. These are the offshore installation, shallow water installation and the land fall installation operations, where the cables are pulled ashore.

Offshore marine installation
The offshore installation spread is likely to comprise two vessels – one laying the cables and the second burying the cables. The offshore spread will typically be moving at a rate of 300m/hour on a 24 hour basis; therefore the noise caused by the installation at any one location will generally be transient and temporary. However, at joint locations the installation spread could be stationary for between 1 and 2 weeks. It is not possible at this stage to specify jointing locations but they are all expected to be some distance offshore.

A study into the noise emitted during subsea power cable installation was commissioned by COWRIE in 2003. During the installation of the cables at North Hoyle Offshore Wind Farm, measurements were made of the noise levels created by trenching of cables into the seabed. Levels were recorded at a range of 160 m from the trenching with the hydrophone at 2 m depth; this was necessary because, at the time the measurements were being made, the work was being undertaken in very shallow water. The sound pressure level of this recording was 123 dB re 1 mPa. The trenching noise was found to be a mixture of broadband noise, tonal machinery noise and transients which were probably associated with rock breakage. It was noted at the time of the survey that the noise was highly variable, and apparently dependent on the physical properties of the particular area of seabed that was being cut at the time. Analysis of the data indicates that if a Transmission Loss of 22 log (R) is assumed, a Source Level of 178 dB re 1 mPa @ 1 m results. Noise modelling undertaken using this source then indicates that, for distances up to 5km from the source, all of the measurements are below 70 dBht (with one isolated exception), and hence below the level at which a behavioural reaction would be expected. It is therefore expected that the impacts from cable laying noise will not be significant.

There are no anticipated emissions to air as a result of the cable laying operation.

Shallow water operation
The shallow water installation spread will be based upon a single vessel that will both lay and bury the section of cables between the intertidal area and deeper waters of approximately 10 m water depth. It will have a shallower draft to enable it to manoeuvre in the shallow waters in Pegwell Bay.

Background noise context
Noise produced by the cable installation in the marine environment is set against a background of noise produced by other shipping activity in the area. These ships include merchant vessels, tankers and ferries of up to 40,000 dead weight tonnes. With this in mind it is anticipated that noise emissions associated with the offshore and shallow water operations will make only a very minor contribution to the typical noise levels found in the vicinity of the cables.

Landfall installation
The landfall installation will be relatively static in its nature and is likely to take place in two phases: site preparation and the shore end cable installation.

The site preparation works will include the construction of a jointing pit to house the connection between the marine and land cables west of the sea defences and the drilling of two conduits under the sea defences. These operations will involve the use of various equipment including a horizontal directional drilling machine and excavation machines/vehicles and will take approximately three weeks in total to complete.

The shore end cable installation could take place any time after completion of the site preparation and conduit installation works and will involve the hauling ashore of the marine cables. This operation will involve the use of excavation machines, tracked vehicles and winches and could take up to two weeks to complete including preparation and remediation. The actual cable pull, where the cable vessel will

be laying relatively close to the shore, may take one or two days depending on factors such as weather and tidal conditions.

Noise associated with the landing will be largely confined to the vicinity of the sea defences, will be short term and generally occur during normal working hours. It is not anticipated that the installation operation will involve 24 hour working. However, it is possible that the pulling of the conduits into the bores drilled under the sea defences could run over one 24 hour period as this operation, once commenced, cannot be interrupted. Also the cable pull ashore may run over into a 24 hour period to take advantage of optimum weather and tidal conditions windows.

The operations will produce construction noise at, and close to, the sea defences and ship's machinery noise for a short period inshore and a longer period further offshore. In all cases the noise levels will not increase background levels significantly offshore and only to a limited extent for a short period onshore.

4.7.4. Rise of Earth Potential (ROEP)

Faults on cables (both sea and land) may occur when the insulation around the HV conductor fails due to internal breakdown or damage from external sources. Although faults are very rare, when the insulation does break down, a fault current flows and returns to the converter station earth mat, which is a metallic grid embedded in the ground under the converter station.

It should be noted the ROEP is a very short-term phenomenon which will disappear rapidly when the system shuts the link down after 150 milli-seconds (ms).

Most of the fault current flow will return from the point of damage to the earth mat via the cable lead sheath and steel armouring (which are bonded to the earth mat at the converter station). The remaining current flow will flow into the sea mass or the ground surrounding the cable fault, and return via the sea or seabed.

Calculations show that the temporary rise in the converter station earth mat potential may reach 800V (SwedPower, 2003b). However, for a member of the public to experience a shock it would be necessary for him to physically "bridge" the distance from a location external to the converter station and touch the earth mat (or connected apparatus). This is highly improbable, and therefore the public would not be at risk from faults occurring on the buried sea or land cables that cause to a transient ROEP. If any planned maintenance work is to be carried out on adjacent infrastructure on land, the placement of suitable earths will limit the spread of any transferred voltage and the use of insulating personal protective equipment will further reduce any risk.

If the ROEP area extends over adjacent infrastructure, such as pipelines, voltages up to 230V may be transferred to the infrastructure. However, touch and step potentials will not prove harmful if the minimum separation between cable and pipeline is maintained at greater than 1.7m (KEMA, 2003).

Stray electrical currents
For bipolar systems which do not utilize sea electrodes, and instead use 2 pole cables, the only situation in which stray currents could possibly occur is in the event of a cable rupture. In such an event the very high line voltage and currents will cause the fault to break down and a rapidly increasing fault current to flow. Any fault currents above 3 amps will be detected and cause a shut down within 150 ms (SwedPower, 2003b). This precludes the possibility of the prolonged circulation of low level fault currents.

4.7.5. Cable repairs

Cable repairs to correctly installed and protected submarine cables are infrequent but require operations which temporarily impact upon the environment and the activities of other users of the sea.

The most common reason for repair of a submarine cable is damage caused by third parties, typically caused by trawlers or commercial ships' anchors. Such damage may be localised or widespread depending on the energy of the interaction and the cable may be locally affected, mauled (where something is dragged with force along the cable for a distance) or dragged from the seabed.

A repair may be carried out by a single vessel. A shallow water repair, in less than 10 m of water, will typically be performed using an anchored barge. In deeper water, a dynamically positioned cable ship or barge will be used. Vessels carrying out cable repair operations are restricted in their ability to manoeuvre and will display the required navigational lights and signals. The operational details and the exact configuration of a repair spread will depend on the type of repair and the contractors' facilities.

Typically the phases of a repair operation are as follows:

- loading of spare cable to the repair vessel;
- location of the damage;
- cable retrieval;
- cutting the cable
- cable recovery to the surface;
- repair of the cables;
- re-deployment onto the sea bed and re-burial.

Spare marine cable will normally be stored at the premises of the nominated repair contractor or a nearby port facility.

A repair invariably requires the insertion of additional cable and two additional cable joints, the initial and the final. The additional cable length in the case of point damage may be equal to approximately three times the depth of water at the site, and longer if the cables have been damaged over a distance.

For the repair of a single cable in a bundled pair, the damaged cable would need to be separated from its partner and brought to the surface, although it is possible that both cables might need to be repaired as a precaution against undetected damage. Alternatively the bundle would need to be recovered.

The extra length of a repaired short cable section means that the repaired cable cannot be returned to its exact previous position and alignment on the seabed. The excess cables will be laid on the seabed in a loop located to one side of the original route. The excess cables and first joint of a longer repair section can be laid along the original route whilst the final joint will form an `omega' loop on the seabed.

The additional joints and the extra cable length will be buried, typically using jetting machines deployed from either the repair vessel itself or a separate specialised vessel. These operations are similar to those described above,

A cable repair operation will be expected to have a duration of several weeks or months, depending on the type and extent of damage and operational constraints.

4.8. Decommissioning

4.8.1. Introduction

The Nemo Consortium recognises the importance of considering the decommissioning process at an early stage, and should decommissioning be undertaken the operation will be conducted according to the standard industry protocol at the agreed time.

At the end of the cable's life the options for decommissioning will be evaluated. In some situations, the least environmentally damaging option may be to leave the cable in-situ. This option raises the issue of liability for any claims from fishermen or other third parties that come in contact with the cables. This issue will be addressed in the planning stage of cable decommissioning.

4.8.2. Extent of decommissioning

The objectives of the Nemo Consortium during the decommissioning process will be to minimize both the short and long term effects on the environment whilst making the sea safe for others to navigate. Based on current regulations and available technology, the Nemo Consortium proposes to perform the following level of decommissioning:

- Cable System – to be either removed or to be left safely in-situ, buried to below the natural seabed level
- Mattresses – to be left in-situ
- Scour protection material – to be left in-situ

The decommissioning aspects of the onshore works will be described in the relevant section of the onshore Environmental Statement for the project.

4.8.3. Retrieval of buried cables

Should cables be required to be removed from the seabed, the following operation is typical.

The first stage of the operation would be to expose a section of buried cable to either attach a gripper directly onto the cable or to install a cable "under roller" to de-bury the full length of the cable. This local cable de-burial operation would be undertaken using either a jetting device to expose a short section of cable or to use a grapnel tool to raise the cable to the surface. Various grapnel types are available, including de-trenching grapnels (the most likely form to be employed) and other more sophisticated cut and hold grapnels.

Once a section of the cable is exposed, there are then two alternative methods to de-bury the full length of cable. Providing cable "peel out" forces are not too excessive, a gripper could be attached to the cable to then lift a cable end back to the cable recovery vessel. Cable recovery could then proceed directly. Alternatively, a cable under roller could be used to run the full length of the buried cable. This device would be connected back to a vessel by a steel wire and raises the cable back to seabed level. Both schemes would ensure that a cable end is recovered back onto the cable recovery vessel. Cable recovery would then commence for the full cable length, or lengths would be cut and stored separately. The cable recovery process would essentially be the reverse of a cable laying operation, with the cable handling equipment working in reverse gear and the cable either being coiled into tanks on the vessel or guillotined into sections approximately 1.5m long immediately as it is recovered. These short sections of cable would be then stored in skips or open containers on board the vessel for later disposal through appropriate routes for material reuse, recycle or disposal.

When back in port, the cable recovery vessel would unload the cable onto the quayside.

The survey route would be surveyed to ensure that all cable had been removed. This survey would be provided as proof of removal.

4.8.4. Disposal / re-use of components

During the decommissioning of the assets wastes must be handled, stored and disposed of according to the following:

- UK waste management legislation

- Environmental best practice (i.e. the Waste Hierarchy)

The Waste Hierarchy is the nationally recognised approach to waste management and forms the basis of the UK Government's approach to waste management. The hierarchy is as follows in order of most-favoured to least-favoured option:

- Reduce
- Re-use
- Recycle
- Recover energy through incineration or from landfills
- Landfill without energy recovery

The three Rs below represent the most important waste options in the hierarchy:

- REDUCE Reducing waste saves both materials and energy, and removes the need and expense of disposal
- RE-USE Re-using minimises the need to buy new items, thereby saving resources
- RECYCLE This saves valuable raw materials and cuts down on waste collection and disposal costs.

At the time of decommissioning a waste management protocol will be drafted addressing the treatment of waste and its minimisation, re-use and recycling where possible, to reduce environmental damage, risks to health and safety, and address economic concerns.

4.8.5. Decommissioning programme

The decommissioning programme is expected to be similar to that during installation, and involve similar vessels and timescales to the installation phase.

4.8.6. Ongoing monitoring

No post-decommissioning monitoring of the seabed is proposed for this project.

5. Environmental Assessment Methodology

This section outlines the methodology that has been used to deliver the EIA of the proposed development and the subsequent Environmental Statement.

5.1. "Rochdale" approach to impact assessment

As with many large infrastructure projects, it is often impractical to provide full details of installation activities and the full specification of equipment at the time of the EIA. Such detail is dependent on a procurement of engineering options which will only commence once consent has been granted.

The 'Rochdale Envelope' provides a solution where there are good reasons why the details of the whole project are unavailable before consent is granted. Such an approach has been used under other consenting regimes (the Town and Country Planning Act 1990 and the Electricity Act 1989) where an application has been made at a time when the level of certainty as to the details of a project, have not been resolved. It has been successfully applied to most marine renewable energy projects, including all of the UK's Round 2 wind farms. However when the project details are deemed insufficient they potentially give rise to an impact greater than that which has been assessed. This was the situation considered in the cases of R v Rochdale Metropolitan Borough Council ex p Milne (2000) and R v Rochdale Metropolitan Borough Council ex p Tew (1999).

The approach is based on assessing the potential impacts of a "realistic worst case scenario", under which the assessment of the project is defined by an "envelope" of theoretical constraints. For example, although the burial equipment for cable cannot yet be specified, its "envelope" can be defined by a maximum footprint in respect to disturbance of the seabed (e.g. width of burial machine, width of burial trench and depth of burial). In this way the design of the project can vary within these maximum parameters without rendering the EIA findings invalid. Any subsequent consent would incorporate these parameters into its conditions, thereby ensuring that the scheme consented is that which has been assessed.

Where details of the proposed development cannot be finalised ahead of the submission of the Environmental Statement the Rochdale principle has been applied. The key aspects of the envelope are detailed below:

- A pre-lay grapnel run will take place prior to cable installation.
- Two cables will be installed, bundled in a single trench in the offshore and intertidal area.
- The cables will be installed by either a ploughing or jetting machine.
- Some pre-sweeping will be required to level the seabed prior to cable installation, estimated maximum quantities have been used to inform this EIA.
- Trenching (as opposed to directional drilling) will be used to install the cables in the intertidal area.

5.2. Impact assessment process and guidance

The sections below outline the method used to undertake the study and reporting of the EIA.

The impact assessment has been carried out taking into account the guidance provided by the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS) in 2004 - CEFAS (2004). Guidance notes for EIA in respect of FEPA/CPA requirements. (Version 2 - June 2004). Although the project does not constitute EIA development the explanatory memorandum to The Marine Works (EIA) Regulations 2007 No. 1518 prepared and issued by DEFRA has also been taken into account as appropriate.

Specific guidance in relation to individual topics (e.g. benthic ecology, archaeology) has been referenced as relevant.

5.3. Baseline environment

The baseline environment for each topic considered will be described within the Environmental Statement based on available data and information. Section 2.4 above details the primary data collected.

The data collected has been supplemented with relevant available information and literature from public bodies (e.g. CEFAS, JNCC and Natural England), government initiatives (e.g. the offshore Strategic EIAs), similar and proximate projects (e.g. Thanet Offshore Wind Farm and the BritNed project) and other relevant literature. The Appraisal of Sustainability associated with the Marine Policy Statement will also be taken into account in describing the baseline environment as appropriate (HM Government *et al*, 2011).

5.4. Identification of environmental impacts

The scoping report and associated consultee responses indentified all anticipated environmental impacts. The impacts described in Chapters 6 to 8 of this ES have been identified based on a review of the likely interactions between the proposed development activities and the physical, biological and human environment.

5.5. Assessment of environmental impacts

This section describes the method of EIA used to determine the significance of the effects of the installation and operation of the marine cable system.

Each potential impact and associated receptor identified during the EIA scoping exercise has been assessed in an impact assessment matrix that takes into account the assessment method details below. The matrix can be found in Appendix 6 – Assessment of Impact Significance.

5.5.1. Nature of effect

The magnitude of the effect has been assessed using the following criteria:

- Likelihood – the probability of the impact occurring
- Spatial Extent – the spatial extent over which the impact may occur
- Level of Change – the potential level of change from baseline conditions taking into account known information on natural variation
- Duration – the length of time over which the impact may occur

Effect Factor	Classification	Definition	Score
Likelihood	Certain	Will occur as a result of the project	100
	Possible	Likely to occur	10
	Unlikely	Not likely to occur	1
Spatial Extent	Regional	Regional to national/international (e.g. entire English Channel)	100
	Local	Within range (few km) of the source of impact	10

Effect Factor	Classification	Definition	Score
	Immediate vicinity	At source of impact only	1
Level of Change	High	Large change compared to natural variations in baseline	100
	Medium	Change will or may be noticeable/measurable against the natural variation in the baseline	10
	Low	Change will not be noticeable/measureable against natural variation in baseline	1
Duration	Long-term	Effect will occur for >5 years	100
	Medium-term	Effect will occur for between 6 months and 5 years	10
	Short-term	Effect will occur up to 6 months	1

Table 5-1 : Effect factor classification and definition

Using the criteria above an impact has been given a value of magnitude using the scoring system below. For example, for a long term effect that will definitely occur, at a regional scale with a large change from the baseline the score is 400. The Magnitude (Severe, Moderate or Low) of the effect has been determined using the thresholds below (:

Magnitude of Effect	Score Threshold
Severe	400 - 211
Moderate	202 - 22
Low	13 – 4

Table 5-2 : Magnitude of effect score thresholds

5.5.2. Description of receptor

In order to identify the level of impact on each receptor or feature the following has been described:

- Sensitivity – the sensitivity or tolerance of the receptor to the effect
- Recoverability – how rapidly the receptor recovers to baseline state following effect
- Importance – Receptor's importance in terms of its occurrence in the UK, its national/international significance and its conservation or commercial value

Receptor Aspect	Classification	Definition
Sensitivity	High	Receptor or feature is highly sensitive to effect and will be detrimentally damaged (in ecological terms killed/destroyed) by effect
	Moderate	Some damage may occur to the receptor or feature
	Low	Some minor damage to receptor or feature
Recoverability	Low	No recovery
	Moderate	Recovery to baseline conditions within years

Receptor Aspect	Classification	Definition
	High	Recovery to baseline conditions within weeks or months
Importance	High	Receptor is either rare, and/or significant in conservation or commercial terms
	Moderate	Feature is significant but not rare
	Low	Receptor is neither rare or significant in conservation or commercial terms

Table 5-3 : Receptor aspect classification and definition

Using the general criteria above a Receptor Value can be determined. The definition of Value (High, Moderate, Low) will vary between topics, and these criteria have been defined specifically in each relevant topic section. An example is given below for recreation and tourism.

Receptor Value	Definition
High	Damage or loss of an area of national or international importance for tourism, recreational activity or amenity. The area will not recover.
Medium	Damage or loss of an area of regional importance for tourism, recreational activity or amenity, the area may not recover. Temporary disturbance to sites of national or international importance.
Low	Small-scale, temporary disturbance to sites identified as being of regional, national or international importance to tourism. The area will recover.

Table 5-4 : Receptor value definition

5.5.3. Impact assessment

The impact significance is a function of the Magnitude of the effect and the Value of the receptor, as illustrated below.

		Value of Receptor		
	Sensitivity	High	Medium	Low
Magnitude of effect	High	Significant	Significant	Moderate
	Moderate	Significant	Moderate	Minor
	Low	Moderate	Minor	Negligible

Table 5-5 : Determination of impact significance

Where an impact cannot be fully quantified due to its complexity or subjective nature, a subjective scale based on professional judgement has been used. Where this is the case the basis for this judgement has been outlined.

The significance of each impact is assessed as being minor, moderate or major. Impacts of 'major' or 'moderate' significance are considered to be 'significant' in EIA terms. Potential impacts may be positive (beneficial) or negative (adverse).

5.5.4. Cumulative impacts

Cumulative impacts with other cable projects and of the proposed development with other regulated human activities in the marine environment are assessed and reported on in Section 9.

6. Physical Environment

6.1. Geology

This section describes the geology along the potential cable route, and the potential impacts of the proposed development upon geological issues.

6.1.1. Baseline data sources

The information used for describing the geological environment was obtained from a variety of sources. These included:

- British Geological Survey United Kingdom Offshore Regional Report 1992. The Geology of the southern North Sea.
- British Geological Survey (BGS) data on surface sediments, supplied by SeaZone as GIS layers
- BGS reports on the geology of the North Sea (Cameron *et al.,* 1992)
- Futurecoast (2002) which includes geological information for the UK coastline
- Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI) citation
- Sediment data from geophysical survey carried out by MMT between August and October 2010
- Royal Haskoning (2005) Thanet Offshore Windfarm Environmental Statement
- Several journal papers and reports provide evidence about geology of the area surrounding the proposed cable route (see references).

6.1.2. Baseline

6.1.2.1. Geology description

The southern North Sea is a shallow shelf sea that is dominated by a deep channel in the west, connected to the Strait of Dover, flowing into the English Channel that eventually connects with the Atlantic Ocean in the south. Holocene sediments in the North Sea are generally present as a thin veneer of mainly sand and gravels, which cover earlier Pleistocene (or older) sediment formations (Cameron *et a*l., 1992). However, in the area of the proposed cable route, there are sediment accumulations in the form of tidal sand ridges (sandbanks) where the Holocene sediments can be up to 30 m in thickness (see Figure 6-1-1). Other exceptions to this, elsewhere in the North Sea, are scour hollows/palaeovalleys.

Sand ribbons, sandbanks and sand waves are common features in the southern North Sea. Although the water is shallow enough for wave-induced currents with sufficient strength to move bottom sediments, these are considered to be of minor importance when compared to the stronger and more regular tidal streams (Cameron *et al., 1992*). Sand ribbons and sandbanks are longitudinal bedforms parallel or subparallel to the dominant flow, whereas sand waves are flow-transverse bedforms.

The offshore sandbanks are considered to have formed relatively early in the Holocene period as the sea transgressed through the Dover Strait. The Goodwin Sands are believed to be banner period sandbanks formed in the lee of the headland of North Foreland. Sandy sediments dominate over much of the offshore area and much of the sand is mobile under current hydrodynamic conditions and therefore its distribution relates to modern sand-transport processes.

The preferred proposed UK landfall area lies in the embayment of Pegwell Bay, just to the south of Ramsgate, Kent. The sediments in this area are composed of superficial Pleistocene sand and gravel

deposits, which are overlain by marine and estuarine alluvium. The marine alluvium comprises fine grained grey and brown sands with local silty clays and abundant marine shells. The depression which underlies Pegwell Bay may have been initiated by drainage from the Thames estuary into the English Channel during a period of lower sea levels in the early Holocene (Futurecoast, 2002).

To the north of the landfall location, the Thanet Sand Formation is exposed at the cliff face (Pegwell Bay cliffs) with an overlaying layer of Head Brickearth. The Thanet Sand Formation contains a diversity of fish fossils, representing the assemblage of species which were destroyed by volcanic action in the North Sea area, when ash fall caused an extinction event. These fossils consist of disarticulated fish debris, including a diversity of identifiable shark teeth. They are considered in the Sandwich and Hacklinge Marsh SSSI citation as being of "very great significance".

The citation for Sandwich and Hacklinge Marsh SSSI says "Pegwell Bay is also the most important site for loess studies in Britain. The section shows up to 4 m of Devensian loss overlying Upper Chalk and Thanet Beds. The loess, an accumulation of wind-blown dust produced under periglacial conditions during the Ice Age is probably thicker here than at any other site in Britain, and is certainly the most closely studied example. Although leached in its upper part, the loess is calcareous below, with rootlet tubes and small concretions. Where the loess rests on the Chalk, there is often a highly frost-shattered zone with well developed involutions. In one part of the section where an infilled channel is cut into the frost-shattered chalk, the loess overlies chalky-flinty gravels and loams produced by solifluction. Pegwell Bay provides the best exposures of true loess deposits in Britain. They are exceptional in having escaped modification by solifluction; no other site provides such useful sections in highly calcareous loess that has not been reworked."

The geology of Pegwell Bay to the south of the preferred landfall location is characterised by marine beach deposits and tidal flats. Inland, the surface deposits are marine and estuarine alluvium, comprising mainly of silty clay, which overlay the Thanet Sand Formation, which in turn overlies chalk.

The proposed cable route runs approximately east-west from Pegwell Bay to Zeebrugge, Belgium. Immediately east of Pegwell Bay, the surface sediments consist of sands and muds, followed by a chalk exposure area between The Brakes. The proposed route then passes through a sandy area to the north of Goodwin Sands. Further east the surface sediments are gravels, sands or sandy gravel. Some of these gravel areas consist of a silty chalk formation, that was clarified during the geophysical survey carried out by MMT between August and October 2010. South Falls is a linear sand bank/ridge approximately 28 km east of Pegwell Bay. To the east of this bank, numerous small sediment features are present and the sediments consist of sands and gravels and include a further area of silty chalk.

Published marine surface sediment types are shown in Figure 6-1-2 on the following page.

6.1.2.2. Seismic activity

In the UK the understanding of seismic events has predominantly been based on historic data due to the low rate of earthquake occurrence. Musson (1996) identified the area of the Dover Strait as being significant since two of the UK's largest earthquakes occurred there in 1382 and 1580 (Richter local magnitude $\approx$ 5.8 M_L). Musson suggests that the area may be structurally continuous with a zone of activity running east through Belgium and therefore, stress in this region has been released further east. Musson also considers that there may well be another large event in the future.

Seismic activity offshore in the North Sea has been linked with graben (a downthrown block between two parallel faults) systems and structure. Musson *et al*. (1997) reported on studies carried out in 1992. These studies suggest that for the whole North Sea area the likely return period for earthquakes with a magnitude of 4 M_L is around two years and for magnitude 5 M_L, every fourteen years. For larger period return events there is more uncertainty, although 6 M_L return period events are predicted at around 130 year intervals. However, historical records show only three events in the last 900 years (Musson *et al*., 1997). This may be due to missing data, a decrease in the frequency in the return period of 6 M_L events, or that such events represent a near maximum magnitude for events in this

area and thus the magnitude-frequency curve is tapering off. This latter explanation is considered the most likely explanation (Musson *et al*., 1997).

EQE International (2002) state that in the southern North Sea the peak ground acceleration hazard is less than that in the northern North Sea where the analysis shows the highest value. These values were obtained from a map of seismic hazard offshore, which was generated using a seismic hazard computation on a regular spatial grid of individual sites, with an approximate mesh size of 50 km x 50 km. The 10^{-4}/yr exceedance peak ground acceleration can reach values of almost 25%g (2.5m/s^2) in the southern North Sea (EQE International, 2002).

6.1.3. Description of potential impacts

The table below shows how sensitivity, recoverability and importance of the geology crossed by the cable route have been considered in determining significance of effect.

Receptor Value	Definition
High	Area with unique, unusual or rare geological interest, that contributes to the scientific understanding of geological processes. If damaged, there will be a permanent loss to the integrity of the geology.
Medium	Area with uncommon geological interest, that contributes to the scientific understanding of geological processes. Extensive enough that damage will only impact a small percentage, such that the integrity of the geology will be preserved.
Low	Area of commonly encountered geology. Changes will not result in any loss to the scientific understanding of geological processes or any loss to geological integrity.

Table 6-1-1 : Definition of receptor value

6.1.3.1. Cable Installation

The most sensitive geological feature in the vicinity of the proposed cable route is the landfall location in Pegwell Bay on the UK coast. The geological interest features listed in the Sandwich Bay to Hacklinge Marshes SSSI citation are identified in the impact assessment matrix as being of high value and that there is potential for severe impact, in the worst case scenario. Should the cliffs at this location be trenched through, during cable installation, it is considered that irreversible damage would be caused.

Various sandbanks along the route will also be impacted as their crests will be dredged during the pre-sweeping operation. It is proposed that the dredge trench will vary depending on the shape and size of the features to be crossed. The greatest width of the trench is anticipated to be 20 m wide at the base, with side slopes of 10 m width on either side and an overall depth of 2 m. Studies have been carried out to determine whether these features would be altered or how long the trench will persist after dredging (see Appendix 7). The studies revealed that the features would not suffer any permanent alteration and that the trench would infill within a matter of weeks. This impact is therefore considered to be **minor**. Further information regarding these studies and a discussion of these features, is contained within the Chapter 6.2 - Bathymetry and Seabed Processes.

6.1.3.2. Cable Operation

The cabling through the landfall route will be buried at a nominal depth of 2 m. It will be insulated and protected with steel armouring in the cable design to ensure that maintenance requirements are reduced and kept to a minimum wherever possible. Should maintenance works be required, then local and temporary disturbance would occur, but these would be kept within the original installation area as far as possible. Therefore, **no impacts** to underlying geology are anticipated during the operation phase of the new cable.

6.1.3.3. Decommissioning

Should the cable system require removal at the end of its operational life, it will be removed through the same soils and sediments disturbed during installation. It is anticipated that the working areas for removal will also be restricted to the area used for installation. Therefore, **no impacts** to the underlying geology are anticipated during the decommissioning phase.

6.1.4. Mitigation

Six options for the landfall location were considered prior to the scoping stage, with only two being taken forward into the scoping assessment report. Discussions with Kent Wildlife Trust, who are considered to be the stewards of the Pegwell Bay area, and responses to the scoping report by the relevant consultees (see Appendix 2), indicated that the favoured landfall route will follow a similar course to the Thanet Offshore Wind Farm electricity export cable. It is therefore considered that the area of disturbance through the geology will be minimised. This location also avoids the indicated area of high geological interest, cited in the Sandwich and Hacklinge Marshes SSSI documentation.

An installation methodology that ensures the geological exposures of interest are not affected will be used during all installation activities to minimise impacts wherever possible. The working area of the cable route will be demarcated with fencing to ensure that installation, construction plant movements and any storage is kept away from the SSSI.

6.1.5. Residual impact

The choice of installation route close to the area utilised by the Thanet Offshore Wind Farm electricity export cable, will reduce the impacts on the geology to a **minor** level, as the highly sensitive and important geological exposure identified in the Sandwich Bay and Hacklinge Marshes SSSI citation will be avoided. The geological sensitivity of the subsea portion of the proposed cable route is low and mobile sandbank features are predicted to recover quickly, resulting in a **negligible** impact. **Minor** impacts are predicted in the areas where the cable goes through chalk outcrops, as the impact is very localised and the receptor value is low.

6.1.6. References

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6.2. Bathymetry and Seabed Processes

This section describes the bathymetry and sea bed processes along the cable route, and the potential impacts of the project upon sea bed processes.

6.2.1. Baseline data sources

The information used for describing the baseline bathymetry and sea bed environment was obtained from a variety of sources. These included:

- Marine hydrographic data from Seazone describing the bathymetry of the southern North Sea based upon surveys between 2009-2011.
- Bathymetry data from a geophysical survey carried out by MMT between August and October 2010 (see Appendix 7)
- Marine hydrographic data from the UK Hydrographic Office
- FutureCoast (2002), which describes sediment transport pathways along the UK coast and some distance offshore
- Isle of Grain to South Foreland Shoreline Management Plan (South East Coastal Group, 2007), which contains descriptions of sediment transport processes around the UK landfall
- The Southern North Sea Sediment Transport Study (HR Wallingford, 2002), which provides modelled sediment transport pathways in the southern North Sea
- The MAREBASSE reports (Van Lancker *et al*., 2007), which provides modelling results of sediment transport for the Belgium Continental Shelf
- Several journal papers provide evidence relating to sediment movement and sand waves, especially on the Flemish Banks (see references)

6.2.2. Baseline

6.2.2.1. Bathymetry

The marine cable route proposed between Richborough and Zeebrugge is described in terms of its bathymetry from the proposed landfall area in the embayment of Pegwell Bay, south of Ramsgate, across to the median line between the UK and France (see Figure 6-1-1).

The proposed route crosses north of the shoals at Cross Ledge before crossing the Gull Stream channel (approximately 14 m water depth), and onwards to a shallow area to the north of Goodwin Knoll (4 – 8 m depth). The Goodwin Sands are highly mobile and the 2009-2011 surveys undertaken by the UK Hydrographic Office (UKHO), demonstrate that the bathymetry of this area has altered significantly in the last six years. East of the Goodwin Knoll, the seabed drops rapidly to a maximum depth of around 55 m, before rising to approximately 10 m at the South Falls bank. The South Falls bank potential sand mobility poses more of a risk to commercial navigation than the Goodwin Sands and for this reason is surveyed by UKHO annually. East of South Falls, the depth falls to an average of around 30 m for the next 50 km. This area is not smooth and contains several sandbanks, varying in height between 3 and 10 m along the proposed cable route.

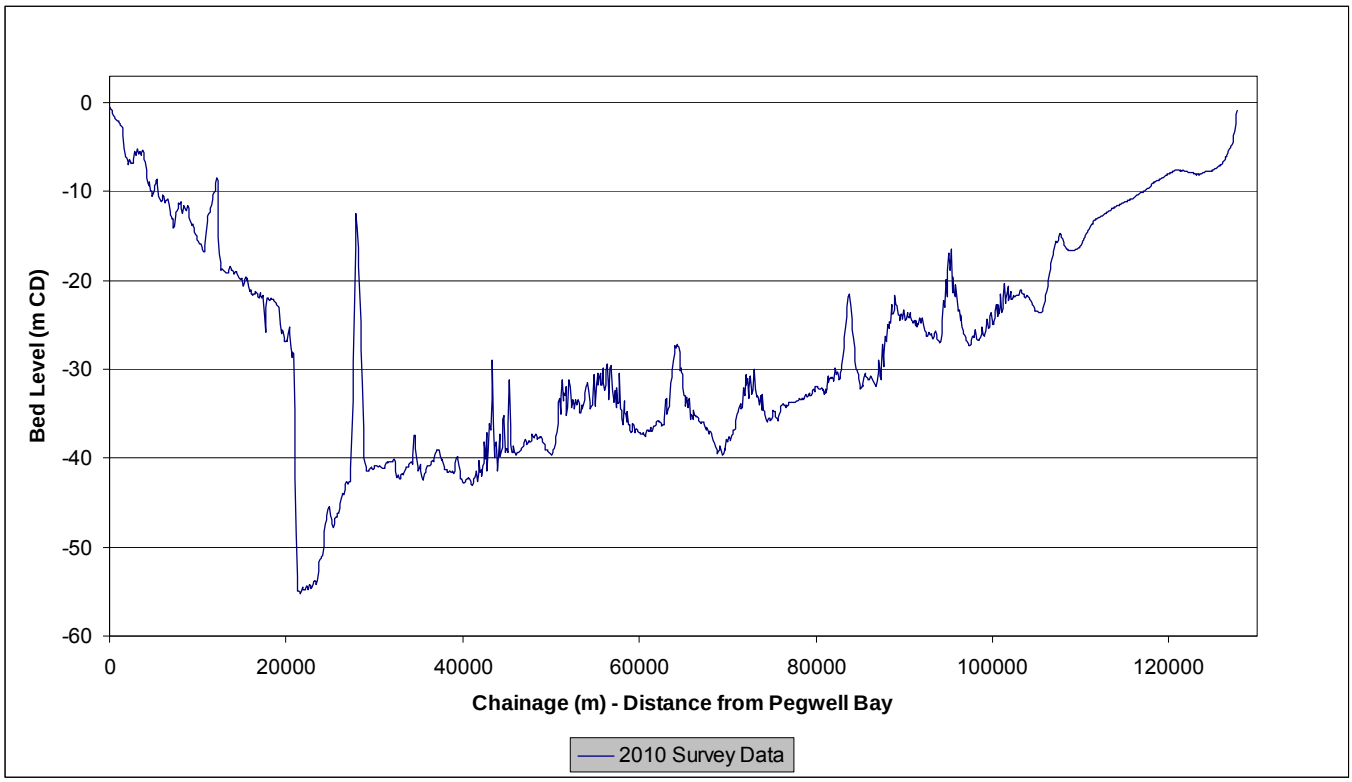

Figure 6-2-A : Profile of cable route interpolated from detailed bathymetry collected during the geophysical survey

A full bathymetric survey of the route was carried out by MMT as part of the overall geophysical survey. High-resolution bathymetric data was collected using a Kongsberg EM3002D Multibeam echo sounder, with data recorded using Kongsberg SIS software. Sound velocity profiles were measured using Valeport SVP SVX2 at regular intervals when needed, to maintain correct depth measurements. This high-resolution data revealed several sand wave fields, each stretching across several kilometres of the survey path. The path of the surveyed route is shown in Figure 6-1-1.

6.2.2.2. Metocean conditions

Hydrographic and meteorological conditions are important for determining sediment transport in the marine environment. Across the continental shelf, tidal currents are primarily responsible for the movement of sediments. However, during storm events, waves may be large enough to have an impact on sediment transport, through the effect of waves (stirring sand from the bottom) acting in combination with tidal currents. Even in deeper water, storm wave action will tend to flatten bedforms. At the proposed landfall locations, waves may also be significant due to the shallower depth which enables wave effects throughout the water column. This can cause changes in sediment transport, leading to beach profile and volume changes and the resuspension of muddier sediments.

Tidal range in this part of the North Sea is approximately 4.8 m on spring tides, reducing to approximately 2.7 m on neaps. Peak current velocities reach between 1 m/s and 1.5 m/s in the proposed cable route area of the North Sea (ABPmer, 2007; MUMM GIS data). This reduces towards both coasts, with typical coastal values of 0.75 m/s to 1 m/s. Pegwell Bay is relatively sheltered from tidal currents and the peak spring flow experienced at this location is less than 0.5 m/s (ABPmer, 2007). The HR Wallingford flow model of the North Sea shows good agreement with these peak velocities (Figure 6-2-B, which shows flow direction vectors and is colour coded for current speed).

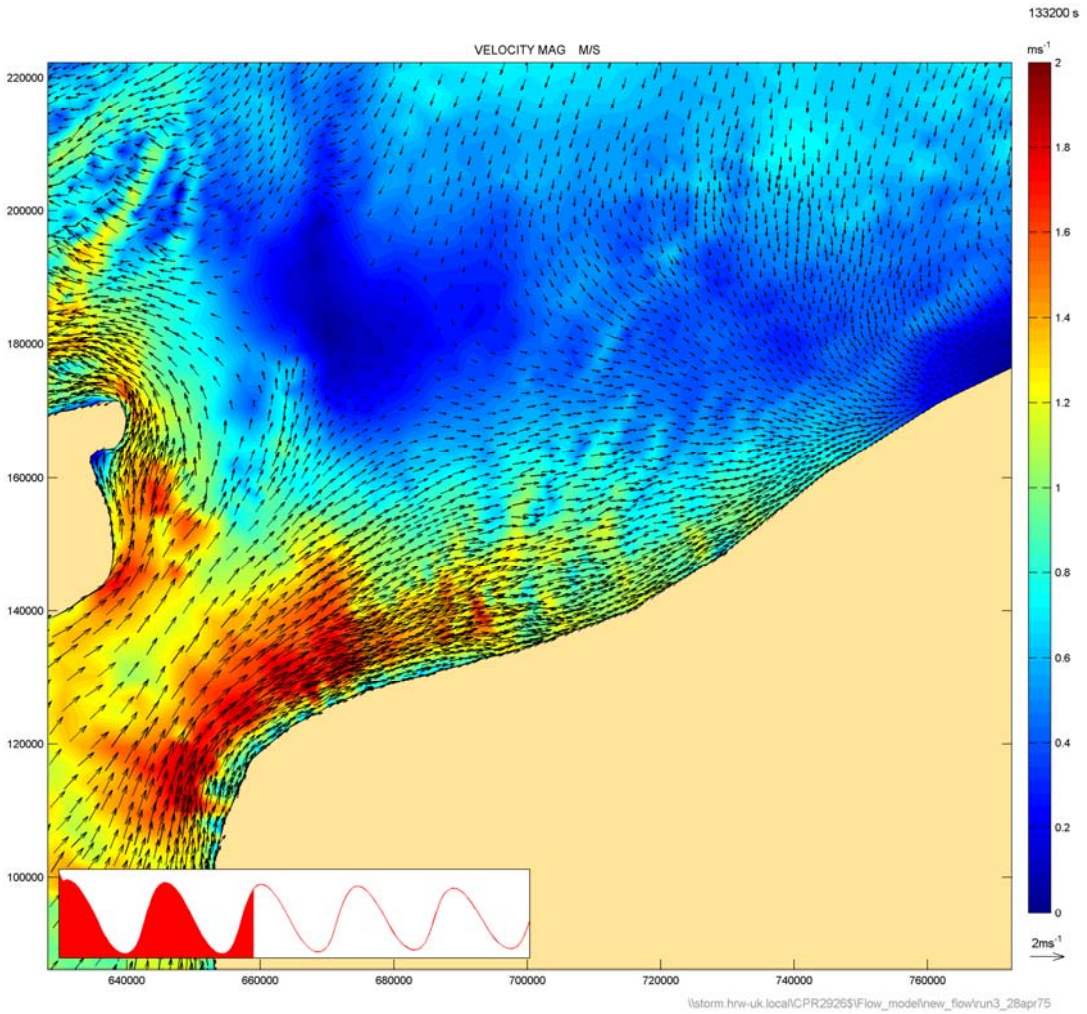

Figure 6-2-B : Flood tide current velocities from HR Wallingford North Sea flow model

Current velocities around the Flemish Banks have been studied by Lanckneus and De Moor (1990, 1995) and Williams *et al*. (1996). At Kwintebank, the tidal currents recorded were 0.7-0.8 m/s on springs and 0.5-0.6 m/s on neap tides (Lanckneus and De Moor, 1990). At Middelkerke Bank, currents along the crest were reported to be up to 0.8 m/s, and up to 0.6 m/s in the troughs.

ABPmer (2007) quotes a mean annual wave height of 1.25-1.5 m offshore from the UK coastline. This decreases to less than 0.75 m in Pegwell Bay. FutureCoast (2002) suggests that over a ten year period, around 10% of waves exceed 1 m in height at Sandwich Bay, just south of the UK landfall. Wave periods recorded at this location were generally between 4 and 6 m/s.

At Middelkerke Bank, less than 10% of wind waves generated produced significant wave heights exceeding 2 m (Williams *et al.*, 1996). During poor weather conditions, wave heights of up to 5 m, with a period of 9 s, were measured. Swell waves were not observed for much of the study period, but occasionally long period (20 s) /low amplitude (0.75 m) or short period (10 s)/ high amplitude (2 m) swell waves were recorded (Williams *et al.*, 1996).

ABPmer (2007) quotes a mean annual wind speed of 9-9.5 m/s offshore. This decreases to 7.5-8 m/s close to the coast. HR Wallingford (2002) used westerly winds of 10 m/s to represent the winter wind conditions in model set up for the North Sea and the Southern North Sea Sediment Transport Studies. At Middelkerke Bank, winds are predominantly from the south to west and peak speeds of more than 36 m/s have been observed from this direction (Williams *et al*., 1996).

6.2.2.3. Seabed processes

The presence of sand banks along the proposed cable route generates complex sediment transport pathways in certain regions. Sand waves are found on the sandbanks and in the swales, indicating active sediment transport across much of the seabed. Some of these have been studied in detail so that locally, sediment transport patterns are well described. Sandbanks located off the north Kent coast are believed to influence coastal processes and sediment transport patterns, and sand from these banks feeds onshore, naturally replenishing the sand beaches along the Thanet coast. On the east coast sandbanks are believed to exert a key control on the wave climate and sediment pathways. Goodwin Sands, located between 4 and 12 km offshore Deal, is the most notable for these effects. The series of natural shallow sandbanks are maintained by the tidal currents of the area (Deal to Kingsdown Strategy Study, 2001) and serve as a division between the offshore wave climate and the inshore wave climate.

Modelling studies (e.g. HR Wallingford, 2002; FutureCoast, 2002; Van Lancker *et al*., 2007) suggest that sediment transport is generally northward along both the UK coast and the French/Belgium coast, but is directed southward in the deeper water through the Straits of Dover. Sediment transport along the UK coastline is directed southward to the north of Pegwell Bay and northward to the south, resulting in a drift convergence at the UK landfall site (South East Coastal Group, 2007). As a result of this drift convergence, fine sediment tends to accumulate at Pegwell Bay as transport of sediments slows. Sediment transport is northward between Pegwell Bay and Goodwin Sands, turning eastward over the shoal and directed south further offshore (HR Wallingford, 2002; FutureCoast, 2002).

To further assess the potential sediment transport patterns in the vicinity of the cable route, several sediment transport simulations were carried out. Potential sediment transport rates are the rates that would occur in the case of abundant availability of sediment of the considered median grain size. Actual sediment transport rates may be reduced due to limited availability or in the case of sediment mixtures where finer fractions are sheltered by coarser fractions. Hence, in the absence of detailed particle size distribution information throughout the model domain, and of suitable data to calibrate the model predictions against, the model results should be seen as indicative and, in particular regarding predicted quantities, should be interpreted whilst keeping these uncertainties in mind. A full report of the modelling can be found in Appendix 7.

For these sediment transport simulations it was considered that the simplifying assumption of a uniform median grain size (d50) of 400 µm would be justified for the purpose of demonstrating typical sediment transport patterns in the study area. In addition, a sensitivity test was conducted with a smaller median grain size of 250 µm. Given that the median sediment grain size along the European mainland coastline is generally smaller than that in the deeper areas and along the English coast, the results of the simulations with the smaller grain size of 250 µm could be more representative in that area, whereas the model results based on the coarser 400 µm sand would be a better indication for potential sediment transport along the shallow area of the English coast. The fact that coarser gravels are indicated to be present in this area would suggest transport rates would be smaller than those presented.

The model used to provide these simulations was SANDFLOW, which is the non-cohesive sediment transport model developed by HR Wallingford for use with the TELEMAC system. SANDFLOW uses the flows calculated by TELEMAC-2D to study the transport, deposition and erosion of non-cohesive (sandy) sediment and thereby identify areas of potential siltation and erosion. The model (Figure 6-2-C) was driven with tidal flows resulting from simulations made with the tidal flow model, which was used to simulate tidal flows over a neap-spring-neap cycle. In addition, a sensitivity test was conducted for a representative case with moderate waves approaching the study area from the northeast. A wave model was set-up for this purpose, using the same model mesh and bathymetry as the flow model. The wave orbital velocities resulting from the wave model were then input, together with the tidal flow fields, into the sediment transport model. Strong orbital velocities will stir up sediment which is subsequently advected by the ambient tidal current.

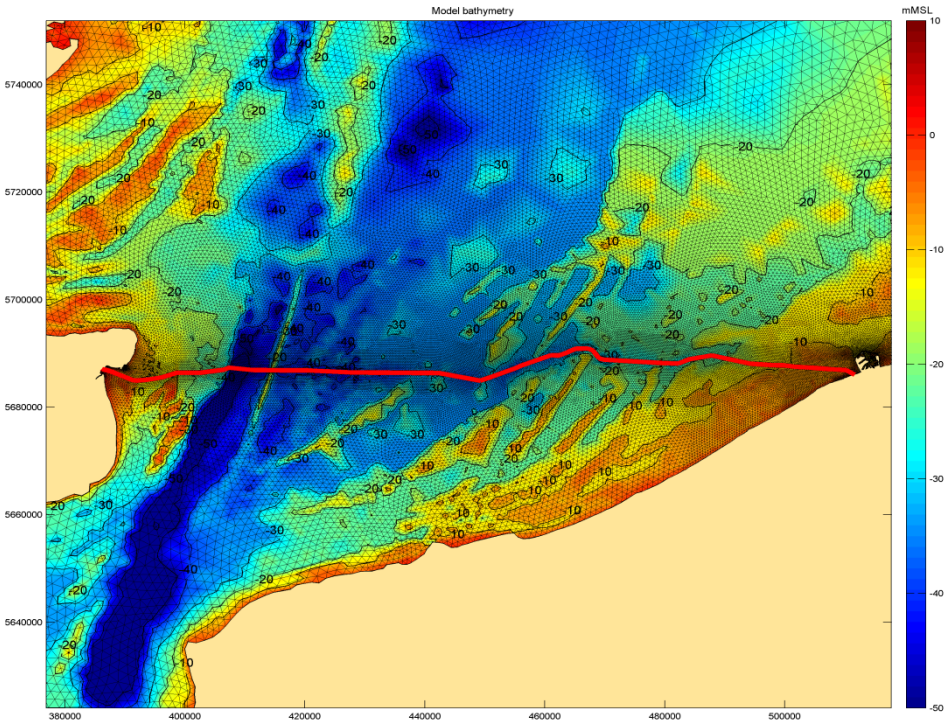

Figure 6-2-C : SANDFLOW Model bathymetry and mesh – near cable route

The resulting instantaneous sediment transport patterns, assuming abundant, uniform 400 µm sand at the same points in time, suggest that the largest potential transport rates occur off the English coast to the south of the cable route, gradually reducing to the north. During peak spring ebb the predicted potential transport rates decrease towards the European mainland coastline, whereas during peak spring flood there is less transport capacity north of the cable route near the English coast and increased rates along the French and Belgian coastline. The model predictions for spring tides, when the maximum potential transport patterns were observed, are shown in Figures 6-2-D and 6-2-E. The plots show the vector of transport and are colour coded to show the predicted magnitude.

The potential transport patterns predicted for a median grain size of 250 µm are similar to those predicted for 400 µm sand, but the magnitude of the fluxes is increased. The smaller grain size material is more easily entrained by the imposed flow conditions and therefore leads to an increase in potential transport. Comparison of the model output patterns to those showing the residual fluxes for the coarser material confirm the previously mentioned increase in potential transport magnitude along similar patterns. The model predictions for spring tides, when the maximum potential transport patterns were observed, are shown in Figures 6-2-F and 6-2-G.

In addition to the instantaneous transport patterns, the predicted sediment fluxes were integrated over a full tidal cycle to produce residual transport patterns for both grain sizes. Figures 6-2-H to 6-2-I indicate a net southward potential transport along the deeper central area toward Dover Strait and net northward and eastward fluxes along the English and European mainland coastline, respectively, over the spring tide. Over the neap tide the residual fluxes are northward throughout, and are much smaller and limited to the area in the vicinity of Dover Strait.

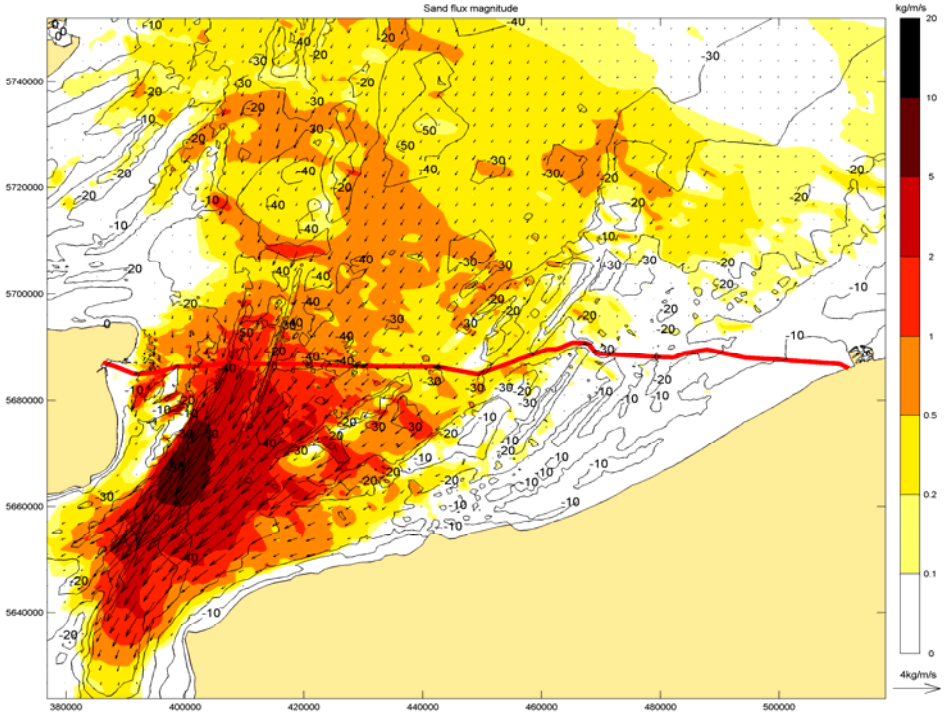

Figure 6-2-D : Peak ebb sand transport rates – Spring tide, 400 µm sand

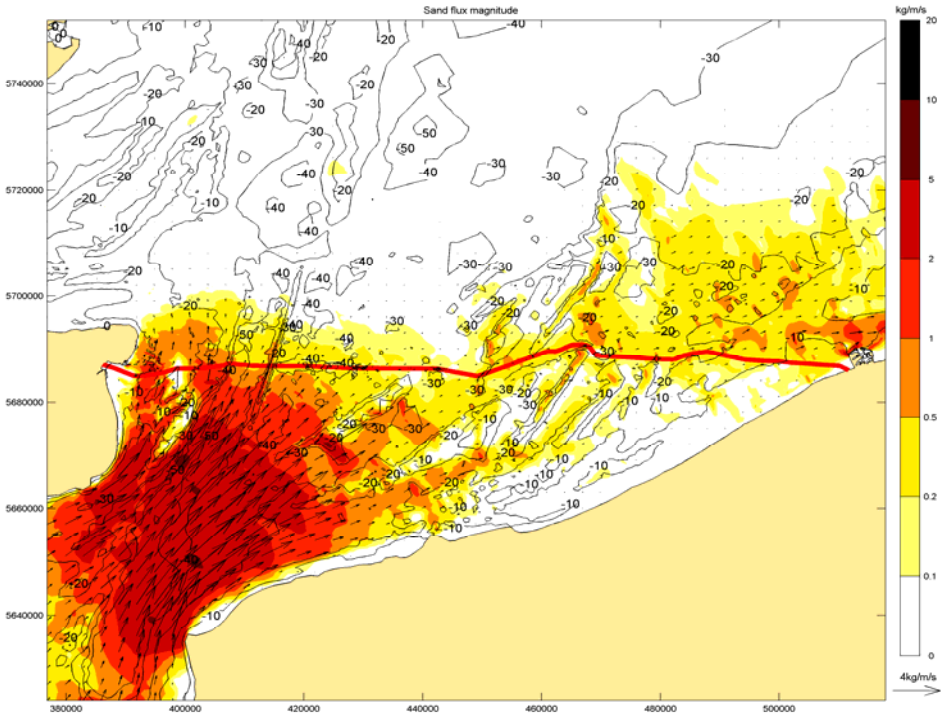

Figure 6-2-E : Peak flood sand transport rates – Spring tide, 400 µm sand

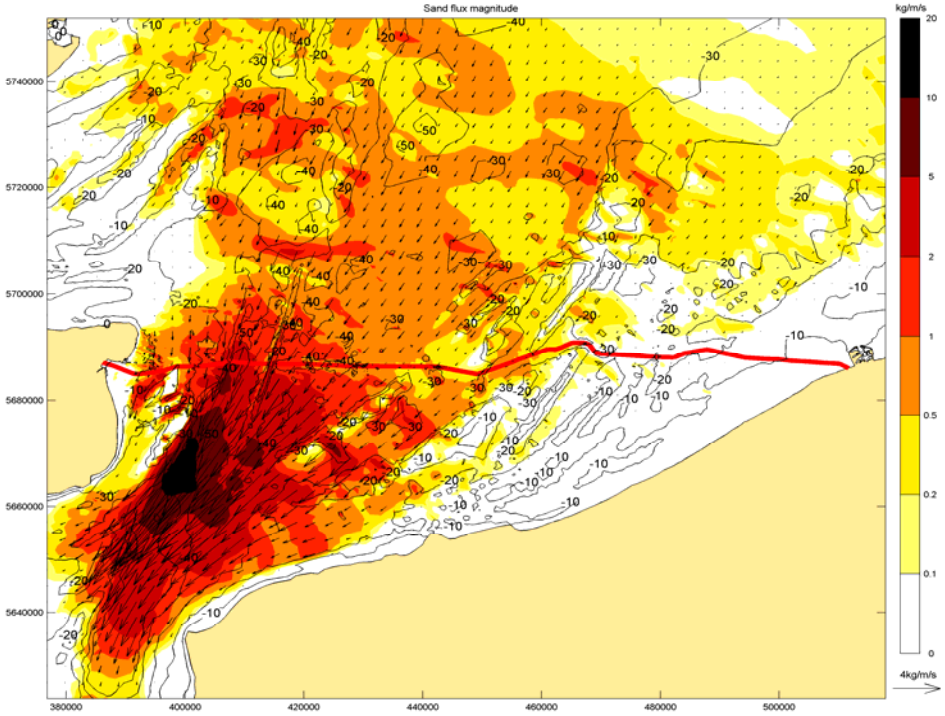

Figure 6-2-F : Peak ebb sand transport rates – Spring tide, 250 µm sand

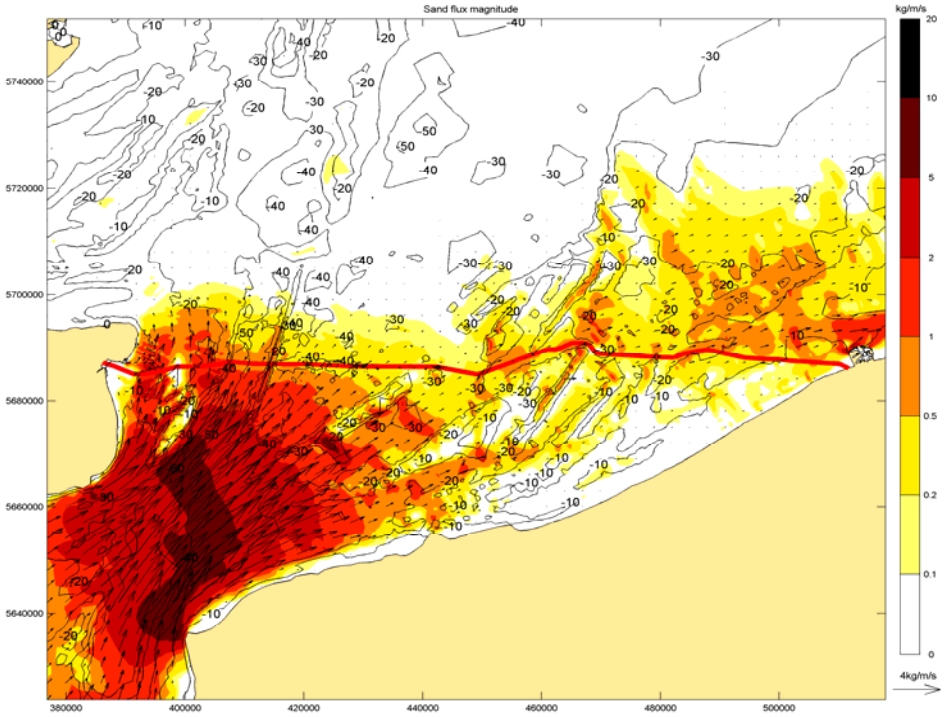

Figure 6-2-G : Peak flood sand transport rates – Spring tide, 250 µm sand

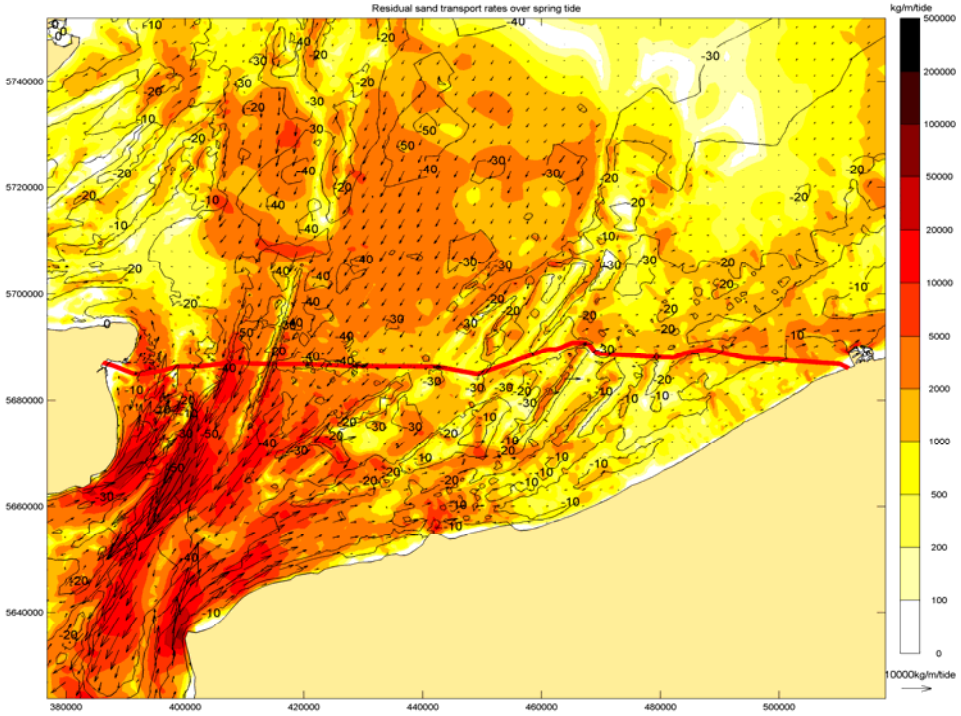

Figure 6-2-H : Residual sand transport rates over Spring tide – 400 µm sand

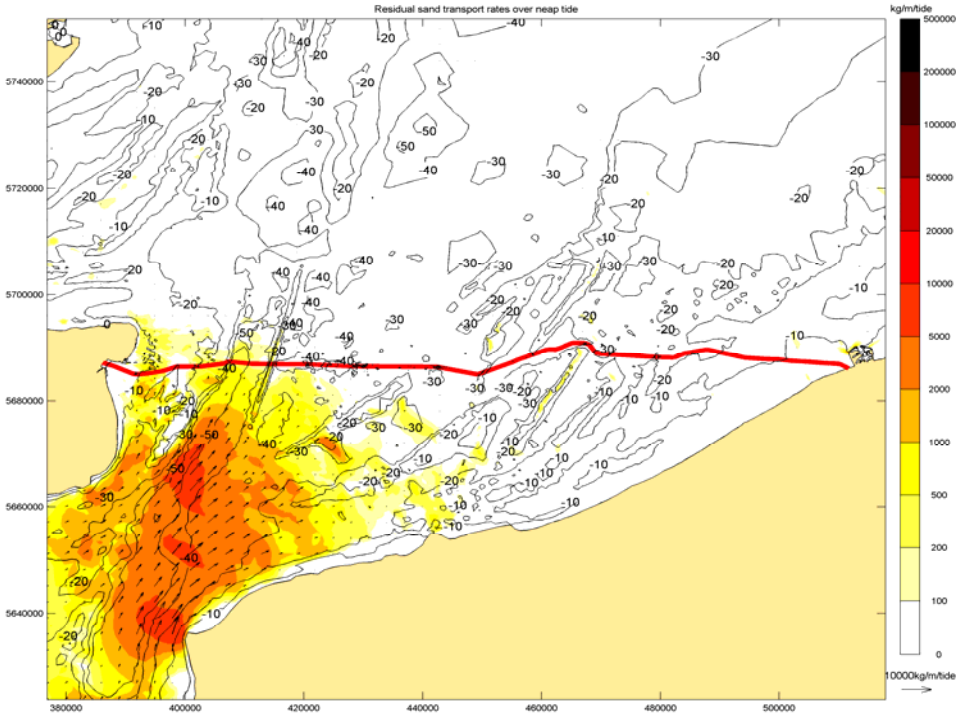

Figure 6-2-I : Residual sand transport rates over Neap tide – 400 µm sand

As stated previously, these results are indicative of the potential sediment transport patterns. Limited availability of the sediment simulated would reduce the expected transport rates. Given that the largest sediment fluxes are predicted in areas where the available sedimentological information indicates the presence of gravel and sandy gravel, it would be likely that actual transport is (much) lower than that predicted by the model. Similarly, if finer material than simulated is available and this finer fraction is not being sheltered by coarser fractions, rates could be larger in the coastal areas, where muds and silts exist. Keeping the uncertainties of the horizontal distribution of available mobile sediment and the inherent uncertainties associated with state-of-the-art sediment transport modelling,

the presented model results provide, in a qualitative way, an indication of the likely sediment transport patterns under the imposed flow conditions.

Given that the median sediment grain size along the European mainland coastline is generally smaller than that in the deeper areas and that along the English coast, the results of the simulations with the smaller grain size of 250 µm could be more representative in that area, whereas the model results based on the coarser 400 µm sand would be a better indication for potential sediment transport along the English coast.

Between South Falls and Sandettié the net sediment transport direction is south-southwest, with South Falls orientated slightly anticlockwise to the dominant tidal flow and Sandettié orientated clockwise (Kenyon *et al*., 1981). The banks are steeper on the side away from the dominant flow and this causes some local reversal to tidal currents on the down drift side. This results in sediment transport that is generally towards the crest of the sandbank. The sand wave field at the southern tail of South Falls is observed to be highly stable (Wright, 1992). Sand waves were observed to move by up to 25 m/year, but tended to oscillate back and forth, therefore maintaining approximately the same position. Sand wave heights were more variable, but no overall pattern to these changes was discerned.

6.2.3. Description of potential impacts

The tables below show how sensitivity, recoverability and importance of the bathymetry and seabed processes have been considered in determining significance of effect. Table 6-2-1 outlines receptor value associated with bathymetry and Table 6-2-2 relates to the receptor value associated with seabed processes.

Receptor Value	Definition
High	Changes to bathymetry result in changed coastal processes, tidal flows and/or sediment characteristics which are considered adverse, widespread and long term.
Medium	Changes to bathymetry result in changed coastal processes, tidal flows and/or sediment characteristics which are undesirable, local and persist in the medium term, although may recover in the long term
Low	Changes to bathymetry do not result in changes to coastal processes, tidal flows and/or sediment characteristics, or any changes are transient and recover in the short term.

Table 6-2-1 : Definition of bathymetry receptor value

Receptor Value	Definition
High	Seabed processes which contribute significantly to supporting scarce ecological value and ecosystem functions, to the extent that changes to the seabed processes will result in permanent loss or impairment.
Medium	Seabed processes which contribute to supporting ecological value and ecosystem function, to the extent that changes to the seabed processes will result in changes that can recover, to the original state or result in impairment of a limited area.
Low	Seabed processes where changes do not result in changes to the ecological value and ecosystem function of an area.

Table 6-2-2 : Definition of seabed processes receptor value

6.2.3.1. Cable Installation

In shallow seas with sandy seabeds such as the southern North Sea, rhythmic bedform patterns are abundant. These bedform patterns can exist at a range of scales and have been shown to migrate. Dorst (2009) presents typical migration rates for different scales of bedforms along with their typical heights and wavelengths. Table 6-2-3 presents these characteristic features:

Bedform	Wavelength (m)	Height (m)	Migration rate
Ripple	1	0.01	1 m/hour
Megaripple	10	0.1	1 m/day
Sandwave	1500	5	10 m/year
Sandbank	6000	10	1 m/year

Table 6-2-3 : Migration rates of seabed features

The migration of bedforms such as sand waves may cause the cable to become exposed or develop free spans (Whitehouse *et al*., 2000). Conversely, sand wave migration could cause over burial of the cable which may be an issue for thermal performance or if access is needed for any reason. Literature regarding sand waves at South Falls suggests that large sand waves, with heights between 0.5 m and 5 m, are stable in position, and tend to oscillate back and forth, reflecting the alternating dominance of ebb and flood directional strengths in the spring and neap tidal cycle, rather than migrating (Wright, 1992; Lanckneus and De Moor, 1990; Lanckneus and De Moor, 1995).

To minimise effects on the cable from migration of sand waves, or to allow the cable installation equipment to work effectively, it is proposed that a trailing suction hopper dredger (TSHD) will be used to “pre-sweep” sand waves and sandbanks. It is proposed that the dredge trench will vary depending on the shape and size of the features to be crossed. However, the greatest width of the trench is anticipated to be 20 m wide at the base, with side slopes of 10 m width on either side and an overall depth of 2 m. Following the bathymetry survey, areas to be dredged have been identified and an exercise carried out to quantify how much material will require removal by dredging. Only the crests of sandbanks and sand waves will be removed, so the locations shown in Figure 6-2-K contain many smaller areas, rather than being contiguous dredging. The quantities calculated are shown in Table 6-2-4

KP (km from Belgian landfall)	Longitude (E)	Latitude (N)	Easting	Northing	Volume (m^3)	Purpose
26 - 29	2.77979	51.35257	484,665	5,689,057	38,273	Protect cable from sand wave mobility
29.25 - 29.35	2.75559	51.34716	482,978	5,688,460	743	Allow effective installation
30.05 - 30.15	2.74507	51.34426	482,245	5,688,140	33	Allow effective installation
31.5 - 34	2.70636	51.34514	479,549	5,688,248	10,829	Protect cable from sand wave mobility
37.5 - 41.25	2.61177	51.34873	472,963	5,688,678	20,479	Protect cable from sand wave mobility
42.8 - 43	2.56172	51.35095	469,479	5,688,944	482	Allow effective installation
54 - 57	2.40024	51.34705	458,230	5,688,590	27,899	Protect cable from sand wave mobility
61.8 - 63	2.30903	51.32294	451,852	5,685,965	48,491	Allow effective installation
63 - 65.4	2.28503	51.31696	450,174	5,685,316	21,330	Protect cable from sand wave mobility
68.5 - 69.2	2.21952	51.32001	445,612	5,685,702	4,593	Allow effective installation
69.2 - 73.6	2.18433	51.32437	443,165	5,686,213	60,249	Protect cable from sand wave mobility
74.5 - 77.5	2.11854	51.32572	438,583	5,686,417	32,614	Protect cable from sand wave mobility
82.3 - 87	1.99369	51.32529	429,883	5,686,480	24,470	Protect cable from sand wave mobility
99 - 100.75	1.77564	51.32706	414,694	5,686,908	93,138	Protect cable from sand wave mobility
123 - 123.5	1.44542	51.30614	391,638	5,685,017	1,170	Allow effective installation
Total quantity of dredging required					384,794	

Table 6-2-4 : Locations and quantity of sediments to be dredged from each location.

The approximate locations of areas containing features to be dredged in pre-sweeping operations are shown in Figure 6-2-1.

		2000	2001	2002	2003	2004		2005		2006		2007		2008		2009	2010
Disposal Site	**Month of Disposal**	CD	CD	MD	MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	MD	MD	MD
TH070	January		113227		68560		0	0	0	0	0	0	0	0	0	113952	0
	February		146529		0		344512	0		0	0	0	0	2950	0	0	0
	March		86586		0		0	0		0	0	0	0	0	0	0	0
	April		0		0		0	0		0		0	0	1872	0	0	0
	May	0	0		0		0	0	7000	0		0	0	0	0	0	0
	June	0	0		0		0	0	0	1400		0	0	0	0	0	0
	July	0	0		0		0	0	0	0	0	0	297750		0	0	0
	August	66950	0		0		0	0	0	0	0	0	0		0	0	0
	September	0	0		0		0	0	114335	0	0	0	0		0	0	89502
	October	0	0		0		0	0	0	0	0	0	0		0	0	0
	November	0			0		0	0	0	0	0	0	0		0	0	0
	December	0		0	0	0	0	0	0	0	0	0	0		0	0	0
Grand Total		66950	346342	0	68560	0	344512	0	121335	1400	0	0	297750	4822	0	113952	89502

Table 6-2-5 : Table of dry tonnes of licensed dredged material disposed at South Falls over the last ten years (CD-Capital Dredgings, MD-Maintenance Dredgings)

No figures in the cells indicate that no active licence was in force for disposal at the site.

Disposal of the material dredged in the pre-sweeping operation has been considered, with a licensed disposal site, TH070 South Falls identified as a potential area to receive the dredged material arising. Information on previous disposal operations at TH070 South Falls was provided by Cefas (D. Bastreri *pers.comm*). Disposal operations over the last ten years are shown in Table 6-2-5.

It can be seen that TH070 South Falls has not been utilised for the type of quantities liable to arise from the pre-sweeping activities. Disposing of material at pre-existing licensed sites has a number of additional drawbacks, including:

- extending the duration of dredging operations, with long periods of travel for the dredger between operational area and disposal site;
- decreasing the dredging efficiency whilst increasing overflow requirements to fill the hopper adequately for travel to disposal sites;
- increasing the carbon footprint of the dredging operation by increasing the travelling distances; and,
- removing the sediments from the local sedimentary budget.

It is therefore proposed that sediment arising from pre-sweeping dredging operations should be disposed in the vicinity (up to 1.5 km away from the dredging sites) of the dredging works, similar to the methodology employed by the installation of the BritNed interconnector cable. This allows the sediment to remain within the local sedimentary budget and local seabed processes, increases the dredging efficiency and reduces the carbon footprint of the dredging operation.

Dredging will necessarily alter the sedimentary bedforms and therefore, modelling was undertaken to establish whether these bedforms would re-establish and if so, what sort of time frame was expected. The computational sediment transport model SEDFLUX has been developed at HR Wallingford over a number of years (HR Wallingford, 2007). It predicts the magnitudes and directions of bedload, suspended load and total load transport rates for sand or shingle, together with suspended sediment concentrations at specified heights. SEDFLUX has been updated in successive stages during its development, namely up to its current version, SEDFLUX2010. A full report of the modelling can be found in Appendix 7.

SEDFLUX2010 includes:

- the method of calculating the bottom orbital velocity under combined waves and currents;
- the effect of a rippled bed, based on explicit predictions of ripple geometry and roughness;
- the effect of a bed sloping in an arbitrary direction relative to a current, combined with a wave in an arbitrary direction relative to the current; and,
- contributions of wave asymmetry to the sediment transport.

SEDFLUX2010 has been tested against benchmark observations of suspended concentrations collated for the EC Projects SEDMOC and SANDPIT. For the case of a current alone (e.g. rivers) reasonable agreement was found with the widely-used methods of Ackers and White, and Engelund and Hansen. A set of “saturation tests” of the model has been performed for a range of coastal conditions, based on a standard set of input values of sediment, water, currents and waves originally produced by van Rijn (1993). SEDFLUX2010 gives results that are generally similar to those produced by van Rijn’s own method.

SEDFLUX is ideally suited to analyse the sediment transport on the continental shelf, and allows for the analysis of the impact of a trench on that transport. For this purpose the transport rates at a location far away from the trench with the transport rates on the slopes of the trench were calculated. The differences in the transport then determine the infill rate of the trench.

Infill rates were calculated in kg/day and in m^3/day. The infill rate was calculated at water levels: 20 m and 40 m, with maximum tidal velocities set at 0.75 m/s, 1.1 m/s and 1.5 m/s, respectively. A 0.1 m/s residual current was assumed and waves varied with heights of 0.5 m, 1 m and 2 m. The sediment sizes varied between 0.2 mm and 0.5 mm. An assumption was made that the trench would be at 45° to the dominant tidal currents. The results are shown in Figures 6-2-J AND 6-2-K.

The SEDFLUX calculations give the initial trench infill rates. These values are only valid for the duration that the slopes and depths at the reference points are unaltered. As long as the cumulative infill is less than 10 to 20 % of the initial trench depth, this condition can be assumed to be met. If the cumulative infill exceeds this threshold, the infill rates will drop significantly. This implies that for some of the cases considered, the initial estimates are no longer reached after the first day. Therefore, the infill rates, and in particular the higher valued ones, should be considered as indications of the expected rate of infill and not as a precise prediction.

For all conditions the infill rates are high enough to fill the trench within a few weeks. The higher depth averaged tidal velocities in the deeper parts result in higher infill rates for these depths. The impacts of pre-sweeping sand waves and cable burial are therefore considered to be **minor**.

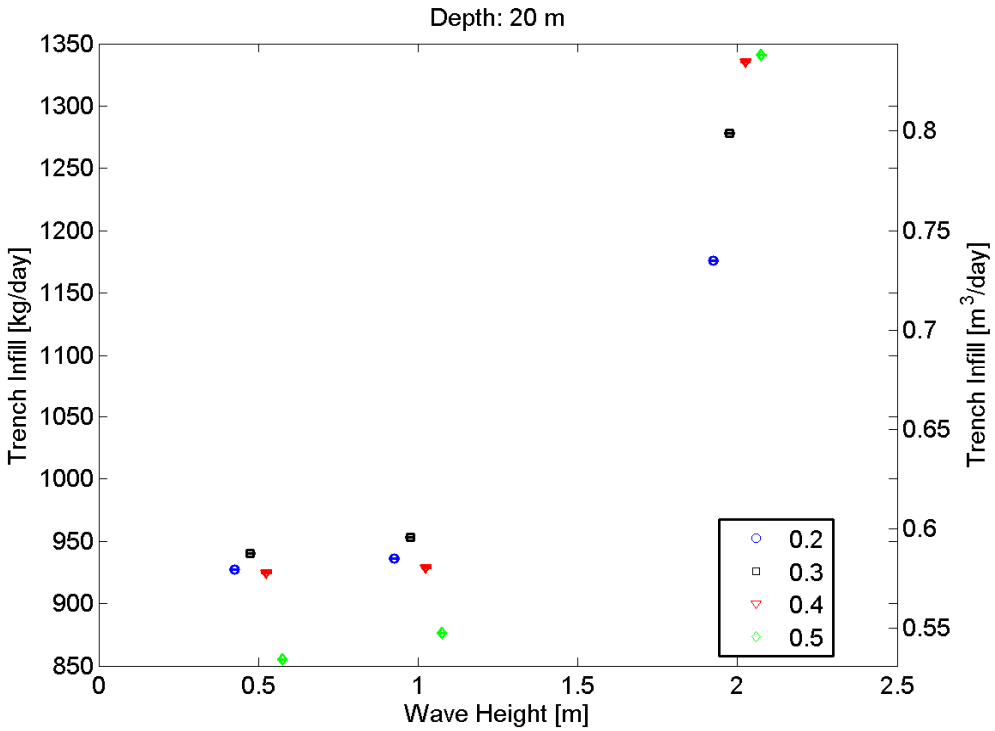

Figure 6-2-J : Infill rates per metre run of trench at 20 m water depth, for a range of sediment sizes (range from 0.2 mm to 0.5 mm)

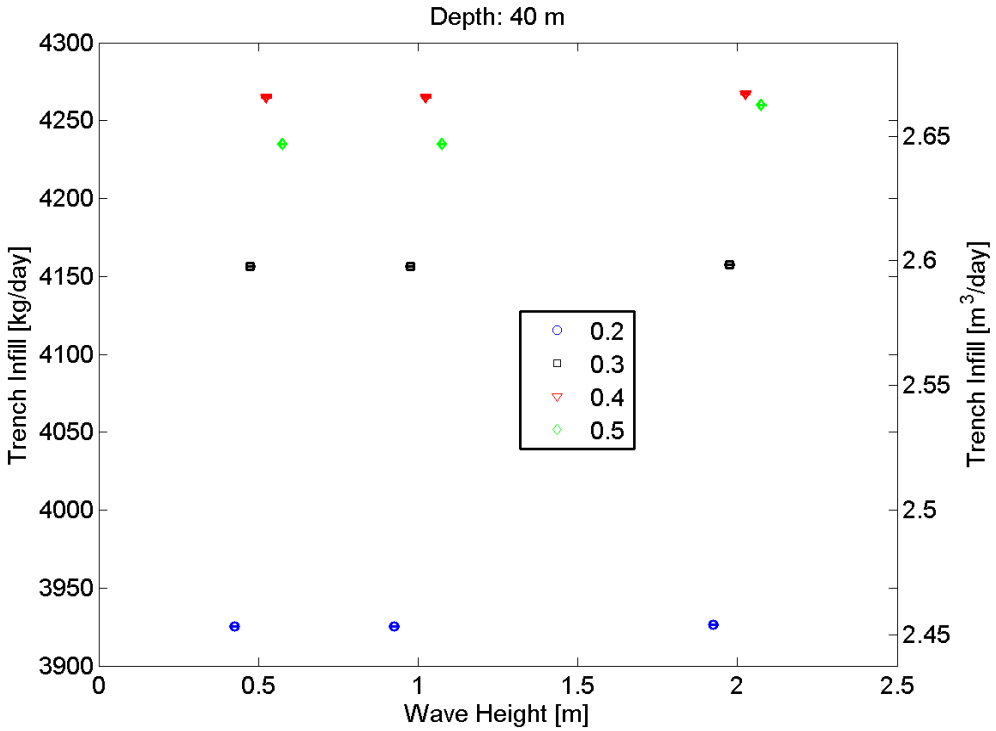

Figure 6-2-K : Infill rates per metre run of trench at 40 m water depth, for a range of sediment sizes (range from 0.2 mm to 0.5 mm)

The displacement of sediments due to dredging and installation of the cable can therefore be expected to be of a localised and temporary nature. Consequently, the predicted impacts are of minor significance. Since the dredged material sediments will be placed near to the cable route and hence remain within the system and contribute to the re-establishment of the sand wave regime, the impact of the disposal operations on bathymetry and seabed processes is considered to be **minor**.

6.2.3.2. Operation

The design of route and installation method has been carefully prepared to minimise the likelihood of cable exposure. Should cables become exposed however, there may be a requirement to provide external cable protection. Various methods are available to protect cables, such as rock placement, concrete mattressing and frond mattressing. These methods may occasionally be combined, e.g. concrete mattresses plus frond mattresses. These methods will all interrupt seabed processes on a local scale and thus only **minor** impact is predicted.

6.2.3.3. Decommissioning

If the cable is to be removed upon the cessation of operations, it will be recovered through the same seabed features that existed during installation, as these features are predicted to recover rapidly following installation. The same rapid recovery is anticipated following the disturbance to the seabed through decommissioning and therefore the impact is considered to be **minor**.

6.2.4. Mitigation

The pre-sweeping operations have been designed to trench only where judged necessary through the seabed features, which minimises sediment disturbance and resuspension. The dredged trench will be kept to the minimum possible length, width and depth, which will ensure that the cable burial will proceed effectively and result in a stable burial depth. Installing the cable to a stable burial depth will minimise the requirement for external cable protection and disturbance.

6.2.5. Residual impact

The impacts predicted are of **minor** significance, as all changes predicted will be reversible, transient and confined to a comparatively local area. They will remain minor after mitigation measures.

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6.3. Water Quality

This section describes the water quality along the proposed cable route, and the potential impacts of the project upon water quality issues.

6.3.1. Baseline data sources

Various sources of information have been used to inform this assessment, including:

- European Commission Environment Water Information System for Europe.
- Environment Agency What's In Your Backyard?
- Southern North Sea Sediment Transport Study (HR Wallingford, 2002), which contains a summary of CEFAS data on suspended sediments
- CEFAS report on temperature and salinity around UK coastlines (Joyce, 2006)
- Ramsgate West Rocks Development. Siltation in proposed shipping channel and turning area. HR Wallingford Report EX855, November 1978
- Thanet Offshore Wind Farm EIA. Coastal and Seabed processes. HR Wallingford Report EX5171, September 2005
- Management Unit of the North Sea Mathematical Models (MUMM), which has data on many aspects of the North Sea, including temperature, salinity and chemical concentrations
- Sediment data from the geophysical survey carried out by MMT between August and October 2010.

6.3.2. Baseline

Water quality monitoring is generally carried out in coastal locations with respect to EC Directives on Bathing Water quality (76/160/EEC and 2006/7/EC) and Shellfish Water quality (79/923/EEC and 2006/113/EC). These existing water quality monitoring programmes are gradually being harmonised and co-ordinated across EC countries, to protect the fresh and coastal water environment, under the auspices of the Water Framework Directive (2000/60/EC). Marine territorial waters are to be regulated for sustainability under the Marine Strategy Framework Directive (2008/56/EC), to provide coherence with the Water Framework Directive. Under this Directive (transposed into UK law by the Marine Strategy Regulations 2010), an assessment of the current state of UK seas, upon which the monitoring programme will be based, is being carried out which will be completed by July 2012.

6.3.2.1. Water Framework Directive

The Water Framework Directive (WFD) ('Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy') establishes a framework for the protection of European waters, including inland surface waters, transitional waters, coastal waters and groundwater. Its environmental objectives are, *inter alia*:

a) the prevention of further deterioration of the present status of all surface and ground water bodies;
b) a good chemical and good ecological status for all surface and ground water bodies within
c) 15 years (2015). This includes:
    (i) coastal waters (1 nm): good ecological status;
    (ii) territorial waters (12 nm): good chemical status;
d) a good chemical status and maximum ecological potential for all artificial and "heavily modified water bodies" within 15 years (2015);
e) a progressive reduction of emissions, discharges and losses of "Priority Substances";
f) the phasing out of emissions, discharges and losses of "Priority Hazardous Substances";
g) the progressive reduction of pollution of ground water and prevention of its further pollution;

h) to achieve compliance with any standards and objectives for protected areas established under Community legislation by 2015; and
i) several less stringent objectives or time schedules in specific cases.

The WFD's objective of a "good chemical status" is defined in terms of compliance with all the quality standards established for chemical substances at European level. The Directive also provides a mechanism for renewing these standards and establishing new ones by means of a prioritisation mechanism for hazardous chemicals. This will ensure at least a minimum chemical quality, particularly in relation to very toxic substances.

The WFD's objective of a "good ecological status" also requires certain chemical conditions. The chemical requirements include the achievement of environmental quality objectives for discharged priority substances and for any other substances liable to cause pollution and identified as being discharged in significant quantities.

The South East River Basin Management Plan (Environment Agency, 2009) has been drafted as a requirement of the Water Framework Directive. It indicates that the ecological status of Pegwell Bay is moderate and the chemical status is good.

6.3.2.2. The Marine Strategy Framework Directive

Directive 2008/56/EC of the European Parliament and of the Council of 15th July 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) aims to achieve "good environmental status" of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The Directive calls for the development of a marine strategy by each Member State. By July 2012, they must provide a comprehensive assessment of the state of the environment, identifying the main pressures on their respective marine regions, and defining targets and monitoring indicators. The UK Government and Devolved Administrations launched consultation on the 27th March 2012, ending 18th June 2012. By 2015, they will have to develop coherent and coordinated programmes of measures. To reach the 2020 target, they will have to achieve efficient communication and close cooperation, notably through regional sea conventions.

Good Environmental Status must be determined at the level of marine regions or sub regions, on the basis of 11 qualitative descriptors of the marine environment specified in the Marine Strategy Framework Directive.

1. Biological Diversity
2. Non-indigenous Species
3. Commercial Fishing
4. Food Webs
5. Eutrophication
6. Seafloor Integrity
7. Hydrographical Conditions
8. Contamination
9. Seafood Contamination
10. Marine Litter
11. Noise

The marine strategies to be developed by each Member State must contain a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level and the establishment of clear environmental targets and monitoring programmes. Water quality would fall within the contamination descriptor. No targets have yet been implemented.

6.3.2.3. Bathing waters

There are two designated bathing waters in the vicinity of the proposed cable route at the UK coast; these are at Sandwich Bay and at Ramsgate Western Undercliffe. A third bathing water, Ramsgate Sands, is situated to the north of Ramsgate Harbour and is included following scoping comments from the Environment Agency. The Environment Agency is responsible for monitoring water quality at these locations and regularly reports data collected against Environmental Quality Standards (EQS), which are designed to protect both the environment and human health. These standards were originally provided in the original EC Bathing Waters Directive (76/160/EEC), adopted by the Council of the European Communities in 1976. The standards were transposed into UK law for England and Wales to form The Bathing Waters (Classification) Regulations 1991. There were two types of microbiological standards set out, namely the mandatory standards and the more stringent guideline standards.

The mandatory microbiological standards are:

- 10,000 total coliforms per 100 ml of water in 95% of samples collected within a bathing season (15th May to 30th September); and
- 2,000 faecal coliforms per 100 ml of water in 95% of samples collected within a bathing season (15th May to 30th September).

The guideline microbiological standards are:

- 500 total coliforms per 100 ml of water in 80% of samples collected within a bathing season (15th May to 30th September);
- 100 faecal coliforms per 100 ml of water in 80% of samples collected within a bathing season (15th May to 30th September); and
- 100 faecal streptococci per 100 ml of water in 90% of samples collected within a bathing season (15th May to 30th September).

Water quality is classified as Excellent (E) if the guideline standards have been met, Good (G) if mandatory standards have been met and Poor (P) if the minimum mandatory standards have not been met. The achieved water quality for the relevant bathing waters is given in Table 6-3-1.

Bathing Water	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ramsgate Western Undercliffe	E	G	G	G	G	E	E	G	G	G	E	E	E	G	E
Ramsgate Sands	E	E	E	G	G	E	E	G	G	G	E	E	E	G	E
Sandwich Bay	E	E	E	G	G	E	E	G	E	E	E	E	E	E	E

Table 6-3-1 : Classification of monitored UK Bathing Waters from 1997 to 2011

These standards are being tightened, following the new Bathing Waters Directive (2006/7/EC) of the European Parliament and of the Council of 15 February 2006, concerning the management of bathing water quality, and repealing the original Directive 76/160/EEC as a gradual process to conclude in 2014. These were transposed into UK law for England and Wales to form The Bathing Waters (Classification) Regulations 2008. This sets out new standards to be met and in May 2012 monitoring began for a four year classification of bathing waters to be in place by 2015.

Parameter	Excellent quality	Good quality	Sufficient
Intestinal enterococci (cfu/100 ml)	100 (*)	200 (*)	185 (**)
Escherichia coli (cfu/100 ml)	250 (*)	500 (*)	500 (**)

cfu – colony forming units.
(*) Based upon a 95 percentile evaluation.
(**) Based upon a 90 percentile evaluation.

There are also additional criteria to be taken into account. These are a description of the physical, geographical and hydrological characteristics of the bathing water, identification and assessment of causes of pollution and assessments of the potential for proliferation of cyanobacteria, macro-algae and phytoplankton. Poor quality continues to be the classification given if standards are not met.

6.3.2.4. Shellfish Waters

There is a designated shellfish water in Pegwell Bay. This has complied with the mandatory standards since its designation in 2004.

The original Directive 'Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters as amended by Council Directive 91/692/EEC (further amended by Council Regulation 1882/2003/EC)', known as the Shellfish Waters Directive, was designed to protect the aquatic habitat of bivalve and gastropod molluscan species of shellfish. It sets out standards for various parameters that should be monitored in designated shellfish areas. It has since been superseded by 'Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters'.

The Directive establishes parameters applicable to designated shellfish waters, as well as indicative values, mandatory values, reference methods of analysis and the minimum frequency for taking samples and measurements. These parameters are set for pH, temperature, salinity and the presence or concentration of certain substances (dissolved oxygen, hydrocarbons, metals, organohalogenated substances, etc.).

The competent authorities for each Member State must take samples from the waters to verify their conformity with the criteria set by the Directive. The following proportions of samples must conform to the established values:

- 100% of the samples for the parameters 'organohalogenated substances' and 'metals';
- 95% of the samples for the parameters 'salinity' and 'dissolved oxygen';
- 75% of the samples for the other parameters; and
- No evidence of harm to the shellfish from organohalogenated compounds.

Additionally, the Directive stipulates that a discharge should not cause increase of suspended solids to exceed 30% above background levels, as shellfish can be adversely affected by the smothering effects of sediment settling.

6.3.2.5. Suspended sediments

Suspended sediments enter the southern North Sea from the English Channel, via the Strait of Dover. Estuaries such as the Thames, Scheldt and Rhine also contribute to the suspended sediment load. Suspended sediment concentrations are generally low in the North Sea during the summer but these may double during the winter. Away from the coast, summer concentrations of 0-4 mg/l are typical, with winter concentrations of up to 16 mg/l (HR Wallingford, 2002). Along the UK coastline, suspended sediment concentrations are higher, and may exceed 60 mg/l during winter months (HR Wallingford, 2002; Fettweis *et al*., 2007).

Net suspended sediment transport is generally northward from the Strait of Dover along the UK coastline area and net transport fluxes peak in winter (Van Lancker *et al*., 2007). Sediment transport

along the UK coastline is directed southward to the north of Pegwell Bay and northward to the south, resulting in a drift convergence at the UK landfall site, with fine sediment tending to accumulate at Pegwell Bay as transport of sediments slows.

6.3.2.6. In situ sediments

Sediment core samples taken along the UK landfall area of the cable route during the geotechnical investigations were analysed for contaminants. The locations of these sediment core sampling sites are shown in Figure 6-3-A and the results of the contaminant analyses are presented in Table 6-3-2.

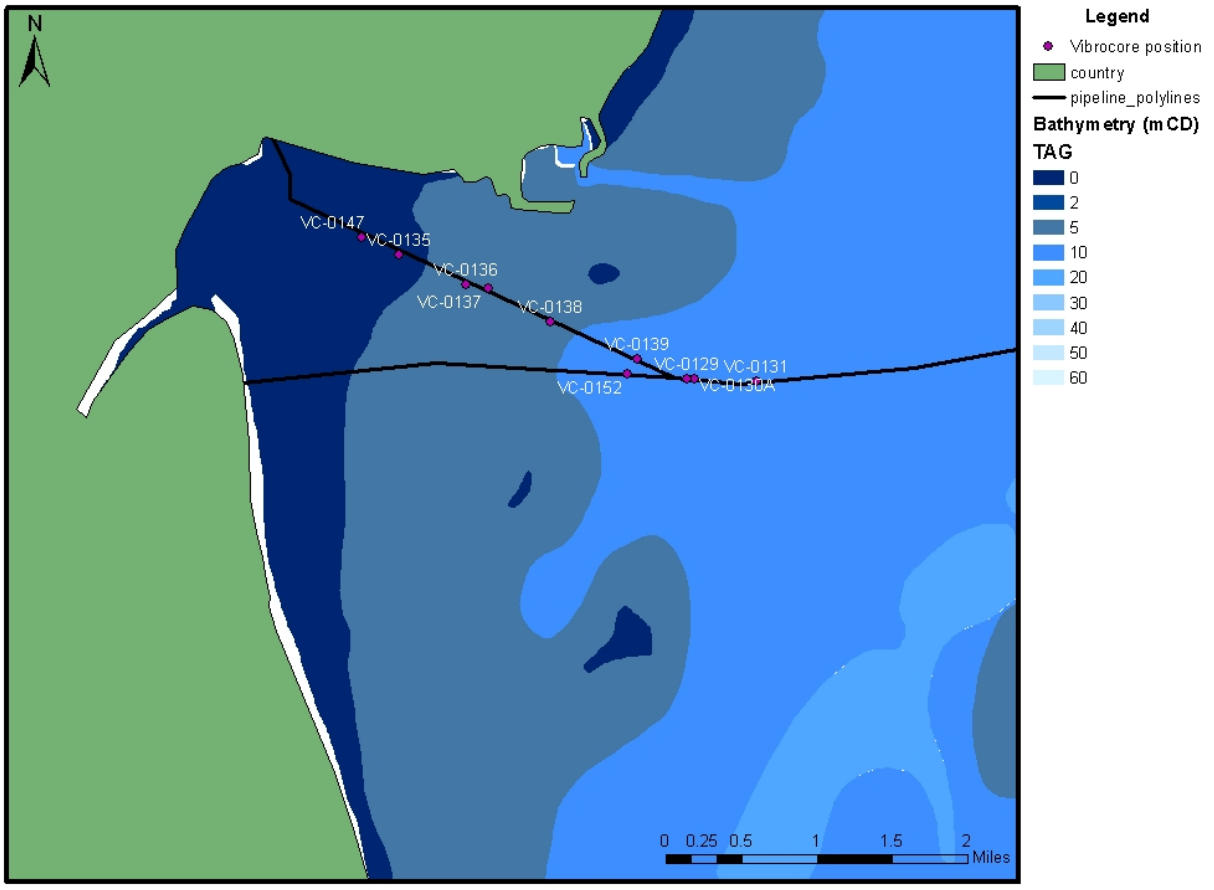

Figure 6-3-A : Location of vibrocore sites sampled for sediment contaminant analyses

Determinand	Unit	Sample No.																
		129 (0.4 – 0.8)	129 (1.85 – 2.05)	130A (0.6 – 0.9)	131 (0.5 – 0.85)	131 (1.9 – 2.0)	135 (0.4 – 0.85)	135 (1.8 – 2.2)	136 (0.7 – 0.95)	137 (0.6 – 0.95)	138 (0.55 – 0.85)	138 (1.6 – 2.0)	139 (0.45 – 0.9)	139 (1.9 – 2.25)	147 (0.5 – 0.95)	147 (1.95 – 2.1)	152 (0.5 – 0.85)	152 (1.35 – 1.7)
Sum of PCBs	mg/kg dw	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
PAH L	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
PAH M	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
PAH H	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
EOX	mg/kg dw	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monobutyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibutyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	2.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tributyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Triphenyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	mg/kg dw	31	28	4.3	17	21	8.6	11	3.6	28	25	13	13	21	12	11	15	18
Barium	mg/kg dw	5.7	6.7	30	4.6	5.6	20	27	9.3	6.0	4.5	14	7.9	8.8	33	26	6.5	6.2
Lead	mg/kg dw	6.7	6.1	6.3	4.9	3.8	9.1	7.6	3.6	6.8	5.0	8.9	4.3	5.7	22	6.3	4.9	5.0
Cadmium	mg/kg dw	0.31	0.25	<0.24	<0.22	0.22	<0.24	<0.27	<0.24	0.26	0.24	0.24	<0.22	0.21	<0.24	<0.24	<0.21	<0.21
Cobalt	mg/kg dw	5.2	4.7	5.5	3.0	3.7	2.4	5.0	3.2	4.8	3.9	4.1	2.6	3.6	4.3	4.1	2.8	3.0
Copper	mg/kg dw	<0.52	0.53	6.8	0.9	0.53	1.5	5.6	4.5	0.54	0.69	3.5	0.76	0.85	9.1	3.1	0.7	<0.53
Chromium	mg/kg dw	4.4	4.7	21	5.2	4.5	8.2	15	20	5.7	4.5	9.1	6.6	5.9	16	13	5.3	4.1
Mercury	mg/kg dw	<0.05	<0.05	<0.05	<0.05	<0.05	0.053	<0.05	<0.05	<0.05	<0.05	0.066	<0.05	<0.05	0.22	<0.05	<0.05	<0.05
Nickel	mg/kg dw	3.8	37	14	3.4	3.0	3.2	11	9.7	4.0	3.6	7.0	3.9	3.8	8.6	7.6	3.4	3.1
Vanadium	mg/kg dw	27	25	12	16	20	15	29	15	25	23	16	14	20	26	25	15	15
Zinc	mg/kg dw	23	20	31	17	13	21	32	19	23	17	27	16	19	50	25	16	17
Sulphur	mg/kg dw	450	380	220	380	380	650	4100	5700	340	260	1200	350	320	2700	2600	360	320
pH		9	8.9	9.1	8.9	9.1	8.75	8.7	8.77	9.09	9.31	8.9	9.06	9.32	8.61	8.75	9.07	8.9
Calcium	% dw	10	7.0		7.8	6.2	5.3	7.8	2	2.2	5.6	6.7	4.2	4.8	5.9	5.6	3.9	3.6
Loss on ignition	% dw	1.5	1.3	2.5	1.6	1.2	2.8	4.4	2.4	0.97	0.96	2.7	1.1	1.2	3.3	2.5	1.2	1.3
Dry weight	%	86.4	88.7	76.2	82	89.8	75.7	65.7	75.2	88.1	92.9	78.9	83.1	94	73.6	76.4	85.5	84.5

Table 6-3-2 : Results of chemical contaminant analyses of vibrocore samples

There are no Environmental Quality Standards for *in situ* sediments in the UK, unlike for water quality. In the absence of any standards an initial assessment of whether organisms are at risk from concentrations of toxic contaminants can be undertaken by comparing data with the CEFAS guideline action levels for the disposal of dredged material.

CEFAS's guideline action levels for the disposal of dredged material are not statutory contaminant standards for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material to sea. The action levels are presented in Table 6-3-3. [The action levels are not pass/fail criteria, but triggers for further assessment. Accordingly, if concentrations are below action level 1, then refusal of disposal at sea on grounds of contamination is unlikely. If concentrations fall between levels 1 and 2, then further assessment is required. If concentrations exceed level 2, then the dredged material may not be acceptable for disposal at sea.]

	Action Level 1	Action Level 2
Contaminant / Compound	**mg/kg Dry Weight (ppm)**	**mg/kg Dry Weight (ppm)**
Arsenic	20	100
Mercury	0.3	3
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Lead	50	500
Zinc	130	800
Organotins; TBT DBT MBT	0.1	1
PCB's, sum of ICES 7	0.01	none
PCB's, sum of 25 congeners	0.02	0.2

Table 6-3-3 : CEFAS guideline action levels for the disposal of dredged material

A comparison of the results gained shows that only arsenic displays some elevation above CEFAS Action Level 1 and in only some locations. Also arsenic concentrations did not exceed Action Level 2. It also shows that TBT and its derivatives were not detected in most cases, with the exception of the surface sample at station 135. This result does not exceed Action Level 1 and is considered to be a local hotspot, possibly as the result of a paint flake within the sediment matrix, rather than indicative of contamination over a wider geographic spread.

6.3.2.7. Offshore water quality

Very little water quality monitoring has been or is currently undertaken in the offshore environment for the proposed cable route and the vast majority of the cable installation will be in areas where little to no water quality information currently exists. Water quality is linked to sediment quality, as certain contaminants tend to move between water and sediments. Certain types of contaminants are generally associated with fine and cohesive sediments, as they are adsorbed to the surface of mud particles. Disturbance of the seabed can mobilise sediments, lead to temporary increases in suspended sediment concentrations and has the potential to cause the release of contaminants from the sediment into the water column. Chapman (1992) suggests that the North Sea sediments away from point sources are likely to be unpolluted and thus it is thought that water quality is liable to be good. The silt/clay content of the surface sediments along the UK section of the proposed cable route tends to be low as revealed by the geotechnical investigation carried out by MMT between August and

October 2010. This would also suggest that little accumulation of contaminants in the sediments is likely and hence water quality is liable to be good.

6.3.3. Description of potential impacts

The table below shows how sensitivity, recoverability and importance of the water body crossed by the cable route have been considered in determining significance of effect.

Receptor Value	Definition
High	Water body is of high quality, would not recover from impact and its ongoing quality status is of national importance
Medium	Water body is of high or good quality, would recover from impact slowly and its ongoing quality status is of regional importance
Low	Water body is of good or acceptable quality, would recover from impact quickly and its ongoing quality status is of local importance

Table 6-3-4 : Definition of receptor value

In order to consider the potential effects of sediment suspension from the cable laying operations of pre-sweep dredging and ploughing on the surrounding water environment, HR Wallingford carried out plume modelling. The plume dispersion model used to simulate the dispersion of fine sediment from ploughing and trailer dredging is the SEDPLUME-RW model developed by HR Wallingford. A description of the model and full modelling report is in Appendix 7. The model was run using the hydrodynamic output from the flow model and the assumption of a logarithmic velocity profile through the water column to track the three dimensional movement of sediment particles.

Dispersal in the direction of flow in the model is provided by the shear action of differential speeds through the water column while turbulent dispersion is modelled using a random walk technique. The deposition and resuspension of particles are modelled by establishing critical shear stresses for erosion and deposition. Erosion of deposited material occurs when the bed shear stress exceeds the critical shear stress for erosion while deposition of suspended material occurs when the bed shear stress falls below the critical shear stress for deposition.

For simulation of the fine sediment plumes arising from trailer dredging HR Wallingford has developed a specially adapted form of the SEDPLUME-RW code which allows the representation of the moving sources and of the near-field mixing that occurs with trailer suction hopper dredgers (TSHD) (Spearman *et al*, 2003). The overflow discharge of sediment was calculated using the TASS overflow model developed at HR Wallingford (Aarninkhof *et al*, 2010). This model calculates the sediment transport processes in the hopper using a one-dimensional vertical (1DV) model and calculates the magnitude and particle size distribution of the sediment flux out of the hopper in the overflow discharge.

Five scenarios were investigated:

- Scenario 1 - Ploughing sand near *Sabellaria* area
- Scenario 2 - Ploughing chalk
- Scenario 3 - Ploughing sand at Goodwin Knoll
- Scenario 4 - Pre-sweeping by TSHD at South Falls
- Scenario 5 – Jetting sand in UK waters

The assumptions made for the model in each case are contained in the technical modelling report at Appendix 7.

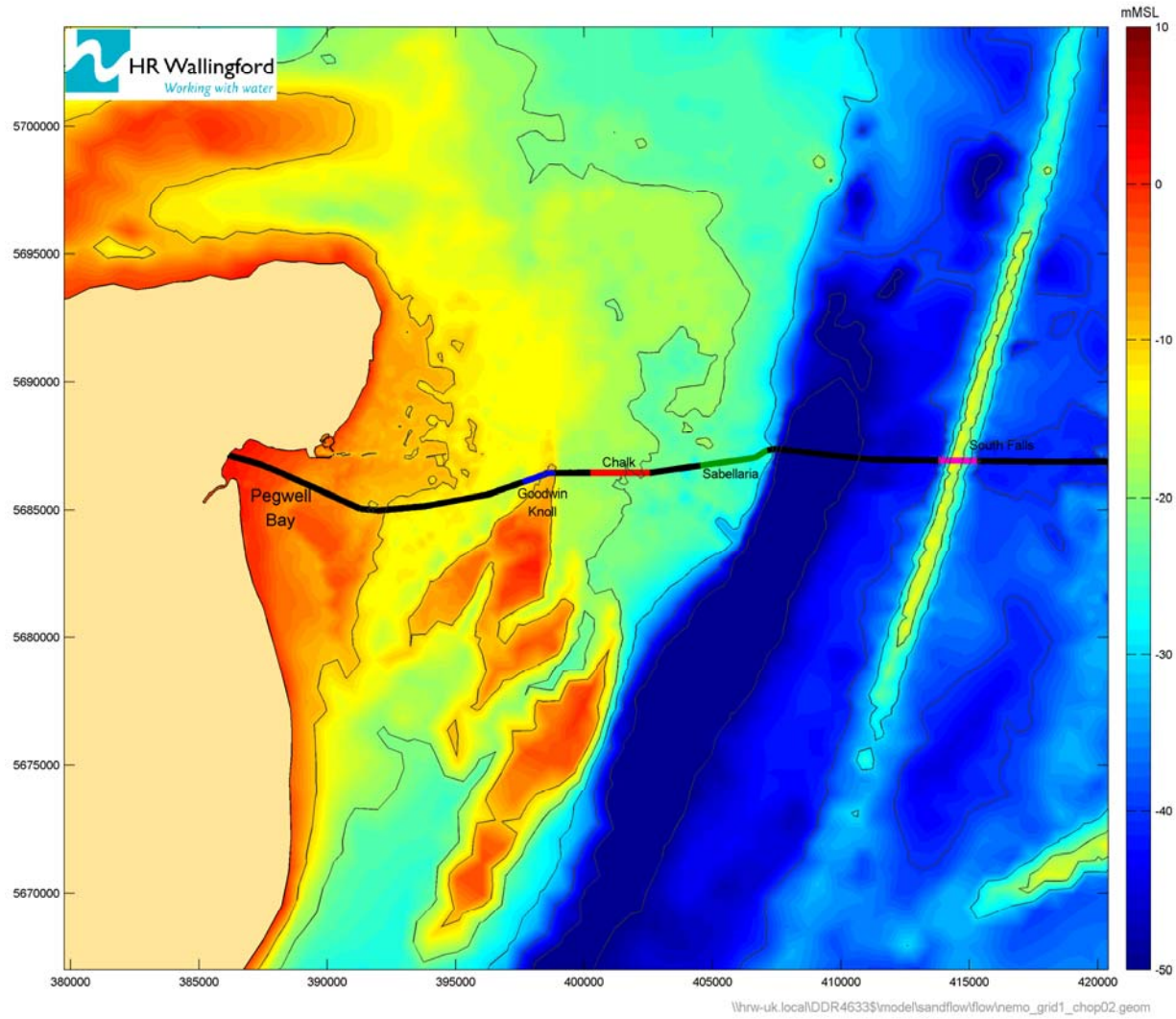

Figure 6-3-B : Location of proposed cable route in UK waters and cable laying sections for which plume dispersion simulations have been undertaken.

6.3.3.1. Scenario 1 - Ploughing sand near Sabellaria area

The scenario of ploughing sand with 3% fines content is predicted to produce depth-averaged and near bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. These levels are of an order of magnitude less than the natural variation range of suspended sediments. On this basis the potential effects of sediment suspension from ploughing near the *Sabelleria spinulosa* reef are considered to be **negligible**.

6.3.3.2. Scenario 2 - Ploughing chalk

Figures 6-3-C and 6-3-D show the *envelope* of predicted increases in near bed (Figure 6-3-C) and depth-averaged (Figure 6-3-D) suspended sediment concentrations above background during the simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation (one tidal cycle in this case). This style of figure is informative for showing the footprint of effect but tends to over-emphasise the size of the plume at any particular instant.

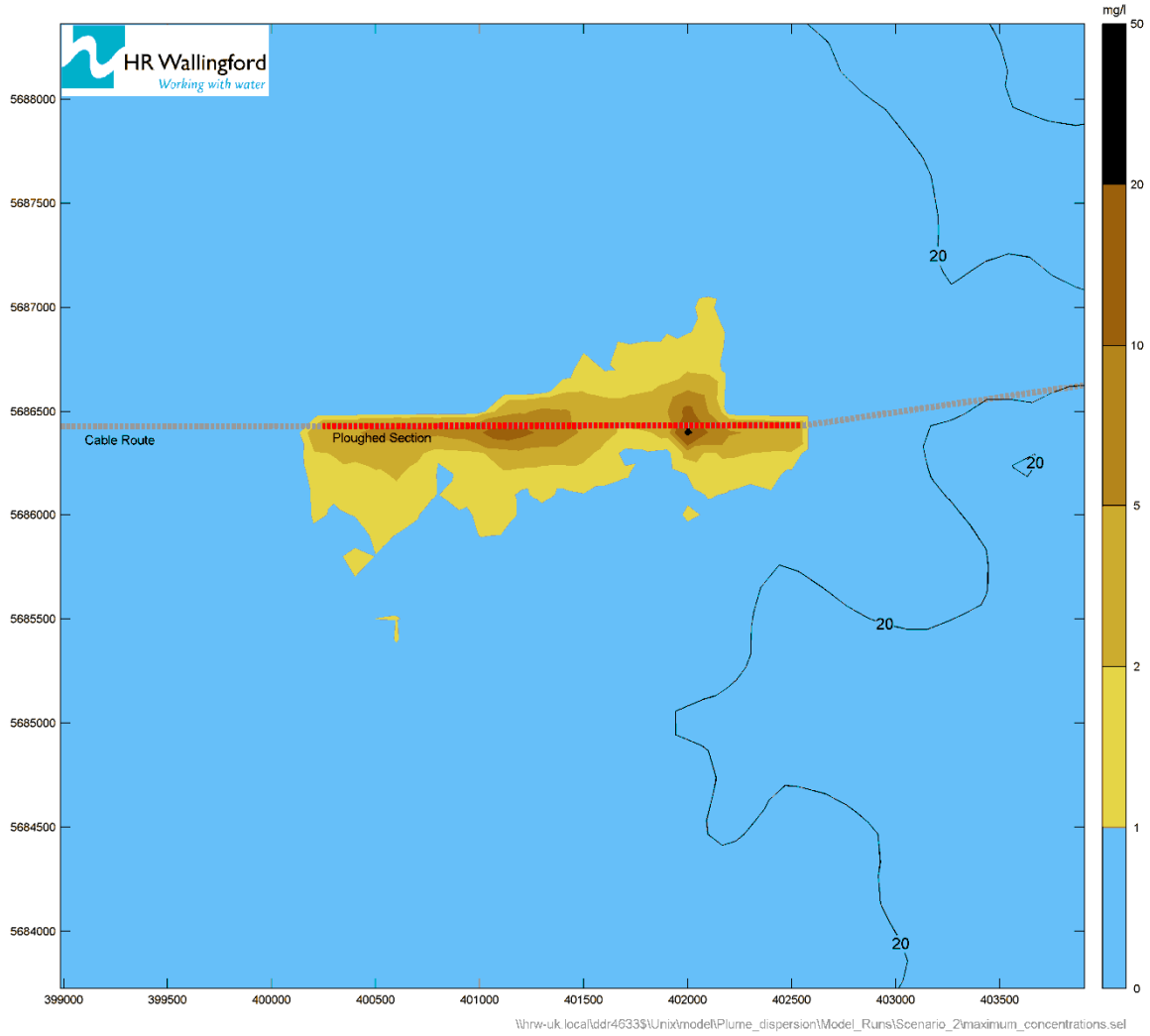

Figure 6-3-C : Predicted increase in near bed suspended sediment concentration above background, Scenario 2, ploughing chalk

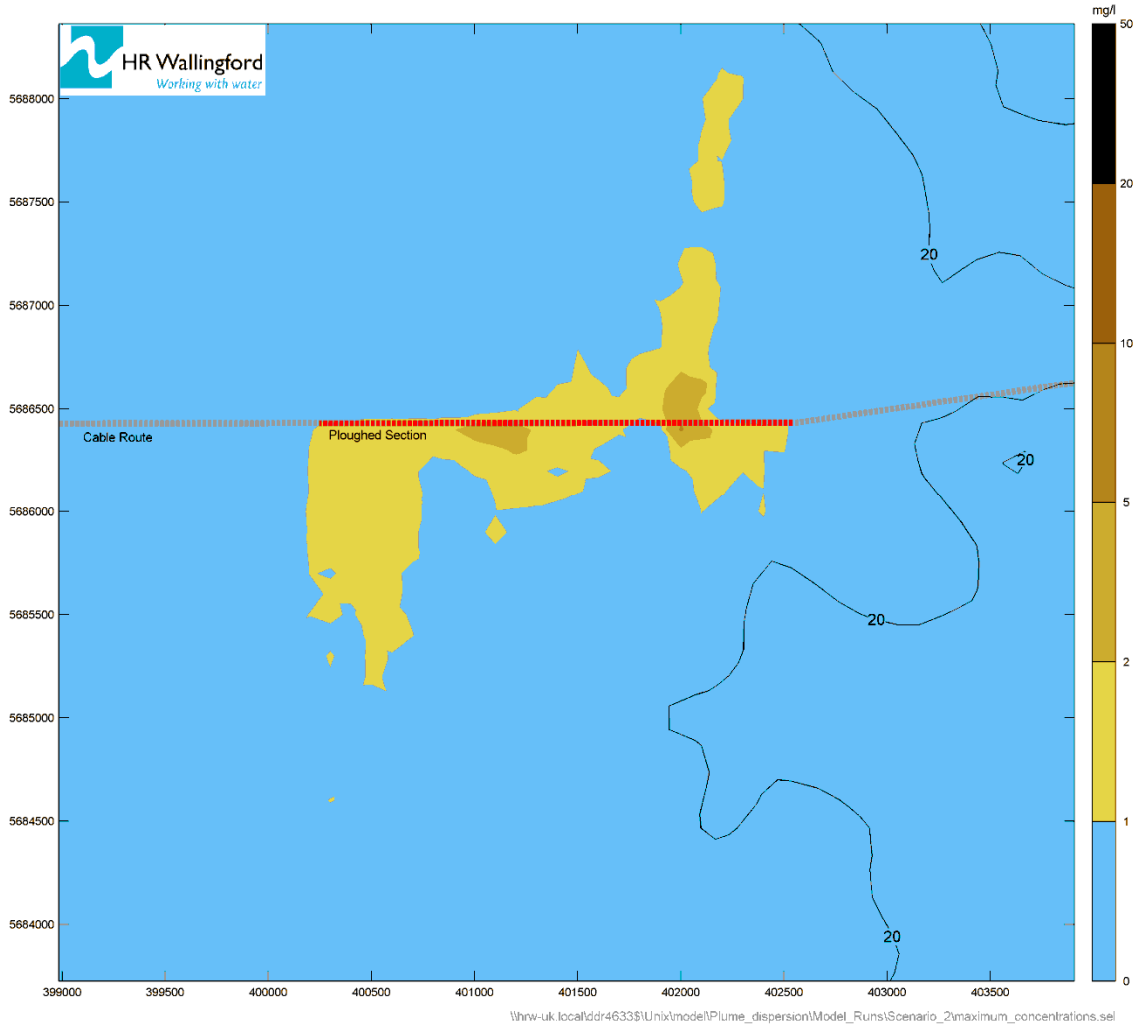

Figure 6-3-D : Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 2, ploughing chalk

The figures show that the footprint of impact extends up to 700 m from the cable route but that at these distances, the predicted increases in suspended concentration are less than 1 mg/l above background. Background suspended loads vary from typical summer values of 16 – 30 mg/l to typical winter values of up to 60 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable path. The peak predicted increase in concentration is about 20 mg/l. Deposition of fine sediment is predicted to be **negligible**.

This plume may provide some aesthetic impact, as suspended chalk particles are extremely visible, even in comparatively low concentrations. Concerns with regard to such impacts were raised as part of the Thanet Offshore Wind Farm development and Royal Haskoning provided an aerial survey of the plume caused by experimental ploughing when establishing best methodology for installing the export cable. This demonstrated that despite the visibility of the plume, it was similar to natural sediment suspension, or the effect of vessels moving through the coastal environment off Ramsgate Harbour. The water quality value in this offshore area is considered to be low (as defined in the receptor value table above), would recover very quickly and the changes are localised. The predicted impact of the chalk plume on water quality is therefore considered to be **minor**.

6.3.3.3. Scenario 3 - Ploughing sand at Goodwin Knoll

As for Scenario 1, the scenario with ploughing sand with 3% fines content is predicted to produce depth-averaged and near bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. On this basis the effect of ploughing over Goodwin Knoll on sediment suspension levels is considered to be **negligible**.

6.3.3.4. Scenario 4 – Trailer dredging at South Falls

Figures 6-3-E and 6-3-F show the *envelope* of predicted increases in near bed (Figure 6-3-E) and depth-averaged (Figure 6-3-F) suspended sediment concentration above background during the pre-sweep simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation (in this case 24 hours). The plume footprint is mainly due to the presence of fine material at the extremities of the plume. Closer to the point of release, the majority of the plume will be coarser, sandy material.

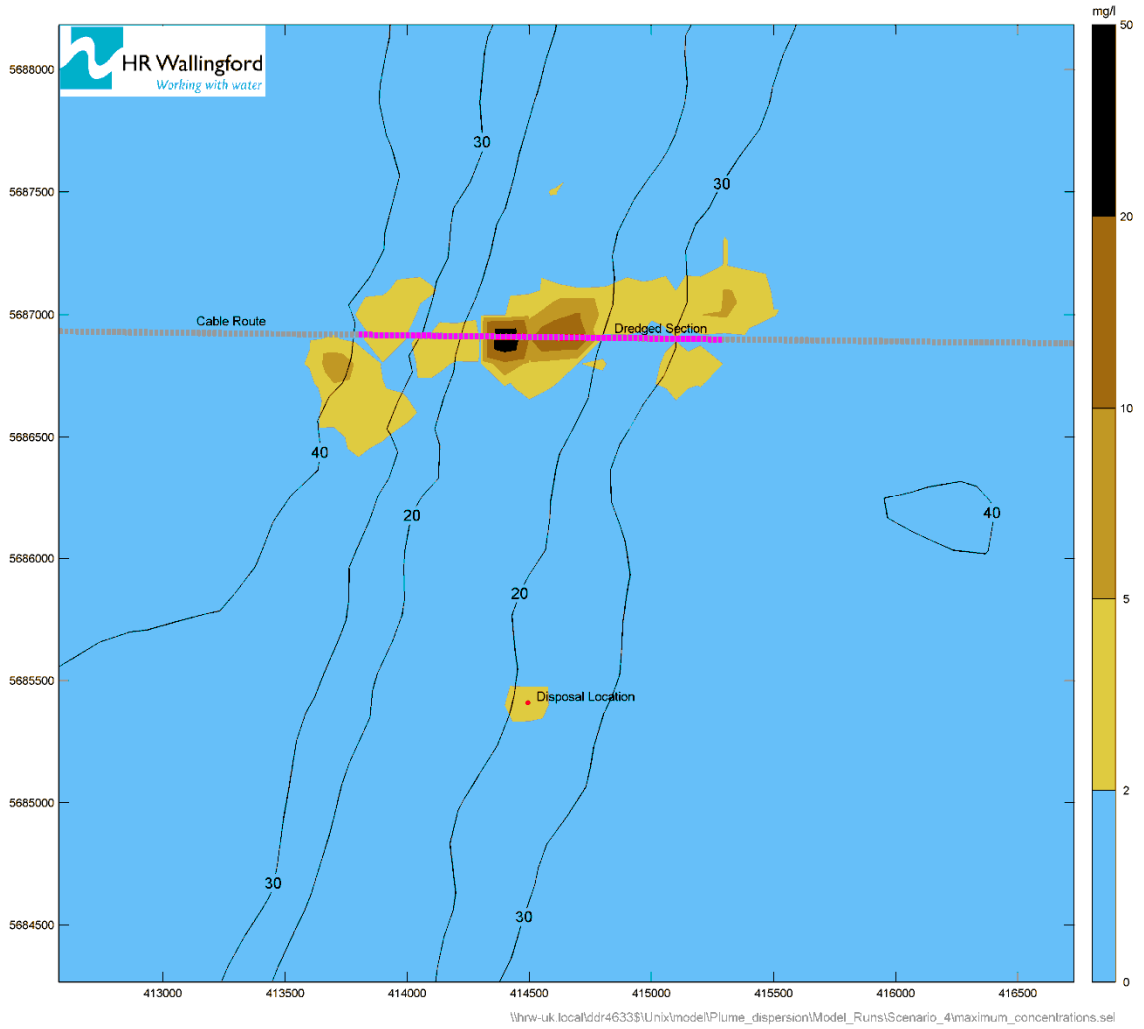

Figure 6-3-E : Predicted increase in near bed suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south

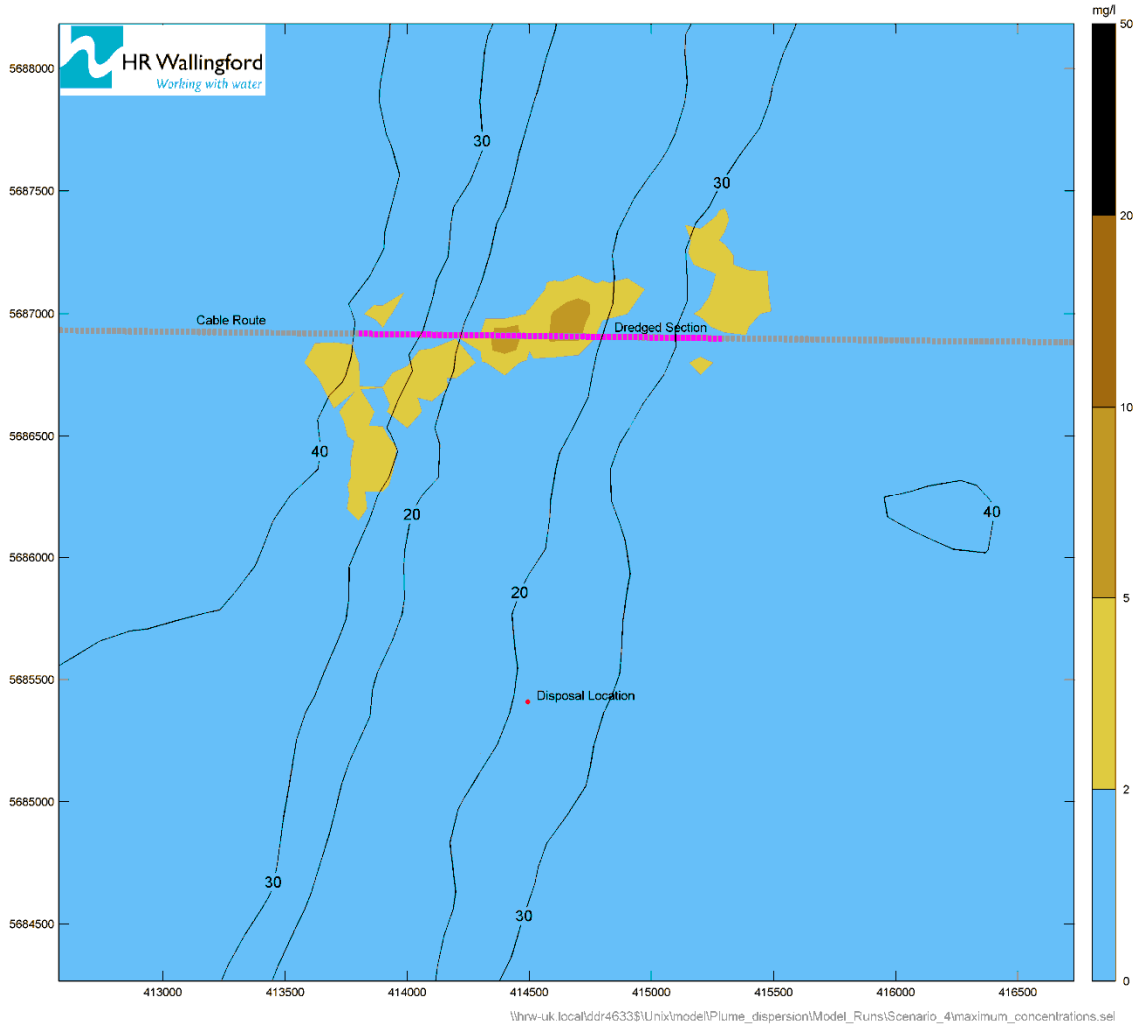

Figure 6-3-F : Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south

The figures show that the footprint of impact extends up to 500 m from the cable route but that at these distances the predicted increases in suspended concentration are less than 1 mg/l above background. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 250 m of the cable route. The peak predicted increase in concentration is about 30 mg/l.

Figures 6-3-E and 6-3-F also show that the plume of fine material arising from disposal produces concentration increases of around 2 mg/l of fine material (< 63 µm) owing to the small amount of fines released. There will however be considerably more coarse sediment released than fine sediment and concentration increases will be of the order of 1000s mg/l within one hundred metres of the point of disposal over a period of around ten minutes while these coarser particles settle to the bed.

Deposition of fine sediment is predicted to be less than 0.1 mm and so is considered to be **negligible**. Any sandy sediment released from the dredger is estimated to fall to the bed within 200-400 m of the cable route and within 100 m of the point of disposal.

Increased turbidity from suspended sediments during dredging and disposal are therefore considered to cause potential **minor** impacts on water quality.

6.3.3.5. Scenario 5 – Jetting sand in UK waters

The release rate corresponding to jetting in the sandy conditions of UK waters, is about 2 kg/s or less. The release rate is much lower for these sandy substrates compared to muddy conditions, because of the low fines content (i.e. the small proportion of particles less than 63 µm in diameter) of the sand. A release rate of 2 kg/s corresponds roughly with the release rate resulting from ploughing of chalk. The predicted deposition arising from fine sediment plumes with such a low release rate can be deduced to be **negligible** on the basis of the simulations undertaken in this study. On this basis we used the result from simulation of chalk ploughing (Scenario 2) to give reasonable approximation of the increase in suspended sediment concentrations from fine sediment plumes caused by dredging sand.

6.3.3.6. Contaminants

Most contaminant levels in the vibrocore samples at the UK landfall area are relatively low, with the exception of some elevations of arsenic and a singular hotspot of organotin compounds. Arsenic is a naturally occurring chemical element that is normally found in small amounts. Arsenic concentrations in estuarine sediments from England and Wales range over three orders of magnitude. Enrichment of arsenic can occur either from natural biogeochemical processes or due to anthropogenic sources (e.g. mining activities). The arsenic levels found are only slightly above CEFAS's guideline Action Level 1 for arsenic (20 mg/kg dry weight) and well below Action Level 2 (100 mg/kg dry weight) for the disposal of dredged material. Ploughing or jetting will resuspend sediments in a localised area. However, the resuspension will be local and for a very short period of time during the cable installation phase or potentially during the decommissioning, should the cable be removed from the seabed. Natural biogeochemical reactions can result in the release of arsenic to the water column when redox conditions are altered (from the presence of oxygen for example) and, if released, the speciation of arsenic will then be an important factor related to its toxic and mobile behaviour. It is not possible to quantify the release due to the dynamic nature of the marine environment, i.e. a number of parameters which fluctuate, such as salinity, iron content and redox potential. Considering these points on the behaviour of arsenic and the fact that the levels are elevated for only some of the locations, it is considered that the ploughing or jetting process will not release significant contamination into the local environment. Organotin compounds decay upon prolonged exposure to elevated temperature and light, when in aerobic conditions and thus the resuspension of one small area of contamination will affect only the immediate locale and will not persist. The impact of contaminants on water quality in the coastal area is therefore considered to be of **minor** significance. As discussed in the baseline section, it is considered that sediments further offshore are unlikely to contain significant levels of contamination and therefore the impact of contaminants on water quality in the offshore area is predicted to be **negligible**.

6.3.3.7. Heat emissions

Operation of the cables will result in some heat being emitted from the cable. Such losses as heat reduce the efficiency of the cable system; the cable design will be optimised to maximise the efficiency of the cable system thereby reducing heat emissions. Any heating effects will be very local to the cable and the sediment surrounding it. Transmission of heat through to the marine environment will be minimal and the presence of sea water will aid the dissipation of any heat produced. Elevated temperatures will therefore be very localised and during the operation of the cable, impacts on water quality are considered to be **minor**.

6.3.3.8. Accidental contamination

Accidental contamination is a risk to the project, however, with good practice and observation of MARPOL regulations, this risk should be managed to be as low as reasonably practical (ALARP), during the installation, operation and decommissioning phases. It is therefore not considered within potential impacts, but is noted here in order to provide completeness of consideration.

6.3.4. Mitigation

The pre-sweeping operations have been designed to trench only through the seabed features where judged necessary, which minimises disturbance and resuspension of sediments and any associated contaminants from dredging and disposal.

The cable will be designed for maximum efficiency and therefore minimise any excessive heat losses.

6.3.5. Residual impact

The impacts predicted are of minor significance, as the water quality is expected to be impacted only in localised low value receptor areas, will recover quickly and high value receptors will not be affected. Impacts are also predicted to remain **minor** after mitigation measures.

This chapter has aimed to determine the potential impacts in relation to water quality caused by the development and disturbance to the seabed sediments. Once the contract has been awarded for the installation work and the full engineering design has been undertaken and finalised, an assessment will be completed in relation to the potential effects on ecological and chemical status in Pegwell Bay (as covered within the South East River Basin Management Plan). This will be undertaken in line with the parameters set out in the Environment Agency Guidance (Clearing the Waters: Marine Dredging and the Water Framework Directive Stage Two, the Scoping Process – April 2010).

6.3.6. References

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7. Biological Environment

7.1. Conservation Designations

The Project has the potential to affect areas designated for nature conservation in terms of habitat and the species protected within them in the following ways:

- Direct impacts on species through location and installation of landfall, onshore and offshore works;
- Direct impacts on habitat/species from offshore and onshore cabling;
- Indirect impacts of disturbance or habitat loss associated with installation work and operation; and
- In-combination effects with other developments.

The following section provides information on sites that are protected under European Directives or British legislation, that are located near to or could be directly or indirectly affected by the scheme. This also includes potential cumulative effects from other schemes. It should be noted however that this section only concerns biological designations and has not considered areas prioritised for their landscape or amenity value (such as Areas of Outstanding Natural Beauty). Habitats Regulations Assessment signposting can be found in Appendix 5.

7.1.1. Baseline Data Sources

Data to inform the conservation designations section has been sourced from the following locations:

- Joint Nature Conservation Committee (JNCC) website (http://www.jncc.gov.uk);
- Natural England's Nature on the Map Website (http://www.natureonthemap.gov.uk);
- Multi Agency Geographical Information for the Countryside (MAGIC) database (http://www.magic.gov.uk);
- Balanced Seas Project;
- Natural England;
- Ramsar Website (http://www.ramsar.org.uk) and;
- Kent Wildlife Trust (KWT).

7.1.2. Baseline

There are a range of international and national statutory designations that vary in their level of importance and protection located in the Project area. Statutory and non statutory local designations have also been considered based on the available information. The designated areas that have been considered are defined and summarised below and shown in Figure 7-1-1.

7.1.2.1. Special Areas of Conservation

Special Areas of Conservation (SACs) are areas of land or water of international conservation importance designated under the EC Habitats Directive (92/43/EEC) and relate to habitat or species types which are listed for protection in Annexes I and II of the Habitats Directive. If an activity has the potential to have a significant adverse impact on the conservation features for which the SAC is designated, and that activity is not directly connected with the management of the site for nature conservation, then the proposal will be subject to an 'Appropriate Assessment'.

There are two SACs located within the study area, Sandwich Bay and Thanet Coast, details of which are shown in Table 7-1-1.

7.1.2.2. Special Protection Area

A Special Protection Area (SPA) is site of international conservation importance for birdlife designated under the EC Birds Directive (79/409/EEC). The requirement for Appropriate Assessment, briefly described above, also applies to SPAs. As birds are also mobile species, those birds protected by SPA designation are not only protected at the site itself, but also afforded protection away from the SPA throughout their range. For this reason, both SPAs in close proximity to the proposed project site and those SPAs designated for target species whose foraging ranges overlap with the site have been included in the table.

There is one SPA that could potentially be impacted by the Project, Thanet Coast and Sandwich SPA, which is listed in Table 7-1-2 and considered in detail in Chapter 7.2 – Ornithology.

7.1.2.3. Ramsar Sites

Ramsar sites are designated under the Convention of Wetlands, which requires member states to designate wetlands that meet the criteria for inclusion on the List of Wetlands of International Importance (Ramsar list). The only Ramsar site that has the potential to be affected by the Project is Thanet Coast and Sandwich Bay Ramsar Site, details of which are shown in Table 7-1-1.

7.1.2.4. Sites of Special Scientific Interest

A Site of Special Scientific Interest (SSSI) is an area of land or water designated under the UK Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). SSSIs provide legal protection for areas of special interest by reason of their flora, fauna, or geological features. In the majority of cases the seaward boundary of coastal SSSIs have been demarcated by Mean Low Water (MLW), although some have been notified with boundaries which extend seawards of MLW. Although there are SSSIs in the vicinity of the proposed project, in particular Sandwich Bay to Hacklinge Marshes SSSI, there are none that extend below MLW or include submerged habitats.

The SPA and SACs discussed above are also underpinned through designation as SSSIs. In the area of the Project the relevant SSSI is Sandwich Bay to Hacklinge Marshes SSSI. This site has been designated for the most important sand dune system and sandy coastal grassland in South East England. It includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. It also supports outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded.

It is also an important landfall for migrating birds and also supports large wintering populations of waders, some of which regularly reach levels of national importance.

7.1.2.5. National Nature Reserve

A National Nature Reserve (NNR) is a nationally important area designated under the National Parks and Access to the Countryside Act 1949, or under the Wildlife and Countryside Act of 1981. NNRs are set up to conserve and allow people access to the fauna, flora, or geological features of special interest.

There is one NNR located within the project area, Sandwich and Pegwell Bay NNR that has been designated for its habitats. These include eroding chalk cliffs and wave cut platforms to the north of Pegwell Bay, intertidal mudflats, developing beaches, sand dunes and saltmarsh. Semi-natural habitats include ancient dune pasture and coastal scrubland while the re-created grassland of the Pegwell Bay Country Park, along with ponds, dykes and ditches are artificial habitats.

The intertidal mudflats support nationally and internationally important numbers of waders and wildfowl, both on migration and over-winter. The sand dunes and ancient dune pasture contain large numbers of southern marsh orchid, marsh helleborine, pyramidal orchid and the occasional lizard orchid.

7.1.2.6. Local Nature Reserve

A Local Nature Reserve (LNR) is a statutory designation made under Section 21 of the National Parks and Access to the Countryside Act 1949 by principal local authorities. LNRs protect habitats and species and help forge partnerships between the local authority, nature conservation organisations and the community. The nearest LNR to the project is Prince's Beachlands LNR.

It should be noted that this section only concerns biological designations and has not considered areas prioritised for their landscape or amenity value (such as Areas of Outstanding Natural Beauty (AONB).

7.1.2.7. Marine Conservation Zones

A Marine Conservation Zone (MCZ) is a protected area created under the Marine and Coastal Access Act 2009 that will protect inshore and offshore areas to complement existing Marine Protected Areas such as SACs and SPAs. The purpose of the MCZs is to protect nationally important marine wildlife, geology and geomorphology. The bodies responsible for MCZs within the project area are Natural England and the Joint Nature Conservation Committee, who in turn seek guidance from Balanced Seas, a regional body created to make recommendations specifically for the waters off the South East England.

Originally, the Balanced Seas project put forward a list of draft Marine Conservation Zones (dMCZ) and, within these draft Reference Areas (dRAs). Consultation was completed in respect of the dMCZs and a revised list of 31 recommended MCZs (rMCZ) and recommended Reference Areas (rRAs) have now been put forward. Impact Assessments have been ongoing since October 2011 and Natural England and the JNCC collated the outputs. It is important to note that rMCZ status does not necessarily mean that the site will become an MCZ (and likewise with rRAs). Furthermore, MCZ status will not automatically preclude development in a given area. Rather the development must not disturb the designated species or habitat. However, Reference Area status would include a blanket ban on all development within its boundaries.

There are four rMCZs in proximity to the Project, one of which lies across the cable route (Goodwin Sands rMCZ). The Project does not fall within any areas currently put forward as rRAs; the only rRA in close proximity to the Project is the Goodwin Knoll rRA (within the Goodwin Sands rMCZ), which lies approximately 1 km to the south of the Project. Figure 7-1-1 shows all rMCZs and rRAs that are in close proximity to the Project and Table 7-1-1 provides further detail.

Site Name	Grid Reference	Area (ha)	Approximate Proximity to Project (km)	Qualifying Interest
Goodwin Sands (rMCZ 8)	ETRS89 N51 15' 23.836" E1 35' 11.227" N51 15.397' E1 35.187'	27691	Project overlaps with the northern extent of the rMCZ.	Broad-scale habitat types present qualifying for designation within Goodwin Sands are: Moderate energy infralittoral rock, moderate energy circalittoral rock, sub-tidal coarse sediment, and sub-tidal sand. Habitat FOCI are blue mussel beds and rossworm (*Sabellaria spinulosa*) reef.
Goodwin Knoll (rRA6)	ETRS89 N51 16' 47.126" E1	2318	1 km	Qualifying broad-scale habitat types present within Goodwin Knoll are sub-tidal coarse sediment and sub-tidal

Site Name	Grid Reference	Area (ha)	Approximate Proximity to Project (km)	Qualifying Interest
	32' 33.767" N51 16.785' E1 32.563'			sand. It is important as a haul-out area for seals and a foraging ground for birds.
Thanet Coast (rMCZ 7)	ETRS89 N51 22' 40.556" E1 22' 44.002" N51 22.676' E1 22.733'	6279	2 km	Features proposed for designation are broad-scale habitat types: moderate enery infralittoral rock, moderate energy circlittoral rock, sub-tidal coarse sediment, sub-tidal sand and sub-tidal mixed sediments. Habitats of conservation interest are; blue mussel beds, peat and clay exposures, rossworm (*Sabellaria spinulosa*), sub-tidal chalk and sub-tidal sands and gravels. Species of conservation interest are: St John's jellyfish and Kaleidoscope jellyfish.
Offshore Foreland (rMCZ 9)	ETRS89 N51 7' 43.961" E1 41' 9.693" N51 7.733' E1 41.162'	25249	4 km	Broad-scale habitat types present within Offshore Foreland qualifying for rMCZ are: high energy infralittoral rock, high energy ciralittoral rock, moderate energy circalittoral rock, sub-tidal coarse sediment and sub-tidal sands.
Dover to Deal (rMCZ 11)	ETRS89 N51 9' 21.617" E1 23' 32.638" N51 9.360' E1 23.544'	1040	12 km	Features proposed for designation are: broad-scale habitats; moderate energy intertidal rock, intertidal coarse sediment, intertidal mud, high energy infralittoral rock, moderate energy infralittoral rock, sub-tidal coarse sediments and sub-tidal mixed sediments. Habitat FOCI in this area are blue mussel beds, intertidal underboulder communities, littoral chalk communities, subtidal chalk and rossworm (*Sabellaria spinulosa)* reef.

Table 7-1-1 : rMCZs and rRAs in the vicinity of the cable route

The areas described above, rMCZs and rRAs, are assessed within Chapter 7.4 - Benthic and Intertidal Ecology along with Annex I Habitats

A summary of the designated areas with the potential to be affected by the proposal are listed in Table 7-1-2.

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Thanet Coast and Sandwich SPA (UK9012071)	634735E 161127N	1870.16	28/07/94	The site supports an important wintering population of turnstone (*Arenaria interpres*), 940 individuals representing at least 1.3% of the wintering Western Palearctic - wintering population (5 year peak mean 1991/2 - 1995/6). Also supports a wintering population of golden plover (*Pluvalis apricaria*) and breeding colony of little terns (*Sterna albifrons*). The SPA also has supports the following habitats; mesophile grassland, tidal rivers, estuaries, sand flats, lagoons, coastal sand dunes, shingle, sea cliffs and improved grassland.

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Sandwich Bay SAC (UK0013077)	635450E 161750N	1137.87	08/01/96	Primary reason for designation of the site is the presence of several types of marine habitat detailed under Annex I of the Habitats Directive – Embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes"), fixed dunes with herbaceous vegetation ("grey dunes"), and dunes with *Salix repens ssp. argentea* (*Salicion arenariae*). The Annex I Habitat humid dune slacks is also a qualifying feature of the site.
Thanet Coast SAC (UK0013107)	634288E 170421N	2,803.84	14/10/96	Thanet Coast SAC Designated due to the presence of two types of marine habitat detailed under Annex I of the Habitats Directive – reefs and submerged or partially submerged sea caves.
Thanet Coast and Sandwich Bay Ramsar Site (Ramsar Site No. UK11070)	635667E 161632N	2,169.23	28/07/94	A coastal site, consisting of a long rocky shore, adjoining estuary, dune, maritime grassland, saltmarsh, and grazing marsh. The site supports internationally important numbers of wintering turnstone (*Arenaria interpres*), and four waders occurring at nationally important levels: ringed plover, golden plover, gray plover and sanderling. Large numbers of migratory birds use the site for staging. Large numbers of nationally scarce invertebrate species occur at the site (supports up to fifteen British Red Data Book wetland invertebrates. Human activities include recreation, bait collection, agriculture, livestock grazing, fishing, and hunting.
Sandwich Bay to Hacklinge Marshes SSSI	635350E 158550N	1756.5	1951	The SSSI contains the most important sand dune system and sandy coastal grassland in South East England. Includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. Outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded. Invertebrates are also of interest with recent records including 19 nationally rare, and 149 nationally scarce species. Important landfall for migrating birds and also supports large wintering populations of waders, some of which regularly reach levels of national importance. Cliffs at Pegwell Bay are of geological interest.

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Sandwich and Pegwell Bay NNR	635490E 163517N	629.31	Not Known	Natural habitats include: eroding chalk cliffs and wave cut platforms to the north of Pegwell Bay, intertidal mudflats, developing beaches, sand dunes and saltmarsh. Semi-natural habitats include; ancient dune pasture and coastal scrubland while the re-created grassland of the Pegwell Bay Country Park, along with ponds, dykes and ditches are artificial habitats. The intertidal mudflats support nationally and internationally important numbers of waders and wildfowl, both during migration and over-winter. The sand dunes and ancient dune pasture contain large numbers of southern marsh orchid, marsh helleborine, pyramidal orchid and the occasional lizard orchid.
Prince's Beachlands LNR	635190E 161729N	6.15	Not Known	No information regarding this designated area has been received from Dover District Council.

Table 7-1-2 : Conservation Designations

7.1.3. Description of potential impacts

The potential impacts on the receptors identified in this section, the designated sites, are listed below for all phases of the proposed development; installation, operation and decommissioning. A detailed impact assessment is included in Appendix 6 with a summary shown below.

The definition of receptor values is shown in Table 7-1-3 below. These values take into account sensitivity, recoverability and importance.

Receptor Value	Definition
High	A site of international importance such as a SPA, SAC or Ramsar site. By definition the sites or qualifying features are considered to be of the highest sensitivity and rarity and could be destroyed or irreversibly damaged by the effect. Effects on the sites and their qualifying features could be irreversible and/or take considerable time to recover.
Medium	A site of national importance such as a SSSI or NNR. By definition the sites or qualifying features are considered to be sensitive but are likely to be less susceptible to damage and irreversible effects. Effects on the sites and their qualifying features could be significant but are likely to recover with time.
Low	A site of local importance such as a LNR. By definition the sites or qualifying features are considered to be less sensitive and effects are less likely to result in significant damage and irreversible effects. Effects on the sites and their qualifying features are likely to be tolerable and less likely to be significant. Site will recover.

Table 7-1-3: Receptor Value Definitions

7.1.3.1. Cable Installation

The main impacts associated with the installation phase will be those direct impacts associated with the laying of cables and open trenching works that could destroy or displace habitats and flora and fauna that are qualifying features of the designations. The cable trench in the intertidal area is expected to be 1-2 m wide and approximately 2-3 m deep. The cable laying process however, is temporary in nature and likely to take approximately 2 months to complete (within British waters)

although the potential effects as a result of habitat and species disturbance will be longer lasting due to the removal of vegetation.

Based on this information it is predicted that the cable installation could have a **moderate** impact on internationally and nationally designated sites, prior to application of mitigation. This has been based on a review of the sensitivity of the habitats, which are designated as internationally and nationally important areas for the flora and fauna they support. However, it is also considered that the habitats affected, mud and sand flats are likely to recover quickly following disturbance and these effects are temporary and short term in nature. Mitigation is available to reduce the impact and this is discussed in Section 7.1.4 below.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2 - Ornithology.

7.1.3.2. Cable Operation

Whilst there will be maintenance requirements for the cable and at the landfall location it is considered that these will be temporary in nature and will be localised to the areas in question. Maintenance works are likely to last a matter of days for ongoing surveys to monitor the cable with any remedial or repair works taking no more than a couple of weeks. It is considered that these will result in very moderate or minor impacts (depending on the status of the designation) on all designated areas and are therefore considered **not significant**.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2.

7.1.3.3. Decommissioning

The degree of impact for decommissioning will depend on the level of works required; complete removal of the cable will result in a higher magnitude of impact than leaving the cable insitu. Based on a worst case full removal of the cable the level of impact will be similar to that of the installation phase; a **moderate** impact on internationally designated sites and **minor** impact on nationally and locally designated areas. This has been based on the fact that the internationally designated areas are of the highest sensitivity based on its qualifying features whilst the nationally designated areas are less sensitive. It is considered that the habitats will take longer to recover if the cables were removed during decommissioning rather than left in situ.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2.

7.1.4. Mitigation

7.1.4.1. Installation

Avoidance of the most sensitive habitats, such as high quality saltmarsh (discussed in the terrestrial conservation designations chapter) has been used to minimise the magnitude of impact. The landfall selected is located at the Service Station area, close to the landfall for the Thanet Offshore Wind Farm which is not located within a designated area.

Installation in the intertidal areas in the bird nesting and wintering periods will occur outside of the most sensitive periods where practical to ensure impacts upon ornithology are reduced as far as possible.

7.1.4.2. Cable Operation

Maintenance activities during the operational phase should take into account the qualifying features of the designations and works should be planned to minimise disturbance and damage. This should also include indirect effects caused by the vehicles and plant (such as access and generation of noise emissions).

7.1.4.3. Decommissioning

It is recommended that decommissioning of the project allows for the cable to be de-energised and remain in situ to minimise the level of disturbance on designated areas.

7.1.5. Residual impact

7.1.5.1. Installation

The cable route has been located away from the most sensitive areas based on the qualifying features of the designations, namely the high quality saltmarsh and ornithological interests. The likelihood, therefore, of potential impacts on the sites is reduced. In the case of disturbance to SPAs and SACs, the impact on internationally designated areas will be of **minor** significance (in terms of the EIA regulations) due to the limited extent and duration of the works and the fact that the cable route avoids the most sensitive habitats and features of the site. This is supported by the positive consent determination for the Thanet Offshore Wind Farm cable installation and anecdotal evidence regarding recovery of the local area.

7.1.5.2. Decommissioning

If the cable remains in situ in the intertidal area, it is likely to have **no impact** on the qualifying features of the designations.

7.2. Ornithology

7.2.1. Data, information and guidance

The following sources of data and information have been used to inform the baseline summary in this report.

- JNCC website for details of Special Protection Areas (SPAs) including site information and designation details
- Kent Wildlife Trust (KWT) - Consultation meeting with KWT provided information on ecological sensitivities at Sandwich and Pegwell Bay National Nature Reserve (NNR), Thanet Coast and Sandwich Bay SPA and Ramsar site, Sandwich Bay Special Area for Conservation (SAC) and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI)
- The UK Offshore Energy Strategic Environmental Assessment (Department for Energy and Climate Change (DECC), 2009)
- The Wetland Bird Survey (Holt *et al*, 2009)
- The Joint Nature Conservation Committee (JNCC) atlas of seabird distribution in north-west European waters (Stone *et al*, 1995) and
- A wintering bird survey undertaken to for the project to inform cable routeing and EIA (Appendix 8).
- Pegwell Bay inter-tidal sediment and invertebrate surveys (Appendix 9)
- Pegwell Bay breeding bird and redshank nesting survey (Appendix 10)
- Thanet Offshore Wind Farm Environmental Statement (2005)
- JNCC Seabirds at Sea database

It is understood that Kent Wildlife Trust and Natural England have been carrying out surveys to determine potential causes of disturbance to the local bird populations at Pegwell Bay, with surveys carried out each month. Although this study was not concluded in time for inclusion in the Environmental Statement, interim results and species data were available. A local ornithological group “Planet Thanet” also undertakes regular informal surveys of the area and produces annual reports.

7.2.2. Baseline overview

7.2.2.1. Intertidal Bird Species

The area surrounding Pegwell Bay is used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn. These include nationally important numbers of ringed plover (*Charadrius hiaticula*) and greenshank (*Tringa nebularia)* during their migration and red-throated diver (*Gavia stellata*) during the winter period. The area is also of importance for several other species including wintering populations of dunlin (*Calidris alpina*), curlew (*Numenius arquata*), oystercatcher (*Haematopus ostralegus*), redshank (*Tringa tetanus*), sanderling (*Calidris alba*) and grey plover (*Pluvialis squatarola*) as well as breeding populations of shelduck (*Tadorna tadorna*), redshank (*Tringa tetanus*) and oystercatcher (*Haematopus ostralegus*).

The proposed location of the cable landfall area is protected by several conservation designations (as detailed in Chapter 7.1 – Conservation Designations). In relation to ornithology, it is designated as an SPA and a Ramsar site and it is also classified as an Important Bird Area (IBA). There is a level of overlap between the birds covered under different designations, however the SPA and Ramsar sites note all nationally important bird species.

Thanet Coast and Sandwich Bay SPA

Thanet Coast and Sandwich Bay SPA consists of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (JNCC, 2001). Specifically the area is designated for supporting over-wintering populations of European importance of turnstone (*Arenaria interpres*) and golden plover (*P. apricaria*), and a breeding population of little tern (*Sterna albifrons*) as shown in Table 7-2-1 below (JNCC, 2006).

Thanet Coast and Sandwich Bay Ramsar Site

Thanet Coast and Sandwich Bay Ramsar site covers a similar area to the SPA, covering 2169 hectares. The wetland habitats support 15 British Red Data Book invertebrates, as well as a large number of nationally scarce species (Bratton, 1991). The site attracts nationally important numbers overwintering bird populations including Lapland buntings (*Calcarius lapponicus*) and several wader species; ringed plover, golden plover, grey plover and sanderling. The site is used by large numbers of migratory birds. The following species occur at levels of national importance during migration periods in spring and autumn (JNCC, 2008):

- Ringed plover, 649 individuals representing 2% of the Great British (GB) population
- Common greenshank, 35 individuals representing 5.8% of the GB population.

The following species occur at nationally important levels in winter (JNCC, 2008):

- Red-throated diver, 57 individuals, representing an average of 1.1% of the GB population
- Great crested grebe (*Podiceps cristatus cristatus*), 218 individuals, representing an average of 1.3% of the GB population
- European golden plover, 4190 individuals, representing an average of 1.6% of the GB population
- Sanderling 598 individuals, representing an average of 2.9% of the GB population.

Species	Period of use	Numbers at SPA	Percentage of population	Qualification
Turnstone (Arenaria interpres)	Winter	940 individuals	1.4% of wintering Western Palearctic population	Article 4.2 (79/409/EEC)
Golden Plover (Pluvialis apricaria)	Winter	411 individuals	0.2% of British Population	Article 4.1 (79/409/EEC)
Little Terns (Sterna albifrons)	Breeding season	6 breeding pairs	0.3% of British population	Article 4.1 (79/409/EEC)

Table 7-2-1 : Annex I bird species regularly occurring at Thanet Coast and Sandwich Bay SPA (JNCC, 2006)

The most numerous bird species recorded during the winter bird survey, carried out in 2008 and 2009, included lapwing and golden plover followed by dunlin and oystercatcher (TEP, 2010). The survey identified a number of specific areas within Pegwell Bay that are used regularly by certain wader and wildfowl species for roosting or feeding. These areas are listed below and shown on Figure 7-2-1:

- The mudflats near the north bank of the River Stour
- The large area of saltmarsh immediately to the east of Stonelees
- Shellness
- Saltmarsh and grazing marsh on the south bank of the River Stour
- The mudflats at the south-east end of Pegwell Bay.

It is likely that the distribution of wader species is dictated by the abundance of invertebrate prey species. The Inter-tidal Sediment and Invertebrate Survey (Appendix 9) recorded 42 different invertebrate taxa and distinct areas of Pegwell Bay could be identified based on the invertebrate

species identified there. However, certain species had widespread distributions within the bay including annelid species and the common cockle (*Cerastoderma edule*), which was found to be widespread and abundant, and they are considered important prey for several wader species. Pegwell Bay and Stonelees are also considered to have local importance for breeding birds with 34 bird species observed during the 2009 breeding bird survey (Appendix 10). The table below summarises species information for birds that occur at nationally or internationally important levels at the SPA and Ramsar sites discussed above.

Bird Species	Species Information
Little Tern	Little tern traditionally nest at Shell Ness in Pegwell Bay approximately 800m south of the cable route. They tend to nest in small, single-species colonies on areas of shingle and sand. It has been observed through the ongoing surveys undertaken by KWT and other groups that numbers of little terns have been decreasing dramatically in recent years and this is thought to be largely as a result of increased disturbance (not solely due to recreation but this has triggered the introduction of control measures). Little terns are not present in the UK during the winter months as they overwinter off the coast of Africa, however a survey visit was undertaken in May to include the spring migration period. In addition to their breeding grounds little tern feed in the shallow coastal waters on small fish (e.g. sand eel, pipefish, and gobies) and crustaceans (shrimps, prawns and crabs). When the tide is in, feeding activity occurs in the Sandwich and Pegwell Bay area and in the lower reaches of the River Stour (Dover District Council, 2010).
Turnstone	Turnstone feed on sandy beaches and rocky shores along the north-east Kent coast particularly in areas of loose stones or seaweeds. Their preferred food includes peeler crabs, small crustaceans such as shrimps, and barnacles, as well as marine molluscs such as periwinkles. They may continue to forage at high tide on areas of washed up weed at the tideline. Roosting within the SPA occurs from Swalecliffe to Pegwell Bay mainly on areas of sand and shingle but also on man-made structures such as the sea wall. Additionally, some birds roost on fields at the top of the cliffs and other areas of open space landward of the boundary of the SPA (Dover District Council, 2010).
Golden Plover	Golden plover overwinter on land around Sandwich Bay. In recent years golden plover have taken to roosting in large numbers on the intertidal mudflats of the bay itself. It is likely that, whilst there, some feeding takes place but this is not their prime feeding habitat. Their main feeding habitat is arable fields and grazing marsh located inland of the dunes of Sandwich Bay. Mudflats and sandflats in Pegwell Bay and Sandwich Bay provide roosting grounds for golden plover (Dover District Council, 2010).
Ringed Plover	Ringed Plover breed and overwinter on beaches around the British coast line. In Pegwell Bay significant numbers of ringed plover pass through during migratory periods travelling to and from Canada and Greenland (RSPB, 2011). Over winter they are not observed in high numbers in the Bay but when they were seen, they appear to feed near the mouth of the River Stour (Appendix 8). They eat spiders and flies as well as marine worms, crustaceans and molluscs.
Greenshank	Migrating greenshank can be found in Pegwell Bay mostly in April and May and between July and September while travelling to and from African wintering grounds (RSPB, 2011). They are rarely seen in the bay in winter and were not observed during the Winter Bird Survey (Appendix 8). Greenshank tend to feed on worms, snails and fish (RSPB, 2011).
Red-throated Diver	Red-throated divers are known to breed mainly on the Shetland Islands, Orkney, the northern Scottish coastline and the Outer Hebrides (RSPB, 2011). Outside of the breeding season they are numerous along the East coast of Britain and they are known to over winter in Pegwell Bay. Only four individuals were observed during the TEP Winter Bird Survey (2010a) and these were seen towards the middle of the bay, swimming south. They feed on a wide range of fish species.
Great Crested Grebe	Numbers of great crested grebe peak within the Thanet Coast and Sandwich Bay Ramsar site during winter, however, no individuals were observed in Pegwell Bay during the Winter Bird Survey suggesting individuals tend to reside elsewhere within the Ramsar site (Appendix 8). Great crested grebe dive to catch fish as well as to escape, tending to prefer this to flying.
Sanderling	Sanderling breed in the Arctic but overwinter in the UK in places such as Pegwell Bay. Over 100 individuals were observed in Pegwell Bay during the Winter Bird Survey (Appendix 8). The birds were observed in various locations, appearing not to be restricted to certain areas of the bay. They feed on small marine worms, crustaceans and molluscs (RSPB, 2011).

Table 7-2-2 : Species information for Nationally and internationally important bird species

7.2.2.2. Current Disturbance of Intertidal Bird Species

KWT is currently undertaking a disturbance study in Pegwell Bay investigating factors that disturb waders and wildfowl in the bay. A sample of raw data that spanned 2010 was obtained and analysed by PMSS as the study has yet to be fully concluded. It was observed that on average motor boats caused the greatest disturbance to birds, tending to cause birds to fly more than 50m away from their original position or abandon the study area entirely. Predators, in the form of birds of prey and foxes, also caused a high level of disturbance, tending to cause birds to walk or fly short distances. When considering the most serious disturbance events, where birds have flown to a different position in the bay or abandoned it, it was found that the cause of many of these events was unknown however, of those disturbances where the cause was identified the majority (65%) appeared to be caused by walkers or walkers with dogs.

7.2.2.3. Offshore Bird Species

Areas further offshore are important as feeding and loafing areas, and migration routes. The JNCC Atlas of Seabird Distribution in northwest European Waters and the DECC Offshore Energy SEA (2009) indicate that the following species have been observed in the vicinity of the cable route.

Species	Likely period present
Red Throated Diver	October - March
Fulmar	All year
Gannet	All year but predominant in February to November, moving to the Channel over winter
Cormorants	All year
Velvet Scoter	January – April, October – December. Tend to be coastal species occasionally recorded offshore.
Red Breasted Merganser	November - April
Arctic Skua	August - October
Great Skua	All year
Little Gull	March – May, August to February
Black Headed Gull	All year
Common Gull	All year
Lesser Black Backed Gull	All year
Kittiwake	All year
Sandwich Tern	March – August. High densities found at coastal breeding sites in this period but some birds feed offshore. Birds become widely distributed outside of this period.
Guillemot	March – June, August, September - February. Guillemots are widespread in winter but generally at higher densities further north than the cable route.
Razorbill	October - June
Little auk	November - February

Source: JNCC atlas of seabird distribution in north-west European waters and DECC Offshore Energy SEA (2009)
Table 7-2-3 : Bird species potentially present along the cable route

7.2.3. Description of potential impacts

The table below provides details of how receptor value has been defined for the purposes of the impact assessment. The likely impacts on birds have been identified as:

- Disturbance to birds during the intertidal works
- Habitat contamination or loss

The section below assesses the level of impact before mitigation and the following sections discuss potential mitigation of the residual impact. A detailed description of the potential impacts is included in Appendix 6. The table below details how receptor sensitivity, recoverability and importance have been taken into account in determining significance of effect.

Receptor Value	Definition
High	Populations of national or international importance that are highly sensitive to the potential impact. The population will not return to its former level within several generations.
Medium	Populations of regional importance that are moderately effected by potential impact in terms of decline in abundance or change in distribution above that experienced under natural conditions, but does not threaten the integrity of the population(s). The population(s) will return to former levels within a few generations.
Low	Populations of local importance where the potential impact only causes small-scale or short term disturbances and no long term noticeable effects above the levels of natural variation. The impacts are not sufficient to be observed at population level.

Table 7-2-4 : Definition of receptor value

7.2.3.1. Cable Installation

Although there will be seabirds feeding offshore in the area of cable installation, it is not likely that the proposed cable installation will have a substantially greater impact on these bird species than the existing shipping already present in this area. It is predicted that the most likely impacts on bird species will occur in the intertidal area in Pegwell Bay and these impacts are discussed below.

Disturbance to Wader and Waterfowl Species in the Intertidal Area

Cable installation in the intertidal area will be undertaken by trenching across Pegwell Bay to a location just south of the service station (Figure 7-2-1). It is expected that the intertidal works will take approximately less than one week. Pegwell Bay forms part of Thanet Coast and Sandwich Bay SPA and Ramsar sites which are designated for nationally important numbers of ringed plover and greenshank as well as nationally or internationally important populations of over wintering golden plover, little tern, turnstone, red-throated diver and sanderling. The winter bird survey (Appendix 8) noted that the most numerous species feeding and roosting in Pegwell Bay were lapwing and golden plover, followed by dunlin and oystercatcher. The survey also identified a number of specific areas within Pegwell Bay that are likely to be particularly sensitive however, these are all located in the south of Pegwell Bay near the course of the River Stour which is approximately 900m from the cable route. As birds were found across the bay, the intertidal works will almost certainly cause some level of disturbance. This will most likely affect the birds in the immediate vicinity of the works and will only occur for the short period of time that the installation works are taking place in the bay (expected to be less than a week). The works will likely constitute a low level of change for birds considering that other activities such as dog walking and bait digging are also common in the bay. The receptor value has been defined as moderate due to the fact that Pegwell Bay forms part of Thanet Coast and Sandwich Bay SPA and Ramsar sites which support nationally and internationally important numbers of wader and waterfowl species and that these birds are sensitive to disturbance although they are likely to recover quickly. Based on this assessment, it is anticipated that the installation will have an impact of **minor** significance.

Pegwell Bay Country Park is believed to be of local importance for breeding bird species including redshank and whitethroat. The Breeding Bird and Nesting Redshank Survey (Appendix 10) identified a total of 34 bird species during the survey although it was noted that some species may not have been breeding in the survey area. The vast majority of nesting and breeding behaviours occur above

the high water mark and are more likely to be impacted by the onshore works and so will be discussed further in the onshore Environmental Statement. There is the possibility that the offshore works very near to the landfall could cause disturbance to nesting birds if completed during the breeding season. There were three redshank nesting areas identified by the survey in Pegwell Bay and one of these is located near to the landfall. At the closest point it will be just under 100m from the intertidal works. It is possible that the intertidal works may cause some disturbance to breeding birds for a very short period of time when the works are taking place in this area. Although the breeding birds will be very sensitive to disturbance, it is expected that the impact of the works taking place during the breeding season, will be of **minor** significance.

Loss of Prey Species

It is considered that the distribution of wader species is dictated by the abundance of invertebrate prey species. The Intertidal Sediment and Invertebrate Survey (Appendix 9) identified four distinct areas of Pegwell Bay based on the invertebrate species range and abundance. The cable route will pass through three of these areas. Certain species, including annelid species and the common cockle which are important prey for many wader species, were found to be abundant in several areas of the bay. The cable route will only disturb a very small proportion of the total prey species in the bay. The trench across the intertidal area is expected to be 1–2m wide and 2-3m deep. Furthermore, visual observations of the area where the Thanet Offshore Wind Farm cable was installed (also in Pegwell Bay) suggest that the area recovers well (meeting/pers comms with Natural England, March 2011) and so the loss of prey will only result in a low level of change and occur for a short period of time. Overall, it is expected that the magnitude of change will be low. Although, bird numbers of national and international importance visit the site, the loss of prey will account for only a small area of the bay and therefore bird species are unlikely to be sensitive to it and will have high recoverability. Based on this information it is expected that the impact on prey species is likely to be of **negligible** significance.

Habitat Contamination or Loss
As discussed above it is likely that any habitat loss will be highly localised and temporary in nature. There is, however, the possibility for accidental contamination of habitat by vessels or equipment associated with the installation. In such a situation, the incidence will be localised, infrequent and likely to dissipate or be neutralised by construction workers in a short period of time. Although, bird numbers of national and international importance are observed in the area and will be sensitive to habitat contamination, they are likely to have high recoverability. It has been assessed that the receptor value is moderate and it is likely that the overall impact will be of **minor** significance.

7.2.3.2. Cable Operation

Habitat Contamination or Loss

As discussed above it is likely that any habitat loss will be highly localised and temporary in nature. It is expected that the cable will be relatively benign during operation and have no impact on habitat. There is, however, the possibility for accidental contamination of habitat or individuals by associated vessels or equipment, including failure of the integrity of the cable. However, it is likely that any contaminations will be localised and likely to dissipate or be neutralised by maintenance workers in a short period of time. On this basis, it is likely that any impact will be of minor significance.

7.2.3.3. Decommissioning

In the event that the cable is removed, it is likely that any impacts during decommissioning will be similar to those experienced during installation. Once the project is in operation decommissioning options will be periodically re-evaluated via a decommissioning plan.

7.2.4. Mitigation

Disturbance to Wader and Waterfowl Species in the Intertidal Area

The Winter Bird Survey (Appendix 8) states that Pegwell Bay bird populations will be most sensitive to disturbance during the periods from October to February (lapwing, golden plover, turnstone and grey plover) and in May (turnstone, sanderling and grey plover). Therefore, if practicable, installation activities in the intertidal area will be timed to avoid these periods. The installation works in the intertidal area will be completed in as short a period as possible to further reduce disturbance to birds.

Disturbance to breeding birds

The Environmental Management Plan (EMP) that will be produced prior to installation commencement will detail sensitive areas that will be fenced off to avoid installation work accidentally entering them and causing unnecessary disturbance to birds. The main breeding period for redshank is from mid April to July. If practicable, the intertidal works will avoid this period and if it is not practical, the Project will then attempt to avoid the most sensitive periods within the breeding season.

Habitat Contamination or Loss

Standard construction and environmental best practice will be used to minimise the likelihood of contaminants being released. This will be documented in an EMP that will be issued to the Contractor prior to the commencement of the installation phase. The contents of the EMP will be strictly adhered to by the Contractor to ensure that contaminants are not released but should, in the unlikely event, a pollution event occur a robust response plan will be initiated.

7.2.5. Residual Impact

Disturbance to Wader and Waterfowl Species in the Intertidal Area

If installation activities can be restricted to periods when overwintering birds are not frequently present in the bay, it becomes unlikely that the installation works will affect these species of national and international importance. Although there may be other birds present, the most sensitive species will be unlikely to be impacted upon by the installation and therefore the significance of the impact is reduced to minor.

Disturbance to Breeding Birds

Although the mitigation measures discussed above may reduce the likelihood of disturbance to birds, the significance of the impact will remain minor as the receptor value is moderate.

Habitat Contamination or Loss

By ensuring strict adherence to the EMP, the likelihood of an accidental contamination event and duration will be reduced. It is likely that the significance of the impact will remain minor.

7.2.6. References

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5. JNCC (2008) Information Sheet on Ramsar Wetlands (RIS): Thanet Coast and Sandwich Bay. JNCC; Peterborough
6.
7. TEP (2010a) UK-Belgium interconnector project Nemo; winter bird survey. National Grid Ltd; Warwick (Ref TEP 1430.01.024 r1)
8. TEP (2010b) UK-Belgium interconnector project Nemo; intertidal sediment and invertebrate surveys. National Grid Ltd; Warwick (Ref TEP 1430.01.027 r1)
9. TEP (2010c) UK-Belgium interconnector project Nemo; breeding bird survey and redshank nesting survey. National Grid Ltd; Warwick (Ref TEP 1430.01.025 r1)
10. DECC (2009) Offshore Energy SEA. DECC; London.

7.3. Marine Mammals

7.3.1. Introduction

Cetaceans and pinnipeds (seals) are protected under various laws, including the Habitats Directive, which is transposed into UK law by the Conservation of Habitats and Species Regulations 2010, and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007.

Marine mammals are particularly sensitive to noise, primarily because they rely heavily on sound for communication, navigation and locating prey. The impact of noise on marine mammals has been taken into account below, drawing upon available data on the noise created during cable installation from other projects and the sensitivity of marine mammals to this type of marine installation.

In response to the scoping report, Natural England noted that this chapter should determine what marine mammal species are likely to be present in the area and whether the development is likely to cause disturbance or injury to them. They suggest that work undertaken by Southall and colleagues (2007) on effects of noise on marine mammals should be used to help inform this process. Kent Wildlife Trust also noted that sea mammal numbers are often underestimated in the area and suggested referring to a study commissioned by Kent Mammal Group investigating haul out sites of common and grey seals on the north Kent coast.

7.3.2. Baseline data sources

The key data sources that have been taken into account in relation to the distribution of marine mammals in the vicinity of the cable route are detailed below:

- JNCC Atlas of Cetacean Distribution in Northwest European Waters - Data compiled from a number of sources detailing the distribution of the 28 cetacean species known to have occurred within the waters of northwest Europe in the last 25 years. It provides an historic account of recorded sightings of cetaceans around the British Isles, potentially providing a more accurate record than observations taken over a limited period of time.
- JNCC Atlas of Cetacean Distribution in Northwest European Waters; Online monthly distribution maps
- DECC (2009) UK Offshore Energy Strategic Environmental Assessment - Strategic Environmental Assessment of the waters around the UK undertaken, in part, to enable Round 3 wind farm leasing. This is a good overview of existing marine mammal data including SCANS (Small Cetaceans in the European Atlantic and North Sea) II survey data.
- National Biodiversity Network website - Provides biodiversity data for the UK, including otter sightings and distribution.
- Multi Agency Geographic Information for the Countryside - Interactive mapping system showing data from UK conservation agencies and organisations. Specifically, in relation to this section of the report, it provides seal data collected by the Sea Mammal Research Unit (SMRU).
- SCANS II data - Cetacean population estimates and distribution obtained from SMRU in the form of the SCANS-II (Small Cetaceans in the European Atlantic and North Sea) final report (SCANS-II 2008) Kent Mammal Group pilot study on seal haul out sites on the North Kent Coast (Bramley Associates, 2004).
- Southall and colleagues (2007) Marine mammal noise exposure criteria: initial scientific recommendations.

7.3.3. Baseline

The southern North Sea is of relatively low importance for cetacean and seal populations when compared with other parts of the United Kingdom. Only two species of cetacean are periodically sighted within the area surrounding the cable route and no species is highly abundant (Reid *et al*., 2003). There are also grey and common seals within the area and these, as well as cetaceans, are discussed in more detail below.

7.3.3.1. Cetaceans

Cetacean species diversity and abundance is believed to be low in the area of the cable route compared to other areas in the North Sea (SMRU, 2005). The only frequently occurring species in this southern area of the North Sea is the harbour porpoise. This is the most frequently observed cetacean in European waters in both inshore and offshore waters thus the proportion of the total population that frequents the area near the cable route is very small (Reid *et al*, 2003). The seasonal movements of the Harbour Porpoise are difficult to infer as survey data is often patchy (Reid *et al*, 2003). The highest levels of sightings in the south eastern North Sea occur from January to April. The harbour porpoise has an extended breeding season occurring mainly between May and August, although some can be as early as March. The diet of the harbour porpoise comprises of a wide variety of small fish species (Reid *et al*., 2003). This includes young herring, sprat, sand-eel, whiting, saithe and pollock. Southall and colleagues (2007) surmise that harbour porpoises fall within the high frequency cetacean hearing group with an estimated auditory bandwidth of 0.2 kHz to 180 kHz.

The Cetacean Atlas indicates that common bottlenose dolphin and white-beaked dolphin are also occasionally present in the area along the cable route (Reid *et al.*, 2003). In UK waters, the white-beaked dolphin occurs predominantly in waters surrounding the western coast of Scotland and Northern Ireland. Distribution of white-beaked dolphin is generally restricted to the northern half of UK waters, sightings are rare below 54°N in the North Sea (DECC, 2009). They tend to be present on the continental shelf year-round but in nearshore water the species is observed more frequently between June and October. The white-beaked dolphin diet consists of a wide variety of fish (including cod, sand-eels and flatfishes) and some invertebrate species such as octopus and snow crab. They are believed to breed mainly between May and August but breeding may also extend to September and October (TOW, 2005). Southall and colleagues (2007) suggest that bottlenose dolphin have a mid-frequency cetacean hearing range between 0.15 kHz and 160 kHz. Thus different noise frequencies may affect bottlenose dolphins compared to harbour porpoises which fall within the high frequency cetacean hearing group.

The common bottlenose dolphin is an inshore species, in UK waters it is most frequently sighted within 10km of land. Their numbers in UK waters appear to peak between July and October. However, most sightings in the South East of England are in spring (Reid *et al*, 2003). They feed on a wide variety of benthic and pelagic fish as well as cephalopods and shellfish. Southall and colleagues (2007) surmise that the white-beaked dolphin also have a mid frequency hearing range with an estimated auditory broad bandwidth between 0.15 kHz and 160 kHz.

7.3.3.2. Pinnipeds

Two species of seal breed in British Waters: the harbour seal (also known as the common seal) and the grey seal. Both these seal species are listed under Annex II of the Habitats Directive. The abundance of pinniped species is very low in comparison to other areas in the North Sea. However, Kent Wildlife Trust noted that marine mammal numbers in the area are often under estimated (see Appendix 2 Scoping Response Matrix). Both harbour and grey seals occur in the area, according to count data collected by the Sea Mammal Research Unit (SMRU) in the period August 1996 to 1997 (SMRU, 1997). SMRU breeding colony data from 2005 (SMRU, 2005) also indicates that there is a minor Grey Seal breeding colony located off Ramsgate, approximately 1.5 km from the cable route. There are believed to be 50 common seals in the Stour Estuary and 20 on Goodwin Knoll

approximately 1.9 km south of the cable route. The Kent Mammal Group completed a survey in 2004 of haul out sites in the region of the cable route. Goodwin Sands complex was identified as an area of locally important haul out sites. The survey counted 60 harbour seals and 21 grey seals on the Goodwin Sands complex on a single survey day. The distribution of the seals across the sand bank complex is shown below in Table 7-3-1 and the location of the sand banks can be found in Figure 7-3-1.

Sandbank	Harbour Seal	Grey Seal
North Sand	25	20
Keellet Gut Bank	1	1
Central Goodwin	34	0

Table 7-3-1: Kent Mammal Group commissioned pilot survey of seals on Goodwin Sands Complex.

Common Seals

The UK population represents approximately 5 % of the global population of harbour seals. Harbour seals often haul out onto tidally exposed sandbanks to rest, moult and suckle their young. Harbour seals tend to breed near their haul out sites but may feed long distances from these locations (Brasseur and Fedak, 2003).They are more frequently observed at haul out sites from June to September. Pupping tends to occur in August and September (Hammond et al, 2003). Harbour seals are generalist feeders that take a wide variety of fish, cephalopods, and crustaceans obtained from surface, mid-water, and benthic habitats (Thompson & Härkönen, 2008). Pinniped species have an estimated auditory band width of 0.75 kHz to 75 kHz when in water, while out of water their auditory range is believed to be between 0.75 kHz and 20 kHz (Southall et al, 2007).

Grey Seals

Grey seals haul out on land between foraging trips and for breeding. Pupping tends to occur in January in the southern North Sea followed by moulting in February and March (Hammond *et al*, 2002). Grey seals are largely demersal or benthic feeders with sandeels, cod and Dover sole shown to make up the majority of the grey seal diet in the UK. Grey seals also eat a variety of flat fish species (Thompson & Härkönen, 2008).

7.3.4. Description of potential impacts

The potential impacts on the receptors identified in this section are listed in the following sections for all phases of the proposed development; installation, operation and decommissioning. A detailed impact assessment is included in Appendix 6.

The definition of receptor values is shown in below. These values take into account sensitivity, recoverability and importance. Receptor value has been taken into account

Receptor Value	Definition
High	Permanent decline in abundance and/or change in distribution above that experienced under natural conditions. The population will not return to its former level within several generations.
Medium	Temporary decline in abundance or change in distribution above that experienced under natural conditions, but does not threaten the integrity of the population(s). The population(s) will return to former levels within a few generations.
Low	Small-scale or short term disturbance to habitats or species and no long term noticeable effects above the levels of natural variation. The impacts are not sufficient to be observed at population level.

Table 7-3-2 – Definition of receptor value

7.3.4.1. Cable Installation

Neither the cable route nor the landfall site of the Project is within an area of particular importance or sensitivity for cetaceans or pinnipeds (SMRU, 2005). These species are particularly sensitive to impacts from marine noise, because they use noise for communication, navigation and prey location. There are considered to be three types of noise that can disturb or injure marine mammals. Single pulses, such as those caused by a single explosion, multiple pulses, such as pile striking, or nonpulses caused by events such as drilling (Southall et al, 2007). The main sources of noise during cable installation will be nonpulse noise, likely to be associated with the excavation of the cable trench, pre-sweeping and from the presence of cable laying vessels.

Impacts resulting from vessel noise

Vessel noise may have an effect on both seals and cetacean species. For harbour seals, the noise from construction vessels is likely to be audible up to 15 to 20 km from source, and 1 to 3 km from source for harbour porpoises depending on the noise frequency (Thompson *et al*, 2006). The noise impact from the vessels therefore is likely to affect the local area. Thompson and colleagues did not expect temporary threshold shift (TTS)[1] from shipping noise except at exceptionally close distances. Thus it is expected that the majority of marine mammals will not be sensitive to the noise or they will have a high recoverability from noise disturbance. The area of the cable installation is also not of high importance for marine mammal species and based on this information it is predicted that the receptor value will be low. The main effect of shipping noise will be disturbance of marine mammals in the area. The likelihood and degree of such disturbances will vary between auditory groups but, even when taking these into account, it is difficult to predict accurately due to the high degree of variation in the results obtained by different noise disturbance studies (reviewed by Southall et al, 2007). It is important to note that the area surrounding the cable route is regularly used by large commercial shipping vessels that travel to and from the Port of Ramsgate as well as shipping lanes that navigate around the Goodwin Sands complex thus the level of change compared to back ground shipping will be low (See Chapter 8.2 – Shipping and Navigation).

The seals observed on Goodwin Sands (less than 2km from the cable route) may also be temporarily disturbed by the installation activities in the local area. Brasseur and Fedak (2003) observed that seals at haul out sites would leave their site when powerboats passed over a kilometre away. Evidence appears to suggest that seals are able to habituate to anthropogenic noise. Therefore, whilst any marine mammals present in the vicinity of cable installation activities may experience local and temporary disturbance by cable installation vessels, their sensitivity to the effect is low and recoverability is expected to be high. Overall it is considered that there is a possibility of this impacting on pinnipeds and cetaceans. It is likely that this will be only a minor change from baseline shipping traffic in the area and any effect will be in the local area only and short in duration, the impact is therefore expected to be of minor significance.

Impacts resulting from burial of cables

There are two main sources of noise generated during the cable burial process itself; the first is during cable trenching and the second can be generated if rock placement is required to protect the cable. Although rock placement had a slightly greater noise level than trenching (Nedwell, 2004), its use will be highly localised to the area of cable crossing. Trenching noise was found to be a mixture of broad band noise, tonal machinery noise and transient noise, most likely associated with rock breakage (Nedwell, 2004). It was also noted that the noise was highly variable probably due to the specific physical properties of the sea bed being cut at the time. When noise levels at different distances were compared to species specific hearing sensitivities in certain marine mammals (dB_{HT} levels) it was found that no significant behavioural reactions, such as fleeing the area, will occur over 100m from source (Nedwell et al, 2003). There was some evidence to suggest minor behavioural reactions may occur in harbour porpoises at distances of less than 1000m. Based on this it has been determined that sensitivity to the effect is low and recoverability is expected to be high. It is predicted that noise

[1] Temporary threshold shift is the term for temporary hearing loss often induced by a loud noise

associated with excavation of the cable trench may disturb marine mammals in the local area on a temporary basis and therefore the impact significance of this is expected to be minor.

There is potential for disturbance of seals within the intertidal works area as there are believed to be 50 common seals in the Stour estuary. The intertidal works will be highly localised, taking place approximately 800m from the Stour estuary. Considering the works will be temporary (expected to last approximately one week) and will cause a low level of change for seals in the immediate area, it is expected that the impact to seals will be of negligible significance.

Accidental contamination

Contamination of habitats could occur from any accidental spills from installation vessels and equipment. Such an occurrence has the potential to cause significant damage. The Project will undertake risk assessments and produce contingency plans as a matter of course to ensure this risk is reduced to be as low as reasonably manageable.

7.3.4.2. Cable Operation

Electric and magnetic fields

There is some evidence that suggests that cetaceans are able to sense magnetic fields. Cetaceans species appear sensitive to variations in the Earth's magnetic field (Klinowska, 1990). For example, they are thought to be sensitive to changes in the geomagnetic field of 30-60 nT, and probably employ much finer levels of discrimination (CMACS, 2003). Consideration has therefore been given to whether cetacean migrations might be affected by electromagnetic fields generated from the Nemo Link cable.

There is no apparent evidence that existing interconnector cables have influenced migration of cetaceans. Migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operational subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration patterns (NSR Environmental Consultants, 2001). The area of the Nemo Link cable route in UK waters is not of particular importance for cetaceans. The most frequently observed species in nearshore waters are the harbour porpoise and bottlenose dolphin (both of which are listed in Annex II of the Habitats Directive). These species are however rare in the region. There have been no reported impacts on the migration of harbour porpoise over existing interconnector cables in the Baltic Sea. The magnetic fields generated are expected to be perceived by cetaceans as a new localised addition to the heterogeneous pattern of geomagnetic anomalies of the North Sea, and no significant impact on cetaceans is therefore expected as a result of magnetic fields produced during operation of the cable.

With respect to pinnipeds, there is currently no evidence that they are influenced by, or use, electromagnetic fields. It is likely that there will be no significant impact on harbour or grey seals as a result of magnetic fields produced during operation of the cable.

Noise

Noise generated by maintenance vessels is likely to be similar to that generated by installation vessels although it is likely to be more localised and shorter in duration therefore it is predicted that the impact will be of negligible significance.

Accidental contamination

Similar to installation activity, contamination of habitats or individuals animals could occur from any accidental spills from installation vessels and equipment. Such an occurrence has the potential to cause significant damage. It is likely that the level of change will be small and impact the local area only. Furthermore, any incident will be dealt with rapidly by the operators and thus it is expected that the impact of this will be of **minor** significance.

7.3.4.3. Decommissioning

If the cable is retrieved, there may be an impact of minor significance in relation to disruption and accidental contamination in the decommissioning phase, similar to that experienced during installation. However, it is often the practice to leave cables on the seabed after they are no longer in service as this action often causes the least environmental disruption.

7.3.5. Mitigation

Based on the low level of impact expected and the existing baseline of ongoing shipping activity in the area of interest no mitigation is proposed.

7.3.6. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

7.3.7. References

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7.4. Benthic and Intertidal Ecology

7.4.1. Baseline data sources

This chapter details the benthic and intertidal habitats and communities within the study area. Baseline conditions have been determined in order to conduct an assessment of the impacts associated with the installation, operation and decommissioning of the proposed Nemo Link high voltage direct current (HVDC) interconnector cable.

Substantial data on the region already exist in the public domain, with much of the literature published on benthic communities of the Thanet coast and south-east seas relating to the area's numerous existing and potential conservation designations.

As part of the planned network of Marine Protected Areas (MPAs) required by the Marine and Coastal Access Act (2009) regional projects have been conducted to identify Marine Conservation Zones (MCZs). The MPA network includes sites of national, European and international importance. The MCZ Project is led by Natural England (NE) and the Joint Nature Conservation Committee (JNCC) and it has identified broad-scale habitats and features of conservation interest (FOCI) to be included in and represented by MCZs (Natural England and the JNCC, 2010). The regional MCZ project responsible for the south-east seas, known as Balanced Seas, has identified and mapped several broad-scale habitats and FOCI that may occur within the area. Balanced Seas' area covers the UK waters of the English Channel and adjacent areas from north of the Suffolk/Essex border to the Hampshire/Dorset border, and includes the Solent and the Thames Estuary. The Balanced Seas website has been a valuable resource for information on the region, along with conservation authorities including the JNCC and Natural England.

Existing information has been used to support the description of the environment along with more detailed geophysical and marine benthic studies along the cable route (MMT, 2010a; 2010b). Intertidal data collected during surveys by English Nature (Tittley et al., 1998; Tittley et al., 2002) and a survey for the Thanet Offshore Wind Farm (TOWF) project (Royal Haskoning, 2005) have been used to establish baseline conditions within the nearshore part of the survey area and proposed landfall site. Impacts have been assessed using available literature and review of scientific data, including that referred to in the similar BritNed interconnector cable development (Metoc, 2004a).

Other information sources have included the Marine Habitat Classification for Britain and Ireland (Connor et al., 2004), the EUNIS Biodiversity database (European Environment Agency; EEA, 2011), the Mapping European Seabed Habitats website (MESH, 2011) and the UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).

7.4.1.1. Intertidal survey

The Thanet OWF intertidal survey (Royal Haskoning, 2005) was carried out in May 2005, across the intertidal flats of Pegwell Bay. A total of 38 stations were investigated, with box core samples sieved over 1mm mesh size and 0.25m^2 quadrats used on rocky substrata, to obtain baseline counts of organisms in the intertidal environment. Data were described using the Marine Nature Conservations Review (MNCR) SACFOR scale, a widely accepted method for recording faunal abundance, presented in Table 7-4-1.

% cover	Growth Form		Size of individuals/colonies					Number
	Crust/ meadow	Massive/turf	<1cm	1-3cm	3-15cm	>15cm	Density	
>80	S		S				>1/0.001m^2 (1x1cm)	>10,000/m^2
40-79	A	S	A	S			1-9/0.001m^2	1000-9999/m^2
20-39	C	A	C	A	S		1-9/0.01m^2 (10x10cm)	100-999/m^2
10-19	F	C	F	C	A	S	1-9/0.1m^2	10-99/m^2
5-9	O	F	O	F	C	A	1-9/m^2	
1-5	R	O	R	O	F	C	1-9/10m^2 (3.16x3.16m)	
<1		R		R	O	F	1-9/100m^2 (10x10m)	
					R	O	1-9/1000m^2 (31.6x31.6m)	
						R	<1/1000m^2	

S=superabundant; A=abundant; C=common, F=frequent; O=occasional; R=rare

Table 7-4-1 : SACFOR abundance scale

7.4.1.2. Subtidal survey

The sub-tidal benthic survey was carried out between the 22nd September- 2nd October-2010. Within UK waters, twenty stations were investigated with a drop-down digital stills camera with a freshwater lens and video system. Two camera cross transects were carried out over two stations where potentially sensitive biogenic reef habitat was identified, to determine the nature and extent of any reef structures. Sediment sampling was conducted using a 0.1m^2 Day Grab, with samples sieved over a 1mm mesh. Three grab samples were collected from each station, where possible, and retained for faunal analysis. A 500ml sediment sample was retained from one grab for particle size analysis (PSA). Details of the survey methodology and the target and actual positions of each sample are provided in the Environmental Survey Report (MMT, 2010b; Appendix 11). The positions of the twenty environmental survey stations in UK waters are presented in Figure 7-4-1.

Fauna identified from video analysis was quantified using the SACFOR abundance scale (Table 7-4-1) while fauna captured in still photographs and grab samples were enumerated as individuals per m^2 and percentage cover for colonial species during analysis.

7.4.1.3. Subtidal epibenthic survey

Epibenthic trawling was carried out at four trawl locations using a 2m beam trawl to investigate megafauna (>1cm) abundance and distribution. Three trawls were conducted over a distance of 600m, with the fourth over a distance of 1200m. Samples were washed over a 5mm mesh sieve prior to sorting and field identification. Details of the survey methodology and the positions of each trawl are provided in the Environmental Survey Report (MMT, 2010b; Appendix 11). The positions of the trawl locations in UK waters are presented in Figure 7-4-1 and presented in more detail in Chapter 7.5 – Fish and Shellfish Ecology.

7.4.2. Baseline Environment

7.4.2.1. Intertidal communities

The intertidal area of the landfall region has previously been described by the Thanet OWF Environmental Statement, after an extensive survey of the intertidal flats of Pegwell Bay in May 2005. Much of the data for the intertidal communities have been sourced from the Marine Ecology chapter of the Thanet OWF Environmental Statement (Royal Haskoning, 2005).

Pegwell Bay is a sheltered muddy sand bay, which is exposed over a wide area of approximately 542 hectares at low tide. Low chalk cliffs mark the northern edge of the Bay, which extends westwards into marshland and southwards into an area of mudflats.

The preferred cable route is to cross the intertidal flats of Pegwell Bay and make landfall to the south of the Service Station in the centre of the bay. This location is already used as landfall for the Thanet OWF export cables.

Pegwell Bay holds a number of conservation designations due to its importance to local and national biodiversity:

- Sandwich Bay and Hacklinge Marsh Site of Special Scientific Interest (SSSI)
- Sandwich and Pegwell Bay National Nature Reserve (NNR)
- Thanet Coast and Sandwich Bay Special Protection Area (SPA);
- Thanet Coast and Sandwich Bay Ramsar Wetland of International Importance (Ramsar); and
- Thanet Coast and Sandwich Bay candidate Special Areas of Conservation (cSAC);
- The preferred landfall site would also require the proposed cable route to cross intertidal mudflat and coastal saltmarsh Biodiversity Action Plan (BAP) priority habitats.

The Joint Nature Conservation Committee have identified a number of Annex I marine habitats along the Thanet coast. These Annex I habitats have been pivotal in the recommendation of the Thanet coast as an SAC. Annex I habitats that occur within the area of Pegwell Bay where the UK cable landfall will be located include:

- Sandbanks which are slightly covered by sea water all the time
- Mudflats and sandflats not covered by seawater at low tide
- Reefs
- Coastal saltmarsh
- Coastal lagoons
- Submerged or partially submerged sea caves

The Thanet intertidal survey (Royal Haskoning, 2005) identified four main habitat types with their associated faunal communities. These comprised:

- Wave-cut chalk platforms at the base of the chalk cliffs and sea defences;
- Upper midshore boulders and reefs;
- Midshore muddy sandflats; and
- Saltmarsh and associated mudflats

Wave-cut chalk platforms and upper midshore boulders

Chalk platforms are characteristic of areas where vertical rocky cliff faces abut a wave-eroded foreshore creating soft chalk reef susceptible to erosion. These wave-cut chalk platforms support unique faunal assemblages, characterised by resilient and opportunistic species, such as rock-boring piddocks (Family Pholadidae) and *Polydora* sp. and ephemeral algal species adapted to the soft-rock environment (OSPAR, 2009a; Tittley *et al*., 1998). Algae and lichens can become established well above the high water mark due to the porous nature of the chalk, developing unique and specialised communities scarcely found elsewhere (Fowler and Tittley, 1993). Extensive sublittoral chalk reefs have been documented along the Thanet coast, covering most of the nearshore and extending into

the littoral zone, representing 12% of the UK's coastal chalk (Jones *et al*., 2004). The area has thus been selected as a candidate Special Area of Conservation (cSAC), with conservation objectives including maintenance of the intertidal chalk cliff algal and lichen communities found in the chalk reef and submerged sea cave habitats (Tittley *et al*., 2002). The Thanet cSAC is thought to well represent the biotopes that occur on British chalk shores, with intrinsically low species diversity on the chalk platforms reflecting the harsh tidal swept environment (Tittley *et al*., 1998). As with the Thanet export cable, the proposed Nemo Link cable route avoids these sensitive wave-cut chalk platforms to the north of Pegwell Bay.

These chalk platforms have been well documented by numerous intertidal surveys along the coast from Pegwell village to the port of Ramsgate (Tittley *et al*., 1998; 2002; Royal Haskoning, 2005). An extensive intertidal study conducted by English Nature in 2005 determined the presence of four biotopes (Connor *et al*., 1997) which translate to current EUNIS classifications of: 'A1.441 Chrysophyceae and Haptophyceae on vertical upper littoral fringe soft rock'; 'A2.72 Littoral mussel beds on sediment'; 'A1.452 *Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock'; and 'A2.431 Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata' (Tittley *et al*., 2002).

Extensive sampling along the Pegwell Bay chalk platforms during the Thanet OWF intertidal survey recorded an abundance of common mussel *Mytilus edulis*, sand mason worm *Lanice conchilega* and acorn barnacles *Semibalanus balanoides* and *Elminius modestus*, with common limpet *Patella vulgata*, rough periwinkle *Littorina saxatilis*, common periwinkle *Littorina littorea*, edible oysters *Crassostrea* sp. and gobies *Pomatoschistus* sp. also commonly recorded (Royal Haskoning, 2005). The *Mytilus*/*Lanice* community dominate much of the midshore chalk reef, demonstrating a high tolerance to siltation and exposure to air (Royal Haskoning, 2005), although *M. edulis* has shown intolerance to smothering from dredging operations (Rosenberg, 1977). During the Thanet intertidal survey, it was felt that the *Mytilus* reef and associated faunal assemblage was unique enough in the study area to be considered of local conservation importance (Royal Haskoning, 2005). The proposed Nemo Link cable route is estimated to pass at least 250m from the wave-cut chalk platforms and mussel beds identified during the previous surveys.

Intertidal muddy sandflats

Intertidal mudflats and sandflats commonly support communities characterised by polychaetes, oligochaetes and bivalves, which can provide important food sources for juvenile fish, wading birds and wildfowl. Intertidal mudflats and sandflats can be characterised by biota which reflect the established physical conditions, such as salinity and the proportion of sand. In mudflats of lower salinity, typical fauna can include the Baltic tellin Macoma balthica, common cockle Cerastoderma edule, sand-hopper Corophium volutator and laver spire shell Hydrobia ulvae. With an increase in the proportion of sand, the lugworm Arenicola marina and the catworm Nephthys hombergii can dominate (Maddock, 2008).

At high tide, mudflats can provide important nursery areas for flatfish such as sole Solea solea, dab Limanda limanda, flounder Platichthys flesus and plaice Pleuronectes platessa. In the summer months, juvenile plaice and dab move over the flats at high tide to feed on mobile epifauna and sedentary infauna (OSPAR, 2009b). Because of this conservation significance, mudflats and sandflats not covered by seawater at low tide can be designated as Annex I habitat of the Habitats Directive. Intertidal mudflats are also included on the OSPAR List of threatened and/or declining species and habitats (OSPAR Agreement 2008-6). As such, the presence of these mudflats in part prompted the designation of the area as the Sandwich Bay to Hacklinge Marshes SSSI. Intertidal mudflats are also designated as a UK Biodiversity Action Plan (BAP) Priority Habitat.

Intertidal muddy sands dominate a large portion of Pegwell Bay, with this habitat extending from the lower wave-cut chalk platform at mid-tide level to mean low water. The Thanet OWF intertidal survey recorded infauna dominated by species typical for this habitat. Two marginally different biotopes were identified, with the lugworm A. marina, laver spire shell H. ulvae and bivalves including the edible cockle C. edule and the Baltic tellin M. balthica dominating the muddy sand flats closer to the coast. Arenicola marina, C. edule and the sandmason worm L. conchilega, a species common to the UK

coast, were pre-dominant over much of the mid to lower shore area, with L. conchilega particularly abundant in the north of Pegwell Bay.

Species recorded during the Thanet survey are typical for muddy sandflat environments (Maddock, 2008; Royal Haskoning, 2005). Such intertidal species are adapted to mobile nearshore sediments, and thus capable of tolerating physical disturbance and high levels of suspended solids.

Coastal saltmarshes and associated mudflats

Coastal saltmarshes are vegetated areas found in sheltered coastal locations, the development of which is dependant on the presence of intertidal mudflats. Saltmarshes have been assigned as a Biodiversity Action Plan (BAP) habitat action plan (UK BAP, 2009).

The Pegwell Bay saltmarsh comprises a diversity of characteristic plants, dominated by saltmarsh grasses such as Puccinellia maritima and common cord-grass Spartina anglica, with other abundant species such as sea purslane Halimione portulacoides, sea aster Aster tripolium, sea lavender Limonium vulgare and the nationally scarce golden samphire Inula crithmoides (Natural England, 1994). Saltmarshes can also be important nursery sites for fish species. The Thanet OWF intertidal survey recorded emergent patchy Spartina saltmarsh to the north of the disused hoverport site in the north-west of the Bay, and surrounding the proposed landfall site. A more well-developed and diverse Spartina marsh community was recorded to the south of the River Stour. This more mature community can be considered of greater ecological importance to the region. This area of more mature saltmarsh habitat is estimated at over 150m from the proposed northern landfall site, and is not within the path of the proposed cable route.

Dense patches of the green algae Enteromorpha intestinalis were also recorded, along with the burrowing amphipod crustacean Corophium volutator, the small gastropod mud snail Hydrobia ulvae and the ragworm Hediste diversicolor. Other common species identified in this habitat included the edible cockle C. edule and the Baltic tellin M. balthica. Enteromorpha and the bladder wrack Fucus vesiculosus were also found as part of a dense algal assemblage colonising the concrete skirt of the disused hoverport. The range and abundance of infaunal species found in the saltmarsh and associated mudflats can provide an important food source for wading birds.

Dominant species within the intertidal zone comprised both active suspension and surface deposit feeders. The sand mason worm, L. conchilega is capable of both active suspension and surface deposit feeding, and is generally found in fully marine areas, thus is more common in the lower and midshore (Elliot et al., 1998). Suspension feeders can be particularly vulnerable to the impacts of developments such as cable-laying and dredging, which increase the amount of suspended sediments in the water column. Fauna identified within the intertidal mudflats, chalk platforms and saltmarsh at the proposed northern landfall are typical of the region with no rare, scarce or protected species under national or international legislation recorded in the area. They do however provide an important food resource for a range of wading birds, wildfowl and juvenile fish in the region.

7.4.2.2. Benthic communities

The area along the proposed cable route is characterised by softer substrates, with the seabed dominated by mixed sands and gravels, and offshore sandbanks arising up to 26m from the seabed. Sand formations such as sand waves and ripples interrupt the predominantly smooth bathymetry along much of the route. Between KP 82.3 and KP 87, the sand and gravelly sediment was visible in sand wave formations, which reach 2 to 6 metres height above the surrounding seabed. Between KP 99.2 and KP 100.8, the proposed route passes across the South Falls sandbank, which reaches approximately 26m height, at the top of which the water depth is approximately 12m LAT. These sandbanks provide important habitats for benthic invertebrates as well as spawning and nursery grounds for several fish species. Each sandbank is unique with its own characteristic community; the deeper and more stable sandbanks tend to be more species-rich than the more mobile, shallow and thus exposed sandbanks. ‘Sandbanks which are slightly covered by sea water all the time’ are defined in Annex I of the Habitats Directive.

Subtidal sandbanks are high-energy environments, subject to physical disturbance through strong tidal currents. Such sandbanks are characterised by low faunal diversity, with a lack of sedentary taxa such as bivalve molluscs. Fauna recorded on the crests of such sandbanks tend to be restricted to those species associated with sandy habitats, and are characteristically dominated by agile swimmers such as burrowing haustoriid amphipods and isopods; species which typically have a short lifespan and are tolerant of sediment disturbance (Elliot *et al*., 1998).

Bedrock is rarely evident at the seabed, with visible bedrock generally exposed as chalk (Jones *et al*., 2004). Submerged chalk platforms are also present off the east Kent coast (Jones *et al*., 2004) and have been identified in the intertidal zone (Royal Haskoning, 2005). There is no exposed chalk within the subtidal area surveyed for the proposed cable route; however underlying chalk was detected close to the surface from KP 87 to KP 108, covered only by a thin layer of sand and gravel. Along much of the route between KP 108 and KP 114.5, the chalk unit is only covered by a thin veneer of sand. Bedrock was present at or near the surface along the westernmost parts of the route beyond KP114.5, close to the UK coastline.

7.4.2.3. EUNIS Habitat Classification

Habitat classification is used to identify different habitats and biotopes based on the biotic and abiotic features of the seabed. Habitat and biotope classification was conducted on the benthic survey data, adhering to protocols within the European Union Nature Identification System (EUNIS). The system was developed between 1996 and 2001 by the European Environment Agency (EEA) in collaboration with European experts. A marine habitat classification system for Britain, Ireland and the North-east Atlantic was developed by the JNCC (Connor *et al*., 2004) and has been fully incorporated into EUNIS.

Table 7-4-2 shows the five EUNIS levels to describe the marine environment in Britain:

Level	Detail Covered (EUNIS / JNCC Classification)
1. Environment	Marine (A)
2. Broad habitats	Sublittoral Sediment (A5 / SS)
3. Main habitats	Sublittoral biogenic reefs on sediment (A5.6 / SS.SBR)
4. Biotope complexes	Polychaete worm reefs (A5.61 / SS.SBR.PoR)
5. Biotopes	Sabellaria spinulosa on stable circalittoral mixed sediment (A5.611 / SS.SBR.PoR.SspiM)

Table 7-4-2 : Example EUNIS Marine Classification Levels

Development of the EUNIS classification comes from both a top-down and a bottom-up approach. Top-down classification differentiates between rock and sediment habitats, and between those habitats on the shore (intertidal) and those in the subtidal or offshore (deep) areas. These high-level divisions can be further subdivided on the basis of different types of sediment (e.g. gravel, mud), different degrees of wave exposure on rocky coasts (exposed, sheltered) and varying depth bands below the low water mark (e.g. shallow water where light penetrates, deeper water with little light). Such broad-scale differences in habitat character are readily understood by non-specialists and provide classification types that are easily mapped. They also have ecological relevance as they reflect major changes in habitat character upon which species distribution depend (Connor *et al.,* 2004).

Bottom-up classification differentiates between places with different species communities. Relative species composition, diversity and abundance vary from place to place and are dependent both on environmental characteristics and upon interactions between species. Surveyed sites with similar environmental characteristics, such as sediment type and depth, show certain levels of similarity in their species communities. Multivariate analysis of the data from field surveys (e.g. grabs and trawls) groups these data into clusters that have a similar character. These clusters form the basis of defining the types at the lower end of the EUNIS classification.

The top-down and bottom-up approaches have been merged together into the single hierarchical EUNIS classification, which enables broad-scale application in management and mapping, and fine-scale application for detailed survey, monitoring and scientific study.

Based on depth, PSA, fauna data and seabed imagery (following the approach given by Connor *et al*., 2004) the benthic survey stations were classified to EUNIS levels. The identification of the main habitat (EUNIS Level 3) is mainly based on depth and sediment type. The EUNIS classification hierarchy to biotope complex (Level 4) and biotopes (Level 5) includes the use of faunal data, where available. Given the fact that faunal data were not always available to provide added insight into baseline conditions, some stations could only be classified to EUNIS level 3 (main habitat).

Eleven distinct EUNIS sublittoral sediment habitats were identified along the proposed cable route, with seven of these habitats present in UK waters. The most abundant habitat identified within the survey corridor was 'A5.25 Circalittoral fine sand' found along much of the eastern and central parts of the UK route between KP 82.27 and KP 87, and between KP 102.3 and KP 118. This classification describes clean fine sands with less than 5% fines (silt and clay <63µm) in deeper water with a diverse community (Connor *et al*., 2004). This habitat was generally dominated by polychaetes and crustaceans with fewer species found in the UK part of the route than in French or Belgian waters.

Between KP 87 and KP 99.5, the sediment generally comprised tide-swept circalittoral coarse sands and gravel. At EUNIS biotope level, this part of the survey area varied between 'A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' and 'A5.145 *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel'. The *P. triqueter* habitat was characterised by cobbles with tubes of Serpularidae and the sea urchin *Psammechinus miliaris* and anemones Actinaria common. The *B. lanceolatum* habitat was characterised by the lancelet, along with Nematoda and the polychaetes *Polycirrus medusa* and *Notomastus latericeus.*

The area surrounding the South Falls sandbank between approximately KP 99.5 and KP 100.8 was described as tide-swept infralittoral clean sands. The slopes of the sandbank were classified as 'A5.23 Infralittoral fine sand' with an abundance of the polychaete *Ophelia borealis* and the crustacean *Urothoe brevicornis*. The top of the sandbank was classified as 'A5.231 Infralittoral mobile clean sand with sparse fauna' due to the lower faunal diversity and abundance caused by the more mobile substratum. Typical biota in these habitats include opportunistic populations of infaunal amphipods, with recorded taxa including the crustacean *Urothoe* spp. and low numbers of the polychaete *Nephtys cirrosa*.

Between KP 100.8 and KP 115.7, the sediment was dominated by alternating extents of 'A5.25 Circalittoral fine sand' and 'A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles'. Two areas of potential *Sabellaria spinulosa* reef were identified around KP 108.5 and KP 110.3. These areas were delineated using available data (described in more detail in Section 7.4.2.5) and classified 'A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment'. These areas were inhabited by a higher diversity of species in comparison to their surroundings, with associated species including long-clawed porcelain crab *Pisidia longicornis*, brittle stars Ophiuroida and *Amphipholus squamata*, starfish *Leptasterias muelleri* and *Asterias rubens*, mussels *Abra prismatica* and *A. nitida*, snails *Odostomia unidentata*, cnidarians Actinaria and fish *Gaidropsarus* spp.

From approximately KP 115.7, the proposed cable route entered the nearshore area and into Pegwell Bay, along which water depths were generally less than 10m. Along this part of the survey area were alternating bands of the aforementioned 'A5.23 Infralittoral fine sand', 'A5.25 Circalittoral fine sand' and 'A5.231 Infralittoral mobile clean sand with sparse fauna', as well as 'A5.43 Infralittoral mixed sediments' which consisted mostly of gravel with an abundance of the bivalve Mytilidae. At the most coastal point, the sediment was described as 'A5.24 Infralittoral muddy sand'; with an abundance of the polychaete *N. latericeus*, the bivalves *Nucula nitidosa* and *Abra* spp., the crustacean *Gammaridae* spp. and the brittle star *A. squamata*, and the sea spider *Anoplodactylus petiolatus* commonly recorded in this area..

The most diverse infaunal habitat along the proposed cable route was the 'A5.24 Infralittoral muddy sand' biotope in UK waters; with 74 species identified in one grab sample. The *Sabellaria spinulosa* reef habitat was also diverse with 46 species recorded.

7.4.2.4. Features of Conservation Importance

Recommended Marine Conservation Zones (rMCZs) have been selected to ensure the MPA network protects:

- Habitats representing the range of biodiversity in UK seas (Broad-scale habitats);
- Habitats and species that are rare, threatened or declining in UK waters (Features of Conservation Importance; FOCI).

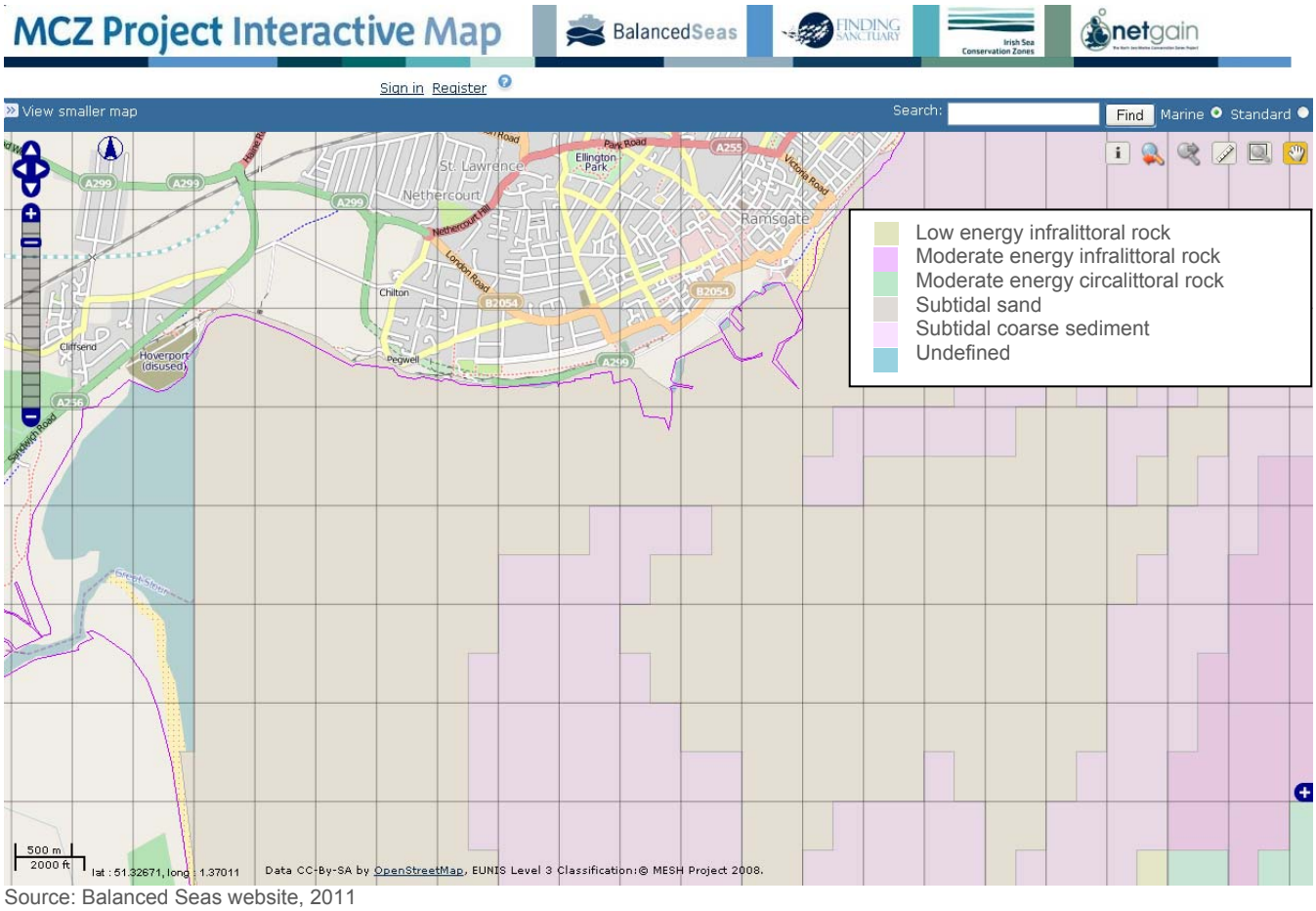
There are four rMCZs in proximity to the Project, one of which lies across the cable route (Goodwin Sands rMCZ). The Project does not fall within any areas currently put forward as recommended Reference Areas (rRAs); the only rRA in close proximity to the Project is the Goodwin Knoll rRA (within the Goodwin Sands rMCZ), which lies approximately 1 km to the south of the Project.

Analysis of the habitats and species identified by Balanced Seas (2011) and the data obtained during the Nemo Link benthic survey, Thanet intertidal survey (Royal Haskoning, 2005) and English Nature (Tittley *et al*., 2002) intertidal survey indicate the presence of at least eight broad-scale habitats within the survey area. The intertidal broad-scale habitats cannot be considered certain, as the classifications have been interpolated from previous data sets. The identified broad-scale habitats are detailed in Table 7-4-3 and data from the Balanced Seas (2011) website is presented in Figure 7-4-A.

Broad-scale habitat types	EUNIS Level 3 habitat code
Intertidal habitats identified during previous surveys	
Moderate energy infralittoral rock	A3.2
Moderate energy circalittoral rock	A4.2
Intertidal sand and muddy sand	**A2.2**
Intertidal mud	**A2.3**
Intertidal mixed sediments	A2.4
Coastal saltmarshes and saline reedbeds	**A2.5**
Subtidal habitats identified during benthic survey	
Subtidal coarse sediment	**A5.1**
Subtidal sand	**A5.2**
Subtidal mud	**A5.3**
Subtidal mixed sediments	**A5.4**
Subtidal biogenic reefs	**A5.6**

Intertidal habitats were identified during previous studies conducted by English Nature (Tittley et al., 2002), calculated for this report from data collected during previous surveys (Tittley et al., 1998; Royal Haskoning, 2005), or extrapolated from the Balanced Seas website (2011).
Subtidal habitats were recorded during the Nemo Link benthic survey (MMT, 2010b).
Habitats in bold are likely to be encountered within the proposed route installation corridor.

Table 7-4-3 : Broad-scale habitats within Pegwell Bay and the Nemo Link benthic survey area



Source: Balanced Seas website, 2011

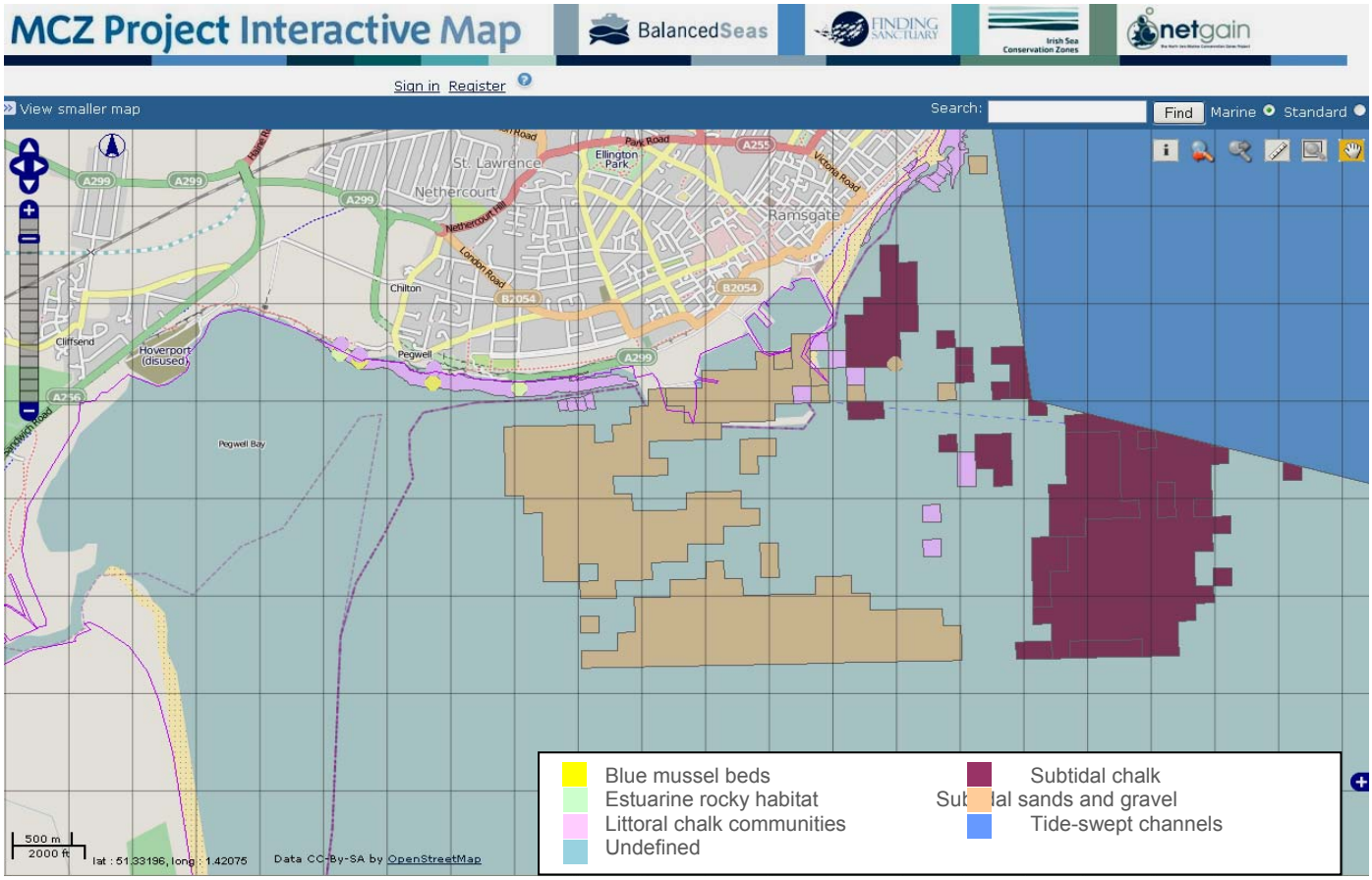
Figure 7-4-A : Broad-scale habitats within Pegwell Bay and the surrounding area

Analysis of the data obtained during the Nemo Link benthic survey and habitats identified by Balanced Seas (2011) indicate the presence of four (possibly five) habitat FOCI within the survey area. These habitat FOCI are presented in Table 7-4-4, with data from the Balanced Seas (2011) website presented in Figure 7-4-B. No species FOCI were identified within the UK section of the proposed development.

Habitats of conservation importance (Habitat FOCI)	Intertidal	Subtidal
Littoral chalk communities	X	
Ross worm (Sabellaria spinulosa) reefs		X
Subtidal chalk		X
Subtidal sands and gravels		X
Tide-swept channels		X

Habitat FOCI in italics were extrapolated from the Balanced Seas website (2011) and expected to predominantly fall outside the proposed cable development.

Table 7-4-4 : Features of conservation interest within the Nemo Link survey area



Source: Balanced Seas website, 2011

Figure 7-4-B : Habitat FOCI within Pegwell Bay and the surrounding area

7.4.2.5. Sabellaria spinulosa

Aggregations of the tube-building ross worm, *Sabellaria spinulosa,* are well documented within the region, occasionally dense enough to form biogenic reef structures (Jones *et al*., 2004; Royal Haskoning, 2005). *S. spinulosa* is a filter feeding polychaete, which constructs and inhabits a hard tube formed from sand grains collected while feeding. The planktonic larvae are strongly stimulated to metamorphose and settle by the presence of the cement secretions from other *S. spinulosa* or dead shells. Individuals may occur solitary or in dense aggregations and have been reported to stand up to 60cm proud of the seabed and persist for several years. Dense aggregations of *S. spinulosa* exert considerable influence on the benthic community structure, stabilising mobile sediments and increasing the structural complexity of the seabed. As a result, these forms support a rich and diverse range of associated infauna and epifauna (Holt *et al.,* 1998).

S. spinulosa requires a good supply of suspended sediment for feeding and tube formation. As such, reef communities only occur in turbid areas where sand is placed in suspension by water movements (Holt *et al.,* 1998). While bedrock may not be required for settlement, a somewhat firm substratum is necessary. It has also been suggested that, once established, a colony may increase in size by addition to itself, removing the need for additional hard substratum. This raises the possibility of relatively large aggregations occurring on predominantly sandy bottoms. Foster-Smith and White (2001) suggested that favorable conditions for *S. spinulosa* were silty sand and cobbles and large shells on areas where sand supply is high, such as edges of sand banks and where there are sand waves.

Examination of the sidescan sonar data and the drop camera still photographs collected during the Nemo Link benthic survey in 2010 identified two areas of possible *S. spinulosa* reef; example

photographs are provided in Figure 7-4-C. Grab samples collected from these sites indicated the presence of several *S. spinulosa* tubes attached to stones at Station B03_040, while a large number (>900 individuals per 0.2m^2) were identified at Station B03_039. The elevation of *S. spinulosa* tubes measured in the Day grab was approximately 7cm. There was also a vast increase in faunal diversity at Station B03_039, with dominant species including the long-clawed porcelain crab *P. longicornis*, brittle stars Ophiuroidea and *A. squamata*, starfish *Leptasterias muelleri* and *Asterias rubens*, mussels *Abra prismatica* and *A. nitida*, snails *Odostomia unidentata*, fish *Gaidropsarus* spp. and cnidarians Actinaria. In addition, two camera cross transects were conducted over the two sites, with photographs taken every 20m, in order to estimate the extent of any *S. spinulosa* reef.

The distinction between what is, or is not, a *Sabellaria* 'reef' is imprecise. To try to make the process of 'reef definition' more transparent and reproducible, Hendrick and Foster-Smith (2006) produced a scoring system based on a series of physical, biological and temporal characteristic reef features. Where possible, the Hendrick and Foster-Smith (2006) scoring system has been applied to the survey data in an attempt to define the 'reefiness' of the areas of *Sabellaria* colonies identified along the proposed pipeline route.

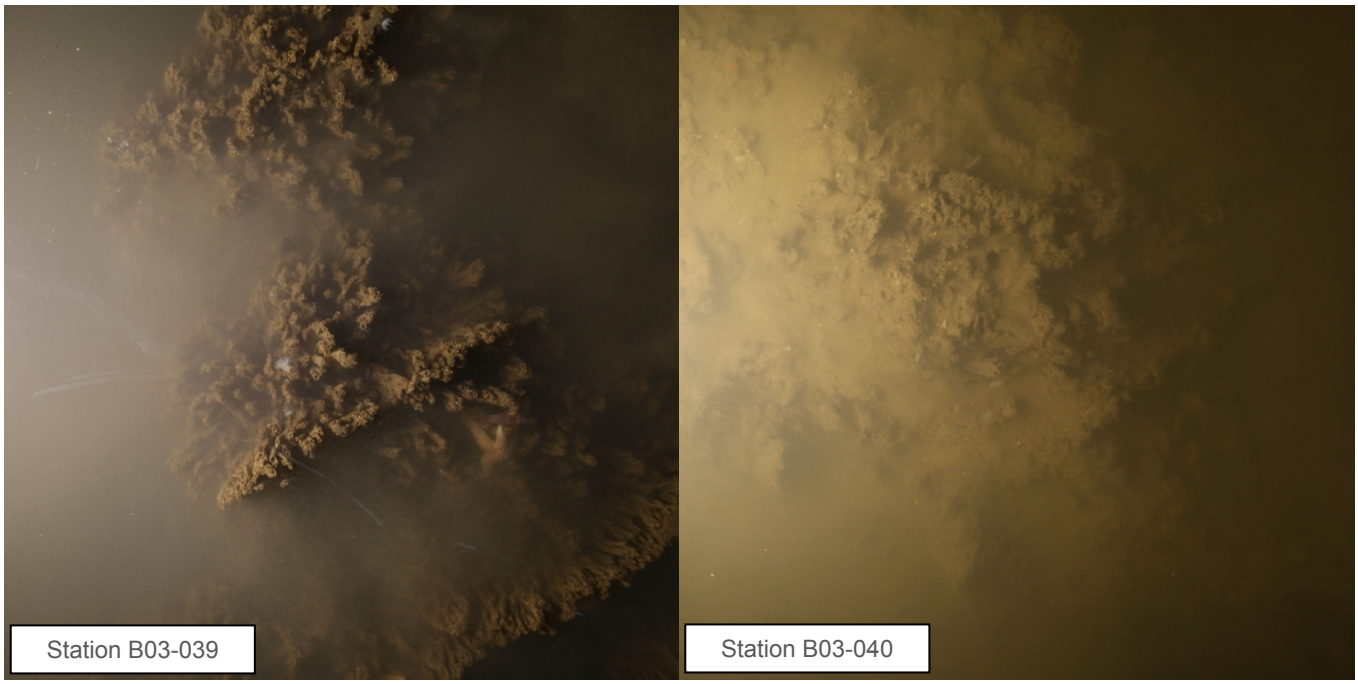


Figure 7-4-C : Sabellaria spinulosa reef

It has been possible to use only some of the scoring criteria, notably:

- Spatial Extent – Area (from the sidescan data) of possible extent of colonies;
- Patchiness – Percentage cover (from stills photographs);
- Elevation – Average height of tubes within colony(ies) (from photographs and grab samples);
- Consolidation – Degree that colony is consolidating the underlying sediment (from photographs and samples).

The 'reefiness' scale has been based largely on results of an inter agency workshop run by JNCC to help define and manage *S. spinulosa* reefs and reported in Gubbay (2007). During the workshop participants were asked, based on their experience, to indicate what they believed would be suitable cut off points for grading an area on a scale of low-medium-high for 'reefiness'. The best, but not unanimous, agreement, which could be reached on the day, is given in Table 7-4-5. It should be

emphasized that the figures presented are considered as a starting point for wider discussion rather than accepted and fully agreed thresholds for *S. spinulosa* reef identification.

Other scoring criteria, e.g. biodiversity and longevity scores, were not applied as they are reliant upon time series of data and detailed benthic community data being available. Whilst mainly subjective, the results have allowed a basic understanding of the *Sabellaria* colony composition of each area to be made, and a measure of its 'reefiness' to be arrived at.

Measure of reefiness	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m²)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Source: Gubbay, 2007.

Table 7-4-5 : Proposed measure of 'Reefiness'

S. spinulosa reef was identified in several of the photographs of the sand and gravel habitat along Transects B03_039_001 and B03_039_002, with associated epifauna including starfish *A. rubens*, crustaceans *P. longicornis*, Paguridae, Galatheidae, Caridea, Portunidae spp., anemones Actinaria and sea urchins *Psammechinus miliaris* identified. *Sabellaria* tube height varied along the camera transects, with reef elevation between 0.05 and 0.15m (5-15cm). This area was classified using the seabed imagery to EUNIS biotope A5.611 '*Sabellaria spinulosa* on stable circalittoral mixed sediment', with the narrow habitat extending NW-SE over an area of approximately 424m by 59m. Figure 7-4-2 displays the area around Station B03-039 covered by *S. spinulosa* with example photographs, bathymetry and shaded relief of bathymetry, sonar mosaics and EUNIS habitat classification.

The sediment across Transects B03_040_001 and B03_040_002 comprised sand with gravel and some cobbles. Structures resembling *Sabellaria* reef were visible in the photographs, but due to the poor visual range in the turbid conditions, the density and elevation of the structures could not be determined as *Sabellaria* reef with absolute certainty. The potential reef across this area appears patchy and scattered, with the extent of potential reef identified as 26.8m by 31m using side scan sonar and confirmed using the camera transect ground truthing. Figure 7-4-3 displays the area around Station B03-040 covered by *S. spinulosa* with example photographs, bathymetry and shaded relief of bathymetry, sonar mosaics and EUNIS habitat classification.

Using the scoring criteria in Table 7-4-5 and data collected during the seabed imagery and sampling, the area of *Sabellaria* at Station B03_039 can be classified with a high degree of confidence as having a medium measure of reefiness, while Station B03_040 has a low measure with regard to reefiness.

There is little knowledge of the sensitivity of *S. spinulosa* to natural events; however, JNCC consider *S. spinulosa* to be particularly susceptible to trawling and dredging activities, particularly with prolonged disturbance, often leaving behind impoverished communities. Holt *et al.,* (1998) also documented that biogenic reef areas have almost certainly suffered widespread and long-lasting damage due to the activities of bottom fishing and that recovery is impossible while fishing activities in these areas persist.

7.4.2.6. Non-native species

Only one non-native species was identified during the subtidal benthic survey. The slipper limpet *Crepidula fornicata* was identified within the sample from Trawl B03-002. *C. fornicata* is a gastropod mollusc introduced to Europe in 1872, and has since spread throughout the south and southeast of the UK. The species is known to compete with other filter-feeding invertebrates for food and space, and in waters containing high suspended fines, it encourages deposition of mud (Eno *et al*., 1997). For these reasons, *C. fornicata* is considered a pest on commercial oyster beds. Eleven individuals were recorded in the aforementioned trawl during the epibenthic survey, but there were no occurrences in the remaining trawls or the grab sampling.

The amphipod crustacean *Corophium* spp., and the molluscs *Ensis* spp. and *Mya* spp. were also identified, thus the presence of the non-native species *Corophium sextonae*, *Ensis americanus* and *Mya arenaria* could not be eliminated.

The common cord-grass *Spartina anglica*, identified around the proposed northern landfall side during the Thanet OWF intertidal survey, is a non-native hybrid species that arose from a crossing between the native small cord-grass *S. maritime* and the introduced smooth cord-grass *S. alterniflora. S. anglica* was planted in the past to aid the stabilisation of intertidal mudflats, but is generally considered to be a negative conservation feature and several attempts have been made to control its spread (JNCC, 2011).

7.4.3. Description of potential impacts

7.4.3.1. Introduction to assessment

The life of an offshore cable development can be divided into three separate phases:

- Pre-installation
- Installation
- Operation
- Decommissioning

Each of these phases will have potentially significant impacts on the existing environment, including benthic invertebrates, intertidal communities and fish, and may lead to the creation of new habitats and a change in species composition and communities. The table below takes into account sensitivity, recoverability and importance in order to determine a receptor value in assessing the significance of an effect.

Receptor Value	Definition
High	Receptor of national or international importance, that is highly sensitive to predicted impact and will not recover.
Medium	Receptor is either highly sensitive to predicted impact or will not recover. Receptor may be a species / habitat of regional or national importance.
Low	Receptor is not sensitive to predicted impact or will likely recover. Receptor is not a species / habitat of national or international importance.

Table 7-4-6 : Definition of receptor value

The table in Appendix 6 provides a detailed description of the impact assessment.

7.4.3.2. Pre-installation

Disturbance of habitats and species due to pre-lay grapnel run
A pre-lay grapnel run (PLGR) is likely to cause disturbance to and possible mortality of benthic fauna within the immediate vicinity of the grapnel hook. During the pre-lay grapnel run, out of service cables will be cut and removed using a grapnel. The level of change to the intertidal and subtidal faunal communities is unlikely to be noticeable and the impact will be only short-term. Benthic fauna is likely

to recover quickly through natural recruitment and migration from adjacent sediments, and hence the impact can be considered of negligible significance, even in the protected sites within Pegwell Bay.

The impact of a pre-lay grapnel run will be of greater significance should the hook be dragged across two areas of potential *Sabellaria spinulosa* reef identified during the benthic survey as close to and across the proposed route between KP108 and KP111. Biogenic reefs are designated a broad-scale habitat and *Sabellaria* reef is a habitat FOCI, thus areas of reef have been considered for protection during MCZ designation. Despite the small spatial extent of impact for a grapnel run, the high conservation importance of this habitat type means that any direct loss that damages the integrity of the reef structures or adversely affects their development would be considered as being moderately significant. *S. spinulosa* recruitment rates are high, so although the species is highly intolerant of substratum loss and moderately intolerant of physical disturbance, recoverability can be considered high (Jackson and Hiscock, 2008), resulting in a medium receptor value and a moderate impact significance. This impact on *Sabellaria* reef can be mitigated, as discussed in Section 7.4.4.

Disturbance of habitats and species due to pre-sweeping of sand waves
Pre-sweeping of sand waves is proposed at three points along the UK sector of the route, in order to reduce the height of the sand waves to aid the path of burial equipment and allow for greater control of the cable burial depth. No pre-sweeping will be required in the intertidal zone, thus no impacts are anticipated on intertidal habitats or communities.

Between KP82.3 and KP87, approximately 24470m^3 of material is proposed for dredging, while between KP123 and KP123.5, an area of 1170m^3 of sediment is proposed for removal. The area of the South Falls Sand Bank between KP99 and KP100.75 constitutes the largest area for pre-sweeping, with a proposed 93138m^3 of material to be dredged. It has been proposed that a trailing suction hopper dredger (TSH) will be used with a total pre-sweeping corridor of 40m in width (20m either side of the cable centreline). These spoil volumes are considered typical of dredging operations for channel or port maintenance. The current proposal is for the dredged spoil to be deposited back on the seabed, in the immediate vicinity of the sandbank system from where it was derived, within 1500m of the point of dredging.

The impacts of pre-sweeping are two-fold: the removal of sediment from the areas to be dredged, and the deposition of the dredged sediment elsewhere. Removal of large amounts of sediment will have an influence on sediment transport as disturbance of the seabed will cause sediments to become re-suspended in the water column and deposited elsewhere. Sand and coarser sediment would only be dispersed over a short distance, while finer particles such as silt and chalk will be carried in suspension further from the disturbed area, as influenced by tidal currents. Further information on plume dispersal can be found in Chapter 2 – Project Background. Sandbanks are characterised by species which are adapted to the variable hydrographic conditions and mobile substrates (Elliot *et al*., 1998), and many species can therefore be considered tolerant of disturbance.

Suspension and deposition of fine particles may have an effect on sessile filter feeders, through the blocking of feeding siphons, and may also affect reproductive processes of some species. The significance of these impacts relates directly to the sensitivity of the habitats and species in the affected area. Benthic communities in mobile sandy sediments are generally well adapted to regular disturbance, with low sensitivity to turbidity, increased suspended sediments and potential smothering, and often have rapid recovery rates. Several species identified during the subtidal benthic survey have been identified as having some intolerance to smothering, including the active suspension feeding polychaete worm *P. triqueter* (Hiscock *et al*., 2005; Riley and Ballerstedt, 2005) and the deposit feeding crustacean *Urothoe* sp. (Hyslop *et al*., 1997); hence the sensitivity and recoverability of the benthic community have been considered moderate. Neither of these species is considered rare or scarce within the UK, nor are they protected under UK or European legislation.

Plume concentrations and footprints of increased suspended sediment concentration above background levels have been calculated for the assessment of pre-sweeping and trenching impacts. This modelling, conducted by HR Wallingford, predicts increases in suspended sediment of more than 10mg l^{-1} within 250m of the cable route, and the plume of fine material arising from disposal of dredged material from the South Falls sandbank to produce concentrations of around 2mg l^{-1} above

background levels, due to the minimal amount of fines present and thus suspended from the sediment (HR Wallingford, 2011). The peak increase in suspended sediment concentration is not expected to exceed 30mg l^{-1} and deposition of fine material is predicted to be negligible, less than 0.1mm (HR Wallingford, 2011). Substantially more coarse sediment is expected to be released due to the nature of the seabed in the vicinity of the areas of pre-sweeping, with concentrations expected to increase to >1000mg l^{-1} within 100m of the disposal site during the time it takes for the coarser particles to settle on the seabed; approximately ten minutes (HR Wallingford, 2011). Due to the limited spatial extent of the predicted impact, the lack of any rare or scarce species and the predominantly coarse sand found in the vicinity, the effects of suspended fine sediment and smothering on benthic communities can be considered of minor significance.

As with physical disturbance from a grapnel hook, *Sabellaria* is considered to have a medium receptor value with regard to disturbance from pre-sweeping. The two areas of existing *Sabellaria* reef identified during the benthic survey are over 8km from the areas of proposed pre-sweeping. The footprint of impact is not expected to extend beyond 500m from the proposed cable route (HR Wallingford, 2011), and thus the impacts of pre-sweeping on both the direct physical disturbance of, and smothering of, *Sabellaria* will be **minor**.

7.4.3.3. Cable Installation

Disturbance of habitats and species due to use of cable lay barges
Up to four anchors are proposed for use by each cable laying barge, and would be deployed up to 100m from the vessel. Anchors will only be used should the vessels be stationary for a lengthy period of time (days), or when cable jointing is taking place, which is expected to take up to five days per cable joint. Deployment of anchors may cause direct displacement of species on the seabed. This displacement and possible mortality of intertidal and subtidal benthic fauna will be localised at the point of anchor penetration and have no measurable effect on communities or habitats against natural variation in the baseline environment. This impact can be considered of minor significance.

The deployment of anchors could cause a significant impact on the two areas of *Sabellaria* reef should they be struck by an anchor. Although affecting only the immediate point of penetration, damage may be caused to part of the localised reef structure, which may take years to recover to baseline conditions. Thus the use of anchors could be considered of moderate impact significance on the existing *Sabellaria* reef within the installation corridor, although it will be possible to plan the works to avoid such damage.

Disturbance of habitats and species due to excavation of cable trench
Equipment used for excavation of the trench and burial of the cable will depend on the type of sediment encountered. Potential equipment to be used includes ploughs, jetting machines and mechanical trenchers, with land based spider ploughs for the intertidal installation, within the inshore zone - 1.5 to 2km from the beach. The last inshore 100 to 200m will require open cut trenching with tracked excavators, as for the landfall installation.

Disturbance of the seabed caused by excavation of the cable trench will lead to direct displacement and mortality of species located within the installation corridor, though only in the immediate vicinity of the burial path. Intertidal species are more tolerant of and well adapted to regular disturbance, and subsequent recovery of these fauna is expected to be very rapid as they are replaced by natural recruitment within a few weeks or months (Ager, 2008; Budd and Rayment, 2001; Jackson, 2000). There is little variation in the faunal community across the muddy sandflats of the intertidal area, with the exception of the *Lanice* dominated community in the mid-shore and the *Hydrobia/Macoma* community closer to the coast. The proposed cable route avoids the more sensitive wave-cut chalk platform to the north of Pegwell Bay and the mature saltmarsh communities to the south of the River Stour. The proposed cable landfall site is in the vicinity of an area of *Spartina* saltmarsh, though the patchy nature of this marsh suggests an emergent community (Royal Haskoning, 2005) and thus is unlikely to be of high conservation significance. Excavation of the cable trench is therefore likely to have only minor impact significance on intertidal communities. It should be noted that informal

discussion with Natural England and Kent Wildlife Trust has indicated that the intertidal habitat is recovering well following installation of the Thanet Offshore Wind Farm cables in 2010.

Benthic species within the subtidal zone would also have rapid recovery rates following disturbance and potential mortality. The impacts of excavation and burial will be one off occurrences; seabed species and habitats can begin recovery immediately after burial of the cable is completed. Although there is the potential for the intertidal and subtidal communities to be affected by the installation beyond the level of change which occurs with natural variation, the faunal community is predominantly of low conservation value and typical of these particular habitats and this region of the southern North Sea, thus the impact significance can be considered minor.

The effects of different burial equipment on direct disturbance of the seabed fauna are generally similar, although localised invertebrate mortality along the proposed cable route may be higher with jetting equipment than with ploughs, due to the greater amount of disturbance to the sediment. Smothering of sensitive species may occur, and buried species may be uncovered and exposed to predation. With burial by plough, impacts arise only from disturbance of the sediment by the plough itself. Displacement ploughs will create a v-shaped trench, while non-displacement ploughs shear though the sediment without creating an open trench, thus creating less disturbance to the seabed. Trenching would have the greatest impact on the seabed, while jetting would increase the re-suspension of sediments rather than increased direct physical disturbance of fauna. It is estimated that using the range of jetting and trenching burial technology suitable for the sediment type, the maximum footprint of the burial machine will be 10m and the footprint of the trench will be up to 5m.

Excavation of the sediment during installation will also have an impact on habitat FOCI that have been identified within the survey area. Sediment along the proposed route in UK waters was predominantly comprised of subtidal sands and gravels, with subtidal chalk also observed from the geophysical data along a large section of the route, covered by a veneer of sand and gravel, with the occasional small outcrop (MMT, 2010a). Considering the extent of these habitats across the survey area, and wider region, the disturbance of sediment within the cable installation corridor would be of minor significance. Data obtained from the Balanced Seas (2011) website indicates the prevalence of tide-swept channels within the survey area. Evidence has suggested that subtidal areas subject to strong tidal action may be host to diverse communities and robust fauna able to withstand such dynamic and changeable environments (Hill *et al*., 2010; Hoare and Peattie, 1979).

The habitat FOCI of greatest concern with regard to disturbance caused by the proposed cable development is *Sabellaria spinulosa* reef. Installation of the cable has the potential to cause direct loss of the two areas of *S. spinulosa* that have been identified as being dense enough in aggregation to be considered as being potential reef structures. Excavation of the cable trench would remove any *Sabellaria* reef in the vicinity of the cable trench, up to 5m width, and within the footprint of the burial machine, up to 10m width. The high conservation importance of this habitat type means that any direct loss that damages the integrity or development of the reef structures would be considered as being significant. *Sabellaria* is generally ephemeral in nature, often being removed or damaged during winter storms. Data from other surveys have shown that rapid colonisation of existing reefs can begin almost immediately following cessation of such activities as aggregate dredging, with rapid growth within the first eighteen months and worms reaching adult body size within a year of settlement (Gubbay, 2007; Pearce *et al*., 2007). Vorberg (2000) recorded average tube growth rates for in situ colonies of *S. alveolata* of 4.4mm per day after damage from trawling. Mature patches of *Sabellaria* in the area surrounding the Hastings Shingle Bank were estimated at three to five years of age (Pearce *et al*., 2007). Therefore it is likely that the re-forming of *Sabellaria* reef and re-colonisation by associated species would occur within five years of completion of the cable installation. Due to the moderate magnitude of effect and the importance of *Sabellaria*, which has a medium receptor value, the impact of trench excavation will have moderate impact significance; though this impact can be mitigated.

Re-suspension of sediment into the water column

Excavation of the cable trench and burial of the cable may also have an influence on sediment transport, though only within the immediate vicinity of the cable trench. Disturbance of the seabed during excavation and cable burial will cause sediments to become re-suspended in the water column and potentially deposited elsewhere. Smothering from deposition of coarser suspended sediment due

to excavation of the sediment is only expected to have an effect on the immediate vicinity of the cable trench. This impact is localised and temporary and less significant for ploughing the cable trench than for jetting, where the sediment is fluidised for ease of cable burial. The indirect impacts of suspension of finer sediments extend beyond the installation corridor.

Plume dispersal was modelled for sandy sediment at a dry density of 1700kg m^{-3}, with the assumption that sandy material disturbed upon ploughing would fall to the seabed almost immediately, with only fines re-suspended and transported in the water column (HR Wallingford, 2011). Sandy sediment containing 2-3% fines (<63µm) was modelled, as this was the sediment recorded along much of the route, including the area surrounding the *Sabellaria*. A release rate of 0.05kg s^{-1} was calculated with such fines assumed to have a settling velocity of 1mm s^{-1} (HR Wallingford, 2011).

Benthic and intertidal communities in mobile sandy sediments are generally well adapted to regular disturbance, with low sensitivity to increased turbidity and suspended sediments. The dominant intertidal species are particularly well adapted to turbidity (Ager, 2008; Budd and Rayment, 2001; Tyler-Walters, 2008). At least two benthic species, *P. triqueter* (Hiscock *et al*., 2005; Riley and Ballerstedt, 2005) and the deposit feeding crustacean *Urothoe* sp. (Hyslop *et al*., 1997), have a higher intolerance to smothering, although these species are of low conservation value. Sediment dispersal modelling predicts that ploughing sand with 3% fines content would produce near seabed increases in suspended sediment concentration of less than 0.5mg l^{-3} above background levels and deposition of less than 0.1mm (HR Wallingford, 2011). The impact of such a small increase in suspended sediments on the benthic communities with a limited duration and spatial extent would be negligible, thus the predicted impacts of turbidity and smothering on the intertidal and subtidal communities can be considered of **negligible** significance.

Sabellaria spinulosa is also a filter feeding organism, requiring a good supply of suspended sediment for feeding and tube formation and, as such, *Sabellaria* reef communities generally occur in turbid areas where sand is readily placed in suspension (Holt *et al*., 1998). It is expected that *Sabellaria's* tolerance of turbidity and poor water quality (Holt *et al*., 1998) would make the species more tolerant of increased sediment loads. It has even been suggested that an increased sediment load could have a positive impact on the development of *S. spinulosa* aggregations, as the worms could utilise the sediment in their tube building (Pearce *et al*., 2007). *Sabellaria* may well be tolerant to smothering in the short term. Suspension of fine material during nearby activities such as dredging is not considered to have a detrimental effect, although long term smothering may affect feeding and growth (OSPAR QSR, 2010). As a protected Annex 1 habitat, the impact of long term smothering on *Sabellaria* would be of greater significance. However, *Sabellaria* is considered to be tolerant of increased suspended sediments and would likely have high recoverability following smothering for several weeks, once the population is able to recommence feeding and tube growth (Jackson and Hiscock, 2008). Suspended sediment concentration is predicted to increase to less than 0.5mg l^{-3} above background levels, with deposition of less than 0.1mm (HR Wallingford, 2011); at these levels and with the small spatial extent and short duration to which the *Sabellaria* reef will be exposed, the impact of sediment re-suspension can be considered **minor**.

Re-suspension of fine materials also has the potential to release sediment-bound contaminants into the water column, which would then be transported and potentially deposited on the seabed elsewhere. The Thanet OWF survey and results of MMT analysis of geotechnical samples reported metal and hydrocarbon concentrations in the intertidal sediments as within interim sediment quality guidelines, thus the effect of re-suspending these sediment-bound contaminants would likely have a **negligible** impact on intertidal communities (Royal Haskoning, 2005).

Disturbance of habitats and species due to chalk cutting

There is potentially the need for rock-cutting at some points along the proposed route between KP100 and KP115 where the underlying silty chalk substrate is close to the surface, covered only by a thin veneer of gravelly sandy sediment, and thus within the 2-3m depth intended for cable burial.

The two areas of *Sabellaria* reef are in proximity to the areas that may require chalk-cutting; therefore there is the potential for suspended silty chalk being transported to and deposited on the reef, along with other suspended fines. Plume dispersal of suspended sediments was modelled for chalk at a dry

density of 2000kg m^{-3} with 100% assumed to be released from ploughing, resulting in a release rate of 2kg s^{-1} and with chalk assumed to have a settling velocity of 0mm s^{-1}, deposition will be negligible (HR Wallingford, 2011). This would suggest only a minor impact of re-suspended chalk fines on the benthic communities within the area of chalk-cutting, while the fines may be transported along the predominant tidal direction. The predominant tidal direction and thus direction of sediment transport is north to south (HR Wallingford, 2011b), so it is likely that the chalk fines would be carried into the English Channel in the water column and dispersed, with minimal deposition. The impact on subbenthic fauna and *Sabellaria* within the survey area would be of **minor** significance.

Disturbance of habitats and species due to installation of external cable protection
External cable protection would be required where the proposed cable is required to cross an existing cable or pipeline. There is one potential cable crossing in UK waters: Global Crossing's Atlantic Crossing 1 telecom cable. The exact nature of external cable protection will be dependant upon crossing agreements with the parties owning the assets to be crossed. The footprint of the cable crossing will be approximately 100m of rock or concrete mattress along the Project cable, with approximately 30m of rock or concrete acting as a bridge over the existing cable.

The installation of this external cable protection will have an effect on the seabed, in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fauna and displacement of benthic habitat. This could effectively cause a long-term change in the faunal baseline at those immediate localities; however, the benthic faunal assemblage along the cable route can be considered typical of fauna in this region of the southern North Sea and is generally of low conservation value. Despite the use of external cable protection creating a potentially moderate impact significance in terms of substrate change, as a whole the spatial extent of effect is minimal and the provision of new hard substrate can create new habitat for colonisation, thus can be considered a positive impact rather than a negative one. The impact of installation the external cable protection will be of minor significance due to the small spatial extent and duration of any works, and the lack of any sensitive habitats or habitats of conservation importance in the area surrounding the cable crossing.

Only two areas of *Sabellaria* reef have been identified along the UK route, and neither of these occurs within 10km of the potential cable crossings and anticipated external cable protection. Thus there is no anticipated impact upon these dense *Sabellaria* aggregations.

Impacts from noise and vibration
Evidence suggests that several intertidal species present within Pegwell Bay, including *Hydrobia ulvae*, *Macoma balthica* and *Lanice concilega* are tolerant to noise (Ager, 2008; Budd and Rayment, 2001; Jackson, 2000). Monitoring studies conducted at the Horns Rev wind farm indicated that noise and vibration have not caused any detrimental effects to marine invertebrates within the survey area (Vella *et al*., 2001). The noise and vibration associated with cable-laying operations would not therefore be produced at a high enough intensity to cause physical damage or disturbance to intertidal benthic species, thus can be considered of negligible impact significance.

Accidental contamination from associated vessels and equipment
During cable-laying operations, any use of associated vessels and equipment would have potential for accidental contamination of the sediment. Such contamination is unlikely given environmental procedures, but could have a minor impact on benthic communities in the local area and have a medium-term effect, depending on the type and spread of contamination. This impact could also potentially occur during the operational and decommissioning phases, should there be any maintenance activities required or if the cable is removed.

7.4.3.4. Cable Operation

Impacts due to changes in current regime
There is no anticipated impact of buried cables on the current regime in the intertidal area of Pegwell Bay or the subtidal region along the UK portion of the proposed cable route. The presence of external cable protection used around cable crossings may potentially cause minor localised alterations in current flow, resulting in localised turbulence during peak flow and increase the potential for scour to

occur around the structures. The impact of this given the small spatial size of external cable protection is expected to be negligible.

Disturbance of habitats and species due to external cable protection (scour and substrate change)
The use of rock or concrete as external cable protection will provide an additional hard substrate in a generally sandy environment, providing a new habitat for colonisation by a range of benthic invertebrates, with associated epifauna and fish communities over time. The extent of scour that would occur is dependant upon the type and size of structure installed and the seabed sediment type in the vicinity of the structure. Scour would have a short-term impact directly after initial installation of any external cable protection, and likely be negligible considering the structures would be readily re-colonised by an array of benthic fauna. Despite the use of external cable protection creating a potentially moderate magnitude of effect, it can be considered a minor positive impact.

Impacts due to maintenance activities
Routine maintenance work to the cables is not anticipated. Some unscheduled work may be required to maintain the burial of the cable to protect it following adverse interactions with other sea users or marine processes such as tidal scour. In the event of such maintenance work, it is likely that benthic species and habitats in the immediate vicinity of the area of works would be disturbed with some possible small scale mortality. Any such work would be localised to the immediate vicinity and be short in duration and therefore have an impact of negligible significance. Accidental contamination from associated vessels and equipment during maintenance works may also occur. Such contamination is unlikely given environmental procedures, but could have an effect on benthic communities in the local area and have a medium-term effect, depending on the type of contaminants.

Impacts due to operational noise and emissions
No noise will be produced during operation of the cables and thus is more relevant as a concern during the installation and decommissioning phases of the project.

As the cables are to be buried, the impact of heat from the operating cables at the seabed would be minimal, with temperatures expected to increase above background levels only in the 10-30cm immediately above the cables (Metoc, 2004a). Generated heat is absorbed and dissipated into the surrounding environment, thus the presence of sea water will aid the dissipation of any heat produced. Calculations from a study conducted for the BritNed interconnector cable development indicate that during summer the temperature may increase between 0.5˚C and 5.5˚C through localised heating directly above the cable, where the cable is buried at a depth of 1m, and from less than 0.5˚C to 1.8˚C where the cable is buried at a depth of 3m (Swedpower, 2003).

Cable Burial Depth	Predicted Temperature Increase							
	10cm (summer)		30cm (summer)		10cm (winter)		30cm (winter)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1m	0.5˚C	1.5˚C	1.5˚C	5˚C	0.5˚C	2˚C	1.5˚C	5.5˚C
3m	<0.5˚C	N/A	0.5˚C	1.8˚C	<0.5˚C	N/A	0.4˚C	1.7˚C

Data from Swedpower (2003) on behalf of BritNed.

Table 7-4-7 : Predicted temperature increase when cables are buried at 1 and 3 metres

Burial of the cables will reduce the level of magnetic and electric fields occurring at the seabed surface. It is expected that the electromagnetic field (EMF) created by the operation of the cables will be small and within the natural range occurring in the North Sea (Metoc, 2004a; 2004b). There is no evidence that benthic invertebrates are adversely affected by low levels of electric and magnetic fields. The impacts of operational noise and heat emissions on benthic fauna are expected to be **negligible**.

7.4.3.5. Decommissioning

There is a lack of clear guidance in legislation regarding the decommissioning of marine installations, such as cables. Subsea cables would be isolated offshore, with two alternatives, removing the cable or leaving it buried in situ.

The current proposal is for the external cable mattressing and any scour protection to be left in-situ, with the cable to either be left buried deep enough in-situ, or removed. If the cable is to be removed, then either a grapnel hook will be used to lift the cable from the seabed, or a jetting device will be used to expose a section of cable to allow removal. As such, an assessment of the impacts of decommissioning will be carried out prior to any decision being made on whether to recover the cables, and a survey of the seabed will need to be conducted to assess the species and habitats within the vicinity.

Cable recovery would have a variety of impacts, similar to installation, with disturbance to the immediate vicinity as the cables are removed, and sediment re-suspended into the water column, causing smothering and other potentially detrimental effects on suspension feeders. Consideration must also be given to the disposal of materials being removed from the seabed and the consequent effect on the habitat and colonising species.

Leaving the cable buried in-situ will be unlikely to have new impacts, especially as faunal communities will likely have “recovered” to their previous state or adapted to the presence of the cable and any external protection. Additional factors to consider in the presence of any external cable protection will be the degree of epifaunal colonisation that has taken place, including the presence of potentially sensitive Sabellaria and associated fish communities supported by the increased and varied diversity (Vella et al., 2001). Studies at the Horns Rev offshore wind farm in Denmark recorded considerable colonisation of the wind turbine foundation by numerous species, within only five months of construction being completed (Leonhard, 2000). Hisock et al. (2005) suggested that if wind farm foundations have supported productive artificial reef communities, it may be a more environmentally beneficial and cost-effective alternative to leave the foundations in place after decommissioning. The same should be considered of any external cable protection in place, such as rock or concrete mattressing.

7.4.4. Mitigation

The predicted impacts of the interconnector cable development are minimal, with the most significant impacts concerning the sensitive *Sabellaria spuinulosa* reef habitat identified at two points along the UK cable route. Several mitigation measures have been identified in order to minimise impacts from the various phases of the cable development.

The original proposed route passed directly through one area identified as *Sabellaria spinulosa* reef from the geophysical data and the seabed imagery, and within 65m of a second, smaller, area of potential reef. To avoid these areas of *Sabellaria* reef, the proposed installation has been re-routed between KP107.5 and KP112 and to pass approximately 165m south of the original route at the point of the larger area of delineated reef. At its closest point, this revised route will pass approximately 90m from the larger reef and approximately 150m from the smaller area of potential reef. Both routes are displayed in Figure 7-4-1, and are shown in relation to the *S. spinulosa* reefs at Stations B03-039 and B03-040 in Figures 7-4-2 and 7-4-3 respectively. Delineation of the reef at Station B03-039 is shown in Figure 7-4-D in relation to the original and revised proposed routes. This re-routing to avoid *S. spinulosa* reef will provide adequate mitigation to eliminate any threat of direct disturbance or damage to this habitat from the pre-lay grapnel run, pre-sweeping of sand waves, the use of cable lay barges, excavation of the cable trench and burial of the cable. Avoidance of the areas of *Sabellaria* has been discussed with Natural England and it has been agreed that the revised cable route alignment will ensure that there are no impacts on the areas identified.

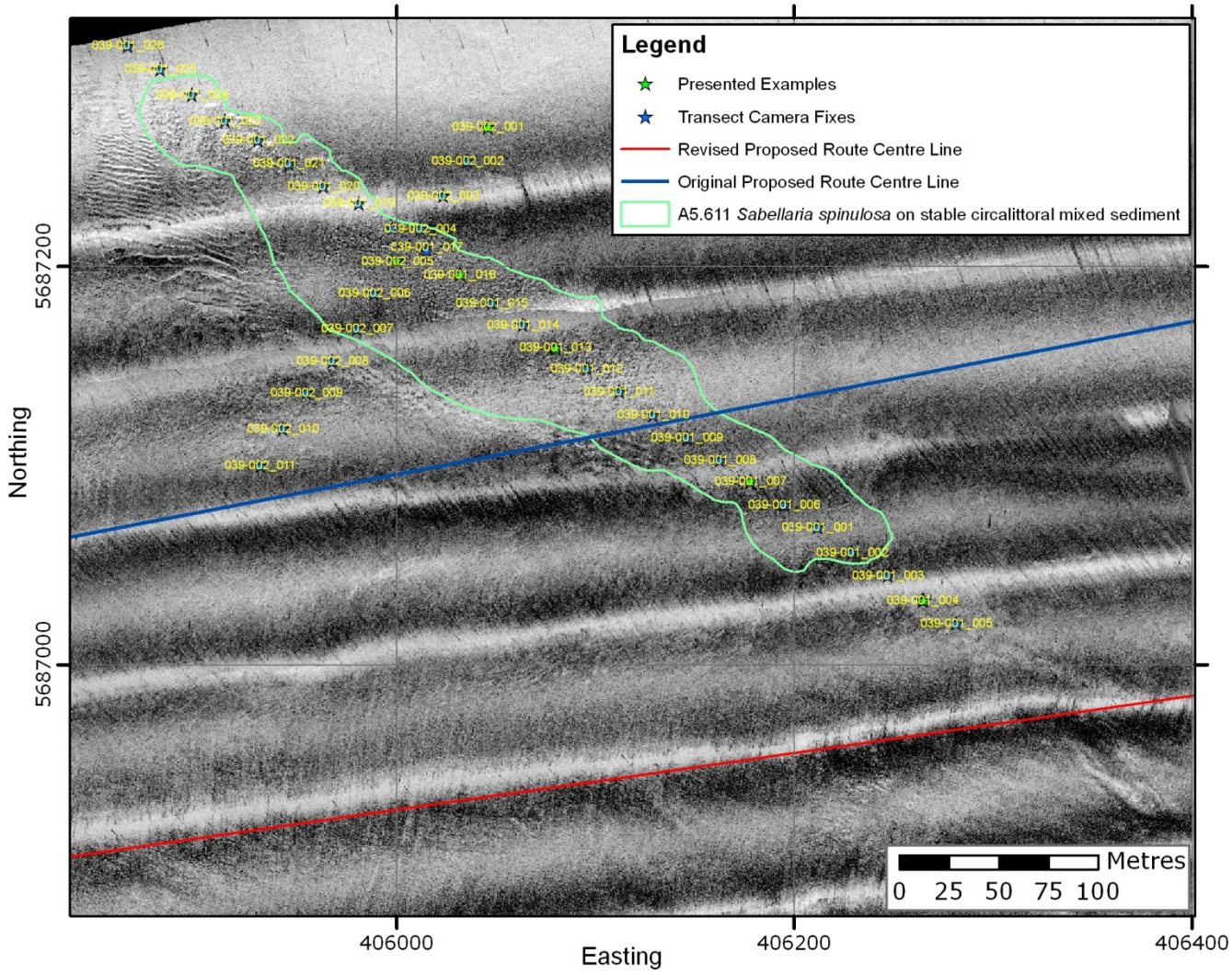


Figure 7-4-D : Delineation of Sabellaria reef – Station B03-039

Ploughing or jetting are the recommended methods to excavate the cable trench as they reduce the re-suspension of sediments and thus minimise impact on benthic communities. Jet trenchers result in more turbidity than non-displacement ploughs due to the use of water to fluidise the sediment. Bundling the cables together in one trench, rather than two separate trenches will also reduce the impact footprint of trench excavation and cable burial. Simultaneous lay and burial would also be recommended to minimise repeated impacts on the benthic community. The size and amount of external cable protection should also be minimised in order to mitigate the impact of the structures on current flow, and thus reduce scour. A smaller amount of external cable protection would also result in less disturbance to and loss of the seabed.

The current project plan includes the proposal to deposit the spoil removed from the seabed during pre-sweeping at least 1km from the area in which it was dredged. It will be ensured that this spoil is not deposited in the vicinity of the *Sabellaria* reefs to eliminate any further impact of sediment re-suspension and potential smothering.

It is currently recommended to leave the cable in-situ after decommissioning to avoid further impacts on the seabed, though this will likely require further impact assessment as conditions may change throughout the lifecycle of the development.

Strict environmental health and safety guidelines and spill procedures will be followed to minimise the risk of accidental contamination throughout the life of the project.

7.4.5. Residual impact

No rare or scarce species have been identified in the vicinity of the cable route. Impacts of cable installation are therefore expected to be **minor**, with the exception of potential impacts on the two areas of *Sabellaria* reef, which will have been mitigated for accordingly.

Following re-routing to avoid the areas of *Sabellaria spinulosa* reef, there are no anticipated significant impacts from the installation, operation and decommissioning phases of the cable development. Residual impacts are all considered to be of minor significance; however the presence of *Sabellaria* along the route means that the potential impacts of the pre-lay grapnel run, the use of cable lay barge anchors, excavation of the trench and cable burial may still have a **moderate** impact on this high value receptor.

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7.5. Fish and Shellfish Ecology

7.5.1. Baseline data sources

This chapter details the natural fish and shellfish resource within the study area. Baseline conditions have been determined in order to conduct an assessment of the impacts associated with the installation, operation and decommissioning of the proposed Nemo Link high voltage direct current (HVDC) interconnector cable. Impacts upon commercial fishing are assessed in Chapter 8.1 – Commercial Fisheries.

Substantial existing information has been used to support the description of the environment, with much of the published literature of the south-east seas relating to the area's numerous potential conservation designations. While no specifically commissioned fish surveys were conducted as part of the Environmental Impact Assessment (EIA) some datasets were provided by four trawls carried out for the subtidal epibenthic survey (MMT, 2010; Appendix 11 – Environmental Survey Report (ESR)). General descriptions of commercially and non-commercially important fish species in the area have been obtained from numerous sources, including English Nature's Marine Natural Area Profile (Jones et al., 2004a and 2004b), and Environmental Statements from other offshore wind farm developments in the Outer Thames Estuary. This includes data collected during adult and juvenile fish surveys for the nearby Thanet Offshore Wind Farm project (Royal Haskoning, 2005).

Other information sources have included surveys conducted by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and the UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).

7.5.1.1. Subtidal benthic survey

The subtidal benthic survey was conducted between the 22nd September and 2ndOctober 2010. The benthic survey design and sampling strategy was conducted in accordance with existing survey guidance (ALSF, 2010; CEFAS, 2002; Davies *et al.,* 2001; JNCC, 2010) and consultation with Natural England (NE), the JNCC and the Environment Agency (EA). Within Block 3, UK waters, twenty stations were investigated with a drop down digital stills camera and video system, at two of these stations cross camera transects were carried out as potentially sensitive biogenic reef habitat was identified. Sediment sampling was conducted using a 0.1m^2 Day Grab. At each station three samples were collected and, , where possible, these were sieved over a 1mm mesh to collect faunal samples for analysis. The positions of the twenty environmental survey stations are presented in Figure 7-4-1. Details of the survey methodology are provided in the ESR (MMT, 2010; Appendix 11). Description of the baseline marine benthic environment and A discussion of potential impacts of the interconnector cable upon this is made in Chapter 7.4 – Benthic and Intertidal Ecology.

7.5.1.2. Epibenthic trawl survey

The epibenthic 2m trawl survey was conducted on the 30th September 2010. The epibenthic survey was designed and implemented in accordance with existing survey guidance (CEFAS, 2002; Davies *et al.,* 2001) and consultation with Cefas.. Epibenthic trawling was carried out at four locations in Block 3 using a 2m beam trawl to sample megafauna (>1cm). Three trawls were conducted over a distance of 600m, with the fourth over a distance of 1200m. Samples were washed over a 5mm mesh sieve prior to sorting and field identification. Details of the survey methodology and the positions of each trawl are provided in the ESR (MMT, 2010; Appendix 11). The positions of the trawl locations are presented in Figure 7-4-1.

7.5.2. Baseline Environment

7.5.2.1. Marine Fish

The southern North Sea is characterised by a sandy, flat, shallow seabed with substantial tidal mixing, it contains greater fish species diversity than either the central or northern North Sea (Callaway *et al*., 2002), this diversity is most pronounced towards the west (Rogers *et al*., 1998). The southern North Sea is characterised by a high abundance of small non-commercial demersal (bottom-dwelling) species(Callaway *et al*., 2002) and also contains a number of important nursery and spawning grounds.

The area of the southern North Sea stretching between the English and Dutch coasts contains a distinctly different community comprising of pelagic species, in particular horse mackerel (*Trachurus trachurus*) and mackerel (*Scomber scombrus*) (Callaway *et al*., 2002).

Fish identified during the Nemo Link epibenthic grab and trawl surveys are listed in Table 7-5-1. Trawl abundance reflects the total number of individuals recorded during the survey, while the grab abundance reflects the number of individuals captured per square metre of the survey area.

Latin Name	Common Name	Grab Abundance (number per m^2)	Trawl Abundance (number of individuals)
Actinopterygii		-	1
Arnoglossus laterna	Mediterranean scaldfish	-	4
Callionymus lyra	Common dragonet	-	8
Gaidropsarus spp.	Rockling	10	-
Hyperoplus lanceolatus	Greater sand eel	-	3
Pleuronectes platessa	European plaice	-	17
Pomatoschistus spp.	Gobies	-	195
Solea solea	Common sole	-	7
Trachinus draco	Greater weever	-	22
Trachurus trachurus	Atlantic horse mackerel	-	1
Trisopterus minutus	Poor cod	-	2

Table 7-5-1 : Fish species recorded within the survey area

Demersal species

Demersal fish dwell at or near to the bottom of the water column and their lifecycle is closely associated with the seabed which is commonly used to forage, shelter and breed.. The flat sandy sediments found in the southern North Sea are well suited to demersal fish who are prevalent and use the region as both spawning and nursery grounds.

Atlantic cod (Gadus morhua) occurs ubiquitously around the UK coast and favour sandy sediments. The juveniles tend to inhabit the inshore waters while adults are generally found further offshore in deeper, cooler waters. Cod commonly school during the day at depths of 30-50m below the surface.

Cod occur throughout the North Sea, including the region of the proposed Nemo Link cable route, spawning is concentrated within several the central North Sea (Dogger Bank), the southern North Sea and the German Bight (CEFAS, 2001). Spawning generally occurs between January and April (Coull et al., 1998) at temperatures ranging between 0-12˚C, both eggs and larvae are pelagic and are dispersed over a wide area (Cohen et al., 1990). . North Sea cod stocks have been heavily impacted by the combined effects of overfishing and temperatures changes throughout the water column thus impacting on all life stages (Rindorf and Lewy, 2006). Only 2 cod were caught during the Thanet OWF spring fish survey (Royal Haskoning, 2005).

European plaice (Pleuronectes platessa) occurs throughout UK waters generally in association with sandy sediments, but is also found in areas of mud and gravel, plaice tend to inhabit depths of <50m. Plaice spawn in the south-eastern waters of the UK and shallower parts of the southern North Sea from December to March (Coull et al., 1998). Plaice eggs have a temperature tolerance 0 -14˚C (Rijnsdorp and van der Veer, 2008) but spawning occurs at around 6˚C (CEFAS, 2001). Plaice eggs and larvae drift in the water column for 2-3 months (Rijnsdorp and van der Veer, 2008), enabling them to settle in the shallow, sandy bays of the east and south-east coasts of Britain. From these inshore nursery grounds the juveniles disperse offshore as they mature (Coull et al., 1998; DECC, 2009). Plaice is one of the most commercially important European fish species. A total of 17were caught during the 4 Nemo Link epibenthic trawls (MMT, 2010). During the Thanet OWF spring and summer fish surveys, 174 plaice were caught, 57 in spring and 117 in summer (Royal Haskoning, 2005).

Whiting (*Merlangius merlangus)* are found in deeper waters on sandy and gravelly sediments, where they feed predominantly on crustaceans, sand eels and other small fish. Whiting spawn offshore between February and June (Coull *et al*., 1998), with eggs remaining in the water column (Cohen *et al*., 1990) and juveniles living closer inshore in sheltered bays and estuaries (Coull *et al*., 1998), migrating to the open sea at around a year old (Cohen *et al*., 1990). Although temperature is believed to have an effect on the geographical distribution of whiting, the effects of temperature on spawning are likely to be minor as the species is so widespread in the North Sea (Loots *et al*., 2010). During the Thanet OWF spring and summer fish surveys 58 whiting were caught, 28 in spring and 30 in summer (Royal Haskoning, 2005).

Poor cod **(***Trisopterus minutus)* is common in UK waters, though less so in the southern North Sea (Kay and Dipper, 2009), it is an important food source for valuable commercial species such as cod. Poor cod spawn in the spring when the water has warmed to at least 8˚C (Kay and Dipper, 2009), with eggs scattered and left unguarded on the seabed (Cohen *et al*., 1990). The Nemo Link epibenthic trawl captured 2poor cod (MMT, 2010). The Thanet spring and summer fish surveys captured 7 and 7 individuals respectively. (Royal Haskoning, 2005).

Common sole (*Solea solea)*, sometimes referred to as Dover sole, is a coastal species, usually found on sandy and muddy seabeds and estuaries in depths of <70m. Sole spawn in shallow inshore areas and sandbanks of <30m deep between March and May (Coull *et al*, 1998; DECC, 2009) at temperatures of 6-12˚C (Quéro *et al*, 1986). A literature review conducted by Wehner *et al.* (2003) suggests water temperatures influence spawning times with earlier peaks in spawning in warmer years and vice versa. The optimal temperature range for egg survival is 8-16˚C. Larvae are pelagic for approximately 1 month, before metamorphosing into the demersal phase consequently shallow coastal nursery grounds are situated close to spawning areas (Coull *et al*., 1998). The common sole is an important heavily exploited commercial species. During the Thanet OWF fish surveys, 6 sole were landed in spring and 47 in summer (Royal Haskoning, 2005).

Lemon sole **(***Microstomus kitt)* inhabits coarser sediments than the common sole and deeper waters <200m. Spawning occurs in deep waters between April and September (Coull *et al*., 1999; Kay and Dipper, 2009), little else is known of lemon sole spawning characteristics; however they are believed to spawn over a wide area (CEFAS, 2001). The Thanet OWF spring fish survey captured 3lemon sole and the summer survey 26 individuals (Royal Haskoning, 2005).

The lesser sand eel *(Ammodytes tobianus)* is the commonest species of sand eel in the North Sea, it provided an important food source for fish e.g. herring and mackerel and seabirds such as puffins. The greater sand eel ***(****Hyperoplus lanceolatus)* was also recorded in the survey area, and is known to commonly associate with shoals of *Ammodytes* spp. Sand eel spawning generally occurs between November and February (Coull *et al*., 1998), with demersal eggs laid in sticky clumps on sandy sediments (CEFAS, 2001). Upon hatching, larvae become planktonic resulting in a wide distribution, then return to being demersal between 2-5 months (CEFAS, 2001). There is little movement between spawning and feeding grounds (Coull *et al*., 1998; DECC, 2009). Sand eels are also harvested as an important part of industrial fisheries.

Gobies **(***Pomatoschistus* spp.) inhabit clean inshore sands throughout the UK's coastal waters. Gobies feed on a range of planktonic organisms and crustaceans, and themselves form an abundant food source for many demersal fish, including commercial species such as cod and flatfish. Various species of goby were recorded in the epibenthic trawls in quite high numbers.

Mediterranean scaldfish *(Arnoglossus laterna)* can be found all around the British Isles and is especially common in the southern North Sea, where it provides an important food for larger commercial fish. The scaldfish spawns in the spring and summer in the North Sea.

Common dragonet *(Callionymus lyra)* is the most abundant of three species of dragonet found around the British Isles. Dragonets inhabit shallow water with sand and muddy sands, they feed primarily on polychaete worms, crustaceans and molluscs. The common dragonet spawns between late winter and early spring, in depths of less than 50m (DECC, 2009).

Greater weever fish **(***Trachinus draco)* and lesser weaver fish (*Echiichthys vipera)* can both be found on sandy seabeds all around the British coasts, where they spawn during the summer months.

Other demersal species recorded during the Thanet OWF surveys included tub gurnard (Trigla lucerna), grey gurnard (Eutrigla gurnardus), dab (Limanda limanda), bib (Trisopterus luscus) and flounder (Platichthys flesus) (Royal Haskoning, 2005).

Pelagic species

There are several pelagic species that make extensive migrations through the southern North Sea.

Atlantic herring (Clupea harengus) are widespread in the North Sea, spending much of the year in feeding grounds in the northern North Sea, migrating south to spawn in shallow coastal regions, using coastal waters, estuaries and inlets as nursery grounds. Herring require coarse sands and gravels in depths of 15 to 40m, upon which to lay sticky adhesive eggs. This species is particularly sensitive to disturbance; egg mortality occurs as a result of predation, suffocation due to silting and, in intertidal areas, from exposure to air and wave action (Haegele and Schweigert, 1985). Herring spawning off the south-east coast occurs between November and January (Coull et al., 1998). Young herring can be found in inshore waters, in dense mixed shoals with sprat (DECC, 2009). The Thanet OWF spring fish survey captured 5 herring (Royal Haskoning, 2005).

Sprat (*Sprattus sprattus)* prefer shallower coastal waters and estuaries and are widespread along the coasts of the southern North Sea. Sprat spawn through summer months in waters of 10-20m depths (Coull *et al*., 1998; DECC, 2009). The eggs and larvae are pelagic and dispersed across wide areas (Kay and Dipper, 2009).

Mackerel (*Scomber scombrus)* are widely distributed around the UK and can be found in huge shoals, feeding on crustaceans, zooplankton and small fish. The North Sea mackerel stock spawns between May and August, with highest egg concentration in the central North Sea (Coull *et al*., 1998). Mackerel are batch spawners meaning they cover a wide area (Kay and Dipper, 2009). A review of existing information on mackerel suggests that the primary limitation for the timing of spawning is temperature, with an optimal range of 10 -15˚C (Johnson, 1977).

Horse mackerel (*Trachurus trachurus)* spend much of the year in the central North Sea, forming large shoals and migrating to the southern North Sea in the summer to feed on plankton and spawn in open water. Eggs and larvae are released into the water column and dispersed over a wide area (Kay and Dipper, 2009). In winter, horse mackerel move into deeper offshore waters to feed on bottom living invertebrates (Kay and Dipper, 2009). The optimal spawning temperature for horse mackerel is ~13˚C, with a range of between 10-22˚C (Eaton, 1983).

7.5.2.2. Spawning and nursery grounds

The area along the proposed cable route is characterised by offshore sandbanks, with sediment formations such as sand waves and ripples interrupting the predominantly smooth bathymetry along much of the route. Sandbanks provide important habitats for benthic invertebrates and thus provide an important food resource for a range of fish and seabirds, as well as being spawning and nursery grounds for many commercially important fish species.

The majority of fish species spawn in the water column (pelagic spawning), and remain there as larvae after hatching, feeding on microscopic organisms until they develop into adults. Some species rely more heavily on the seabed (demersal spawning) and a more specific set of conditions for spawning to occur. Herring is particularly sensitive with regard to spawning conditions, requiring well-sorted coarse sands and gravels in depths of 15 to 40m, elevated from the surrounding seabed and with exposure to the main flow of water to provide oxygenation of the sediments. Much of the sediment along the proposed route comprises such coarse sands and gravels, and with numerous sand ripples and sand waves, these areas are likely to host herring spawning grounds.
Juveniles require food sources and protection from predators both of which are provided by the seabed, whereas inhabiting the water column can be more risky . Nursery areas can host vast numbers of juvenile fish, sometimes together with older individuals, and even adult fish. Depending on the species, nursery areas can be found in shallow and productive coastal waters where there is an abundance of polychaetes and crustaceans (in the case of juvenile flatfish), and others in coastal reef environments (such as juvenile cod) or deeper offshore areas. Nursery areas are difficult to delineate as they can be affected by changing hydrographic and biological conditions, such as temperature, currents and food availability.

It is typical for juvenile fish of many species to remain in these nursery grounds which are sheltered from predators and provide an abundance of food. Within nursery and spawning grounds, fish aggregate in large numbers and so are particularly vulnerable to disturbance. The proposed offshore cable route is situated in an area used by several key commercial species as spawning and nursery grounds. Cod, herring, lemon sole, common sole, plaice, sand eel, sprat, horse mackerel and whiting use at least part of the area for spawning, while lemon sole, common sole, sand eel, cod, plaice, mackerel, herring, tope and whiting have been recorded using the area as a nursery ground.

An overview of the approximate spawning periods for each species is presented in Table 7.5.2. Overviews of potential spawning and nursery grounds for selected fish within the survey area are presented in Figure 7.5.1 and Figure 7.5.2, highlighting areas of high and low intensity. Areas of higher concentrations of juveniles (H) are considered to relate to more important nursery grounds (Coull et al., 1998; Ellis et al., 2010).

Species (stock)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herring (SE England)												
Common sole				*								
Lemon sole												
Plaice	*	*										
Sprat					*	*						
Sand eel												
Whiting												
Cod		*	*									
Mackerel (N Sea)						*	*					
Horse mackerel (N Sea)					*	*	*					

Table adapted from Coull *et al*., 1998 and CEFAS GIS mapping data (Ellis *et al*., 2010)
* Peak spawning

Table 7-5-2: Approximate spawning periods within the survey area

7.5.2.3. Diadromous fish

Diadromous species are those that migrate between fresh and salt water during different stages of their life cycle, many of which are of high conservation importance.

Anadromous species are those diadramous fish that live in salt water and migrate to fresh water specifically to breed. Atlantic salmon (*Salmo salar)* are known to spawn in rivers and estuaries of the south-east region of England (DECC, 2009) and are likely migrate over the proposed cable route to spawning grounds in the River Stour, Kent.

Sea trout (*Salmo trutta)* are found in streams, ponds, rivers and lakes and there is a recorded trout run into the River Stour (DECC, 2009) with individuals generally arriving in early June (Royal Haskoning, 2005).

Smelt (*Osmerus eperlanus)* are rarely found far from the shore, entering rivers for spawning between February and April (Barnes, 2008). Smelt have been recorded within the Thames Estuary (Royal Haskoning, 2005), thus it is likely that they also use the River Stour for spawning. Smelt can form an important food source for many birds.

The European eel (*Anguilla anguilla)* is a catadromous species, metamorphosing twice, with part of its life cycle spent in freshwater and part in estuarine or fully saline seawater (Whitehead *et al*., 1986). Eels are a severely declining species, the IUCN red list classifies eels as critically endangered. Eels inhabit a range of fresh water and marine habitats, including: rivers, estuaries, low salinity pools, tidal pools, coastal and oceanic waters. They migrate an approximate 5000km to the Sargasso Sea in the West Atlantic to 0 spawn during late winter and spring.

Adult eels have been recorded in the River Stour and will therefore pass over the proposed cable route as they migrate. Adults and juvenile eels (elvers) will also likely traverse the route on their return journey to the estuaries in April and May. The species has undergone a sharp decline in recruitment and population size, and is listed as critically endangered on the IUCN Red List of Threatened Species (Freyhof and Kottelat, 2008).

7.5.2.4. Elasmobranchs

Current knowledge of elasmobranch distribution around the UK is recognised as being very limited. Elasmobranchs are a subclass of cartilaginous fish, which includes the sharks, skates and rays. Shark species generally found within the coastal regions of the southern North Sea include nursehound,or greater-spotted dogfish, (*Scyliorhinus stellaris)*, the small-spotted catshark, or lesser-spotted dogfish, *(Scyliorhinus canicula)*, smoothhound (*Mustelus mustelus)*, spurdog (*Squalus acanthias)* and tope (*Galeorhinus galeus)*.

Ray and skate species include the thornback ray (*Raja clavata)*, small-eyed ray (*Raja microocellata)* and endangered undulate ray (*Raja undulata)*, with the endangered common skate (*Diptura batis)* present but rare (DECC, 2009). Large open water fish species such as porbeagle shark, blue shark, thresher shark and basking shark are occasionally sighted in coastal waters of the south east coast of England and English Channel (DECC, 2009), but there are no confirmed records within the proposed area of development. Available data on elasmobranchs is primarily based on catch and by-catch data (Gill *et al*., 2001).

No elasmobranch species were recorded during the Nemo Link epibenthic survey (MMT, 2010). However *Raja* spp. (including a total of 58 thornback ray), 307 small-spotted catshark and 69 starry smoothhound were all recorded during the Thanet OWF fisheries surveys (Royal Haskoning, 2005). The small-spotted catshark is widely distributed in the shallow sublittoral zone around the UK coasts. This species has been recorded within the area of planned work around the Kent coastline by numerous surveys conducted by CEFAS (Marine Biological Association, 2008) and Seasearch Marine Surveys (Marine Conservation Society, 2010) between 1998 and 2010.

Dogfish display a wide but patchy distribution in the North Sea, feeding on crustaceans, cephalopods and fish (Ellis *et al*., 1996) and are generally found living on the seabed. Breeding occurs between November and July, peaking in the summer months, and as with all elasmobranchs, is heavily associated with the sediment, as eggs are laid on the benthos.

The dependency of elasmobranchs on the seabed as a source of food, refuge and breeding ground makes them potentially vulnerable to consequences of alteration of the seabed e.g. cable laying, dredging and increased sediment mobility etc.

7.5.2.5. Cephalopods

A number of cephalopod (squid, cuttlefish and octopus species) occur in UK waters. The most frequently observed species include the long-finned squid (*Loligo forbesi*), bobtail squids and the octopus (*Eledone cirrhosa)* (DECC, 2009).

No cephalopods were recorded during the Nemo Link epibenthic trawls (MMT, 2010); however long-finned squid and common cuttlefish (*Sepia officinalis)* were both identified during the Thanet OWF fish surveys (Royal Haskoning, 2005).

The long-finned squid is the most commercially important squid species in the UK, and is generally recorded in shallow coastal waters and along the continental shelf (DECC, 2009).

The common cuttlefish is the largest cuttlefish species found in UK waters, and is widespread along British coasts, feeding on molluscs, crustaceans and small fish.

The little cuttlefish (*Sepia atlantica)* is also widespread along the British coasts, especially in England and Scotland. This small species can be found burrowing into sandy sediments, in the shallow subtidal zone often in rockpools, and further offshore. Seven individuals were recorded in the epibenthic trawls (MMT, 2010).

7.5.2.6. Shellfish

The Kent coast is important for various shellfish species, including cockles, scallops, oysters, mussels, whelks, lobster and crab. Pegwell Bay is designated as a Shellfish Water under the Shellfish Waters Directive; aimed at protecting the aquatic habitat of bivalve and gastropod molluscs, including oysters, mussels, cockles, scallops and clams. The Shellfish Waters Directive does not cover shellfish crustaceans such as crabs, crayfish and lobsters.

There are extensive shellfish fisheries within the vicinity of Pegwell Bay, most notably for cockles, scallops, oysters, whelks and lobster. It is understood from Kent and Essex Sea Fisheries Committee (now Kent and Essex IFCA), that fishing for whelks and lobster takes place along the cable route where it enters Pegwell Bay (pers. comm.). Wave-cut chalk platforms were identified along the northern coast of Pegwell Bay during the Thanet OWF survey (Royal Haskoning, 2005). Along these rocky reefs was recorded an abundance of common mussel (*Mytilus edulis)*, in an assemblage considered unique enough to be of local conservation importance (Royal Haskoning, 2005). The outer extent of these chalk platforms and mussel beds is over 250m from the proposed cable route.

Shellfish identified during the Nemo Link epibenthic trawl survey are listed in Table 7.5.3. Trawl abundance reflects the total number of individuals recorded within the survey. Grab abundance reflects the number of individuals per square metre. Species include crabs, lobster, shrimp and molluscs and are not limited to only commercially important species. A full species list is presented in the benthic survey report (MMT, 2010).

Latin Name	Common Name	Grab Abundance (number per m^2)	Trawl Abundance (number of individuals)
MOLLUSCA			
Aequipecten opercularis	Queen scallop	-	8
Buccinum undatum	Common whelk	20	1
Cryptonatica affinis	Arctic moonsnail	-	1
Spisula elliptica	Bivalve mollusc	110	1
CRUSTACEA			
Liocarcinus holstatus	Flying crab	-	9
Liocarcinus marmoreus	Marbled swimming crab	10	40
Liocarcinus spp.		10	-
Pagurus bernhardus	Hermit crab	10	84
Pagurus spp.		10	-
Macropodia tenuirostris	Slender spider crab	-	6
Pisidia longicornis	Long clawed porcelain crab	1650	6
Galathea intermedia	Squat lobster	20	2
Galathea spp.	Squat lobsters	10	4
Crangon crangon	Brown shrimp	-	84
Crangon spp.	Shrimp	-	81
Caridea	Shrimp	-	6
Crangon allmanni	Shrimp	-	2
Pandalina spp.	Shrimp	-	44
Gastrosaccus spinifer	Opossum shrimp	10	4

Table 7.5.3 Shellfish species recorded within the survey area

Common mussel reef and edible oysters (*Crassostrea* sp.) were identified along the wave-cut chalk platforms during the Thanet OWF intertidal survey (Royal Haskoning, 2005), this is to the north of the proposed cable route and therefore outside the expected area of impact.

Native oyster (*Ostrea edulis)* were not found within the survey area, and are believed to be mainly found in the Thames Estuary (Royal Haskoning, 2005).

Common cockle (*Cerastoderma edula)* are found in the muddy sandflats of Pegwell Bay but were not recorded in the Nemo Link benthic or epibenthic surveys, during which there was no intertidal sampling conducted. *Cerastoderma* were recorded within the intertidal muddy sand flats of Pegwell Bay during the Thanet OWF intertidal survey (Royal Haskoning, 2005).

Queen scallop (*Aequipecten opercularis)* is commercially fished in some areas, but was not recorded during the benthic or epibenthic surveys.

The common whelk (*Buccinum undatum)* is found throughout all UK coastlines, preferring subtidal muddy sands, gravels and rock (Barne *et al*., 1995). One individual was identified during the epibenthic trawls, with an additional 20 identified in the grab samples from Station B03-050. Common whelks are commercially exploited in the UK and are a high value species.

The brown shrimp (Crangon crangon) is found on sandy and muddy seabeds around the British coast. The brown shrimp is an important food source for many species, including other crustaceans, fish and birds and is commercially exploited throughout northern Europe (Neal, K., 2008). Brown shrimp were recorded in both the Nemo Link epibenthic survey and Thanet OWF epibenthic survey (Royal Haskoning, 2005).

The European lobster (*Homarus gammarus*) was not recorded during the Nemo Link epibenthic survey, but was captured during the Thanet OWF fish survey (Royal Haskoning, 2005).

7.5.2.7. Species of conservation importance

No rare, scarce or protected species under national or international legislation were recorded in the survey area during the Nemo Link benthic and epibenthic surveys (MMT, 2010). Of the Annex II protected species, twaite and allis shad, river and sea lamprey were not found within the survey area. Given the distribution of these species and their preferred habitats, it is unlikely that these protected or threatened species could be present along the proposed cable route.

However as detailed in section 7.5.2.3 salmon are known to utilise the waters of south eastern England including the Kent Stour and despite not being captured during the survey work it is very likely that they will be migrating over the cable route. Salmon are

As well as being listed on the IUCN red list eels are also a CITIES appendix II species and are protected under EC provisions for species specific management plans. As with salmon the presence of eels was not recorded in the Nemo Link survey work however secondary data sources indicate it is likely that they inhabit the vicinity of the cable route.

The area along the route has been identified as a potential nursery ground for tope (*Galeorhinus galeus*), a species of shark classified as vulnerable by the IUCN; and the common skate (*Dipturus batis*) classified as endangered by the IUCN and protected as a UK BAP species is rarely recorded in the area. Neither species was recorded during the Thanet fish surveys (Royal Haskoning, 2008), but their presence in the survey area cannot be discounted with certainty.

7.5.3. Description of potential impacts

7.5.3.1. Introduction to assessment

The life of an offshore cable development can be divided into four separate phases:

- Pre-installation
- Installation
- Operation
- Decommissioning

Each of these phases will have potentially significant impacts on the existing environment, benthic invertebrates, intertidal communities and fish. Changes may occur in habitats and in turn changes in associated species composition and communities. The table below takes into account sensitivity, recoverability and importance in order to determine a receptor value in assessing the significance of an effect.

Receptor Value	Definition
High	Receptor is highly sensitive to predicted impact and will not recover. Receptor is a species / habitat of national or international importance.
Medium	Receptor is either highly sensitive to predicted impact or will not recover. Receptor may be a species / habitat of national or international importance.
Low	Receptor is not sensitive to predicted impact or will likely recover. Receptor is not a species / habitat of national or international importance.

Table 7.5.4: Definition of receptor value

The table in Appendix 6 provides a detailed description of the impact assessment.

7.5.3.2. Pre-installation

Disturbance of spawning and nursery grounds due to pre-installation activities

A pre-lay grapnel run is likely to cause disturbance of and possible mortality to benthic fauna within the immediate vicinity (the maximum width - 200m - and depth – 1m) of the grapnel hook. Potential removal of this benthic habitat and associated floral and faunal assemblages will be both localised and short-term. Disturbance to fish populations as a result of this activity would be difficult to measure against natural variations in abundance and distribution. As the impact will be of a short-term duration and highly localised it is considered of negligible significance.

Fish spawning and nursery grounds are likely to be more significantly impacted by sediment disturbance from vessels involved in the work as well as the grapnel hook movements. Fish are at their most vulnerable to anthropogenic impacts at larval and juvenile life stages. Species that rely on the seabed as a functional habitat (for breeding, feeding, shelter etc) are particularly vulnerable, especially to changes in its physical form in relation to substrate type, sediment movement and water depth. Any disturbance of the seabed could damage eggs already attached, remove or bury the suitable substrate on which fish deposit the eggs, or deter fish from spawning in the area; such impacts could be mitigated. A description of fish spawning and nursery grounds in the area is given in Section 7.5.2.2.

Sensitivity maps are available for many commercial fish species this data can be used to assess effects of activities such as cable trenching and laying. These maps, summarised in Figures 7-5-1 and 7-5-2, show that the proposed cable route (in UK waters) passes through spawning areas for sprat, plaice, sand eel, common sole, lemon sole, and herring. Cod, whiting and horse mackerel use part of the area for spawning, while nursery areas for mackerel, plaice, sand eel, cod, sole, lemon sole, herring, whiting and tope shark have been recorded (Coull et al., 1998; Ellis et al., 2010).

The most sensitive of these species with regard to spawning is herring, which has the potential to be impacted by the various pre-installation and installation works. Herring spawn in discrete areas on the seabed, and the eggs or larvae may therefore be affected by disturbance to the seabed during the pre-lay grapnel run, leading to measurable change against the baseline. The impact of the pre-lay grapnel run may therefore be considered of moderate impact significance with regard to herring spawning. It should be noted that due to the following factors the significance of effect on all but the most sensitive receptors (i.e. herring spawning) is expected to be minor, even without the application of mitigation:

- The limited spatial extent of the pre-lay grapnel run;
- Change in the fish community as a result of the impact is unlikely to be measurable against natural variation;
- The duration of the effect in any location will be short term (i.e. a matter of hours to days);
- The sensitivity, recoverability and importance of fish nursery grounds typically combines to give a medium receptor value.

Pre-sweeping of sand waves is proposed at three points along the UK sector of the route, in order to reduce the height of the sand waves to aid the path of burial equipment and allow for greater control of the cable burial depth. Between KP82.3 and KP87, an area of approximately 24470m^2 of material is proposed for dredging, while between KP123 and KP123.5, an area of 1170m^2 of sediment is proposed for removal. The area of the South Falls Sand Bank between KP99 and KP100.75 constitutes the largest area for pre-sweeping, with a proposed 93138m^2 of material to be dredged. The proposed trailing suction hopper dredger will be used with a total pre-sweeping corridor of 40m in width (20m either side of the cable centreline). These spoil volumes are considered typical of dredging operations for channel or port maintenance. The current proposal is for the dredged spoil to be deposited back on the seabed, in the immediate vicinity of the sandbank system, within 1500m of the area of dredging.

Sandbanks are characterised by species which are adapted to the variable hydrographic conditions and mobile substrates (Elliot *et al*., 1998), and can therefore be considered somewhat tolerant of disturbance. These include epibenthic species and demersal fish including sand eels *Ammodytes* spp. Benthic species inhabit highly dynamic environments and as such are generally well adapted to regular disturbance therefore significant disturbance to food webs as a result of cable laying should be unlikely. Increased suspended sediment may however have a negative impact on sessile organisms through smothering and juvenile fish species by clogging gills. Pre-sweeping at the South Falls sandbank is expected to cause an increase in suspended sediment concentration of more than 10mg l^{-1} within 250m of the proposed cable route, with a peak predicted increase of 30mg l^{-1} and the footprint of impact extending up to 500m away (HR Wallingford, 2011). However, the sediment along this part of the proposed route is predominantly coarser sands, which settle quickly, rather than fines, which would be transported further when disturbed. Within 100m of the point of disposal of the dredged sediment, the coarser material will be suspended in concentrations reaching >1000mg l^{-1}; with these concentrations of suspended sediment lasting approximately ten minutes, before settling on the seabed (HR Wallingford, 2011).

The rate at which the coarser sediment will settle on the seabed, and the localised extent affected by the suspended sediments, would indicate that, for most fish spawning and nursery grounds, change would not be measurable against natural variation in the baseline. Thus pre-sweeping would have a low magnitude of impact and minor impact significance, even without the application of mitigation. However, as with the pre-lay grapnel run, given the sensitivity of species such as herring that rely on the seabed for spawning, a greater level of change would be noticeable; pre-sweeping would have a moderate magnitude of effect for these more sensitive species, resulting in **moderate** impact significance.

Disturbance of shellfish beds due to pre-installation activities

It is not anticipated that pre-installation activities will impact upon the intertidal shellfish beds to the north of Pegwell Bay where pre-sweeping is not required. The predicted footprint of pre-sweeping impacts is within 500m of the cable route (HR Wallingford, 2011), and the predominance of coarser sediment which settle quickly ensures that pre-sweeping will have a **negligible** impact on the intertidal zone. Fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries); however the impacts of these activities on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

7.5.3.3. Cable Installation

Disturbance of spawning and nursery grounds due to trench excavation and cable burial

Due to the mobile nature of fish communities, cable installation works will not have a direct impact on adult fish species that can be measurable against natural variation. Disturbance to and mortality of benthic species within the installation corridor will remove a food resource for fish communities, however this impact is very localised and short-term and hence can be considered of negligible significance.

The potential impacts of cable installation works on fish spawning and nursery grounds are of greater concern. The majority of fish species in the area are pelagic spawners, releasing eggs into the water column to be transported with the currents during development into larvae. These species would be largely unaffected by direct disturbance to the sediment during trench excavation and cable burial, with no measurable change beyond that of natural variation in abundance and distribution. The impact of trench excavation and cable burial on these species would have a low magnitude of effect and thus have minor impact significance. The significance of these impacts is greater on demersal spawners these more sensitive species, such as herring, utilise specific grounds for spawning the conditions they require are not prevalent across the entire survey area. Juvenile cod, sand eel and plaice also utilise the seabed and would also be impacted by the cable installation works; however their mobility makes them less sensitive to impacts than demersal eggs or larvae. The magnitude of effect on

herring spawning is moderate, resulting in moderate impact significance, although it will be possible to plan works to avoid the most sensitive period for demersal spawning fish.

Disturbance of shellfish beds due to trench excavation and cable burial

The impact of trench excavation, cable burial and use of cable-lay barges are expected to have only a minor impact on shellfish beds, as these beds are predominantly outside the survey area, within the intertidal zone to the north of Pegwell Bay. Fishing for lobster and whelk occurs along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries). The impacts on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

Re-suspension of sediment into the water column

Studies on the effects of increased suspended sediments on salmonids indicate that factors such as concentration, duration of exposure and the life stage of the fish determine the level of impact (Larkin *et al*., 1998), these results also apply to other species. With low suspended sediment loads, subtle behavioural changes may be observed along with a reduction in feeding rate (Newcombe and Jensen, 1996). Higher sediment loading can kill fish directly through clogging or abrasion of the gills (Herbert and Merkins, 1961) and indirectly via smothering of fish eggs or larvae and habitat degradation, such as reduced porosity of spawning gravels.

The effect of coarser sediments suspended due to excavation of the seabed is only expected to affect the immediate vicinity of the cable trench, as these sediments are too heavy to travel far.. This impact is localised and temporary and less significant for ploughing the cable trench than for jetting, which fluidises sediment for cable burial. However, the indirect impacts of suspension of finer sediments extend beyond the installation corridor, with modelling data showing the release of fine material from ploughing over a 3km path (HR Wallingford, 2011). The re-suspension of sediment would cease upon completion of activities such as trench excavation, although the effects of turbidity, transport of sediment fines and potential smothering of eggs or larvae on the seabed may last beyond these works where the proportion of sediment fines is higher, with the corresponding impact on fish communities having a medium-term effect. HR Wallingford's (2011) modelling of sediment ploughing along the proposed route predicted a release rate of 0.05kg s^{-1} for sediments containing 3% fines, assumed to have a settling velocity of 1mm s^{-1}. The release of chalk from ploughing was modelled at a dry density of 2000kg m^{-3} with 100% assumed to be re-suspended; this model produced a release rate of 2kg s^{-1} and with chalk assumed to have a settling velocity of 0mm s^{-1}, deposition will be negligible (HR Wallingford, 2011).

The release of fine sediments into suspension and the resultant smothering of demersal eggs and larvae would produce a moderate magnitude of effect and have **moderate** impact significance on the more sensitive species, notably herring. The impact on other pelagic fish species, eggs and larvae would be of short duration, with no notable change outside natural variation; resulting in a low magnitude effect and thus the re-suspension of sediments will have **minor** impact significance on the less sensitive spawning and nursery grounds.

While mobile fish can move away from areas of increased sediment loads, suspension-feeding shellfish could be more detrimentally impacted by the re-suspension of sediments from marine anthropogenic activities. Research has suggested that cockles can initially benefit from the increased food availability associated with higher suspended sediment loads, but that this benefit reduces as suspension persists with durations of >5 days producing negative impacts(Hewitt *et al*., 2008).. Growth rates of cockles can be adversely affected by high sediment loads, depending on the concentrations and duration of their exposure. Laboratory results have suggested that >400mg l^{-1} for 14 days would decrease adult cockle condition (Hewitt *et al*., 2008). Shellfish beds were identified in the intertidal zone, along the north coast of Pegwell Bay, outside the installation corridor and over 250m from the proposed cable route. Fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries).

The footprint of re-suspension of finer silts and clays in the intertidal zone will likely extend over an area similar in size to the ploughing of chalk, up to 700m from the cable route. Silt will likely settle

during periods of slack water, and be re-suspended during the following tide. The release of fine material would be east to west with the predominant tidal direction, and thus the suspended sediments could reach the wave-cut chalk platforms and mussel beds within Pegwell Bay, however at those distances the predicted increases in suspended sediment would likely be less than 1mg l^{-1} above background (HR Wallingford, 2011). Modelling of sediment containing up to 60% fines was conducted for the Sheringham Shoal Offshore Wind Farm, with a predicted maximum rate of silt deposition of <0.5mm, even under slack water conditions (Scira, 2006). Thus the impact of suspended sediments on shellfish beds can be considered of **minor** significance.

Disturbance of spawning and nursery grounds due to external cable protection

Installation of external cable protection would have moderate impact significance for demersal spawning grounds in the region, such as herring. Any eggs or larvae present on the seabed at the time of external cable protection installation would be removed or destroyed. This impact would be of minor significance to those species that spawn in the water column, as the eggs are unlikely to be damaged; the impact would be restricted to the area of work, and any displacement of spawning fish would be temporary.

Disturbance of shellfish beds due to external cable protection

There will be a negligible impact of the external cable protection on shellfish as the area of cable crossing will be well outside the intertidal area where shellfish beds have been recorded. However, fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries); the impacts on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

Substrate change due to installation of external cable protection

The installation of external cable protection around the area of the cable crossing will have an effect on the seabed, effectively replacing the sandy sediment with hard substrate. This will result in localised disturbance of any benthic fauna, causing a long-term though very localised change. In terms of the fish community, the hard substrate may create a new habitat for colonisation, in effect acting as an artificial reef. This habitat may then support a new range of benthic epifauna that prefer harder substrates, and a resulting fish community that may feed on them. Although this will have a severe magnitude of effect due to the long duration and high level of change given the removal of existing habitat, and thus have moderate impact significance for fish, the effect could be considered a positive one. However it is important to note that rather than changing the baseline by attracting new fish species to the area, it is more likely that existing fish in the area will be using the new habitat and feeding on newly colonising fauna.

Impacts from noise and vibration

The low frequency noise and vibration associated with cable-laying operations comes from a variety of sources, including shipping operations and the trenching, laying and burial of the cable. Given the level of shipping traffic that already exists in the region, the presence of the trenching and cable-laying barges is unlikely to have a significant impact on fish around the installation corridor. Measurements of suction and hopper dredgers and pipe laying vessels indicate a peak spectral source level of up to 177dB re 1µPa at 1m between frequencies of 4Hz and 1KHz (Nedwell and Howell, 2004), in the range of that heard by most fish species.

Few measurements of sound produced during cable-laying are available in published media, although data from Richardson *et al*. (1995) and Nedwell *et al*. (2004) suggest that the source level of trenching noise from mechanical dredging operations could reach 185dB re 1µPa at 1m. Modelling conducted for the Beatrice Offshore Windfarm Demonstrator predicts that at the same source level for umbilical-burying operations, the expected noise level salmon might receive (as a function of that species' sensitivity to noise) at a distance of 1m, would be 90.8dB_{ht}, with the received sound level remaining above the 90dB_{ht} (*species*) threshold at which avoidance behaviour is expected, within 5m of the source (Talisman Energy, 2005).

Measurements from deep water pipe laying noise from the *Trenchsetter* in the Yell Sound near Shetland indicate that the expected noise level cod might receive at a distance of 1m from the trenching activity would be 75dB$_{ht}$, a level 5dB$_{ht}$ above the threshold expected to produce a mild behavioural response (Nedwell and Howell, 2004), but below the suggested avoidance threshold of 90dB$_{ht}$ (*species*) (Nedwell *et al*., 2004). The data also indicate that salmon and dab might receive 50dB$_{ht}$ at the same distance (Nedwell and Howell, 2004). Results from the North Hoyle offshore wind farm in Wales showed that during cable trenching at a source level of 178dB re 1µPa at 1m, cod, salmon and dab all had received levels of sound below the 70dB$_{ht}$(*species*) level, expected to elicit a mild behavioural response (Nedwell *et al*., 2004). These received sound levels are summarised in Table 7-5-5.

Species	Received sound levels (dB$_{ht}$Species)		
	Pipe trenching at 1m (Nedwell and Howell, 2004)	Mechanical dredging 185dB re 1µPa at 1m (Richardson *et al*., 1995; Talisman Energy, 2005)	Cable trenching 178dB re 1µPa at 1m (Nedwell *et al*., 2004)
Cod Gadus morhua	75dB$_{ht}$	N/A	<70dB$_{ht}$
Dab Limanda limanda	50dB$_{ht}$	N/A	<70dB$_{ht}$
Salmon Salmo salar	50dB$_{ht}$	90.8dB$_{ht}$	<70dB$_{ht}$

Table 7-5-5 : Received trenching and dredging sound levels by fish species

Given that mechanical dredging and trenching for pipelines will cause considerably more noise than trenching to lay sub-sea cables, this suggests that noise produced by trenching activity could have a moderate impact, though only on fish at close range to activities. The zone in which the sound will be at a sufficiently high level to elicit a behavioural response will be very small, likely within 50m; therefore the number of fish that may be exposed to such levels will be low. The presence of several vessels and continued noise with 24-hour operations means it is likely that the most sensitive fish will demonstrate an avoidance response early on and remain outside the zone of operations for the short duration of the installation activities.

Sound will also be produced during any rock dumping or pre-sweeping activities, but the lack of measurements and behaviour observations of fish during such activities make it difficult to draw any conclusions regarding the effects of such sound. However, the extent and duration of effects from rock placement will be limited.

Although an avoidance response to the sound produced during trenching is expected, with a moderate magnitude of effect, the short duration of the impact, moderate sensitivity and recoverability of the fish indicate the impact to be of **minor** significance.

Accidental contamination from associated vessels and equipment

During cable-laying operations, any use of associated vessels and equipment has potential for accidental contamination of the sediment. Such contamination is unlikely given standard environmental management procedures, but could have a medium-term impact on fish communities in the local area, with a knock-on effect on bioaccumulation in fish that consume contaminated fauna. Contaminants could adhere to the sediment and be transported outside the local area creating a moderate magnitude of effect. Despite the generally moderate sensitivity and high recoverability of fish to contaminants, the impact of accidental contamination of habitats and individuals would still have **minor** significance. This impact could also potentially occur during the operational and decommissioning phases, should there be any maintenance activities required or if the cable is removed.

7.5.3.4. Cable Operation

Disturbance of habitats and species due to external cable protection

Rock or concrete external cable protection will add hard substrate to a generally sandy environment, providing a potential new habitat for colonisation by a range of benthic invertebrates, associated epifauna and fish communities over time. There is evidence for the artificial reef effect to occur where turbine foundations have been constructed at offshore wind farms. Test fishing has been conducted before and after the construction of wind turbines at the Vindeby offshore wind farm in Denmark, indicating an increase in fish yields, attributable to the creation of artificial reef (Krohn, 2002). Turbine foundations can act as reefs, which can be colonised by bivalves and other epifauna, creating a habitat and food source for fish communities and potentially increasing localised biodiversity. Although aggregations of fish may be recorded around seabed structures, this may not signify an actual increase in fish biomass. Although the small amount of external cable protection that may be required during the Nemo Link development may have a noticeable effect on fish within the area, due to the substrate change, the effect will be localised and may be considered a positive impact and is of minor significance.

Impacts due to maintenance activities

Routine maintenance work to the cable is not anticipated. Some unscheduled work may be required to maintain the burial of the cable to protect it following adverse interactions with other sea users or marine processes such as tidal scour. In the event of such maintenance work, it is likely that fish species in the immediate vicinity of the area of works would be disturbed, however, any such work would be localised to the immediate vicinity and be short in duration so would likely only result in short-term displacement from the area. Maintenance work may be of more concern should it occur during fish spawning or nursery season, in a sensitive location, where eggs, larvae or juvenile fish might be disturbed. Due to the low receptor value, and short duration of impact caused by maintenance activities, the impact significance would be negligible. Accidental contamination from associated vessels and equipment during maintenance works may also occur. Such contamination is unlikely given environmental procedures, but could have an effect on faunal communities in the local area, and potentially have a medium-term effect on a fish feeding resource, or possible mortality of fish eggs or larvae on the sediment. As such, the impact of accidental contamination would have minor significance on fish communities.

Impacts due to operational noise from cables

The majority of previous research on the effects of noise on fish relates to seismic exploration, which is not really comparable to the operational noise of cables. No significant noise will be produced during operation of the cable (PMSS, 2010) and thus is more relevant as a concern during the installation and decommissioning phases of the project. It is likely that any low level of noise produced during operation of the interconnector cable will merely contribute to the background low frequency noise levels in the area, that result from shipping, fishing vessels and environmental noise such as wind and waves. As such the impact of operational noise on fish is expected to be of minor significance.

Impacts due to emission of electromagnetic fields from cables

Electromagnetic fields (EMF) created by power cables may affect fish feeding behaviour and navigation in elasmobranchs (sharks, skates and rays) and the migration routes of bony fish (including salmon and eels). Electromagnetic fields are composed of electric fields, shielded by and retained within the cable structure, and magnetic fields, which are detectable outside the cable (Gill et al., 2005). Electric fields are produced as a result of seawater passing through the earth's natural geo-magnetic field, and similarly when passing through the magnetic field surrounding a cable. The strength of such an electric field is dependent on the qualities of the seawater (such as velocity and direction of flow), the strength of the magnetic field produced by the cable and distance from the cable.

A desk study conducted for the BritNed interconnector cable route estimated the geo-magnetic field in the vicinity of the cable to be approximately 48μT, which along with a water current speed relative to the seabed of 0.85m s-1, allowed the calculation of a maximum background electric field of between 39μV m-1 and 42μV m-1 depending on the direction of water flow (Swedpower, 2003a; Metoc, 2004b).

These background magnetic and electric field strengths can be considered applicable for background levels in the vicinity of the Nemo Link cable route.

The expected electric and magnetic fields from the BritNed interconnector system were modelled for the cables being bundled together at 0.2m separation, or in two trenches separated by 2m; these different cable configurations are similar to those proposed for the Nemo Link. These calculations can be considered the maximum possible electric and magnetic field strengths and are presented in Table 7-5-6.

Cable configuration	Electric field strength (μV m^{-1})		Magnetic field strength (μT)	
	1m from cable	5m from cable	1m from cable	5m from cable
Bundled (0.2m separation)	61	1.9	72	2.2
Separated (2m separation)	260	18	310	21

Source: BritNed Interconnector system modelling (Swedpower, 2003a)

Table 7-5-6Expected electric and magnetic field strength

Elasmobranch fish are known to be electroreceptive as they have receptor cells along the surface of the skin (Ampullae of Lorenzini) that can detect very weak voltage gradients in the environment around them. They use this detection of bio-electric fields to locate and catch burrowing prey. Electroreceptive elasmobranchs can also detect the induced electrical field, produced by the magnetic field, either passively or actively as an aid for navigation (Gill *et al*., 2005). Laboratory tests have shown that dogfish (*Scyliorhinus canicula*) are attracted to a DC field of 10μV m^{-1} at 0.1m from source, similar to that produced by their prey, while they demonstrate avoidance behaviour to constant DC electric fields of 1000μV m^{-1} (Gill and Taylor, 2001). The same study demonstrated the minimum DC field strength eliciting a response from fish was 0.5μV m^{-1}.

Teleost (bony) fish are also electrosensitive, though the method of detection is unclear as they do not possess specialised electrosensors. Teleost fish have not generally been recorded as reacting to electric field strengths of less than 6V m^{-1} (Uhlman, 1975), nor do they react to the type of permanent static electric field that would be produced by a DC cable such as the BritNed or Nemo interconnectors (Lamarque, 1990 cited in Metoc, 2004b, p. 8). This suggests that teleost fish are not susceptible to the types of electric field strengths that will be generated by the Nemo Link cable.

Other species are magnetosensitive, responding directly to geomagnetic or magnetic fields for navigation. Elasmobranchs use the Earth's magnetic field for navigation, with sharks known to induce an electric field (between 5 and 50μV m^{-1}) around their bodies to allow them to detect their heading through the magnetic field, like using a compass (Metoc, 2004b). Some species of shark have demonstrated sensitivity to localised magnetic fields during behavioural experiments, indicating an ability to differentiate change in magnetic field emissions against the existing background geomagnetic field (Meyer *et al*., 2004). Changes in the magnetic field surrounding the cable are therefore likely to have the same impact on elasmobranchs as described for changes to the electric fields.

The Earth's magnetic field is also used for navigation by a small number of teleost fish species; Atlantic salmon, sea trout and eel. Results of an experiment conducted by Swedpower (2003a), fitting sea trout and salmon with a transmitter that generated a magnetic field approximately twice the magnitude of the earth's magnetic field in the fishes' brains, indicated no effect on fish behaviour and movement. Research has also been conducted on the sensitivity of *A. anguilla* silver eels (those migrating back to the Sargasso Sea to spawn aged 6-12 for males and 9-20 for females), to changes in magnetic field strength. Silver eels have been observed swimming significantly lower around a 130kV AC subsea cable, suggesting that some subsea cables have an impact on behaviour, although conflicting information has been published on the effect of DC cables (Westerberg and Lagenfelt, 2008). Eels are often found close to or buried in the surficial sediment, and thus are more likely to be impacted by proximity to magnetic fields produced by the cable. Brown shrimp (*Crangon crangon)* have also been recorded demonstrating attraction to the magnetic fields of the magnitude expected from wind farms (ICES, 2003).

Some studies have suggested that exposure to electromagnetic fields may be disruptive to embryonic development in sea urchins and fish (Cameron *et al*., 1993; Zimmerman *et al*., 1990). COWRIE (Collaborative Offshore Wind Research into the Environment) funded a study (CMACS, 2003; Gill *et al*., 2005) that determined cable burial does not provide sufficient mitigation against the effects of electromagnetic fields, although it is still not clear how significant the impacts of these fields are on potentially sensitive species.

Only two species recorded during the epibenthic survey in the area surrounding the proposed cable route can be considered sensitive to electric or magnetic fields; the electro-sensitive cod and the magneto-sensitive brown shrimp. However, other species known to be electro-sensitive and/or magneto-sensitive have been recorded in the region surrounding or adjacent to the proposed development. Plaice is known to be both electro-sensitive and magneto-sensitive, and is also found in the Thanet region (Royal Haskoning, 2005; DECC, 2009), while smaller-spotted catshark, starry smoothhound and thornback ray were abundant during the Thanet OWF survey (Royal Haskoning, 2005) and have been recorded in numerous locations off the coast of Kent (Marine Biological Association, 2008; Marine Conservation Society, 2010).

A direct current (DC) cable such as the proposed Nemo Link HVDC cable will produce less EMF than an alternating current (AC) cable due to the current passing in only one direction rather than both directions as with AC. Natural background electric fields are on average 130V m^{-1} at surface level in fair weather, increasing up to 3000V m^{-1} prior to storms, with background static geomagnetic fields increasing from approximately 35μT at the equator to 70μT at the poles when measured in air (WHO, 2006). The expected magnetic fields produced by bundled cables at only 1m depth (Table 6) are within natural background levels, while the electric field produced by the cables at 1m or 5m would be well within background levels. These factors indicate that EMF would have a low magnitude of effect on the behaviour of fish along the proposed cable route despite the long-term nature of the impact; which, despite the sensitivity of some species in the area, would mean the impact is of **minor** significance.

Impacts due to emission of heat from cables

Calculations from a study conducted for the BritNed interconnector cable development (Table 7-5-7) indicate that during summer the temperature may increase between 0.5˚C- 5.5˚C through localised heating directly above the cable, where the cable is buried at a depth of 1m, and from less than 0.5˚C to 1.8˚C where the cable is buried at a depth of 3m (Swedpower, 2003b).

Cable Burial Depth	Predicted Seasonal Temperature Increase (at 10cm and 30cm below seabed surface)							
	10cm (summer)		30cm (summer)		10cm (winter)		30cm (winter)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1m	0.5˚C	1.5˚C	1.5˚C	5˚C	0.5˚C	2˚C	1.5˚C	5.5˚C
3m	<0.5˚C	N/A	0.5˚C	1.8˚C	<0.5˚C	N/A	0.4˚C	1.7˚C

Data from Swedpower (2003b) on behalf of BritNed.

Table 7-5-7 : Expected temperature increase

As the cable is to be buried, the impact of heat from the operating cable at the seabed would be minimal, the generated heat should be dissipated by the presence of sea water and temperatures are expected to increase above background levels only in the 10-30cm immediately above the cable (Metoc, 2004a). Therefore the temperature at the seabed surface is expected to be the same as the water temperature and would not have an impact on fish species in the water column, on the seabed or eggs laid by some fish species on the seabed surface. Therefore the increase in temperature would have **minor** impact significance.

7.5.3.5. Decommissioning

The impacts of decommissioning are very similar to those associated with the installation phase of the development, with disturbance to the seabed such as use of grapnel hooks to lift the cable, and the resulting re-suspension of sediments. The current proposal is for the external cable mattressing and any scour protection to be left in-situ, with the cable to either be left in-situ, or removed. An assessment of the impacts of decommissioning should be carried out prior to any decision being made on whether to recover the cable, and a survey of the area will need to be conducted to assess any change in species and habitats within the vicinity.

Leaving the cable buried in-situ will be unlikely to have new impacts, especially as fish communities will likely have returned to baseline conditions. Once the cable is no longer operational, the impacts of heat, noise and electromagnetic fields on fish will cease, and fish will likely have adapted to the presence of the cable and any external protection. Epifaunal colonisation of external structures should be considered during this phase as fish communities will likely have been supported by the increased and varied diversity (Vella et al., 2001).

7.5.4. Mitigation

The impacts of installation, operation and decommissioning of the cable upon most fish populations are generally expected to be minor as the area of seabed affected is predominantly localised and the installation and decommissioning works are temporary.

The impacts of most concern relate to species that spawn on the seabed, or use the area as nursery grounds and localised populations of shellfish along the north coast of Pegwell Bay. Mitigation of potential impacts of the developmental phases on fish spawning and nursery grounds is possible. Knowledge of the most sensitive spawning periods by month can enable operators to plan their activities more efficiently. If peak times for nursery and spawning grounds can be avoided, this effectively removes the potential impact of each phase on this particular receptor. An examination of seasonal seismic sensitivity data compiled by Coull *et al*. (1998) and displayed in Table 8, shows that November to May is the most sensitive period for disturbance to fish spawning and nursery grounds. This data set does not include species of less concern due to their very wide spawning distributions, such as sprat and lemon sole.

For the purpose of the areas surrounding the proposed cable route, the most sensitive period is November to May. However, the majority of species spawn in the water column and have large spawning grounds across the wider area, thus do not require mitigation. The most sensitive species is the herring, which spawns in discrete areas on the seabed and is more vulnerable to disturbance and the mortality of eggs and larvae. Herring spawn in this region between November and January, thus works should be planned to avoid these months.

Month	Sensitivity				
	HIGH Entire planned route	MODERATE Majority of planned route	LOW Outside planned route	NONE	Species spawning
January		x			Herring, plaice, sand eel (cod nursery)
February		x			Plaice sand eel (cod nursery)
March	x				Plaice, common sole (cod nursery)
April	x				Lemon sole, common sole (cod nursery)
May	x				Lemon sole, common sole, Sprat (mackerel nursery)

Month	Sensitivity				
	HIGH Entire planned route	MODERATE Majority of planned route	LOW Outside planned route	NONE	Species spawning
June			x		Lemon sole, sprat (mackerel nursery)
July			x		Lemon sole, sprat (mackerel nursery)
August			x		Lemon sole, sprat (mackerel nursery)
September				x	Lemon sole
October				x	
November		x			Herring, sand eel
December		x			Herring, plaice, sand eel

Table adapted from seasonal seismic sensitivity data in Coull *et al*., 1998.

Table 7-5-8 Seasonal sensitivity along the proposed cable route

Several additional actions can be taken to mitigate the severity of effects during installation and operation. Such mitigation measures include:

- The use of non-displacement ploughing equipment rather than jet trenchers to minimise the level of sediment re-suspension during cable installation, however this is dependent on ground conditions along the proposed route and available technology at the time of construction which may not allow much flexibility in the choice of installation methods;
- Burial of the cable to the maximum depth possible in the survey design to minimise the increase in temperature at the seabed surface;
- Bundling the cables together in one trench to minimise the footprint of electromagnetic fields generated during operation;
- Simultaneous cable lay and burial to minimise repeated impacts on fish in the area.

For the purpose of avoiding further impacts during the decommissioning phase, it is currently recommended to leave the cable in-situ, though this will likely require further impact assessment as conditions may change throughout the lifecycle of the development.

Strict environmental health and safety guidelines and spill procedures should be followed to minimise the risk of accidental contamination throughout the life of the project.

7.5.5. Residual impact

No rare or scarce species have been directly identified in the vicinity of the proposed cable route, although the presence of salmon, eel, tope and common skate cannot be discounted. Impacts of the cable development are generally expected to be minor, with a few exceptions, such as the potential impacts on the most sensitive fish spawning and nursery grounds, which will have been mitigated for accordingly.

The impact on fish communities of substrate change caused by the use of external cable protection can be considered **moderately** significant; however it is important to note that this may be considered a positive impact rather than a negative one, through the creation of new habitat.

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8. Human Environment

8.1. Commercial Fisheries

8.1.1. Introduction

In order to assess the impact of the installation, operation and decommissioning of the Nemo Link upon commercial fisheries, a fisheries assessment has been undertaken. This draws upon available data and consultation with fishing organisations to give an indication of:

- the quantity of commercially important species landed in the area surrounding the cable route;
- the types and intensity of fishing effort expended along the cable route;
- seasonal variation in commercial fishing activity;
- restrictions related to commercial fishing activity, and;
- the location of key fishing grounds in the vicinity of the cable route.

A large proportion of submarine cable faults are caused by fishing gear and the majority of these faults are caused by trawl gear and dredgers, however other types of fishing gear (e.g. long lines, gillnets) have also brought about cable faults. The intensity of bottom contact fishing methods and their potential interaction with the Project cable has been considered as part of the determination of the target cable burial depth of 2-3 m. This will help to minimise any impacts on commercial fishing activity.

The commercial fishing activities in the vicinity of the cable route fall into two specific categories; effort expended by local fishermen of Kent and Essex ports (which is generally concentrated within the 12 NM limit) and larger vessels of the national fleet which are restricted to areas outside of the 6 NM fisheries limit and tend to fish beyond the 12 NM territorial limit.

8.1.2. Baseline data sources

The key sources of data used to inform this impact assessment are vessel monitoring system (VMS) data and value, effort and landings data from the Marine Management Organisation (MMO). This data has been supplemented with data and information from the Thanet Offshore Wind Farm Environmental Statement, the COWRIE programme fish value report, discussion with Thanet Fishermen's Association (TFA) and Kent and Essex Sea Fisheries Committee (KESFC) (Now Kent and Essex IFCA).

Fisheries data including landings (weight and value of catch) and effort (days at sea) is aggregated by ICES (International Council for the Exploration of the Sea) rectangles which encompass one degree of latitude by 0.5 degrees (30 minutes) of longitude (see Figure 8-1-1). This fisheries data cannot be targeted along the cable route specifically, however, analysis of ICES rectangle data can provide an overview of gear types used, target species , seasonality of the fishery, landing quantities and catch values. Fisheries data by ICES rectangle were obtained from the MMO. The MMO data includes fishing effort from all UK fishing boats and foreign vessels that land their catch in the UK. The data indicates that there are low levels of fishing effort expended outside of the 12 NM limit (in ICES rectangle 32F2) but in reality further effort is expended beyond this point by foreign vessels, typically undertaking trawling. These data form the basis of the UK's annual fisheries reports which are the only widely available data from which to calculate fishing trends and are therefore useful in assessing relative differences between fishing effort and landings between ICES rectangles. ICES data has been acquired for the years 2007 to 2011. The cable route crosses ICES rectangles 31F1 and 31F2, in UK waters, and then 31F3 before landfall in Belgium (Figure 8-1-1).

Effort, landings and value data have been supplemented with MMO satellite VMS data for the year 2009. The positions of all vessels, over 15 metres in length, in UK waters are logged at 2 hour intervals. For each record in the database there are fields documenting the year, month, day, ICES rectangle, latitude and longitude, vessel nationality and the gear type used. The data also indicates whether the vessel is steaming or actively fishing. The data can be used to give an indication of the location of important fishing grounds. VMS data has been used to supplement the MMO ICES data for the area up to the median line.

8.1.3. Baseline

The Fish Value Report (ABPmer, 2009) and the Energy SEA (DECC, 2009) indicate that trawling and static gear (e.g. trammel nets and gill nets) are the main fishing methods used in the vicinity of the cable route in UK waters, probably targeting mainly sole, plaice, cod, bass and rays (DECC, 2009). Over recent years, fishing activities within the Thames Estuary have shifted towards shellfish, predominantly oyster, whelks and mussels (KEOWFE, 2011).

The MMO ICES rectangle data (2007-20011) shows that static gear (gillnets, trammel nets, pots) is typically deployed by small day boats (less than 10 m in length). These reports do not fully reflect the activities of other small fishing vessels operating out of local ports. The main fishing ports in Kent are Dungeness, Folkestone, Ramsgate and Whitstable and Leigh-on-Sea, West Mersea and Harwich in Essex. Some vessels also land fish onto the beaches at Herne Bay, Deal, Hythe and Dungeness (KEIFCA, 2012). MMO landing data show Ramsgate and Whitstable to be the key ports for landings in the area.

Just over three-quarters of the UK fleet comprises of vessels less than10 m, a trend reflected in the Thames, although a few 10-15 m vessels do operate in the area. Lowestoft is the closest administrative port to the UK landing of the cable. It has 347 registered vessels the vast majority of which are less than 10 m vessels operated predominately by 581 regular, rather than part-time, fishermen. There are 275 licensed vessels within the KEIFCA District directly employing >300 people. The local fleet is dominated by vessels less than 10 m in length deploying a range of gear including trawling, pair trawling, drift and fixed netting, potting and scallop, oyster and cockle dredging. Over the past decade there has been a continual decline in fishing activity within the district accompanied by a decline in active vessels (KEIFCA, 2012).

The available information also suggests that significant effort is being deployed by foreign vessels in the area crossed by the cable. Typically foreign vessels are not allowed to fish within the 12 NM UK territorial limit. Belgium and France have historic fishing rights around south east England that allow them, in certain locations, to fish within the territorial limit. In recent years the numbers of foreign vessels fishing in the area have reduced due to increased fuel costs and days at sea restrictions (TOW, 2005).

A meeting with the executive committee of Thanet Fishermen's Association (TFA) indicated that the vast majority of vessels fishing in the area between the landfall and South Falls are based in Ramsgate. It was suggested that approximately 12 vessels could be disrupted by cable installation activities in summer months, based on the current situation. These vessels are operating fixed trammel and drift nets but there is also some lobster and whelk potting taking place in the Pegwell Bay Area, outside of the SSSI boundary.

Information on fishing activity along the proposed cable route is best described as that which takes place within the 12 NM limit, and that which takes place between the 12 NM limit and the median line with France. As detailed above, ICES data has been acquired for the years 2007 to 2011 for the rectangles surrounding the cable route. In UK waters the cable route crosses ICES rectangles 31F1 and 31F2 while, 31F3 is crossed in Belgian waters before landfall. A summary of fishing activity is presented below and an outline of fishing methods in the vicinity of the cable is also discussed. This is important information for both the assessment of possible impacts upon the fishing industry, and in understanding the potential interaction between fishing gear and the cables.

In comparison to the rest of the UK, 31F1 is important for demersal species, producing higher than average landings by weight and by value but is less important for pelagic fish and shellfish with below average landings (MMO, 2011).Sole is the main target species landed in 31F1 followed by bass, other key commercial species include mackerel, skate, cod and plaice. Netting is the predominant activity and key gears used are fixed and drift nets with some demersal trawling and cockle dredging also occurring. The key shellfish species are mussels, scallops, oysters, crab and whelk. Fishing activities are predominantly seasonal as are the prices for key species, sole and skate values peak in April, bass peaks in September and whelks and lobster remain high between May and September (KFOWFE, 2011). The COWRIE Fish Value Report (Dunstone, 2009) shows that, with the exception of trawling, fishing by boats greater than 15 m to be relatively limited in comparison to the rest of the UK. The Dunstone report, when investigating non-VMS data based on ICES rectangle fishing effort data, found high levels of dredging in the area surrounding the cable route and above average netting. Overall the level of fishing effort in the area is comparable with many areas of the UK (Dunstone, 2009).

Landings and effort expended within the 12 nautical mile limit

Figure 8-1-1 shows that ICES rectangle 31F1 is crossed by the cable route and falls within the 12 NM limit. In terms of effort (days at sea) between 2007-2011, 31F1 remains the most important of the ICES rectangles surrounding the cable route (31F1, 31F2, 31F3, 32F1, 32F2 and 32F3) to UK fishing vessels. Combined with 32F1, these two rectangles account for 98% of fishing effort by UK fishing vessels in the area surrounding the cable route (see Figures 8-1-A & 8-1-1). This suggests that the majority of UK fishing vessels fish within the 12 NM limit in this region.

Effort within 31F1 averages at 4449 days annually, the majority of which is undertaken using gillnets, and the average landing value recorded by MMO data between 2000-2009 for the rectangle is £2,276, 858 (KEOWFE, 2011).

Analysis of the data indicates that:

- Within the 12 NM limit, a range of gears are used including: otter trawls, pots, drift nets, gillnets and trammel nets;
- Mechanised dredges are also used in rectangle 31F1 (however, discussions with Thanet Fishermen's Association indicate that shellfish dredging does not generally take place in the vicinity of the cable route, with the exception of Pegwell Bay in some seasons);
- Lobster, whelks, crabs, scallops, cockles, Pacific and native oysters are the most important invertebrate species groups in terms of both weight caught and commercial value within ICES rectangle 31F1.

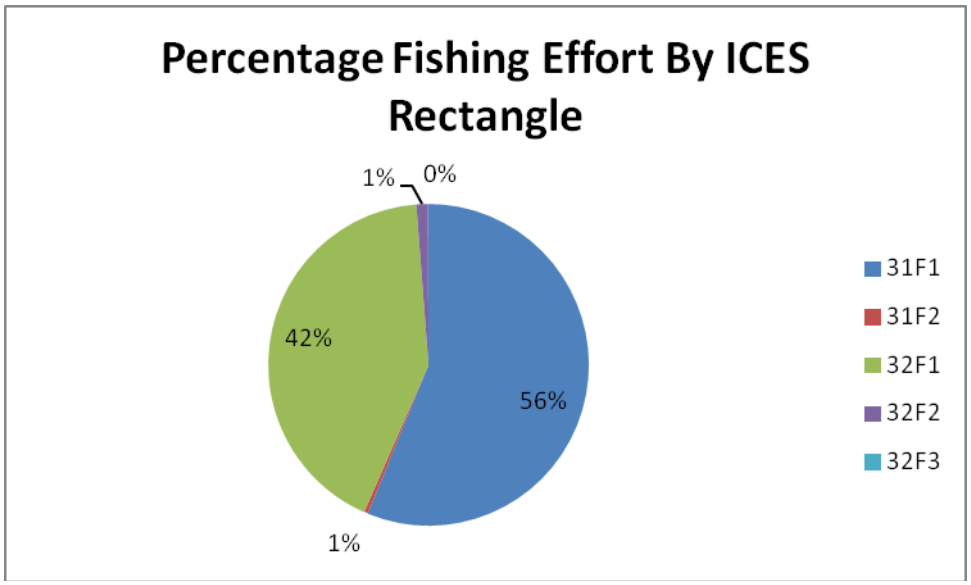

Figure 8-1-A: MMO data (2007-2011) showing the percentage of fishing effort (days at sea) expended in ICES rectangles surrounding the cable route

Between 2007-2011, sole remains the highest value species captured within ICES rectangle 31F1 (with an average of approximately £808,000). It is primarily targeted using otter trawls (bottom, twin or unspecified) or gillnets. Other high value species in this rectangle include bass, cod, lobsters, whelks and skates and rays. Figure 8-1-B shows the mean annual value of the top 15 most valuable catches in the ICES squares. It is important to note that this reflective of the commercial value of the species rather than catch volume, as each species has a different monetary value associated with it. Figure 8-1-C below illustrates the highest quantities of catch by species.

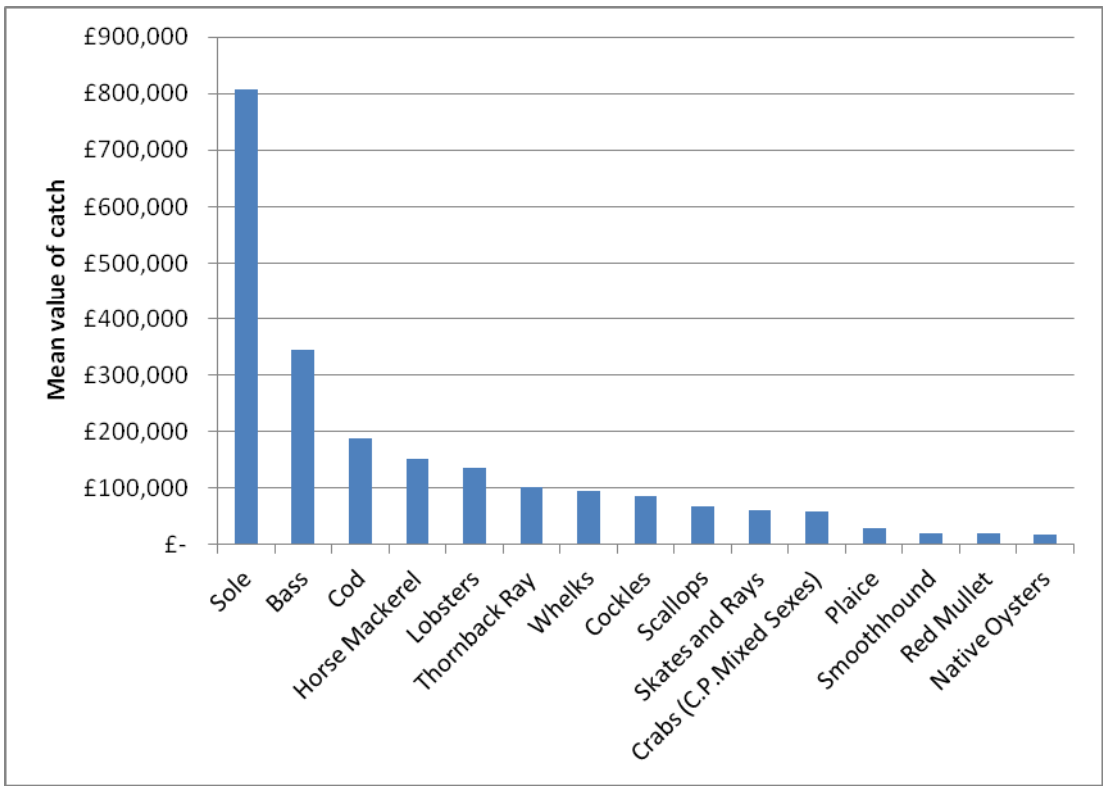

Figure 8-1-B: Mean annual value of the top 15 most valuable catches in ICES rectangle 31F1 (MMO, 2007-20011)

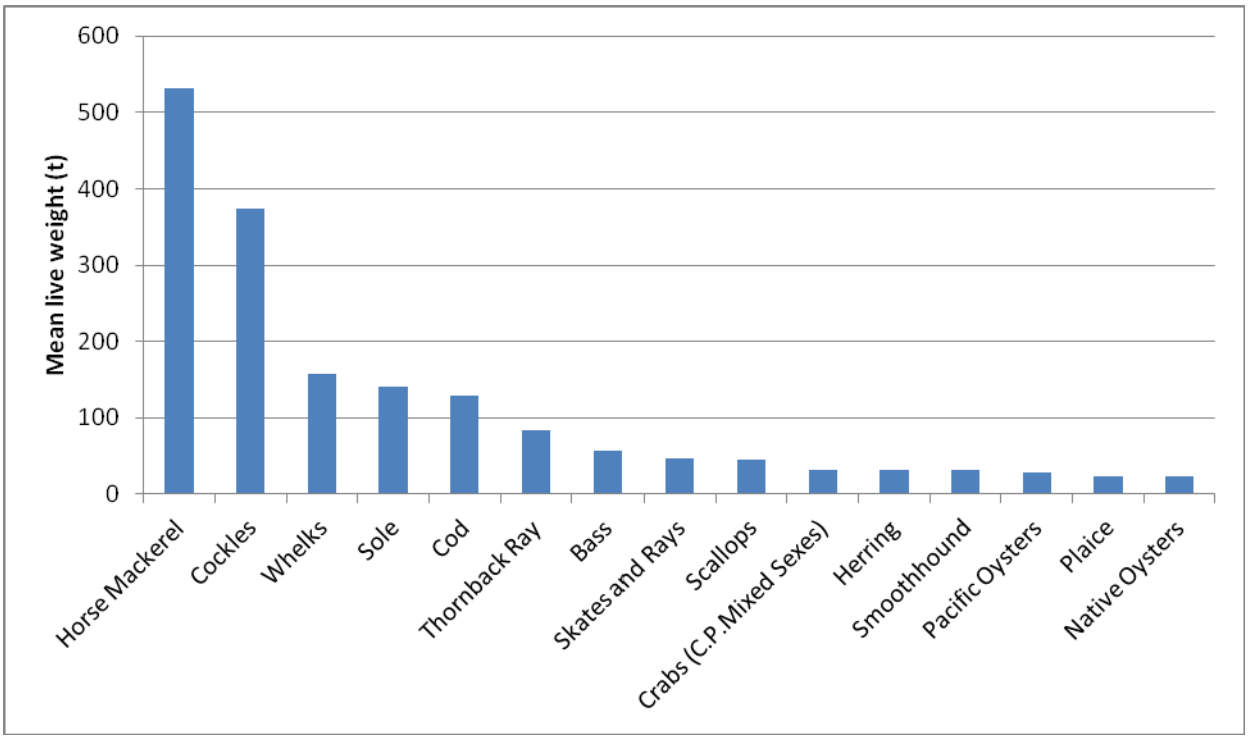

Figure 8-1-C: Mean annual live weight of the top 15 catches in ICES rectangle 31F1 (MMO, 2007-2009)

Landings and effort expended outside 12 nautical mile limit to median line

Figure 8-1-1 shows that a small portion of ICES rectangle 31F2 falls between the median line with France and the UK 12 NM limit, and that the cable route crosses this area. The data indicates that whelks, lobster and squid have the greatest catch value of shellfish species. However, finfish dominate landings in this rectangle, with plaice, sole, cod and bass being among the highest value species. . These species are most commonly caught with beam and otter trawls although gillnets are also used.

Fishing vessels and gear operating within the 12 nautical mile limit

Consultation with the TFA suggests that the key fisheries associated with the inshore fishing fleet that operate static trammel nets and drift nets as well as lobster and whelk pots in the area between the coast and the South Falls Bank. VMS data is largely congruent with the TFA information identifying the key fishing methods in the vicinity of the cable route as gillnetting, trawling, drift netting and potting (Figure 8-1-2). Consultation with KESFC (now KESIFCA) revealed that the area around Pegwell Bay is popular with very small day fishing boats (<8m) based at Ramsgate as the area is in easy steaming distance from the port.

The majority of vessels operating in 31F1 are <10m in length, between 2007-2009 89% of fishing effort in 31F1 was undertaken by <10m vessels, this rose to 93% between 2010-2011. Between 2007-2009, 10 % of fishing effort was undertaken by vessels between >10-<20m in length declining to 6% 2010-2011. Vessels >20m accounted for a mere 1% of fishing effort between 2007-2009 and <1% between 2010-2011.

Within 31F1 gillnets account for the highest value landings of the gears deployed by <10m vessels, followed by pots, otter trawls and trammel nets (ICES, 2011). (Figures 8-1-3 & 8-1-4).

Both set and drift gillnets are deployed. Drift gillnets are set to drift with the tide and cannot exceed 500m. The nets can drift approximately 2 NM during a deployment and the vessel stays with the gear for the entire time. These vessels operate in water depths between 10 and 30 m. Set gillnets are generally set diagonally to the tide in strong tidal areas. Trammel nets are similar to gillnets and other

fixed nets in terms of the basic fishing procedure. KEIFCA restricts the soaking time of nets to 30 hours and no net, or continuous line of nets is allowed to exceed 1km in length (KESFC, 2010). Trammel nets are an efficient general purpose net which can be used to catch a wide variety of fish species from cod to sole. The net consists of three walls of netting and there is plenty of slack netting to allow fish to become entangled in it (Marine Services, 2005).

Otter trawling consists of cone shaped nets towed across the seabed with otter boards which hold the horizontal spread of the net and keep the gear on or near the seabed. The speed ranges from 1.5 to 3 knots for 0.5 to 3 hours at a time. Multi-rigs are commonly used in the area surrounding the Nemo Link cable route.

Mid-water pair trawling involves two vessels towing a set of trawl gear. This method targets pelagic species rather than demersal species. All trawling vessels operating within the 12 NM limit are restricted to engine powers of 300 hp or less and have an average speed whilst towing of approximately 2.6 knots (4.63 km/hr). It is generally accepted that vessels of this type tow for an approximate average of 1.5 hrs at a time (KESFC pers. comm.). A vessel therefore covers approximately 7 km in one tow.

Baited crab, lobster and whelk pots are strung together on a lead line of up to 20 pots. The pots are laid at water depths usually between 5 and 35 m and are allowed to soak for 12 to 48 hours before they are retrieved.

Although the available data indicates that mechanised dredges for shellfish are used in rectangle 31F1, discussions with TFA indicate that they are not being utilised within the vicinity of the cable route.

Ports in the local area of Thanet include Ramsgate, Broadstairs, Herne Bay and Margate. Whitstable is sometimes listed within this group, however it is outside of the Thanet area and so was not included. Ramsgate, Folkstone and Whitstable are key ports for landings from rectangle 31F1 and the rest of this region. To give an example of the landings to these ports during 2011 into Whitstable £64,786 worth of seabass, £4,544 of cod, £14,224 of skates and rays and £27,111 of sole was landed, whereas Shellfish landings were dominated by whelks with a value of £59,071 followed by £34,744 of oysters and £29,357 of lobster (although this landings data does not state the ICES rectangle in which catches were made) (MMO, 2011).

Fishing vessels and gear operating from the 12 nautical mile limit to median line

A small portion of ICES rectangle 31F2 falls between the median line with France and the UK 12 NM limit, and that the cable route crosses this area.. Of the fishing effort (days at sea) recorded in this rectangle with 56 % was undertaken by vessels less than 20m between 2007 and 2009 and a mere 15% from 2010-2011. Only 24 % of fishing effort recorded in this rectangle was by boats greater than10-m but less than 20m between 2007-2009, declining to 3% from 2010-2011. Vessels <10m in length accounted for 20% of recorded effort there between 2007-2009, this increased to 82% 2010-2011 a trend which mirrors and increase in <10m fleet and improvements to engine capacities. The lack of exploitable shellfish beds and the large distance small fishing vessels would have to travel to reach offshore grounds in this rectangle result in less diverse fishing activities occurring than in more inshore areas. Within 31F2 beam trawling accounts for the highest value of catch per by gear type, vessels generally tow at speeds (ranging from 5.5-7.5 knots) for 1.5 -2 hours with beams up to 24m in aggregate width. The next highest values of catch were captured using trammel nets, then by otter trawls. Trammel nets are used to target cod in this area while the beam and otter trawls capture a wide range of species including bass, cod, plaice, brill, sole, turbot, skates and rays (ICES, 2011). _

Traditionally landings caught in ICES rectangle 31F2 have not been of great significance to local ports with catches tending to be landed into foreign or more distant British ports.

Seasonality

The fisheries in the vicinity of the proposed cable route are seasonal in nature and also restricted by quotas, both within the 12 NM limit and between the 12 NM limit and the median line. Figure 8-1-D below shows the months when 10% or more of the mean yearly catch is landed based on MMO ICES rectangle data.

Species name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horse Mackerel												
Cockles												
Sole												
Cod												
Skates and Rays												
Sprats												
Thornback Ray												
Plaice												
Whelks												
Bass												
Herring												
Scallops												
Crabs (C.P.Mixed Sexes)												
Pacific Oysters												
Lobsters												

Figure 8-1-D : Lists the top 15 most commonly caught species in the ICES rectangles surrounding the cable route (2007-2009). Months when 10% or more of average yearly catch is landed are shown in dark blue and months where less that 0.05% of the years catch are landed are shown in white, those in between are shown in light blue.

Figure 8-1-D is based on 2007-2009 fish catch data and indicates that the majority of species are caught year round including; sole, cod, skates and rays, thornback rays, plaice, whelks, bass, crabs, pacific oysters and lobsters. However, it is acknowledged that seasonality of fisheries is highly variable as it relies on as fishing effort (dependent upon a number of variables such as weather, sea temperature, quota etc.) and therefore it is not directly equitable with fish abundance. Seasonality is displayed by the majority of species and is reflected in the fishing activities employed by fishermen throughout the year. The winter fin-fishery targets cod, herring, mackerel and sprat, while key summer species are seabass, Dover sole and Thornback ray. With the exception of scallops that are a winter fishery most shellfish are targeted in spring (whelks) and summer crab, lobster and oysters.

Anecdotal evidence from the Thanet Fisherman's Association (TFA) indicates that seasonal variation in the targeting of different species by fishermen is also dictated by when fish quotas have been reached, this is generally supported by the Thanet Offshore Wind Farm Environmental Statement (TOW ES). . There were, however, some differences including that Thanet considered most plaice to be caught in spring and summer while the data above suggested it was not a seasonal catch. While, the data above suggested lobster were caught mostly in summer the Thanet ES suggested lobsters were not seasonal However, it is important to note the potential for seasonal variability when considering this anecdotal evidence.

The MMO data (2007-2011) reflects the seasonal variation in the use of different fishing methods and the general trend for increased fishing activities throughout summer months.. Many gears e.g. gillnets, trawls and pots are used year round as they target different species at different times of the year e.g. gillnets target cod in winter and seabass in summer, dredgers target scallops in winter and oysters in summer (ICES, 2011).

Restrictions to fishing activity in the area crossed by the cable route

Fishing activity in the vicinity of the Project cable system is affected by a number of restrictions defined by the EU Common Fisheries Policy (CFP) and local KEIFCA byelaws and agreements. The key geographical restrictions are outlined below

- The CFP allows EU member states to fish up to the 12 NM limit.
- Vessels operating between the shore and the 6 NM territorial limit are restricted in length to 17 m or less (KESFC, 2010).
- Vessels operating between the shore and the 12 NM limit are restricted to engine power of 300 hp or less and an aggregate beam length of 9 m.
- Vessels operating between the 12 NM limit and the median line are restricted to engine power of 2000 hp or less and an aggregate beam length of 24 m.
- No fixed engine (staked nets) shall be set within a radius of 1.5 nautical miles of the chimney of Richborough Power Station, Kent (51018.56'N, 010 20.85'E) from April to September (KESFC, 2010).
- There is a seasonal closure zone to the north of the cable route in ICES rectangle 33F2 with a radius of 10 nautical miles, closed from January to April[2].
- KEIFCA By-Laws:
- Application to fish for scientific or breeding purposes
- Whelk Pot Limitation Emergency By-Law
- Winkle closed season
    - Lobster permit
    - Dredging for, fishing for and taking of oysters & clams and removal of cultch
    - Fixed engines (nets)
    - Fishing for and taking of whelks
    - Vessel length
    - Fishing instruments (permitted fishing methods)
    - Trawling exclusion
    - Scallop closed season

Shellfish harvesting is also governed by a number of separate restrictions to encourage sustainable exploitation of the resource. These include restrictions relating to the size and engine power of vessels and the size of the dredge heads used as well as the enforcement of "closed" seasons. Cockle vessels are restricted to a power of 300 hp or less and dredge heads cannot exceed 76 cm in width. The fishery is also closely monitored throughout the year via enforcement of set quotas along with minimum shell landing size and maximum shell damage rates. The Thames Estuary Cockle Fishery Regulating Order (1994) divides the Thames Estuary into regulatory fishing areas which are illustrated below (Figure 8-1-E). The Nemo Link cable route only crosses the South Kent Coast to Dungeness area which falls outside of the estuary and is not covered by the Thames Estuary Fishing order (1994).

[2] In 2011 this seasonal closure zone was reopened on the 1 March.

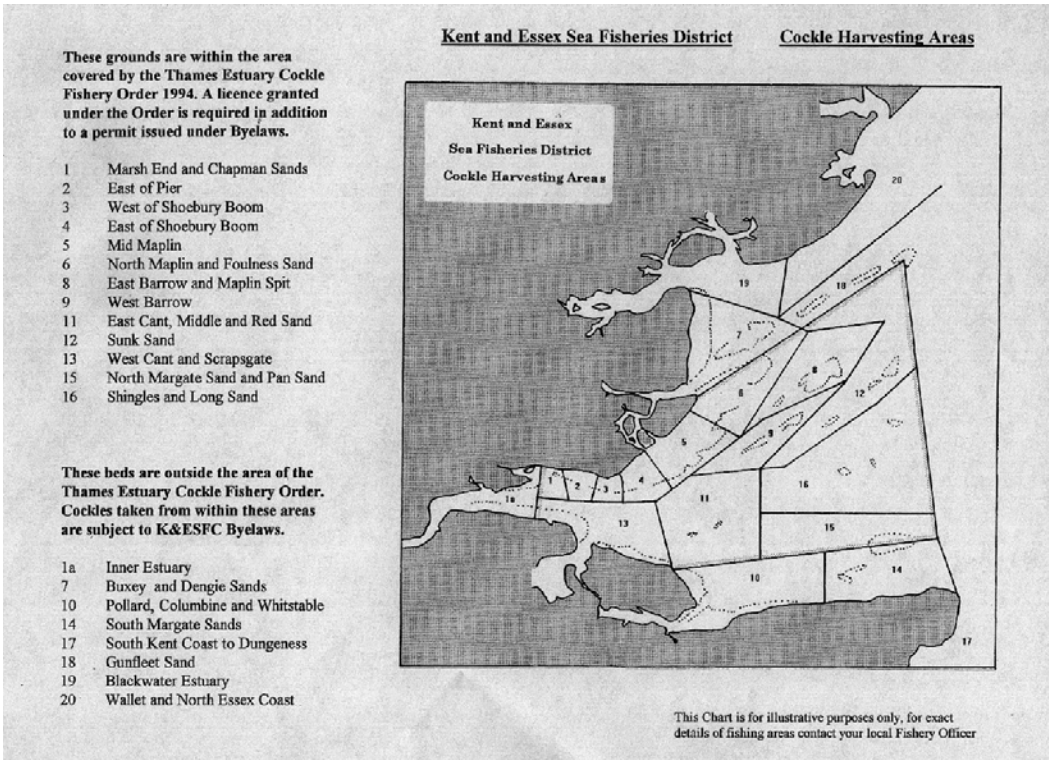

Figure 8-1-E : Kent and Essex Sea Fisheries District showing the cockle harvesting regulatory areas

8.1.4. Description of potential impacts

The table below provides details of how receptor value has been defined for the purposes of the impact assessment. A detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Fishing rendered permanently impractical or impossible over an area of national commercial importance. The viability of regional fishing fleet is threatened.
Medium	Fishing impractical or disrupted over an area of regional commercial importance. The viability of local fishing vessels is threatened. Temporary loss of income .
Low	Fishing impractical or disrupted over a local area. Loss of income to some local vessels. The viability of fishing is not threatened.

Table 8-1-1 : Definition of receptor value

The possible impacts on commercial fisheries both inshore and offshore of the 12 NM limit are discussed below. Impacts on fish ecology are discussed separately in Section 7.5 – Fish and Shellfish Ecology. Impacts upon commercial fisheries during the installation, operation and decommissioning of the Project cable have been quantified on the basis of quantity of fishing grounds affected during these phases.

The table in Appendix 6 provides the detailed impact assessment work. The information below provides a summary of the key findings of the impact assessment.

Consultation with the TFA suggests that key fisheries liaison issues will be with the inshore fishing fleet that operate static trammel nets, drift nets and lobster and whelk pots in the area between the coast and the South Falls Bank. Vessel Monitoring System (VMS) data is largely congruent with the TFA suggestion and identifies the key fishing methods in the vicinity of the cable route as gillnetting,

trawl, drift nets and potting (Figure 8-1-2). Based on the MMO data (2007-2011), the TFA and the VMS data it appears the most significant fishing types within the area are:

- gillnetting
- trammel netting
- trawl
- drift net
- pots

Commercial fisheries may be affected in four ways:

1. During installation there will be a mobile exclusion zone of approximately 2 km by 1 km around the cable laying spread, moving at the rate of installation, which will be typically 300 m/h. Fishing vessels using drift nets and trawl gear will be required to avoid this temporary exclusion zone.

2. Direct disturbance of any seabed fisheries (e.g. beam trawling, potting, dredging and fixed net grounds). The footprint of the burial machine used will be a maximum of 10 m in width. The maximum trench width will be 1–2 m if a jetting machine is used and less if a plough is used. The creation of a trench into which to lay the cables may disturb objects (e.g. clinker and shells) present in the first 1-2 m of sediment, and leave some of these on the seabed surface. Although these features would be unlikely to impede a trawler which happens to tow over the cable, it may render the ground too rough for fine gillnetting gear.

3. Indirect disturbance of the fishery due to the dispersal of sediment displaced during pre-sweeping and burial of the cable. There are three areas that are expected to require pre-sweeping within British waters these are at Kilometre Points (KP) 82.3 to 87, KP 99 to 100.8 and KP 123 to 123.5. The approximate extraction dredging from these regions is expected to total 118,778 m^2.

4. Cable protection and rock placement at cable crossings may exclude some types of gear being used for fishing the area directly over the cable and damage may be caused to fishing gear that is used over the cable.

Based upon the discussion above the following impacts have been assessed:

- Displacement of fishing activity within the area of temporary exclusion zones and the indirect impacts on fishermen outside of the cable installation area by the displaced vessels
- Disturbance of bottom trawling and dredging activity that will need to avoid the installed cable and associated cable protection
- Damage to certain types of fishing gear (for example, risk to nets and pots laid along the route etc.)

Installation Impacts

A 2 km^2 exclusion zone will be a temporary measure that will move with the installation array at 300 m/hr (typically) and therefore it is expected that any hindrance to fishing activity would be for a relatively short period of time. The entire installation phase in UK waters is expected to take less than 3 months, although it is likely that each ground will be affected for a few weeks given the nature of cable route installation.

Displacement of fishing activity

Marine cable installation is likely to take place between the months of April and October, which is when sole, thornback rays, cockles, whelks, Pacific oysters, crabs and lobsters are mainly being targeted. Most fishing methods are used throughout the year, in particular gillnetters operate with no seasonal peak in activity. The use of trammel netting peaks from June to October and the majority of

trawling occurs from April to October as weather conditions during the spring and summer months are usually more favourable. Some fishermen will experience a temporary loss of traditional fishing grounds in the immediate vicinity of the cable route, during the installation of the cable. Only a very small area of total available fishing grounds will be affected at any one time and only for a short period of time therefore it is predicted that only an impact of minor significance will result.

Fish stock displacement

Indirect impact to the commercial fishing industry may occur through impacts on fish and shellfish species due to sediment re-suspension and deposition. The dredging or pre-sweeping of sand waves will account for approximately 95 % of the sediment released during installation, the remaining 5 % of sediment will be related to the cable burial activities. Impacts of sediment re-suspension and deposition on fish and shellfish are discussed in Chapter 7.5 – Fish and Shellfish Ecology.

Operation Impacts

Damage to fishing gear
Damage to certain types of fishing gear, especially drift and trammel netting, may occur during the operation phase of the project as a result of rock placement for cable protection or interaction with material used for cable crossings. There is one cable crossing between the landfall and the UK median line. Although this crossing will require the placement of rock or concrete mattresses it will be over a very limited extent; approximately 30 m wide along a 100 m of the cable route. Given the limited spatial extent of the area affected in relation to the total fishing area available the impact on commercial fishing activity is expected to be negligible. It is, however, understood from the local fishing industry that Thanet Offshore Wind Farm and the BritNed cable, have had some challenges burying cables to a depth of 2m (pers comm. W. Wright, KESFC, May 2011). Thus it is acknowledged that it is possible that rock armouring may be required if sufficient burial cannot be achieved in particular areas. If this is the case, it is likely that the impact will increase to minor significance due the increased area that would become difficult to fish with trammel and drift nets. This is likely to be perceived as a large level of change to the small number of day vessels that fish the inshore area around Pegwell Bay who will find it difficult to travel to alternative fishing areas. However it is not possible to determine the level of impact until the location or extent of any potential rock armouring is known. It is important to note that any rock armouring required for cable protection will require a separate Marine Licence application to be submitted which would be accompanied by a full assessment of the likely effects of that rock placement.

There is a potential risk of drift and trammel nets becoming snagged and damaged as a result of rough ground or anchor mounds created during the cable laying process. Burial in hard ground is most likely to increase the potential for snagging of fishing gear. Seabed surveys indicate that much of the seabed is fine sand and gravel in the area crossed. Hard ground, in the form of chalk, is expected to be encountered over a 15 km stretch of the cable route, running between KP 100 and 115, spanning the 12 nautical mile limit (see Chapter 4 – Project Description). This represents a very small area in relation to the total available fishing ground. Additionally the project will aim to bury the cable at a depth of 2-3m below the seabed. At this depth it is unlikely that trawlers will snag the cable and this should ensure that should a trawler accidently trawl over the cable system it is unlikely that there will be damage to their equipment or vessel. Taking this and the temporary nature of the exclusion zone into account it is anticipated that installation impacts on commercial fisheries will be minor.

Reduction in fish stocks
A minor impact on fish resources in the vicinity of cable is expected during cable operation. Emissions of electromagnetic frequencies (EMF) and heat from the cable or accidental contamination by vessels or equipment may lead to disturbance of sensitive species, spawning and/or nursery grounds. These impacts on fish are discussed further in Chapter 7.5 – Fish and Shellfish Ecology.

Displacement of fishing activity
Trammel and other set nets and pots will be displaced from the one crossing where rock placement has been used. Static nets are mostly used within the 12 NM limit. Bottom trawlers and dredgers are expected to be displaced from the length of the cable route as this fishing method may lead to cable

snagging/ exposure. The area that the cable occupies is relatively small in comparison to the total trawling area, it is therefore expected that the cable will cause an impact of **minor** significance to commercial fishing.

There will also be brief periods of repair and survey work during the life of the cable, these will cause similar disruption to the construction period but will likely be on a smaller scale and shorter in duration. Overall it is expected that impacts during the operation phase of the project will be **minor.**

Decommissioning Impacts

It is likely that any impacts during decommissioning will be similar to those experienced during installation. It is often the practice to leave cables on the seabed after they are no longer in service as this action often causes the least environmental disruption.

8.1.5. Mitigation measures

During cable installation a Fisheries Liaison Officer (FLO) will be employed from the local fishing industry to ensure that interactions between the cable installation vessels, personnel and equipment and fishing activity are managed. It is proposed that detailed information (including locations and programmes) about installation, maintenance and survey work be passed on to the FLO in good time before the installation work commences. This will help to ensure that disturbance to fishing is kept at a minimum. Additionally to this Notices to Mariners (NtM), will be issued in good time to advise fishermen of where and when the installation spread will be operating, as well as the expected vessel speed. Local fishing associations will also be contacted directly.

Post-installation fishermen will be advised of the presence and location of the operational cable system via the Kingfisher Cable awareness charts. This will enable them to avoid interactions between their fishing gear and the cable system during its operational phase. If any geophysical surveys are to be completed prior to construction, these will be used to identify any debris or rough ground. Findings will then be compared to any post-construction geophysical survey results to assess whether the cable laying process has created rough ground that may snag fishing gear. Furthermore, if complete burial of the cable is not possible, the fishermen will be consulted on the burial solutions under consideration so that any potential impacts to fishing can be assessed as required.

In the event a trawler was to snag the cable it is unlikely the vessel would have sufficient power to bring the cable off the seabed. The vessel is more likely to back down the gear to try and dislodge it from the cable, or otherwise cut the gear. A strategy for dealing with/compensating fishermen for gear snagging will need to be developed. A handful of vessels may have winches with adequate pulling force to damage the cable. In reality these low-powered vessels are at greater risk keeping their vessel stable if entanglement occurs, rather than cause the cable damage.

8.1.6. Residual impact

Installation

The impact on displacement of fishing activity is likely to remain negligible if the above mitigation measures are implemented. The likelihood of any impact will be reduced to unlikely if Notices to Mariners are issued to fishermen (given the short term disturbance to fishing grounds and the range of fishing grounds in the area), as this will allow fishermen time to plan alternate fishing for this period. .

Operation

The likelihood of damage to certain types of fishing gear will be reduced if Notice to Mariners are issued to fishermen and fishermen are advised of the cable location via the Kingfisher Cable

Awareness charts. The overall impact is predicted to be reduced to negligible significance if the above mitigation is implemented.

Decommissioning

The impact on displacement of fishing activity is likely to also remain negligible if the above mitigation measures are implemented similar to that experience in installation (given the short term disturbance to fishing grounds and the range of fishing grounds in the area). The likelihood of any impact will be reduced to unlikely if Notices to Mariners are issued to fishermen.

Details of the full impact assessment are included in Appendix 6.

8.1.7. References

- ABPmer Ltd (2009) Development of spatial information layers for commercial fishing and shellfishing in UK waters to support strategic siting of offshore windfarms. Commissioned by COWRIE Ltd (project reference FISHVALUE-07-08).
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- MM0 (2010C) UK Fishing Industry in 2010 Structure and Activity http://www.marinemanagement.org.uk/fisheries/statistics/documents/ukseafish/2010/structure_activity.pdf

- http://www.vattenfall.co.uk/en/file/110321_Section_13_Commercial_Fisheries_V3.0.pdf_17881609.pdf

8.2. Shipping and Navigation

8.2.1. Baseline data sources

The following sources of information were used as per MCA guidance;

- Admiralty Charts (Chart Number 323)
- DECC Maritime Data including International Maritime Organisation (IMO) routing, Recreational Routing and Radar recordings from Dover Vessel Traffic Services (VTS) and AIS data.
- MGN 371 - Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues.
- DECC Methodology for Assessing Marine Navigational Risk
- RYA Data - RYA Sailing Areas, Racing Areas and Cruising Routes Data

To ensure impacts on shipping and navigation in UK waters are fully assessed, this chapter assesses the impact upon shipping and navigation out to longitude 2° 08'E (which is in French Waters) as requested by the MCA (Captain Clive Lane – 22nd November 2010). Specialist environmental consultants are undertaking similar studies for France and Belgium.

8.2.2. Baseline

The planned cable route transits through several areas of dense marine traffic and IMO designated shipping routes (as shown in Figure 8.2.1). Figure 8-2-A provides an overview of a month of AIS data from summer 2012.

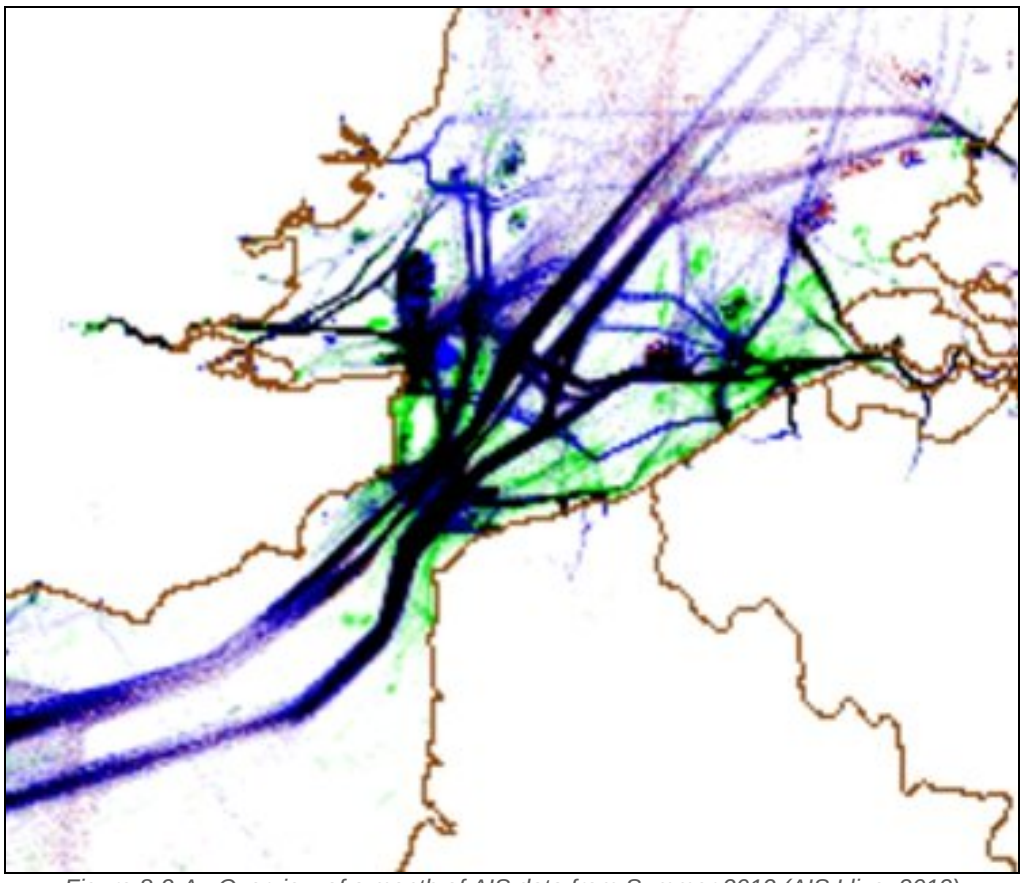

Figure 8-2-A : Overview of a month of AIS data from Summer 2012 (AIS LIive, 2012)

A baseline navigational review has been undertaken of the proposed cable route and impacts have been informed and assessed using information on the existing level of sea use in the area. The following significant marine risks have been considered:

- the potential for installation of the cable system to pose a hazard to marine navigation in terms of significant risk of vessel collision;

or

- the potential for installation of the cable system to pose a significant obstacle to navigation in terms of causing significant diversion of vessels' passage from their normal route through the area.

It is expected that a Safety Zone of 500m by 1000m with the major axis lying along the direction of travel will be in force during the cable installation at any one time, and that the rate of cable lay will be in the range of several hundred metres to 1km per hour.

The main navigational areas crossed by the cable system in UK waters are detailed below.

Ramsgate Harbour Approaches

Traffic within this area is within buoyed or depth constrained channels and is multi directional. Within the buoyed channels, traffic is diverse including recreational, commercial and passenger ferry traffic. Outside of the main buoyed channel, the traffic is smaller and combined with recreational craft. RYA data indicates that there are recreational racing and sailing areas within vicinity of Pegwell Bay and a number of heavy and medium cruising routes will be crossed by the cable route.

Ramsgate Harbour Approaches are covered by Channel Navigation Information Service (CNIS) radar coverage, required reporting area (CALDOVREP – Vessels 300GT) and CNIS Vessel Traffic Services (VTS) Coverage area. See Section 8.2.5.1 for description of the role of CNIS. Required reporting and VTS coverage means that all vessels transiting the CNIS and VTS are required to report in and are monitored through the area. This includes the provision of information and navigational warnings.

The cable also crosses the Port of Ramsgate port control reporting area, although it remains south of the West Cardinal Buoy which marks a sand bank and therefore also remains south of the main Ramsgate approaches and buoyed channel (as shown on Figure 8-2-B).

The tidal stream sets across the harbour entrance in a north easterly / south westerly direction, with the north going tide running from about 1½ hours before high water to 4 hours after high water. A risk exists from vessels Not Under Command (NUC) which could drift towards the installation spread. Guard vessels shall therefore include procedures for dealing with a vessel Not Under Command.

There are small craft holding areas, for when large vessels are transiting the break waters and awaiting marina openings. These are located directly to the north and south of the buoyed channel. As these are located along different sections of the cable route, either one could be used during installation works, depending on the position of the installation spread.

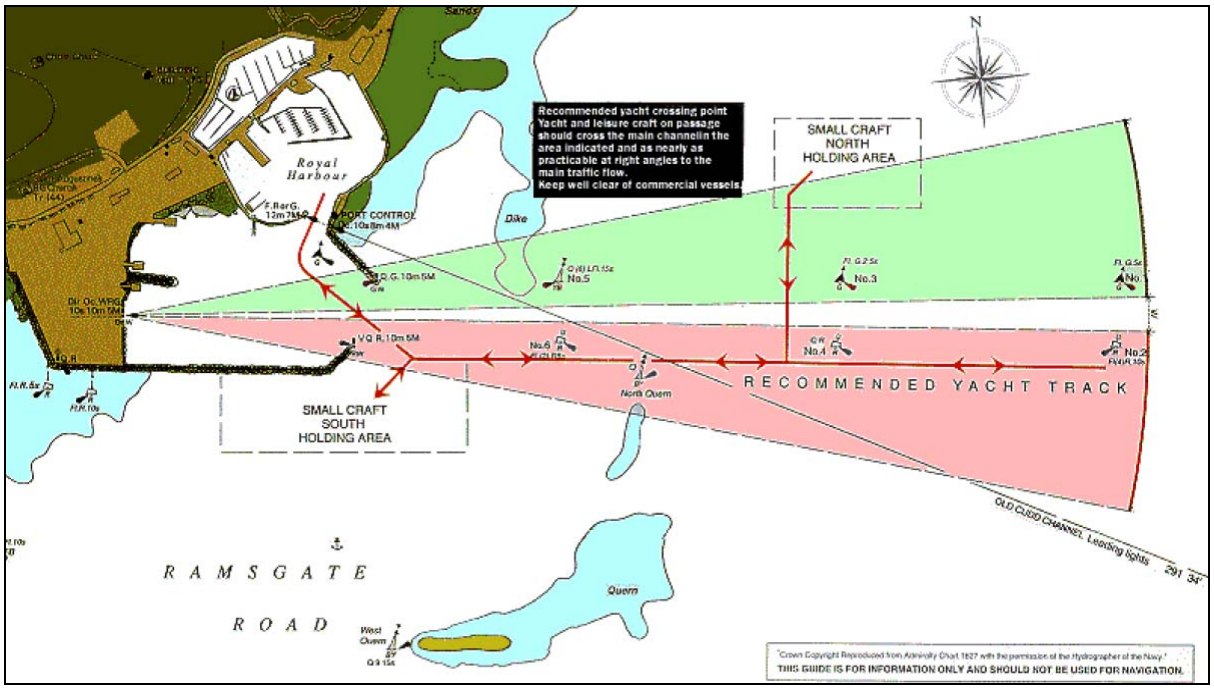

Figure 8-2-B : Small Craft Holding Areas - Ramsgate Harbour Approaches (Source: Port of Ramsgate, 2011)

Radar data indicates that a small number of small craft approach Ramsgate from the south via the Ramsgate Channel and Gull Channel (see Figure 8-2-A). Larger vessels using the Gull Channel continue to enter Ramsgate Harbour via the main buoyed channel turning between the South and East cardinal buoys just north of the proposed cable route. This would be a potential be risk area during cable laying due to surrounding shallow banks, converging and crossing of traffic and pilotage movements.

Ramsgate Harbour operates a Pilotage system; the Pilot station is located over 2 nautical miles north of the proposed cable route and operations should not interfere with the boarding of pilots. Communications should however be maintained with the Pilot service and a watch maintained on the ports working channel (VHF Channel 14).

There are heavy and medium Royal Yachting Association (RYA) recreational routes that transit across the proposed cable route. The cable route passes through areas used for RYA racing and there are a number of seasonal buoys (April to September only, unlit yellow spherical buoys) within the vicinity of the cable route. There are seasonal variations in recreational activity which mean heavy levels of recreational activity during late spring, summer and early autumn seasons including the Royal Harbour Yacht Club who have a yacht racing week in July and August. Separate consultation with local and national water sport associations will be required to ensure that installation can be timed to avoid major recreational events.

Inshore Shipping Route

The inshore shipping route (see Figure 8-2-B) is generally used by medium sized vessels transiting between UK coastal ports and therefore is not required to comply with the Traffic Separation Scheme (TSS). The traffic is multi directional within these areas.

The western inshore traffic route where cable laying will occur is covered by CNIS radar coverage, which incorporates the required reporting area and CNIS VTS coverage area. The eastern inshore traffic route is within radar coverage but outside of the VTS and reporting areas. However vessels generally call the VTS in advance of reaching the designated CALDOVREP line and therefore within the vicinity of the cable installation vessels should already be in contact with CNIS.

Vessels enter Ramsgate Harbour via the main buoyed channel and turn south of the north east Goodwin buoy and directly north of the proposed cable route. This would be a potential high risk area during cable laying operations due to surrounding shallow banks and converging / crossing of traffic. This would need to be mitigated by use of guard vessels and promulgation of information to mariners.

There is also high level of fishing activity within the vicinity of Ramsgate and the inshore routes (see Chapter 8.1 – Commercial Fisheries for further details. Although the effect on the fishing activity will be assessed separately, there will also be the potential for displacement of fishing vessels into areas used by commercial and recreational craft during installation works. Consultation will be required with local fishing organisations (this will be undertaken via the Fisheries Liaison Officer) and extensive promulgation through Notice to Mariners and Kingfisher Bulletins.

Rule 10 of the International Regulations for Prevention of Collisions at Sea (COLREGS) and its effects on traffic within and in proximity to Traffic Separation Schemes (TSSs).

Rule 10 of the International Regulations for Preventing Collisions at Sea 1972 (as amended) and also known as the COLREGS, specifies the conduct of vessels in (TSS) adopted by the IMO.

The installation of the cable may at times prevent vessels, especially crossing vessels, being able to fully comply with the requirements of Rule 10 however this should not significantly increase the risk if effectively mitigated through promulgation of information and traffic management.

South West (SW) Traffic Separation Scheme (TSS) Lane

The cable installation across the SW TSS lane is within radar coverage but outside of the VTS and reporting areas.

The traffic is dense but controlled by the rules of the TSS. The cable lay area crosses the SW TSS lane within the vicinity of traffic crossing the Channel.

Within and around the lane there are also a number of recreational routes (including sailing and recreational diving excursion transit routes) and fishing areas. No wrecks, used for recreational diving, are crossed and therefore impacts would be from a traffic management perspective rather than interference with the diving.

A temporary and minor displacement of commercial vessels and recreational craft is expected to occur but can be mitigated with effective promulgation of information.

North East (NE) Traffic Separation Scheme (TSS) Lane, Deep Water Route and Restricted Vessels

The cable laying with the NE TSS lane will be within CNIS radar coverage and CALDOVREP reporting areas.
The traffic is dense but controlled by the rules governing the TSS. The area where the cable installation will cross is at a wider section of the lane allowing adequate room for vessels to manoeuvre around the installation vessels.

As with the SW lane a temporary and minor displacement of commercial vessels and recreational craft is expected to occur but can be mitigated with effective promulgation of information.

The NE TSS lane is also used as a deep water route and deep draught vessels will be restricted in their manoeuvrability and navigational choices. These vessels are extremely slow to manoeuvre and need to make early course alterations. The slow speed at which the cabling will be undertaken, early notification and communication with the vessels will help mitigate risk.

To the East of the Sandettie Bank is the second NE route (non deep water). The cable route crosses to the north east of the Sandettie Buoy. An area of increased risk will occur due to the shallow Sandettie Sand Bank to the west which means vessels can only alter course to the east. Again early

communication with vessels, promulgation of information and the guard vessels will help mitigate this temporary risk.

Crossing Channel Traffic

As noted above the cable route is in close proximity to the main cross Channel route. Rule 10 (of the COLREGS) states that vessels crossing a TSS must do so on a heading as near as practicable to right angles to the direction of traffic flow. The main area of increased risk is within the SW lane where the cable installation takes place in close proximity to the main cross channel route. Areas of concern would include areas where crossing traffic, including high speed ferries, comes into close proximity with the traffic in the south west TSS lane and the cable installation spread. The crossing traffic is restricted in its movement by the requirements of Rule 10 COLREGS which states that vessels crossing a TSS must do so on a heading as near as practicable at right angles to the direction of traffic flow. There is adequate water depth to allow crossing vessels to make small course adjustments and still be able to meet the requirements of Rule 10 of COLREGS.

8.2.3. Description of potential impacts – Installation & Decommissioning

For shipping and navigation, installation and decommissioning impacts are considered to be similar.

As any effects on shipping and navigation are more risks than impacts it is not appropriate or meaningful to assign a receptor value in this analysis, although a detailed assessment of the risks has been included in the impacts matrix in Appendix 6. This impact assessment therefore outlines the risks and associated mitigations that will reduce the risks to as low as reasonably practicable.

8.2.3.1. Temporary mobile Safety Zone around the cable recovery spread/s

Potential impacts from the temporary Safety Zone, as outlined in the baseline section, are as follows:

- Displacement of shipping vessels and recreational craft from the area surrounding the cable laying spread. This would be of particular concern for:
  - Cross Channel Ferries and their ability to comply with Rule 10 of COLREGS including interaction with other traffic within the TSS.
  - Commercial vessels and recreational craft crossing the TSS and their ability to comply with Rule 10 of COLREGS including interaction with other traffic within the TSS.
  - Recreational craft and commercial vessel interaction.
  - The Deep Water Route and the restricted manoeuvrability of vessels using it.
  - Creation of choke point in the vicinity of Sandettie Buoy where manoeuvrability of vessels altering to avoid the installation is restricted by the shallow water of the Sandettie Bank.

- Impeded access to the Port of Ramsgate
  - Minimal impact on Pilotage activities.
  - Inshore and recreational traffic when installing in proximity of channels such as limited use of Gull Stream during installation within the channel.
  - Interaction and congestion in vicinity of NE Goodwin Buoy.

Displacement caused by the works is considered to be a temporary and low impact and effects mitigated with methods listed in 8.2.5.

8.2.4. Description of potential impacts – Operation

8.2.4.1. Electromagnetic Interference (EMI)

Concern has been expressed on similar projects as to the potential for vessels navigating with magnetic compasses being affected by the Electro Magnetic Field (EMF) associated with operational

HVDC cables. An increase in risk would occur particularly in areas of a restricted nature such as in channels and in proximity to banks such as Sandettie. Hence, there is an increased risk of vessels running aground or collisions particularly during periods of restricted visibility. The MCA has confirmed that compass deviation of less than 5 degrees would be acceptable in terms of risk to vessels.

8.2.4.2. Emergency Anchoring within Vicinity of Cables.

Although there are no designated anchorages crossed by the cable route within UK waters there is still a requirement for adequate cable protection post installation. This will be required in order to mitigate against anchor damage to the cable system in the event that a vessel needed to deploy an anchor in an emergency in the vicinity of the cable. Although accidental anchor deployment is unlikely, and damage to a vessel minimal, should an instance occur significant damage could be sustained to an unprotected cable. It is therefore in the interests of the Project to ensure the cable system is well protected by suitable burial methods.

Receptor Value	Definition
High	Permanent disruption to an IMO shipping route, a route used by vessels of limited manoeuvrability resulting in an increase in journey distances, permanent disruption to a shipping route resulting in unacceptable impacts on the safety of navigation. Permanent disruption to commercial shipping routes.
Medium	Permanent disruption to a recognised shipping route, but alternative route does not result in additional journey times or impacts on the safety of navigation.
Low	A temporary and minor impact resulting in displacement for vessels and obstruction of navigational routes. A permanent but minor (e.g. within the 5 degree limit outlined by the MCA) effect on compass deviation.

Table 8-2-1 : Definition of Receptor Value

8.2.4.3. Cable Exposure

Should any part of the cable become exposed for extended periods, additional mitigation measures may be required to protect both the cable and prevent vessels potentially interacting with it and potentially becoming snagged. Mitigation measures could include buoyage as per Trinity House Lighthouse Service (THLS) requirements or additional guard vessel cover depending on the density of traffic within the vicinity.

8.2.5. Mitigation

A temporary, minor displacement of shipping activity is expected to occur during cable installation. Due to the speed and size of the installation spread it will only require temporary mitigations to aid the flow of traffic and prevent high risk choke and crossing points for vessels. Any impacts on vessels navigating in the region will be temporary and only affect a limited area at any given time. The mitigation measures outlined below will be implemented for the installation works to ensure that impacts upon shipping and navigation are minimised.

8.2.5.1. Cooperation with Channel Navigation Information Service (CNIS)

The objective of the CNIS is to contribute to the safety of navigation in the Dover Strait by encouraging vessels to comply with IMO procedures for vessels navigating within a TSS and to provide the latest information to shipping on activities, conditions and navigational irregularities which may affect safe navigation.

The mandatory reporting scheme, CALDOVREP, and the area radar coverage provide substantial risk mitigation for the cable installation. It is important for the project to communicate its planned operation with advance notification and daily reports to CNIS.

The CNIS area is monitored by Dover Coastguard Station in the UK and Cap Gris Nez Station in France.

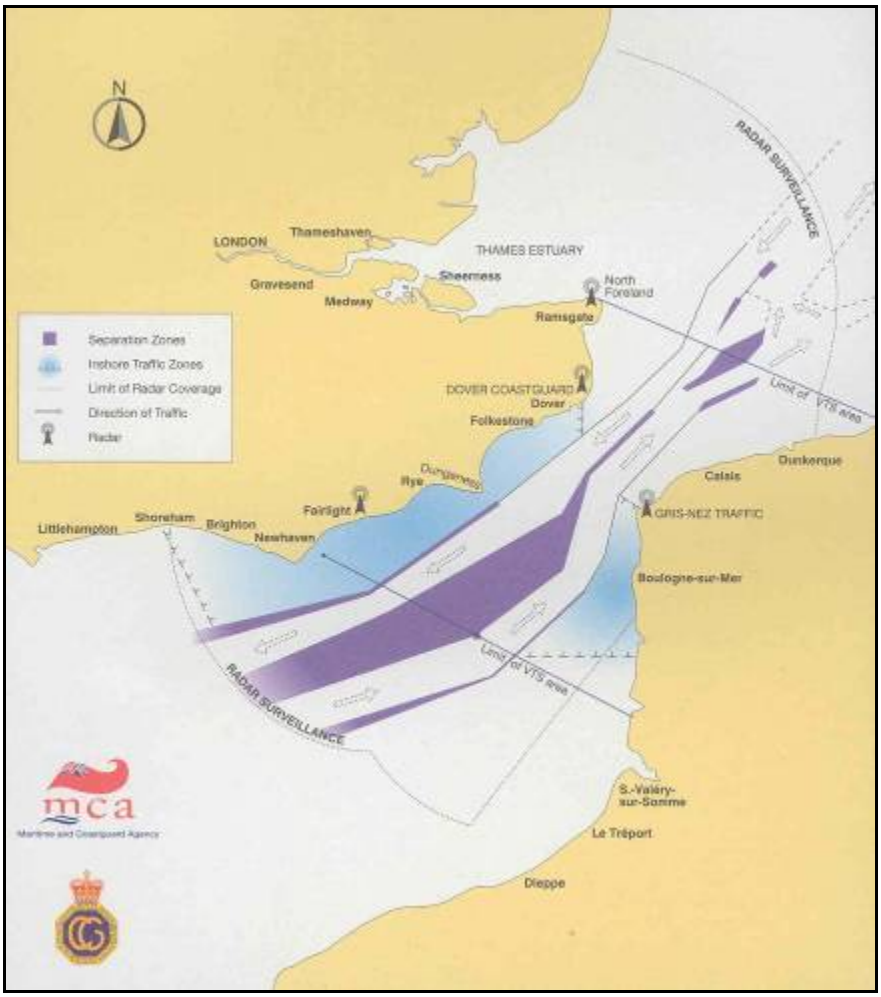

Figure 8-2-C : Extent of Dover Straights TSS (Source: MCA, 2011)

A regular plan for communication including daily position and activities will be established with CNIS to ensure that there is a continual two way flow of information. A communications plan will be in place prior to commencement of works and will be controlled by the installation contractor.

Although an unlikely occurrence, occasionally 'rogue' vessels still transit the TSS. These are vessels that are not in communication with CNIS as required by CALDOVREP regulations. Should a situation occur, guard vessel response plans shall include procedures for dealing with the 'rogue' vessel.

8.2.5.2. Provision of an Emergency Response Coordination Plan (ERCoP)

The HSE representatives for the offshore operations will provide an Emergency Response Coordination Plan to cover all phases on the Project. This ERCoP will be required to be approved by

the Maritime and Coastguard Agency. This plan will include details of cooperation with the CNIS, MCA emergency response resources, Ramsgate Harbour and Pilot.

8.2.5.3. Promulgation of Information to Mariners

Safety information will be promulgated by the installation contractor in accordance with MCA guidance and through the United Kingdom Hydrographic Office (UKHO) who promulgate maritime safety information and update nautical publications including NAVTEX, Local and National Notice to Mariners. Safety information and notices will include a description of the operation and area of operation and will be regularly updated to show accurate information on the current location of the installation spread and the names of the vessels onsite including clear identification of the guard vessels.

Kingfisher Information Service who provides accurate positional information for all offshore surface and sub-sea hazards will also be notified so details of the works and final cable route can be published in their bulletins.

Local recreational and fishing organisations will also be notified by the installation contractor via a Fisheries Liaison Offiscer (FLO).

8.2.5.4. Guard Vessels

Guard vessels will be assigned to both protect and support the cable laying activities and will be chosen according to speed, maritime equipment provision and endurance.

Two guard vessels shall be assigned to the installation spread. One guard shall provide close protection to the installation vessel spread whilst a secondary vessel will be available to enable interaction with any rogue vessels or vessels in distress approaching the spread.

A clear vessel management and response plan will be provided by the vessel operators which will include communication and cooperation with Ramsgate Harbour, Ramsgate Pilots, channel ferry operators, CNIS and other Emergency Response Resources in the area.

8.2.5.5. Lighting and Marking

The cable installation vessels will show such lights and shapes as required by the COLREGS.

8.2.5.6. Cable Protection

Rock placement/mattresses are currently only intended to be used at cable crossings (there are no pipeline crossings in the UK). Burial depths will be determined based on estimated anchor and fishing gear penetration depths and precedent. Captain Lane of the MCA recommended that cable burial should be an absolute minimum of 0.5m along the entire length of the route.

8.2.5.7. Emission of EMF from cables and magnetic compass interference.

A study was undertaken as part of the BritNed Development (2004) to determine the maximum deviation possible from a DC interconnector of similar specification to the Nemo Link cable system. The study found that the deviation was less than 5 degrees (SwedPower, October 2003). The MCA confirmed these levels of compass deviation are acceptable. Due to similar burial depth / voltage, it is assumed that similar levels of maximum deviation will be present upon installation of the Nemo Link cable and therefore would be within MCA acceptable limits.

8.2.6. Residual Impacts

It is expected that the implementation of the above mitigation measures will mean that the residual effects of the development on any shipping and navigation receptors will be **minor to moderate** (see Appendix 6 for details of impact assessment).

The risk of collision with other vessels during construction has been considered to be reduced to minor significance in view of the mitigation measures such as the communication of safety information, establishment of safety zones enforced by guard vessels, continuing consultation with appropriate shipping and navigation stakeholders and the requirement for vessels to comply with lighting and marking requirements. Likewise the risk of electromagnetic interference affecting navigational instruments, has been reduced to minor significance taking into account the previous work completed by the BritNed development which measured electromagnetic interference at less than 5 degrees deviation, which was confirmed by the MCA to be an acceptable level of deviation for compasses.

In relation to anchoring, the armouring of the cable and burial to a safe depth in addition to charting the position of the installed cable are considered to significantly reduce the risk of anchoring along the cable route. However, anchoring of vessels remains a moderate risk.

8.3. Archaeology and Cultural Heritage

8.3.1. Introduction

The Nemo Link passes through English Territorial Waters (to the 12 nautical mile limit) and extends beyond the limit to the UK EEZ (see Figure 8-3-1). This section provides a brief overview of legislation and guidance – more detail can be found in the marine archaeology desk-based assessment Volume II (Wessex Archaeology 2011) and a full report covering French, Belgian and British waters can be found in Appendix 12.

From the low water mark to the 12 nautical mile limit, the archaeology and historic environment is under the responsibility of English Heritage who are a statutory consultee to the Marine Management Organisation in relation to heritage matters relating to environmental impact assessment or appropriate assessment in relation to marine development. In addition, some UK legislation applies to English wrecks whether in English or international waters. In general, newly discovered maritime sites in the UK are not automatically protected under the current legislation until a request for protection is formulated following an identified threat upon the site or an evaluation of its particularity. Military aircraft are however automatically protected. The current legal framework relates to the Ancient Monuments and Archaeological Areas Act (AMAA, 1979), the Protection of Military Remains Act (PMRA, 1986) and the Protection of Wreck Act (PWA, 1973).

International heritage policies can apply beyond a country's territorial waters. Current international law such as UNCLOS Articles 149 and 303, places on signatory states, a direct duty of care in regards to wrecks and other submerged historic environment resources. Additionally, some indirect regulation arises from the environmental controls placed on the regulated exploitation of natural resources.

Legislation in England is currently under review. Although not yet ratified, the draft Heritage Protection Bill, published in 2008, has been designed to unify the terrestrial and marine heritage protection systems, and will replace the provisions of the Planning (Listed Buildings and Conservation Areas) Act (1990), the Ancient Monuments and Archaeological Areas Act (1979) and the Protection of Wrecks Act (1973). But as in the present situation, the laws and guidance mentioned above are in force.

8.3.2. Baseline data sources

The principal sources consulted in drafting this chapter of the Environmental Statement comprise:

- United Kingdom Hydrographic Office (UKHO) wreck record;
- English Heritage's National Monuments Record (NMR);
- Kent Historic Environment Record (Kent HER);
- Previous archaeological studies in the area;
- A wide range of secondary sources, including those providing an overview of the historical and archaeological resources of Kent, France, Belgium and the Southern North Sea, and with particular reference to:
- sources related to historic shipping patterns and potential wreck sites and casualties, specifically *England's Shipping* (Wessex Archaeology 2003) and *Navigational Hazards* and *Areas of Marine Archaeological Potential* projects (Bournemouth University 2007, 2008, Seazone ongoing);
- sources related to historic aviation patterns and the potential for aircraft crash sites, specifically *Aircraft Crash Sites at Sea* (Wessex Archaeology 2008b) which provided an understanding of the potential density and general distribution of wartime aircraft activity across the English Channel;
- sources relating to the palaeoenvironment of the Southern North Sea, with specific reference to submerged palaeolandscapes and coastal change; and
- sources related to the terrestrial and marine historic environment of Kent, including the South East Research Framework (Kent County Council), the Maritime and Marine Historic

Environment Research Framework (University of Southampton, ongoing); the Isle of Grain to South Foreland Shoreline Management Plan (South East Coastal Group 2010).

- Geophysical data provided by Marin Mätteknik (MMT) AB that had been gathered from the Study Area during the summer of 2010, including: sidescan sonar, sub-bottom profiler (sparker and boomer), multibeam bathymetry and marine magnetometer datasets; and
- Geotechnical data provided by Marin Mätteknik (MMT) AB including 100 vibrocore logs and 10 actual vibrocores acquired from the Study Area during the summer of 2010.

8.3.3. Baseline

8.3.3.1. Introduction

This section covers a brief summary of the known and potential archaeological features present or potentially present in the study area. Further details can be found in the full technical report compiled by Wessex Archaeology for PMSS (Wessex Archaeology 2011).

8.3.3.2. Known Archaeological Features within the Study Area

The following presents a summary of the known and potential archaeological features in the vicinity of the marine cable route and landfall (Figure 8-3-2), further details can be found in the Desk-Based Assessment (Wessex Archaeology 2011):

- In the broad vicinity of Pegwell Bay:
  - 2 Listed Buildings
  - 69 other archaeological sites and findspots, dating from the Neolithic to modern period
- In English Waters:
  - 5 sites of anthropogenic origin of archaeological interest identified or confirmed by the archaeological assessment of geophysical survey data including:
  - 1 previously unrecorded wreck (located in the English Exclusive Economic Zone);
  - 4 further geophysical anomalies of anthropogenic origin and archaeological interest, including a live obstruction recorded by the UKHO;
  - 123 additional geophysical anomalies of possible archaeological interest;
  - 19 wrecks and obstructions recorded by the UKHO but outside of the geophysical survey area;
  - A number of channels of probable prehistoric date and potential archaeological interest.

Table 8-3-1 provides additional information about the five sites of anthropogenic origin considered to be of archaeological interest and confirmed by the archaeological assessment of geophysical survey data.

WA ID	Classification	Easting	Northing	Description
7024	Wreck	389786	5685532	Previously unrecorded wreck identified at least partly ferrous in nature by all geophysical equipment. Structure is relatively small and appears to be mostly buried, though still retains some structure and height. The wreck is orientated NNE - SSW, and is situated within a scour approximately 30m x 11m x 0.4m. A large sand wave lies to the north and east, so the structure is probably periodically buried (Figure 8-3-3).
7027	Debris	391279	5685143	Located in an area of sand ripples and probably partially buried ferrous debris or the remains of a badly degraded structure, identified originally as a medium magnetic anomaly (Figure 8-3-4).
7047	Debris	394777	5685245	Probably an area of ferrous debris, or the remains of a highly degraded structure, associated with a medium magnetic anomaly (Figure 8-3-5).
7049	Debris	395957	5685445	Large, elongate feature (or collection of features) upstanding and associated with a small magnetometer contact. Identified on multibeam

WA ID	Classification	Easting	Northing	Description
	[Live Obstruction]			bathymetry data as a depression measuring 22m x 15m x 0.5m, probably representing a scour. Probably an area of debris or the remains of a badly degraded structure. Observed at the location of a known obstruction (foul ground).
7098	Debris	416527	5686440	Two poorly defined, short, parallel linear dark reflectors with shadows possibly associated with a small magnetic anomaly. Possible partially buried ferrous debris (Figure 8-3-6).

Table 8-3-1 : A1 Geophysical anomalies of archaeological interest

Further details about other sites mentioned in this Chapter can be found in Appendix 12.

8.3.3.3. Potential Archaeology within the Study Area

Introduction

The baseline study revealed potential for as yet undiscovered sites and material dating from the Palaeolithic to the modern period, including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material. In the Palaeolithic and early Mesolithic, hominin populations occupied, when habitable, vast plains that extended between England and the Continent, and since the inundation of the Southern North Sea and English Channel, people have travelled across the waters in a variety of ever increasingly technologically advanced watercraft. Since the Neolithic, settlements on both sides of the Channel have flourished. The historic environment of the Kent coast and English territorial waters in between have to be viewed as a continuum, since the activities that shaped the cultural heritage land and seascape are intertwined.

Chronologies

Archaeological material is generally studied within a framework of 'Periods' or 'Ages' which reflect the activities and cultural changes taking place over time. However, because of geographical and cultural differences, the chronologies are defined slightly differently by each country. The following table provides a rough overview of the chronologies (Table 8-3-2). Note that for archaeological studies of the Palaeolithic period, dates are expressed in terms of years Before Present (BP), whereas from the Mesolithic period onwards, absolute (or calendar) dates are used, either in Before Christ (BC) or *Anno Domini* (AD).

Period Names	Dates for England
Palaeolithic	~900,000 BP-9500 BC
Mesolithic	9500-4000BC
Neolithic	4000-2200 BC
Bronze Age	2200-700 BC
Iron Age	700 BC – AD 43
Romano-British/Gallo-Roman	AD 43- AD 410
Anglo-Saxon	AD 410-1066
Medieval	1066 – 1500
post-medieval	1500 – 1800
Modern	1800 – present

Table 8-3-2: Chronologies

Palaeolithic

There were several periods during the Lower and Middle Palaeolithic (1,000,000 BP to 18,000 BP) when the Study Area would have been dry land. Areas that are now submerged would have been part of a vast plain, and the temperatures would have been moderate enough to be habitable (see Panels A, B, C Figure 8-3-7).

The Lower Palaeolithic begins with the earliest hominin occupation of an area: in Britain, evidence from the site at Happisburgh suggests that it could have begun over 900,000 years ago (Parfitt *et al*. 2010, Roberts and Grün 2010). There is extensive evidence for Lower Palaeolithic activity in Kent, particularly from the Thames gravels and other rivers, where artefacts were deposited as glaciers melted (Scott 2004: 7). At the end of the glaciation, as temperatures had begun to rise, there is evidence for hominin occupation in Kent, as three pieces of skull were found in the Upper Middle Gravels at Swanscombe (dated to c. 423,000 BP) (Scott 2004: 7).

The emergence of *Homo neanderthalensis* (Neanderthals) in the Middle Palaeolithic (around 300,000 – 40,000 BP) led to European-wide changes in technology. Middle Palaeolithic deposits have been found in Kent during quarrying (Scott 2004: 7).

The Upper Palaeolithic (roughly 40,000 BP to 10,500 BP) provides evidence for the emergence of *Homo Sapiens* in northern Europe. During the Devensian glacial maximum (roughly from 20,000 - 15,000 BP), sea levels were at a maximum of approximately 120 m lower than today (Pieters *et al.* 2010: 81). However, although the ice sheets did not reach as far south as the Study Area, the cold climatic conditions would have rendered the area difficult to occupy; at this time, the landscape in Britain would have resembled Arctic tundra. As glaciers began to melt, the area would have been impacted by major changes to river systems as a result of meltwater. As soon as climatic conditions ameliorated however, humans reoccupied the landscape. In Britain reoccupation appears to have begun around 13,000 BP (Scott 2004: 8).

Mesolithic

At the beginning of the Mesolithic, sea levels were still considerably lower than present with the sea level in Kent thought to be 40-65 m lower (Young 2004: 3). As a result of these lower sea levels, the Southern North Sea was a vast plain which comprised a habitable landscape, intersected by strongly flowing rivers (Scott 2004: 9). As sea levels rose the landscape became increasingly difficult to traverse, and human groups in Britain became increasingly isolated. By around 6700 BC, sea levels reached around 25 m lower than present, and the North Sea and the Channel flooded, breaching the Dover Straights. Britain was finally isolated from Europe around 6300 BC. A considerable amount of this now-drowned landscape is preserved underwater, and has been explored through projects such as Doggerland (Gaffney *et al.* 2009). In Kent, find types include stone, antler and bone tools possibly for tree felling and woodworking, however, there is little direct evidence for hunting and gathering activities (such as bone assemblages or plant remains). By the end of the Mesolithic, the majority of the cable route would have been completely submerged. The southern part of Pegwell Bay would also have been submerged, as part of the Wantsum Channel, which was not reclaimed until the post-medieval period. The northern part of Pegwell Bay (on the historic Thanet Island) remained dry land.

Neolithic

During the Neolithic, there is considerable evidence for cross channel traffic, such as the transport of material (including the many species of plants and animals that were used for food production but were not native to Britain) as well as the ideas of farming and animal domestication. The Neolithic period began in England around 4000 BC, and evidence includes particular styles of earthworks, causewayed enclosures, long barrows, evidence for pottery and the emergence of henges. It is not surprising that Kent was one of the first regions in England to undergo the economic, technological and social changes associated with the Neolithic period, as its proximity to the Continent was no doubt a great influence. There is evidence of pottery and a causewayed enclosure near Ramsgate (Ashbee 2004: 11). During the Neolithic, maritime transport was characterised by log boats and skin boats which are likely to have continued in use. These early logboats are from a time when sizeable trees

and appropriate tools were just becoming available. The earliest logboat in Britain was discovered at Locharbriggs, Scotland, and dates to around 1860 BC (McGrail 1998: 86).

Bronze Age

From the beginning of the Bronze Age, the expansion of trade in metals involved cultural contact through a system of sea routes which connected a network of rivers and roads used as the dominant way of transporting goods and people (Philippe, 2009, Lebecq, 1994). By the late second and early first millennia BC, active trade networks focussed on the transport of bronze implements (Cunliffe 2009, Muckelroy, 1981; O'Connor, 1980). In addition to metalwork, the archaeological evidence from ceramics confirms maritime trade and the movement of goods across the Dover Straights area and the southern North Sea (Piningre, 2005). Settlements in Kent were focussed on coastal locations, major river valleys and estuary foreshores, particularly on either side of Wantsum Channel, which would have been a key navigation route for regional exchange (Yates 2004: 14). Trade across the Channel was accomplished using boats such as the Dover boat (Clark 2004). It was a 3000 year old sewn plank boat capable of crossing the channel while carrying a substantial cargo of supplies, livestock and passengers. The hazardous nature of these journeys is represented by the Langdon Bay wreck, which is thought to have been carrying a cargo of scrap metal from France to Britain.

Iron Age

Although some cross-Channel trade networks continued into the Early Iron Age (between the 8th and 6th centuries BC), the decreasing numbers of elite exchange items found in Britain suggests that the intensity of cross-Channel traffic had slowed down by the Middle Iron Age. By the Late Iron Age, contact between Britain and the Roman Empire had increased (Parfitt 2004: 16). As maritime trade increased, so did the importance of settlements along the Kent coastline, and there was a concentration of Late Iron Age settlements in the east of Kent and on the Isle of Thanet (Parfitt 2004: 17). Settlements at sheltered inlets would have provided convenient ports of entry and access, with major rivers providing further access inland (Parfitt, 2004: 17).

Romano-British Period

In Britain, Claudius' invasion force arrived at Richborough in AD 43, and Kent rapidly became the industrial heartland of *Britannia*, producing a considerable quantity of iron with pottery and building tiles also important (Andrews 2004: 20). In addition, towns emerged, coastal fortifications and new transportation infrastructure were built, and various religious centres developed (Andrews 2004: 20). The large concentration of fortifications around Kent's coast reflects its vulnerability to threats from the Continent and the need to secure the shortest Channel crossing routes. Richborough is a major example of coastal fortification (Andrews 2004: 21). In addition to international trade, there was considerable traffic along the coast as well, for example Ragstone, a building material quarry in the Maidstone area (Kent). It was not only widely used locally, but for transportation by barge to Londinium for the construction of its walls in the 3rd century (Andrews 2004: 20). Kent's marine resources were also exploited probably by small local fishing and oyster dredging boats, and salt production was undertaken in coastal areas by evaporating seawater in large shallow reservoirs of unfired clay (ibid).While the designs of some of the Romano-Celtic vessels likely restricted them to use in estuaries or other sheltered waters, others, such as 'Blackfriars I' from London and 'St Peter Port I' from Guernsey are thought to be have been seagoing (ibid).

Anglo-Saxon

The Anglo-Saxon period was characterised by an influx of Anglo-Saxon peoples and material culture from Germany and southern Scandinavia in the 5th and early 6th centuries, followed by Viking raids and later settlement in the 8th and 9th centuries. The traditional landing place of the Saxons in Kent is at Ebbsfleet, in Pegwell Bay, in AD 449. During the early part of the period, Anglo-Saxon activity in eastern Kent is identified through cemeteries and burials, with the majority of evidence confined to rivers and the coast (Riddler 2004: 25-28). The finds of ceramics in Kent highlight changes in maritime trade – in the 6th and 7th centuries, in addition to local ware, ceramics were also imported from north France, and around AD 750, Ipswich ware was being 'imported' (Riddler 2004: 28). The pottery could

have been transported in boats similar to the 7th century clinker-built wooden boat discovered in the ship burial at Sutton Hoo near Ipswich. It appears that England may also have had a distinctive shipbuilding tradition in the 9th to 14th centuries, as indicated by the Graveney boat, excavated from a former tidal creek of the River Thames, east of Faversham, Kent (McGrail 2004: 218).

Medieval

Around 1050, the Cinque Ports developed in Kent and East Sussex, and comprised Sandwich, Dover, Hythe, New Romney and Hastings. These were based on an informal coastal defence arrangement made in the reign of Edward the Confessor, where in return for substantial constitutional fiscal and trading privileges, the Ports were required to furnish, for limited periods, ships and crews for the King's service (Lawson 2004: 52). The Nordic or 'Keel' tradition of boat building, with double-ended clinker built wooden vessels, continued into the later medieval period. Ship's timbers from this type of vessel have been recovered from re-use-locations such as waterfront structures in London (McGrail 2004: 223). Examples of clinker built vessels have also been depicted on the 11th to 12th century Bayeux tapestry, and later on town seals. However, from the 13th and 14th centuries, vessels of the Nordic tradition become rarer. The 'Cog' appears to have developed in the 9th century and early documentary examples are associated with Frisian shipping and trade (McGrail 2004: 232). References to cogs increase considerably in the 13th and 14th centuries; the vessels were widely used by the Hanseatic League in northern Europe and traded between Britain and Ireland and the Continent.

Post-medieval

In the 16th century, maritime trade in Sandwich began to decline, however, some trade did continue with the Low Countries and the Baltic through the 17th century (Bower 2004: 66). Ramsgate and Margate had easily overtaken Sandwich in the tonnage of vessels based there. In 1701, shipping tonnage in Sandwich had increased to around 1000 tons, while at Ramsgate it had increased to 2500 tons (Lawson 2004: 91). When trade with the Baltic began to decline in the 18th century, trade expanded to the Mediterranean, West Indies and the Americas (Killingray & Compton 2004: 129).

The post-medieval period witnessed some major battles at sea – and many of them took place within the vicinity of the Study Area. In England, a carvel built vessel known as the 'Gresham Wreck', was discovered in 2003 in the Princes Channel in the Thames Estuary, and recovered in 2004 (Wessex Archaeology website). A small to medium sized ocean-going armed merchantman, the vessel was carrying a cargo of iron bars when it sank. Four cannons were recovered from the site. Another wreck site, with artefacts and bronze cannon that appear to date to the 16th century has been found in the Goodwin Sands.

Modern

In the late 18th and through the 19th centuries in Kent, ports and harbours were constructed and improved and piers were built to facilitate sea-borne freight and passenger landings (Killingray & Crompton 2004: 129). In 1800, merchant ships and fishing boats were being built at Ramsgate and Sandwich, and although Sandwich ceased to build ships in the 1830s, construction at other ports increased between 1800 and 1860 (*ibid*: 130). The import of coal from Wales and the North East for domestic use, gas works and later the railways was a major focus of maritime trade in Kent. Dover developed as the main cross-Channel ferry point, with regular cross-Channel steamboat services from the 1820s, and became a major shipping centre in terms of tonnage. The towns could also provide ships with supplies or repairs, and with boat pilots who navigated the ships past the Goodwin Sands and the shallows of the Thames Estuary. By the 1850s, Ramsgate had a fishing fleet 147 boats strong, each 35 tons or more, many of them were engaged in deep-sea fishing. The typical trawlers were still sailing vessels, and in 1914, Ramsgate had 172 sailing smacks. The lifeboat station at Ramsgate attests to the potentially hazardous nature of the sea and the Kent coast. Kent's long sea coast facing France and many north shore inlets made it a popular place for smugglers, and smuggling was a regular occupation of Kent sailors and fishermen. In the 18th and 19th centuries, smuggling increased, and the government made concerted efforts to suppress it. During the 19th century, ship technology underwent a revolution. The advent of steamships meant that ships were no longer at the mercy of wind and tide, and further advances such as the early steel-hulled ships meant

that ships were stronger than ever. In the UK, the vast majority of known shipwrecks date to the modern period.

World War I

In World War I, trade was disrupted, but economic and social changes were accelerated, as wartime industries expanded rapidly (Smith & Killingray 2004: 140). A vast number of Belgian refugees arrived in Kent between 1914 and 1915. Although aircraft were only just coming into their own, World War I saw the development of numerous airfields across Kent, such as at Ramsgate, Manston and Westgate (*ibid*: 141).

World War II

A coastal defence battery was located in the north of Pegwell Bay, and there were anti-aircraft batteries at Pegwell Bay, near Broadstairs and at Manston (Smith & Killingray 2004: 141). The anti-aircraft gun batteries were situated to protect vital infrastructure targets inland, such as the industries in Thameside, and they defended the enemy air routes to London. During the war Ramsgate was one of the 'most-raided parts of England' by air attacks (Whyman 2004: 179). In addition to being intermittently shelled by German guns from 1940-1944, roughly 1000 High Explosive Bombs were dropped on the city between 1939 and 1946 (Smith & Killingray 2004: 144-145). Airfields that had developed in World War I were revived, and Manston, located just inland from Pegwell Bay, was one of the main airfields during the Battle of Britain. A German Dornier 17 of the 'Blitz' Geschwader, KG3 crashed on the Sandwich Flats on 31 August 1940 after attacking Manston. A photograph of the air craft crash site in Pegwell Bay has been uploaded onto flickr (www.flickr.com, http://forum.12oclockhigh.net). However, positional data for the site remains vague and a detailed location has not been confirmed. Locals have mentioned that the bent propeller blades used to be visible in the intertidal zone at low tide, and parts of the aircraft may have found their way to the Spitfire Memorial Museum at Manston. Another German Dornier 17 has been discovered in the Goodwin Sands (Wessex Archaeology in press), and is located 200 m to 300 m from the shore in front of Deal, Kent, over 5 km south of the study area.

8.3.4. Receptors of Importance

8.3.4.1. Known or Potential Terrestrial Sites and Submerged Prehistory of Importance

This section provides information about the importance of terrestrial sites and submerged prehistory – shipwrecks and aircraft will be discussed in the following sections. In the UK, the criteria for scheduling ancient monuments (AMAA 1979) is based on a site's period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential. Also, current international law such as UNCLOS Articles 149 and 303, places on signatory states a direct duty of care in regards to wrecks and other submerged historic environment resources

This section does not present a detailed assessment of the importance of terrestrial receptors, as a detailed assessment will be undertaken by the onshore contractor in their archaeological assessment of the landfall area above mean high water and the onshore cable route. The information presented here was researched to assist in the interpretation of the maritime assessment, and further information can be consulted in the desk-based marine archaeological environmental impact assessment compiled by Wessex Archaeology (Appendix 12).

There are two Listed Buildings at the landfall, and these are protected by their designation. Although the majority of other known sites have not been designated or scheduled, this does not mean that they lack importance, and they may in fact fulfil many of the criteria. The fact that they are included in the National Monument Record, Historical Environment Record, indicates that they have at least some value as historic and archaeological resources.

Despite the fact that there are no known archaeological sites or material that date to the Palaeolithic, if any remains were to be discovered, they would be of considerable national and international

importance, as finds from this period are relatively rare in the British and European records (English Heritage 1998).

Finds from the Mesolithic would also be of importance because of their rarity. A number of palaeochannels of archaeological interest have been identified in the Study Area (Figure 8-3-8). The discovery of peat (**WA VC7**) highlights the potential of these palaeochannels to provide further palaeoenvironmental information, and in addition, they indicate the potential for additional archaeological material in the vicinity.

There are a wide range of known sites from the Neolithic to post-medieval period across the Landfall Study Area. These sites provide details that enrich the historic environment resource and are locally, regionally, and nationally important. Further discoveries of sites or material from these periods also have the potential to be of local, regional or national importance.

The coast of Kent played a key role in defending Britain against attack during both of the World Wars, and therefore military material is likely to be of heightened importance. There is a wide range of known and recorded military sites at the Kent Landfall from World War I and World War II. English Heritage has produced guidance for evaluating 20th century sites (English Heritage 1998, 2003). These guidances are based on the site's national importance or the presence of structures of special interest, as well as the site's survival or completeness, group value, rarity of building types and historic importance. Details about the sites not discussed above can be found in Appendix 12.

8.3.4.2. Known and Potential Shipwrecks of Importance

In the UK, criteria have been developed for the identification of the importance of shipwrecks, including the criteria for designating shipwrecks under the Protection of Wrecks Act (1973) (based on period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential), the criteria of the Protection of Military Remains Act (1986) (based on military status), and the criteria outlined in On the Importance of Shipwrecks (Wessex Archaeology 2006) (based on the concept of 'ship biography' and covering: build, use, loss, survival and investigation).

There are no protected wrecks in the study area. All wrecks located in the vicinity of the cable route are illustrated in Figure 8-3-9.

Two of the known wrecks in the Study Areas were lost due to acts of war (**WA7275, WA7276**), and two further known wrecks had been in military use at some point in their careers (**WA7270, WA7274**). The military associations of all of these vessels would indicate high importance.

The two relatively recent wrecks (**WA7017** (1995)**, WA7287** (1986)) may be regarded as having low archaeological importance. Other 'wrecks' with low archaeological importance include **WA7271** (abandoned four wheel drive vehicle)**, WA7273** (steel tank), and **WA7286** (abandoned Suzuki jeep).

It is not possible to assess the importance of two of the wrecks with the limited information available (**WA7272, WA7277**), or the wreck discovered through the archaeological assessment of geophysical data (**WA7024**) shown in Figure 8-3-3. Nor is it possible to assess the importance of the known obstructions or the geophysical anomalies of possible anthropogenic origin. As such, the importance of each site must potentially be regarded as potentially high until further information becomes available.

So little is known about shipwrecks before the medieval period that any wrecks discovered are likely to be of considerable special interest, in addition, post-medieval shipwrecks are also rare and would be expected to be of special interest. There are more examples of boats and ships from the 19th century, so greater discrimination would be required to determine which ones are of special interest, but ship technology was rapidly changing as were the way vessels were used and any wrecks that make a distinct contribution to understanding and appreciating these changes could be regarded as having special interest. As mentioned above, ships lost during the two World Wars could have increased importance. However, a special case would need to be made for any vessels lost after 1945.

8.3.4.3. Known and Potential Aircraft of Importance

The majority of aircraft losses in the 20th century have been related to military activity, and, as mentioned above, British aircraft lost while in military service are automatically protected by the Protection of Military Remains Act (1986).

There is a known report of a German World War II aircraft in the intertidal zone of Pegwell Bay, a Recorded Loss of a British World War II aircraft (WA1235) and considerable potential for the discovery of additional aircraft crash sites in the Study Areas. If the remains of any military aircraft were to be discovered, whether in English waters or in international waters, they would automatically be protected under the Protection of Military Remains Act (1986). These archaeological receptors would be of high importance. However, because these sites lack detailed positional data, they have not been illustrated in the figures.

Aircraft are also important because they provide a tangible reminder of the development of aviation in the UK and on the Continent throughout the 20th century. Because of their recent history, aircraft crash sites also have significance as survivors and living relatives may be found, and they are important for remembrance and commemoration. They also have importance through their cultural value as historic artefacts and for the information they contain about the aircraft itself and its circumstances of loss (English Heritage 2002, Wessex Archaeology 2008b).

8.3.5. Assessment of potential impacts

8.3.5.1. Overview

There is potential for impact to the known and potential archaeological receptors from route installation, operation and decommissioning activities. This section provides an overview of the impact assessment. A detailed methodology for the impact assessment, and further details about the results are outlined in the Desk-based Assessment (Wessex Archaeology 2011). The impact assessment was based on: the nature and magnitude of the effects and the value of the receptor, which has been determined from the receptor's sensitivity, recoverability and importance. Table 8-3-3 outlines the receptor values. Appendix 6 presents the impact assessment in table form.

Receptor Value	Definition
High	Designated receptor of national or international importance (e.g. intact, in situ feature of historical interest. Feature will be permanently damaged.
Medium	Receptor of non-designated archaeological importance, and/or interest, whether intact or of degraded quality (e.g. feature not intact or in situ). Feature will be permanently damaged.
Low	Receptor of limited archaeological importance/historical interest. Feature will not be permanently damaged.

Table 8-3-3 : Receptor Value

The possible impacts on known and potential archaeological receptors comprise damage or destruction to both archaeological material and the disturbance or destruction of relationships between material and the wider surroundings. Archaeological receptors include: known and potential terrestrial sites and findspots, submerged prehistoric archaeological material (including palaeoenvironmental evidence), shipwrecks, aircraft crash sites, associated material, and geophysical anomalies of possible anthropogenic origin.

The types of impacts can be described as direct, indirect, secondary and cumulative. Direct impacts are those that directly impact archaeological receptors on or under the seabed. Indirect effects are those beyond the primary footprint of the development, affecting archaeological sites or deposits that are located some distance away, for example as a result of changes to erosion/sedimentation regimes. Secondary impacts arise from activities that occur as part of the development process but

might not be considered to be part of the development as such, for example from anchorages for construction vessels. Cumulative impacts include: impacts occurring over a wider area as a result of various development activities; impacts within the development that affect different environmental topics; and visual impacts / changes to setting.

This section examines the potential impact based on the installation, operation and decommissioning activities, and explores the nature of the effect (the likelihood of potential impact, spatial extent , level of change and duration) in order to determine the magnitude of impact. The description of the receptor (its sensitivity to change, potential for recoverability and importance) are taken into account to determine the value of the receptor. The significance of impact is based on the value and sensitivity of the receptor.

Because of the nature of archaeological receptors, the vast majority of archaeological receptors have the same level of change, duration of impact, and sensitivity and recoverability. Therefore, these will be discussed first before identifying the individual impacts, in order to minimise repetition in the following paragraphs.

The level of change of known and potential archaeological receptors from direct and secondary impacts would be high, as any change would be more than what is predicted as part of the natural baseline. In addition, and as the archaeological receptors are sensitive to change and will not recover, the duration of the effects are long term, and therefore any change is permanent. The historic environment is a non-renewable resource, and once an archaeological receptor has been damaged or destroyed or its context altered it is not possible to repair or reinstate the lost value. Hence, the impact from a temporary anchorage is of the same magnitude as the impact from cable installation, because if an anchor is dropped on an archaeological receptor such as a wreck or dragged through the site the damage would be permanent.

The design of the cable route has been proposed in order to avoid all known wrecks. However, the following impacts are still possible.

As a result of pre-installation, installation, operation and decommissioning impacts, the following effects are possible and have been assessed:

- Potential damage or destruction of known marine archaeological receptors (submerged prehistoric archaeological material; shipwrecks; aircraft crash sites; associated material; and geophysical anomalies of possible anthropogenic origin) from direct or secondary impacts;
- Potential damage or destruction of the relationships between known or potential marine archaeological receptors and their wider surroundings;
- Potential damage or destruction of marine archaeological receptors as a result of indirect impacts, in particular changes to erosion and sedimentation regimes;
- Potential cumulative effects from a combination of seabed developments being undertaken in the area (i.e: other cable routes, offshore wind farm developments, port / harbour dredging, etc).

8.3.5.2. Installation impacts

There is potential for direct and secondary impact to archaeological receptors from route preparation and installation activities. The potential impacts that may occur (if no mitigation is applied) are detailed below and summarised in Appendix 6.

Damage or destruction of submerged prehistoric material below the seabed

The cable trench will have a width of 1–5m and a depth of 2-3m. It should be noted that the archaeologically interesting material from **WA VC7** (Wessex Archaeology 2011:16) was located 4.28 m below seabed and is unlikely to be impacted, however, it is possible that shallower sediments exist and may be impacted upon. The spatial extent of impact is within the immediate vicinity, as impact will

only affect the directly affected area. The level of change will be medium, as the archaeological receptor covers a wide area, and only a small section of it will be impacted. Duration of the effect will be long term. Overall, the magnitude of impact is moderate. The sensitivity of the receptor is medium, as some of the shallower sediments could have been reworked by natural processes, however, in areas where there are still sealed deposits, the level of change would be high, were it to occur. The recoverability is low as once damaged a receptor will not recover. Although submerged prehistoric material below the seabed is of high archaeological interest, because it has not been designated, it is classed as of moderate importance. The value of the receptor has been rated medium, and the overall impact would be **moderate** and negative should such material be disturbed

Damage or destruction of late 20th century wrecks (WA7017, WA7287, WA7292, and WA7303) and other 'wrecks' of low archaeological importance (WA7271, WA7273, and WA7286)

Impacts could occur as a result of:

- the pre-sweeping of sandwaves (to a maximum path width of 20 m)
- use of a grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (e.g. rock placement with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present
- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1 – 5 m wide and a depth of 1 – 2 m)
- cable burial
- use of anchors to maintain position of installation vessels.

These impacts are however unlikely, as the sites are located some distance from the cable route. The spatial extent of impact is low, as impact will only affect the direct area, and therefore these wrecks are unlikely to be impacted. However, any impact would cause a high level of change and be of long duration. Overall, the magnitude of impact has been determined to be moderate. The sensitivity of the receptors is high and recoverability is low. These sites are currently interpreted as of low archaeological importance because they represent modern material with low archaeological interest. Overall, their value is low, and the significance of impact is **minor**.

Damage or destruction of A1 (wrecks and geophysical anomalies of archaeological interest) archaeological receptors and A3 (historic records of possible archaeological interest with no corresponding geophysical anomaly) receptors

As these receptors are located some distance from the path of the cable route, they are unlikely to be directly impacted by the majority of cable laying activities, however there is still potential for secondary impacts from anchors. The spatial extent of any impact would be within the immediate vicinity. However, any impact would cause a high level of change – as the damage from an anchor could destroy an archaeological site, and the duration of that change would be permanent. The magnitude of the impact is considered to be moderate. The sensitivity of the receptors is high and the recoverability is low. These sites are not designated, however they are of archaeological interest, so their importance has been rated moderate. Overall, the value is high and the level of significance of impact is significant.

Damage or destruction of A2 (geophysical anomaly) archaeological receptors

Impacts could occur as a result of:

- the pre-sweeping of sandwaves (to a maximum path width of 20 m)
- use of a grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (e.g. rock placement with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present

- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1 – 5 m wide and a depth of 1 – 2 m)
- cable burial
- use of anchors to maintain position of installation vessels.

The likelihood of impact is almost certain, as a number of the A2 geophysical anomalies are located in the path of the cable route and therefore will be impacted. Additionally, there is also potential for anomalies located some distance away from the cable route to be impacted from anchors of installation vessels. The spatial extent of impact will be limited to the immediate vicinity of the receptors. The level of change from any impact would be high, and the duration of that change would be long term. Overall, the magnitude of the impact would be high. Although A2 geophysical anomalies have been identified of possible archaeological interest, as they could represent previously unidentified archaeological sites, there is also the possibility that they could turn out to be modern debris of no archaeological importance. For this assessment, a precautionary view has been taken – and the sites have been identified as having moderate archaeological importance,until proven otherwise. These sites and features are of high sensitivity and low recoverability. Overall, the value is high and the level of impact **significant**.

Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites)

Impacts may occur as a result of:

- pre-sweeping of sandwaves (to a maximum path of 20 m)
- use of grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present
- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1-5m and a depth of 2-3m)
- cable burial
- use of anchors to maintain position of installation vessels.

It is not possible to determine the location of potential archaeological receptors, as they could be obscured by sandwaves or could comprise archaeological receptors that are difficult to identify through geophysical survey. The likelihood of impact is assessed as possible, and any archaeological receptors that have been obscured by areas of sandwaves could be impacted by the pre-sweeping of sandwaves. There will only be impact in the immediate vicinity of any receptor, however, the level of change would be high and the duration long term. Overall, the magnitude of impact would be moderate. Hitherto unknown sites could be of considerable archaeological interest, and therefore they are considered to be of medium importance. The overall value is high based on the high sensitivity of the receptor and the low level of recoverability, and the impact would be **significant** and negative.

Damage or destruction of relationships between known or potential archaeological receptors and the wider environment

Impacts may occur as a result of:

- pre-sweeping of sandwaves
- use of a grapnel hook to clear obstructions
- construction of bridging and separation structures
- landfall installation activities
- trenching for cables
- cable burial
- use of anchors to maintain position of installation vessels.

The likelihood of impact is possible – if any archaeological receptors are impacted, their relationships with other receptors and the wider environment will be affected. In this case, the spatial extent is local

to regional, as archaeological receptors can have relationships with receptors within the vicinity but also international relationships based on their character, period, and a number of other factors. For example, submerged prehistoric material can have international interest and linkages, as can WWII shipwrecks or aircraft crash sites, while fishing vessels may have more local connections. The level of change from any impact could be high and the duration long term. Therefore, the magnitude of impact has been determined to be moderate. The sensitivity of the receptors is moderate and recoverability is low. No sites in the area have been designated, however they are still of archaeological interest and therefore their importance is considered to be moderate. Overall, the value is considered to be high and the impact would be **significant** and negative.

8.3.5.3. Installation and Operation

Changes to the erosion and sedimentation regimes during installation and operation could have a degree of impact as detailed below.

Indirect negative impacts on known or potential archaeological receptors and their relationships with the wider environment

Such changes could be caused by changes to erosion regimes at bridging structures (i.e. rock placement) – depending on the height of the bridging structure from the seabed. There is however unlikely to be an impact, as any changes to erosion regimes are expected to be within natural variation. The spatial extent would also be low, as the bridging structures are expected to be effectively flush with the seabed, and therefore any erosion would be localised. Should there be change, it could represent a significant alteration in local conditions for archaeological receptors – as any material that is exposed through erosion would begin to degrade and would be permanently damaged. Overall, the magnitude of this impact is considered to be moderate. The sensitivity of the receptors is moderate (due to the fact that most areas will already have been reworked) and recoverability is low. The importance of any receptors impacted by erosion is medium, and the value is considered to be medium. Overall, the impact is considered to be **moderate** and negative.

In areas where sedimentation is increased, the archaeological receptors will be afforded increased protection. There is unlikely to be impact, as any changes to sedimentation regimes are expected to be within natural variation. If there are any changes, they will likely be within the immediate vicinity of structures such as cable crossings which stand proud of the seabed. The level of change to archaeological receptors is expected to be medium, and the duration of change could be medium- to long-term. Overall, the magnitude of the effect is considered moderate. The receptors have a high level of sensitivity and a low level of recoverability. The importance of the archaeological receptors is rated medium. Overall, the value is high and the impact would be positive.

8.3.5.4. Operation and decommissioning

There is potential for direct and secondary impact to archaeological receptors from route operation activities.

Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors

Impacts could arise from activities including repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) as well as the removal of infrastructure (cable-de-burial, cable removal). Impact to archaeological receptors within the immediate vicinity of the cable route is expected to be unlikely at this stage, as any impact will already have occurred during the installation phase. The spatial extent of any change will be within the immediate area. The level of change will be low and the duration negligible. The sensitivity of the receptor is considered to be low, as the receptor would already have been impacted, and there is low recoverability. Although the importance of the receptors is medium, the overall value is low. This impact would be **negligible**.

Secondary impacts may also occur as a result of anchors used to maintain position of repair for decommissioning vessels. The likelihood of impact is possible. The extent of impact will be in the immediate vicinity of the works. The level of change to any impacted archaeological receptors would be medium, and the duration of impact would be long term. The magnitude of impact would therefore be high. The sensitivity of the receptors is low with low chance of recovery. The archaeological receptors are of archaeological interest but not designated and therefore are of medium importance. Overall, any impact would be **significant**.

8.3.6. Mitigation

With regards to the archaeological resource, international best practice and government policy favours preservation *in situ.* As part of the Nemo Link cable route design, all known wrecks were avoided.

A number of geological features of potential archaeological and palaeoenvironmental interest have been identified along the proposed cable route (see Figure 8-3-10), namely the terrestrial/estuarine deposits and palaeochannels. With regards to cores **WA VC7** (peat), a Stage 3 archaeological geotechnical assessment of the samples taken during Stage 2 would provide additional information about the palaeoenvironment and about changes that took place within this landscape. The Stage 3 assessment would comprise an assessment of the pollen, diatoms, foraminifera and ostracods within the sedimentary sequence and scientific dating and recommendations as to whether any further analysis is warranted. No additional vibrocores are needed to complete the Stage 3 scientific dating and palaeoenvironmental work.

Palaeoenvironmental work and scientific dating are standard archaeological techniques used as mitigation for deeply buried or submerged sedimentary sequences. This is a cost effective method, the alternative being a diver based visual survey and manual sampling/excavation of the identified terrestrial sediments for artefactual and ecofactual remains. These palaeoenvironental and dating techniques have the capacity to elucidate anthropogenic activity. For example, the successive arboreal flora known from Northern Europe has changed by both natural climatic and human activity from prehistoric times to today by activities such as deliberate woodland clearance. The evidence of such activity in the form of relative abundances of microscopic plant remains and charcoal can be found using these methods. Scientific dating is recommended in order to better understand the chronology of the sedimentary sequence and therefore the archaeological periods which they span which are impacted by the development. The scientific dating and palaeoenvironmental work should generate significant archaeological information which can be used to mitigate against the impact of the development.

However, due to the limited vertical and lateral impact expected to be caused by the emplacement of the cable, and the generally large size of these features as a whole, no further mitigation measures (such as exclusion zones) are deemed necessary. No further coring or sampling is expected to be undertaken, however, should future coring programs be undertaken in areas of high palaeo-archaeological potential, further archaeological advice will be sought, and the coring will be undertaken in line with the methodologies outlined in COWRIE 2010.

To support the avoidance of known wrecks, particularly with regard to secondary impact activities such as the anchorages of vessels, Temporary Archaeological Exclusion Zones have been placed around the five wrecks and geophysical anomalies of archaeological interest (A1s) identified during the archaeological assessment of geophysical survey data (Table 8-3-4) (Figure 8-3-11). Exclusion zones prohibit development related activities within their extents and have been widely applied in offshore development contexts to sites and anomalies with known or potential archaeological significance.

Class	WA_ID	Type	Name	Easting	Northing
A1	7024	Wreck	-	389786	5685532
	7027	Debris		391279	5685143
	7047	Debris		394777	5685245

Class	WA_ID	Type	Name	Easting	Northing
	7049	Debris		395957	5685445
	7098	Debris		416527	5686440

Table 8-3-4 : 'A1' wrecks assigned Temporary Archaeological Exclusion Zones

For the previously unrecorded wreck site (**WA7024**), a Temporary Archaeological Exclusion Zone is also recommended and further work to fully ascertain the nature and archaeological potential of the site would be advantageous if it is deemed likely to be impacted.

Sites **WA7027, WA7047, WA7049** and **WA7098** are areas of ferrous debris of unknown origin and could represent the remains of badly degraded wrecks or other structures (Figures 8-3-4 to 8-3-6). Temporary Archaeological Exclusions Zones and further investigation are again recommended for these sites, especially since all but **WA7098** are relatively close to the proposed route.

For the wreck sites of archaeological importance that are recorded in UKHO data, but that were not identified in the geophysical data, buffers have been suggested (Table 8-3-5) (Figures 8-3-9 and 8-3-11). As the extent of the wrecks is unknown, and as wreck material can be spread over a wide area in the vicinity of the wreck site, the buffers comprise a 100 m radius around the gazetteer points. Buffers do not limit development activities to the same extent as exclusion zones, but should assist in planning, for example, the location of anchorages.

WA_ID	Type	Name	Easting	Northing
7259	Recorded Wreck	-	506371	5686959
7270	Recorded Wreck	*Harvest Moon*	386196	5685927
7272	Recorded Wreck	-	386928	5685054
7274	Recorded Wreck	*LCP 586*	389454	5685030
7275	Recorded Wreck	-	396314	5685228
7276	Recorded Wreck	*Rydal Force*	396458	5686183
7277	Recorded Wreck	-	404300	5687128

Table 8-3-5 : 'A3' wrecks assigned temporary buffers

Buffers are not recommended for the remaining A3 records (representing recorded obstructions or those representing wrecks or wreckage of low archaeological importance), or for the further 123 geophysical anomalies, rated A2 (of possible anthropogenic origin and archaeological interest) that were identified (Figures 8-3-9 and 8-3-11). However, some of the A2 or A3 anomalies could represent features of archaeological importance. If further assessment is undertaken prior to installation, these records will be detailed in an archaeological reporting protocol for the cable installation works

In response to the Scoping Document, English Heritage recommended the implementation of an archaeological Written Scheme of Investigation (WSI). The Written Scheme of Investigation would address pre-installation and installation activities, such as the grapnel run, and would probably also include a protocol to substitute for a watching brief offshore. A WSI would also be required onshore at the Kent Landfall covering intertidal and terrestrial works.

A detailed level of assessment has been carried out already (Wessex Archaeology 2011, Vol I and II), any further changes would include only minor modifications. Should any further geophysical, geotechnical, dropdown camera, video or diver survey be undertaken, archaeological advice will be sought in designing the methodologies for these activities (English Heritage 2010), and archaeological assessment of any resulting data will be undertaken if required.

It is possible that previously unknown archaeological sites or material may be encountered during the course of the cable route trenching or installation, operation or decommissioning. For example, there is a high potential for the discovery of material from Goodwin Sands. Hence, measures should be taken to reduce the development impact in this instance. A formal Archaeological Reporting Protocol

will be established and agreed with the appropriate statutory consultees and national heritage bodies to ensure that any finds are promptly reported to the correct authority, archaeological advice is obtained and any recovered material is stabilised, recorded and conserved.

A positive cumulative effect of offshore developments is the accumulation of archaeologically interpreted geophysical and geotechnical data regarding prehistoric land surfaces, palaeo-environmental evidence, wrecks on the seabed, and associated material. Any positive effects will be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available.

English Heritage has recommended (English Heritage 2010) that the Project ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). The project are committed to ensuring this takes place and will also copy all relevant documentation to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER).

8.3.7. Residual impact

It is expected that the implementation of the above mitigation measures will mean that the residual effects of the development on any archaeological receptors will be **moderate** to **negligible** (see Appendix 6 for details of impact assessment). All of the known wrecks have been avoided and the mitigation measures minimise impact on geophysical anomalies and areas of archaeological potential. A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis. It should be noted that the archaeology reporting protocol to be implemented during installation will reduce impacts to as low as reasonably manageable.

The residual impacts only affect areas of archaeological potential - which will be dealt with through the Archaeological Reporting Protocol.

8.3.8. References

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8.4. Cables and Pipelines

8.4.1. Baseline data sources

The presence and location of submarine cables has been determined using two key sources of information:

- Kingfisher Cable Awareness Charts (KISCA), which provide detailed information and data on the location of major telecommunications cables and some interconnector cables;
- SeaZone HydroSpatial Data, which has been used to indicate the location of charted cable features not included in the Kingfisher Cable Awareness Charts.

A magnetometer survey (part of the geophysical survey) has been used to confirm the precise locations of the cables crossed. In addition, the detailed route position lists for live cables have been acquired directly from the asset owners.

8.4.2. Baseline

The table below presents each of the cables crossed by the Nemo Link cable within UK waters. Zero pipelines are crossed within UK waters.

Power Cable	Telecom Cable	Name	Cable owner	Notes
	✓	Atlantic Crossing 1	Global Crossing Global Network	Crossing agreement will be sought. Contact is ongoing with cable owner and crossing agreements will be finalised. Agreement in principle has currently been reached.
	✓	UK Belgium 5	BT	Out of service. Contact with cable owner ongoing.

Table 8-4-1 : Cables crossed by the proposed Nemo Link cable route

Figure 8-4-1 shows the routes of each of these cables. One of the cables detailed above is out of service and may be recovered from the seabed by the cable owner resulting in no crossing being required.

The Nemo Link cable route also passes in close proximity to the Tangerine cable, owned by Level 3 Communications. The approximate distance of the Tangerine cable from the Project cable route is 270 m.

In the intertidal area, the Nemo Link cable will be located in close proximity (perhaps within 100m) of the Thanet Offshore Wind Farm export cable. Such a separation is typically acceptable in intertidal areas. The proximity will be discussed with both The Crown Estate and the Thanet offshore transmission owner (OFTO) (Balfour Beatty plc as they are the preferred OFTO bidder for the Thanet project) and a suitable proximity agreement will be drafted.

There are no pipeline crossings for the UK section of the cable route.

8.4.3. Description of potential impacts

Crossing agreements that specify the design of cable crossings will be negotiated with the relevant cable owners to ensure the safety of both the Project cable system and the cables crossed by the Nemo Link. The proposed Nemo Link cable system will be installed whilst the existing cables are in service, using well established industry procedures. No adverse impacts are expected in relation to submarine cables and pipelines. Example crossing designs are detailed in Chapter 4 – Project Description.

The pre-lay grapnel run undertaken before cable installation will remove any out-of-service cables from the vicinity of the route prior to installation taking place.

The Crown Estate has requested that the cable route runs parallel to existing cables as far as possible to ensure efficient spatial use of the seabed. With this in mind, the cable route has been designed to minimise cable length and optimise proximity to existing cable systems such as the Tangerine and the Thanet Offshore Wind Farm cables.

8.4.4. Mitigation

No impacts are expected, therefore no mitigation measures are proposed.

8.4.5. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

8.5. Military and Other Sea Users

8.5.1. Baseline data sources

A desk top study has been conducted of all known areas of sea used by marine industry and the impact of the cable route has been assessed in respect to these. Specifically the following marine uses have been taken into account:

- Wind farm developments and their associated export cables
- Marine aggregate extraction and dredging (including licensed, active, application, option and prospecting areas)
- Oil and gas development
- Disposal sites

SeaZone Hydrospatial data has been used to provide details of the location of oil and gas development, disposal and dredging sites and military practice and exercise areas and the locations are shown in Figure 8-5-1.

Data describing the locations of existing wind farms and future offshore wind developments and aggregate extraction areas have been acquired from The Crown Estate website and the locations are also included in Figure 8-5-1.

Consultation with The Crown Estate has not indicated any further marine developments in the vicinity of the cable route.

8.5.2. Baseline

Wind farms
The Thanet Offshore wind farm, owned by Vattenfall Wind Power, is located approximately 8 km north of the cable route (Thanet Offshore Windfarm Ltd, 2005). The landfall location of the Thanet export cable is near to the previously considered Service Station North landfall option for the Project. The landfall site for the Project is Service Station South, and therefore work will occur near to the Thanet export cable but the cables will not cross.

The Crown Estate had awarded Vattenfall Wind Power the opportunity to extend the Thanet project by up to 50% additional capacity. Vattenfall has however since withdrawn from this process stating that tight timescales and limited grid access made the project unfeasible (Shankleman, 2010). They have noted, however, that they do not rule out future development but this is unlikely to occur before the Nemo Link is completed.

Marine aggregate extraction and dredging
There are no known aggregate extraction sites in close proximity to the cable route in the UK. A former dredging area (used during the construction of the Channel Tunnel) was located approximately 10 km south of the cable route (SeaZone, 2009), however this has been disused since construction was completed on that structure. The Crown Estate has indicated that the cable route may cross areas of potential for aggregate extraction but no data is yet available for specific prospecting areas. It is understood that aggregate extraction vessels cross the cable route transiting to and from extraction sites and ports.

Oil and gas development
There is no oil and gas development in close proximity to the cable route in the UK.

Disposal sites
Dredging occurs in the Ramsgate port area, in particular the port approach and internal port and harbour areas are dredged when required throughout the year (Thanet Coast, unknown). The dredged

material is disposed of at disposal site TH140 in Pegwell Bay which is located near the Sandwich flats landfall site (see Figure 8-5-1, Thanet Coast, 2000). The cable route has been designed to avoid this disposal site and will pass approximately 200 m to the south of the site.

Military practice and exercise areas
There is a military exercise area in open water 3.5 km north of the planned cable route. It is categorised as Navy Department Area X5123 and is a mine disposal area.

8.5.3. Description of potential impacts

The table below provides details of how receptor value has been defined in the impact assessment. A detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Fundamental long term damage, loss or disruption to essential zones of military activity or other sea users or their property and equipment.
Medium	Short term loss or disruption to military activity or other sea users or long term disruption to military activities causing them to relocate.
Low	No measurable direct or indirect impacts that would affect military activities or other sea users. Small-scale, temporary disturbance to military and other sea users identified as being of local importance.

Table 8-5-1 : Definition of receptor value

Wind Farms
There is no direct interaction between the Project and any existing or planned wind farm areas. The landfall of Thanet Offshore Wind Farm export cable is in near to planned landfall of the Nemo Link but the cables will not cross offshore. No adverse impacts are expected in relation to the Thanet Offshore Wind Farm.

Marine aggregate extraction and dredging
There is a considerable distance between the dredging site and the cable route, and therefore no impacts are expected.

Disposal sites
The cable route does not cross the Pegwell Bay disposal site so it is not anticipated that the Project will have any impact on the site.

Military practice and exercise areas
The cable route does not cross any military exercise areas so it is not anticipated that the Project will have any impact on military activities.

8.5.4. Mitigation

No mitigation measures are required as it is not foreseen that the cable route will have an impact on the military or other civilian sea users.

8.5.5. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

8.5.6. References

- Thanet Offshore Windfarm Ltd. (2005) *Thanet Offshore Wind Farm Environmental Statement: Non Technical Summary.* Warwick Energy: Wellesbourne, Warwickshire

- SeaZone (2009) *Shipping and Navigation Extraction_Dredge [GIS Data].* SeaZone: Wallingford
- Shankleman, J. (2010) *Vattenfall scraps Thanet wind farm extension*. businessGreen: London
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- Thanet Coast (2000) *North East Kent European marine sites management scheme: 6.9 Ports and Harbours* [online]. Thanet District Council: Margate. Available at: [http://www.thanetcoast.org.uk/pdf/6_7TO6_9a.pdf] Accessed 7 Dec 2010.

8.6. Unexploded Ordnance

There is potential for Unexploded Ordnance (UXO) risks along the cable route due to its South East location (WWI / WWII activity). Items of UXO are regularly encountered within the North Sea and rarely become inert or lose effectiveness with age. Over time, mechanisms such as fuses and gaines can become more sensitive and therefore more prone to detonation. This applies equally to items that have been submersed in water and/or lodged within the seabed. It is possible that significant kinetic energy created by the intense impacts generated by marine engineering, such as cable trenching, could cause an inadvertent detonation.

8.6.1. Baseline data sources

A desktop UXO Threat and Risk Assessment was undertaken to address the first stage of the UXO risk management process by providing a holistic overview of the UXO threats and risks for the entire marine operation. It was concluded that the main UXO risk for the project is WWI and WWII UXO, although other types of UXO cannot be discounted. The following facets were considered as part of the desktop study:

- The history of the route;
- Relevant military records;
- Wartime activities;
- The holistic UXO threat including the types that could be encountered, the probabilities of encountering them as well as exposing their potential mechanisms and risks of detonation;
- An outline assessment of the maximum likely UXO seabed burial depth;
- The risks regarding UXO;
- The consequences of an inadvertent High Explosive (HE) detonation.

The sources of information consulted for this report included:

- Royal Navy (Southern Diving Unit), Portsmouth;
- The National Archives, Kew;
- Naval Historical Centre, Portsmouth;
- UK Hydrographic Office, Taunton;
- 6 Alpha's "Agility Database ©" which contains historic maps, aerial photographs and records;
- Project related reports;
- Department of Research and Information Services (DoRIS), RAF Hendon.

8.6.2. Baseline

A specialist review was undertaken by 6 Alpha Associates and the details of this report are summarised below (6 Alpha Associates, 2010). For the purposes of UXO assessment the overall route was divided into five distinct segments. Each segment was defined by both the geographical location and the nature of the proposed engineering works. The five segments are as listed below. These areas are considered within the overall UXO report. However, due to geographical location, only Segments 1 and 2 are considered within this report as they are the only segments falling within:

- **Segment 1** - Area surrounding a 500 m radius from the landfall point at Richborough in the UK;
- **Segment 2** – 500m either side of the Cable Corridor as it passes through UK territorial waters;
- **Segment 3** - 500m either side of the Cable Corridor as it passes through French territorial waters;
- **Segment 4** - 500m either side of the Cable Corridor as it passes through Belgian territorial waters;
- **Segment 5** - Area surrounding a 500m radius from the landfall point at Zeebrugge West.

8.6.3. Aerial Bombing Campaigns and Military Fortification

8.6.3.1. Richborough Landing Points

During WWII in 1943 the site was commissioned by the (British) Royal Navy and designated as HMS Robertson, which acted as a holding base for Royal Marine landing craft personnel (gun crews) as well as a (minor) landing craft base. There are no records to suggest that this site was bombed by the German Luftwaffe, although, in the region, Royal Air Force (RAF) Manston and two bombing decoy sites were bombed.

8.6.3.2. Sea Convoy Routes

In 1939 the Thames Estuary and approaches from the east were probably the world's busiest waterway. The Port of London was then Europe's largest and handled one-third of all Britain's foreign trade. The East Coast ports were important commercially and, as WWII progressed, they achieved strategic importance for the transport of coal, as well as from fishing (which was considered key to helping feed the UK's wartime population). A military lesson from WWI was implemented, which saw merchant ships gathered into convoys for protection. Notwithstanding the Royal Navy's attempts to afford such convoys protection, they were regularly attacked from the air as well as by the German surface and U-Boat (i.e. submarine) fleets. The Luftwaffe also dropped thousands of HE bombs on these convoys.

8.6.3.3. Tip and Run

A significant number of air-to-air battles also occurred over this area, some of which resulted in numerous allied and enemy aircraft jettisoning all or part of their payloads i.e. *inter alia* medium and large capacity, HE iron bombs (a tactic known as "Tip and Run"), either in an attempt to escape their pursuers, or to quickly offload weapons from damaged aircraft, before returning to base. Although records of these events are poor, the threat of encountering jettisoned munitions in the sea must be considered an unquantifiable risk when assessing the background UXO threat for all areas in the North Sea.

8.6.4. Allied Sea Minefields

8.6.4.1. Overview

During WWII it is estimated that Allied Forces and Axis Forces laid in excess of 566,000 sea mines in the North Sea. There are over five hundred WWII Royal Navy mine laying reports in the British National Archive for the North Sea region alone; in addition the Royal Air Force (RAF), also emplaced sea mines from the air. The Germans also delivered sea mines (by air, ship and U-Boat); the precise quantities laid are not known.

8.6.4.2. Strategic Planning

As a result of enemy sea mining activity, proposals were made in November 1939 to mine the English Channel. These proposals considered the likely effect on fishing as well as the requirement to provide mine-clear sea-channels for British, Dutch and Belgian shipping. It was finally recommended that, as a first action, the southern part of the area should be "notified" and sown with both deep and shallow water mines.

8.6.5. Effectiveness

Generally the sea minefields were a better “psychological” deterrent, than an operational success, as there were more casualties caused to the Royal and Merchant Navies than the German Navy. There is only one record of a German U-Boat being successfully attacked by mines laid off the Essex coast and that occurred on the 7th November 1940 (when the U-Boat T6 struck a mine and sunk).

8.6.6. Mine Clearance

At the end of WWII there was a significant sea-mine clearance operation undertaken by both Allied and German Navies, who attempted to clear their respective minefields. This operation was undertaken by one of two methods:

- Using two minesweepers, a sweep-wire (with a serrated edge and an “otter” or “kite” to keep the sweep wire at the required depth), was laid into the water and both ends were attached to a winch at the stern of each ship. The sweep-wire was towed by both vessels over a mined area and, when connected to the “mooring stay” of a moored mine, the ships momentum would then force the stay to the serrated edge of the sweep wire, which cut it. The mine would then (usually), float to the surface for disposal.

- An alternative method was to use one ship only with the sweep wire attached to an oropesa float (to keep the sweep wire away from the ships), and the wire would then cut the mooring stay of the mine (as described above). The untethered mine would then (usually) float to the surface where it was then destroyed, often by rifle fire (however, on occasions the bullet only penetrated the outer casing of the mine, which allowed water to ingress and it would then sink and come to rest on the sea bed; an explosive hazard thus remained).

Historical Admiralty mapping confirmed that minefields that had been situated off the coast of Kent and Essex, were cleared post-War. Whether all those mines that were recorded as being laid, were *de facto* recovered during clearance, could not be confirmed (it should be noted that 100% clearance of minefields, even with today’s technology, is not always achievable).

8.6.7. Munition Sea Dumps

Post WWI and WWII, both chemical and conventional munitions were extensively dumped at sea, including in areas off the UK and Belgian coasts. The locations of some of these areas are well known as are the type and numbers of munitions deposited, but in other areas there are problems concerning accuracy of types and numbers dumped. This inaccuracy is incurred because of a combination of factors including: inadequate record keeping; the dumping of items outside designated official dumping areas; and, to an extent, the movement of munitions post dumping as the result of tidal flow. Notwithstanding the risk of UXO migrating on the seabed, there are no known munitions dumps within 5km of the cable route.

8.6.8. Military Training Areas

There is one military training area 3.5km to the north of the cable route within UK waters. It is categorised as Navy Department Area X5123 and is a mine disposal area.

8.6.9. Shipwrecks and Downed Aircraft Containing Munitions

Both merchant and naval vessels that were sunk in WWII may have contained munitions. Empirical evidence has shown that munitions did spill from the ships as they sank and subsequently broke-up. Similarly, aircraft that were shot down or otherwise had to ditch into the sea, may have also contained unexploded munitions. In general, the risk of munitions contamination is somewhat less in the vicinity

of wrecks as compared with munitions dumpsites and weapons trial areas because the munitions, in all probability, are most likely to remain enclosed and immobile within the body of the wrecks. However, it may be possible that some items may have been thrown clear of the vessel as it sank or they could become exposed as the wrecks gradually broke up.

8.6.10. Description of Potential Impacts

The principal risks associated with UXO relate to the safety of equipment and personnel through the installation phase, however there remains a low risk of encountering contamination from explosive materials contained within explosives.

The impacts upon unexploded ordnance, and their impacts on the environment are very unlikely to be a material issue should established protocols be followed within a risk assessment framework. As UXO is a risk rather than an impact it has not been included in the impact assessment matrix. Additionally it is not appropriate or meaningful to assign a receptor value to UXO. The impact assessment therefore outlines the risks and associated mitigations that will reduce the UXO risks to as low as reasonably practicable.

Survey data including comparison between magnetometer and side scan sonar data has been obtained for the entire survey corridor. The findings of the survey identify a number of objects of varying magnitudes of magnetic readings which will be avoided where possible during installation. In general it is unlikely that these metallic objects are UXO, however the possibility remains that this is the case. Furthermore there remains a possibility that potential submerged targets were not identified during the initial survey. Therefore the following mitigation measures are recommended to minimise the risks associated with encountering UXO during cable installation.

8.6.11. Mitigation

It is proposed that UXO issues form part of the construction planning for the project, through appropriate risk management. Following such risk assessment, the following mitigation measures will be implemented as necessary:

- A non-intrusive marine multi-sensor and magnetometer survey will be undertaken to provide any necessary additional information to the current survey;
- If required potential UXO targets should be avoided or investigated;
- The construction principal contractor should provide marine and land based Engineer Support;
- The risk mitigation plan should be flexible with an inherent capability to step up risk mitigation measures if a higher degree of risk presents itself.

Although Richborough has a lower risk profile (compared with Zeebrugge), the effort and cost to mitigate the risk level is comparatively small when compared with the significant benefit gained. The findings of surveys will be reviewed by a reputable UXO contractor and appropriate action agreed in each case. Where additional work (other than avoidance) is necessary, the works will be coordinated by a reputable UXO contractor who will liaise with the UK authorities concerning incident management and disposal actions.

The Principal Contractor will determine if a further detailed geophysical survey should be undertaken to determine the potential existence and location of potential UXO along the route. This will be undertaken in advance of Pre-lay Grapnel Run (PLGR) work and any route adjustments made based on potential UXO findings (if and where they occur). Once the UXO survey has been conducted and potential UXO “targets” avoided, then the intrusive ground investigation and PLGR will be undertaken. Whilst the risk of UXO encounter has significantly been reduced, during both operations there is the potential for smaller UXO to be brought aboard the vessel (e.g. been embedded within the clay attached to the grapnel). It would therefore be prudent to have a UXO specialist to inspect the PLGR equipment during the recovery process, in order to immediately identify and/or discount any potential UXO hazards, as the work proceeds.

8.6.12. Residual impact

The discovery of marine based UXO threats (i.e. washed up sea mines or torpedoes) are considered most unlikely at Richborough. The discovery of Land Service Ammunition are however considered reasonably likely because of the presence of the of the generic UK coastal defences.

The principle threat offshore is from munitions used during WWI and WWII, in the form of air delivered HE bombs in general and historic sea mines in particular. The presence of a body of water will have a considerable affect on the seabed penetration depth for air-delivered bombs. Bombs behave uniquely as they enter a body of water and the velocity is reduced significantly before the bomb penetrates the seabed. It has been assessed that the maximum penetration of a 500kg bomb along this route, is not likely to penetrate more than 1m below seabed level.

Due to the relatively slow tidal movement within the North Sea, tides are likely to have a minimal short-term effect on seabed munitions movement. In the coastal areas, however, there may be sufficient tidal flow to move threat items either into, or out of, the proposed path of the cable. In these areas, it would be prudent to assume that items are still in the process of migration, although the magnitude is likely to negligible. Targets identified (potentially as UXO) may have moved since the time of the geophysical survey, in addition to new items being introduced via migration along the route of the cable.

Depending upon the depth of water where detonation occurs underwater, the main consequence would be injury to personnel and damage to installation vessels, and associated support vessels and equipment. The potential damage may result from direct fragmentation as well as the pulsing gas bubble and its resultant shock wave. A reasonable and practical working assumption is that any UXO which has a charge weight of 40kg or greater, is capable of causing significant damage, given typical water depths seen in the North Sea.

As many of the sea mines and bombs that may be encountered have a Net Explosive Quantity (NEQ) of around 100kg or greater, the effect of these detonating even on the seabed is likely to be catastrophic in water depths of 10-15m, and extremely serious in the deeper waters of the rest of the North Sea.

The specific risk assessment within the UXO report shows that the greatest risk is posed to the PLGR seabed operations and to PLGR equipment recovery to vessel. Appropriate control measures will be included within the responsibility of the installation contractor.

8.6.13. References

- 6 Alpha Associates. (2010) Unexploded Ordnance (UXO) Threat & Risk Assessment. Ref P2068TRA prepared by 6 Alpha Associates on behalf of PMSS Ltd.

8.7. Tourism, Recreation and Amenity

8.7.1. Baseline data sources

The following data and information sources have been used to inform the summary of the baseline in this report.

- UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).
- Kent Wildlife Trust.
- Royal Temple Yacht Club website.
- UK Coastal Atlas of Recreational Boating (RYA, 2008).
- Port of Ramsgate, Royal Harbour Marina (Thanet District Council, 2010)
- Sandwich Bird Tours (Van der Dol, 2007)
- VisitKent Business section.

8.7.2. Baseline

8.7.2.1. Tourism overview

There has been a general decrease in tourism over the past 10 years for the UK as a whole. In South East England, regional figures suggest an increase in overseas tourism and a decrease in domestic tourism (VisitEngland, 2011). County figures showing British tourism in Kent appear to go against the general UK trend and the overall regional shift in tourist demographic. These figures show a gradual increase in British holiday visitors to Kent from just under a million (2006 – 2008 inclusive) to over a million holiday trips (2008 – 2010 inclusive) (VisitEngland, 2011).

Conversely, when factoring in all UK visitors to the area (holidays, day trips etc.), numbers show a marked decrease (from an average of approximately 3.7 million in 2006-2008 to just below 3.3 million in 2008-2010).

There is a peak in overnight tourism in the South East in July and August, with a secondary peak in May and April. Kent is the 9th most visited county in England (when considering all UK visitors and not solely holiday trips) (VisitEngland, 2011). However, when focussing solely on holiday visitors, Kent does not appear within the top ten counties. VisitKent are actively trying to increase both domestic and European visitors to the county through several marketing campaigns.

8.7.2.2. Local Tourism Overview

The traditional seaside town of Ramsgate, located approximately 2.2 km north of the cable route, is a tourist destination in Kent. The Royal Harbour Marina in Ramsgate has been described as the defining characteristic of the town and both the town and Pegwell Bay are of historical interest (VisitKent, 2006). The district of Thanet is of moderate to high importance for tourism in Kent. It is estimated that approximately £162 million was spent on trips to Thanet in 2006 (VisitKent, 2006) and that Thanet is the third most popular district for over-night stay trips after Canterbury and Medway (Kahn, 2008). Recreational activity was by far the most common reason for over-night trips to the county. It is estimated that Thanet supports 8% of Kent's tourism related jobs, compared to other Kent districts this is jointly (with Maidstone) the fourth largest district for tourism related employment (Kahn, 2008). The majority of tourism spending within Thanet is concentrated in Margate, Ramsgate and Broadstairs (VisitKent, 2006; VisitKent, 2010). Ramsgate is a moderately important town in Kent for tourism ranked 7th out of 14 Kent towns in terms of visits to tourist information centres with just under 50,000 visits to the centre in 2009 (VisitKent, 2010). The beach at Ramsgate (Ramsgate Main Sands) has won Kent's Quality Coast Award, has Blue Flag status conferred on it once again in 2012 and is a

popular beach for visitors, with good facilities for children, coastal walks to the Pegwell Bay area, and close proximity to the Royal Harbour Marina, the port and town centre (VisitKent, 2006; VisitKent, 2011). The Pegwell Bay area is part of Kent's largest nature reserve, called the Sandwich and Pegwell Bay National Nature Reserve, and has geological, historical and ornithological features of interest. Facilities include parking, toilets, cafe/restaurant and picnic area (Kent Wildlife Trust, 2010).

8.7.2.3. Boating, Yachting and Passenger Boats

The Port of Ramsgate features the picturesque Royal Harbour Marina with 700 berths and many cafes and bars on the harbour front (Thanet District Council, 2010). This is one of the largest marinas on the south coast. The Royal Temple Yacht Club is located at the harbour and has over 700 members (Brand, 2009). Regular races and cruising events at weekends and in the evenings are organised by the club and it is understood that races take place in the Pegwell Bay area. The Ramsgate Festival sailing regatta takes place annually in August and attracts entrants from around the UK and Europe (Brand, 2009). The Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating (RYA, 2009) indicates that heavy and medium use recreational sailing routes cross the cable route in the area between the landfall and South Falls. It also indicates that the Pegwell Bay area is a racing and cruising area for recreational craft. Furthermore, several ferry services run from Ramsgate to continental ports such as Ostend and Boulogne which cross the cable route (Thanet District Council, 2010). Kite surfing is restricted to the north-eastern side of Pegwell Bay and is unlikely to be impacted by the cable route except if the Cliff End cable landing location is used (National Nature Reserve, 2006).

8.7.2.4. Recreational Angling

The Kent coast offers good fishing almost all year round with only a slight lull in spring. There are several sea angling charter vessels based at the Port of Ramsgate and they catch a large variety of species depending on the time of year. In spring they mainly catch bass, early smooth hounds, late cod and a lot of thornback rays. The fish tend to reside just offshore so this is where most charter vessels remain at this time of year. In summer there is a wide range of species and often in high numbers, inshore and offshore. Wreck fishing is also popular at this time of year. Congor, black bream and turbet are common off wrecks. While, in general the most prolific species are bass, smooth hound, mackerel and rays. In autumn and winter the main fish species pursued are bass, cod and whiting (KentCharterFishing, 2008). It is understood, from the local fishing community, that boats shelter in Pegwell Bay during northerly winds. It also believed that bait digging takes place in Pegwell Bay itself.

8.7.2.5. Bird Watching and Walking

The area offers coastline walks and, as noted in Section 7.2 - Ornithology, the Pegwell Bay area is subject to several conservation designations and parts of the Sandwich and Pegwell Bay nature reserve are accessible to the public (Kent Wildlife Trust, 2010). The area is particularly important for its bird life and is therefore popular for bird watching (Van der Dol, 2007). Kent is a prime county for bird watching due to its proximity to the continent and variety of habitat which ensure that a large variety of bird species can be seen. Pegwell Bay is a nationally important stop-over point for migrating shorebirds and waterfowl and year round guided bird watching tours operate in and around Pegwell Bay (Van der Dol, 2007).

8.7.3. Description of potential impacts

The table below provides details of how receptor value has been defined in impact assessment. Detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Damage or loss of an area of national or international importance for tourism, recreational activity or amenity. The area will not recover.

Receptor Value	Definition
Medium	Damage or loss of an area of regional importance for tourism, recreational activity or amenity, the area may not recover. Temporary disturbance to sites of national or international importance.
Low	Small-scale, temporary disturbance to sites identified as being of regional, national or international importance to tourism. The area will recover.

Table 8-7-1 : Definition of receptor value

The project is located adjacent to the National Nature Reserve and areas of international importance to migratory birds. However, given the nature of the project, it appears that the seabed in this area is rarely used for recreational activities (SCUBA diving is uncommon in the area), thus impacts will likely be limited to surface restrictions during installation, repair, and decommissioning work.

The greatest level of disruption is likely to be to recreational sea users such as yachtsmen and deep sea anglers as their access will be restricted to areas of the bay and open sea for certain periods of time. A temporary exclusion zone will be employed around the installation works and they will be notified in accordance with statutory procedures such as notices to mariners.

8.7.3.1. Cable Installation

The impacts of cable installation across the marine area will be transient; the entire laying process in British waters is predicted to take less than 2 months. Thus users of the area will be inconvenienced for a short period of time. Furthermore, the majority of the installation work will take place in offshore areas where there is little recreational activity.

During the installation, large vessels will be used for pre-sweeping sand waves and to lay and bury the cable. There is likely to be a temporary disruption to recreational sea users as there will be an exclusion zone employed around the cable installation works. The installation vessels will also be visible from the shore for a period of time reducing the visual amenity of the area. This may be disruptive to walkers, bird watchers and visitors to the National Nature Reserve during installation phase. This will mostly occur in the form of reduced visual amenity but there is also the possibility of temporary disruption to birds present in the area. Based on this information it is predicted that the cable installation will have an impact of **minor** significance on recreation and leisure activities and a **negligible** impact, as well as on the natural character and visual amenity of the coastal region.

8.7.3.2. Cable Operation

Transient periods of disruption may occasionally occur during the operation phase due to surveys and repair work. However, this will likely be less disruptive than the installation phase as activity and vessel sizes are lessened for this work. It is predicted that the operation phase will be on **negligible** significance to recreation and leisure activities, as well as to the natural character and visual amenity of the coastal region.

8.7.3.3. Decommissioning

There may be further disruption in the decommissioning phase, similar to that experienced during installation. However, it is often the practice to leave cables on the seabed after they are no longer in service as this action causes the least disruption. Based on this information it is predicted that the cable decommissioning will have a **negligible** impact on recreation and leisure activities, as well as on the natural character and visual amenity of the coastal region.

8.7.4. Mitigation

To minimise the impacts on those using the area for recreational purposes, as much advanced notice as possible will be given of the commencement of installation activities and any changes will be updated. In addition to the required public notices, all local sailing clubs and businesses involved in vessel chartering will be informed of the proposed activities. Notices will also be posted at local harbourmaster offices and at various points close to landfall.

As it is impossible for all third parties of the development to be informed, all activity will be controlled in an appropriate manner, which includes an exclusion zone around the installation vessel and the use of lighting and horns where necessary. Efforts will be made to minimise the duration of the installation phase as much as possible in order to reduce the period of disruption.

8.7.5. Residual impact

The mitigation measures above may assist in reducing the likelihood of potential impacts and therefore it is anticipated that the level of impact will remain of **minor significance** following mitigation. Details of the full impact assessment are included in Appendix 6.

8.7.6. References

- VisitEngland (2011) Regional and County Tourism Statistics/Reports. EnjoyEngland: London.
- VisitKent (2006) Thanet – Margate, Broadstairs & Ramsgate. VisitKentBusiness: Canterbury
- VisitKent (2011) Kent's Resort Coast [online]. VisitKent: Canterbury.
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- KentCharterFishing (2008) The Fishing [online]. KentCharterFishing: Herne Bay. Available from: [http://www.kentcharterfishing.com/fishing.html] Accessed 3 Dec 2010.
- Van der Dol, J. (2007) Sandwich Bird Tours [online]. Sandwich Bird Tours: Sandwich. Available from: [http://www.sandwichbirdtours.co.uk/tours/birding_breaks.asp] Accessed 3 Dec 2010.

9. Cumulative Effects

9.1. Introduction

Cumulative impacts are those resulting from the combined effects of the proposed development with other subsea cable projects through space and time, in the context of natural variability. It also includes the combined effects with other sea users generating similar effects.

9.2. Cumulative Effects

The assessment of cumulative impacts considers the following:

- Existing interconnector cables - BritNed Interconnector and Interconnexion France-Angleterre
- Proposed future interconnector projects located within the vicinity
- Other sea users/uses generating similar effects. These include:
    - Recreational users (bait diggers, dog walkers, kite surfers etc.)
    - Offshore Wind (export cabling)
    - Commercial Fishing

The activities detailed above have been considered in the assessment of cumulative effects for the following reasons:

- The fishing industry has raised concerns regarding the impact upon commercial fishing of increased rock placement, rendering some areas unfishable with gears such as drift and trammel nets.
- Recreation activities in the Pegwell Bay area (including kite surfing, bait digging and dog walking) are understood to contribute to disturbance of birds using the area (see Chapters 7.2 and 8.7)
- Thanet Offshore Wind Farm export cable maintenance activity, if required, could contribute to disturbance of species or habitats
- Both wind farm export cables and interconnector cables emit electric and magnetic fields and there may be cumulative effects associated with these emissions

There are no known existing or planned MoD or aggregate extraction activities taking place in close proximity to the cable route. The level of shipping activity and noise associated with the marine cable installation and operation is insignificant when considered in relation to the shipping activity in the area (see Chapter 8.2 for further details).

The key environmental impacts resulting from the cable installation and operation in relation to cumulative impacts are:

- Seabed disturbance from pre-sweeping and burial activities impacting on ecological and archaeological features
- Turbidity created as a result of pre-sweeping and burial activities
- Noise associated with pre-sweeping and burial activities
- Disturbance as a result of works within the intertidal area
- EMF emissions
- Potential damage to fishing gear associated with rock placement at cable crossing

It is assumed that rock placement will only be required at a single cable crossing location. However, it is possible that additional rock placement may be required in other locations to protect the cable where burial to a sufficient depth cannot be achieved. The requirement for any further rock placement and the location and extent of any such protection will be determined following installation.

It is currently proposed that installation contractors ensure the burial equipment they intend to use is suitable for the ground conditions experienced and will enable sufficient burial depths to be achieved. However, if this is not possible in certain locations, the use of rock armour could give rise to localised effects including making it difficult to fish in those locations with trammel and drift nets. Concern regarding this potential cumulative impact has been expressed by the commercial fishing industry during the EIA consultation process and is noted. It is considered that any other potential environmental effects would be localised given the small scale loss of seabed, and there may be a longer term increase to biodiversity ultimately. However, this would be addressed under a separate application if rock armour is considered to be necessary and the concerns expressed during consultation would be considered during this process.

It should be noted that, if further rock placement is deemed necessary for the purposes of cable protection, a separate Marine Licence will be applied for and an environmental impact assessment, including consideration of cumulative impacts, will be undertaken.

Table 9-1 outlines the cumulative impacts identified. These have been derived through review of the assessments presented in Chapters 6 – 8.

A full assessment of potential cumulative effects on Natura 2000 sites is provided within the The Nemo Link: Pegwell Bay – Assessment of Likely Significant Effects Report, which is available as Appendix 8.9 of the UK onshore Environmental Statement at the following website: www.nemo-link.com.

Potential cumulative effect arising from the Nemo Link	Activities/Projects with similar effect where overlap may occur	Receptors that are potentially impacted by cumulative effects
Seabed disturbance from pre-sweeping and burial activities	• Offshore Wind – Thanet OWF export cable maintenance • Commercial Fishing – interaction of gear on the seabed • Recreation Activities – bait digging	• **Benthic ecology** – There is potential for the Project to cause a localised, temporary cumulative impact on benthic ecology with demersal fishing activity, bait digging in the intertidal area and Thanet cable maintenance. Due to the localised and temporary nature of seabed disturbance as a result of the Project it is anticipated that there will be no cumulative impact on benthic species and habitats. Although impacts on *Sabellaria* reef will be less temporary, cable routeing has been undertaken to avoid areas of reef. Overall ***no cumulative impact*** is anticipated. • **Fish and Shellfish**– There is potential for cumulative impacts on shellfish beds and spawning and nursery areas arising from any maintenance of the Thanet Offshore Wind Farm cable. Given the localised and temporary nature of the activities it is unlikely to give rise to a cumulative impact. ***No cumulative impact*** is anticipated. • **Archaeology** – Cumulative impacts on archaeological features could arise between the Nemo Link and Thanet cable maintenance. Given the localised nature of the effect and the anticipated low level of maintenance expected on the Thanet export cable ***no cumulative impact*** is anticipated.
Turbidity created as a result of pre-sweeping and burial activities	• Offshore Wind – Thanet OWF export cable maintenance • Commercial Fishing – interaction of gear on the seabed	• **Benthic ecology** – There is potential for the Project to cause a localised, temporary cumulative impact on benthic ecology with demersal fishing activity and Thanet cable maintenance. Given the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable and the limited extent of demersal trawling in the offshore region it is not anticipated that the additive effect of the Nemo Link will give rise to a significant cumulative impact. ***No cumulative impact*** is anticipated. • **Fish and Shellfish**– There is potential for cumulative impacts on shellfish beds and spawning and nursery areas arising from potential Thanet OWF cable maintenance. As with benthic ecology above, the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable and the extent of demersal trawling in the offshore region is not anticipated to give rise to a significant cumulative impact. ***No cumulative impact*** is anticipated. • **Water quality** – Given the localised and temporary nature of the impact assessed in Chapter 6 in relation to similar effects from demersal trawling and the low level of maintenance expected on the Thanet OWF export cable, cumulative impacts to water quality are not anticipated. ***No cumulative impact*** is anticipated.
Noise associated with pre-sweeping and burial activities	• Offshore Wind – Thanet OWF export cable maintenance • Shipping	• **Marine Mammals, Fish and Shellfish and Tourism, Recreation and Amenity** – Given the low levels of noise generated by the project and the temporary nature of the effect ***no cumulative impact*** is anticipated.
Disturbance as a result of works within the intertidal area	• Offshore Wind - Thanet OWF export cable maintenance • Recreation Activities	• **Ornithology** – Given the low level of maintenance expected on the Thanet export cable, it is unlikely that any cable maintenance will occur at the same time as the Nemo Link installation. Also the Nemo Link works in the intertidal zone will be temporary in nature and sensitive periods of the year will be avoided where practical. As such, ***no cumulative impact*** is expected. • **Conservation Designations** – There is no cumulative impact anticipated on the Thanet Coast and Sandwich SPA (see above and Table 9-2). Residual impacts on SACs, Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs) and

		Local Nature Reserves (LNRs) have been assessed to be minor due to the limited extent and duration of the works and the fact that the cable route avoids the most sensitive habitats and features of the site (see Chapter 7.1). In terms of recreation activities (e.g. dog walkers and/or bait diggers), there is unlikely to be a cumulative impact as Kent Wildlife Trust restricts access to the more sensitive areas (saltmarsh and bird breeding areas) within Pegwell Bay (Kent Wildlife Trust, 2011). In addition, given the low level of maintenance expected on the Thanet export cable, it is unlikely that any cable maintenance will occur at the same time as the Nemo Link installation. **No *cumulative impact*** is anticipated. • **Tourism, Recreation and Amenity** – Given the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable, it is not anticipated that the additive effect of the Nemo Link will give rise to a significant cumulative impact. Therefore, **No *cumulative impact*** is anticipated.
EMF emissions	• Offshore Wind – Thanet OWF export cable operation • Interconnector cables: BritNed Interconnector; Interconnexion France-Angleterre	• **Fish and Shellfish** – There is potential for cumulative effects, from the project impacts on electro-sensitive fish species. The assessment in Chapter 7.5 identified the impact on these species to be of minor significance. EMF emissions from AC cables, such as the Thanet OWF export cables, are greater than the emissions from DC cables. As a result, it is anticipated that cumulative impacts could be of ***minor significance*** but there is currently no evidence of such cumulative effects.
Disturbance associated with rock placement at cable crossing	• Offshore Wind – Thanet OWF turbines and rock placement • Subsea cables: BritNed Interconnector; Interconnexion France-Angleterre	• **Commercial Fisheries** - impact on commercial fishing could arise from the use of rock placement for this project along with other projects that prevent the use of fishing gear at the seabed. Given that rock placement will only be required at one crossing location in the UK for the Nemo Link this impact will be localised. However, taking into account the crossings in French and Belgium waters as well as rock placement used in other project there will be a cumulative impact on commercial fishing as areas where rock is placed become unfishable by some trawl gears and drift and trammel nets. As the contribution of the Nemo Link to this is going to be relatively small (there is only a single cable crossing in UK waters and this is outside of the key sensitive fishing areas used by the inshore fishing fleet) it is anticipated that the cumulative impact on commercial fishing will be of ***minor significance***.

Table 9-1 : Cumulative Impacts

10. Summary of Effects of Other Project Elements

This section provides an overview of the likely environmental effects of the other elements of the Nemo Link. These other elements comprise:

- Offshore Cable Installation in French Waters
- Offshore cable installation in Belgian Waters
- Onshore UK elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.
- Onshore Belgian elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.

10.1. Offshore Cable Installation in French Waters

Cable installation continues in French waters outside of the boundary of the UK waters. Installation proceeds in the same way with the same type of cables as those discussed in Chapter 4 (Description of Proposed Development) as there is one unified process across the Project. This length of cable installed in French waters is approximately 23 km.

A summary of the findings of the French environmental assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

The major impacts considered were those during the installation phase. These mainly concern cable laying vessels operating at a restricted speed and limited manoeuvrability. The fact that the cable will be buried beneath the surface of the seabed will limit the operational impacts of the interconnector in French Waters.

Further information regarding the offshore elements of the project in France can be found in the Non-Technical Summary document within Appendix 13 in French. This document will be available in translation at the following website: www.nemo-link.com.

10.1.1. Physical Environment

10.1.1.1. Geology and seabed processes

In France the cable route crosses the borders of two of the sandbanks forming part of the area known as ‘Bancs des Flandres’ (although the cable route does not pass through the designated area itself). The sandbanks are composed of fine and gravelly sand, similar to that found in the Belgian and UK sections of the cable route. Although the cable route only crosses the borders of the sandbanks, the changes in the seabed processes could influence the movement of sediments around the borders or on the summits of the sandbanks. However, the terrain will quickly return to its natural state once cable laying activities are completed. Consequently there will be no long term change to the topography of the seabed.

10.1.2. Biological Environment

10.1.2.1. Fish ecology

In France it is recognised that the diversity of fish species is greater towards the south of the North Sea than in the central areas. The species found along the cable route are a heterogeneous coastal mix and it is difficult to identify with precision the exact species that could be impacted by the cable.

10.1.2.2. Benthic ecology

The effect on benthic organisms, one of the main food sources for the fish population, will be temporary, with the area quickly being recolonised post-cable lay by the surrounding communities. The cable route also avoids the most sensitive of the fish feeding and breeding areas as well as the zones frequented by protected marine mammals.

10.1.2.3. Ornithology

The cable route passes to the north of the protected Natura 2000 zone of the 'Bancs des Flandres'. This is designated an area of importance by la Directive Oiseaux as a bird feeding zone, a passage of migration and an area of hibernation. However the vessels linked to both installation and operation should not have any more impact on the migration or feeding habits of birds than the vessels routinely using this area.

10.1.2.4. Marine mammals

No protected marine mammal species frequent the sandbanks of this area.

10.1.2.5. Conservation designations

With regard to the Habitats Directive for this element of the Project, the impacts on the flora and fauna will be temporary and localised.

10.1.3. Human Environment

10.1.3.1. Shipping and Navigation

In France the cable route crosses an important navigational channel used to separate the vessels entering and leaving the Belgian ports. The impacts on shipping traffic are linked to the presence of cable laying vessels which have restricted capacity for manoeuvre and travel at low speeds crossing the path of vessels using the navigational channel. The presence of vessels could therefore create a temporary disruption to the control of shipping traffic in this area, both during the cable laying process with slow moving vessels crossing the path of navigation and during operation when maintenance vessels will be stationary with a safety zone of 2km.

This impact will be reduced by ensuring that cable joints, which will require the presence of stationary vessels for connection and maintenance, are not placed in the navigational channel. In addition, shipping routes are submitted in advance to CROSS Gris-Nez and the Préfecture Maritime de Cherbourg; during cable laying operations this information can be used to redirect marine traffic.

As with the navigational channel, the presence of installation or maintenance vessels may cause a temporary disruption to vessels accessing commercial fishing zones. However, the distribution of fishing zones is vast and local fishing has a tendency to be situated in coastal areas. In addition, the season with the greatest fishing activity tends to be during the fourth quarter, whereas the most favourable period for cable laying is from April to October. The impact on fishing will therefore depend upon whether the cable laying activities can be limited to a timescale outside the main fishing season.

10.1.3.2. Cables and pipelines

The Tangerine communications cable route, situated in French territorial waters, lies 250m to the east of the Nemo Link cable route. However the recommended secure distance between underwater installations has been respected, therefore the impact is negligible. There are no other cable crossings within French territorial waters.

10.2. Offshore Cable Installation in Belgian Waters

Cable installation continues in Belgian waters in the same way with the same type of cables as those discussed in Chapter 4 (Description of Proposed Development) as there is one unified process across the Project. This length of cable installed in Belgian waters is approximately 60 km.

A summary of the findings of the Belgian environmental assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

A semi-quantitative approach has been taken in performing the assessment. The effects are described in relation to their size, their range (dimension) and their temporary or permanent character. In the impact assessment, distinction has been made between effects during construction, operation and potential decommissioning. Knowledge gaps and possible mitigating measures have also been indicated. Attention has been given to both the negative and possible positive environmental effects.

Further information regarding the offshore elements of the project in Belgium can be found in the Non-Technical Summary document within Appendix 14.

10.2.1. Physical Environment

10.2.1.1. Geology and seabed processes

In Belgium sand waves are located at several locations along the route, rising up to 6 m above the surrounding seafloor. The sand waves are usually covered with smaller ripples. Pre-sweeping will result in an increased turbidity and sedimentation in the vicinity of the works. However, because of the limited volume of sand to be moved and because of the high mobility and dynamics that sand waves already naturally exhibit, the impacts on sediment from pre-sweeping is considered small.

At crossings with other cables and pipelines, protective measures and bridges are proposed. In Belgian waters five existing cables and one pipeline need to be crossed. The protective measures disturb the original geological structure. However, given the very limited size of the protective measures, this effect is very limited.

No effect is expected on sediment quality due to accidental discharges from ships and machinery during construction or due to loss of pollutants from the cables or from crossing infrastructures.

10.2.1.2. Water quality

During pre-sweeping operations for cable burial and cable burial itself, there is potential for an impact on water quality arising from the release of existing heavy metals and organic pollutants within the sediment. As the pre-sweeping involves removal of coarse sediments with a low percentage of fine and organic material and consequently low concentrations of heavy metals, this effect is considered negligible. A temporary increase in localised turbidity will also arise from these activities. No long term effects are expected and this will be minimised by carrying out installation in quiet (low flow) weather when the natural turbidity is low and which will allow for quicker sedimentation of the disturbed seabed material.

As part of the overall safety system, there will be a clear procedure available which defines the roles and responsibilities and actions to be taken if an emergency should arise during installation, operation or decommissioning that could adversely affect water quality (e.g. oil spill).

10.2.2. Biological Environment

10.2.2.1. Benthic ecology

In Belgium both during the preparatory work and during cable laying the impacts upon the benthic habitat is considered negligible due to the size of the area affected and the temporary nature of the activities. Permanent habitat loss is unlikely to occur as the cables are entirely laid below the seabed at a minimum depth of 1 m and the benthic communities mainly occur in the first 20 cm of the sediment. It is anticipated that following construction, a natural recovery of the benthic community will occur in areas where there has been small scale disturbance. The effects on fish in relation to ground disturbance are less pronounced due to the mobility of the species.

There are considered to be no significant impacts upon benthic species due to warming of the cable and the surrounding seabed during operation due to the burial depth and, as the majority of benthic species reside within 20 cm of the surface of the seabed, the cooling effects of the seawater.

The potential effects of localised and temporary increases in turbidity upon benthic communities and habitat are considered negligible due to the existing ecosystem being well adapted to a sandy surface that is naturally in motion, the high mobility of fish species present and the limited size of the impact zone.

During the operational phase, an electromagnetic field (EMF) will be generated around the HVDC interconnector. The impacts of EMF on the benthos are largely unknown. EMF can be detected by and affect certain sensitive species, but the extent of the impacts are not yet fully understood and there are thought to be variations at the individual level within species. Given the very local nature of the generated EMF during operation, the rapid decrease of field strength in relation to distance from the cables and the reduction of exposure of sensitive species as a result of cable burial (which creates a physical barrier of some thickness), the potential effects are considered to be minor.

10.2.2.2. Ornithology

Local seabird populations are accustomed to foraging in turbid water, and most species feed close to the surface. Therefore, the effects of increased turbidity and sedimentation on birds are considered to be small.

The increased presence of vessels and machinery can cause a temporary disturbance of birds, especially at the landfall. However, due to the proximity of the port of Zeebrugge to the landfall area, the area already contains a relatively high activity/disturbance level primarily from busy shipping traffic. Therefore the effects upon birds are thought to be negligible.

10.2.2.3. Marine mammals

No long term effects due to disturbance or noise are anticipated upon marine mammals or their migratory patterns in Belgian waters. It is expected that marine mammals will temporarily avoid the area during construction. Short term effects from this avoidance of the area are considered minor to negligible.

10.2.2.4. Conservation designations

No significant impacts are predicted on the special protection areas SPA3 and SPA2 or the future SAC ‘Vlaamse Banken’. Similarly no significant impacts on the quality of the habitat of porpoises are predicted during the construction, operation or decommissioning phases.

10.2.3. Human Environment

10.2.3.1. Landscape and visual

In Belgium during the preparation work and the actual installation of the HVDC interconnector there will be a short term visual change of the seascape due to passage of several vessels and a temporary landscape change at the landfall. The perception of these activities can be assessed as negative (disturbance) or positive (point of interest). Both impacts are temporary and the impact is therefore considered to be negligible. Methods of communication with the public are to be explored to provide informative information regarding construction activities.

10.2.3.2. Archaeology

The positions of known wrecks were avoided during cable routing following consideration of the available data. Existing data was verified against the Side Scan Sonar data originating from the geophysical surveys which also served to identify previously unknown wrecks to maximize avoidance of these historic features and minimise any potential impacts. If a previously unidentified wreck is discovered during construction, the competent authorities will be informed as soon as possible.

10.2.3.3. Commercial fisheries

Disturbance to fishing grounds during construction is considered to be limited and temporary during the construction phase. Fishing grounds will be inaccessible during construction within a given distance from installation activity and associated works.

Potential damage to the cable caused by use of fishing gear is considered to pose a minimal risk at the burial depths anticipated. The Project is located in an area with existing subsea cables present.

No safety risks arising from damage to the cables are expected given the small risk of occurrence and the security mechanisms within the converter station.

10.2.3.4. Tourism and recreation

Only minor negative effects are anticipated on tourism and recreation offshore during construction. The use of safety zones during construction means that a short term disturbance to recreational sea users may be experienced. The effects of this disturbance will be temporary and are considered to constitute a minor impact. The safety zones will be actively monitored during construction and communication with the coastguard will be maintained.

10.2.3.5. Military areas

Communication will be maintained with the maritime agencies during the installation of the HVDC interconnector in the vicinity of the designated military areas.

10.2.3.6. Cables and pipelines

If necessary, out of service telecommunication cables may be cut to allow for cable installation during construction. If this occurs, the appropriate health and safety and environmental precautions will be taken.

10.3. Onshore Installation in the UK

The onshore UK elements of the project include the construction of an electricity converter station and substation located in Richborough, Kent, and the installation of underground electricity cables from the

landfall to the converter station. The site is located approximately 4 km to the southwest of Ramsgate, 3.5 km north of Sandwich and 1.6 km inland from the east Kent coastline.

The purpose of the converter station is to convert between DC (of the interconnector) and AC (of the UK's transmission system). The substation is necessary to connect the converter station to the grid. The converter station will require a footprint of approximately 5 ha and the substation a smaller footprint of 2.65 ha. The onshore cable route which connects the landfall to the converter station is approximately 2.3 km in length and will be installed using a mix of open trenching and HDD,

Further information regarding the UK onshore elements of the project can be found in the Non-Technical Summary document within Appendix 15.

A summary of the findings of the UK onshore environmental impact assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

The assessment covers the impacts of UK onshore elements of the Nemo Link which are the subject of a planning application, plus the grid connection that will be required to enable the Project to operate. The grid connection is being developed separately by National Grid Electricity Transmission plc and the route and technology to be used has not yet been determined. Accordingly, the onshore ES assesses the likely effects of a connection to a range of possible grid supply points, using either an overhead line or underground cable.

10.3.1. Physical Environment

10.3.1.1. Land use

In respect of land use, the construction of the converter station and substation will result in the permanent loss of approximately 8 hectares of derelict brownfield land. The converter station will occupy the footprint of the existing turbine hall and adjacent land. There will be no permanent land take from the installation of the cable, solely temporary disturbance. All effects upon land use during construction will be highly localised and temporary so will be of low significance. Where open space and land which is available for recreation and walking is disturbed, there will be alternative routes available and the absence of any facility will be short term and reversed after the reinstatement of the land. There is no defined ongoing land use and so there would be no adverse effects from the loss of the derelict land to the development.

10.3.1.2. Ground conditions and contamination

A number of potentially contaminated sites within the area of development have been identified, such as areas where there has been previous oil contamination. Due to the ground disturbance from construction activities, targeted investigation works will be undertaken in agreement with an Environmental Health Officer to assess the nature and extent of all known existing areas of contamination and develop appropriate mitigation measures prior to construction commencement. The risk of ground and water contamination from spillages of fuel, oil and chemicals and from the importation of contaminated materials from off-site will managed by adherence to best practice guidelines enforced through the implementation of a Construction Environmental Management Plan will be prepared to set out the minimum requirementswhich contractors will be required to undertake in order to prevent adverse impacts. Where there may be a potential for significant cumulative effects with the grid connection works in relation to ground conditions, the implementation of best-practice industry-standard mitigation adn preventative measures will ensure that these effects can be avoided.

10.3.1.3. Hydrology

The hydrological assessment identified that there was a moderate potential impact upon the environment from the construction of the converter station as the area where the onshore components are sited is within an area of high flood risk. The potential risk of accidental spillage into controlled waters (tidal ponds and the BayPoint sports complex pond) situated close to the construction site was also identified to be of moderate significance. Also during construction, the increase of introduction of impermeable surfaces leading to

surface water run off and the material stockpiles and operations changing overland flood flow pathways were identified as being of minor to moderate adverse impact, the former being an impact that persisted during the operational phase of the converter station. A number of mitigation measures were proposed to address these potential impacts, such as pollution prevention measures which will be contained within a Construction Environmental Management Plan in line with the Environment Agency's Pollution Prevention Guidelines, and the development of a Spillage Emergency Response Plan to minimise the likelihood for spillages which would contain measures such as requirements for bunding of storage areas. In relation to drainage and potential effects upon surface water, drainage solutions have been suggested and built into the design of the substation and converter station. Following mitigation, all impacts formerly identified to be of moderate significance were deemed to be of minor significance,

Where there may be a potential for significant cumulative effects with the grid connection works in relation to hydrological and hydrogeological receptors, the implementation of best-practice industry-standard mitigation and preventative measures will ensure that these effects can be avoided.

10.3.1.4. Air quality

Wind-blown dust may be a short-term nuisance during construction resulting in the deposition of dust on the local area. Construction traffic may also be responsible for carrying dust and mud from the working area.

The construction process has the potential to include dust generating activities and a range of mitigation measures will be used during construction including site management, maintenance of equipment and vehicles used on site and the careful location of storage to avoid wind-blown dust. Following the implementation of these mitigation measures, effects on air quality resulting from construction traffic and other dust generating activities will be negligible.

10.3.2. Biological Environment

10.3.2.1. Ecology

No nature conservation sites of national or international importance will be directly impacted by the construction and operation of the converter station and substation. A number of designated sites are located along the proposed cable route and it crosses the designated areas at three locations along the route. Mitigation measures will be developed in consultation with Kent Wildlife Trust to minimise impacts on, and reinstate, the habitats within these sites.

The construction of the converter station and substation will not have a significant impact on nature conservation due to a lack of ecologically sensitive features within the site.

The cable has been routed to minimise effects on important species and habitats and site specific mitigation measures will be applied where valuable areas cannot be avoided. Those identified along the cable route include reptiles, amphibians and breeding birds and habitats such as (amongst others) saltmarsh and woodland. Water voles have also been identified but works will not affect habitats where these are present. Impacts affecting protected species will be short-term and mainly associated with site clearance during construction and temporary disturbance or loss of habitat. Habitats affected by the works will be reinstated to prevent long term habitat losses and botanical surveys will be repeated prior to the works to confirm the absence of protected plant species. Where necessary, licences to carry out the works will be obtained from Natural England. Potential disturbance to breeding birds will be mitigated by seasonal timing of construction works (to be agreed with the statutory authorites). Overall a minor adverse to negligible impact during construction is predicted. No impacts are envisaged during operation.

There is potential for cumulative ecological effects with the grid connection works on a number of SSSIs through habitat loss, habitat fragmentation and impacts on important species. However, such effects can be mitigated through detailed design and mitigation when the connection option is finalised. Environmental assessment work will also be undertaken for the connection option to determine the significance of likely effects and appropriate mitigation.

10.3.3. Human Environment

10.3.3.1. Heritage

There are no Scheduled Monuments, UNESCO World Heritage Sites, Registered Parks and Gardens or Registered Battlefields within 1.5km of the development area. A total of 165 designated and non-designated heritage assets were recorded, of which only 7 are designated receptors of high importance and 28 are non-designated receptors of medium importance. The remainder are of low importance. There is the potential for deposits from varying ages, to a greater or lesser degree. No significant impacts on above ground or shallow archaeological deposits are predicted, however, a watching brief is proposed during cable installation to identify the presence of unknown archaeological deposits. Where there may be a potential for significant cumulative effects with the grid connection works in relation to archaeological receptors, the implementation of best-practice industry-standard mitigation and preventative measures will ensure that these effects can be avoided.

10.3.3.2. Landscape and views

A moderate adverse visual effect is anticipated on the setting of Richborough Castle. The gently undulating landscape, existing vegetation, and local industrial context will help to reduce the intervisibility between the Proposed Development and the monument. A landscape scheme, to be implemented as part of the Richborough Energy Park proposals around the southern peripheries of the converter station and substation site, will further reduce intervisibility. Following the implementation ofa programme of mitigation, the archaeological and cultural heritage resource within, and close to, the development site will remain unaffected and the overall impact of the scheme is not considered to be significant.

It is considered that the onshore components of the development will be consistent with the existing landscape character of the site and immediate surroundings and would match the scale of existing industrial built form. The existing landscape character of the underground cable route is generally urban as the route runs close to the A256 and the landscape will be reinstated following construction. The Zone of Visual Influence (ZVI), which encompasses the Stour Valley and Pegwell Bay, extends up to 10km inland due to the open nature of low lying ground in the valley floor views. However, views from the north and south have restricted views from natural and man made features. The majority of public and private visual receptors within the ZVI have existing views of the derelict frame of the former turbine hall building within the converter station and substation site.

Mitigation measures have been incorporated into the development proposals to mitigate effects on landscape and views during construction and operation, such as using colour graded cladding where the colours used would be sensitive to the surrounding environs as well as a native tree and shrub planting programme, amongst others. Taking into account the mitigation measures, the underground cable route is not considered to have any effect on landscape character or views 15 years after the reinstatement of land. The above ground cable route through the northern part of Pegwell Country Park will be quickly re-established as grassland resulting in a very limited negative effect on landscape and views after reinstatement. Following 15 years' establishment of the planting proposals surrounding the converter station and substation site it is anticipated that there would be a small negative effect on landscape character as the development would increase the extent of industrial development evident in the locality. However, the converter station and substation development would be consistent with the existing character of the A256 coastal corridor between Ramsgate and Sandwich and vegetation within the coastal corridor along with new planting to the site perimeter would help in accommodating the development in the landscape. Following 15 years' establishment of new planting to the site perimeter the greatest effect on public views would be from the section of the Saxon Shore Way adjacent to the converter station and substation site and by river users on the Stour also adjacent, although there will be partial screening from these viewpoints from planting, resulting in a reduced negative effect on these views.

The cumulative effects of the development have been assessed in combination with neighbouring proposals currently being developed for the remainder of the Richborough Energy Park site, including an internal road and a Peaking Plant Facility. The development of the wider Richborough Energy Park would be consistent with the character of A256 coastal corridor and following the establishment of new planting, there would be a small negative effect on landscape character. The greatest negative visual effects would be experienced by

a few sensitive visual receptors in closer proximity to the Richborough Energy Park site, particularly users of the Saxon Shore Way and river users to the immediate south of Richborough Energy Park, although the views from these locations would be similar to existing.

The significance of cumulative effects on landscape character and on views of the proposed converter station and substation in combination with all development proposals (excluding the solar farm) is considered as being no greater than residual effects (with landscape mitigation and after establishment) recorded in relation to the proposed converter station and substation. Upon completion (with landscape mitigation and after establishment), cumulative effects of the solar farm on landscape will result in a slightly greater adverse effect than reported for the proposed converter station and substation in isolation, but no greater than minor adverse overall. The cumulative operation effects with other unrelated projects on landscape and views are anticipated to be no greater than moderate adverse due to the presence of existing infrastructure in the surrounding area including three 132kV overhead lines, a wind turbine and two masts.

10.3.3.3. Traffic and transport

It is predicted that overall the long-term environmental impact of the Proposed Development on traffic and transport will be negligible, partly due to the introduction of a range of mitigation measures including traffic management during construction, appropriate signage in the local area and the preparation of a Transport Management Plan. There are likely to be a number of minor environmental impacts that cannot be fully mitigated during the construction phase, primarily including those relating to pedestrian and cyclist delay which will be addressed by signage and delivery agreements with routes to be agreed for construction and delivery traffic. This is likely to be temporary during the construction period and is not expected to continue during the operation of the converter station and substation.

The results of the study indicate that noise complaints would not be considered likely and the maximum noise effect, based on the results, would be considered to be small on the most sensitive receptors including local residents. The mitigation of any construction and operational noise has been taken into account in the assessment and would include best practice methods such as proper maintenance of plant and machinery on site, enforced through a Construction Environmental Management Plan and regular communication with local residents. In addition, the design of the Converter Station and Substation would include appropriate measures for sound reduction. Therefore, it is predicted that any significant noise, associated with the development, would be appropriately mitigated by these measures.

10.3.3.4. Coastal tourism, recreation and socio-economics

Indirect impacts on tourism and recreational activities would result from temporary disruption caused by construction activities. This would affect coastal recreational activities during the landfall and cable installation works at Pegwell Bay. However the duration of works in this area would be very short and the wider area of the Bay will provide undisturbed opportunities. Clearly signed temporary diversions will be in place so that coastal trails can remain open throughout the duration of the installation works and access to local amenities and parks will be maintained as far as possible. The reinstatement of the land following construction will mean that there is no permanent disturbance to access of features of tourism and recreational amenity.

There will be a very small number of permanent employment opportunities resulting from the development. The converter station is likely to operate with approximately 6 personnel per day divided between 3 shifts over a 24 hour period. The substation will operate unmanned with only occasional inspection and maintenance required. Converter station and substation personnel are required to be skilled workers and are therefore more likely to be recruited from existing workers in the electricity industry which will assist job retention. However, there would be a large number of construction jobs which would be temporary and short-term. These will be valuable to the local economy and the service industry supporting these temporary workers are also considered to benefit in the local area. Overall, construction is considered have a small benefit through the creation of temporary and permanent jobs locally and nationally.

10.3.3.5. EMF

The Nemo Link, when operational, will produce both alternating and direct currents, therefore both static and alternating electric and magnetic fields will be produced. The new converter station and substation will be designed to ensure that they are compliant with the relevant Code of Practice and UK Government guidelines. The cable installation techniques used will also be compliant with exposure limits. The assessment carried out regarding the likely impacts of the cable route, converter station and substation has demonstrated that no mitigation will be required because the EMFs are within UK Government guidance levels and there will not be any significant effects arising from the NEMO link.

10.4. Onshore Installation in Belgium

The Belgian onshore elements of the project are located in the administrative area of the city of Brugge, west of the harbour of Zeebrugge. They consist of the construction of an electricity converter station and connection to the existing Stevin substation in addition to the installation of underground electricity cables from the landfall to the converter station. The cables will be installed using a mix of open trenching and HDD,

The purpose of the converter station is to convert between DC (of the interconnector) and AC (of Belgium's transmission system). The substation is necessary to connect the converter station to the grid. The converter station will require a footprint of approximately 4.6 ha.

A summary of the findings of the Belgian onshore environmental impact assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

Further information regarding the UK onshore elements of the project can be found in the Non-Technical Summary document within Appendix 16.

10.4.1. Physical Environment

10.4.1.1. Soils

There is potential for the soils to be heated in the locality of the installed cable due to heat dissipation. This is partially mitigated by an insulating layer of dolomite. It is anticipated that this effect will be restricted to cold weather and, even in peak use periods, the temperature increase will remain less than 15°C.

There will be no significant soil profile degradation in the soil surrounding the trenches, which is mainly homogeneous in nature and has already undergone disturbance. Reinstatement of the original top layer of soils will occur and during construction steel planking will be used to minimise compaction of the clay components. No significant effects are expected at the converter station site as it is already paved and the results of ground investigations show that the only soils present are of anthropogenic origin. The re-use of any soils from the trenches will be recorded to minimise the risk of spreading any contaminated soil. Any soils identified as contaminated prior to construction will be decontaminated before works commence.

10.4.1.2. Water

The existing paved portion of ground will be halved by the construction of the development, which will consequently lead to an increase in infiltration (addition to the groundwater) and/or a decrease of surface area run-off. The proposed development will meet the urban regulation on rain water wells, infiltration facilities, buffer facilities and separate discharge of sewage and rain water.

Groundwater levels and flow are likely to be affected during open trench cabling work, however this is anticipated to be relatively small because of the low permeability of the soils. The cable route lies in an area with shallow salinised groundwater, however the duration and depth of the anticipated drainage during

construction is not of the degree that it will lead to an increase in salinity. There are potential for significant groundwater and surface water changes in the de Fonteintjes nature reserve in relation to composition (salinity) and overall level (potential for reduction). Mitigation measures will be applied in order to minimise the potential for this informed heavily by the results of the Appropriate Assessment. Furthermore, the use of dolomite (which is highly permeable) unlike the recipient soils, could cause a draining effect in some connecting grounds and ditches and could extend to the nature reserve. A number of mitigation measures have been proposed to minimise/prevent the above effect, such as re-pumping of groundwater to the site or application of clay plugs to limit the hydraulic contact between the two soil interfaces, amongst others. After mitigation has been applied, significant effects upon groundwater level and flow will be avoided.

10.4.2. Biological Environment

The proposed development is situated within a number of sites designated for nature conservation: an SPA, a Special Habitat Protection Area and a nature reserve. Impacts have been examined in relation to habitat loss, disturbance to birds, drying out and soil heating. These are discussed in summary below.

Temporary habitat loss could potentially occur prior to mitigation as a result of the storage of the ducts bundle, creation of the construction area, trench excavation and installation of jointing pits in the SPA. However, HDD installation will be used under the protected areas, thus eliminating the need for trenching. Furthermore, the ducts bundle will be stored partially at sea or installed on the beach, where possible, and onshore will be stored on the less biologically valuable arable plots. These measures significantly decrease the level of temporary habitat loss. Additionally, the vegetation will be reinstated upon installation of the cables. Permanent habitat loss will only be experienced as a result of the construction of the jointing pits and converter station. Because of the minimal area of permanent land take, and at the converter station site only affects biologically less valuable habitats, the impacts of this on biotopes are considered negligible.

Construction noise impacts upon birds are not considered to be significant given the temporary nature of the noise, the current ambient audible noise (and the subsequently more tolerant species already present), and the relatively limited number of sensitive birds. Operational noise levels will not reach as far as the SPA and therefore no significant impact is predicted.

For the reasons discussed in section 10.4.1 (Physical Environment) in relation to drying out of the nature reserve, the potential effects upon the habitat and species have been examined. Apprioriate mitigation measures will be applied in order to minimise the potential for this informed heavily by the results of the Appropriate Assessment.

Soil heating, also discussed in section 10.4.1 (Physical Environment) if left unmitigated has the potential to speed up the growth of vegetation and may also contribute to the drying out effect. However, due to the installation of a protective dolomite layer which significantly minimises the heating effect, this is not considered to give rise to a significant adverse effect on the natural features present.

10.4.3. Human Environment

10.4.3.1. EMF

The HVDC cables installed will generate EMFs, however the electrical field is considered to be almost completely screened off by the metal screens on the outside of the insulation around each conductor. Magnetic fields conversely are not and further mitigation measures have been required, involving significant neutralisation from the laying of 2 cables close to one another. In relation to the converter station, the equipment is shielded by the converter building which significantly reduces the EMFs. No cumulative impact is anticipated with the future Stevin substation located in the vicinity of the Belgian onshore components of the Nemo Link.

10.4.3.2. Landscape

In the area covered by the Proposed Development, there are no protected landscapes, village views, demarcated anchorages or heritage landscapes. The project has no visual relationship with the protected area in the beach district northwest of the proposed converter station. Visual disruption during the construction phase is caused by the presence of temporary site buildings and soil storage. Upon completion of the work, the surface will be restored to its original condition, linking it up with the existing micro-relief. Because of the temporary nature of the impact, this is not considered significant. The jointing pits are constructed completely underground, although the associated inspection pit will be visible above ground. As the size of the pit and the height of the structure above ground level are limited, there will be no significant visual disruption. For landscaping reasons, erecting a high fence around the inspection pits is not deemed desirable. The former military area has an industrial character, which is further enhanced by the presence of the harbour infrastructure and activities in the surrounding area. It is expected that the erection of a converter station in this area will have little impact on the character of the surrounding landscape. However the architectural and landscaping design of the converter station has been developed to fit the building into the landscape as naturally as possible. In relation to cumulative effects, it is expected that the Stevin substation will cause a potentially greater visual disruption on sensitive receptors than the Nemo Link Belgian onshore components, however it is considered that cumulatively the effects will be relatively limited.

The Central Archaeological Inventory shows that no archaeological finds have so far been reported in the area covered by the Proposed Development. The beach is subject to the effects of tidal movements, and therefore the chance of any archaeological finds in this area will be virtually non-existent. During HDD cable installation, the potential risk upon archaeological heritage are deemed fairly limited, however, an archaeological investigation will be carried out for the part of the HVCD cable that will be installed in an open trench in consultation with the relevant Belgian archaeological agency. Effects upon potential archaeological deposits are considered more unlikely in areas where the soil has already undergone significant human disturbance in the past. In these locations, there will be no archaeological watching brief.

10.4.3.3. Noise

Current audible noise quality at the converter station site already exceeds Belgian standards during the day, although levels are met overnight. It has been concluded, following analysis, that the converter station (after implementing a series of mitigation measures) will have a negligible effect upon ambient noise levels. During the night, it is anticipated that an increase to ambient noise perceptible to the human ear may occur at one measuring point. A cumulative impact assessment was undertaken in relation to the future Stevin substation located in the vicinity of the Belgian onshore components of the Nemo Link. Following mitigation measures, during the day and evening it was concluded that the total cumulative noise impact on top of the existing ambient noise is negligible, however a new study in relation to this will be completed once further details of the Stevin project have been determined. In relation to residents, exposure to human receptors is considered to be a minor negative from construction noise as the audible noise will comply with the relevant Belgian legislation, the effects are temporary, the existing ambient noise is of a high level and, noise reduction measures can be taken. Operational noise will not reach residential receptors.

10.4.3.4. Socio-economics and Tourism

There are considered to be limited impacts upon the residential human population as the project is largely non-residential, and is primarily set in industrial, ex-military and agricultural land. In relation to human agricultural activity, the potential for land take has been assessed. Once trenching has been backfilled, farming activities can be resumed for both grazing and crop cultivation. Compensation will be arranged in accordance with the protocol agreed between Elia and the agricultural organisations to the farmers who are adversely affected, although adverse effects are considered limited. There are considered to be no further land take issues which affect the human population.

Tourism and leisure users of the beach and cycle paths, and residents living along Evendijk West and Veerbootstraat may be considered to be affected by temporary visual impacts cabling and converter station construction. Because of the works' temporary nature, these impacts are considered limited. Following construction, only the inspection pits will be visible along the HVDC link, although this is not considered significant because of the limited size of the pits.

11. Conclusions

The purpose of this chapter is to summarise the potential impacts the cable route may have on the environment. The significance of individual impacts is considered before and after the application of the proposed mitigation measures.

11.1. Impacts and mitigation

As discussed in Chapter 5 – Environmental Assessment Methodology, the potential impacts of the UK marine elements of the Nemo Link on the environment have been assessed against the baseline conditions. The significance of the impacts has been discussed in detail in each chapter and are summarised in Appendix 6. Table 10-1 below provides a summary of the moderate and significant environmental impacts, the proposed mitigation and the associated residual impacts.

Table 11-1: Summary of potential impacts before and after adoption of proposed mitigation

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
6 Physical Environment				
6.1 Geology	No significant impacts	-	-	-
6.2 Bathymetry and Seabed Processes				
6.3 Water Quality				
7 Biological Environment				
7.1 Designated Sites	Disturbance of internationally designated areas (SACs and SPAs) due to installation of cables	Moderate	Avoidance of most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats.	Minor
7.2 Ornithology	No significant impacts	-	-	-
7.3 Marine Mammals	No significant impacts	-	-	-
7.4 Benthic and intertidal ecology	Disturbance of *Sabellaria* reefs during pre-lay grapnel run	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	Disturbance of *Sabellaria* reefs by anchors of the cable laying barge	Moderate	Vessels to be positioned and anchors deployed accordingly.	Minor
	Disturbance of *Sabellaria* reefs during cable trench excavation and cable burial	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fauna and displacement of benthic habitat	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
7.5 Fish and Shellfish Ecology	Disturbance and/or smothering of spawning and nursery grounds of the most sensitive species (most notably herring) that deposit demersal eggs/larvae during pre-sweeping of sand waves and the pre-lay grapnel run and during the cable laying	Moderate	Installation in relevant substrates (e.g. gravel) will occur in months least sensitive for spawning and nursery (e.g. February to October) where practicable.	Minor
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fish communities	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate
8 Human Environment				
8.1 Commercial Fisheries	No significant impacts	-	-	-
8.2 Shipping and Navigation	Risk of another vessel colliding with an installation or decommissioning vessel	Moderate	- Safety information will be promulgated by the installation contractor and will include descriptions of the operation and operation area and will regularly be updated - Establishment of 500m by 1000m Safety Zone around spread. - Two guard vessels shall be assigned to the installation spread - Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). - Vessels to comply with Collision Regulations lighting and marking requirements	Minor
	Risk of electromagnetic interference from the cable affecting a navigating vessel's magnetic compass and causing compass deviation leading to navigational error and grounding	Moderate	Measurement of electromagnetic interference to ensure within accepted limits of less than 5 degrees deviation	Minor
	Risk of damage to cable, vessel or injury to persons on board during emergency anchoring event where the anchor then snags the cable	Significant	Charting of cable. And ensuring cable is buried to suitable depth.	Moderate
8.3 Archaeology and Cultural Heritage	Damage or destruction of submerged prehistoric material below the seabed during cable installation	Moderate	Based on analysis of the relevant survey data, little material of interest was discovered. Where material was found in a single core sample information about the submerged prehistoric resource is being gained from testing and analysis of the core.	Moderate

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
	Damage or destruction of A1 archaeological receptors (wrecks and geophysical anomalies of archaeological interest) and A3 receptors (historic records of possible archaeological interest with no corresponding geophysical anomaly)	Significant	All known wrecks have been avoided in the cable route design. Temporary exclusion zones will be placed around A1 geophysical anomalies during construction where practicable and buffers with a radius of 100m around the gazetteer points will be placed around A3 wrecks of archaeological potential. The locations can also be included in installation planning stages for example during locating anchorages.	Moderate
	Damage or destruction of A2 archaeological receptors (geophysical anomalies) during installation	Significant	A Written Scheme of Investigation (WSI) will address pre-installation and installation activities, such as the grapnel run, and may also include a protocol to substitute for a watching brief offshore. A2 archaeological receptors (geophysical anomalies) in the direct path of the cable route will be considered through the WSI and Archaeological Reporting Protocol.	Moderate
	Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites) during installation and decommissioning	Significant	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	Moderate
	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment during installation and decommissioning	Significant	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	Moderate
	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment through changes to erosion regimes due to bridging structures at the cable crossing	Moderate	Changes are expected to be minimal. Should bridging structures be used in areas in close proximity to known archaeological features monitoring of sediment mobility may assist in providing further information on the feature and act as a form of compensatory mitigation.	Minor
	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts through use of anchors during maintenance and decommissioning activities	Significant	Exclusion zones will be maintained around five known wrecks and will prohibit development related activities within their extents. 100m radius buffers will be placed around wreck sites of archaeological importance that are recorded in UKHO data, but that were not identified in the geophysical data. Any material discovered will be dealt with through the Archaeological Reporting Protocol	Minor
8.4 Cables and Pipelines	No impact is expected	-	-	-
8.5 Military and other sea users	No impact is expected	-	-	-

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
8.6 Unexploded Ordnance	The risk of encountering unexploded ordnance is low	-	-	-
8.7 Tourism, Recreation and Amenity	No significant impacts	-	-	-

The table above indicates that few of the impacts assessed have been determined to have the potential to cause moderate or significant impacts and almost all impacts can be reduced to have a minor impact when mitigation is applied.

Impacts upon designated sites and ornithology have been limited by routing the cable system to avoid the areas of greatest sensitivity. Impacts could be further mitigated by avoiding installation works in the intertidal areas in the key months of sensitivity and this will be done wherever practicable.

In order to avoid impacts upon sensitive and important features of benthic ecology the cable system has been routed to avoid areas of Sabellaria spinulosa aggregations by distance of 90m for the larger reef and 150m for the smaller area, which has been agreed in consultation with Natural England. Contractors will also be advised of the location of these features to ensure that deployment of anchors can be planned accordingly. The project intends to limit the use of rock placement to cable crossings which will limit the area of substrate change.

The impact assessment for fish species has concluded that herring spawning areas could suffer moderate impacts from the installation works as herring only spawn upon gravel seabed sediments for three months of the year. Therefore, it is proposed to avoid the key spawning period (November to January).

Assessment of impacts upon shipping and navigation has concluded that there is potential for moderate impacts/risks to navigation from vessel anchors snagging the cable system. This can be reduced by cable burial and ensuring the location of the cable system is marked on navigational charts. Although these mitigations are expected to avoid such an impact, the potential consequences of such an incident mean that it is not possible to reduce this to a level of minor or negligible significance.

The potential for encountering features of archaeological interest has been considered in detail and where the location of features is known these have been avoided such that no impacts can occur. Although detailed analysis of the geophysical survey data has been undertaken it is still possible that undiscovered and unknown features of archaeological importance could be impacted by installation works and this is why many of the impacts detailed cannot be reduced below a moderate level.
An environmental management plan will be produced prior to construction commencing to ensure that contractors are aware of the proposed mitigations and measures are in place to ensure the mitigation detailed is applied.

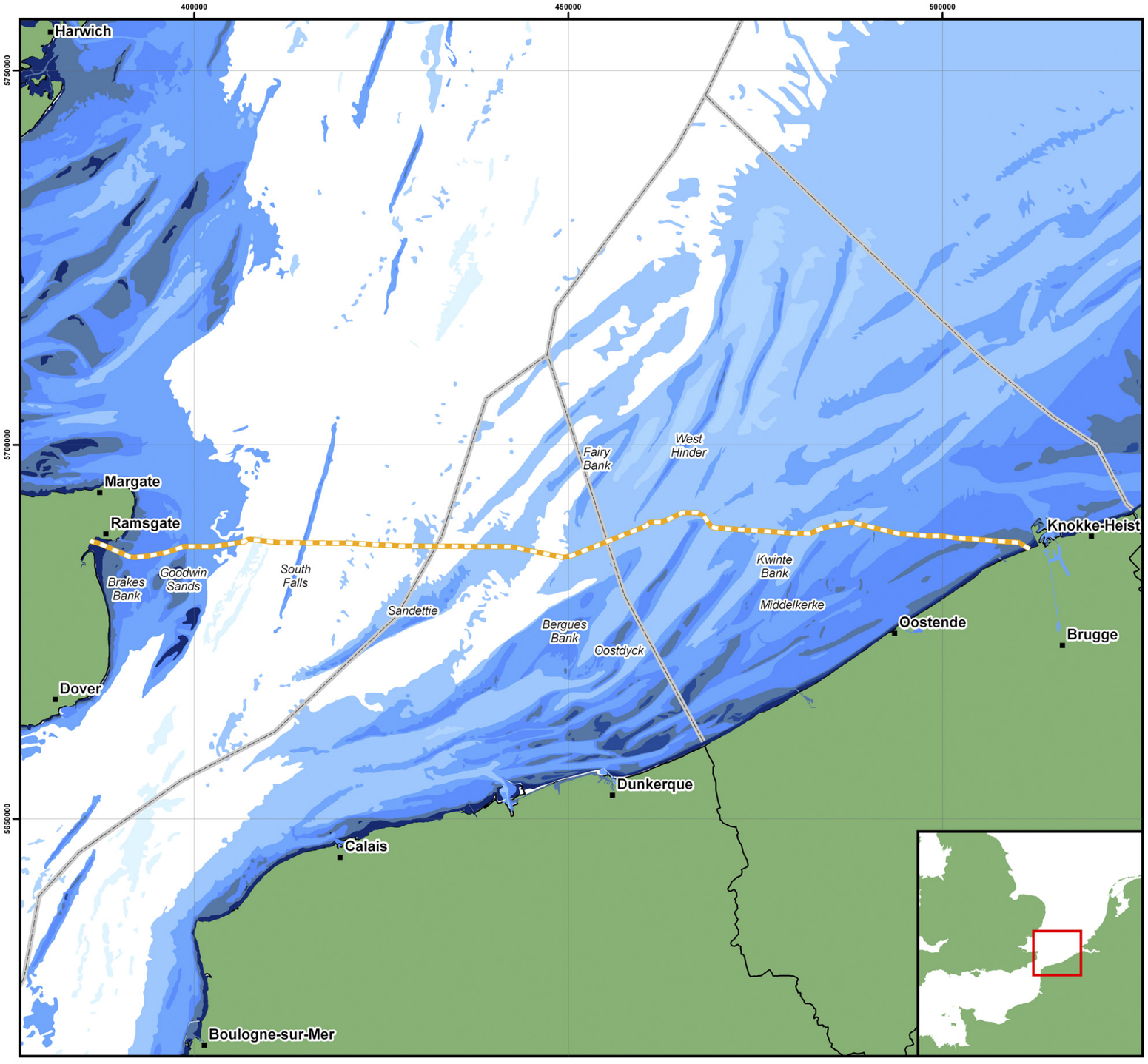
11.2. Monitoring

Following installation, the burial of the cable will be monitored via planned burial surveys that will include geophysical survey to assess the bathymetry and ground conditions and use of an ROV to determine the cable burial depth.

The first post installation survey will be used to ensure the ground along the cable system installation is clear of debris to satisfy the requirements of the fishing industry.

As the potential impacts on ecology detailed above are limited to the installation phase, which is of short duration, and features are expected to recover well it is not considered that monitoring for impacts on biological features will be meaningful.

Appendix 1: Figures



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NEMO

Bathymetry

Maritime Boundaries

Cable Route

Bathymetry (mCD)

- 0
- 2
- 5
- 10
- 20
- 30
- 40
- 50
- 60

Figure No.	Date	Revision
6-1-1	26/05/2011	003
Author dde	**Check** rjsw	**Scale @A3** 1:500,139
Data Source MUMM	**Projection System** UTM Zone 31N	
Spheroid WGS84	**Datum** WGS84	

0 6 12 18 24 km
0 3 6 9 12 nm

N

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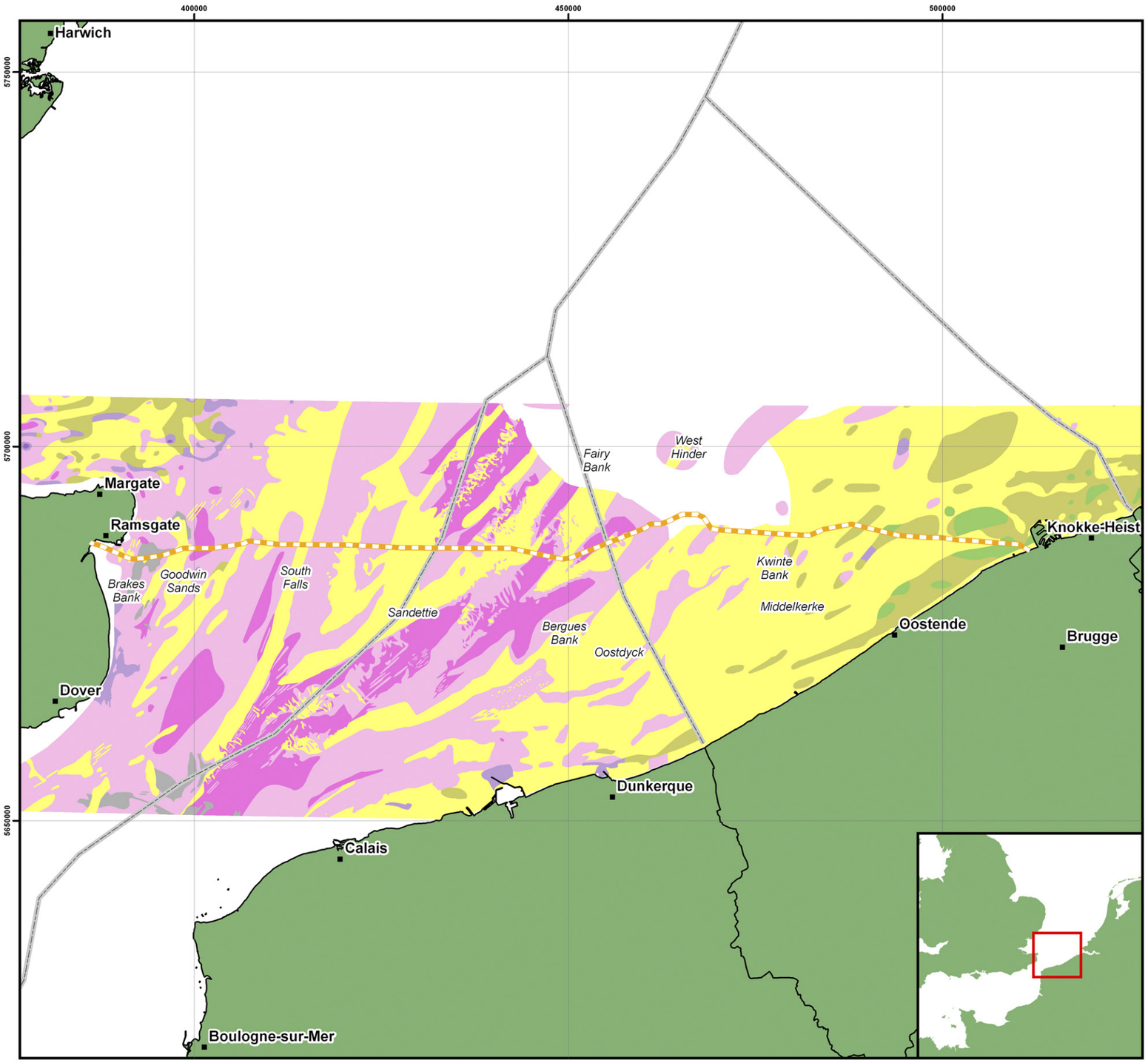
PMSS

HR Wallingford
Working with water



NEMO

Surface Geology

Maritime Boundaries

Cable Route

Sediment Type

- Mud
- Gravel
- Mud, Gravel
- Sand
- Sand, Mud
- Sand, Gravel
- Sand, Mud, Gravel
- Rock

Figure No. 6-1-2	**Date** 26/05/2011	**Revision** 004
Author dde	**Check** rjsw	**Scale @A3** 1:500,139
Data Source BGS	**Projection System** UTM Zone 31N	
Spheroid WGS84	**Datum** WGS84	

0 6 12 18 24 km
0 3 6 9 12 nm

N

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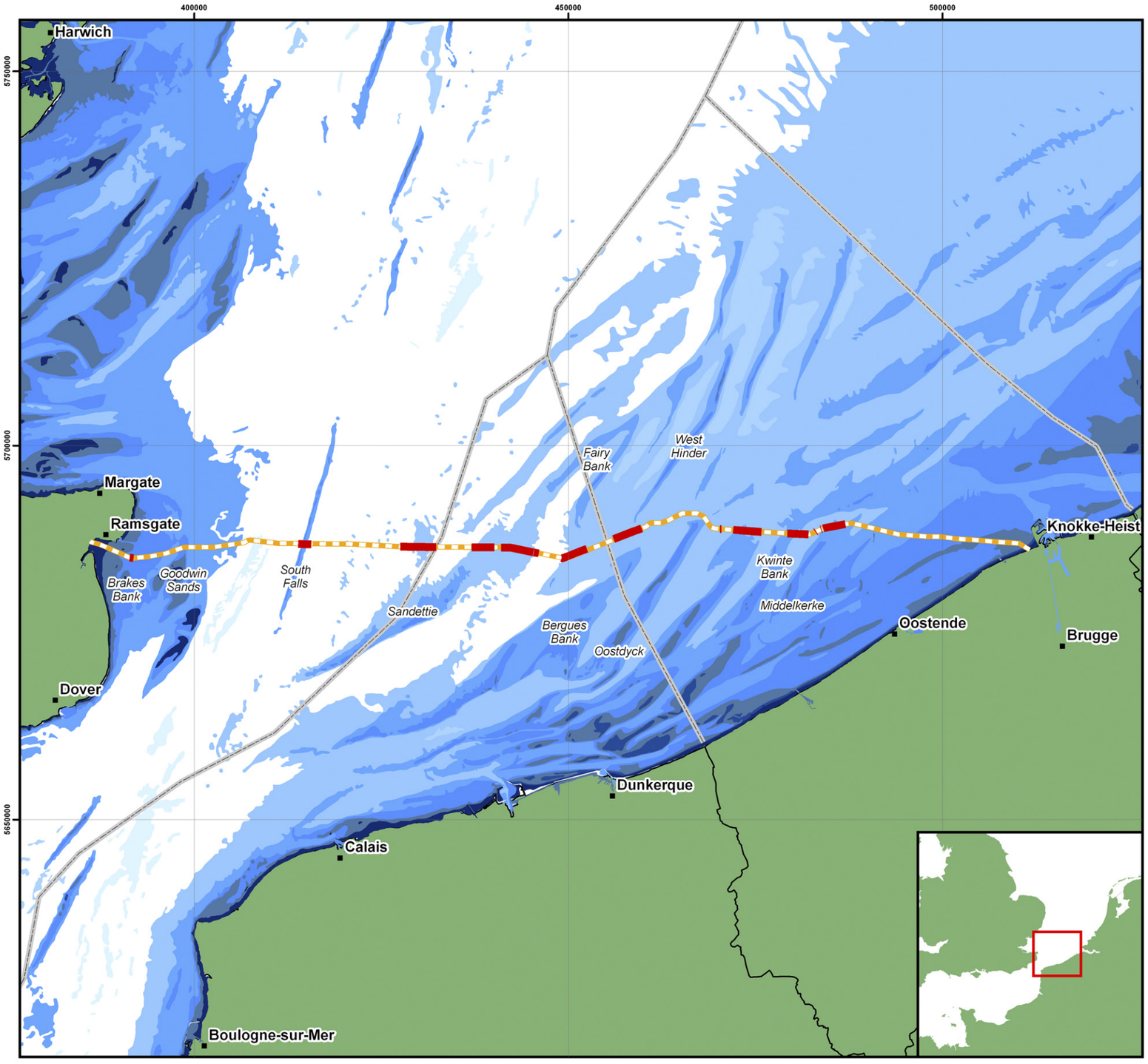

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Proposed Dredge Locations

- Dredging Locations
- Maritime Boundaries
- Cable Route

Bathymetry (mCD)

- 0
- 2
- 5
- 10
- 20
- 30
- 40
- 50
- 60

Figure No.	Date	Revision
6-2-1	26/05/2011	002
Author dde	**Check** rjsw	**Scale @A3** 1:500,139
Data Source MUMM	**Projection System** UTM Zone 31N	
Spheroid WGS84	**Datum** WGS84	

0 6 12 18 24 km
0 3 6 9 12 nm

N

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420000

5680000

5680000

Margate

NORTH FORELAND

ISLE OF THANET

Ramsgate

RAMSGATE

Richborough

GOODWIN

KELLET'S SANDS

SOUTH FALLS

SANDETTIE BANK

DW

DW

DW

ENGLAND

THE FORELAND

Dover

SOURCES

British Government Surveys

Trinity House Coverage

Admiralty Surveys

Netherlands Surveys

French Port Authority Surveys

Belgian Surveys

0 2 4 6 Km

Legend

- Cable Route
- Recommended Marine Conservation Zone
- Recommended Reference Area
- Special Areas of Conservation (SAC)
- Special Protection Areas (SPA)
- Site of Special Scientific Interest (SSSI)
- Ramsar
- National Nature Reserves (NNR)

NEMO

Figure 7-1-1: Conservation designations in proximity to the NEMO cable route

Figure No.	Date
29689/1993.2	21/06/2012

Author	Check	Scale @A3
NDU	CGR	1:125,000

Data Source
Seazone
The Crown Estate
Natural England
JNCC

Projection System	
UTM Zone 31N	
Datum	**Spheroid**
WGS84	WGS84

N

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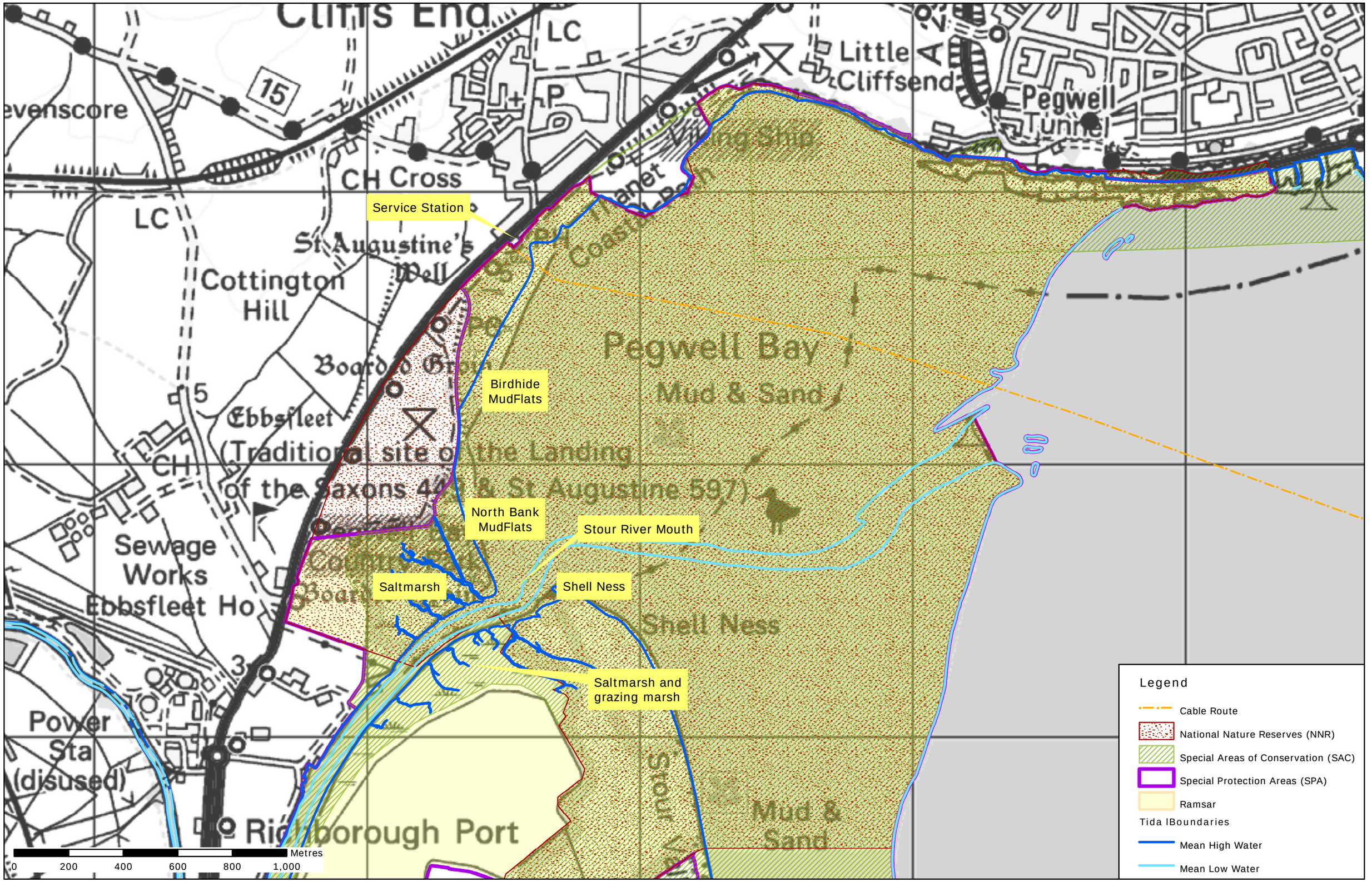

NEMO	Figure No. 29689/2030		Date 25/05/2011	Data Source Seazone The Crown Estate Natural England JNCC	Projection System British National Grid		Client: elia Powering a world in progress; nationalgrid; PMSS	
Figure 7-2-1: Illustration of areas of within Pegwell Bay	Author NDU	Check SAV	Scale @A3 1:12,500		Datum OSGB36	Spheroid Airy 1830		

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400000

420000

5680000

North Sand

Kellet Gut Bank

Central Goodwin Sands

South Calliper

Legend

Cable Route

Kilometres

0 2 4 6 8 10

NEMO		**Figure No.** 29689/1988		**Date** 05/05/2011	**Data Source** Seazone The Crown Estate	**Projection System** UTM Zone 31N	
Figure 7-3-1 : Harbour seal and grey seal haul-out sites		**Author** NDU	**Check** SAV	**Scale @A3** 1:130,000		**Datum** WGS84	**Spheroid** WGS84

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Northern Landfall

Southern Landfall

Northing

Easting

Legend

- Grab Positions
- Benthic Camera Fixes
- Trawls
- UK Sector Boundary
- Revised Proposed Route Centre Line
- Original Proposed Route Centre Line

Surface Geology

- Clay/Silt
- Sand
- Sand and Gravel
- Gravel
- Bedrock

0 1,000 2,000 3,000 4,000 Metres

Project Nemo - Benthic Environmental Survey

Environmental Sampling Positions

Figure No.	Date	Data Source	Projection System		
7-4-1	21/02/2011	MMT, 2010a; 2010b	UTM Zone 31N		
Author	**Check**	**Scale @A3**		**Datum**	**Spheroid**
GM	FC	1:45,000		WGS84	WGS84

Client: elia Powering a world in progress / nationalgrid

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ESRI ArcMap version 9.3.1

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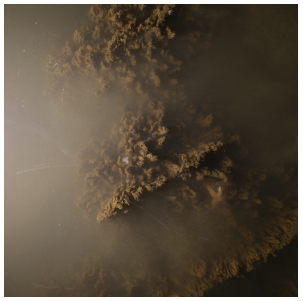
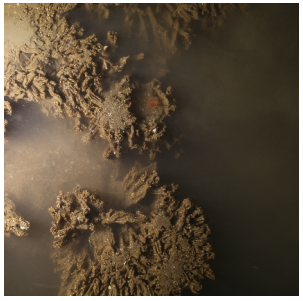
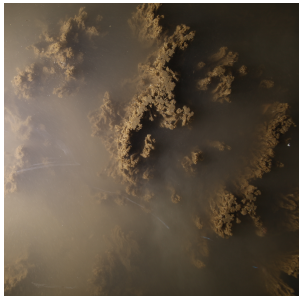
Transect B03-039_001 Fix 007
Sabellaria sp. present as
large elevated colonies

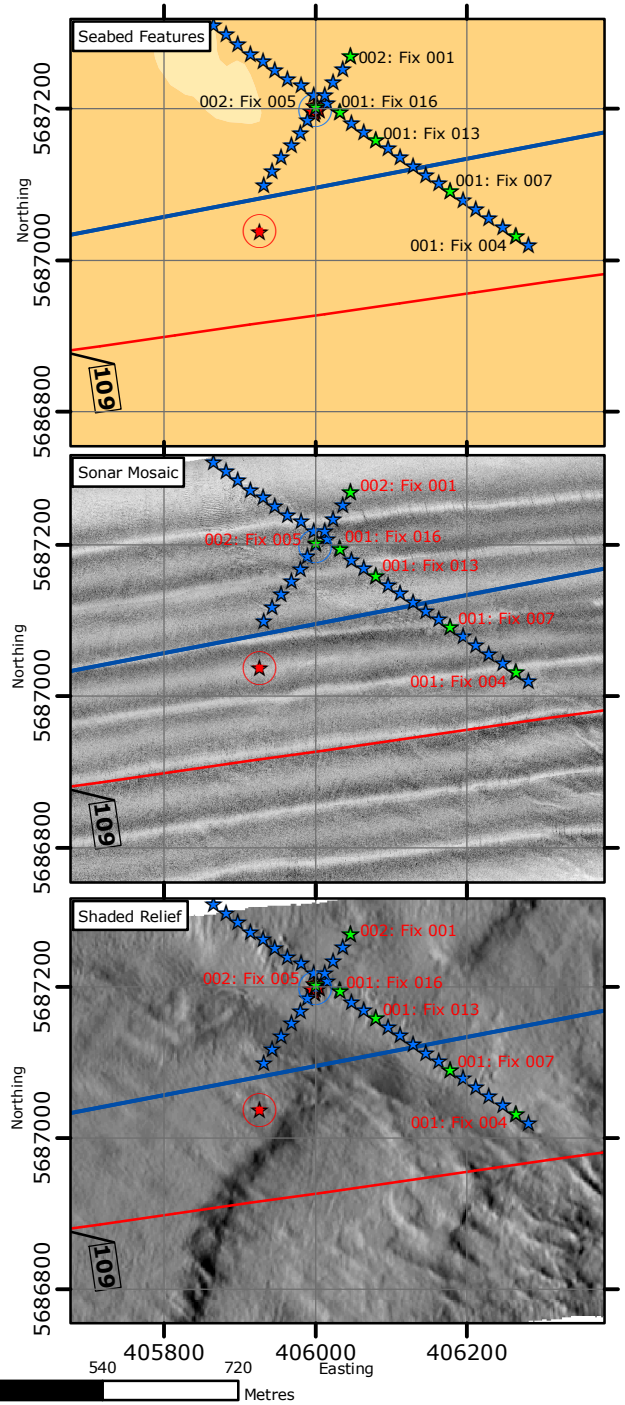


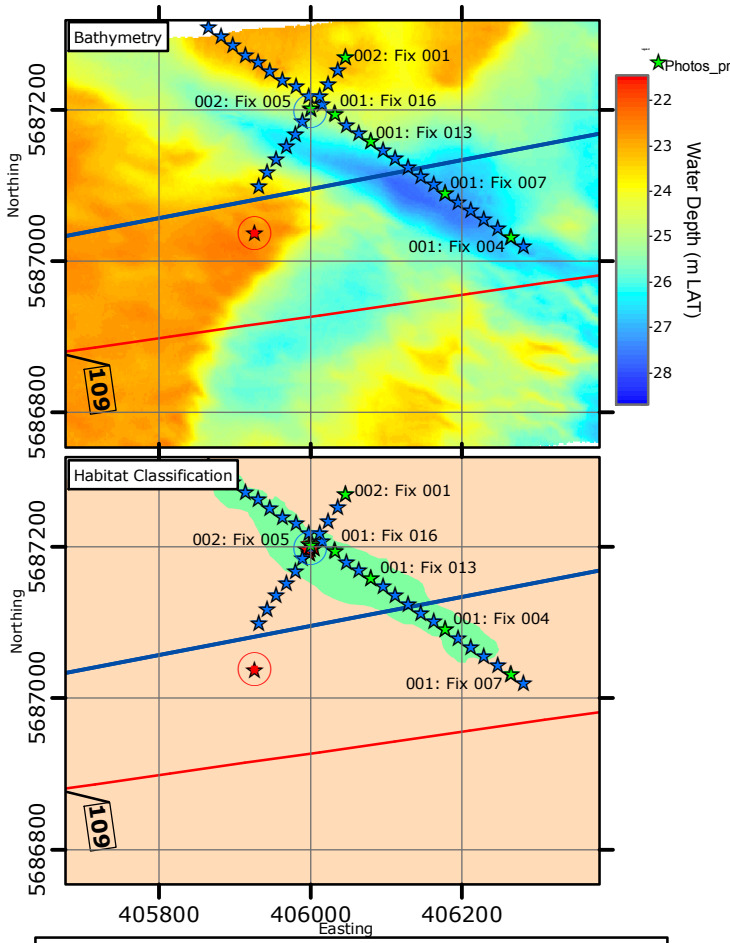
Transect B03-039_001 Fix 013
Sabellaria sp. present as large
elevated colonies



Transect B03-039_001 Fix 016
Sabellaria sp. present as
elevated colony patches







Legend

- Proposed Grab Position
- Actual Grab Sample
- Photos_presented
- Transect Camera Fixes
- Benthic Camera Fixes
- Revised Proposed Route Centre Line
- Original Proposed Route Centre Line

Light Position
Azimuth:270
Vertical: 45

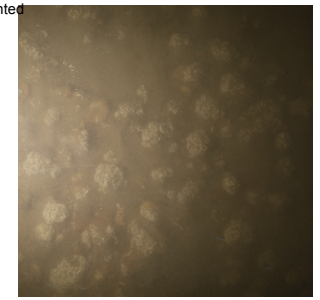
Surface Geology

- Sand
- Sand and Gravel

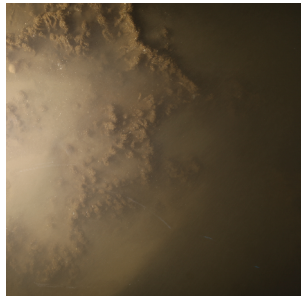
EUNIS Habitat Classification

- A5.25 Circalittoral fine sediment
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment

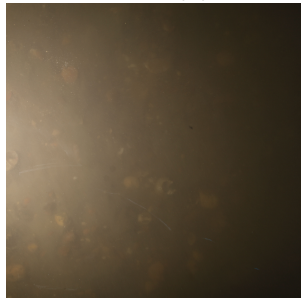
Transect B03-039_002 Fix 001
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



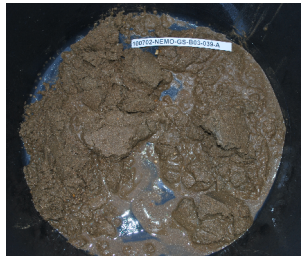
Transect B03-039_002 Fix 005
Sabellaria sp. present as slightly
elevated colony patches



Transect B03-039_001 Fix 004
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



Sediment remaining after sieving (1mm)
Relatively large volume of fine sand



Project Nemo - Benthic Environmental Survey		**Figure No.** 7-4-2	**Date** 18/02/2011	**Data Source** MMT 2010a; 2010b	**Projection System** UTM Zone 31N		Client: elia / nationalgrid
Sabellaria Investigation - Station B03-039	**Author** GM / **Check** FC	**Scale @A3** 1:10,000			**Datum** WGS84	**Spheroid** WGS84	PMSS

ESRI ArcMap version 9.3.1

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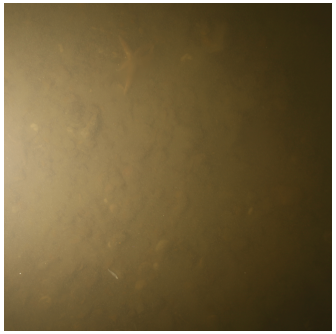
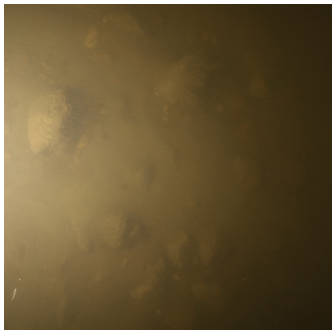
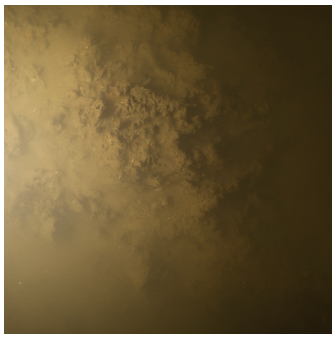
Transect B03-040_001 Fix 003
Photo fix from outside delineated area.
No *Sabellaria* sp. present.

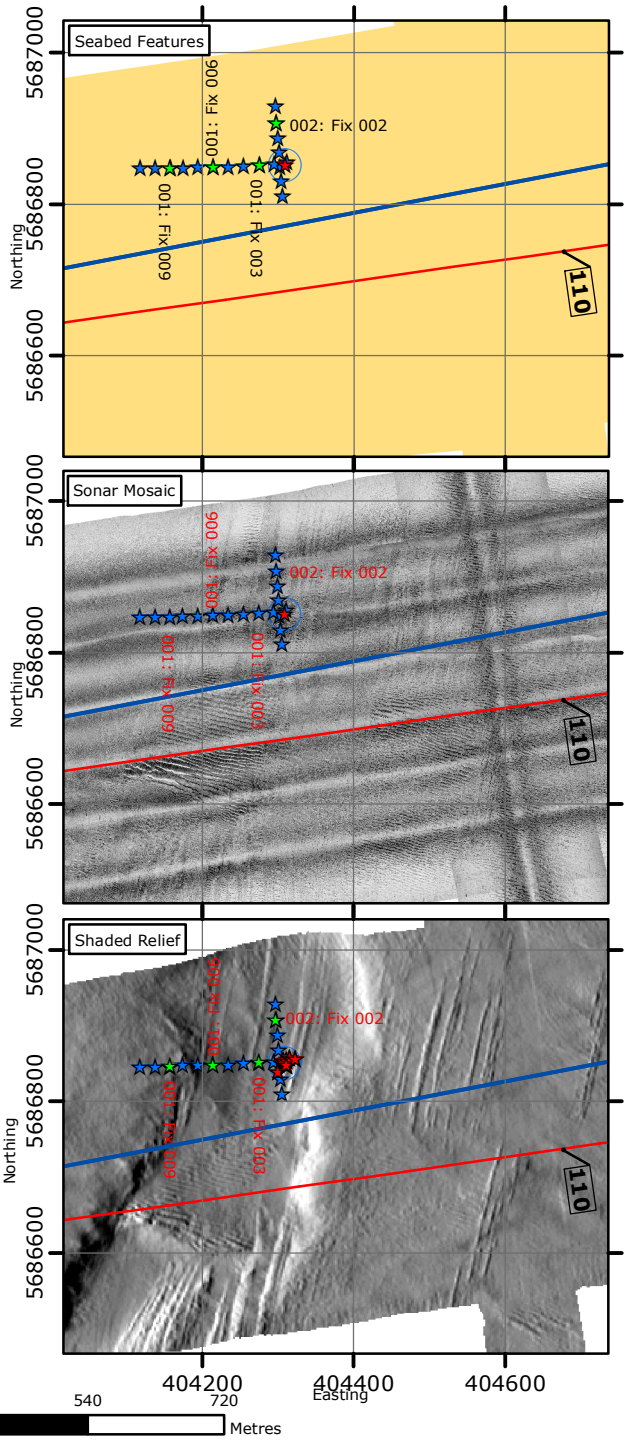


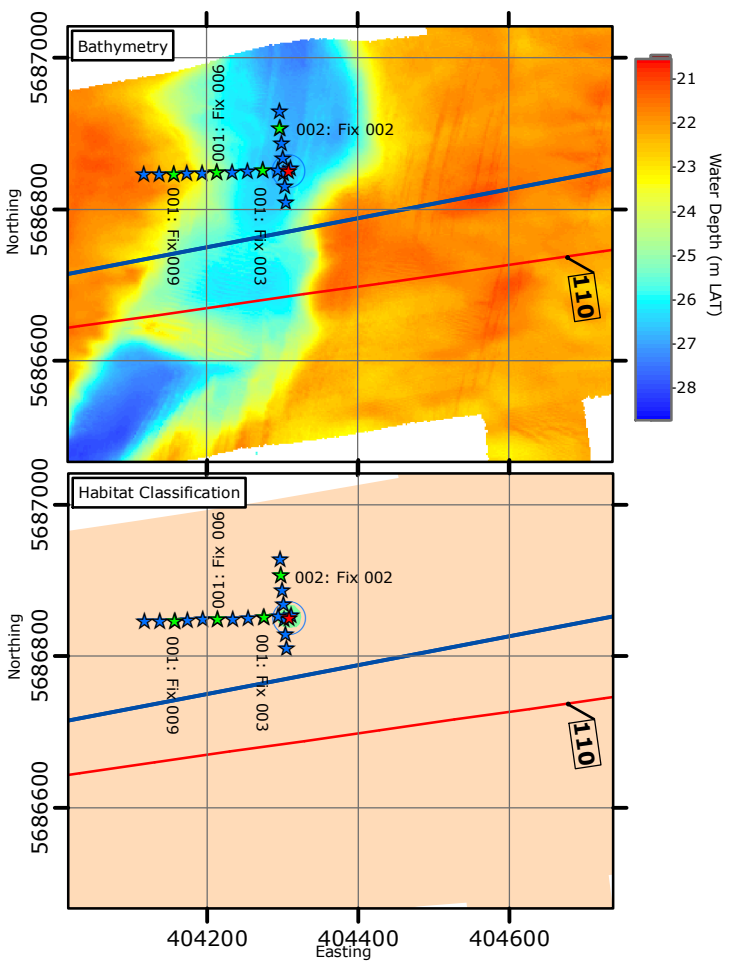
Transect B03-040_001 Fix 006
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



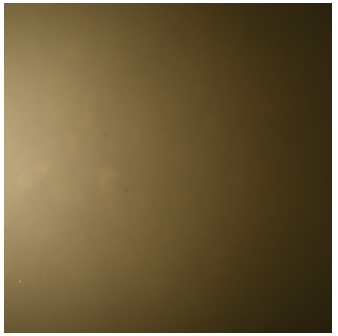
Transect B03-040_001 Fix 009
Photo fix from outside delineated area.
Sabellaria aggregation present



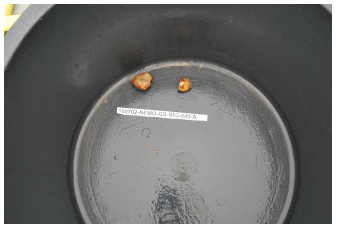




Transect B03-040_002 Fix 002
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



Sediment remaining after sieving (1mm)
Very little sediment retained



Legend

- Photos_presented_Stn40
- Benthic Camera Fixes
- Transect Camera Fixes
- Proposed And Actual Grab Sample
- Revised Proposed Route Centre Line
- Original Proposed Route Centre Line

Surface Geology

- Sand

EUNIS Habitat Classification

- A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
- A5.25 Circalittoral fine sediment
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment

Light Position
Bearing:270
Vertical:45

Project Nemo - Benthic Environmental Survey		**Figure No.** 7-4-3	**Date** 18/02/2011	**Data Source** MMT, 2010a; 2010b	**Projection System** UTM Zone 31N		Client: elia / nationalgrid
Sabellaria Investigation - Station B03-040	**Author** GM / **Check** FC	**Scale @A3** 1:10,000			**Datum** WGS84	**Spheroid** WGS84	PMSS

ESRI ArcMap version 9.3.1

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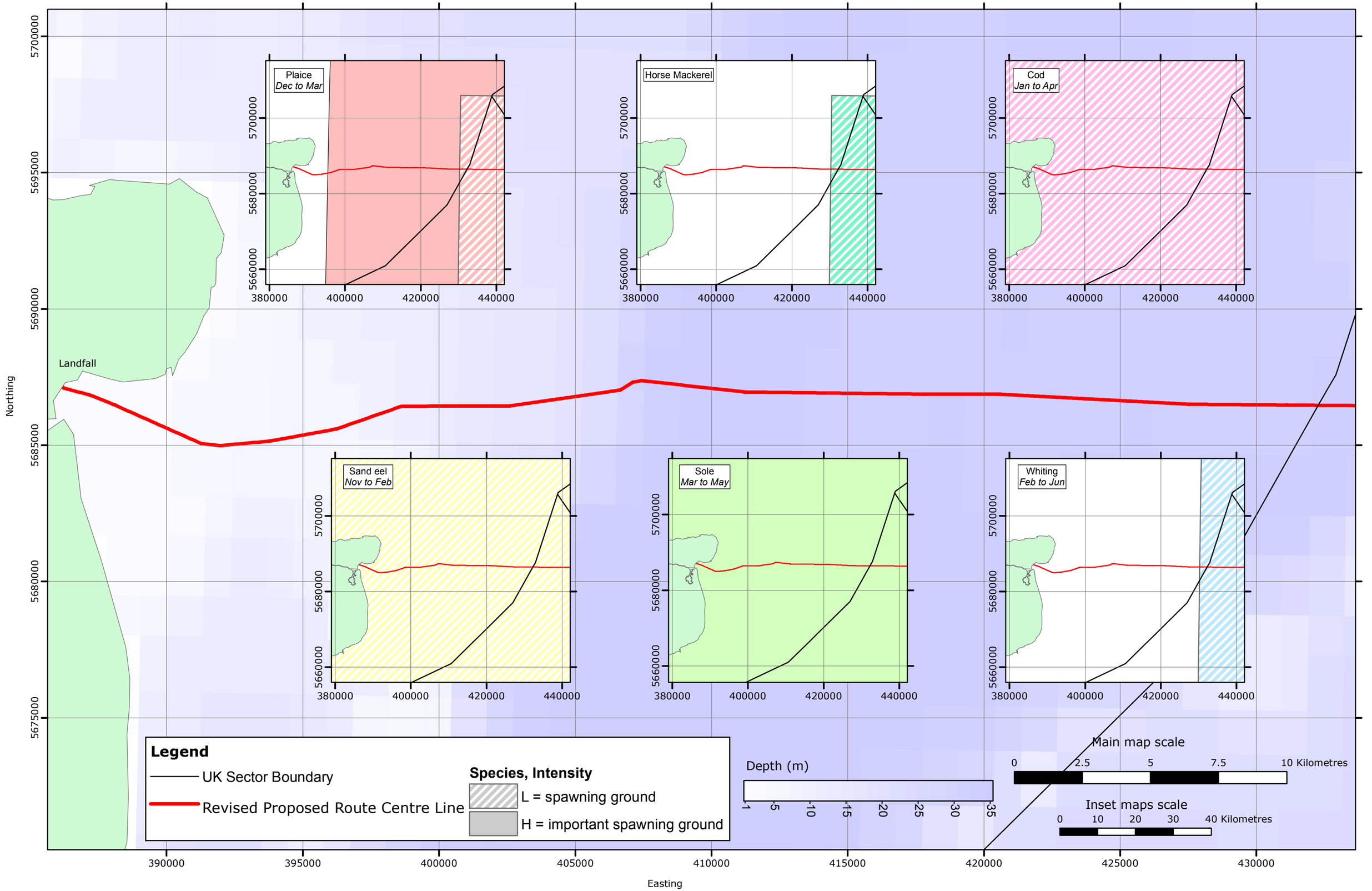

Project Nemo - Benthic Environmental Survey	**Figure No.** 2	**Date** 11/05/2011	**Data Source** Coull *et al*., 1998 Ellis *et al*., 2010 GEBCO, 2008	**Projection System** UTM Zone 31N		Client: elia / nationalgrid	PMSS
7-5-1 Fish Spawning Grounds	**Author** HM	**Check** FC	**Scale @A3** 1:125,000	**Datum** WGS84	**Spheroid** WGS84		

ESRI ArcMap version 9.3.1

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Plaice

Mackerel

Cod

Whiting

Sand eel

Sole

Herring

Tope Shark

Landfall

Northing

Easting

Legend

Revised Proposed Route Centre Line

UK Sector Boundary

L = nursery ground

H = main nursery ground - areas with high relative abundance of juveniles

Depth (m)

1 5 10 15 20 25 30 35

Main map scale

0 2.5 5 7.5 10 Kilometres

Inset maps scale

0 10 20 30 40 Kilometres

Project Nemo - Benthic Environmental Survey

7-5-2 Fish Nursery Grounds

Figure No.	Date	Data Source	Projection System		
3	11/05/2011	Coull *et al.*, 1998 Ellis *et al.*, 2010 GEBCO, 2008	UTM Zone 31N		
Author HM	**Check** FC	**Scale @A3** 1:125,000	**Datum** WGS84	**Spheroid** WGS84	

Client: elia Powering a world in progress; nationalgrid

PMSS

ESRI ArcMap version 9.3.1

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400000
450000
500000
5750000
5700000
5650000

Data presented represents UK vessels landing into the UK and abroad as well as foreign vessels landing into the UK. Data for foreign vessels landing into foreign ports are not captured

32F1
32F2
32F3
31F1
31F2
31F3

Km
0 5 10 15

Legend

- 12NM Limit
- Median Line
- Cable Route

ICES Fishing Areas Tiles

Mean Total

- 0
- 1 - 10
- 11 - 50
- 51 - 500
- 501 - 1000
- >1000

NEMO

Figure 8-1-1 : Mean Annual Fishing Effort Expended by ICES rectangle (2007-2011)

Figure No.	Date	Data Source	Projection System
29869/1861	21/06/2012	DECC MMO	UTM Zone 31N

Author	Check	Scale @A3	Datum	Spheroid
NDU	CGR	1:450,000	WGS84	WGS84

Client: elia Powering a world in progress / nationalgrid

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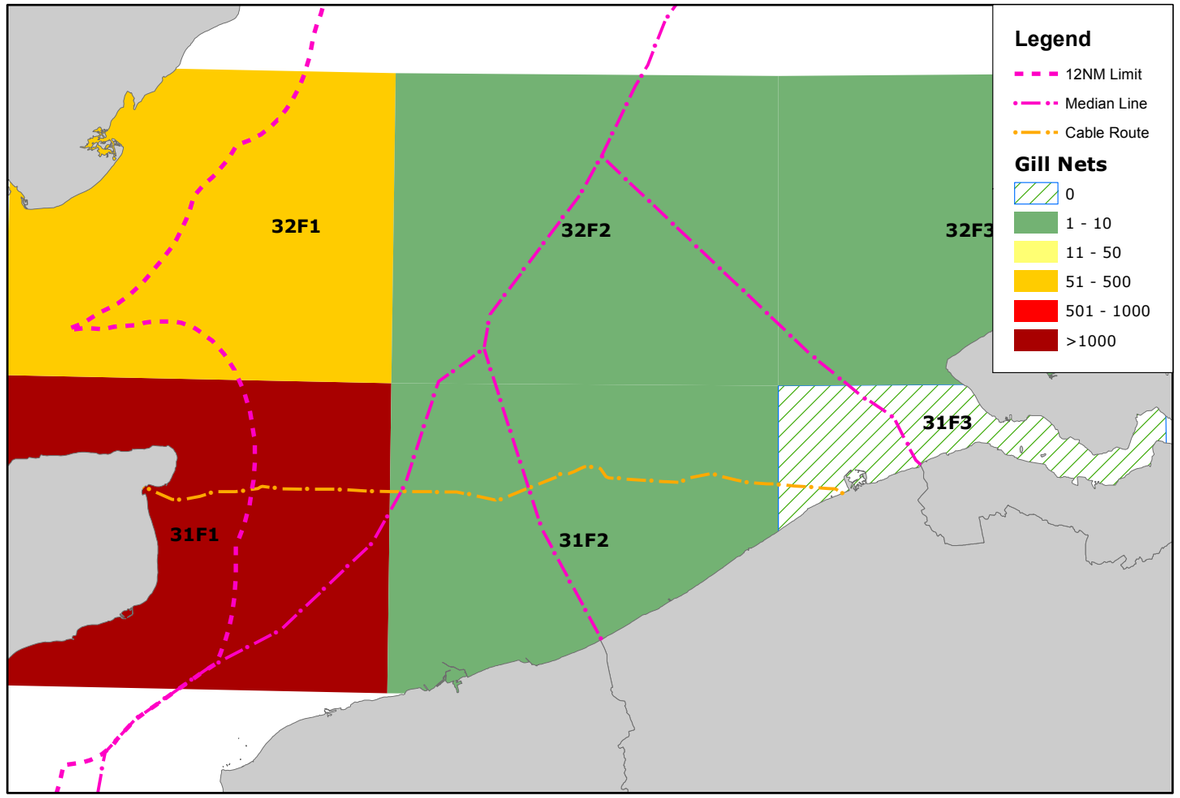

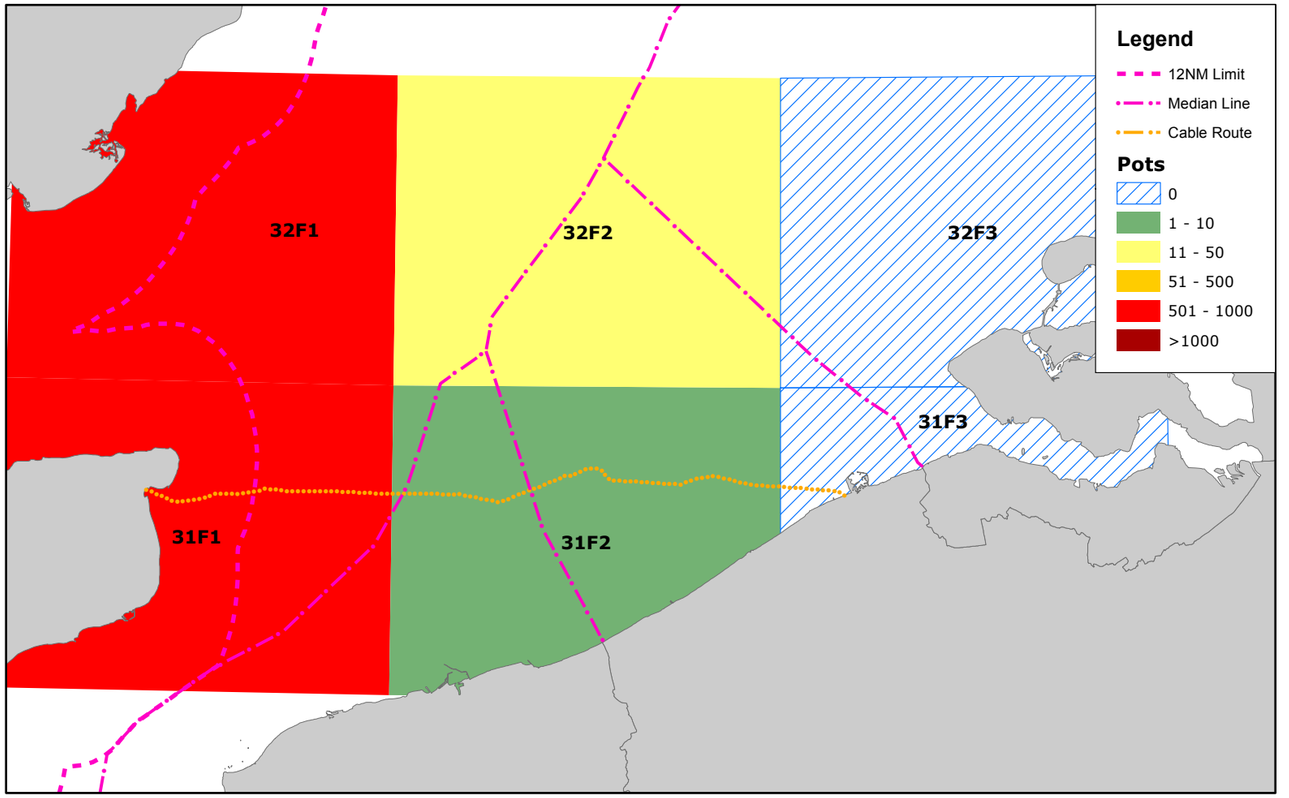

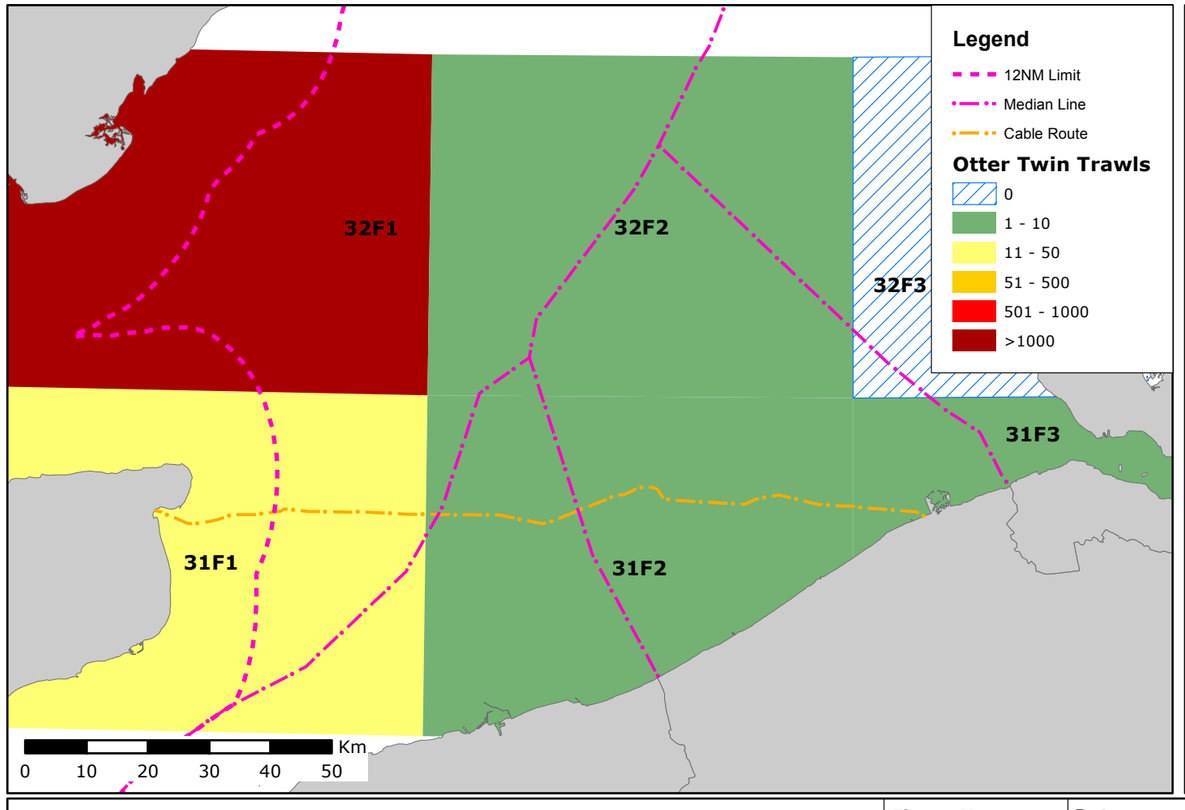

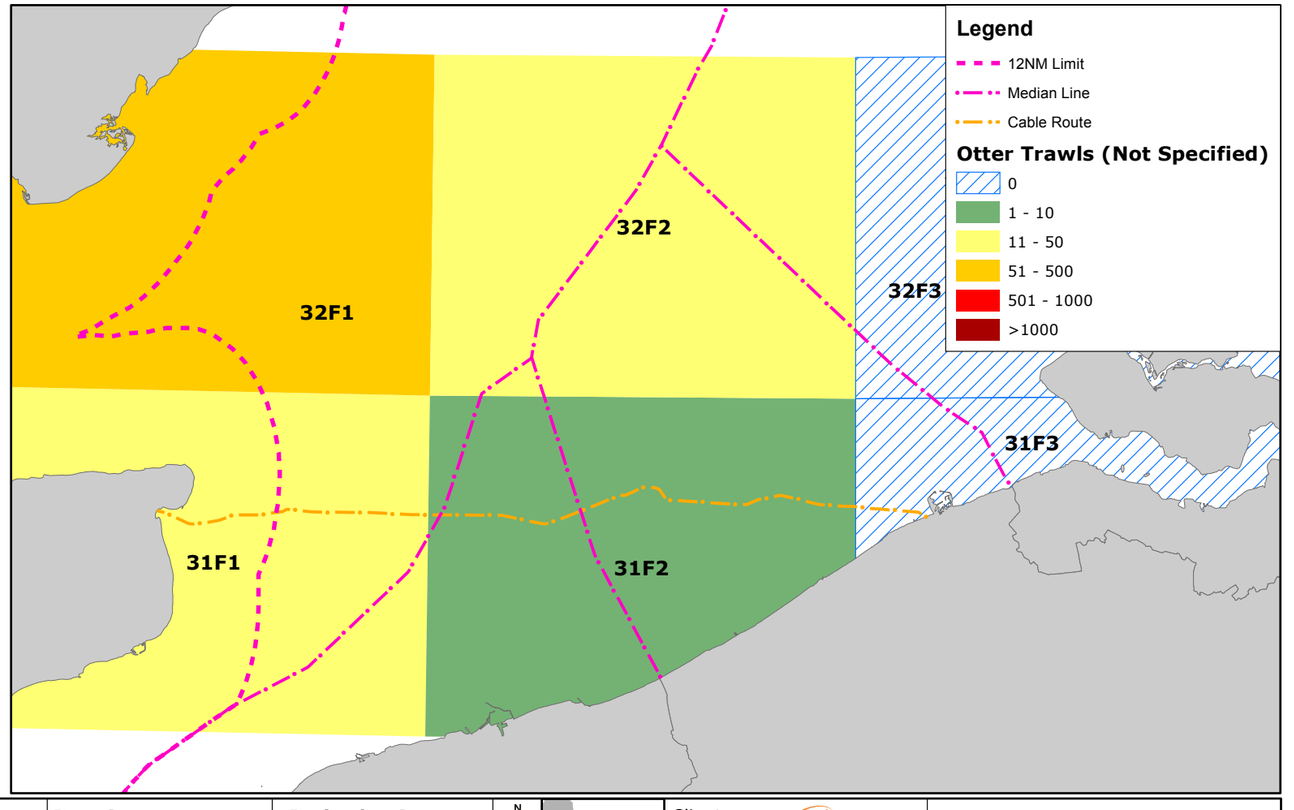

NEMO

Figure 8-1-3 : Mean annual fishing effort expended by gear type (2007-2011): part 1

Figure No.	Date	Data Source	Projection System	
29869/1862.1	21/06/2012	DECC MMO	UTM Zone 31N	
Author NDU	**Check** CGR	**Scale @A3** 1:1,000,000	**Datum** WGS84	**Spheroid** WGS84

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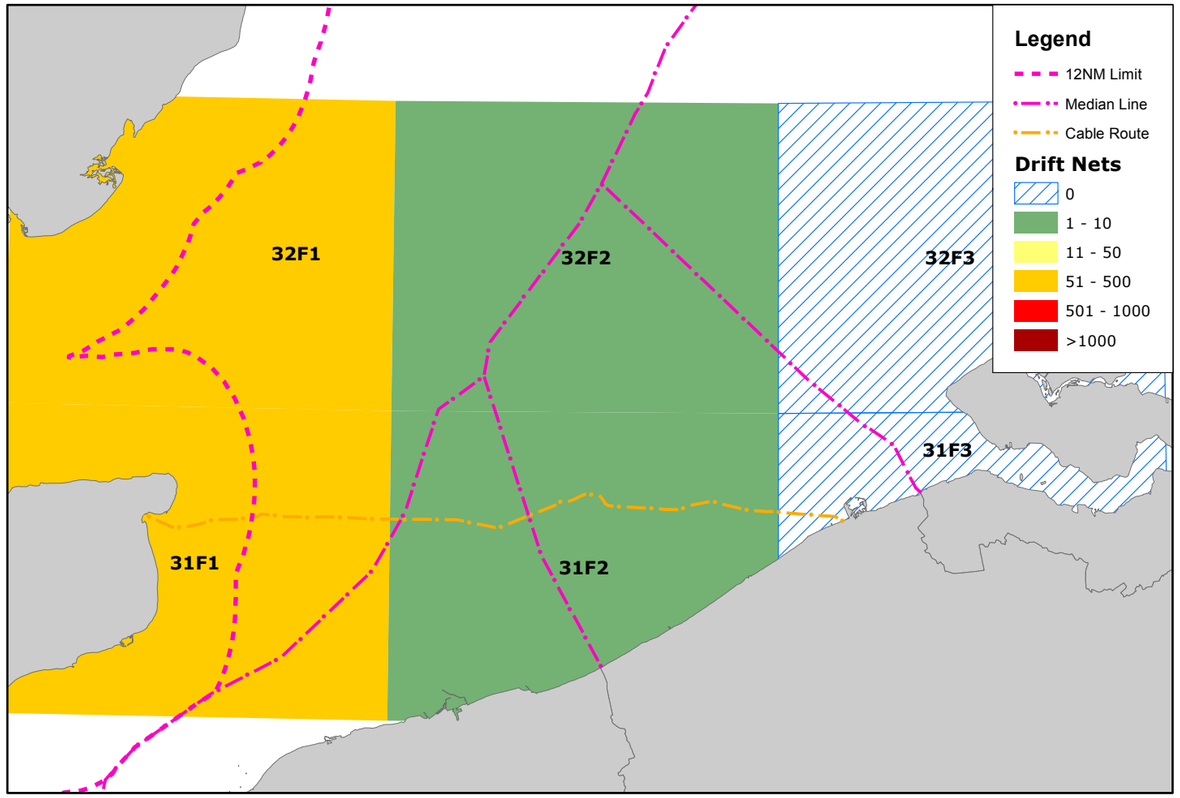

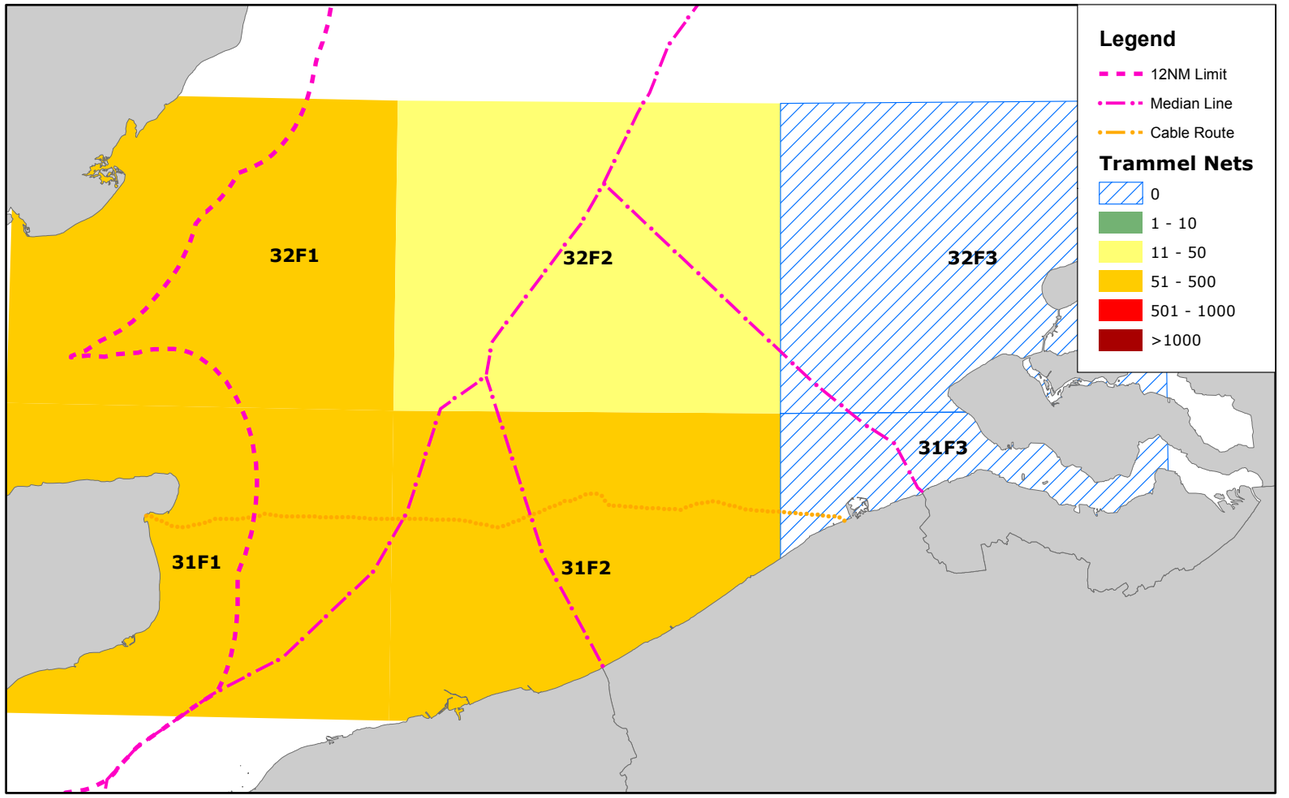

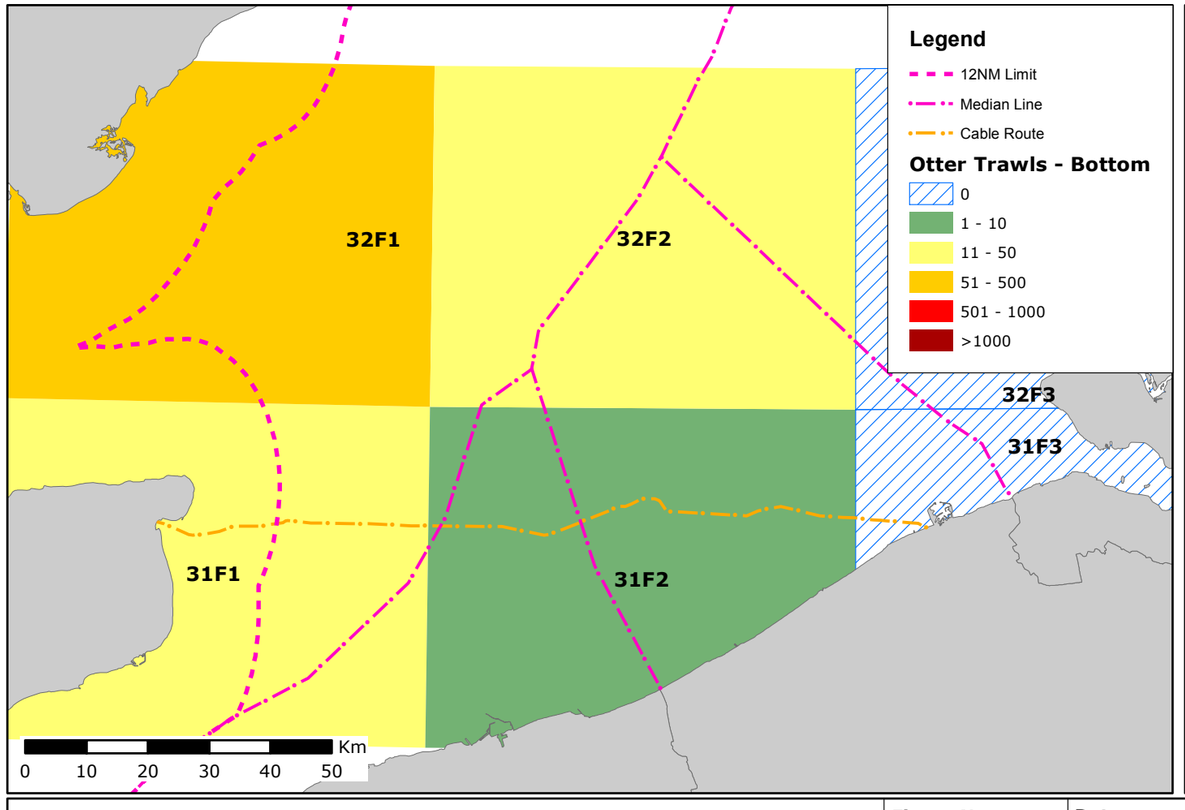

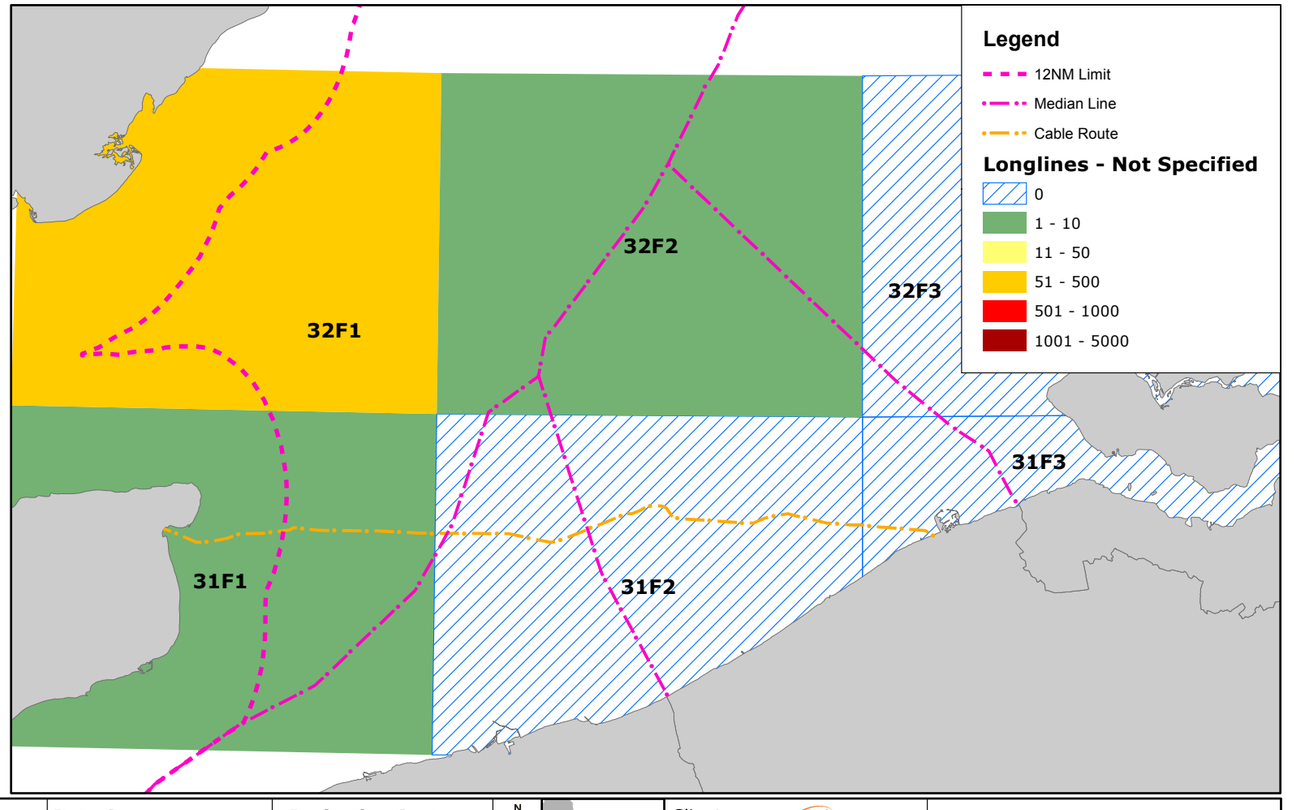

NEMO	**Figure No.** 29869/1863.1		**Date** 21/06/2012	**Data Source** DECC MMO	**Projection System** UTM Zone 31N		Client: elia Powering a world in progress nationalgrid
Figure 8-1-4 : Mean annual fishing effort expended by gear type (2007-2011): part 2	**Author** NDU	**Check** CGR	**Scale @A3** 1:1,000,000		**Datum** WGS84	**Spheroid** WGS84	PMSS

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375000 400000 425000

5700000 5675000

UK France

UK France

Km
0 5 10 15

Legend

- International Limits
- Cable Route
- IMO Routeing
- Cable Route 500m Buffer
- AIS 90th Percentile

NEMO

Figure 8-2-1: Navigational Overview

Figure No.	Date	Data Source	Projection System		
29689/1796.4	21/06/2012	Maritimedata UKHO Seazone	UTM Zone 31N		
Author NDU	**Check** CGR	**Scale @A3** 1:200,000	**Datum** WGS84	**Spheroid** WGS84	

Client: elia Powering a world in progress / nationalgrid

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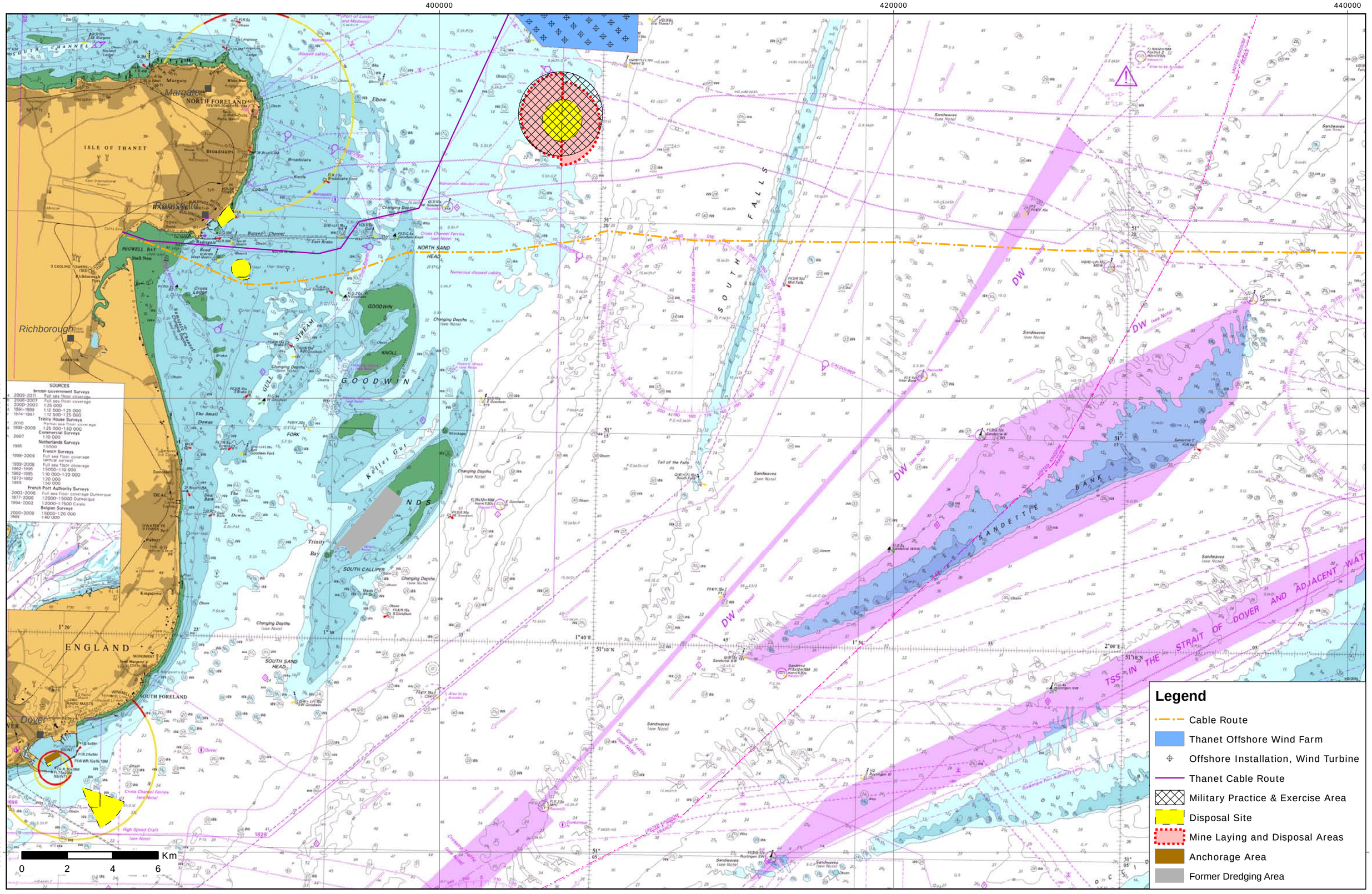

SOURCES

British Government Surveys

2009-2011	Full sea floor coverage	
2006-2007	Full sea floor coverage	
2000-2003	1:25 000	
1991-1998	1:12 500-1:25 000	
1974-1987	1:12 500-1:25 000	

Trinity House Surveys

2010	Partial sea floor coverage	
1999-2009	1:25 000-1:50 000	

Commercial Surveys

2007	1:10 000

Netherlands Surveys

1995	1:5000

French Surveys

1998-2009	Full sea floor coverage (annual survey)
1999-2008	Full sea floor coverage
1962-1995	1:5000-1:10 000
1962-1995	1:10 000-1:20 000
1973-1982	1:20 000
1959	1:40 000

French Port Authority Surveys

2003-2006	Full sea floor coverage Dunkerque
1977-2006	1:2000-1:5000 Dunkerque
1994-2002	1:2000-1:7500 Calais

Belgian Surveys

2000-2008	1:5000-1:20 000
1969	1:40 000

Legend

- Cable Route
- Thanet Offshore Wind Farm
- Offshore Installation, Wind Turbine
- Thanet Cable Route
- Military Practice & Exercise Area
- Disposal Site
- Mine Laying and Disposal Areas
- Anchorage Area
- Former Dredging Area

NEMO		Figure No. 29689/1800.2		Date 21/06/2012	Data Source Seazone The Crown Estate	Projection System UTM Zone 31N	
Figure 8-5-1: Military and other sea users		Author NDU	Check CGR	Scale @A3 1:150,000		Datum WGS84	Spheroid WGS84

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Nemo Link®

Environmental Statement

Non-Technical Summary

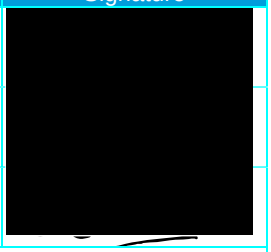
February 2013

Non Technical Summary

The Nemo Link

February 2013

Document Control

Responsible for	Job Title	Name	Date	Signature
Content	Project Support	Helen FitzGerald	2012-07-10	
Checked	Senior Consultant	Rachel McCall	2012-09-17	
Approval	Director	David Bean	2012-09-17	
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Abbreviations

CEFAS	Centre for Environment, Fisheries and Aquaculture Sciences
EIA	Environmental Impact Assessment
EOD	Explosives and Ordnance Disposal
EU	European Union
ES	Environmental Statement
FLO	Fisheries Liaison Officer
HDD	Horizontal directional drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
kV	Kilovolt
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
MMO	Marine Management Organisation
NM	Nautical Mile
NtM	Notices to Mariners
PLB	Post-lay Burial
PLGR	Pre-lay Grapnel Run
PMSS	Project Management Support Services Limited
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TJP	Transition Jointing Pit
UKCPC	UK Cable Protection Committee

1. Introduction

The Nemo Link (the Project) is a proposed electrical interconnector, with an approximate capacity of 1000 MW, which will allow transfer of electrical power between the high voltage grid systems of Belgium and the United Kingdom. The Project is being developed by National Grid Nemo Link Limited, part of the National Grid group, and Elia Asset S.A. which is part of the national transmission company in Belgium (together referred to as the Nemo Consortium).

The Project falls within the UK, France and Belgium and combines onshore and marine elements. Accordingly, five separate consent applications are required to be made for the following elements of the Project:

- Offshore Cable Installation in UK Waters
- Offshore Cable Installation in French Waters
- Offshore cable installation in Belgian Waters
- Onshore UK elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.
- Onshore Belgian elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.

The proposed subsea cable route runs from Richborough in Kent in the UK to Zeebrugge in Belgium, passing through English, French and Belgian waters. Appendix 1 provides an overview of the location of the proposed cable route.

This document is a Non-Technical Summary of the Environmental Statement (ES) covering the cable installation in UK waters for which a marine licence is required under the Marine and Coastal Access Act 2009. This element of the Project is referred to in this document and the ES as ‘the proposed development’.

The ES presents the findings of the detailed Environmental Impact Assessment (EIA) that has been carried out for the proposed development. The assessment work covers all of the potential impacts of the proposed development on the surrounding environment and has been carried out by a team of leading environmental specialists.

2. The Need for the Project

The European Union (EU) has a target to increase the transmission capacity between its member states, with the stated wish to see each country establish an interconnector capacity of around 10% of its own installed generation capacity.

The reasons for this policy are:

- to allow a more efficient energy market within the EU;
- to facilitate the sustainable development of the electricity sector by increasing opportunities for clean and efficient generation;
- to make it easier to exploit intermittent renewable electricity resources in the UK and Continental Europe.

The key benefits of the Project are:

- To allow energy to flow in either direction between the UK and Belgium benefitting both countries by ensuring a secure and affordable energy supply

- To contribute to managing fluctuations in supply and demand as more power is generated by renewable sources and therefore indirectly providing better opportunities for development of renewable energy projects in both countries.
- To increase the potentials for the UK to trade with the wider power markets, as Belgium's electricity transmission system is presently highly connected to Central Europe.
- To reduce the amount of reinforcement works required to the UK high-voltage transmission system from the South East region which is the highest centre of electricity demand in the UK.

3. The Proposed Development

The proposed development consists of the installation of High Voltage Direct Current (HVDC) cable in the offshore and intertidal zone in UK waters within the Eastern English Channel. This section of cabling is approximately 50 km long in the context of the overall distance of the cable route for the whole Project which is approximately 130 km.

The offshore cable route was selected using a desk-top routing tool, taking into account all known offshore constraints and then verified by a full seabed survey. The survey confirmed the route and no major route modifications were made.

Due to this overall cable length, the use of HVDC provides the most efficient and effective means to transport electricity over this distance.

The high voltage grid systems in the UK and Belgium operate using high voltage alternating current (HVAC). To transport electricity from one country to the other first requires the HVAC to be converted to HVDC at the transmitting end and transmitting the power using HVDC cables before being converted back to HVAC at the receiving end. This conversion process is carried out at converter stations which will be located at the former power station at Richborough in Kent and at Zeebrugge in Belgium.

A direct HVAC connection is not feasible due to inefficiencies resulting from the distances involved and since the UK and Belgium transmission systems operate at 50Hz a HVDC system allows for any discrepancies in synchronisation between the two systems.

The subsea cable system is jointed to its corresponding land cable in a joint pit located above mean high water mark and does not form part of this application. The consent for this part of the Project will form part of the planning application for onshore elements.

4. Cable Type / Installation

The sections below give an outline description of the cable system and its installation.

4.1. Cable type

The type and voltage of submarine cable to be deployed will be defined during the detailed engineering design works that will take place once a construction contract has been awarded, following receipt of the relevant project consents. The Nemo Consortium is considering the use of one of two cable types available for HVDC application; Cross Linked Polyethylene (XLPE) and Mass Impregnated (MI). The cable will be rated at between 350 kV and 400 kV.

The cable will be installed in a bundled configuration, comprising two cables buried in the same trench with no separation between these cables.

4.2. Route preparation

Two significant preparation activities are likely to be undertaken prior to installation of the cable system. These are:

- Clearance of out-of-service telecommunications cables that cross the cable route;
- Preparation and deposit of bridging and separation structures over any cables and pipelines that the interconnector cable route crosses.

It is also possible that areas of seabed where bed rock is present, likely to be chalk, may be prepared by the cutting of a trench or trenches that the cables will then be installed into. An alternative approach in these chalk areas, would be to use a specialist rock cutting plough.

4.3. Cable route clearance

Prior to the start of marine operation it is essential to ensure the cable route is clear of obstructions that may hinder the operation.

Seabed debris such as scrap trawler warps or ships' crane wires that may have been jettisoned by vessels onto the seabed, abandoned communications cables and other debris can be detrimental to the burial machine. Before the start of cable laying operations the cable route is surveyed to identify wires and cables so they can be removed.

To clear the route of debris, a small vessel will be mobilised in an operation known as a 'pre-lay grapnel run' (PLGR). The PLGR vessel tows a wire with a specially designed hook, or grapnel, along the centreline of the cable route until it encounters debris. Any debris encountered will be recovered to the deck of the vessel for appropriate licensed disposal ashore. Should any unexploded ordnance be discovered during this process, a registered Explosives and Ordnance Disposal (EOD) specialist will be available to identify any suspicious items and provide advice on the appropriate remediation.

4.4. Route preparation in sandwaves (pre-sweeping)

Sandwaves are known to be present on the sea bed along the cable route in the Eastern English Channel. The sand waves inhibit burial equipment and, if they are mobile, decrease the efficacy of burial.

Pre-sweeping by dredging can be used to reduce the height of the sandwaves along the cable route and produce a flatter path for the installation equipment to move along. This also allows for greater control of the burial depth of the cables and makes the protection afforded by burial more resistant to sandwave mobility and therefore more durable over time.

The spoil volumes resulting from pre-sweeping are typical of dredging operations for channel or port maintenance and therefore relatively small. It is assumed that the spoil will be deposited back on the seabed in the immediate vicinity of the pre-sweeping activity.

4.5. Cable installation methods

The cables will be buried into the seabed either by a plough or trenching machine deployed by the main laying vessel directly or by a support vessel following behind. To ensure cable protection is immediate, operations may be simultaneous with burial equipment being deployed by either the cable layer or the support vessel. Alternatively cables may be buried in a 'post-lay burial' (PLB) operation, where a burial machine is deployed days or even weeks later by a separate vessel.

4.6. Cable joints

As a cable lay vessel or barge cannot carry the entire quantity of cable required for the marine cable route, it will be necessary to install the cable in several sections. Joints will be required to join each section of cable. It is expected that up to five offshore joints will be required for the proposed development however it will not be possible to determine the precise number or location of cable joints until an installation contractor has been appointed. The appointment of an installation contractor will take place once consents for installation and operation of the proposed development have been secured.

4.7. Cable and pipeline crossings

Crossing agreements will be made with parties owning cables and pipelines which the proposed development will cross, in line with UK Cable Protection Committee (UKCPC) guidance. All parties have been informed about the potential for a cable crossing.

4.8. Landfall installation

In the case of Richborough, consideration of the Thanet Offshore Wind Farm installation suggests that marine burial of the cable will be possible between 1.5 km and 2.0 km from the beach. Inshore of this, the Thanet cables were mostly buried using the land based spider plough, with the last 100 m to 200 m being trenched with tracked excavators.

The landfall installation work relates to the construction of the Transition Jointing Pit (TJP) and the intertidal cable installation. The TJP will contain the joint between marine and land cables. The TJP, which will be described in detail in the corresponding onshore planning application, will be constructed from reinforced-concrete and will be situated below ground level and located above the high tide mark. It must be completed well in advance of the cable landing to avoid any delays to the landing operation. It will be necessary to agree temporary access routes to areas such as the beach for installation work to be completed. It is expected that the installation will use similar methods to those used for the Thanet Offshore Wind Farm cables as outlined above.

For the Nemo Link, the proposed installation is via open cut trenching, possibly with the requirement for a cofferdam, which is similar to open cut but with sheet piling used to support the trench walls.

For open trenching, a trench will be constructed using a conventional excavator and rollers will be used in the base of the trench to pull the cable along it. The trench will be approximately 1 – 2 m wide and the cables will be buried at a target depth of 2-3 m. Mechanical excavators will then be used to bury the cable.

A temporary working area of approximately 30m x 30m will be established as a works compound. The working assumption is that this area will be in the lay-by adjacent to the Service Station at Pegwell Bay.

4.9. Programme

Cable installation schedules are dependent on a number of factors such as the delivery of cable, the availability of cable and the other commitments of the installer.

The programme for the commencement of installation has not yet been agreed but it is likely that installation will begin between 2015 and 2016. In general, installations in European waters are undertaken in the summer season, broadly between April and October. This period is determined primarily by the high probability of adverse weather occurring outside of this period.

The schedule will also be affected by factors such as the requirement for any ecological mitigation, cable delivery and the availability of vessels.

Installation work in the intertidal areas in the UK and Belgium is expected to take less than one week. It is expected that up to five marine cable joints will be required on the entire cable system and each jointing operation will take approximately five days.

5. Statutory Consents

The proposed development does not fall within the types of development specified in Annex I or Annex II of the EIA Directive (Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC) on the assessment of the impacts of certain public and private projects on the environment. Therefore there is no specific legislation that requires the proposed development to be subject to an EIA. However, the Nemo Consortium has chosen to carry out an EIA for all elements of the Project, including the elements for which a marine licence is required.

A licence under the Marine and Coastal Access Act 2009 is required for the following aspects of the proposed development:

- Laying and burial of cable from the Mean High Water Spring (MHWS) tide mark to 12 nautical miles (NM)
- Dredging and disposal required to pre-sweep sand waves
- Rock/concrete mattress placement
- Horizontal directional drilling (HDD)

A Habitats Regulations Assessment under The Conservation of Habitats and Species Regulations 2010 is required for crossing a Special Area of Conservation (SAC) and Special Protection Area (SPA) designations at the cable landfall.

6. Consultations

Communication and consultation is a key element of the EIA process. It allows stakeholders and the public to be fully informed and engaged in the evolution of the development proposal. This process also ensures that any concerns relating to the Project or ideas on how it should progress are considered.

Consultation with stakeholders has been undertaken throughout the route selection and definition process, and comments were received from statutory and key consultees on the scope of EIA required for the proposed development via a Scoping Report.

A variety of media have been used to engage proactively with stakeholders at a local, regional and national level. Activities undertaken include:

- Direct consultation meetings;
- Consultations with the fishing industry via an experienced Fisheries Liaison Officer;
- Public exhibitions;
- Project briefing sheets.

7. Environmental Impact Assessment

A full Environmental Impact Assessment (EIA) has been carried out for the proposed development in order to achieve the marine licence outlined above. The findings of the EIA are presented in the ES which accompanies the marine licence application.

The EIA has been carried out taking into account The Marine Management Organisation (MMO) guidance notes:

- Guidance 1 – Overview and Process (September 2011);
- Guidance 2 – Construction (including renewables) and Removals (July 2011);
- Guidance 8 – Environmental Impact Assessment (April 2011); and
- Guidance 10 – Cross-border working (April 2011).

Although the proposed development does not constitute EIA development, the explanatory memorandum to The Marine Works (EIA) Regulations 2007 No. 1518 prepared and issued by the MMO has also been taken into account as appropriate.

As with many large infrastructure projects it is often impractical to provide full details of installation activities at the time of the EIA. Such detail is often dependent on procurement of engineering options which will only commence once consent has been granted.

In situations where there are good reasons why the details of the whole project are unavailable before consent is granted a technique called The 'Rochdale Envelope' can be used. It has been successfully applied to most marine renewable energy projects, including all of the UK's Round 2 offshore wind farms.

The approach is based on assessing the potential impacts of a "realistic worst case scenario", under which the assessment of the proposed development is defined by an "envelope" of theoretical constraints. For example, although the burial equipment for cable cannot yet be specified, its "envelope" can be defined by a maximum footprint in respect to disturbance of the seabed (e.g. width of burial machine, width of burial trench and depth of burial). In this way, the design of the proposed development can vary within these maximum parameters without rendering the EIA findings invalid. Any subsequent consent would incorporate these parameters into its conditions, thereby ensuring that the scheme consented is that which has been assessed in the EIA.

Where details of the proposed development cannot be finalised ahead of the submission of the ES the Rochdale principle has been applied.

7.1. Physical Environment

The EIA considered impacts on geology; bathymetry & seabed processes and water quality with the conclusion that the proposed development would have no significant impacts.

The choice of installation route close to the area utilised by the Thanet Offshore Wind Farm electricity export cable means that the impacts on the geology are minor, as the key sensitive and important geological area identified in the Sandwich Bay and Hackling Marshes Site of Special Scientific Interest (SSSI) will be avoided.

Any impacts construction may have on bathymetry and water quality are judged to be minor and not significant as the area will recover quickly with no lasting impacts anticipated.

7.2. Biological Environment

There are several conservation sites of importance within the development area, including Thanet Coast and Sandwich SPA, Sandwich Bay SAC, Thanet Coast SAC and the Thanet Coast and Sandwich Bay RAMSAR Site. Impacts upon these designated sites and ornithology have been limited by routing the cable system to avoid the areas of greatest sensitivity. Impacts could be further mitigated by avoiding installation works in the intertidal areas in the key months of sensitivity, and this will be done wherever practicable.

In order to avoid impacts upon sensitive and important features of benthic ecology, the cable system has been routed to avoid areas of *Sabellaria spinulosa* aggregations by distances of 90m for the larger reef formations and 150m for the smaller structures, this having been agreed in consultation with Natural England. Contractors will also be advised of the location of these features to ensure that deployment of anchors can be planned accordingly.

The Nemo Consortium intends to use rock placement in one cable crossing location which will limit the area of substrate change. However, where used, this protection is also likely to have the potential to increase the local abundance and diversity of fish species. No further rock placement is intended during the construction phase. However, if further rock placement is deemed to be necessary following construction, this will require a separate marine licence application to be submitted which would be accompanied by a full assessment of the likely effects of that rock placement.

The impact assessment for fish species has concluded that herring spawning areas could suffer moderate impacts from the installation works. However, as herring only spawn upon gravel seabed sediments for three months of the year, it is proposed to avoid the key spawning period (November to January) in areas of suitable habitat.

The EIA has not identified any significant impacts of the proposed development on marine mammals.

7.3. Human Environment

Safety information, including descriptions of the operation and operating area, will be issued and regularly updated by the installation contractor to reduce the risk of another vessel colliding with an installation or decommissioning vessel. There will also be consultation with local, regional and national organisations and authorities, including CNIS and Dover Straits VTS.

There will be a 500m by 1000m safety zone established around the installation vessels and the spread will be assigned two guard vessels to reduce any impact on shipping and navigation. Vessels will also comply with Collision Regulations lighting and marking requirements.

Assessment of impacts upon shipping and navigation has concluded that there is potential for moderate impacts/risks to navigation from vessel anchors snagging the cable system. This can be reduced by the proposed cable burial and ensuring the location of the cable system is marked on navigational charts.

All known wrecks have been avoided in the cable route design and survey data has found little prehistoric material of interest. Temporary exclusion zones will be placed around important geophysical anomalies during construction where practicable and buffers with a radius of 100m will be placed around wrecks of archaeological potential. An archaeological reporting protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.

During cable installation a Fisheries Liaison Officer (FLO) will be employed from the local fishing industry to ensure that interactions between the cable installation vessels, personnel and equipment and fishing activity are managed. This will help to ensure that disturbance to fishing is kept at a minimum. Additionally to this Notices to Mariners (NtM), will be issued in good time to advise fishermen of where and when the installation spread will be operating, as well as the expected vessel speed. Local fishing associations will also be contacted directly.

An impact on commercial fishing could arise from the use of rock placement for the proposed development along with other projects that prevent the use of fishing gear at the seabed. Given that rock placement will only be required at one crossing location in the UK for the proposed development, this impact will be localised.

The proposed development is not expected to have any impacts on socioeconomics offshore beyond those discussed in relation to commercial fisheries, recreation and tourism and other sea users.

7.4. Summary of Potential Impacts

The following table (7-1) provides a summary of the impacts as described in sections 7.1 to 7.3 and is as presented within the ES.

Table 7-1: Summary of potential impacts before and after adoption of proposed mitigation

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
6 Physical Environment				
6.1 Geology	No significant impacts	-	-	-
6.2 Bathymetry and Seabed Processes				
6.3 Water Quality				
7 Biological Environment				
7.1 Designated Sites	Disturbance of internationally designated areas (SACs and SPAs) due to installation of cables	Moderate	Avoidance of most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats.	Minor
7.2 Ornithology	No significant impacts	-	-	-
7.3 Marine Mammals	No significant impacts	-	-	-
7.4 Benthic and intertidal ecology	Disturbance of *Sabellaria* reefs during pre-lay grapnel run	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	Disturbance of *Sabellaria* reefs by anchors of the cable laying barge	Moderate	Vessels to be positioned and anchors deployed accordingly.	Minor
	Disturbance of *Sabellaria* reefs during cable trench excavation and cable burial	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fauna and displacement of benthic habitat	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate
7.5 Fish and Shellfish Ecology	Disturbance and/or smothering of spawning and nursery grounds of the most sensitive species (most notably herring) that deposit demersal eggs/larvae during pre-sweeping of sand waves and the pre-lay grapnel run and during the cable laying	Moderate	Installation in relevant substrates (e.g. gravel) will occur in months least sensitive for spawning and nursery (e.g. February to October) where practicable.	Minor

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fish communities	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate
8 Human Environment				
8.1 Commercial Fisheries	No significant impacts	-	-	-
8.2 Shipping and Navigation	Risk of another vessel colliding with an installation or decommissioning vessel	Moderate	- Safety information will be promulgated by the installation contractor and will include descriptions of the operation and operation area and will regularly be updated - Establishment of 500m by 1000m Safety Zone around spread. - Two guard vessels shall be assigned to the installation spread - Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). - Vessels to comply with Collision Regulations lighting and marking requirements	Minor
	Risk of electromagnetic interference from the cable affecting a navigating vessel's magnetic compass and causing compass deviation leading to navigational error and grounding	Moderate	Measurement of electromagnetic interference to ensure within accepted limits of less than 5 degrees deviation	Minor
	Risk of damage to cable, vessel or injury to persons on board during emergency anchoring event where the anchor then snags the cable	Significant	Charting of cable. And ensuring cable is buried to suitable depth.	Moderate
8.3 Archaeology and Cultural Heritage	Damage or destruction of submerged prehistoric material below the seabed during cable installation	Moderate	Based on analysis of the relevant survey data, little material of interest was discovered. Where material was found in a single core sample information about the submerged prehistoric resource is being gained from testing and analysis of the core.	Moderate

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
	Damage or destruction of A1 archaeological receptors (wrecks and geophysical anomalies of archaeological interest) and A3 receptors (historic records of possible archaeological interest with no corresponding geophysical anomaly)	Significant	All known wrecks have been avoided in the cable route design. Temporary exclusion zones will be placed around A1 geophysical anomalies during construction where practicable and buffers with a radius of 100m around the gazetteer points will be placed around A3 wrecks of archaeological potential. The locations can also be included in installation planning stages for example during locating anchorages.	Moderate
	Damage or destruction of A2 archaeological receptors (geophysical anomalies) during installation	Significant	A Written Scheme of Investigation (WSI) will address pre-installation and installation activities, such as the grapnel run, and may also include a protocol to substitute for a watching brief offshore. A2 archaeological receptors (geophysical anomalies) in the direct path of the cable route will be considered through the WSI and Archaeological Reporting Protocol.	Moderate
	Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites) during installation and decommissioning	Significant	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	Moderate
	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment during installation and decommissioning	Significant	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	Moderate
	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment through changes to erosion regimes due to bridging structures at the cable crossing	Moderate	Changes are expected to be minimal. Should bridging structures be used in areas in close proximity to known archaeological features monitoring of sediment mobility may assist in providing further information on the feature and act as a form of compensatory mitigation.	Minor
	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts through use of anchors during maintenance and decommissioning activities	Significant	Exclusion zones will be maintained around five known wrecks and will prohibit development related activities within their extents. 100m radius buffers will be placed around wreck sites of archaeological importance that are recorded in UKHO data, but that were not identified in the geophysical data. Any material discovered will be dealt with through the Archaeological Reporting Protocol	Minor
8.4 Cables and Pipelines	No impact is expected	-	-	-
8.5 Military and other sea users	No impact is expected	-	-	-

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
8.6 Unexploded Ordnance	The risk of encountering unexploded ordnance is low	-	-	-
8.7 Tourism, Recreation and Amenity	No significant impacts	-	-	-

8. Other Project Elements

The ES includes a summary of the impacts of the other elements of the Nemo Link which form part of the same project for EIA purposes. These other elements of the Project include the onshore development in the UK and Belgium and the marine cables in French and Belgian waters. The full environmental assessments for the UK elements will be available on the Nemo Link website at www.nemo-link.com. The ES documents for the non-UK elements of the Project are available at www.mumm.ac.be.

9. Concluding Statement

The EIA has assessed the worst-case scenario that would have the greatest effect on the environment. This approach results in a maximum impact assessment, giving security and confidence to the regulatory bodies that the environmental impact will be no greater than that which is set out in this document and may in fact be considerably less.

Few of the impacts assessed have been determined to have the potential to cause moderate or significant impacts and almost all impacts can be reduced to have a minor impact when mitigation is applied.

Further information on the assessment of environmental impacts is presented in the main text of the ES.

10. Further Information

Further information regarding the project can be found by visiting www.nemo-link.com or by calling Freephone 0800 083 3149 between 9am and 5pm Monday to Friday (answerphone outside of these hours) or emailing nemointerconnector@communitycomms.co.uk.

Queries can also be made in writing to:

Freepost RSLG-YXEU-BJUC
Nemo Link
PO Box 68215
London
SW1P 9UJ

Copies of the Environmental Statement are available on the Project website at www.nemo-link.com. Copies may be purchased from National Grid either on CD for a charge of £15, or in hardcopy form for £200.

Appendix 1. Location of Proposed Cable Route

400000 425000 450000 475000 500000

5725000 5700000 5675000 5650000

56 11 52 55

Margate
Ramsgate
Richborough
Dover
Strait of Dover
Calais
Gravelines
Dunkerque
Oostende
Nieuwpoort
Bruges
Zeebrugge

129 125 124 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

Km
0 5 10 15

Legend

- Cable Route
- Exclusive Economic Zone
- Cable Distance from Belgium Landfall
- Landfall United Kingdom
- Landfall Belgium

NEMO	Figure No. 29689/1796.6		Date 12/07/2012	Data Source Maritimedata UKHO Seazone	Projection System UTM Zone 31N		Client: elia / nationalgrid
Cable Routel Overview	Author NDU	Check CGR	Scale @A3 1:1,000,000		Datum WGS84	Spheroid WGS84	PMSS

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Nemo Link®

Environmental Statement Volume II

Technical Appendix

February 2013

Volume II: UK Environmental Statement Technical Appendices

The Nemo Link

February 2013

Document Control

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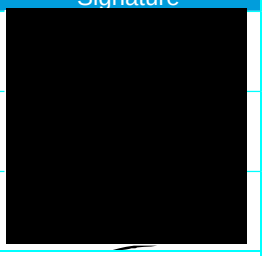
Content	Environmental Consultant	Christine Grant	2012-08-08	
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Appendix 1: Route Position List

Reason	Longitude WGS 84	Latitude WGS 84	Easting UTM31N	Northing UTM31N	Cable Bearing
START POINT	3.1677	51.3270	511687	5686206	298°
ALTERCOURSE	3.1664	51.3277	511592	5686285	280°
ALTERCOURSE	3.1565	51.3295	510902	5686476	293°
ALTERCOURSE	3.1469	51.3335	510232	5686924	273°
ALTERCOURSE	3.1060	51.3353	507385	5687119	273°
ALTERCOURSE	3.0581	51.3379	504047	5687405	272°
ALTERCOURSE	3.0273	51.3392	501902	5687548	275°
ALTERCOURSE	2.9976	51.3416	499833	5687813	271°
ALTERCOURSE	2.9701	51.3419	497919	5687847	273°
ALTERCOURSE	2.9165	51.3444	494188	5688127	278°
ALTERCOURSE	2.8253	51.3580	487839	5689651	263°
ALTERCOURSE	2.7717	51.3516	484105	5688952	255°
ALTERCOURSE	2.7449	51.3442	482234	5688135	271°
ALTERCOURSE	2.7107	51.3449	479849	5688216	274°
ALTERCOURSE	2.7064	51.3451	479549	5688248	272°
ALTERCOURSE	2.5634	51.3505	469593	5688899	284°
ALTERCOURSE	2.5557	51.3524	469060	5689111	312°
ALTERCOURSE	2.5411	51.3653	468054	5690553	286°
ALTERCOURSE	2.5292	51.3687	467225	5690934	270°
ALTERCOURSE	2.5004	51.3686	465221	5690930	254°
ALTERCOURSE	2.4750	51.3606	463449	5690062	256°
ALTERCOURSE	2.4600	51.3570	462402	5689659	270°
ALTERCOURSE	2.4405	51.3571	461041	5689684	256°
ALTERCOURSE	2.4368	51.3562	460780	5689583	232°
ALTERCOURSE	2.4322	51.3526	460459	5689193	256°
ALTERCOURSE	2.2863	51.3152	450262	5685120	264°
ALTERCOURSE	2.2714	51.3137	449222	5684962	277°
ALTERCOURSE	2.2226	51.3196	445828	5685657	277°
ALTERCOURSE	2.1721	51.3259	442316	5686390	270°
ALTERCOURSE	2.0111	51.3253	431094	5686470	270°
ALTERCOURSE	1.9596	51.3252	427506	5686501	271°
ALTERCOURSE	1.8600	51.3276	420570	5686870	269°
ALTERCOURSE	1.8216	51.3272	417893	5686869	270°
ALTERCOURSE	1.7255	51.3269	411202	5686950	273°
ALTERCOURSE	1.6712	51.3301	407423	5687369	262°
ALTERCOURSE	1.6665	51.3295	407098	5687306	248°
ALTERCOURSE	1.6600	51.3268	406634	5687018	264°
ALTERCOURSE	1.6016	51.3209	402558	5686435	269°
ALTERCOURSE	1.5453	51.3201	398629	5686430	257°
ALTERCOURSE	1.5111	51.3122	396231	5685592	263°
ALTERCOURSE	1.4766	51.3078	393814	5685152	266°
ALTERCOURSE	1.4509	51.3059	392021	5684987	275°
ALTERCOURSE	1.4404	51.3064	391290	5685050	285°
ALTERCOURSE	1.3937	51.3187	388066	5686486	283°
ALTERCOURSE	1.3814	51.3216	387212	5686831	279°
ALTERCOURSE	1.3673	51.3237	386239	5687093	297°
END POINT	1.3654	51.3245	386108	5687180	0°

Table 1-A: Location of all points where Nemo cable will start, end and alter course.

Appendix 2: Scoping Response Matrix

Consultee	Summary of comments	Section of report where comments are addressed
Natural England	• Habitat characterisation of area crossed by cable route is required • Habitat characterisation to consider in faunal and epifaunal communities • Habitat characterisation should cover habitats and species of conservation importance including habitats listed under the Wildlife and Countryside Act, Annex I of the Habitats Directive, OSPAR requirements, UK BAP, species and habitats mentioned Features of Conservation Interest listed in the marine conservation zones ecological network guidance. • Impacts of pre lay grapnel run should be considered in EIA • Detailed consideration to be given to impacts of presweeping. • Need to consider maintenance requirements in impact assessment.	Section 7.4 – Benthic ecology Section 7.1 – Conservation Designations Section 7.2 – Ornithology Section 7.5 – Fish and shellfish
	• Details should be given in the ER of any statistical tests used	Appendix 10 – Benthic ecology
	• The EIA should consider the The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007. The noise impact assessment should determine what marine mammal species are likely to be present in the development area and will need to show whether the operations will potentially cause either a disturbance or an injury offence under the regulations and what mitigation measures will be put in place to prevent such offences occurring. Southall et all (2007) should be used to help determine significance of effects.	Section 4.7.3.3 – Noise Section 7.3 – Marine Mammals
	• Request that the number of cable crossings be minimised and that those required are fully justified. Frond matressing is prefereable to concrete matressing or rock armouring. Request ecological monitoring of cable crossing post installation.	Section 8.4 – Cables and Pipelines Section 10 - Monitoring
	• Prefer bundling of cables rather than separate installation (to minimise impacts). • Require dredging amounts to be quantified.	Section 4 - Project Description
	• Require cumulative impact assessment to be undertaken.	Section 9 – Cumulative Impact Assessment
	• EIA should propose a monitoring programme.	Section 10 - Monitoring
	• Consideration must be given to the MCZ process and the ecological network guidance.	Section 7.1 – Conservation Designations Section 7.4 – Benthic Ecology
	• Formally requested a copy of the survey results.	Acknowledged
	• Habitat Regulation Assessment should be included within the EIA in sufficient detail to inform an Appropriate Assessment Screening Exercise.	Appendix 4 – Appropriate Assessment
	• Advice on scope of benthic survey scope.	Acknowledged

English Heritage	• Seabed geophysical survey data to be corroborated with a desk-based examination of archaeological records • Any drop down camera survey should be optimised to assist ground-truthing of anomalies to support determination of archaeological potential. • The statement ""all known wrecks are avoided"" to be expanded to include other historic environment features that may exist within the foreshore area subject to this development. • Recommend that an Archaeological Written Scheme of Investigation is agreed with English Heritage at the earliest available opportunity to inform the setting of survey objectives and thereby to support the delivery of any necessary mitigation measures. • Scope of assessment of marine archaeological potential should be expanded to include action to be taken if any wreck material is encountered in the delivery of this project in accordance with the requirements of the Merchant Shipping Act 1995. • The developer will ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). To enable deposit of reports with the NMR the developer must ensure that an English Heritage OASIS (Online AccesS to the Index of archaeological investigationS') form is completed for the whole consented project, and all copies of completed and agreed archaeological reports are attached as PDF files. All further advice on completing this condition is to be directed to English Heritage's National Monuments Record (oasis@english- heritage.org.uk). Notification of the completion of the OASIS form is also be sent to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER). • There is a possibility of encountering previously unknown wrecks and especially the remains of military aircraft that are subject to automatic protection under the Protection of Military Remains Act 1986. Especially north of the Goodwin Sands. • The project programme should directly inform the production of an Archaeological Reporting Protocol which needs to be agreed with EH. • Advise that detailed consideration is given to the depth of cores to be taken and the potential to encounter sediments of archaeological potential.	Section 8.3 – Marine Archaeology
The Crown Estate	• No comments on survey scope or EIA method. • Require decommissioning to be covered in detail in the project planning. • Require evidence that decommissioning is incorporated into the project business plan.	This report refers to all predicted potential impacts from decommissioning under the relevant sections. Provision for decommissioning in project business plan is not within the scope of environmental assessment but will be discussed separately with The Crown Estate.
CEFAS	• EIA scope is adequate. • Impacts of rock/mattress placement, installation into chalk and incombination effects need to be considered. • A formal ES under EIA Regulations will not be required. • Defer to Natural England with regards to Appropriate Assessment. It should be noted that the CEFAS response referred to various receptors and environmental effects, all of which were detailed in the Scoping report.	Sections 6 - 8.
Environment Agency	• EIA proposed is comprehensive. • Acknowledge EIA is not a statutory requirement for this project but much of the information required to assess its impact still needs to be provided to the consultees (modelling, sediment contaminant data etc). EIA is the most practical way to do this.	Noted.

	• Water Framework Directive (WFD) protected areas to be considered - Kent North waterbody contains the following designations: Shellfish Water Directive and Bathing Waters Directive. • Impacts on Sandwich Bay and Ramsgate Western Undercliffe to also be assessed in the EIA. • Take into account EA WFD guidance http://www.environment-agency.gov.uk/business/sectors/116352.aspx. • Dredging within WFD area will require assessment under Stage 2 WFD Scoping Guidance, which should be covered in EIA if required. • Under the terms of our Land Drainage and Sea Defence Byelaws 1981, written consent from ourselves is required for any works between the mean low water mark and fifteen metres of the landward toe of the flood defence.	Section 6.3 – Water Quality
	• Acknowledge EIA is not a statutory requirement for this project but much of the information required to assess its impact still needs to be provided to the consultees (modelling, sediment contaminant data etc). EIA is the most practical way to do this.	Acknowledged
	• Under the terms of our Land Drainage and Sea Defence Byelaws 1981, written consent from ourselves is required for any works between the mean low water mark and fifteen metres of the landward toe of the flood defence.	Acknowledged
MCA	• Full traffic survey of intended area of operation • Details of how the cable will be laid e.g. trenched or rock armoured for protection against over-trawling and anchors etc. • The crossing of traffic lanes needs to be addressed. • The use of guard vessels during installation works should be considered. • Communications policy/strategy for the whole operation will need to be produced prior to construction commencing.	Section 8.2 – Shipping and navigation
JNCC	• As a result of its size and nature, that this project has the potential to have significant effects on the marine environment. • Highlight the importance of consultation with the relevant authorities in France and Belgium. • More detailed comments, than those that follow in this email, will be submitted to the MMO. Please note that these comments relate only to the marine environment outside of 12nm. • We would recommend that Cefas are consulted with regard to the scoping out of EMF in relation to non-elasmobranch fish species. • Please refer to our comments previously submitted with regards to survey methodologies.	Acknowledged.
	• Need to assess impacts on Annex I habitats in terms of hydrological processes and integrity of relevant habitat. • Full discussion, with reference to the data currently under collection along the cable route, of the potential impacts of this development on Annex I habitat is required. This should include an assessment of any impact in terms of affect on the hydrological processes in the area and also the integrity of the relevant habitat. • Further discussion of use of grapnel hook to clear out of use cables and how this will take place to minimise impacts on potential Annex I habitat and benthic habitat is required. In addition, the application of alternative methods should also be explored. • The use of rock dump or the placement of mattressing to bridge any active cables will result in a loss of benthic habitat at these locations. • Chalk cutting, again has the potential to impact on Annex I reef type habitat. We suggest that alternative options to this are fully explored and that any proposed works are analysed in terms of impacts on the integrity of the habitat feature. • Installation - It should be highlighted that pre-sweeping, rock dump and concrete mattress placement could result in a permanent loss in benthic habitat.	Section 7.4 – Benthic ecology

	• With relation to the decision to be made to employ a single or separate trenches, JNCC would prefer the application of the single trench option.	Section 4 – Project Description
	• Careful consideration to be given to most appropriate route across designated sites and alternatives should be considered.	Section 2.2 - Alternatives
	• Analysis into the potential effects on sediment transport and other hydrological processes will be required. We also suggest that the potential risk of de-stabilising sandbanks such as the South Fall is also explored.	Section 6.2 – Sediment transport and coastal processes Section 6.1 - Geology
	• We are satisfied that within the assessment of projects that the 'Rochdale Envelope' principle will be applied, to ensure that the consent is sufficient to encompass the worst-case scenario of potential impacts, where multiple options exist for an aspect of the project plan. However, in terms of reducing survey costs and increasing efficiency, it is advisable that the projects are finalised as much as possible as early in the life of the project as possible to limit the complexity of the environmental report in terms of identifying 'worst-case' for environmental receptors. In light of this we welcome the proposal to review the design of the 'Rochdale Envelope' with the progression of data collection and stakeholder consultation.	
	• The ecological links between receptors and impacts should be fully considered under each receptor section eg. birds and prey species.	Sections 6 - 8
	• We would recommend that the discussion of the cumulative effect of this development include the full consideration of the ecological links between environmental receptors.	Section 9 – Cumulative effects
Port of Ramsgate	• Content with scope of environmental assessment • If damage occurred to the Thanet Offshore wind cables the environmental impact would be larger than forecast.	Section 8.4 – Pipelines and cables
Trinity House	• No objections to the proposals in principal. • Once the final landfall site has been confirmed, further consideration can be given to any marking requirements depending on location, any existing marking, complete burial of the cable etc. • Any vessels used in the works to exhibit signals as per collregs.	Chapter 8.2 – Shipping and navigation
Thanet District Council	• Report focuses on marine aspects so may fall outside of Council's jurisdiction at this stage. • Council reserves the right to comment at a later date on any aspect that they consider would have significance to this District • Council would like to consult with other consultees before commenting on the report under the Town and Country Planning Act. • Council requires further detail/information on the land based aspect of the scheme which does fall in their jurisdiction, with this info they would also wish to consider whether the development would require planning permission; and to screen the scheme to establish whether or not it is EIA development.	Acknowledged. Onshore consultants will be leading on the onshore aspects of the project and will liaise with TDC accordingly.
Royal Yachting Association	• Wish to ensure safety of marine recreational interests. • Welcomes the detailed description of recreational activity provided. • Encouraged that the UK Coastal Atlas of Recreational Boating and the GIS data is being utilised and considered at this early stage, this information should also be considered in the environmental report. • Recreational boating should be considered as part of the effects on shipping and navigation.	Chapter 8.2 – Shipping and navigation Chapter 8.7 – Recreation and tourism
Kent Wildlife Trust	• Preferred landfall option is service station north, landfall at the country park should also be considered. • Would prefer cables to be laid in a single trench rather than two separate ones.	Section 4 – Project description
	• KWT owns part of the NNR and manages it on behalf of others.	Acknowledged

	• Using the Rochdale principle for the project description is satisfactory but may require an update to the habitat regulations assessment once the installation methods etc are finalised.	Section5 - EIA Method
	• EIA must be coordinated with the terrestrial aspects of the project.	Acknowledged. Onshore consultants will be leading on the onshore aspects of the project and will liaise with KWT accordingly.
	• Concerned about the impacts of installing into chalk, would like installation into exposed chalk to be avoided due to habitat value and would like any sabellaria reefs to be avoided. • Concerned about damage to habitats from the prelay grapnel run.	Section 7.4 – Benthic Ecology
	• Enquired whether backscatter data will be assesses from the multibeam survey.	Appendix 10 – Benthic survey report
	• Request that decommissioning is considered in EIA.	Sections 6 - 8
	• Impacts on spawning and nursery grounds should be minimised. • EMF impacts on eels should also be considered.	Section 7.5 - Fish and Shellfish
	• Sea mammal numbers in the area are often under estimated. Suggest contact SMRU and Jon Bramely at the Kent Mammal Group. 50 common seal in Stour Estuary and 20 on Goodwin Knoll (haul out)	Section 7.3 – Marine mammals
	• The area is very important for flowering lizard orchids	Information passed on to onshore consultants.
	• There are naturally important populations of sanderling, grey plover and important populations of greenshank at Pegwell Bay.	Section 7.2 - Ornithology
Marine Management Organisation	• The ER needs to include mitigation for any potential harm to mussel beds or Sabellaria biogenic reefs to safeguard against possible disturbance during preparatory works. Additionally interference to any sensitive Elasmobranch species in the area must also be mitigated for if effects from the cable are detected.	Section 7.4 – Benthic ecology
	• The MMO also suggests that alternatives to concrete be explored as bridging materials where the cable crosses other cables and/ or structures to provide extra habitat options e.g. rock.	Section 4 – Project description
	• The MMO would also like to point out that there is a commercial cockle fishery in Pegwell Bay, and also a population of grey Seals in the River great Stour.	Section 7.5 – Fish and shellfish Section 8.1 – Commercial Fisheries
	• The MMO would like to suggest that the local Inshore Fisheries and Conservation Authority (IFCA) be contacted and consulted (Kent & Essex Sea Fisheries Committee currently have this responsibility.	Acknowledged
	• The MMO advises that the proposed Project Nemo lies within the South East Marine Conservation Zone and therefore it is recommended that the project reviews whether baseline environmental data provides enough information to assess the impacts of the works on the broad-case habitats and Features of Conservation Importance of the area e.g. areas of chalk off the Kent coast.	Section 7.1 – Conservation designations Section 7.4 – Benthic ecology
	• The MMO suggests that a monitoring programme should be proposed as part of the EIA to verify predictions made within the ER and also the effectiveness of mitigation.	Section 10 - Monitoring
	• The MMO asks that the EIA includes references to all historic environment features, and all known wrecks. Attention must be given to the possibility of encountering previously unknown wrecks and military aircraft. An Archaeological Written Scheme of Investigation should be prepared and agreed with English Heritage, alongside an Archaeological Reporting Protocol, which ensures that a copy of any archaeological reports are deposited with English Heritage's National Monuments Record and Kent County Council, by completing an OASIS form (Oasis Access to the Index of Archaeological InvestigationS).	Section 8.3 – Marine archaeology

Appendix 3: MMO Scoping Response Letter

PO Box 1275
Newcastle Upon Tyne
NE99 5BN

0191 376 2561
Susannah.stephen@marinemanagement.org.uk

FAO: Rachel McCall

17 December 2010

Proposed National Grid Electrical Interconnector from Richborough, Kent to Zeebrugge, Belgium (Project Nemo)

Dear Rachel

I am writing in reply to your correspondence dated 19th October 2010 requesting a screening and scoping opinion.

Background
The Marine Management Organisation has consulted its own scientific advisers (Centre for Environment, Fisheries & Aquaculture Science), Natural England, the Environment Agency, and the MMO coastal office local to the area. In reaching a conclusion, full regard has been paid to the responses and to the information submitted.

I attach a statement below that sets out our response.

The items highlighted in the statement below should be considered in the voluntary Environmental Impact Assessment (EIA) and Environmental Report (ER), which will form part of the application to the MMO for a Licence to undertake works below Mean High Water Springs. However, this letter is not a definitive list of all requirements and other subsequent work may prove necessary, such as consent from the Environment Agency under the Land Drainage and Sea Defence Byelaws 1981 for any works in, over or under sea defences between Mean Low Water and 15m from the landward toe of the defence.

Should you have any further queries in relation to this advice, please do not hesitate to contact Bernard Christie in the future.

Yours sincerely

Susannah Stephen
Marine Case Officer
Marine Management Organisation

REQUEST FOR COMMENTS ON THE SCOPING REPORT: FORMAL RESPONSE

Proposed National Grid Electrical Interconnector from Richborough, Kent to Zeebrugge, Belgium (Project Nemo)

Description: The proposed works involve the preparation, laying and burial of an electrical interconnector cable with approximately 1000 MW capacity that will transfer power between Belgium and the UK. The proposed cable route would run from Richborough, Kent, UK to Zeebrugge, Belgium. The project comprises of two main stages, preparation of the route for laying the cable, and then the laying and burial of the cable. Within each stage a number of activities are planned to lay the cable but the works are not expected to start until 2014, with construction taking two years.

Conclusion: Following submission of a scoping document to the MMO in October 2010, discussing the areas to be covered by a voluntary Environmental Impact Assessment (EIA), this response provides comments on the content of an 'Environmental Report' (ER), which will be produced to support future applications:

- The scoping document adequately describes the proposed works and considers and assesses all potential effects and issues of the project.

- The proposal does not fall under Annex II 10(c) of the Marine Works (EIA) Regulations 2007, and therefore, a formal Environmental Statement is not required.

- A Licence will be required under the Marine & Coastal Access Act 2009, for the following aspects of the project: laying and burial of the cable from MHWS to 12 nautical miles; dredging and disposal required to pre-sweep sand waves; rock/ concrete mattress placement; and horizontal directional drilling.

- The MMO would like to see an assessment of 'in-combination effects' to identify, describe and evaluate the potential of effects from other projects and activities within the area.

- An Appropriate Assessment under the Conservation (Natural Habitat & c.) Regulations 1994 needs to be undertaken to investigate whether the project is likely to have a significant effect on the designated sites (either alone or in combination with other plans or projects), because the project is not directly connected to the management of the sites. The sites include: Sandwich Bay Special Area of Conservation (SAC), Thanet Coast and Sandwich Bay Special Protection Area (SPA) and Ramsar, and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI). The MMO requests that the project provides the regulator with sufficient information in a section of the EIA to adequately inform the appropriate assessment process: detail regarding the features for which the sites are designated; how the development will affect the structure and function of the features, directly and indirectly; identification of mitigation measures that may be needed to avoid, minimise or reduce any adverse significant effects.

- The MMO would like to see the Sandwich Bay and Ramsgate Western Undercliffe Bathing Water areas and other potential impacts of the project further addressed in the ER (See Annex 1 attached at end).

- The MMO would like to see concerns regarding the two techniques for cable laying addressed, namely: use of a coffer dam that could significantly alter patterns of sediment transfer; and the recovery of the cable laying vessel's anchors, which may disturb saltmarsh and further substrates.

- The ER needs to include mitigation for any potential harm to mussel beds or *Sabellaria* biogenic reefs to safeguard against possible disturbance during preparatory works. Additionally interference to any sensitive Elasmobranch species in the area must also be mitigated for if effects from the cable are detected.

- The MMO also suggests that alternatives to concrete be explored as bridging materials where the cable crosses other cables and/ or structures to provide extra habitat options e.g. rock.

- The MMO would also like to bring to point out that there is a commercial cockle fishery in Pegwell Bay, and also a population of grey Seals in the River great Stour.

- The MMO would like to suggest that the local Inshore Fisheries and Conservation Authority (IFCA) be contacted and consulted (Kent & Essex Sea Fisheries Committee currently have this responsibility, see address at end).

- The MMO advises that the proposed Project Nemo lies within the South East Marine Conservation Zone and therefore it is recommended that the project reviews whether baseline environmental data provides enough information to assess the impacts of the works on the broad-case habitats and Features of Conservation Importance of the area e.g. areas of chalk off the Kent coast.

- The MMO suggests that a monitoring programme should be proposed as part of the EIA to verify predictions made within the ER and also the effectiveness of mitigation.

- The MMO asks that the EIA includes references to all historic environment features, and all known wrecks. Attention must be given to the possibility of encountering previously unknown wrecks and military aircraft. An Archaeological Written Scheme of Investigation should be prepared and agreed with English Heritage, alongside an Archaeological Reporting Protocol, which ensures that a copy of any archaeological reports are deposited with English Heritage's National Monuments Record and Kent County Council, by completing an OASIS form (Oasis Access to the Index of Archaeological InvestigationS).

Copies of letter (with formal response) to:
(by email only)

Daniel Bastreri, Regulatory Assessment Team, Cefas

Miriam Knollys, Natural England

Holly Niner, Offshore Industries Advisor, JNCC

Christopher Pater, Marine Planning Unit, English Heritage

Karen Rigg, Environment Agency

Joan Taylor, Kent & Essex Sea Fisheries Committee

Annex 1: Areas of potential impacts of the project as advised by Cefas

- The landfall area is designated as a SSSI (Sandwich and Hacklinge Marshes SSSI) which is of interest for its geological features including Thanet formation geology which contains significant fossils of fish fauna and Devensian loess. It is one of the most important sites for loess studies in Britain. The proposed cable route runs approximately east-west from Pegwell Bay to Zeebrugge. Immediately east of Pegwell Bay, the surface sediments consist of sands and mud, followed by a chalk outcrop between banks known as The Brakes. The proposed route then passes through a sandy area to the north of Goodwin Sands. Further east the surface sediments are gravels, sands or sandy gravel.

- No impacts on Metocean conditions or sediment transport are expected as a result of installation, operation or decommissioning of the cable system.

- Installation, operation and decommissioning of the cables could cause environmental impacts upon the biological environment in the area crossed by the cable. The following aspects have been identified as having potential to result in adverse environmental impacts: noise from installation and decommissioning activities; disturbance, suspension and re-settling of sediment during cable burial, pre-sweeping of sand waves and decommissioning; heat, electric and magnetic field emissions from the operational cables and accidental spillages from vessels and equipment.

- Under the UK Marine and Coastal Access Act 2009 work is underway to identify and designate Marine Conservation Zones (MCZs) around the UK. The process of site identification in the area of the cable route is at an early stage and no information is currently available on the potential locations of such sites. However, Balanced Seas, the organisation responsible for identifying MCZs in this area, is expected to report its recommendations for sites by June 2011. National Grid has attended a local meeting of the Balanced Seas project and will continue to monitor progress on the identification of MCZs.

- The offshore sector of the cable route in the UK crosses coastal areas in the South Falls Bank, where reef habitat or sandy sediment in less than 20 m water depth may be encountered. These habitats are listed under Annex I of the Habitats Directive as being of conservation interest. Natural England and JNCC have recently undertaken an extensive search programme to identify areas of these habitats suitable for designation as SACs and none of the areas crossed by the cable route have been identified to date. However, geophysical and benthic survey work is being undertaken with a key aim of identifying Annex I habitats located in proximity to the cable route. The Annex I Habitats “submerged or partially submerged sea caves”, “coastal lagoons”, and “mudflats and sandflats not covered by seawater at low tide” are all thought to occur in the area of Pegwell Bay where the UK cable landfall will be located.

- The proposed cable landfall area is designated as a SPA and Ramsar site. Specifically the site is designated for supporting over-wintering populations of European importance of turnstone (*Arenaria interpres*) and golden plover (*Pluvialis apricaria*), and a breeding population of little terns (*Sterna albifrons*). There are also nationally important numbers of ringed plover and greenshank during their migration and red-throated diver during the winter period. The area is also of importance for several other species including wintering populations of dunlin, curlew, oystercatcher, redshank, sanderling and grey plover and breeding populations of shell duck, redshank and oystercatcher. Potential impact of the proposed works could result on direct, temporary local, disturbance to the SPA site and associated bird populations.

- Fish species diversity in the southern North Sea is rich in comparison to the central North Sea, and some key commercial species targeted in the southern North Sea and English Channel area use the offshore area as nursery and spawning grounds. Herring, lemon sole, sole, plaice, whiting, sand eel, sprat, ray and skate use the area as spawning grounds. Lemon sole, sole, sand eel, cod, plaice, sprat, skate, ray and mackerel use this area as nursery.

- Each of the species noted above has the potential to be affected during installation works as they either spawn on the seabed or in the water column (or may be affected by turbidity as a result of

cable installation). Herring are particularly sensitive as they only spawn on areas of gravel seabed. Sand eel, plaice and sole also spawn on the seabed.

- Areas of the Kent coast are also important for various shellfish, including cockles, mussels, oysters, whelks, periwinkle, crab, lobster and razor clams. Pegwell Bay is designated as a Shellfish Water under the Shellfish Waters Directive. It is understood that there are also fisheries for whelks and lobster in the vicinity of Pegwell Bay. Trenching and dredging operations associated to the proposed works can potentially affect these populations, directly by smothering, and indirectly, by affecting water quality.

- Cetacean species diversity and abundance is low in the area of the cable route compared to other areas in the North Sea. The only frequently occurring species in this southern area of the North Sea is the Harbour Porpoise. Harbour Porpoise are known to be present all year round and are the most frequently observed cetacean in European waters in both inshore and offshore waters. The Cetacean Atlas indicates that common bottlenose dolphin and white-beaked dolphin are also occasionally present in the area along the cable route. Distribution of white-beaked dolphin is generally restricted to the northern half of UK waters, sightings are rare below 54°N in the North Sea.

- The abundance of pinniped species is also very low in comparison to other areas in the North Sea. However, both harbour and grey Seals occur in the area, according to count data collected by the Sea Mammal Research Unit (SMRU) in the period August 1996 to 1997. There is also a minor Grey Seal breeding colony located off Ramsgate, approximately 1.5 km from the cable route. Potentially, localised, temporary disturbance to cetaceans and pinnipeds could result as a consequence of the operations related to the installation of the cables.

- The cable route crosses an area of high density commercial shipping, transiting in a predominantly north south direction. The area crossed is a key junction for shipping with extensive traffic routeing measures in place. Vessels are transiting to and from ports of the UK, mainland Europe and the North Sea. Thus, the cable installation operations can potentially affect shipping on a temporary basis.

- The potential impacts of the placement of hard substrate, such as chalk arisings, cable protection mattresses and any other structures on a predominantly sandy seabed should also addressed in the ER. This assessment should also consider in combination effects with nearby offshore wind farms.

Appendix 4: Legislative Framework

Although not an exhaustive list, the following table outlines the key policies, laws and guidelines relevant to this project which are considered in this report and the scope of environmental assessment proposed.

Convention/Directive/Legislation	Description	Relevance to Project Nemo
	International Conventions	
Convention on Biological Diversity (CBD) 1992	The objectives of the convention are: • Conservation of biological diversity • The sustainable use of its components • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources	The UK Biodiversity Action Plan is the UK Government's response to the Convention. The UKBAP provides plans for the conservation of the biological resources of the UK. It provides priority lists of species and habitats and action plans for the most threatened. The aim of the UKBAP is to significantly reduce loss of biodiversity, as called for by the CBD (UKBAP, 2010). Impacts on BAP species and habitats present along the cable route will be considered in the environmental assessment.
Convention on Environmental Impact Assessment in a Transboundary Context (Espoo) 1991	• Sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning • Lays down a general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries (UNECE, 2010)	As the project crosses the waters of the UK, France and Belgium environmental assessment will also be carried out in these countries as required. The results of each environmental assessment will be provided to the relevant authorities in each country.
Convention for the Protection of the Marine Environment of the North East Atlantic (Oslo Paris Convention (OSPAR) Convention) 1992	OSPAR is the mechanism by which fifteen Governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic (OSPAR, 2010). A key part of OSPAR's biodiversity strategy is to establish a network of marine protected areas which is both ecologically coherent and well-managed by 2010. The UK has currently identified 63 Marine Protected Areas (JNCC, 2010).	Some OSPAR sites in the UK are also Special Protection Areas and/or Special Areas of Conservation. The cable route may cross the Thanet Coast SAC which is also an OSPAR site. Any impacts on this area will be considered in the environmental assessment.
The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)	Covers all aspects of wetland conservation . Three main 'pillars' of activity: • Designation of wetlands of international importance as Ramsar sites • Promotion of the wise-use of all wetlands in the territory of each country • International co-operation with other countries to further the wise-use of wetlands and their resources	Sites designated under the Ramsar Convention are also designated as Special Protection Areas in the UK. The cable landfall options cross the Thanet Coast and Sandwich Bay Ramsar site. Any impacts on this area will be considered in the environmental assessment.
	EC Law	
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive)	Purpose of the Directive is to establish a framework for the protection of: • inland surface waters (rivers and lakes) • transitional waters (estuaries) • coastal waters and groundwater It will ensure that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands meet 'good status' by 2015	The landfall options under consideration for the project are within the Kent North and Stour water bodies of the Water Framework Directive. The Directive requires that waters within defined River Basin Management Plans must reach at least good status.

Directive 2008/56/EC on establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)	The over-arching goal of the Marine Strategy Framework Directive (MSFD) is to achieve Good Environmental Status, across Europe's marine environment by 2020.	Any potential impacts on the Good Environmental Status of the area crossed by the cable route will need to be considered in the environmental assessment.
Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive)	• Aim of the Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species (specified in Annexes I and II of the Directive) at a favourable conservation status, introducing robust protection for those habitats and species of European importance (JNCC, 2010). • Provides for the designation of sites as Special Areas of Conservation (SACs) to create an ecologically coherent network of sites to protect the habitats detailed in Annex 1 and the species specified in Annex II.	The cable landfall options under consideration cross a SAC. Impacts on this area and particularly the features for which it is designated will be considered in the environmental assessment.
Directive 2009/147/EC on the conservation of wild birds (Birds Directive)	• Provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. • Requires Member States to take measures to maintain favourable conservation status of wild birds. • Provides for the designation of Special Protection Areas (SPAs) to protect rare and vulnerable bird species.	The cable landfall options under consideration cross a SPA. Impacts on this area and particularly the features for which it is designated will be considered in the environmental assessment
National Policy		
Marine Policy Statement	A Consultation on the Draft Marine Policy Statement (MPS) is currently in process. The MPS is the first step in a new system of marine planning being introduced around the UK as a result of the Marine and Coastal Access Act 2009. It will provide the high level policy context within which Marine Plans will be developed, and set the direction for marine licensing and other authorisation systems. The Marine Policy Statement is due to be finalised in Spring 2011 after which point a series of spatial plans will be drawn up for the waters around England (DEFRA, 2010).	The licence decision for the for the project under the Marine and Coastal Access Act will need to follow the Marine Policy
UK Legislation		
Marine and Coastal Access Act 2009	The Act provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment. It covers eight key areas - creation of a MMO; creation of a strategic marine planning system; provision of streamlined marine licensing system; provision of powers to enable marine nature conservation; fisheries management and marine enforcement; migratory and freshwater fisheries; coastal access; and coastal and estuarine management (JNCC, 2010). From April 2011 the Marine and Coastal Access Act (MCAA) will combine the requirements of the Coast Protection Act 1949 and the Food and Environmental Protection Act 1985 to create a single Marine Licensing process. The act makes the MMO the competent marine planning and licensing authority on behalf of UK Government, delivering marine functions in English territorial waters and UK offshore waters (for matters that are not devolved) such as marine licensing and enforcement of marine legislation.	From review of the MCAA and associated draft secondary legislation, and consultation with DEFRA's marine policy unit it is understood that the licence requirements for the project are as follows: Under Section 81 of the MCAA submarine interconnector cables are interpreted to be "exempt cables". Therefore, a Marine Licence is required for: • Laying and burial of the cable system between mean high water springs and the 12 nautical mile limit. Under Section 81 of the MCAA the MMO are obligated to grant a licence for this work, but can place conditions on that licence. No licence is required for a section of cable laid outside of 12 nautical miles. • A Marine Licence/s will be required for dredging of sand waves, disposal of dredged material, rock or concrete

	The act also provides for enforcement of the legislation.	mattress placement, and horizontal directional drilling and the associated installation of conduits.
Town and Country Planning Act 1990	The aspects of the project situated above the mean low water spring tide line constitute development regulated under the previsions of the Town and Country Planning regime.	A separate environmental scoping and assessment process and planning application will made for the terrestrial aspects of the project which will include the onshore section cable and a converter station
Environment Act 1995	Consent from the Environment Agency required for works affecting sea defences and flood defences.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of sea and flood defences in proximity to the cable route
Land Drainage Act 1991	Consent from the Environment Agency required for works affecting drainage ditches.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of drainage ditches in proximity to the cable route
Water Resources Act 1991	Consent from the Environment Agency required for works affecting sea defences and flood defences.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of sea and flood defences in proximity to the cable route
The Conservation of Habitats and Species Regulations 2010	Development within or adjacent to existing, proposed or potential Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) is subject to the Conservation of Habitats and Species Regulations 2010 which relate to onshore sites and those located within territorial waters. The Regulations provide for the designation and protection of 'European sites', the protection of 'European protected species', and the adaptation of planning and other controls for the protection of European Sites.	If the development has the potential to have a significant adverse impact on the conservation features for which the SAC or SPA is designated, then the proposal may be subject to Appropriate Assessment. This process aims to determine whether or not the development would have a significant adverse impact on the conservation interest feature and on the overall ecological integrity of the site. Appropriate Assessment is carried out the by competent authority, which in this case is the MMO, advised by Natural England.
Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007	Development within or adjacent to existing, proposed or potential SACs and SPAs is subject to the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 which relate to sites located outside of territorial waters (i.e. outside of the 12 nautical mile limit).	
Wildlife and Countryside Act 1981	Provides for the protection of rare and vulnerable species and the notification of Sites of Special Scientific Interest (SSSI).	Licences may be required if vulnerable species or SSSI sites are to be impacted by the project
National Heritage Act 2002	This extends English Heritage's statutory responsibilities to the marine environment out to the 12 nautical mile limit.	Impacts on marine archaeology will considered in the environmental assessment
Protection of Wrecks Act 1973	Provides protection for designated wreck sites. Wreck sites can be designated for historical, archaeological or artistic value or if they are deemed dangerous.	Protected wreck sites will be avoided by the cable route by the required distance.
Ancient Monuments and Archaeological Areas Act 1979	Provides for archaeological sites to be designated as Scheduled Ancient Monuments (SAMs) and requires scheduled monument consent for activities that might impact upon such sites.	SAMs will be avoided by the cable route.
Protection of Military Remains Act 1986	Provides for the protection of underwater military remains, including ships and aircraft.	Wrecks including military remains will be avoided by the cable route

Appendix 5: Habitats Regulations Assessment Signposting

A Habitats Regulations Screening Assessment report is included within the Project Nemo application and covers both offshore and onshore elements within the UK (Nemo Link: UK to Belgium Interconnector: Pegwell Bay – Assessment of Likely Significant Effects Report)

Thanet Coast and North-east Kent Natura 2000 Sites

Project Nemo Appropriate Assessment Signposting Document for Thanet Coast and North East Kent Natura 2000 Sites			
Conservation Objectives	**Chapter Issue Discussed**	**Page**	**Sections (if relevant)**
Thanet Coast SAC			
Reefs	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Submerged or partially submerged sea caves	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Thanet Coast and Sandwich Bay SPA			
Sand and shingle shores	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Shallow coastal waters	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Intertidal mud and sandflats	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Chalk shores	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Little tern (breeding population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Golden plover (wintering population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Turnstone (wintering and migratory population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Sandwich Bay SAC			
Shifting dunes along the shoreline with *Ammophila arenaria* (“white dunes”)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Fixed dunes with herbaceous vegetation (“grey dunes”)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Dunes with *Salix repens ssp. argentea* (*Salicion arenariae*)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Embryonic shifting dunes	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Humid dune slacks	Chapter 7.1 Conservation Designations	85	Table 7-1-1

Thanet Coast and Sandwich Bay Ramsar Site			
Rocky shore, estuary, dune, saltmarsh and martime grassland habitat	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Turnstone	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Sanderling	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Ringed plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Golden plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Grey plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Invertebrates	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2Baseline Environment

Appendix 6: Assessment of Significance

Description of Impact				Nature of Effect					Description of Receptor				Impact Significance	Consideration of Mitigation							Residual Impact Significance	Section in Report
Section	Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value		Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation		
A - Bathymetry and Seabed Processes																						
A - 1	Installation	Pre-sweeping of sand waves	Localised changes to seabed	100	10	10	1	Moderate	Low	High	Low	Low	Minor	An appropriate dredging technique (likely to be a Trailing Suction Hopper Dredger) is to be used. The sweep corridor will only dredge through areas judged to be at risk of either mobility or preventing cable burial equipment from operating effectively.	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
A - 2	Installation	Disposal of dredged material from pre-sweeping	Localised changes to seabed	100	10	10	10	Moderate	Low	Moderate	Low	Low	Minor	Dredged material is to be disposed within 1 km of the proposed cable route, rather than being taken to licensed disposal sites	10	10	10	1	Moderate	The residual impact will extend over a greater geographic area, but there is likely to be much smaller impact at any one point	Minor	
A - 3	Installation	Cable burial	Localised changes to seabed	100	1	10	1	Moderate	Low	High	Low	Low	Minor	Appropriate ploughing or jetting techniques are to be used to minimise sediment disturbance	100	1	10	1	Moderate	The residual impact is unchanged	Minor	
A - 4	Operation	External cable protection	Localised changes to seabed	10	1	10	10	Moderate	Low	Low	Low	Low	Minor	Appropriate cable burial depths are to be achieved to minimise the need for external cable protection	10	1	10	10	Moderate	Impact will be prevented as far as possible. Should external protection be required, appropriate techniques will be used to minimise the possibilities of scour and facilitate easier recovery	Minor	
A - 5	Decommissioning	Cable removal	Localised changes to seabed	100	1	1	1	Moderate	Low	High	Low	Low	Minor	Appropriate recovery techniques will be used to minimise sediment disturbance	100	1	1	1	Moderate	The residual impact is unchanged	Minor	
B - Geology																						
B - 1	Installation	Cable burial	Direct damage to geological features of interest associated with the Sandwich and Hacklinge Marshes SSSI.	1	1	1	100	Moderate	Low	High	Low	Low	Minor	The cable will be routed through an area with less geological interest features in accordance with scoping responses and boring techniques will be used to minimise the geological disturbance	10	1	10	100	Moderate	High geological value area will be avoided, so issues of recoverability and sensitivity will be reduced	Minor	
B - 2	Decommissioning	Cable removal	Direct damage to geological features of interest associated with the Sandwich and Hacklinge Marshes SSSI.	1	1	1	1	Low	Low	High	Low	Low	Negligible	The cable will be removed through only the previously disturbed area to prevent the possibility of damage to any other geological feature					no impact	Since the route was already moved to go through an area lower value geology, therefore issues of recoverability and sensitivity will be reduced	no impact	
C - Water Quality																						
C - 1	Installation	Pre-sweeping of sand waves	Increased turbidity	100	10	1	1	Moderate	Low	High	Low	Low	Minor	Only the areas in need of sweeping will be dredged and appropriate dredging techniques will be used to minimise sediment resuspension	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
C - 2	Installation	Pre-sweeping of sand waves	Potential re-suspension and settling of contaminated sediments	10	1	1	1	Low	Low	High	Low	Low	Negligible	Only the areas in need of sweeping will be dredged and appropriate dredging techniques will be used to minimise sediment resuspension	10	10	10	1	Moderate	Sweeping of sand waves is kept offshore, where sediment contamination is unlikely and will not affect other seabed areas	Minor	
C - 3	Installation	Disposal of dredged material from pre-sweeping	Increased turbidity	100	10	1	1	Moderate	Low	High	Low	Low	Minor	The dredger overflow will be minimised and the sediment will be disposed within the vicinity of the cable route, rather than relocated to distant licensed disposal sites	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
C - 4	Installation	Disposal of dredged material from pre-sweeping	Release of contaminants from sediments	10	1	10	1	Moderate	Low	High	Low	Low	Minor	Contaminated sediments are not considered likely to occur in offshore dredging areas	1	1	1	1	Low	Sediment contamination is unlikely and will not affect other seabed areas	Minor	
C - 5	Installation	Cable burial	Increased turbidity	10	1	1	1	Low	Low	High	Low	Low	Negligible	Appropriate techniques of ploughing or jetting will be used for cable burial, to minimise sediment resuspension	10	1	1	1	Low	Residual impact unchanged	Minor	
C - 6	Installation	Cable burial	Disturbance of contaminated sediment	10	10	10	1	Moderate	Low	High	Low	Low	Minor	Sampling of nearshore sediments shows acceptable levels of sediment contamination, ensuring that contamination dispersion to other areas will be minimised	1	1	1	1	Low	Disturbance of nearshore sediments will not release unacceptable levels of contaminants	Minor	
C - 7	Operation	Heat emissions from cable system	Increased ambient seabed temperatures	10	1	1	100	Moderate	Low	High	Low	Low	Minor	The cable design should incorporate adequate thermal insulation and be buried sufficiently deeply for surface sediments to not be heated	1	1	1	1	Low	Heat escape is unlikely to be detectable at the seabed and water interface	Minor	
C - 8	Operation	Accidental contamination from associated vessels and equipment	Deterioration in water quality	1	1	1	1	Low	Low	High	Low	Low	Negligible	Maintenance will only be carried out when necessary, which will be minimised by good installation practice. MARPOL regulations to prevent accidental pollution will be observed	1	1	1	1	Low	Adequate precautions and the use of best practice will minimise the likelihood of accidents	Minor	
C - 9	Decommissioning	Cable recovery	Increased turbidity	10	10	1	1	Moderate	Low	High	Low	Low	Minor	No mitigation identified	10	10	1	1	Moderate	The residual impact is unchanged	Minor	

C - 10	Decommissioning	Cable recovery	Disturbance of contaminated sediment	10	1	10	1	Moderate	Low	High	Low	Low	Minor	Contaminated sediments are not considered likely to occur in offshore sediments, whilst sampling of nearshore sediments shows acceptable contamination levels	1	1	10	1	Low	There is no anticipation of contaminant loading being increased during the operational period, therefore removal will not mobilise any more contaminants than installation	Minor	
D - Conservation Designations																						
D - 1	Construction	Installation of Cables	Disturbance or destruction of internationally designated areas (SACs and SPAs)	100	1	10	1	Moderate	Moderate	High	High	Moderate	Moderate	Avoidance of the most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats. Avoid nesting areas and nesting and wintering season where practical.	10	1	1	1	Low	Impacts will only affect habitats where they can accept some level of disturbance and recover in short periods of time (such as sands and mudfalts). It should be noted that by taking into account this mitigation impacts on the most senstive features of the SAC site (e.g. the wave cut platform habitats will be avoided)	Minor	
D - 2	Construction	Installation of Cables	Disturbance or destruction of nationally and locally designated areas (SSSI, NNR and LNR)	100	1	10	1	Moderate	Moderate	High	Moderate	Moderate	Moderate	Avoidance of the most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats. Avoid key geological features of the SSSI.	10	1	1	1	Low	Impacts will only affect habitats where they can accept some level of disturbance and recover in short periods of time (such as sands and mudfalts).	Minor	
D - 3	Decommissioning	Cable removal	Disturbance or destruction of internationally designated areas (SACs and SPAs)	100	1	10	1	Moderate	Moderate	High	High	Moderate	Moderate	Cable can be left in situ to lessen the magnitude of impact on qualifying features of designations.					No Impact	Qualifying features of affected designations will be unaffected by decommissioning if cable left insitu. An environmental assessment will be undertaken prior to any decommissioning being undertaken.	no impact	
D - 4	Decommissioning	Cable removal	Disturbance or destruction of nationally and locally designated areas (SSSI, NNR and LNR)	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Cable can be left in situ to lessen the magnitude of impact on qualifying features of designations.					No Impact	Qualifying features of affected designations will be unaffected by decommissioning if cable left insitu. An environmental assessment will be undertaken prior to any decommissioning being undertaken.	no impact	
E - Benthos																						
E - 1	Pre-installation	Pre-lay grapnel run	Disturbance of inter-tidal communities	10	1	1	1	Low	Moderate	High	Low	Low	Negligible	None required due to high recoverability and limited duration and spatial extent								
E - 2	Pre-installation	Pre-lay grapnel run	Disturbance of subtidal benthic communities	10	1	1	1	Low	Moderate	High	Low	Low	Negligible	None required due to high recoverability and limited duration and spatial extent								
E - 3	Pre-installation	Pre-lay grapnel run	Disturbance of Sabellaria reefs	10	1	10	10	Moderate	Moderate	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	None	Minor	
E - 4	Pre-installation	Pre-sweeping of sand waves	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required due to high recoverability and limited duration and spatial extent								
E - 5	Pre-installation	Pre-sweeping of sand waves	Disturbance of Sabellaria reefs	1	1	1	1	Low	High	High	High	Medium	Minor	None required due to high recoverability and limited duration and spatial extent								
E - 6	Pre-installation	Pre-sweeping of sand waves	Smothering of subtidal benthic communities from deposition of suspended sediment	100	10	10	1	Moderate	Moderate	Moderate	Low	Low	Minor	None required								
E - 7	Pre-installation	Pre-sweeping of sand waves	Smothering of Sabellaria reefs from deposition of suspended sediment	1	1	1	1	Low	High	Moderate	High	Medium	Minor	Assumption: dredged material to be deposited up to 1500m away from area of pre-sweeping - this should not be deposited close to area of S. spinulosa reef.								
E - 8	Installation	Use of cable lay barge anchors	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required								
E - 9	Installation	Use of cable lay barge anchors	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required								
E - 10	Installation	Use of cable lay barge anchors	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	High	High	High	Medium	Moderate	Re-rerouting to avoid reef. Anchors are expected at up to 100m from vessel - slight possibility that they may hit the area of reef 90m from the cable route. Vessel should be positioned and anchors deployed accordingly.	1	1	1	1	Low	None	Minor	

E - 11	Installation	Excavation of cable trench	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Bundling cables together and in one trench to reduce footprint. Ploughing should be used to minimise sediment re-suspension.	100	1	1	1	Moderate	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 12	Installation	Excavation of cable trench	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Bundling cables together and in one trench to reduce footprint. Ploughing should be used to minimise sediment re-suspension.	100	1	1	1	Moderate	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 13	Installation	Excavation of cable trench	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	High	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	None	Minor	
E - 14	Installation	Excavation of cable trench	Effect of suspended sediment on intertidal communities	10	1	1	1	Low	Moderate	Moderate	Low	Low	Negligible	Use of non-displacement plough instead of jetting to minimise sediment re-suspension								
E - 15	Installation	Excavation of cable trench	Effect of suspended sediment on benthic communities	10	1	1	1	Low	Moderate	Moderate	Low	Low	Negligible	Use of non-displacement plough instead of jetting to minimise sediment re-suspension								
E - 16	Installation	Excavation of cable trench	Effect of suspended sediment on Sabellaria reefs	10	1	1	1	Low	High	High	High	Medium	Minor	Re-rerouting to avoid reef. Use of non-displacement plough instead of jetting to minimise sediment re-suspension	1	1	1	1	Low	Minor. Sediment deposition is <0.1mm.	Minor	
E - 17	Installation	Cable burial	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Simultaneous cable laying and burial should be conducted to minimise duration of impact.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Negligible	
E - 18	Installation	Cable burial	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Simultaneous cable laying and burial should be conducted to minimise duration of impact.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Negligible	
E - 19	Installation	Cable burial	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	Low	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 20	Installation	Sub-tidal chalk cutting	Effects of suspension and deposition of chalk on subtidal benthic communities	10	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None.	1	1	1	1	Low	Minor. Chalk deposition is negligible.	Minor	
E - 21	Installation	Sub-tidal chalk cutting	Effects of suspension and deposition of chalk on Sabellaria reef	10	1	1	1	Low	High	High	High	Medium	Minor	Re-rerouting to avoid reef.	10	1	1	1	Low	Minor. Chalk deposition is negligible.	Minor	
E - 22	Installation	External cable protection	Disturbance of benthic communities	100	1	10	1	Moderate	Low	High	Low	Low	Minor	None required								
E - 23	Installation	External cable protection	Substrate change	100	1	10	100	Severe	Low	High	Low	Low	Moderate	Minimise use of rock protection.						Important to note that this may be a positive impact as creating new habitat.	Moderate	
E - 24	Installation	Cable installation works	Impacts from noise and vibration	1	1	1	1	Low	Low	Low	Low	Low	Negligible	None required								
E - 25	Installation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
E - 26	Operation	External cable protection	Changes in current regime	1	1	1	10	Low	Low	High	Low	Low	Negligible									
E - 27	Operation	External cable protection	Disturbance of subtidal benthic communities (scour and substrate change)	10	1	10	100	Moderate	Low	High	Low	Low	Moderate							Potential creation of new habitats - not necessarily a negative impact	Moderate	
E - 28	Operation	Operational noise, vibration, heat and EMF emissions of the buried cables	Disturbance of subtidal benthic communities	1	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
E - 29	Operation	Maintenance of cable works	Disturbance of subtidal benthic communities	1	1	10	1	Low	Low	High	Low	Low	Negligible	None required								
E - 30	Operation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and subtidal benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
E - 31	Decommissioning	Intertidal works	Disturbance of benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Leave cable in-situ	1	1	1	1	Low	No residual impact.	Negligible	

E - 32	Decommissioning	Cable recovery	Disturbance of subtidal benthic communities	100	1	10	10	Moderate	Moderate	High	Low	Low	Minor	Leave cable in-situ	1	1	1	1	Low	No residual impact.	Negligible	
E - 33	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of intertidal and subtidal benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
F - Fish and Shellfish																					
F -1	Pre-installation	Pre-lay grapnel run	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F - 2	Pre-installation	Pre-lay grapnel run	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -3	Pre-installation	Pre-lay grapnel run	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -4	Pre-installation	Pre-lay grapnel run	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -5	Pre-installation	Pre-sweeping of sand waves	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -6	Pre-installation	Pre-sweeping of sand waves	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -7	Pre-installation	Pre-sweeping of sand waves	Disturbance of shellfish beds	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -8	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	10	1	1	Low	Low	High	High	Medium	Minor	None required								
F -9	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	1	Moderate	High	Moderate	High	Medium	Moderate	Assumption: dredged material to be deposited 1500m away from area of pre-sweeping. Restrict timing to avoid most sensitive spawning and nursery ground activity.	1	10	1	1	Low	None expected	Minor	
F -10	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -11	Installation	Use of anchors on cable lay barge	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -12	Installation	Use of anchors on cable lay barge	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -13	Installation	Use of anchors on cable lay barge	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -14	Installation	Use of anchors on cable lay barge	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -15	Installation	Excavation of cable trench	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -16	Installation	Excavation of cable trench	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -17	Installation	Excavation of cable trench	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	

F -18	Installation	Excavation of cable trench	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -19	Installation	Excavation of cable trench	Effect of suspended sediments on spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	10	1	1	Low	Low	High	High	Medium	Minor	None required								
F -20	Installation	Excavation of cable trench	Effect of suspended sediments on spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	10	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	10	1	1	Low	None expected	Minor	
F -21	Installation	Excavation of cable trench	Effect of suspended sediments on shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -22	Installation	Cable burial	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -23	Installation	Cable burial	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring). Simultaneous lay and burial.	1	1	1	1	Low	None expected	Minor	
F -24	Installation	Cable burial	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required. Simultaneous lay and burial.								
F -25	Installation	Sub-tidal chalk cutting	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -26	Installation	Sub-tidal chalk cutting	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	10	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring).	1	10	1	1	Low	None expected	Minor	
F -27	Installation	Sub-tidal chalk cutting	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -28	Installation	External cable protection	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -29	Installation	External cable protection	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring).	1	1	1	1	Low	None expected	Minor	
F -30	Installation	External cable protection	Disturbance of shellfish beds	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -31	Installation	External cable protection	Substrate change	100	1	100	100	Severe	Low	High	Low	Low	Moderate	Minimise use of rock protection.						Important to note that this may be a positive impact as creating new habitat.	Moderate	
F -32	Installation	Cable installation works	Impacts from noise and vibration	10	1	10	1	Moderate	Moderate	Moderate	Low	Low	Minor	None required								
F -33	Installation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor	
F -34	Operation	External cable protection	Disturbance of fish communities (scour and substrate change)	10	1	10	100	Moderate	Low	High	Low	Low	Minor	None required								
F -35	Operation	Maintenance of cable works	Disturbance of fish communities	1	1	10	1	Low	Low	High	Low	Low	Negligible	None required								
F -36	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor	

F -37	Operation	Emission of noise and vibration from cables	Disturbance to fish communities or changes in behavioural patterns	1	1	1	100	Moderate	Moderate	Moderate	Low	Low	Minor	None required									
F -38	Operation	Emission of EMF from cables	Changes in behavioral patterns of electrosensitive fish species including disturbance to feeding, spawning and migration	1	1	1	100	Moderate	Moderate	High	High	Medium	Minor	Bundling cables together and in one trench and burying to maximum depth would reduce footprint of any potential impact.	1	1	1	100	Moderate	The impact will continue for as long as the cable is operational	Minor		
F -39	Operation	Emission of heat from cables	Disturbance to spawning grounds and shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	Assumption: Cable to be buried at a minimum depth of 1m. Bundling cables together in one trench and burying to maximum depth would reduce footprint of any potential impact.									
F -40	Decommissioning	Intertidal works	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required									
F -41	Decommissioning	Intertidal works	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Leave cable in-situ? Restrict timing to avoid most sensitive spawning and nursery ground activity	1	1	1	1	Low	None expected	Minor		
F -42	Decommissioning	Intertidal works	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required									
F -43	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Medium	Moderate	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor		
F -44	Decommissioning	Cable recovery	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Moderate	None required									
F -45	Decommissioning	Cable recovery	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Leave cable in-situ? If not, restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor		
F -46	Decommissioning	Cable recovery	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	Leave cable in-situ?									
G - Ornithology																							
G - 1	Installation	Intertidal works	Disturbance of birds	10	1	1	1	Low	high	High	high	Moderate	Minor	Construction activities in the intertidal area will aim to avoid Oct-Feb and May	1	1	1	1	Low		Minor		
G - 2	Installation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	The EMP will be strictly adhered to by the Contractor to ensure that contaminants are not released but should, in the unlikely event, a pollution event occur a suitable response plan will be initiated.	10	1	1	1	Low		Minor		
G - 3	Installation	Intertidal works	disturbance of nesting birds	10	1	1	1	Low	High	Low	Moderate	Moderate	Minor	fenced off to avoid installation work accidentally entering them. The main breeding period for redshank is from mid April to July. If practicable, the intertidal works will avoid this period and if it is not practical, the project Nemo will attempt to avoid the most sensitive periods within the breeding season.	1	1	1	1	Low		Minor		
G - 4	Installation/Operation	Intertidal works	Loss of prey species	10	1	1	1	Low	Low	High	Moderate	Low	Negligible										
G - 5	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Standard construction and environmental best practice will be used to minimise the likelihood of contaminants being released.	10	1	1	1	Low		Minor		
G - 6	Decommissioning	Intertidal works	Disturbance of birds	10	1	1	1	Low	high	High	high	Moderate	Minor	Construction activities in the intertidal area will aim to avoid Oct-Feb and May	1	1	1	1	Low		Minor		
G - 7	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	The EMP will be strictly adhered to by the Contractor to ensure that contaminants are not released but should, in the unlikely event, a pollution event occur a suitable response plan will be initiated.	10	1	1	1	Low		Minor		
H - Marine Mammals																							
H - 1	Installation	Noise associated with excavation of the cable trench	Disturbance to cetacean and pinniped species	10	10	10	1	Moderate	Low	High	Low	Low	Minor										
H - 2	Installation	Noise associated with presence of installation vessels	Disturbance to cetacean and pinniped species	10	10	1	1	Moderate	Low	High	Low	Low	Minor										

H - 3	Installation	Intertidal works	Disturbance of seals in intertidal area	10	1	1	1	Low	Moderate	High	Low	Low	Negligible								
H - 5	Operation	Noise associated with presence of any maintenence and repair vessels	Disturbance to cetacean and pinniped species	10	1	1	1	Low	Low	High	Low	Low	Negligible								
H - 6	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	10	1	1	Moderate	Moderate	High	Low	Low	Minor								
H - 7	Decommissioning	Noise associated with presence of decommissioning vessesls and equipment	Disturbance to cetacean and pinniped species	10	10	10	1	Moderate	Low	High	Low	Low	Minor								
H - 8	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	10	1	1	Moderate	Moderate	High	Low	Low	Minor								
I - Commercial Fisheries																					
I - 1	Installation	Temporary mobile exclusion zone around the cable laying and burial spread/s	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place. A Fisheries Liaison Officer Will be appointed to coordinate communication between the construction works and the fishing industry.	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. Although there will be some disturbance to fishermen due to the exclusion zone around the installation works it will be limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Minor	
I - 3	Operation	Cable laying and burial including use of anchors to maintain position of installation vessels	Damage to certain types of fishing gear. Drift and trammel netting can become snagged on rough ground that could be created as a result of cable burial and cable crossings.	10	1	1	1	Low	Low	High	Moderate	Low	Negligible	Notice to Mariners will be issued to advise fishermen where and when the installation will take place. A Fisheries Liaison Officer Will be appointed to coordinate communication between the construction works and the fishing industry.	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. The seabed surveys indicate that much of the seabed is fine sand and gravel in the area crossed. Therefore installation works are unlikely to increase the roughness of the seabed. There is only one cable crossing in UK waters. Although this will require the placement of rock or mattresses it will be over a very limited extent. Any debris encountered during the prelay grapnel run wil be cleared, therefore potentially reducing seabed debris.	Negligible	
I - 7	Operation	Burial surveys and repair work	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place	1	1	1	1	Low	The residual impact after mitigation is low and the resulting impact significance is negligable. Although there will be some disturbance to fishermen due any routine survey or repair work it will be extremely limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Negligible	
I - 8	Operation	Presence of cables	Disturbance to trawling activities that will need to avoid the installed cable and associated cable protection.	100	1	1	100	Moderate	Low	High	Moderate	Low	Minor	Fishermen will be advised of the presence and location of the cable system via the Kingfisher Cable awareness charts. This will enable them to avoid interactions between their fishing gear and the cable system. Additionally the cable will be buried below the depth where it could be expected that trawlers could snag the cable (i.e. 2m burial depth will be sought). This should ensure that should a trawler accidently trawl over the cable system there will be no damage to their equipment or vessel. Additona	100	1	1	1	Moderate	The residual impact will be unchanged as a result of mitigation as trawlers will still be recommended to avoid trawling over the cable system.	Minor	

I - 12	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. Although there will be some disturbance to fishermen due to the exclusion zone around the installation works it will be limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Negligible	
I - 13	Decommissioning	Cable recovery including use of anchors to maintain position of installation vessels	Damage to certain types of fishing gear. Drift and trammel netting can become snagged on rough ground that could be created as a result of cable recovery	10	1	1	1	Low	Low	High	Moderate	Low	Negligible	Mitigation will be determined when the decomissioning options are fully assessed towards the end of the cable system's lifetime. It is possible that a post decomissioning survey could be carried out to determine whether removed of the cable system results in increased roughness/debris on the seabed. Following this survey any substantial debris could be removed if neccesary.	1	1	1	1	low	This issue will only arise if the decision is taken to remove the cable. Leaving the cable in situ is often an attractive alternative to removing the cables. Even if the cable is removed it is expected that the impact will be low due to the limited extent of any area of orugh ground that will be created.	Negligible	
J - Shipping and Navigation																						
J - 1	Installation	Temporary mobile safety zone around the cable laying and burial spread/s	Impeded access to the Port of Ramsgate	10	1	1	1	Low	Low	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Prior liaison with Port of Ramsgate. Maintain watch on Port working channels during activities.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 2	Installation	Installation spread	Other vessel collides with installation vessels	10	10	10	1	Moderate	High	High	Low	Moderate	Moderate	Promulgation of MSI Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 3	Installation	Temporary mobile safety zone around the cable laying and burial spread/s	Displacement of shipping and recreational boating traffic from area surrounding the vessel spread.	10	10	1	1	Moderate	Moderate	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP). However unlike local effects there is a higher risk due to the nature of the traffic - many of which may be new to navigating to the area.	Minor	
J - 4	Operation	EMI from HVDC cables	Compass deviation leading to navigational error and grounding	100	1	1	100	Moderate	Moderate	High	High	Moderate	Moderate	Measurement of EMI to ensure within accepted limits	1	1	1	100	Moderate	Ensure within MCA Accepted Limits	Minor	
J - 5	Operation	Vessels anchoring	Damage to cable Damage to vessel/ injury to persons on board	10	1	100	100	High	High	Low	High	Moderate	Significant	Charting of cable Cable buried to minimum depth (0.5m) as specified by MCA. Cable is armoured.	10	1	10	100	Moderate	Anchoring in emergency remains a Moderate risk.	Moderate	
J - 6	Decommissioning	Temporary mobile safety zone around the cable recovery spread/s	Impeded access to the Port of Ramsgate	10	1	1	1	Low	Low	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Prior liaison with Port of Ramsgate. Maintain watch on Port working channels during activities.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 7	Decommissioning	Decommissioning spread	Other vessel collides with decommissioning vessels	10	10	10	1	Moderate	High	High	Low	Moderate	Moderate	Promulgation of MSI Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 8	Decommissioning	Temporary mobile safety zone around the cable recovery spread/s	Displacement of shipping and recreational boating traffic from area surrounding the vessel spread.	10	10	1	1	Moderate	Moderate	High	High	Moderate	Minor	Promulgation of Information and use of Guard Vessel. Consultation and cooperation with regional authorities including CNIS/Dover Straits VTS.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP). However unlike local effects there is a higher risk due to the nature of the traffic - many of which may be new to navigating to the area.	Minor	
K - Archaeology and Cultural Heritage																						

K - 1	Installation	Cable installation	Damage or destruction of submerged prehistoric material shallowly buried below the seabed. Any material within 2 m of the surface could be impacted.	10	1	10	100	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Geotechnical samples from the cable route area have been archaeologically assessed – and Stage 3 assessment will provide further information	10	1	10	100	Moderate	Shallow sections of the resource will still be impacted by development, however, information about the submerged prehistoric resource will be gained from geotechnical assessment (as explained in section 11.1.3) – and the area of impact on the feature is comparatively small.	Moderate	
K - 2	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of late 20th century wrecks (WA7017, WA7287, WA7292, and WA7303) and other 'wrecks' of low archaeological importance (WA7271, WA7273, and WA7286).	1	1	100	100	Moderate	High	Low	Moderate	Low	Minor	None required, however, to prevent damage to cable laying equipment, wrecks should be avoided.	1	1	100	100	Moderate	None	Minor	
K - 3	Installation	Use of anchors to maintain position of installation vessels	Damage or destruction of A1 archaeological receptors and A3 known wrecks.	1	1	100	100	Moderate	High	Low	Moderate	High	Significant	All known wrecks have been avoided in the cable route design. Temporary exclusion zones have been placed around A1 geophysical anomalies and buffers have been placed around A3 wrecks of archaeological potential.	1	1	1	1	Minor	None	Moderate	
K - 4	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of A2 geophysical anomalies.	100	1	100	100	High	High	Low	Moderate	Moderate	Significant	Some A2 geophysical anomalies are in the direct path of the cable route and will be impacted. However, these will be considered through the WSI and Archaeological Reporting Protocol.	10	1	10	100	Moderate	A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis through the WSI	Moderate	
K - 5	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites).	10	1	100	100	High	High	Low	Moderate	High	Significant	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	1	1	1	1	minor	Potential archaeological sites and material may still be affected by installation activities, however, reporting of discoveries through the Archaeological Reporting Protocol will considerably lessen impact	Moderate	
K - 6	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment	10	10	10	100	Moderate	Moderate	Low	Moderate	High	Significant	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	1	1	1	1	minor	Mitigation measures will considerably lessen impact	Moderate	
K - 7	Installation and Operation	Changes to erosion regimes at bridging structures	Indirect negative impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	1	100	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Changes to erosion regimes are expected to be minimal – areas of high sediment movement will be monitored. Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	1	1	1	10	minor	Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	Minor	
K - 8	Installation and Operation	Changes to sedimentation regimes at bridging structures	Indirect positive impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	1	10	Minor	Moderate	Low	Moderate	Moderate	Minor	Changes to sedimentation regimes are expected to be minimal	1	1	1	10	Minor	Changes to sediment regimes are expected to be minimal	Minor	Positive

K - 9	Operation and Decommissioning	Repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) Removal of infrastructure (cable de-burial, cable removal)	Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors	1	1	1	1	Minor	Low	Low	Moderate	Low	Negligible	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	1	1	1	1	Low	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	Negligible	
K - 10	Operation and Decommissioning	Anchors used to maintain position of repair or decommissioning vessels	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts	10	1	100	100	High	Low	Low	Moderate	Moderate	Significant	Known sites will be avoided through the maintenance of temporary exclusion zones and buffers, and any material discovered will be dealt with through the Archaeological Reporting Protocol	1	1	1	1	minor	Although sites could still be impacted, the implementation of mitigation measures would greatly lessen impact	Minor	
L- Toursim, Recreation, Amenity and Leisure																							
L -1	Installation	Cable laying and burial including use of anchors to maintain position of installation vessels	Disturbance to recreation and leisure activities	10	1	1	1	Low	Moderate	High	High	Moderate	Minor	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use of lighting and horns where necessary.	1	1	1	1	Low	With local water users aware of cable installation activities it is highly probable that they will avoid the area and will therefore not be directly disturbed by the works. The region is reasonably unconstrained and so there is likely to be sufficient room for the installation spread and water users to co-exist.	Minor	
L -2	Installation	Cable laying and burial including use of anchors to maintain position of installation vessels	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										
L -3	Operation	Burial surveys and repair works	Disturbance to recreation and leisure activities	10	1	1	1	Low	Low	High	High	Low	Negligible	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use of lighting and horns where necessary.	1	1	1	1	Low		Minor	
L -4	Operation	Burial surveys and repair works	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										
L -5	Operation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and coastal area	10	1	1	1	Low	Low	High	High	Low	Negligible										
L -6	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Disturbance to recreation and leisure activities	10	1	1	1	Low	Low	High	High	Low	Negligible	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use	1	1	1	1	Low		Minor	
L -7	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										

Appendix 7: HR Wallingford Technical Report

Project Nemo - UK to Belgium Interconnector

Tidal Flow Modelling

Technical Note DDR4633-01

HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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Project Manager	J. Harris
Project Director	R. Whitehouse

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1. Introduction

Tidal flows in the area of the NEMO project have been simulated using the TELEMAC modelling system and the model set up as part of the Southern North Sea Sediment Transport Study (HR Wallingford *et al*., 2002). The SNSSTS model was set up to define regional flows in the Southern North Sea and English Channel, and was not specifically calibrated or validated along the cable route corridor. The existing model was used as the basis for developing a new flow model tailored to simulating tidal flows in the NEMO study area of interest.

2. Model coverage

The model covers a large area of the Southern North Sea from Flamborough Head in the north and beyond the Strait of Dover to Plymouth in the south-west. The bathymetry for the model is presented in Figure 1, which was obtained by digitising UK Admiralty Charts that cover the area for the original study. The regional model has been locally revised and re-gridded to include detailed local bathymetry from digital Admiralty Charts provided under licence by Seazone (License details: © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 012010.011) and survey data supplied by the Client:

Survey data filenames - 702-NEMO_P_Landfall_Ramsgate_Gnodes_2x2m.txt
702-NEMO_P_Landfall_Zeebrugge_Gnodes_2x2m.txt
702-NEMO_IB_B1_Gnodes_2x2m.txt
702-NEMO_IB_B2_Gnodes_2x2m.txt
702-NEMO_IB_B3_Gnodes_2x2m.txt

The model grid mesh size is about 20 km at the northern open boundary, 5 km in the English Channel and 100 m along the cable route which is appropriate for determining local flow fields. Figures 2 and 3 show the bathymetry to Mean Sea Level and model grid for the area local to the cable route.

3. Model run and calibration

The model was run using water levels along both the northern boundary, which was located near Flamborough Head, across the North Sea to Europe and the southern boundary located near Plymouth across the English Channel to Roscoff. Siting the boundaries far away from the study area enabled good resolution of the tidal propagation through the Strait of Dover, and also simplified the boundary specification by using harmonic data from Primary ports and other published literature (the national British Oceanographic Data Centre (BODC) database).

No project specific flow data was available to refine the calibration of this model local to the cable route. Therefore, calibration targets against field measurements have not been set and evaluated. As a suitable alternative, a comparison of the model flows with relevant Admiralty current tidal diamond data has been carried out. This data is usually of sufficient quality for general model validation but does not for allow detailed validation as the data is typically derived from measurements which can be decades old. A model simulation which captures the broad behaviour of the flow field represented by

tidal diamonds provides local detail along the cable corridor route by virtue of the local bathymetry that has been implemented.

The model was run to simulate a spring-neap tidal cycle and model data for a mean spring tide and a mean neap tide were extracted for the current report. The comparison of the model flows with the Admiralty tidal diamonds is shown in Figures 4 and 5 (spring and neap tides, respectively). It can be seen that overall there is an appropriate level of agreement between the model current speeds and directions in terms of magnitude and phase with those observations.

4. Baseline results

Figures 6 to 8 illustrate the model flow vectors at peak flood and ebb for a spring tide for baseline conditions, i.e. pre-dredging. The vectors have been extracted on a regular grid for clarity of presentation. Moving from west to east along the cable route the direction of ebb flow varies from south to south-west and speeds at peak ebb tide reduce from over 1.5 m/s to below 0.5 m/s. For the flood tide flow directions change progressively from north to east as the flow expands once it has passed through the Strait of Dover, and speeds vary from over 1 m/s to around 0.5 m/s.

Figure 9 shows current speed at three locations along the cable route over a 15 day period. The current speeds time series are highest at Location 1 which is in deep water and slowest in shallow water at Location 3.

5. Use of model

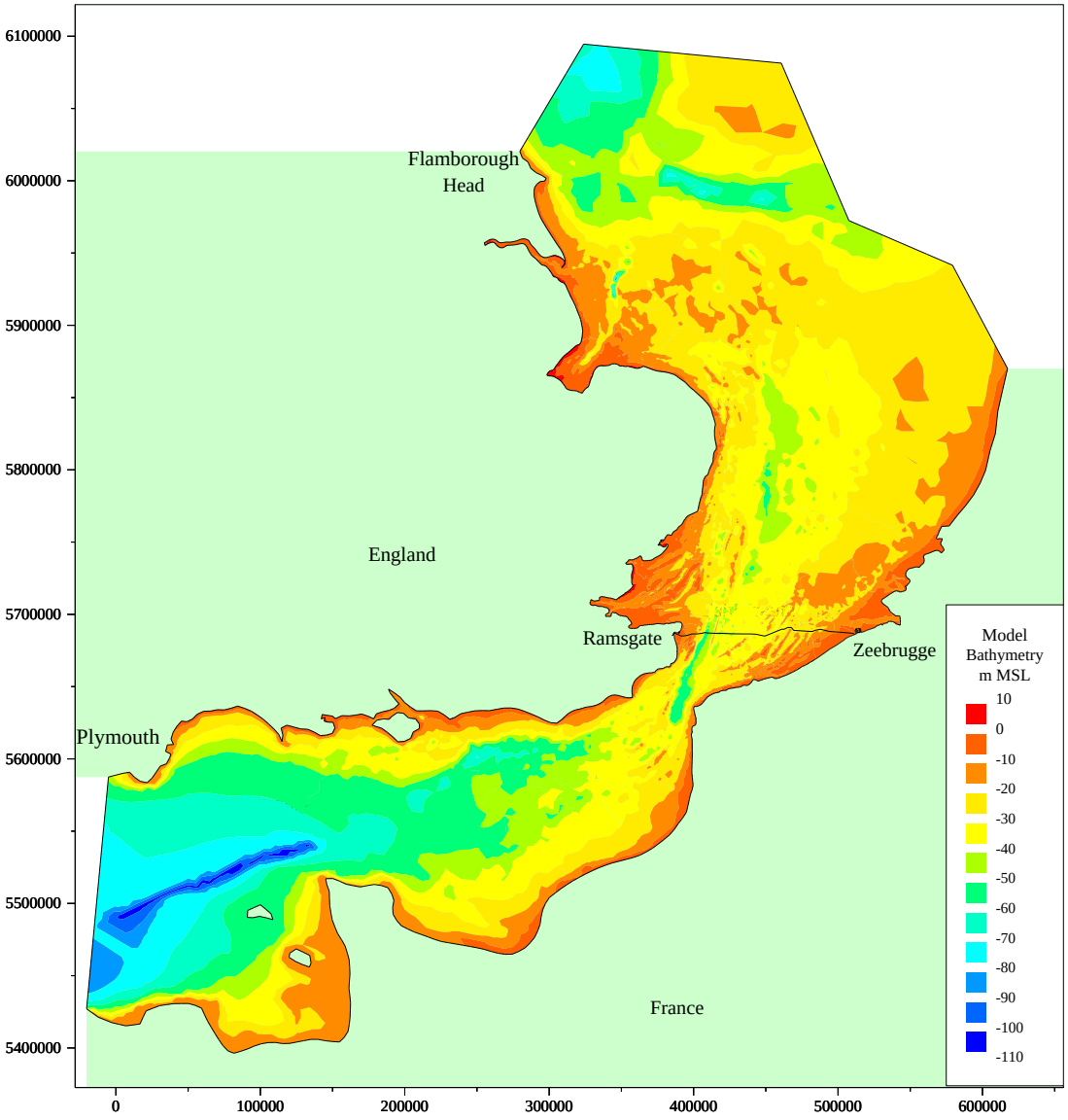
The results from the model run will feed directly into the baseline hydrodynamic assessment, the sediment transport and bedform modelling assessment, as well as the assessment of plume dispersion from dredging. Model results will be extracted at selected dredging locations to drive the plume dispersion model.

Selected final results from the model can be provided in GIS format.

6. References

HR Wallingford, Cefas/UEA, Posford Haskoning & Dr Brian D'Olier, 2002. Southern North Sea Sediment Transport Study Phase 2, Sediment Transport Report, HR Wallingford Report EX4526 produced for Great Yarmouth Borough Council, August 2002 (see *http://www.sns2.org/theproject.html* and *http://www.sns2.org/project-outputs.html*).

Figures



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/bathy.i

Figure 1 Flow model bathymetry in metres with respect to Mean Sea Level

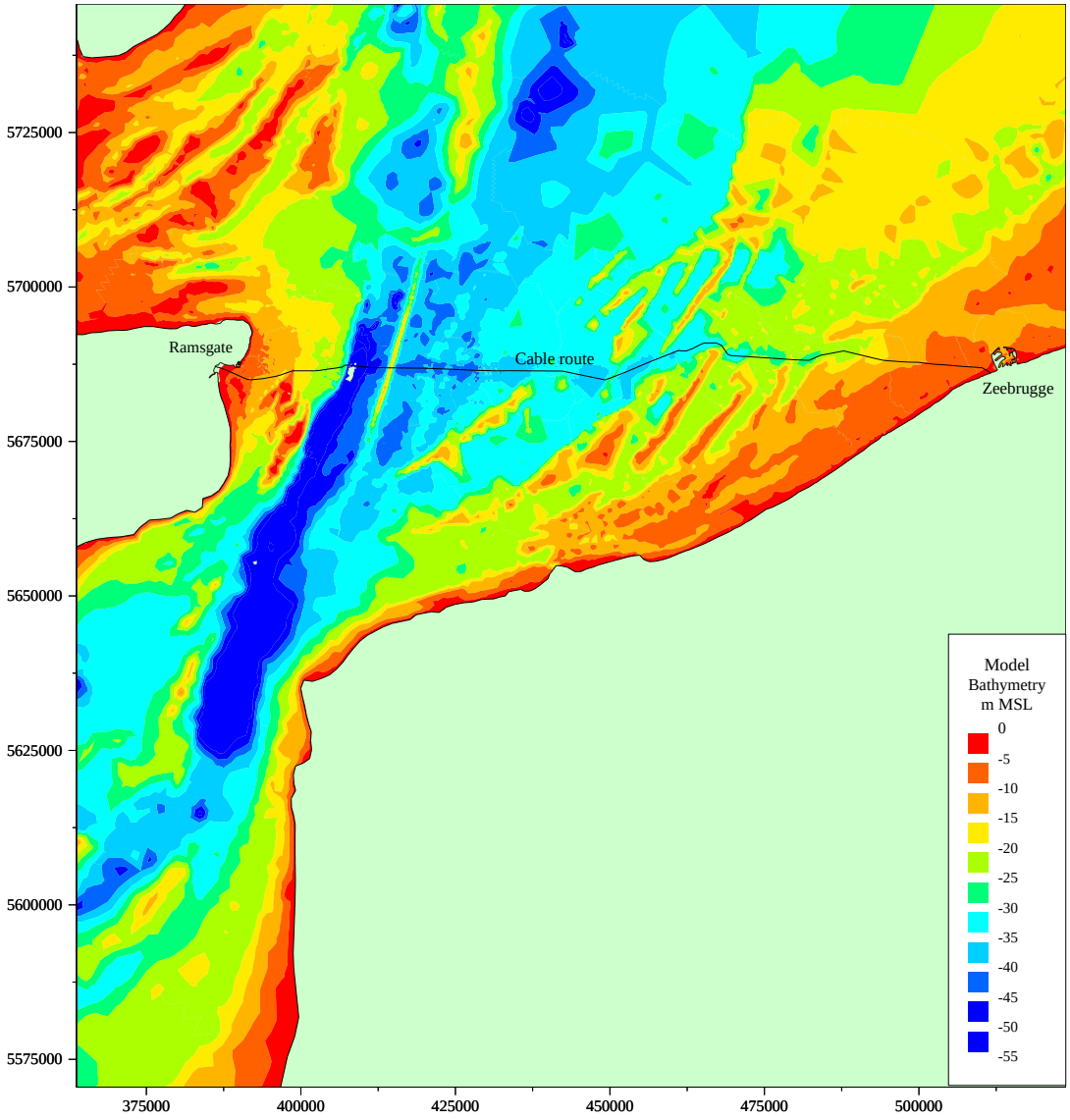


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Figure 2 Model bathymetry local to the cable route

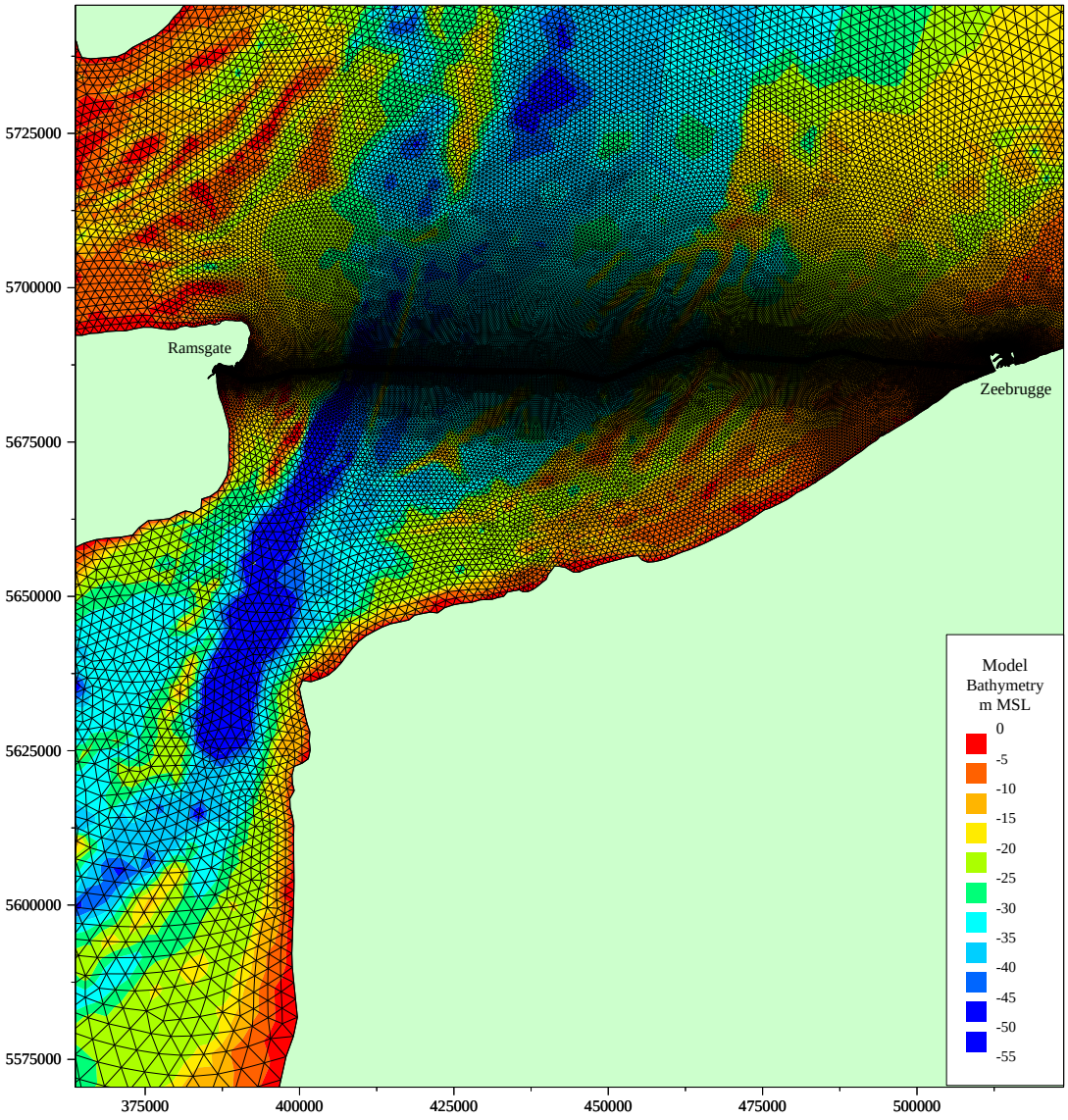

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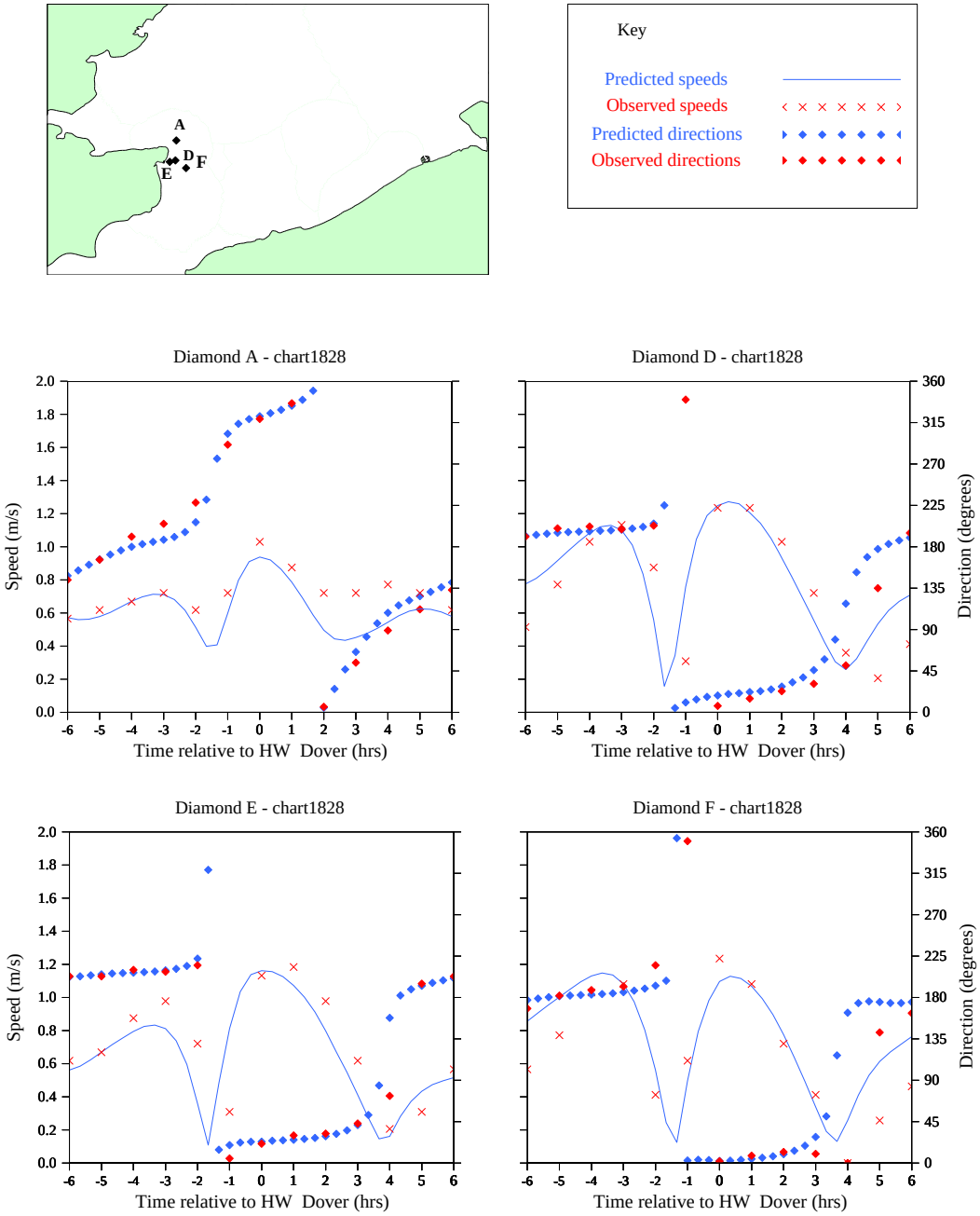
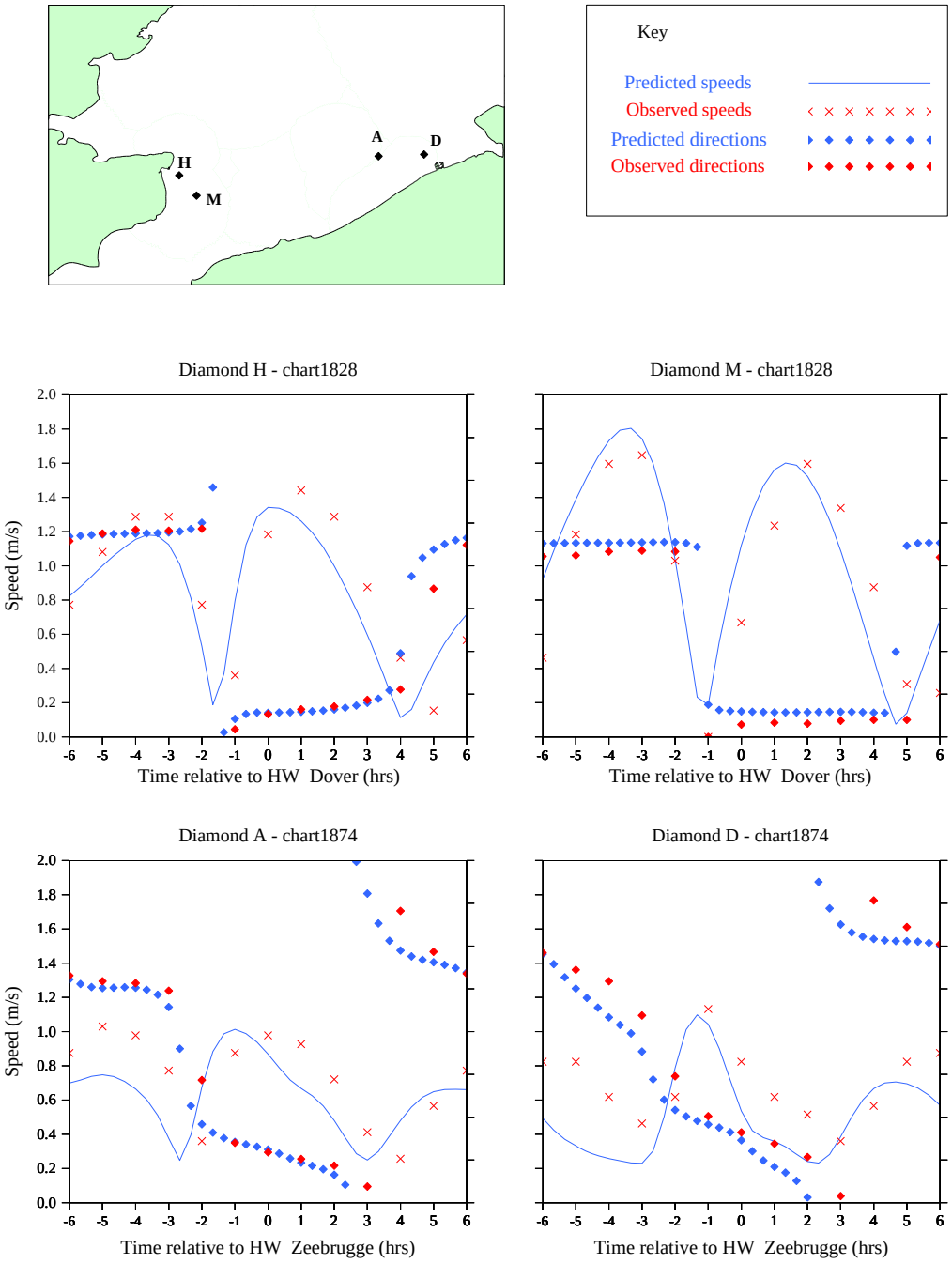
Figure 3 Model mesh local to the cable route



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/chart1828_ADEF.i

Figure 4a Spring tide observed and simulated currents



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/both_HM_AD.i

Figure 4b Spring tide observed and simulated currents

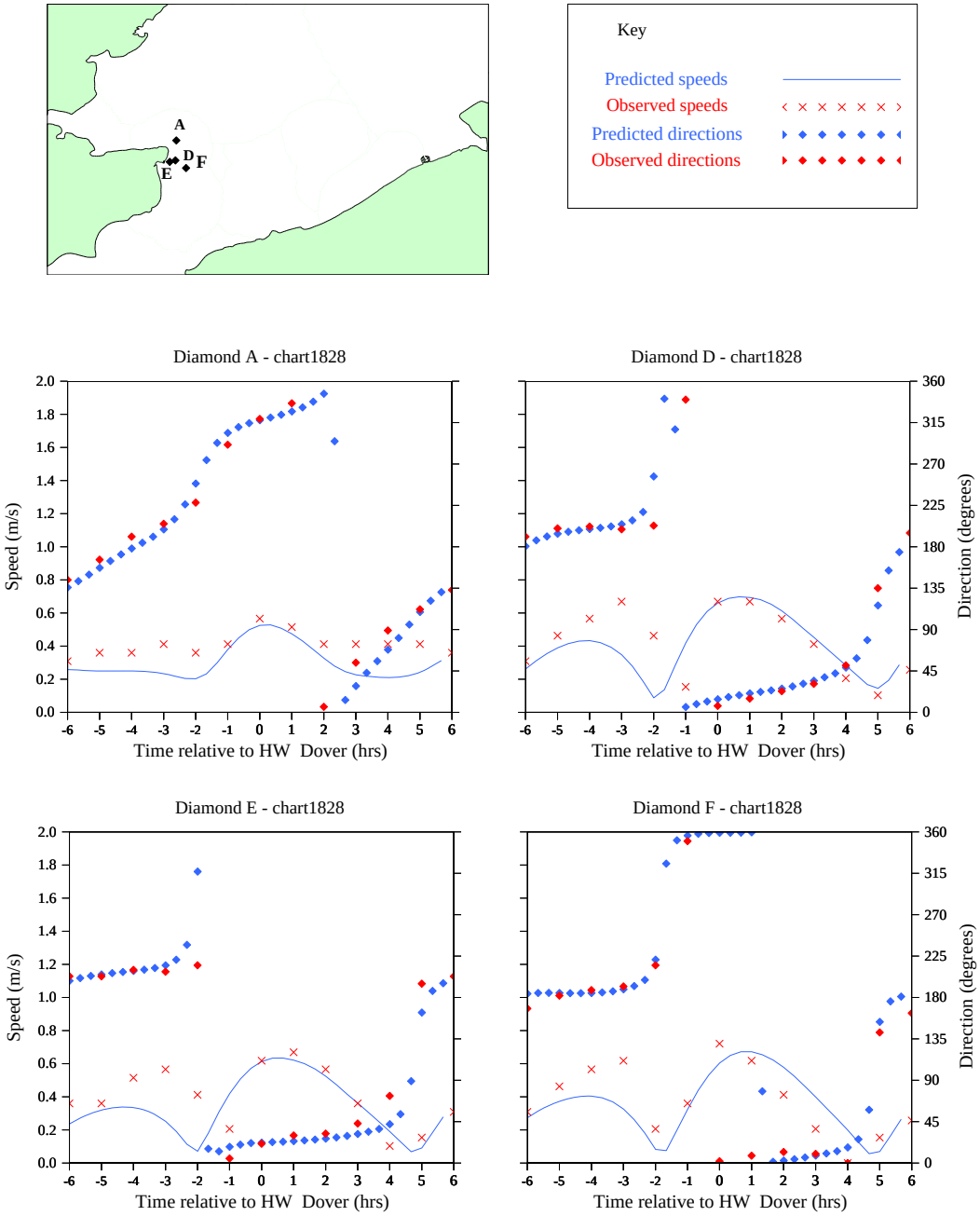


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Figure 5a Neap tide observed and simulated currents

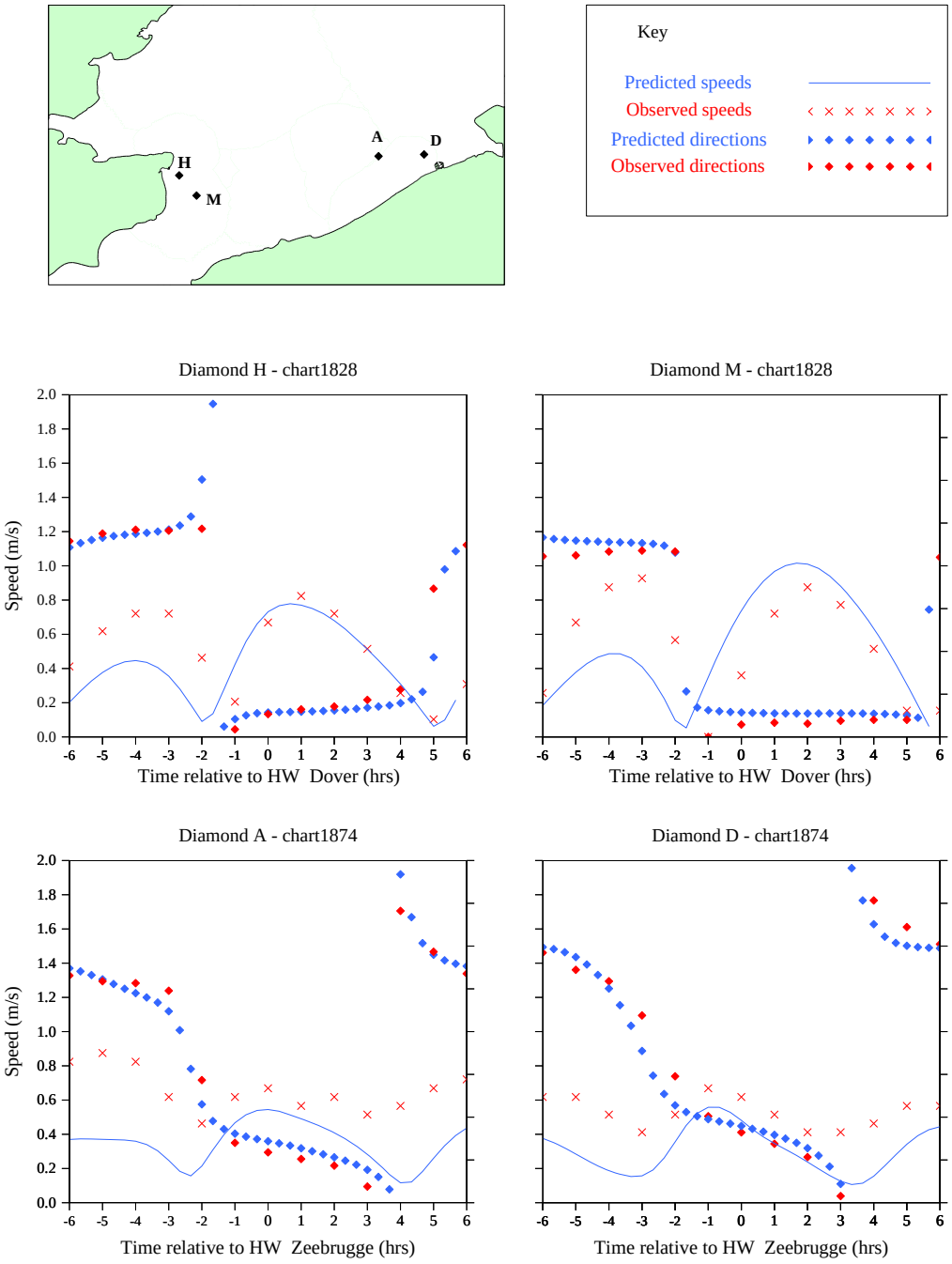

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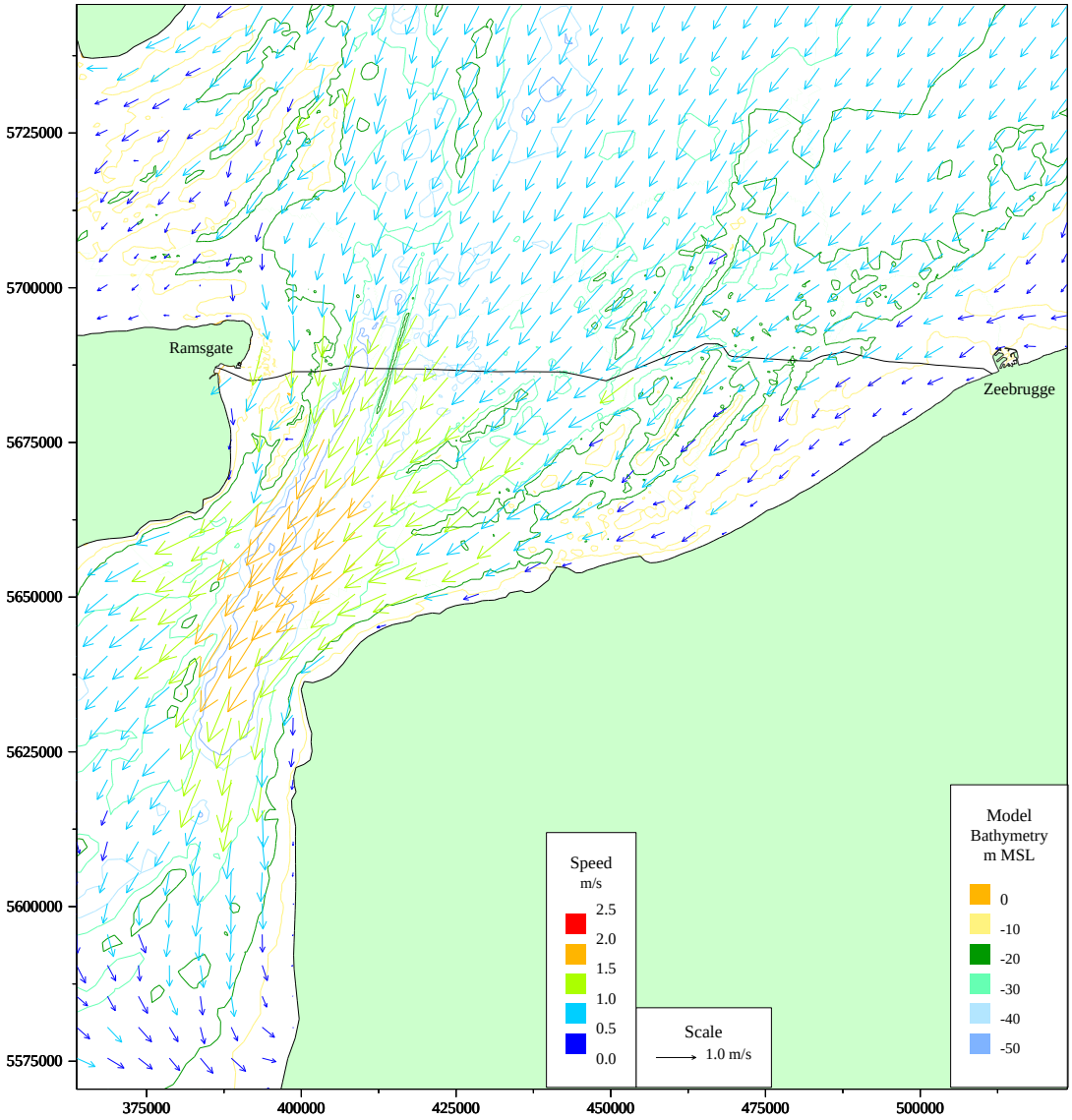
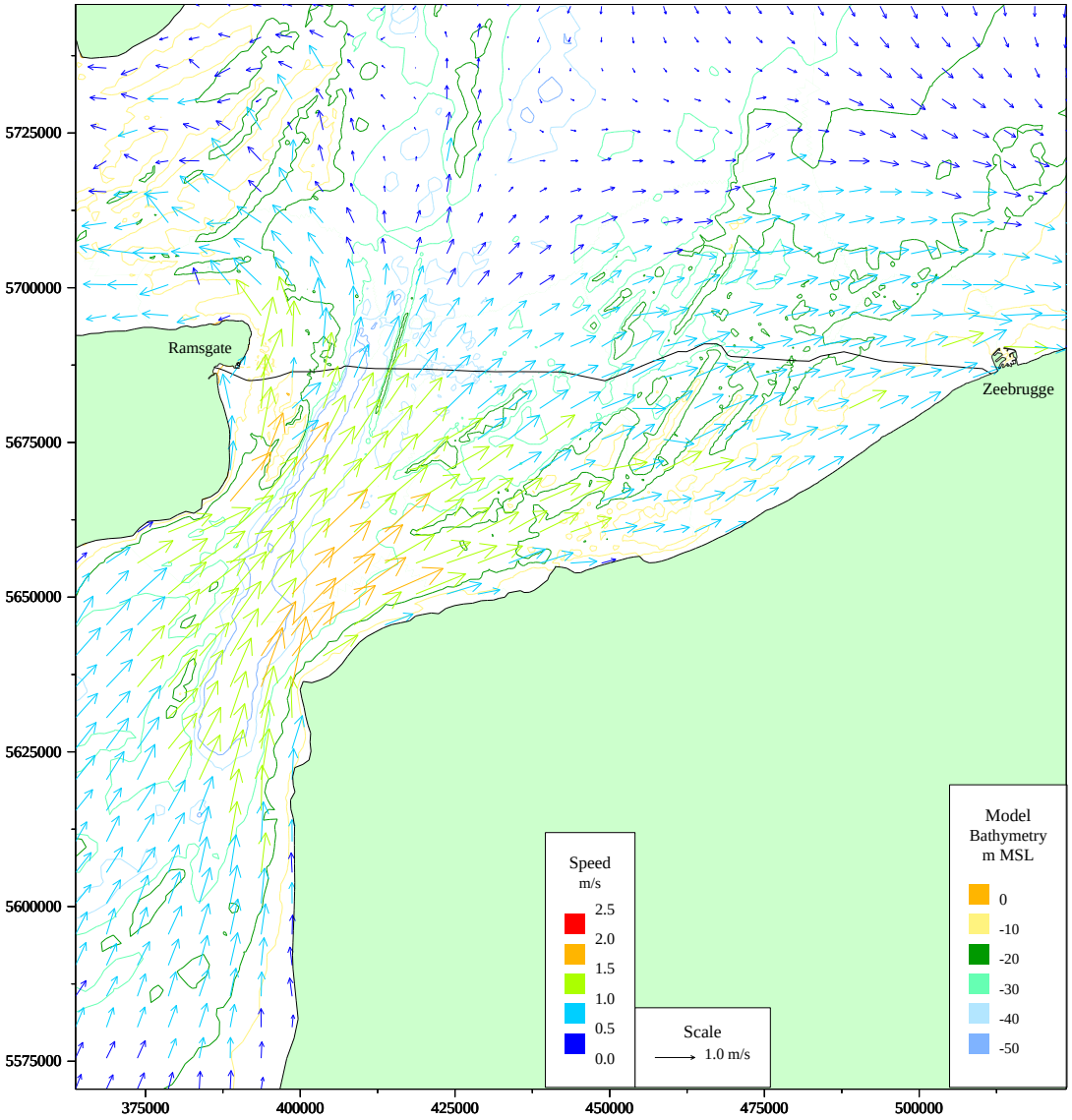
Figure 5b Neap tide observed and simulated currents



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/peak_ebb.i

Figure 6 Peak ebb current – spring tide



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/peak_flood.i

Figure 7 Peak flood current – spring tide

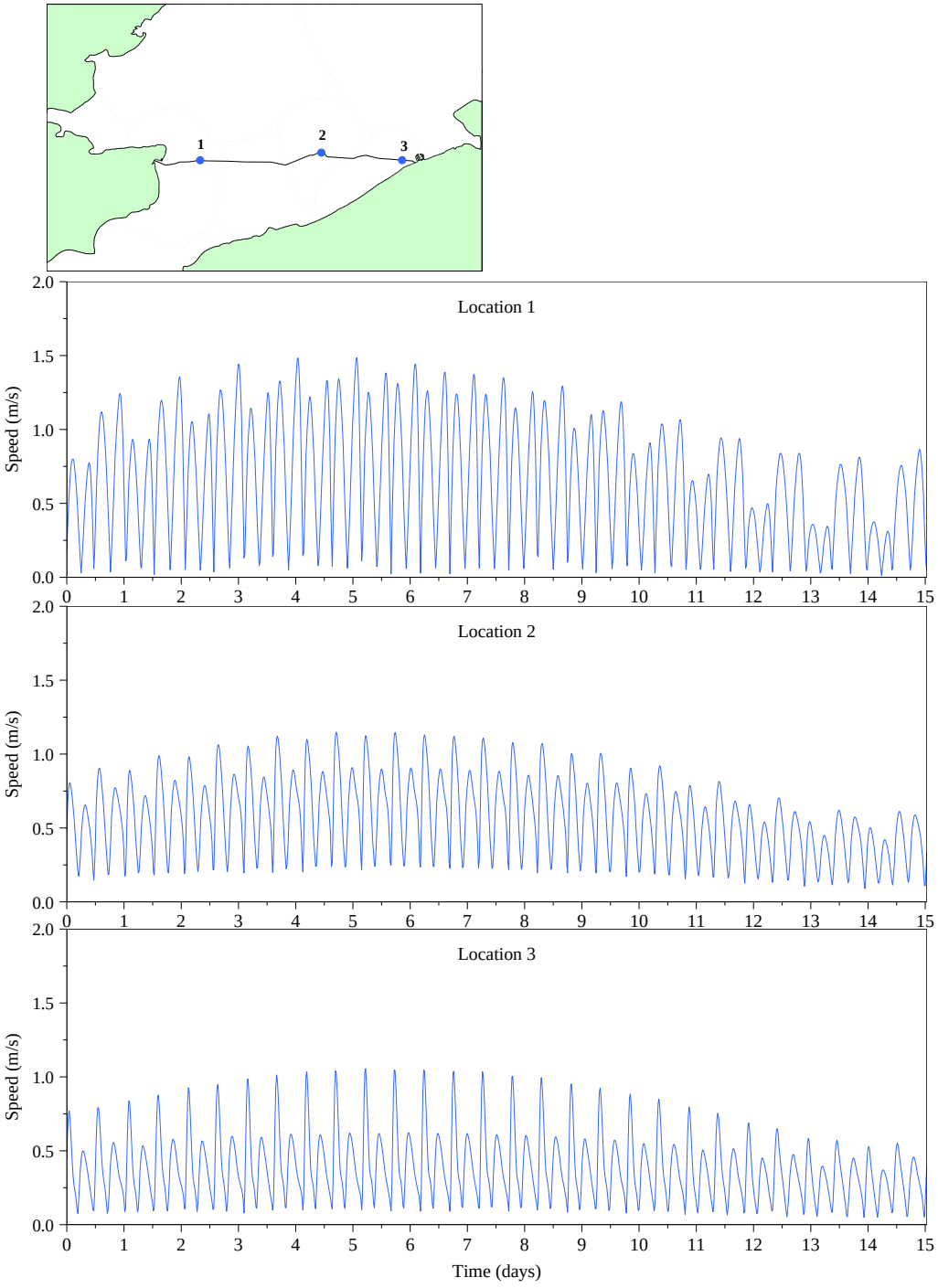


Figure 8 Time series of current speed at three locations for the spring-neap cycle

Project Nemo – UK to Belgium Interconnector

Sand Transport Modelling and Bedform Analysis

Technical Note DDR4633-02

HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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1. Introduction

An assessment of the potential non-cohesive sediment transport patterns in the vicinity of the proposed Project Nemo interconnector cable, between UK and Belgium, was made on the basis of sediment transport simulations over a spring-neap tidal cycle with HR Wallingford's non-cohesive sediment transport model SANDFLOW. This model was driven with simulated tidal flows as reported in Technical Note DDR4633-01 (HR Wallingford, 2011). The sensitivity of the model predictions was assessed for wave stirring effects and modelled grain size. The model results were interpreted to inform assessment of the potential transport patterns that are likely to exist in the area of the cable route.

Additionally, the potential bedform dynamics in the vicinity of the Project Nemo cable route are assessed on the basis of a detailed processing of the bathymetric data along the cable route. The analysis locates bedforms in the bathymetry, determines their shape characteristics wavelength, height, asymmetry and crest orientation. From these characteristics the migration rates that can be expected for these patterns are calculated, indicating the likelihood of future cable exposure.

The results obtained, of which this report forms a record, have been used to inform the preparation of the chapter in the Environmental Statement on Bathymetry and Seabed Processes.

The bathymetry used in the sand transport modelling was the same as reported in the flow modelling (HR Wallingford, 2011). The bathymetry analysis carried out to assess the behaviour of bedforms used the route survey data from 2010 (MMT, 2010).

2. Model coverage

The model domain of the sediment transport model was derived from that of the tidal flow model (shown in Figure 1 and Figure 2) and uses the same mesh and bathymetry over an area extending approximately 75 km north and south of the proposed cable route. Local views of the model domain and of the model mesh, together with the cable route, are shown in Figure 3 and Figure 4, respectively.

The size of the mesh elements varies from the order of 4 km near the northern and south-western boundaries of the domain to about 100 m along the cable route.

The bedform analysis was performed on the bathymetric data of the cable corridor, as provided by the client.

3. Sand transport modelling

3.1 INTRODUCTION

Several sediment transport simulations were carried out to assess the *potential* sediment transport patterns in the vicinity of the cable route. Potential sediment transport rates are the rates that would occur in the case of abundant availability of sediment of the considered median grain size. Actual sediment transport rates may be reduced due to

limited availability or in the case of sediment mixtures where finer fractions are sheltered by coarser fractions. Hence, in the absence of detailed particle size distribution information throughout the model domain, and of suitable data to calibrate the model predictions against, the model results should be seen as indicative and, in particular regarding predicted quantities, should be interpreted whilst keeping these uncertainties in mind.

3.2 SANDFLOW SEDIMENT TRANSPORT MODEL DESCRIPTION

SANDFLOW is the non-cohesive sediment transport model developed by HR Wallingford for use with the TELEMAC system. SANDFLOW uses the flows calculated by a TELEMAC-2D flow model and wave orbital velocities from a TOMAWAC wave model to study the transport, deposition and erosion of non-cohesive (sandy) sediment and thereby identify areas of potential siltation and erosion. Although sand transport in estuaries and marine environments is really an unsteady, 3D problem, it has been shown by HR Wallingford that it can be dealt with using a 2D, depth-averaged model provided provision is made to account for the vertical profile effects of the sediment concentration. Deposition or erosion takes place depending on whether the instantaneous sediment load exceeds or is less than the saturated value.

3.3 SEABED SEDIMENT CHARACTERISTICS

Information on the characteristics and distribution of the seabed sediments over the model domain was available from the desktop study (HR Wallingford, 2010) in the form of a median grain size map of the Belgian Continental Shelf and a sediment type map of the study area (based on data from the British Geological Survey). This information indicates in general terms that gravel and sandy gravel is dominant along the western section of the cable route, with several sandy areas present, and sand is strongly dominant along the eastern section of the route. Along the eastern, sandy section the median sediment grain size decreases from medium to coarse (order 300 to 400 μm) to fine to medium (100 to 200 μm) in eastward direction. The gravels along the western section are likely to have larger median grain sizes (larger than 2 mm).

For the sediment transport simulations described in this Technical Note it was considered that the simplifying assumption of a uniform median grain size (d50) of 400 μm would be justified for the purpose of demonstrating typical sediment transport patterns in the study area. In addition, a sensitivity test was conducted with a smaller median grain size of 250 μm.

3.4 DRIVING FORCES

The model was driven with tidal flows resulting from simulations made with the tidal flow model, which was used to simulate tidal flows over a neap-spring-neap cycle. Hence, the simulated sediment transport patterns are tide-only for this case.

In addition, a sensitivity test was conducted for an exemplary case with moderate waves approaching the study area from the northeast. A wave model was set-up for this purpose, using the same model mesh and bathymetry as the flow model. The wave orbital velocities resulting from the wave model were then input together with the tidal flow fields into the sediment transport model. Strong orbital velocities will stir up sediment that is subsequently advected by the ambient tidal current.

3.5 TOMAWAC WAVE MODEL DESCRIPTION

TOMAWAC is a phase-averaged spectral wave model. It was developed by the National Hydraulics Laboratory (LNH) of the Research and Development Division of the French Electricity Board (EDF-DER) and is part of the TELEMAC finite element hydraulic modelling system. TOMAWAC simulates the transformation of random directional waves considering the processes of wave refraction, shoaling, depth-induced breaking, bottom friction and white-capping.

3.6 MODEL RESULTS

The peak ebb and peak flood flow fields resulting from the tidal flow model are shown in Figure 5 and Figure 6 for a typical spring tide and in Figure 7 and Figure 8 for a typical neap tide.

3.6.1 Tide-only – 400 µm sand

The resulting instantaneous sediment transport patterns assuming abundant, uniform 400 µm sand at the same points in time are shown in Figure 9 and Figure 10 for the spring tide. These figures suggest that the largest potential transport rates occur off the English coast to the south of the cable route and gradually reduce in northward direction. During peak ebb the predicted potential transport rates are further reduced toward the European mainland coastline, whereas during peak flood there is less transport capacity north of the cable route near the English coast and somewhat increased rates along the French and Belgian coastline.

Figure 11 and Figure 12 show the transport patterns for the neap tide on the same scale. With the reduced tidal velocities the model does not predict large transport rates over the ebb phase, whereas during the flood phase some sediment transport potential remains near the Dover Strait.

In addition to the instantaneous transport patterns, the predicted sediment fluxes were integrated over a full tidal cycle to produce residual transport patterns. These are shown in Figure 13 for the spring tide and in Figure 14 for the neap tide. These figures indicate a net southward potential transport along the deeper central area toward Dover Strait and net northward and eastward fluxes along the English and European mainland coastline, respectively, over the spring tide. Over the neap tide the residual fluxes are northward throughout, and are much smaller and limited to the area in the vicinity of Dover Strait.

3.6.2 Tide-only – 250 µm sand

The potential transport patterns predicted for a median grain size of 250 µm are shown in Figure 15 and Figure 16 for the spring tide, and in Figure 17 and Figure 18 for the neap tide, for respectively peak ebb and peak flood flow.

The predicted sediment patterns are rather similar to those predicted for the case with 400 µm sand, whereas the magnitude of the fluxes is increased. The smaller grain size material is more easily entrained by the imposed flow conditions and, therefore, leads to an increase in potential transport.

Similar to the results for the case with 400 µm sand, the simulated sediment fluxes have been integrated over a full spring and neap tidal cycle. The resulting patterns of residual fluxes are shown in Figure 19 and Figure 20, respectively. Comparison of these figures

to those showing the residual fluxes for the coarser material confirm the previously mentioned increase in potential transport magnitude along similar patterns.

3.6.3 Tide and wave-induced stirring – 400 µm sand

The potential impact of wave-induced stirring of seabed sediments has been assessed by carrying out sensitivity tests in which, in addition to the tidal flow fields, a constant wave orbital velocity field has been imposed in the sand transport simulation. Wave orbital velocities cause an additional shear stress at the seabed that may result in additional suspension of mobile sediment present on the seabed.

For the purpose of these sensitivity tests a TOMAWAC wave model was set-up in which an offshore swell wave condition with a significant wave height of 2.0 m, a peak period of 8.0 s and an offshore direction of 135 °N was imposed on the northeastern boundary, considered to represent a fairly frequently occurring wave condition. The resulting field of significant wave height for a steady-state 1.0 m above MSL water level is shown in Figure 21, together with vectors indicating the mean wave direction. Figure 22 shows the corresponding field of wave orbital velocities as predicted by the wave model.

The potential transport patterns predicted for the case with wave orbital velocities and a median grain size of 400 µm are shown in Figure 23 and Figure 24 for the spring tide, and in Figure 25 and Figure 26 for the neap tide, for respectively peak ebb and peak flood flow.

Similar to the results for the case with 400 µm sand and tide-only conditions, the simulated sediment fluxes have been integrated over a full spring and neap tidal cycle. The resulting patterns of residual fluxes are shown in Figure 27 and Figure 28, respectively. Comparison of these figures to those showing the residual fluxes for the tide-only case (Figure 13 and Figure 14) suggests that, for the wave conditions considered, the effect of the wave orbital velocities on the sediment transport magnitudes and patterns is limited. Some differences can be identified near the English coastline and on the Flemish Banks where, as expected, the limited water depth leads to some influence of the wave orbital velocities on the potential sediment transport.

3.6.4 Tide and wave-induced stirring – 250 µm sand

A second simulation, using the same wave orbital velocity field as described in Section 3.6.3, was carried out for a median grain size of 250 µm. The potential transport patterns predicted for this case are shown in Figure 29 and Figure 30 for the spring tide, and in Figure 31 and Figure 32 for the neap tide, for peak ebb and peak flood flow respectively. The corresponding patterns of residual fluxes are shown in Figure 33 and Figure 34, respectively.

When compared to the results of the simulation with wave stirring and a median grain size of 400 µm, it is seen that qualitatively the predicted sand transport patterns for peak ebb and flood flow for both the spring and neap tide conditions are the same, however, transport rates are somewhat larger. Within the area nearer the European mainland coastline where a smaller grain size of 250 µm is likely to be more representative, this increase along the proposed cable route is particularly apparent over the spring tide, during peak ebb conditions and, as a result, also in the residual sand transport pattern for spring tide conditions (shown in Figure 27 for 400 µm and Figure 33 for 250 µm).

Comparison of the model results of the simulations for a median grain size of 250 μm with tide and waves (Figure 29 through Figure 34) to those for tide-only conditions (Figure 15 through Figure 20) reveals only small differences in the predicted sand transport patterns and rates. These differences are generally found in shallow areas where tidal flow velocities are relatively small. This indicates that for this median grain size sand transport is dominated by the tidal flow, and that enhancement of transport rates due to wave stirring is limited to shallow areas (sandbanks and near the shoreline) where waves dissipate and/or break whilst tidal flow is limited.

4. Bedform analysis

Large scale bedforms on the seabed increase the probability of exposure of cables and pipelines buried in the seabed. Most of these bedforms are non-stationary. Even though the displacement happens slowly at a migration rate of a few meters per year, crest locations at the time of installation may change to become a trough location over the lifetime of the buried cable. This may cause a lowering of the bed of several meters.

An assessment of the potential bedform dynamics in the vicinity of the Project Nemo cable route was made on the basis of a detailed analysis of the bathymetric data along the route. The analysis locates bedforms in the bathymetry, determines their shape characteristic wavelength, height, asymmetry and crest orientation. From these characteristics the migration rates that can be expected for these patterns are calculated.

Based on the migration rates, suggestions are made about mitigation options to prevent cable exposure.

4.1 APPROACH

Knaapen (2005) and Knaapen et al. (2006) were the first publications describing the analysis of large sets of multi-beam bathymetric data to determine the characteristics of offshore bed forms: sandwaves and mega-ripples, respectively. To enable large datasets to be analysed an automated approach was used and this leads to the required level of information on the bedforms where they exist in the bathymetry dataset. Here, the published approach is extended to include a measure for the sand volume within the profile, which is also a measure for the crest-trough asymmetry, and crest orientation. Additionally, the method of height estimation presented by Knaapen (2005) is improved to give a more accurate estimate.

4.1.1 Crest orientation

The first step in the analysis of the bedforms is to determine their orientation, here defined as the direction perpendicular to the crest line. The orientation is determined based on the gradients in the bathymetry, following the approach of Bazen and Gerez (2002). They determined orientation of ridges on grey-scale fingerprints, but the same principles are valid for bedforms in bathymetric data. This approach is based on the principle that in regular rhythmic patterns the steepest gradient is perpendicular to the direction of the crests. The orientation angle φ between the gradient vector and the x-axis is defined as:

$$\varphi = \tfrac{1}{2}\,\mathrm{atan}\left(\frac{2\,G_{xy}}{G_{xx} - G_{yy}}\right) + \varphi_c \qquad (1)$$

in which (x, y) are the coordinates of every measurement point and G_{ij} is the product of the gradient in direction i and the gradient in direction j:

$$\begin{aligned} G_{xx} &= \left(\frac{\partial z}{\partial x}\right)^2 \\ G_{yy} &= \left(\frac{\partial z}{\partial y}\right)^2 \\ G_{xy} &= \frac{\partial z}{\partial x}\frac{\partial z}{\partial y} \end{aligned} \qquad (2)$$

where z is the measured bed level and φ_c is a correction to adjust for the fact that areas on opposite sites of the crests have opposing gradient vectors:

$$\begin{aligned} \varphi_c &= \pi \;\forall G_{xx} - G_{yy} < 0 \;\&\; G_{xx} - G_{yy} \geq 0 \\ \varphi_c &= -\pi \;\forall G_{xx} - G_{yy} < 0 \;\&\; G_{xx} - G_{yy} < 0 \\ \varphi_c &= 0 \;\forall G_{xx} - G_{yy} \geq 0 \end{aligned} \qquad (3)$$

If one applies this algorithm to the matrix containing the seabed bathymetry, it produces an array of local estimates of the orientation of the smallest bedform. Therefore, one has to smooth the bathymetric data removing all bedforms smaller than the bedform of interest. A window size that is about half the wavelength of the targeted bedform gives reliable and robust results.

The calculation of the orientation using equation (1) seems rather cumbersome compared to the straightforward estimate with the tangent of the gradients in x and y direction. However, with the tangent of the gradients, averaging gives the problems that opposing vectors average out to zero which is avoided when using equation (1).

Once the orientation of the bed forms is known, determination of the other shape characteristics along crest-normal profiles can be undertaken.

4.1.2 Determining the crest and trough positions

Based on the orientation, the bathymetric data is interpolated to a regular orthogonal grid with the main axis perpendicular to the mean crest direction (parallel to the mean orientation of the bedforms. Taking the profiles in the direction of the bedform orientation, which is normal to the crests, the crest and trough positions in bedforms are identified following an improved approach to the one proposed by Knaapen (2005).

In that approach, the bathymetry is smoothed using weighted averaging in which the weight reduces linearly with distance (Bartlett window). The size of this window is dependent on the typical wavelength of the targeted bedform. It should be considerably less than this wavelength but larger than the typical size of smaller bedforms. A window size that is about half the wavelength of the targeted bedform gives reliable and robust results.

The crests and troughs are then defined as the highest and lowest points in the profiles of the smoothed profiles. The weighted averaged smoothing leads to an underestimation of the crest position, especially in case of sharp crested sandwaves. In the new approach, a fourth order polynomial is fitted through the original measurements that are in the

neighbourhood of the extreme points in the smoothed profile. Once the crest and trough positions are known, they are analyzed to retrieve information on the wavelength, height and asymmetry. Although the definition of these characteristics is straightforward, to calculate them from the observed crests and troughs requires making a few assumptions.

4.1.3 Wavelength

The distance between the trough positions on both sides of the crest (x_1, x_2) determines the length of the bedform L:

$$L = | x_2 - x_1 | \cos(\alpha) \tag{4}$$

With α being the angle between the mean crest orientation and the direction of the profiles.

4.1.4 Height

The height H is defined as the difference between the crest levels z_c at location x_c and the line through the neighbouring trough levels (x_1, z_1) and (x_2, z_2).

$$H = z_c - \frac{z_1(x_c - x_2) + z_2(x_c - x_1)}{L}\cos(\alpha) \tag{5}$$

The height of the pattern is here defined as the height of the envelope resulting from a linear interpolation of the crest and trough levels. This results in heights that are equal to the difference between a crest level and the mean level of the neighbouring troughs weighted by the distance between those troughs and the crest. Using this weighted value, the method is valid for bed forms on arbitrary sloping surfaces, whereas more straightforward averaging of the two trough levels will cause errors for asymmetric waves on a sloping mean surface. For superimposed bed forms it is important to avoid such errors.

4.1.5 Lee-stoss asymmetry

The lee-stoss asymmetry A is defined as the difference of the distance between the trough south of the crest and the distance between the crest and the trough north of the crest divided by the wavelength:

$$A = \frac{L_2 - L_1}{L} \tag{6}$$

Following this definition, a perfect symmetric wave has an asymmetry value A=0. A positive asymmetry value denotes a wave with the steepest side facing North.

4.1.6 Migration rate

The migration rate c can then be estimated using the predictive formula of Knaapen (2005), which has been verified for a number of locations in the North Sea:

$$c = 9.78 \cdot 10^{-4} \frac{L^2}{H} A|A| \tag{7}$$

4.2 RESULTS OF BEDFORM ANALYSIS

The approach of section 4.1 has been applied to the data available for the project (MMT, 2010).

The results of the bedform analysis are averaged over half a kilometre stretches along the profile. In the bathymetry two types of bedforms can be distinguished. Both the mega-ripples and the sandwaves show up in the histograms of the median wavelength per stretch (Figure 35), represented by a peak at about 75 m and between 150-175 m, respectively. The majority of the bedforms have heights less then 2 m (Figure 36), but distinct peaks are visible around 4 m, 5 m and 6 m.

4.2.1 Height

The analysis shows the presence of bedforms for most of the cable route. However, for the majority of the route, the mean height is below 1 m. Higher bedforms are found (Figure 37) between Easting 428 km and 432 km, around 436 km between 438 km and 445 km (Sandettie), between 450 km and 453 km (Fairy Bank), around 459 km (West-Hinder) and around 472 km (Kwintebank). Bedforms with a mean wave height above 2 m are found between Eastings 441 km and 456 km, near 459 km and near 480 km (Middelkerke Bank).

However, as Figure 38 shows, the maximum observed bedform heights along the cable route can be significantly higher than the mean height. Especially between 428 km and 430 km, individual bedforms reach up to 8 m high, in an area where the mean height is below 2 m. Other individual high bedforms are found around 422 km, 451 km (Fairy Bank), and 469 km (Kwintebank).

4.2.2 Wavelength

The wavelength of the bedforms ranges from 50-100 m in the west up to Easting 435 km, apart from a short stretch east of 402 km (Figure 39). From 435 km eastward, the pattern is more patch, with bedforms longer than 200 m between 435 km and 445 km, around 450 km, between 460 km and 465 km and around 478 km. Wavelengths between 200-250 m can be seen from 470 km to 475 km (Kwintebank) and around 455 km. All other locations show shorter bedforms.

4.2.3 Orientation

The orientation of the bedforms varies between an east-west alignment of the crests in the west (90^o in Figure 40) to west-northwest to east-southeast aligned crests (up to 120^o in Figure 40) in the centre and the east. For the majority of the cable route this implies that the route is oblique to the bedform crests.

4.2.4 Migration rate

The migration estimates for most of the observed bedforms is well below 1 m per year (Figure 41). The bedforms are quite symmetric, which means that their location is stable and does not change much. However, on several locations there are short stretches where moving bedforms are predicted: 400 km to 405 km, 416 km (South Falls), 420 km to 425 km, 436 km (Sandettie), 450 km (Fairy Bank), 453 km, 461 km to 463 km (West-Hinder), 470 km (Kwintebank) and the area east of 480 km.

5. Sandwave recovery from trenching

Few data are available describing the recovery of the bed after trenching through a sand wave crest. However, a good indication of the trench infill for such a case is published by Knaapen et al. (2006). They use data from a navigation channel monitoring program to evaluate the dynamics of a trench through a sandwave in the approach to Rotterdam Harbour. The sandwave was 5 m high in a mean water depth of 32 m. The trench reached all the way down to the trough levels of the sandwave. The trench had disappeared almost completely within the first year, leaving little or no evidence of the presence of a trench.

Being only a few tens of kilometres more to the south, there is little reason to suspect that the trenching for Project Nemo through the sandwave crests will recover any slower than in this location.

6. Discussion

The approach to understanding the sediment dynamics along the Project Nemo cable route has combined predictive computational modelling of sand transport and the analysis of bedforms identified in the 2010 route survey. The results have been used to inform preparation of the chapter in the Environmental Statement on Bathymetry and Seabed Processes.

6.1 SAND TRANSPORT MODELLING

The model results presented are indicative of the potential sediment transport patterns along the cable route. Limited availability of the sediment simulated would reduce the expected transport rates. For example, given that the largest sediment fluxes are predicted in areas where the available sedimentological information indicates gravel and sandy gravel to be present, it would be likely that actual transport is (much) lower than that predicted by the model. Similarly, if finer material than simulated is available and this finer fraction is not sheltered by coarser fractions, rates could be larger.

Keeping the uncertainties of the horizontal distribution of available mobile sediment and the inherent uncertainties associated with state-of-the-art sediment transport modelling, the presented model results provide an indication of the likely sediment transport patterns under the imposed flow conditions in a qualitative manner.

Given that the median sediment grain size along the European mainland coastline is generally smaller than that in the deeper areas and along the English coast, the results of the simulations with the smaller grain size of 250 μm could be more representative in that area, whereas the model results based on the coarser 400 μm sand would be a better indication for potential sediment transport along the English coast. Based on the apparent presence of coarser gravels in this area would suggest transport rates will be smaller than those presented.

Comparison of the sediment transport patterns predicted by the model for the cases with and without the imposed wave conditions suggests that the sediment transport pattern is largely tide-dominated for both simulated median grain sizes, albeit that localised effects are seen near the English coast and the Flemish Banks along the European mainland coast.

6.2 BEDFORM ANALYSIS

In general, the migration rates for the bedforms are estimated to be low as the overall pattern of sandbanks and associated bedform patterns are broadly stable and non-migratory. However, individual bedform crests might still move significantly related to changes in crest bifurcations and/or crest end positions.

The location of the most dynamic bedforms coincides with the locations of the (tails of the) tidal sandbanks in the area. These locations are notoriously dynamic, with large fluctuating residual transport patterns. This explains the high likelihood of moving bedforms and the size of the bedforms.

The locations where the cable route passes the sandbank tails are covered with dynamic bedforms. In these areas, maximum care should be taken to determine the cable installation profile as the probability of cable exposure during its lifetime is high.

Away from the sandbanks, the patterns appear stable with little bedform migration. The probability of exposure due to bedform movement is much lower in these areas. However, there is still a possibility of individual moving crests, so any part of the cable that is above the local trough levels may be exposed. The benefit to be gained from burying the cable much deeper than local trough level will need to be evaluated on cable protection grounds.

6.3 SANDWAVE RECOVERY FROM TRENCHING

There is little published information about the recovery of sandwaves after sweeping with a dredger. The only surveys from scientific publications show that the trench disappeared within a year (Knaapen, *et al.*, 2006). However, it is not possible to determine from this data whether the trench filled over days, weeks or months.

7. References

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Figures

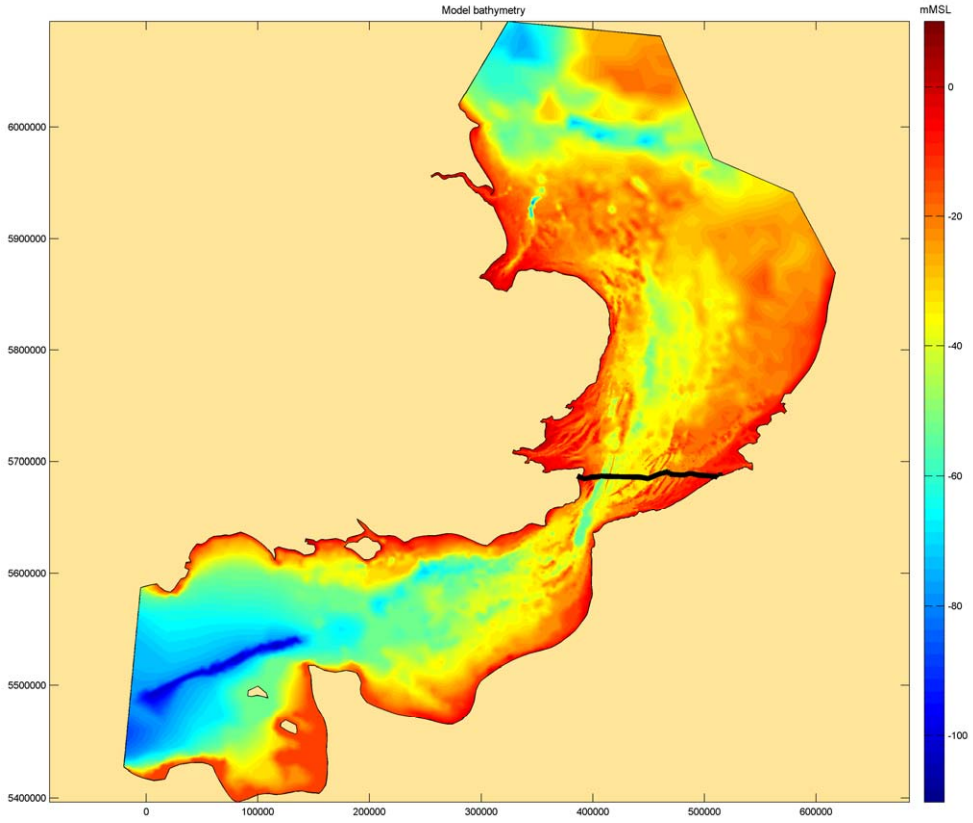

Figure 1 Model bathymetry (Project Nemo cable route indicated by black line)

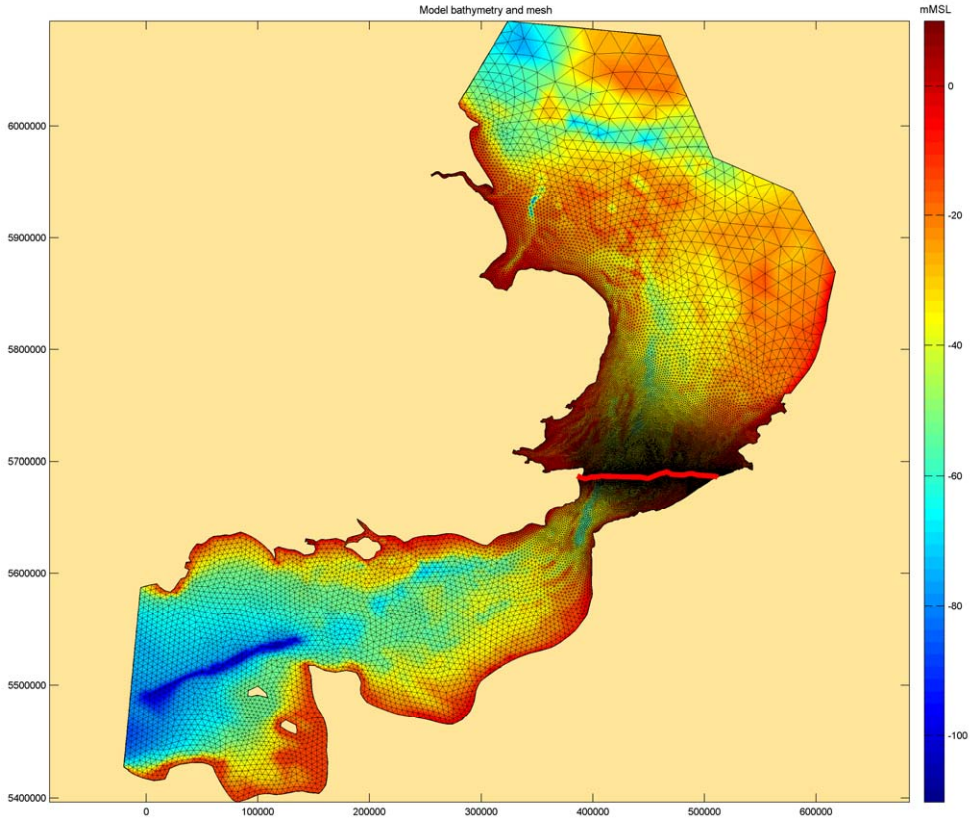

Figure 2 Model bathymetry and mesh

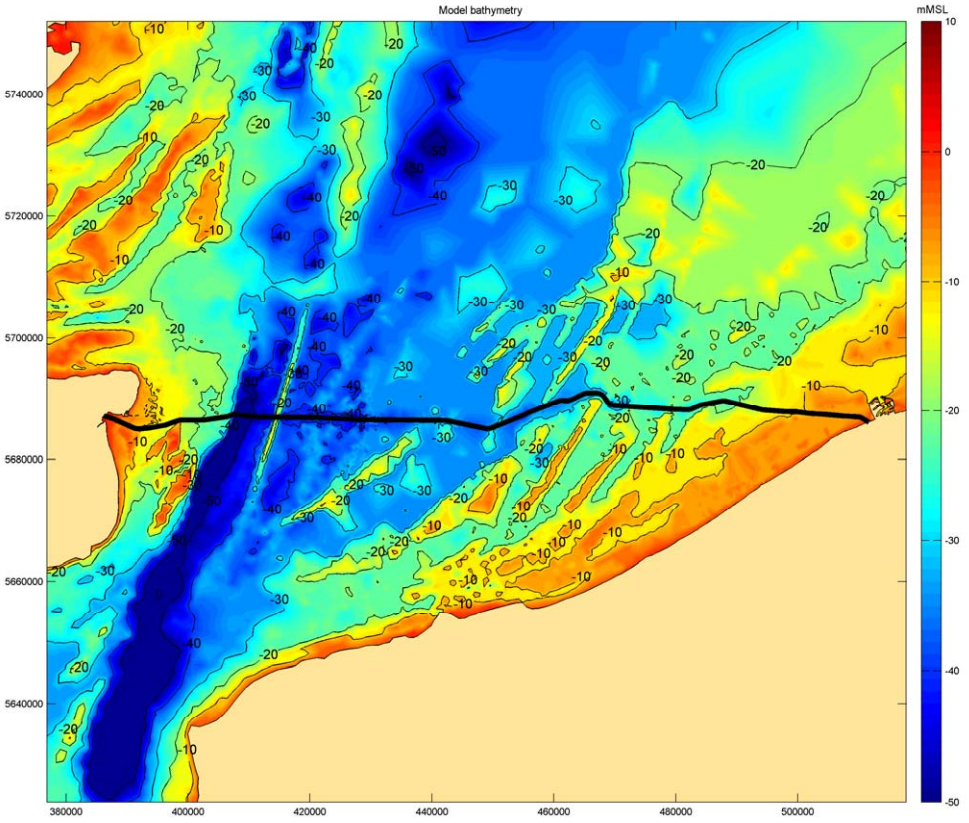

Figure 3 Model bathymetry – near cable route (black line)

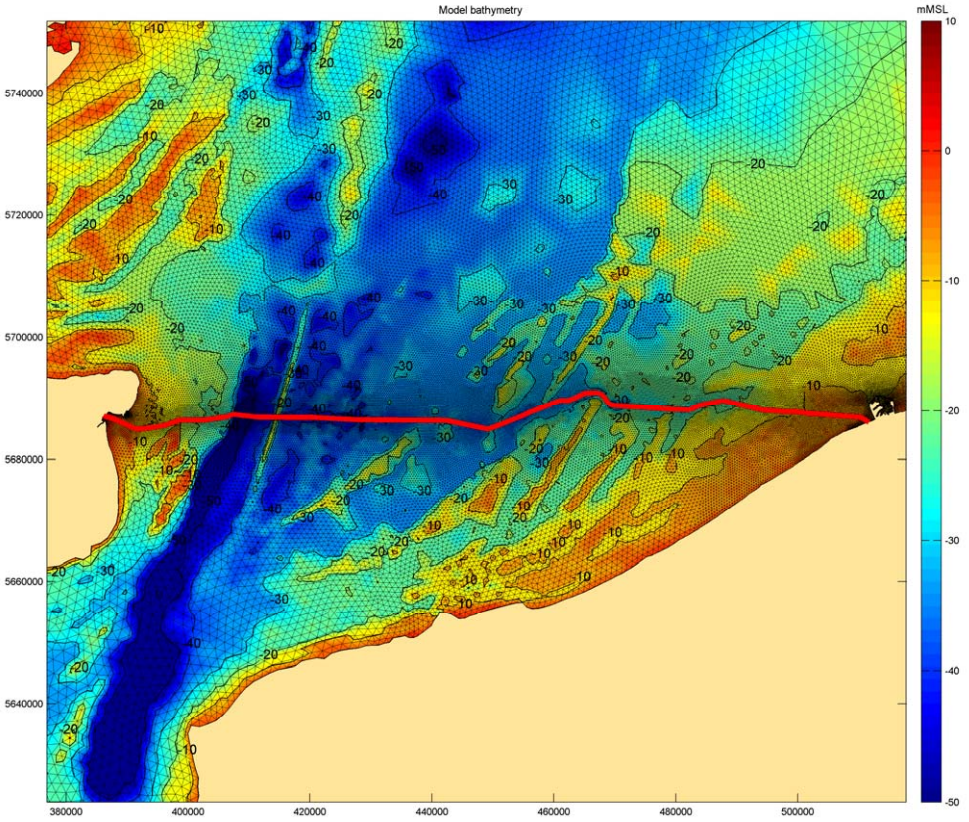

Figure 4 Model bathymetry and mesh – near cable route

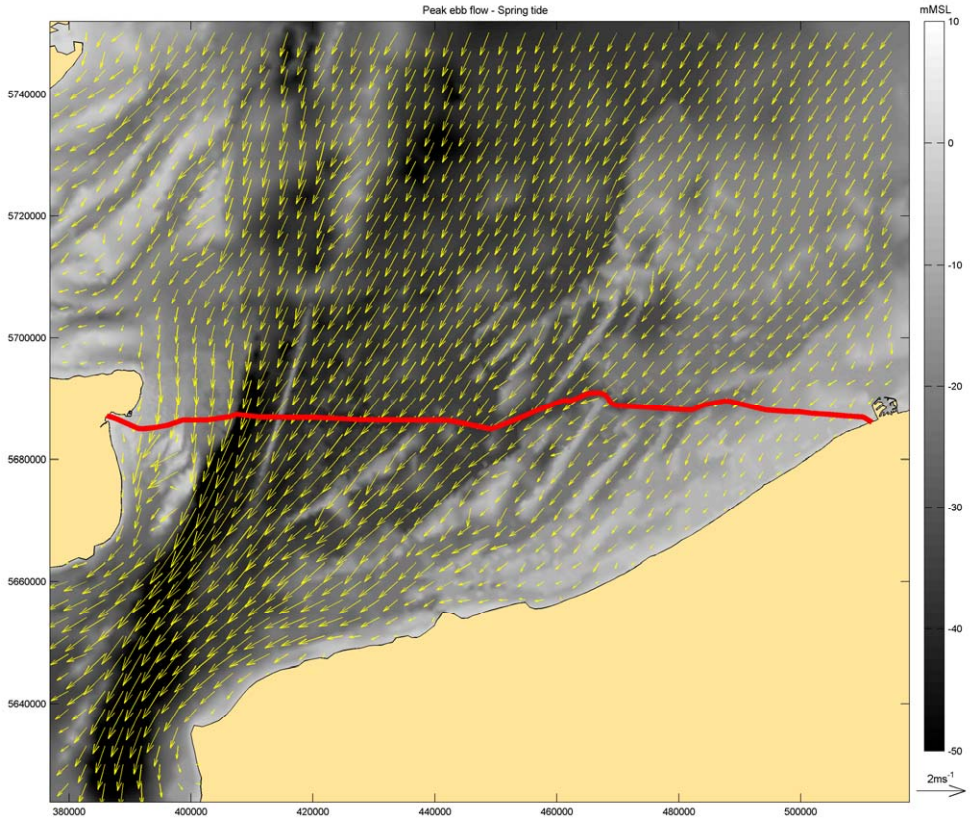

Figure 5 Peak ebb flow velocities (m/s scaled on vector length) – Spring tide

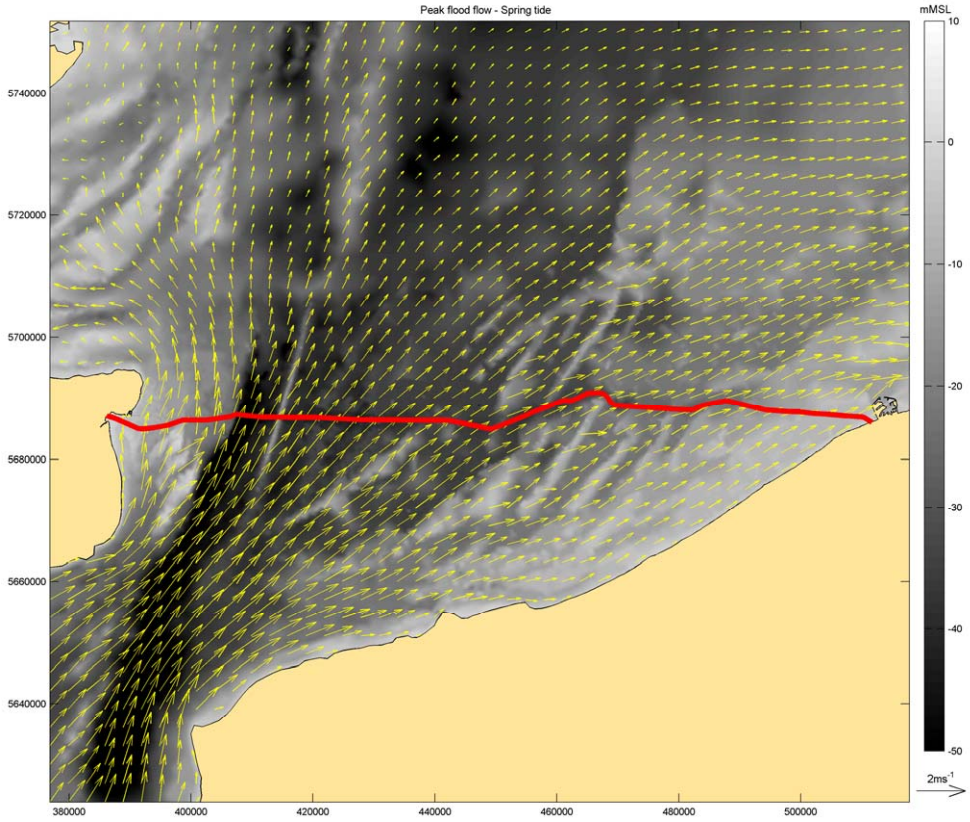

Figure 6 Peak flood flow velocities (m/s scaled on vector length) – Spring tide

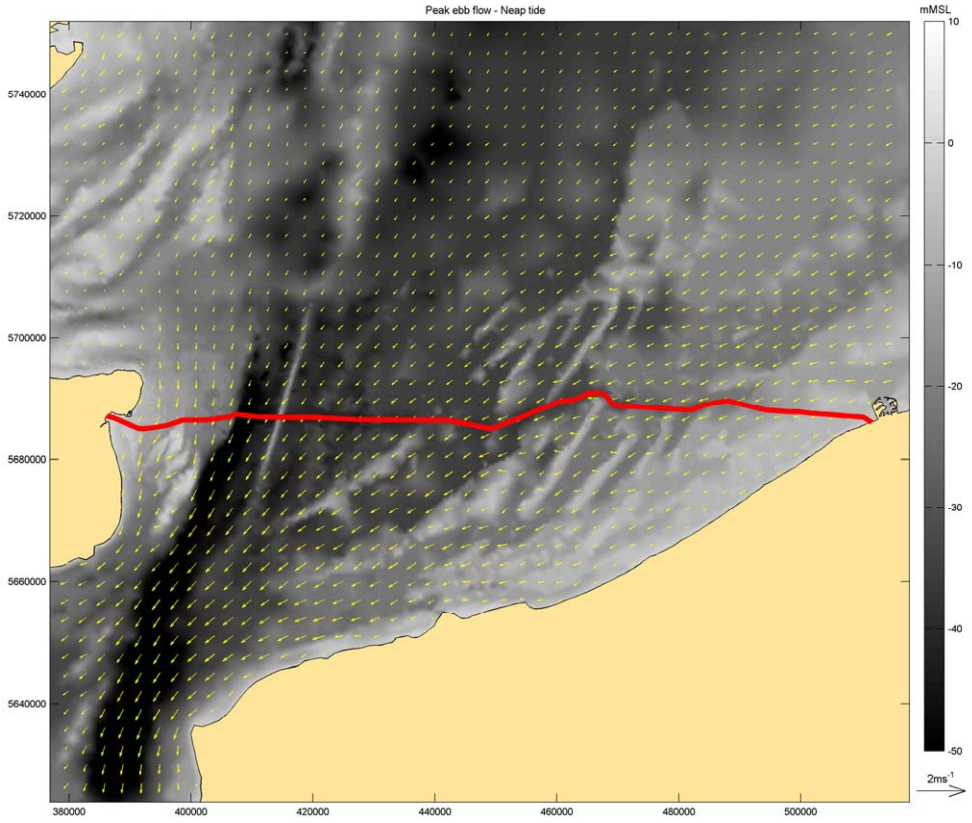

Figure 7 Peak ebb flow velocities(m/s scaled on vector length) – Neap tide

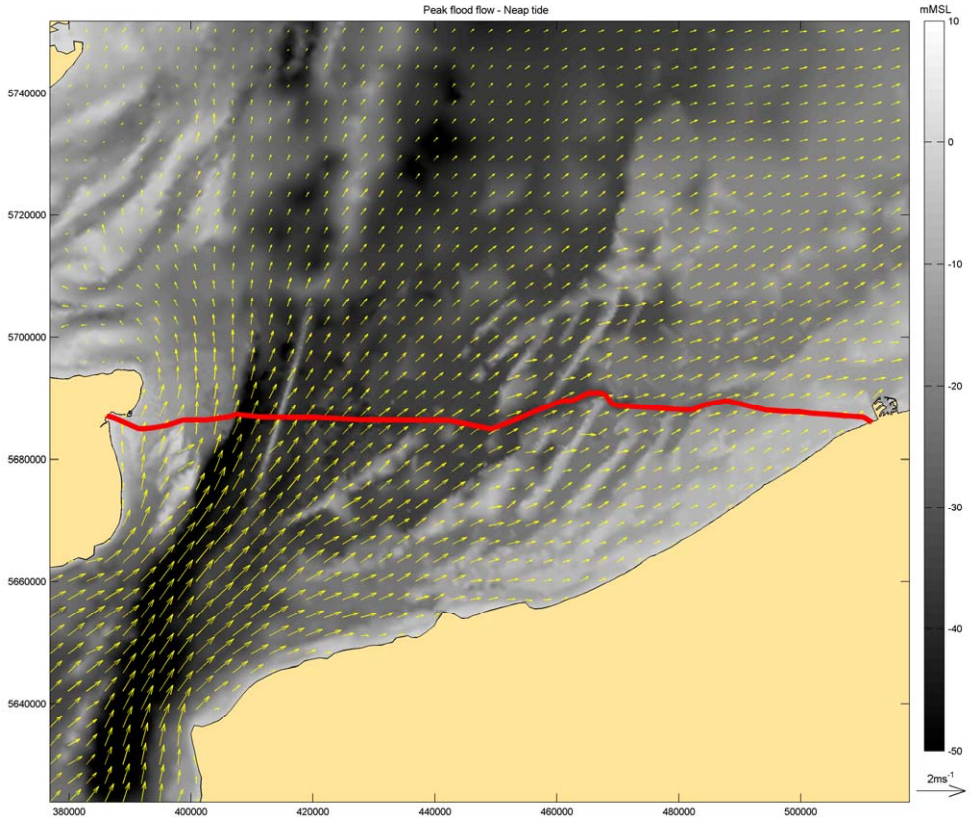

Figure 8 Peak flood flow velocities (m/s scaled on vector length) – Neap tide

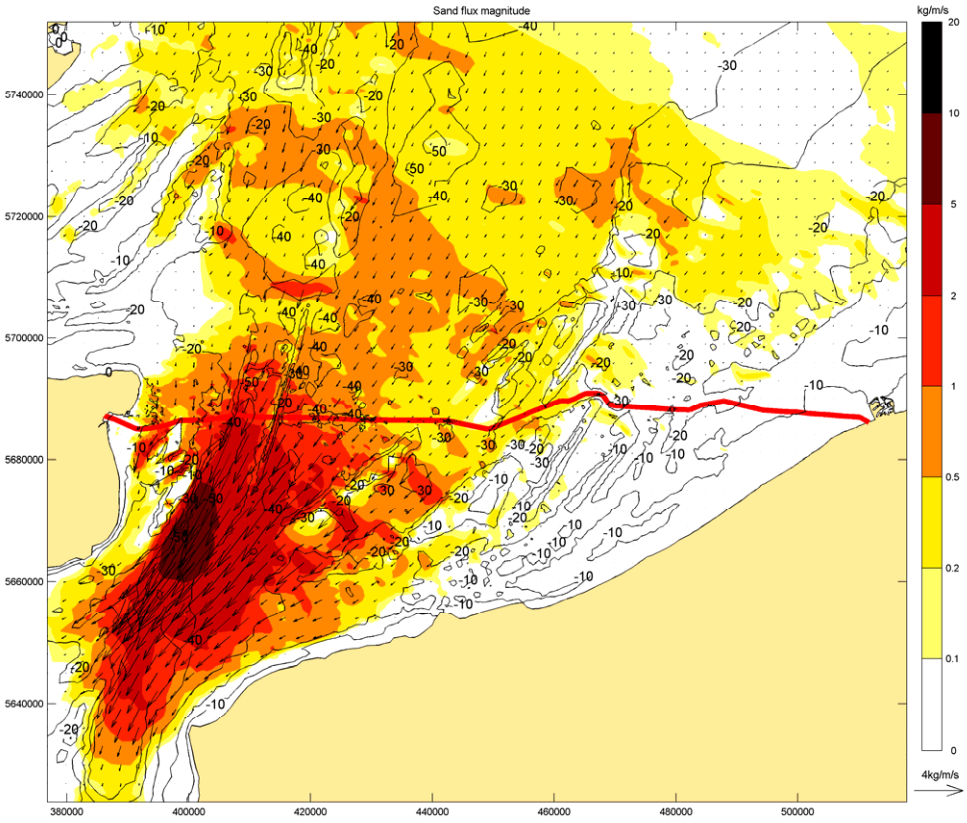

Figure 9 Peak ebb sand transport rates – Spring tide, 400 µm sand

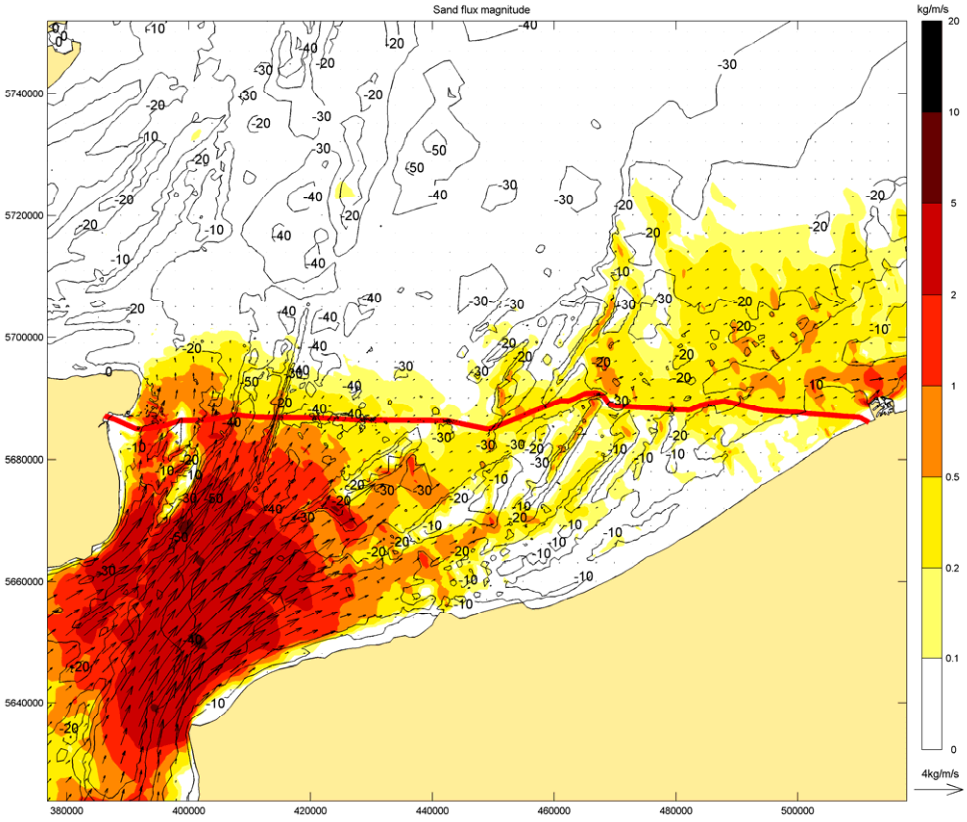

Figure 10 Peak flood sand transport rates – Spring tide, 400 µm sand

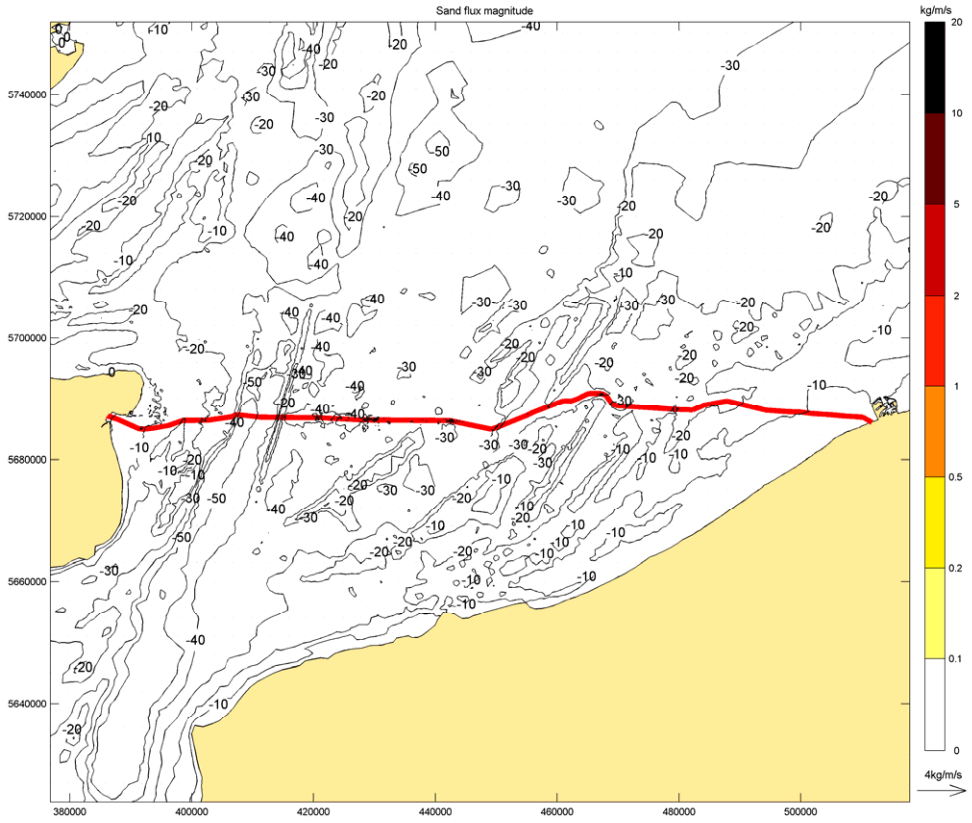

Figure 11 Peak ebb sand transport rates – Neap tide, 400 µm sand

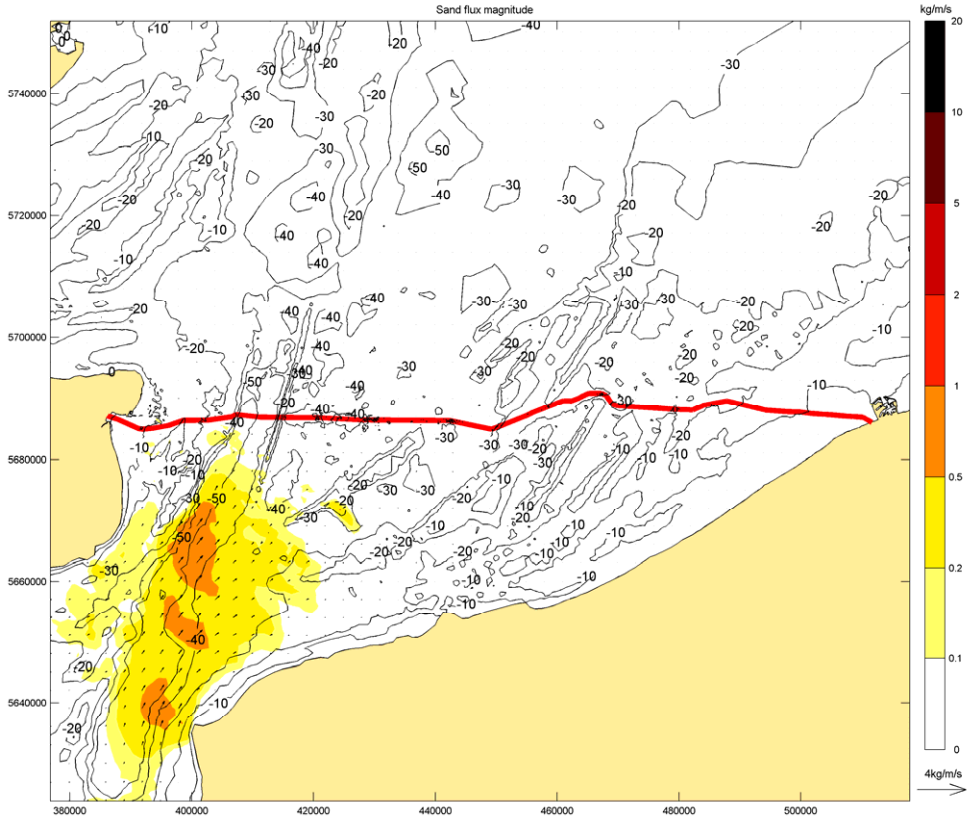

Figure 12 Peak flood sand transport rates – Neap tide, 400 µm sand

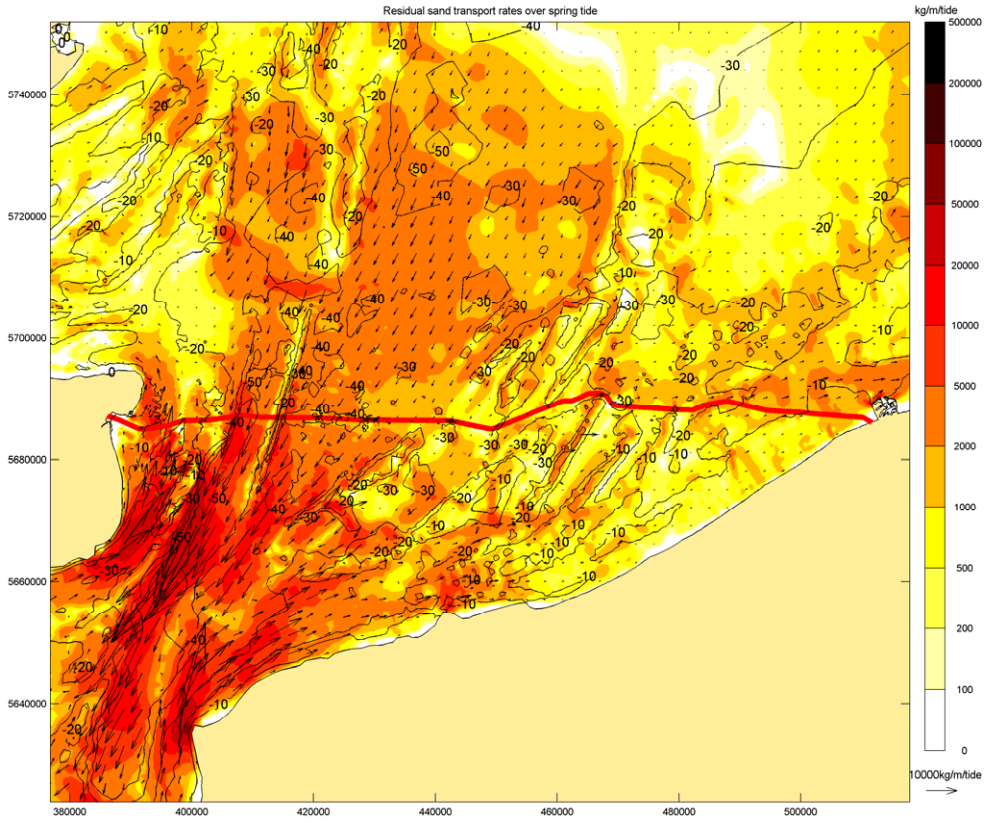

Figure 13 Residual sand transport rates over Spring tide – 400 µm sand

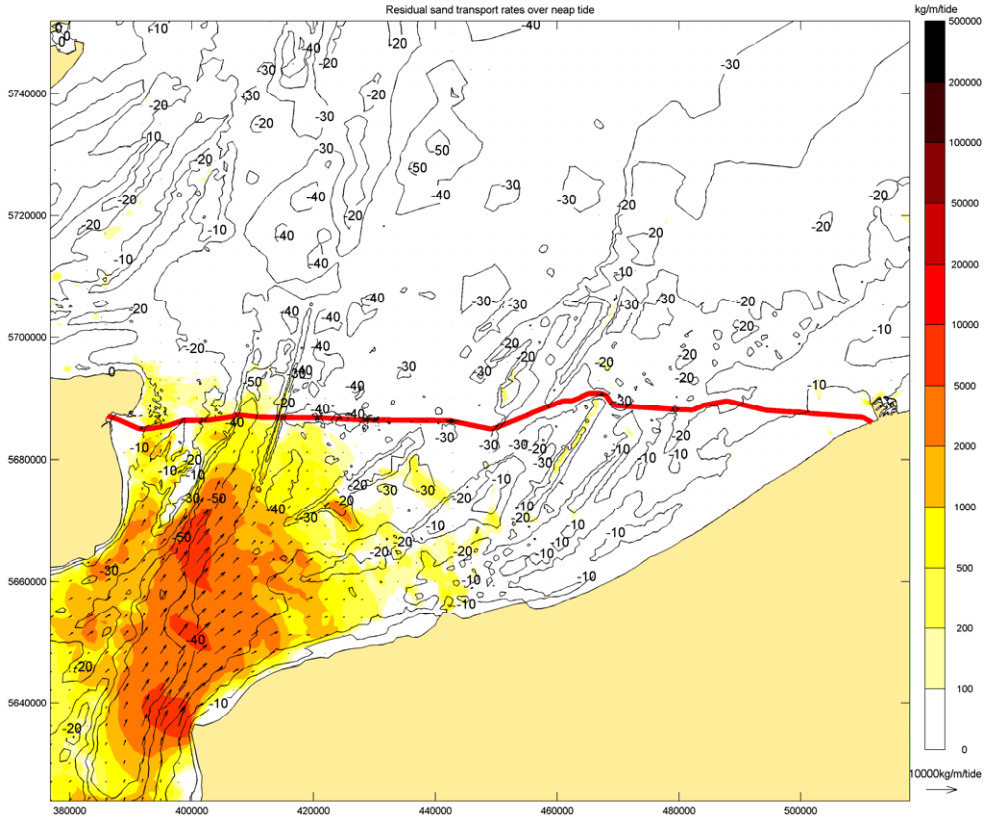

Figure 14 Residual sand transport rates over Neap tide – 400 µm sand

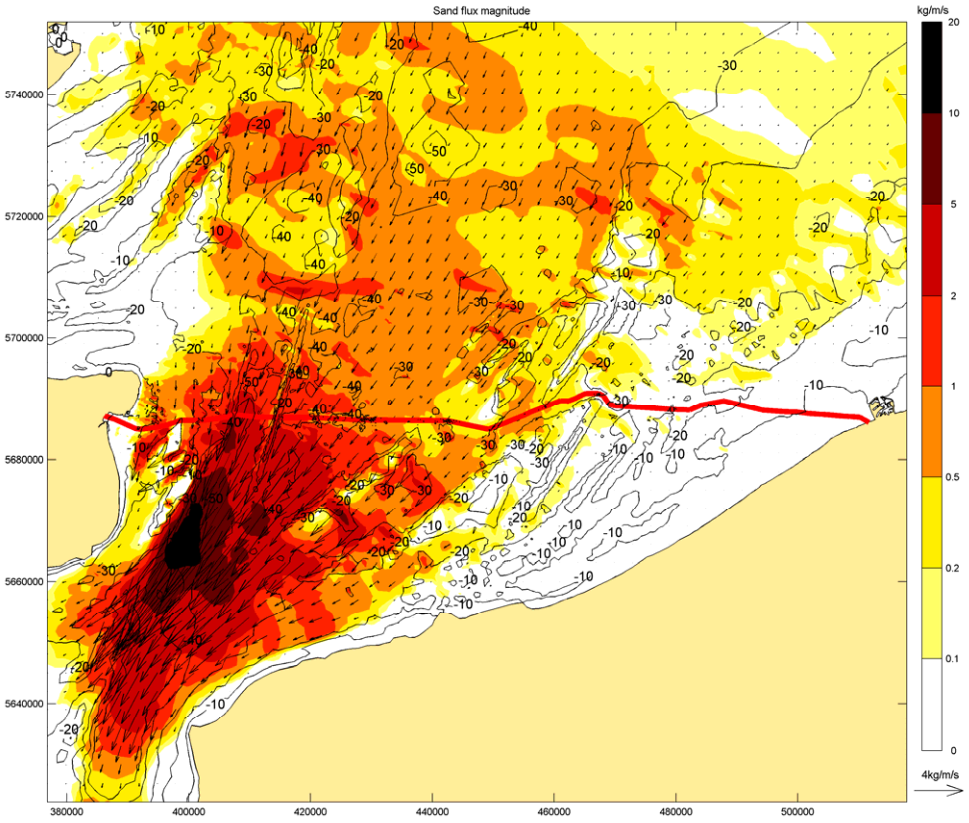

Figure 15 Peak ebb sand transport rates – Spring tide, 250 µm sand

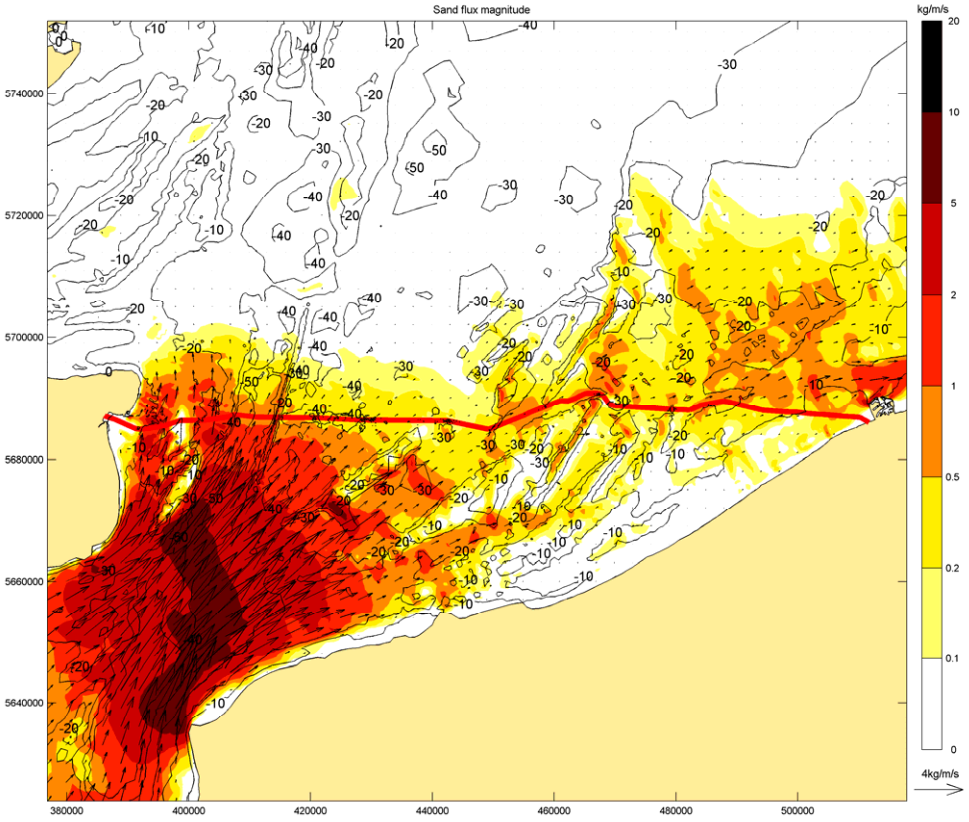

Figure 16 Peak flood sand transport rates – Spring tide, 250 µm sand

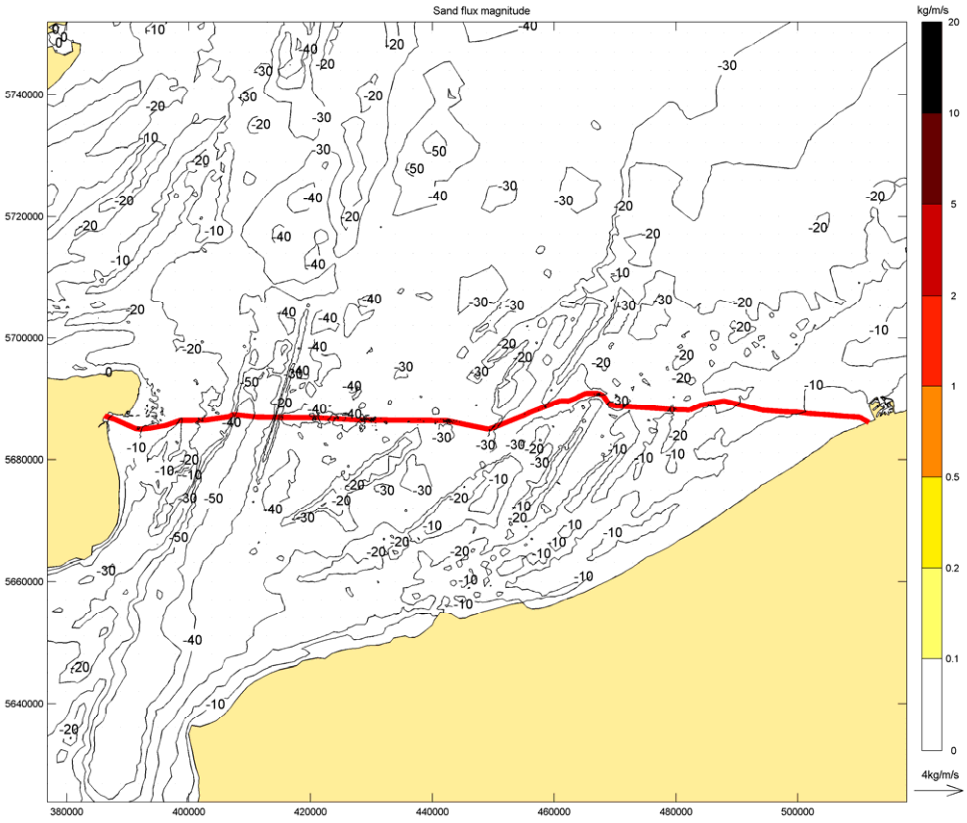

Figure 17 Peak ebb sand transport rates – Neap tide, 250 µm sand

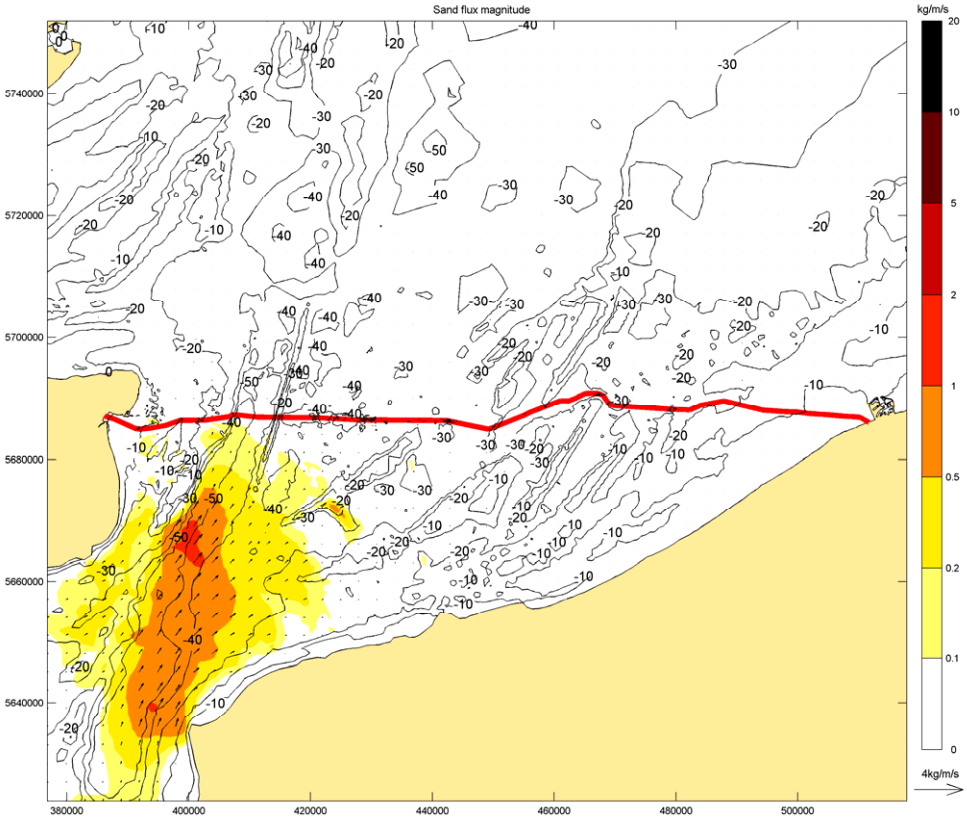

Figure 18 Peak flood sand transport rates – Neap tide, 250 µm sand

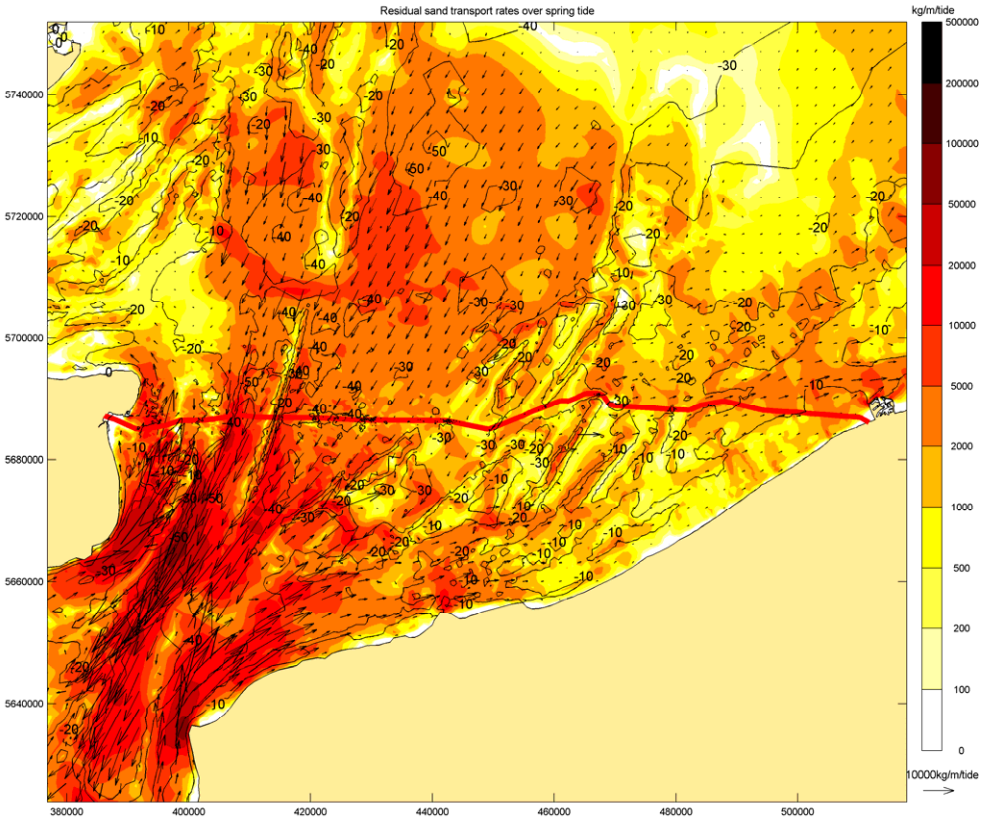

Figure 19 Residual sand transport rates over Spring tide – 250 µm sand

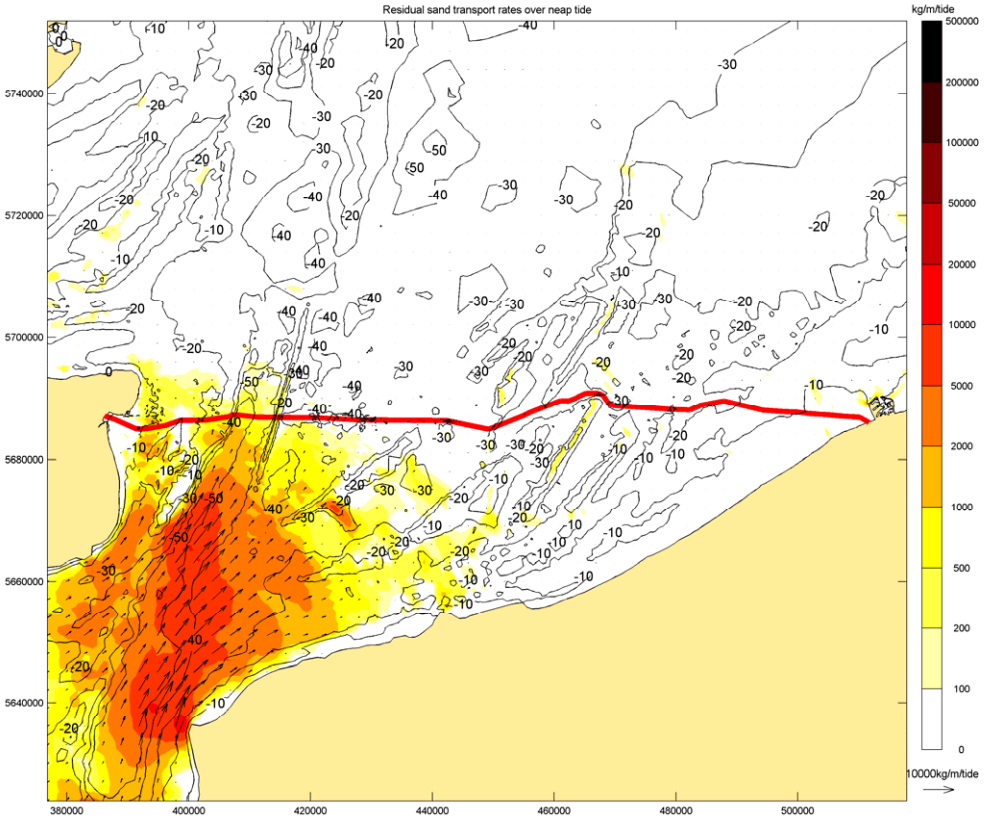

Figure 20 Residual sand transport rates over Neap tide – 250 µm sand

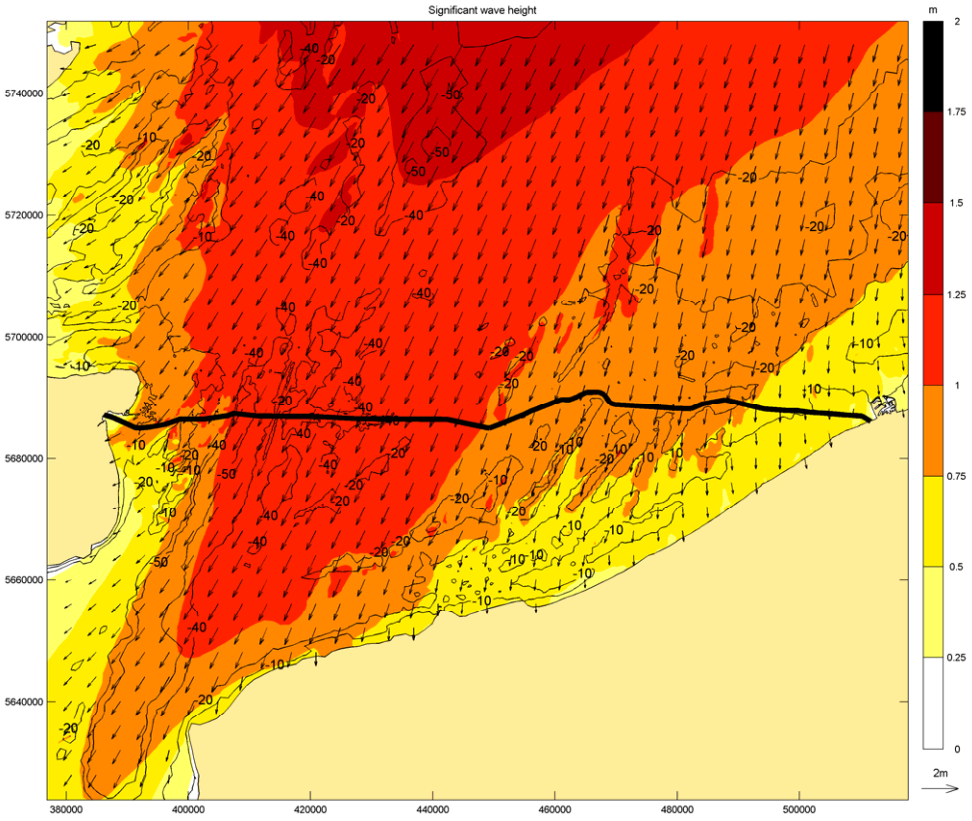

Figure 21 Wave height and direction for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N

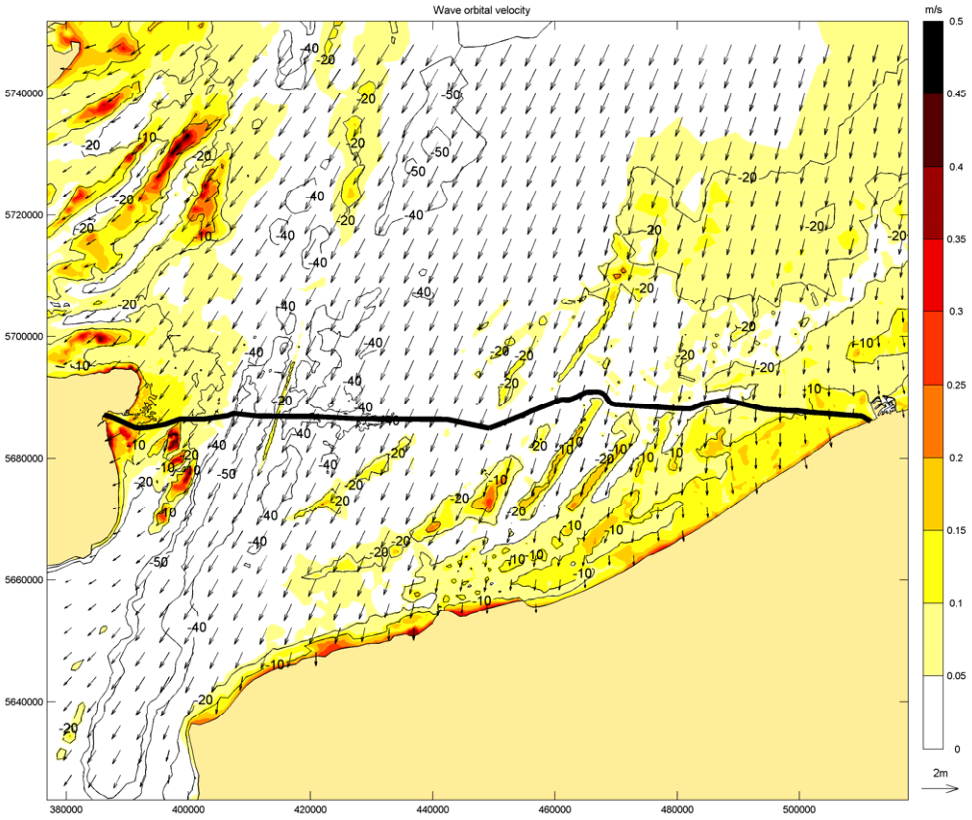

Figure 22 Wave orbital velocities for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N

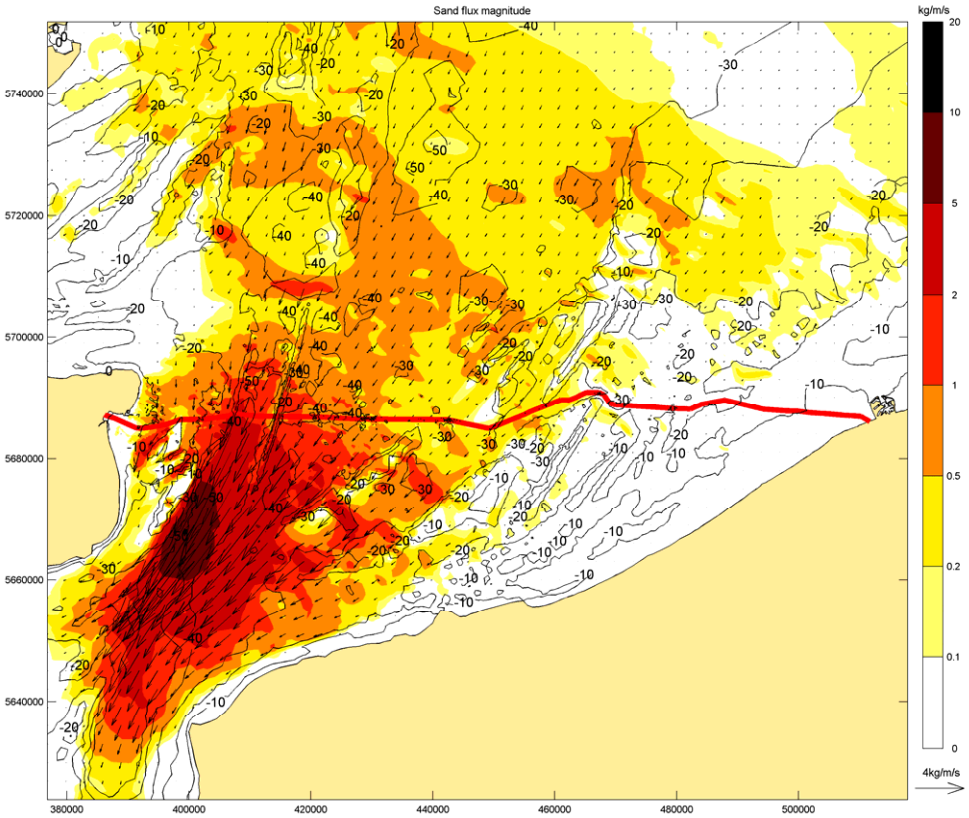

Figure 23 Peak ebb sand transport rates – Spring tide and waves, 400 µm sand

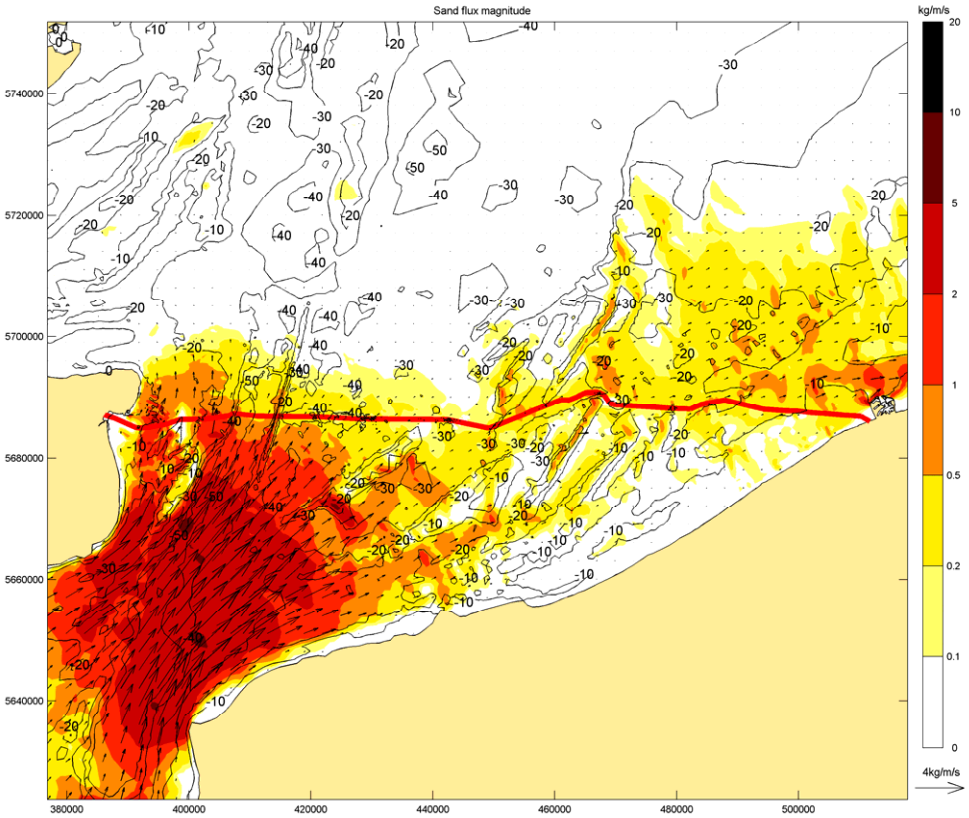

Figure 24 Peak flood sand transport rates – Spring tide and waves, 400 µm sand

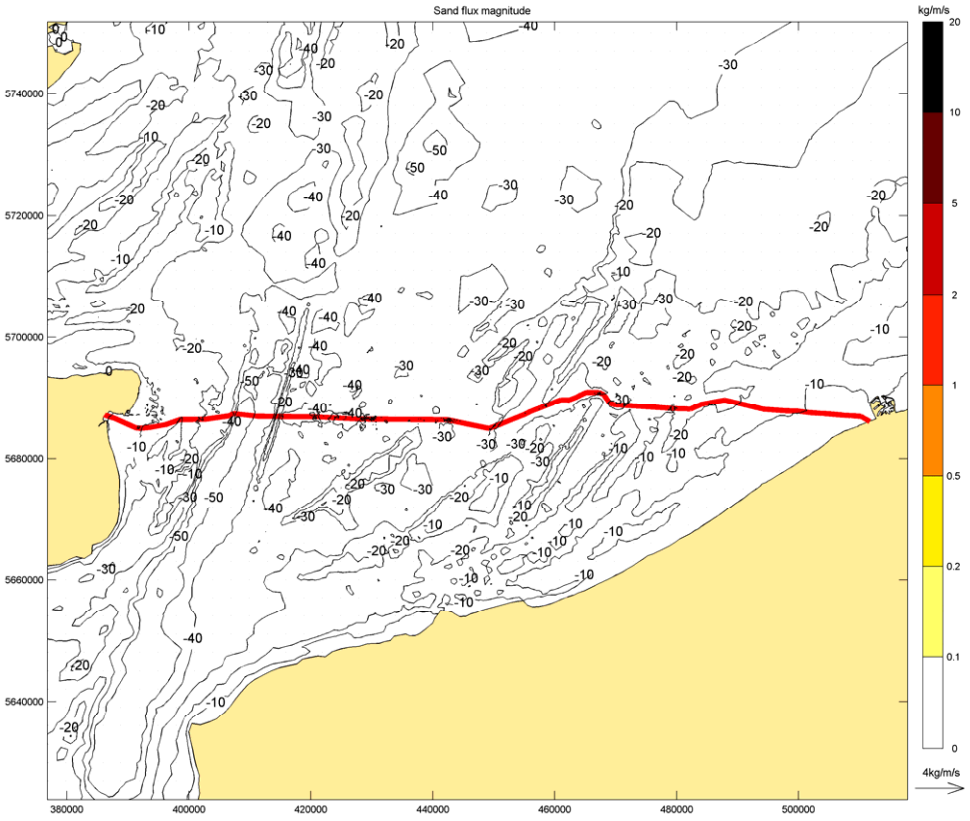

Figure 25 Peak ebb sand transport rates – Neap tide and waves, 400 µm sand

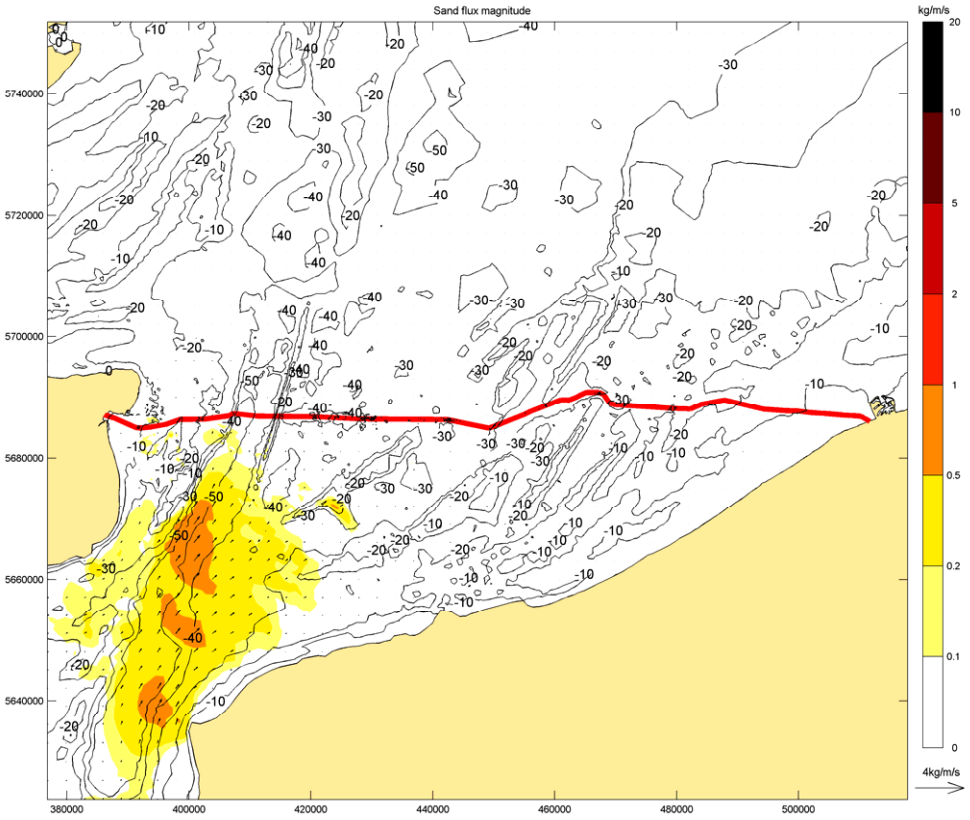

Figure 26 Peak flood sand transport rates – Neap tide and waves, 400 µm sand

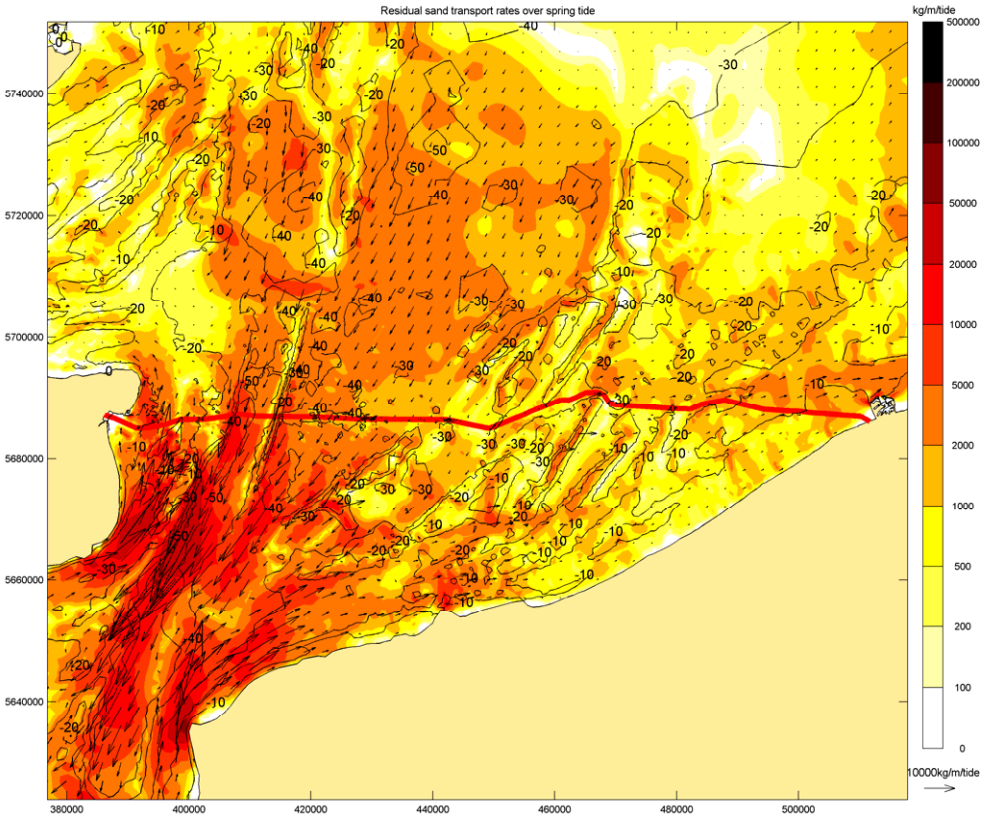

Figure 27 Residual sand transport rates over Spring tide, with waves – 400 µm sand

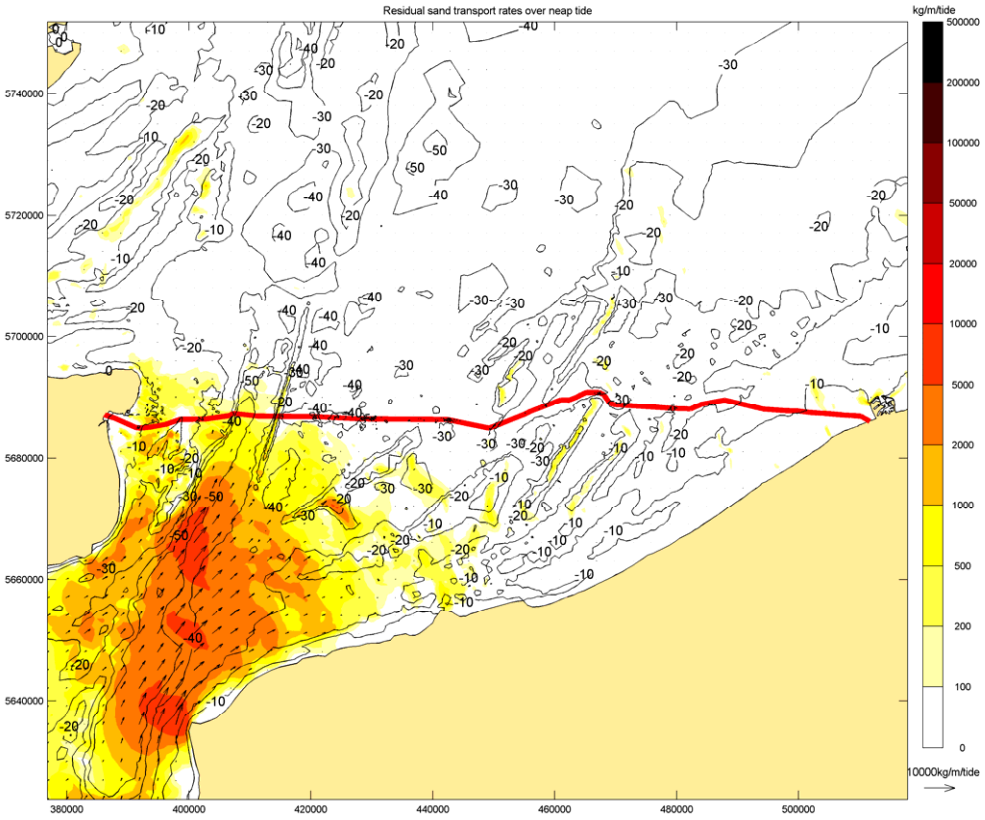

Figure 28 Residual sand transport rates over Neap tide, with waves – 400 µm sand

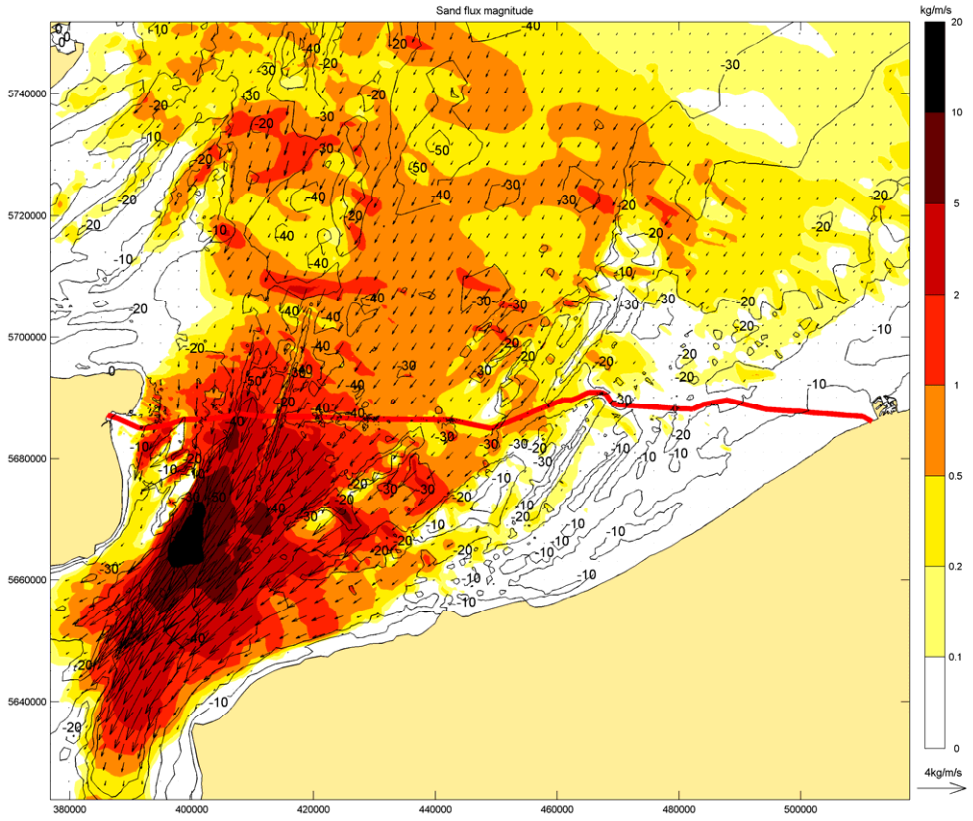

Figure 29 Peak ebb sand transport rates – Spring tide and waves, 250 µm sand

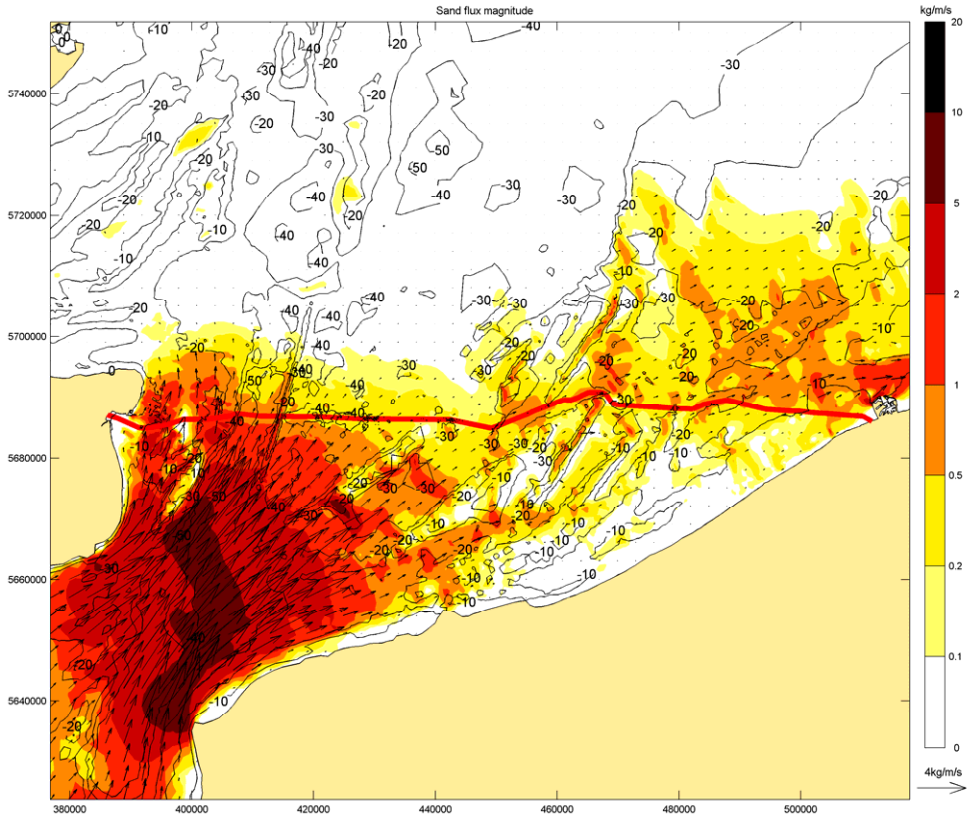

Figure 30 Peak flood sand transport rates – Spring tide and waves, 250 µm sand

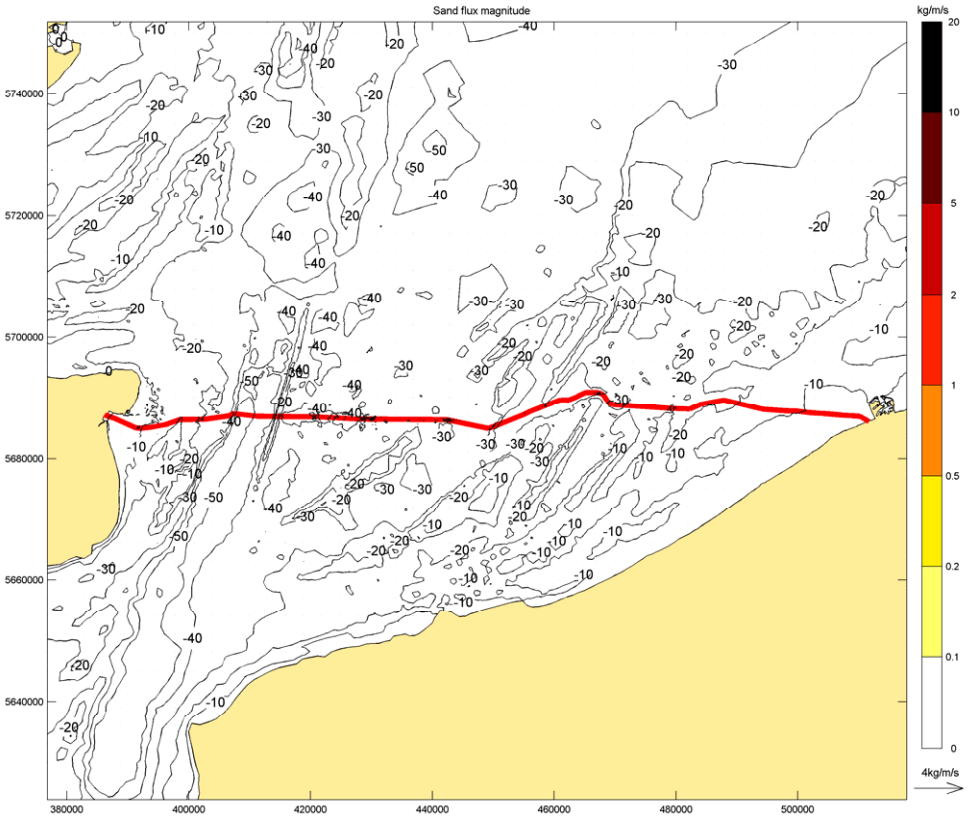

Figure 31 Peak ebb sand transport rates – Neap tide and waves, 250 µm sand

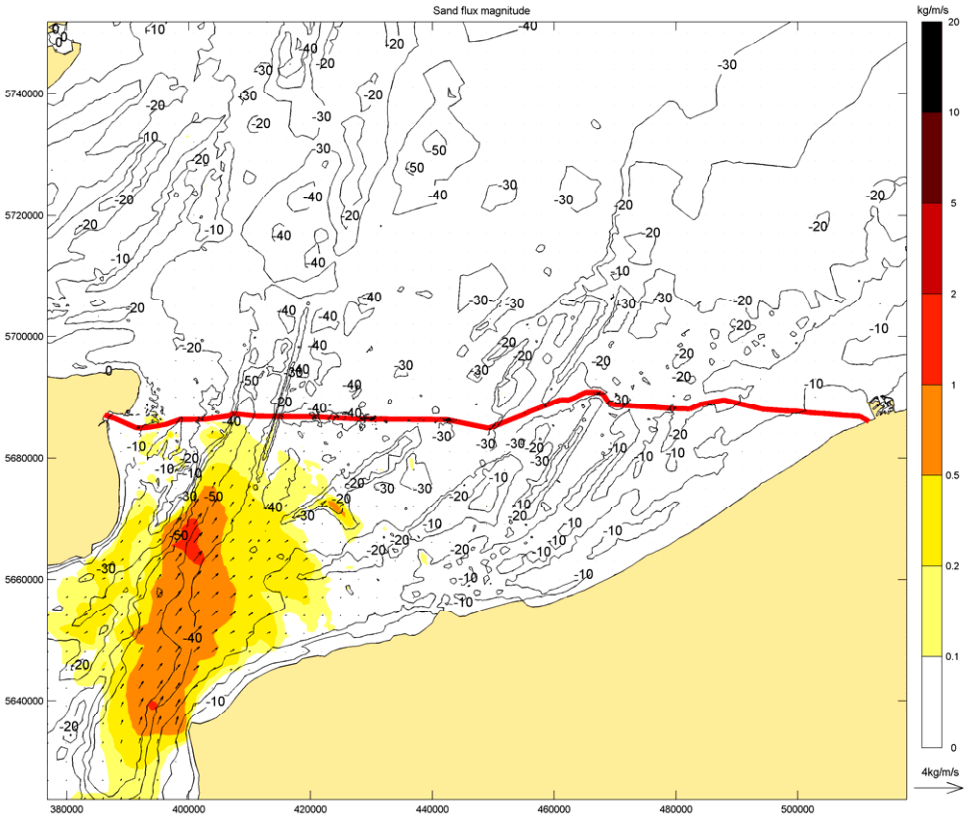

Figure 32 Peak flood sand transport rates – Neap tide and waves, 250 µm sand

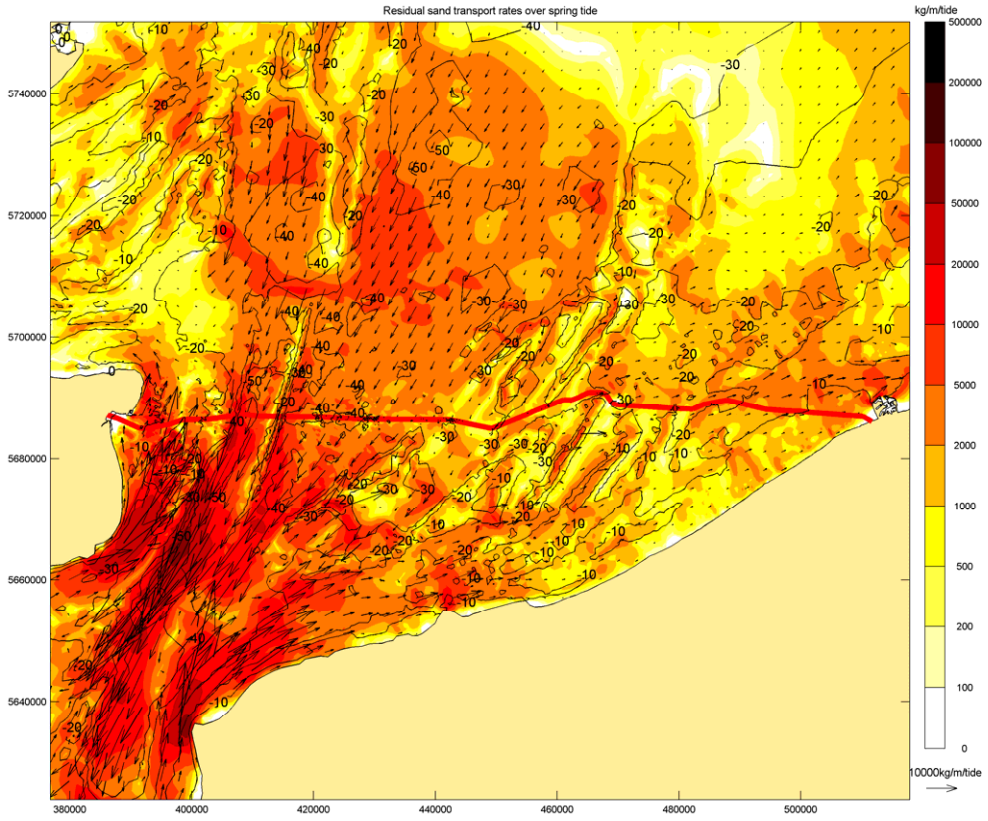

Figure 33 Residual sand transport rates over Spring tide, with waves – 250 µm sand

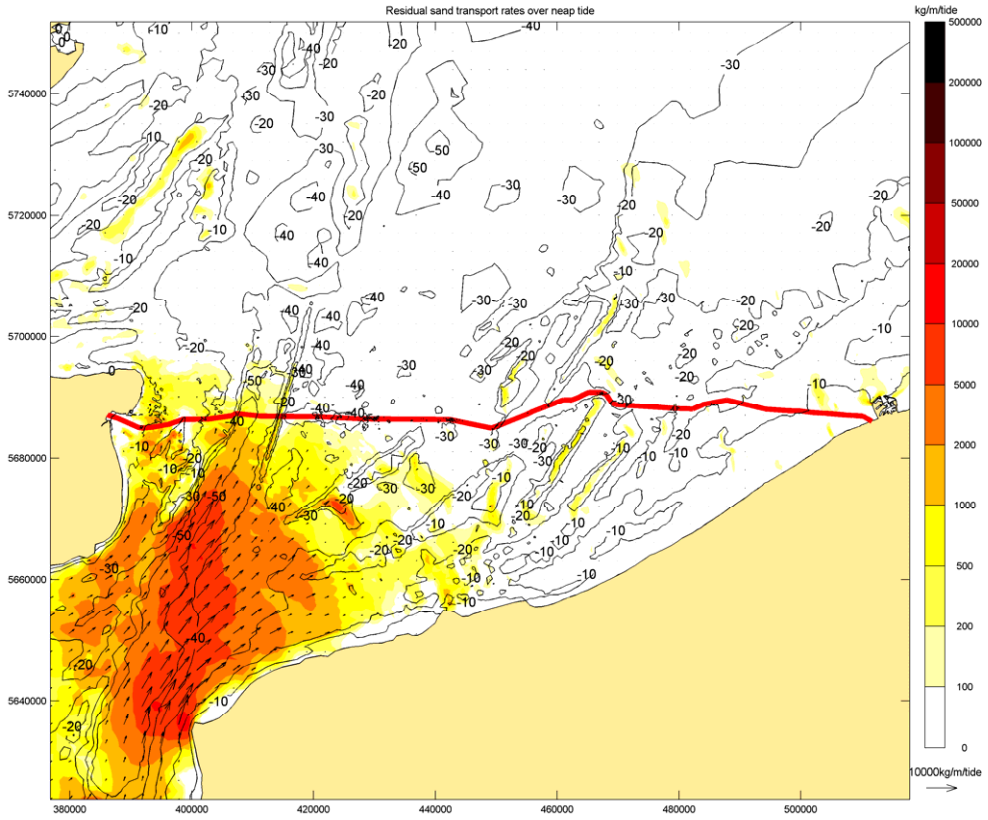

Figure 34 Residual sand transport rates over Neap tide, with waves – 250 µm sand

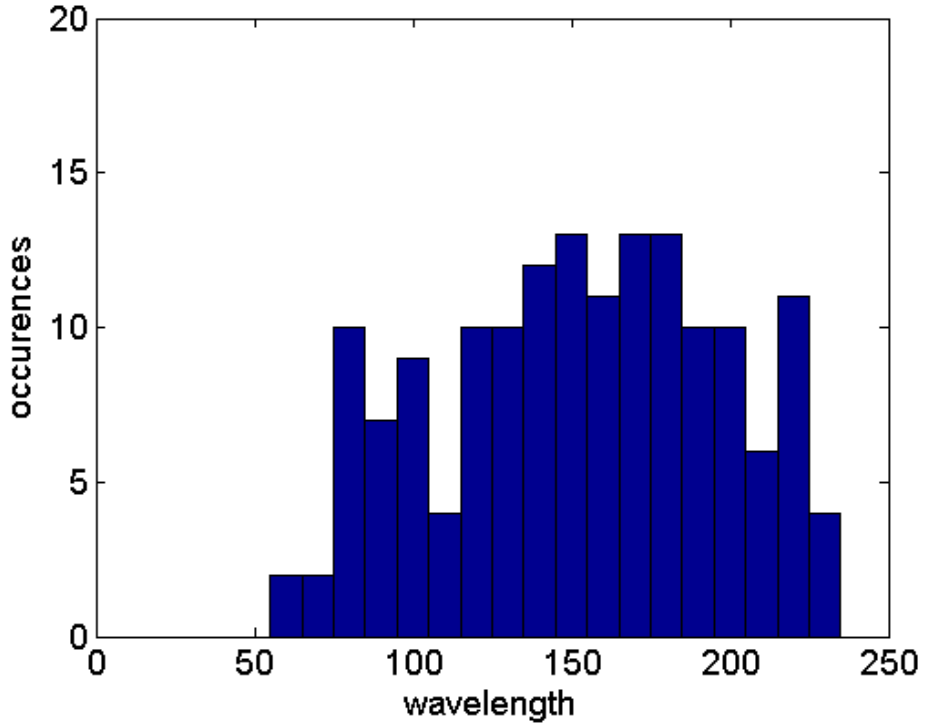

Figure 35 Frequency of occurrence of the median wavelengths (m) of bedforms along the cable

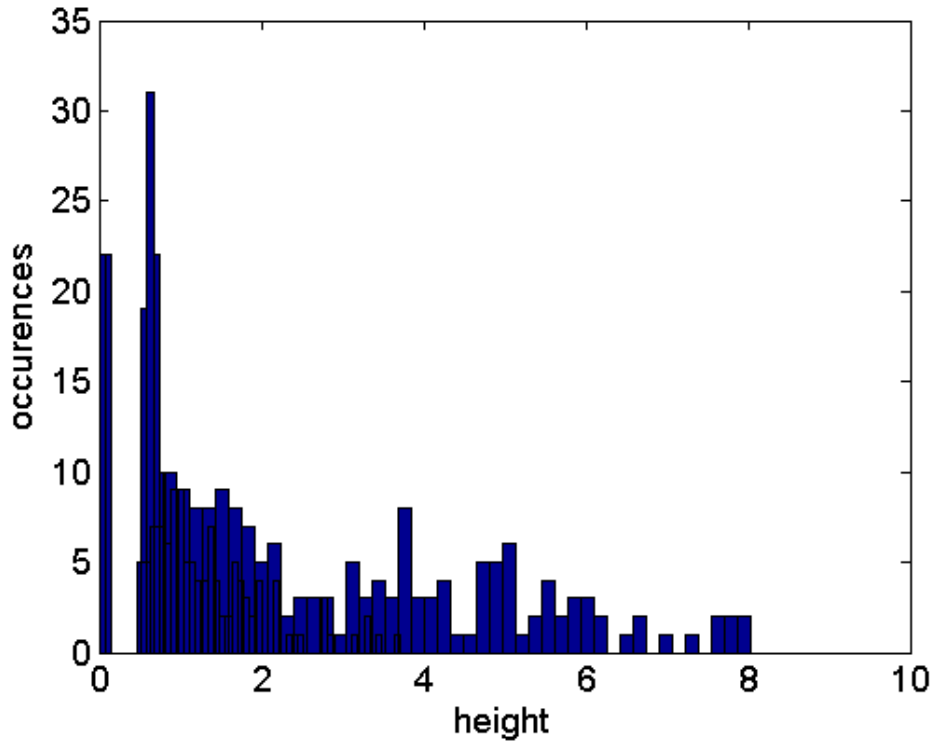

Figure 36 Frequency of occurrence of the median bedform height (m) along the cable

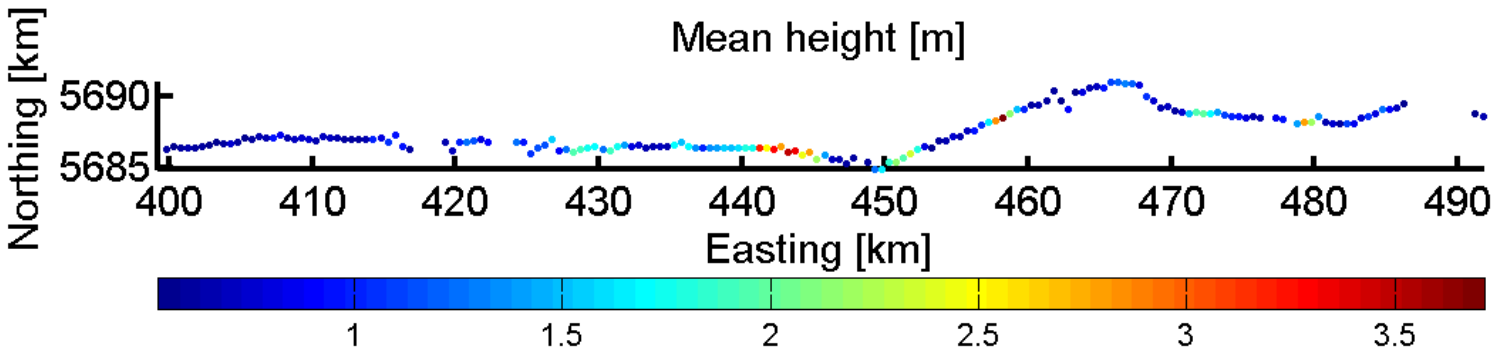

Figure 37 Mean height of bedforms along the cable corridor

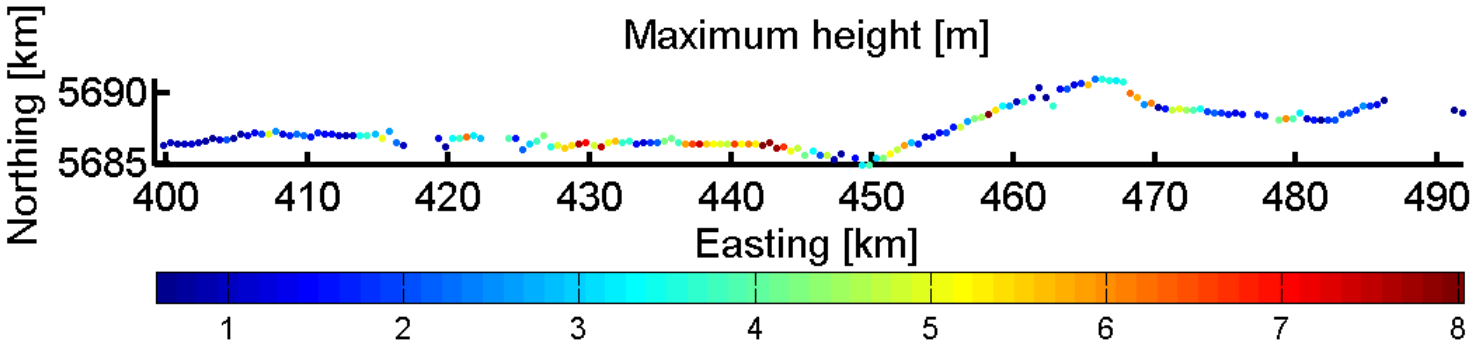

Figure 38 Maximum height of bedforms along the cable corridor

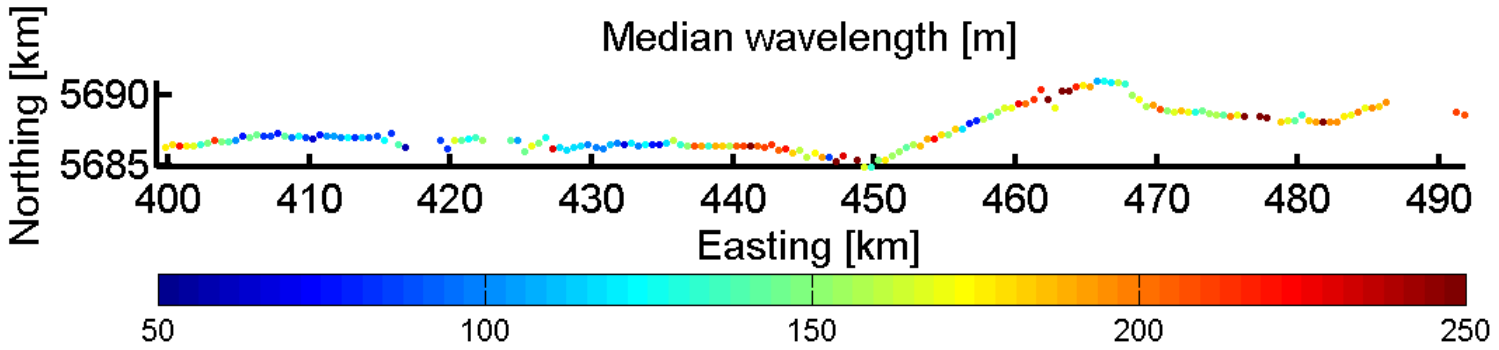

Figure 39 Bedform wavelength along the cable corridor

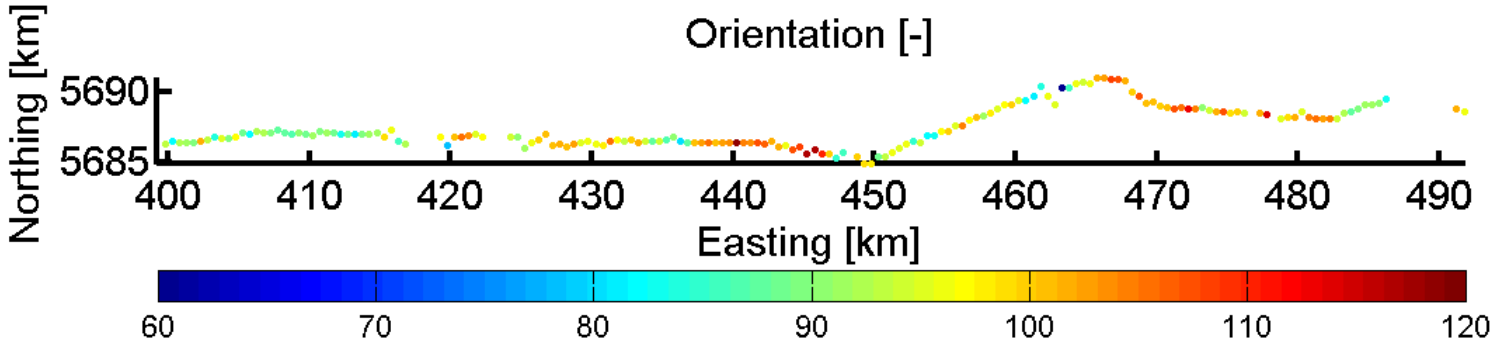

Figure 40 Bedform crest orientation in degrees with respect to north along the cable corridor

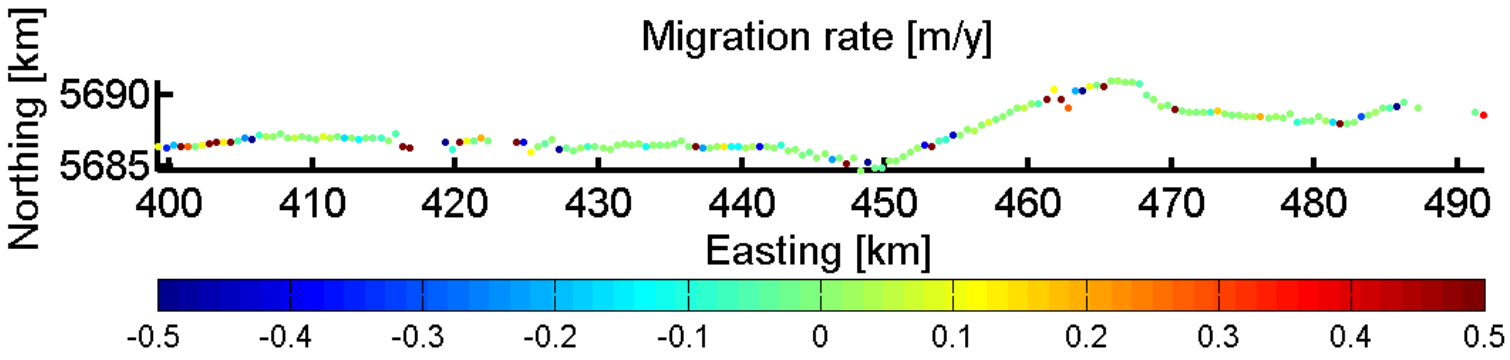

Figure 41 Bedform migration rate along the cable corridor

Project Nemo - UK to Belgium Interconnector

Plume Dispersion Modelling

Technical Note DDR4633-03

HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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Appendix 1 SEDPLUME-RW technical description

1. Introduction

1.1 BACKGROUND

The Nemo Project concerns the laying of an HVDC electrical interconnector, which would allow the transfer of electrical power between the high voltage grid systems of Belgium and the United Kingdom (Figures 1 and 2). The proposed cable route runs from Richborough in Kent in the UK to Zeebrugge in Belgium. As part of the studies associated with the Environmental Impact Assessment for Project Nemo, an assessment of the impacts of fine sediment plumes arising from pre-sweep dredging of sandwaves, non-displacement ploughing and jetting associated with the laying of the cable has been undertaken.

1.2 OBJECTIVES

The objective of this assessment has been to evaluate the fine sediment plumes arising from pre-sweep dredging, non-displacement ploughing and jetting activities associated with cable installation. The modelling work has led to quantitative estimates of the increases in suspended sediment concentration and deposition of fine sediment from these activities.

1.3 REPORT STRUCTURE

The remainder of this report comprises a further seven chapters. The proposed operations are described in Chapter 2. Chapters 3 and 4 briefly describe the flow and plume dispersion models used to drive the plume dispersion and the plume dispersion model itself. Chapter 5 discusses the scenarios simulated by the plume dispersion model. Chapter 6 presents the results of the plume dispersion modelling, and the results of the study are discussed. The conclusions of the report are presented in Chapter 7.

2. Description of proposed trenching activities

2.1 CABLE LAYING METHODOLOGY

The methodology for the proposed cable lay is described in PMSS (2010). The main points from this reference, as regards the present study are as follows:

- In UK waters the trench for the cable will pass through substrates of sand, gravel, chalk and mud (near landfall).
- It is expected that non-displacement ploughing will be utilised to lay the cable in areas of chalk and mud. This type of plough is commonly used for the installation of telecommunications cables and is also used for power cables, umbilicals and other flexible products. A non-displacement plough uses a thin blade that slices through sedimentary seabed material without creating an open trench. This type of plough often causes minimal disturbance to the seabed surface.
- In some areas it may be that ploughing is unsuitable in which case jetting could be used.
- In areas with sandwaves pre-sweeping by dredging will be used to reduce the height of the sandwaves along the cable route and produce a flatter path for the installation equipment to move along. This also allows for greater control of the

burial depth of the cable. It also makes the protection afforded by burial more resistant to sandwave mobility and, therefore, more durable over time.

As agreed between PMSS and HR Wallingford at the Cable Routing Workshop the uppermost 2 m of the sandwave along the proposed cable route will need to be removed by trailer suction hopper dredger (TSHD). The dredging footprint will be 20 m at the bottom of the dredge (in order to enable ploughing to take place) and, assuming sideslopes of 1:5, 40 m at the surface.

2.2 PLOUGHING

Royal Haskoning (2002) describe the effects of non-displacement ploughing as causing the disturbance of 0.02 m^3 per metre of cable layed. This was used in the plume dispersion studies undertaken for Sheringham Wind Farm (Appendix 2 of Scira, 2006), assuming a cable laying speed of 0.05 m/s (based on industry advice). For chalk, for an assumed (dry) density of 2000 kg/m^3 this gives a sediment release rate of 2 kg/s.

2.3 JETTING

Jetting inevitably creates more disturbance than non-displacement ploughing. Reach (2007) describe plume dispersion studies for a cable laying jetting operation in Hong Kong with an assumption that 20 per cent of a trench cross-section of 1.75 m^2 would be disturbed by the jetting process and the speed of the jetting machine would be 300 m/hr (0.083 m/s). ASA (2005) describe similar studies for a cable laying operation near Cape Cod in the USA and assumed that 30 per cent of a trench cross-section of 3 m^2 would be disturbed by the jetting process and the speed of the jetting machine would be 91 m/hr (0.025 m/s). This latter study also assumed that any sand particles would quickly return to the bed and only the fine sediment particles (particles with a diameter greater than 63 μm) would form a plume in the water column.

Based on these previous studies, for the current study it is assumed that 25 per cent of the trench cross-section area of 3 m^2 is disturbed and that the jetting machine moves at 180 m/hr (0.05 m/s). For the muddy substrates which arise close to Zeebrugge (see Section 5.7) this results in a sediment release rate of about 40 kg/s. For the sandy substrates in UK territory, with very little fines content, the effect of jetting results in a lower release rate of about 2 kg/s or less.

2.4 TRAILER SUCTION HOPPER DREDGING

The process of loading the dredger entails pumping a mixture of solids and water from the seabed into the hopper of the dredger (which is usually partially full of water at the start of loading). The solids content in the pumped mixture is relatively low (approximately 25 per cent by volume) and so the vessel fills quickly with water while loading. In order to allow the vessel to load a full cargo of sand (and/or gravel) without becoming overloaded, the excess water in the hopper is returned overboard through overflow spillways which discharge through the hull of the dredger. The returned water also contains a proportion of suspended solids (typically fine sands and silt).

Once returned to the sea through the hull of the dredger, this sediment interacts with the ambient tidal currents, the boundary layer of the dredging vessel and the air bubbles entrained in the overflow discharge. As a result of this interaction the overflow tends to form two different plumes: a surface plume which contains around 15 per cent of the sediment discharged from the overflow (based on measurements undertaken by Nick

Bray and John Land in Hong Kong, *pers.comm.* Nick Bray, HR Wallingford, and more recent measurements undertaken by the EcoShape Project in Dutch waters, Aarninkhof *et al.*, 2010) which is released quickly into the water column, and a negatively buoyant dynamic plume, carrying most of the released sediment, which rapidly descends towards the bed mixing with the surrounding water as it does so. This dynamic plume usually impinges on the bed, collapsing onto the bed as a density current. This density current is at some point entrained into the overlying waters by tidal currents forming a passive plume, albeit more diffuse than the passive plume caused by the surface plume. Once passive plumes are formed they will be dispersed horizontally and vertically in the form of a plume by tidal flows and wave action and be advected by the tidal currents. The processes of advection and dispersion will continue until the sediment concentrations are reduced to close to background levels.

The requirements for the dredging associated with the proposed cable laying have been identified as follows:

- Dredging using a TSHD of size similar to the *Brabo* (11650 m^3, Clarkson Research Services Ltd., 2009).
- "Local" release of dredged sediment to reduce cycle times. In this study local has been assumed to be a location 1500 m from the point of dredging, close enough to keep the sediment in the vicinity of the sandbank system from where it was derived, but far enough away that the sediment will not return to the dredged area before the cable has been laid. The location has been chosen in the lee of the cable route with respect to the net direction of sand transport (see HR Wallingford, 2011a).

3. Flow modelling

The tidal flow modelling undertaken for the project is described in HR Wallingford (2011b). A brief description is presented here.

The model covers a large area of the Southern North Sea from Flamborough Head in the north and beyond the Strait of Dover to Plymouth in the south-west. The bathymetry for the model was locally improved and re-gridded to include information on the local bathymetry along the cable route. The model grid mesh size is about 20 km at the northern open boundary, 5 km in the English Channel and 100 m along the cable route which is appropriate for determining local flow fields and for use in the current plume modelling study. The model was driven using water levels at the boundary from near Flamborough Head across the North Sea to Europe and across the English Channel based on harmonic data from Primary ports and other published literature (the national British Oceanographic Data Centre (BODC) database).

The spring tide peak ebb and peak flood current patterns in the vicinity of the cable route are shown in Figures 3 and 4.

4. Plume dispersion model

The plume dispersion model used to simulate the dispersion of fine sediment from non-displacement ploughing and trailer dredging is the SEDPLUME-RW model developed by HR Wallingford. A description of the model is included in Appendix 1. The model

was run using the hydrodynamic output referred to in Chapter 3 and the assumption of a logarithmic velocity profile through the water column to track the 3 dimensional movement of sediment particles.

Dispersal in the direction of flow in the model is provided by the shear action of differential speeds through the water column while turbulent dispersion is modelled using a random walk technique. The deposition and resuspension of particles are modelled by establishing critical shear stresses for erosion and deposition. Erosion of deposited material occurs when the bed shear stress exceeds the critical shear stress for erosion while deposition of suspended material occurs when the bed shear stress falls below the critical shear stress for deposition.

For simulation of the fine sediment plumes arising from trailer dredging HR Wallingford has developed a specially adapted form of the SEDPLUME-RW code (SEDTRAIL-3D) which allows the representation of the moving sources and of the near-field mixing that occurs with trailer suction hopper dredgers (Spearman *et al.*, 2003). The overflow discharge of sediment was calculated using the TASS overflow model developed at HR Wallingford (Aarninkhof, *et al.*, 2010). This model calculates the sediment transport processes in the hopper using a 1DV model and calculates the magnitude and particle size distribution of the sediment flux out of the hopper in the overflow discharge.

For each scenario a similar number of particles were used for each model run, with the mass of each particle varying depending upon the source term for each scenario.

5. Description of modelled scenarios

In this report seven scenarios are modelled as follows:

- Scenario 1 - Ploughing sand near Sabellaria area
- Scenario 2 - Ploughing chalk
- Scenario 3 - Ploughing sand at Goodwin Knoll
- Scenario 4 - Pre-sweeping by TSHD at South Falls
- Scenario 5 - Pre-sweeping by TSHD for Belgian Sandbanks
- Scenario 6 - Ploughing mud close to Zeebrugge
- Scenario 7 - Jetting mud near Zeebrugge.

In addition, a further scenario will be evaluated based on the results above but without additional modelling:

- Scenario 8 – Jetting sand in UK waters

5.1 SCENARIO 1 - PLOUGHING SAND NEAR SABELLARIA AREA

There are 3 vibro-cores (104, 106, 107, see Appendix C of MMT 2010a) of *in situ* sediment in the area local to the Sabellaria reef with soil samples from a depth that corresponds to disturbance by ploughing. These vibro-core samples give the *in situ* sediment as being sandy with 2-3 per cent fines. A nearby grab sample (B39, see Appendix P of MMT, 2010b) also gives the fines content as 3 per cent fines. The fines content for the soil was therefore taken as 3 per cent for the purpose of the simulation.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre ploughed, at a (dry) density of 1700 kg/m^3, of which 3 per cent is fine material (< 63μm in diameter). The release of fine material is therefore 0.05 kg/s which is the release rate simulated in the plume dispersion model. It was assumed that sandy material disturbed by the plough falls straight back down on the bed and is not released into the water column. Fine sediment released into the water column was assumed to flocculate and have a constant settling velocity of 1 mm/s.

The release of fine material from the ploughing was represented as moving over a 3 km path from east to west at 0.05 m/s for a period of slightly less than 1½ tides.

5.2 SCENARIO 2 - PLOUGHING CHALK

In this scenario non-displacement ploughing was simulated through the chalk feature located on the cable path between KP114 and KP116.2.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of chalk ploughed, at a (dry) density of 2000 kg/m^3, of which 100 per cent is assumed to be released into the water column as fine material. This represents a worst case scenario. The release of chalk simulated in the plume dispersion model was 2 kg/s. Chalk released into the water column was assumed to have a settling velocity of zero mm/s for the purposes of the simulation.

The release of fine material from the ploughing was represented as moving over the 2.2 km extent of the chalk from east to west (as shown later in Figure 10) at 0.05 m/s, for a period of approximately 1 tide.

5.3 SCENARIO 3 - PLOUGHING SAND AT GOODWIN KNOLL

In this scenario non-displacement ploughing was simulated through the sandbank at Goodwin Knoll between KP117.6 and KP118.9.

The only source of data regarding the particle size distribution of the sediment that will be disturbed by the proposed ploughing at Goodwin Knoll is from one nearby grab sample (B43, see Appendix P of MMT, 2010b). However the fines content (i.e. content of particles less than 63 μm in diameter) indicated by this sample was zero per cent. It is not known whether this sample is representative so as a conservative case the fines content for the soil was taken as 3 per cent (as for the area adjacent to the Sabellaria) for the purpose of the simulation.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of sand ploughed, at a (dry) density of 1700 kg/m^3, of which 3 per cent is assumed to be released into the water column as fine material. The release rate of the fine material simulated in the plume dispersion model was, therefore, 0.05 kg/s.

The release of fine material from the ploughing was represented as moving over a 1.3 km path from east to west at 0.05 m/s for a period of approximately 1 tide.

5.4 SCENARIO 4 - TRAILER DREDGING AT SOUTH FALLS

For the scenario of pre-sweeping at South Falls a dredger of the same characteristics as the *Brabo* was simulated dredging over a 1.5 km path. The dredger was assumed to

move at a speed of 1 m/s whilst dredging, and turning for 5 minutes at the end of every pass. The total dredge volume identified is about 90,000 m^3.

The *in situ* sediment appears to have a fines content (content of particles less than 63 μm) of 0 per cent (Grab B35 and VC-93; MMT, 2010a, b). Allowing for a small trace (0.1 per cent) of fines in the overflow discharge and when all of the sediment fractions are considered the TASS model predicts the total release of sediment in the overflow, including coarser fractions, to vary by up to 24 kg/s over the loading period. The results of the TASS overflow model are summarised in Figures 5 and 6. The median particle size in the overflow is predicted to be 280 μm.

A summary of the loading and cycle times involved in the pre-sweeping dredging is presented in Table 1. The TASS model predicts that on each loading period the hopper will fill with 8500 m^3 of dredged material. On this basis 11 loading cycles are required for the pre-sweep at South Falls and the whole operation (at this location) will take 24 hours. The whole 24 hour period of operations is reproduced in the simulation.

Table 1 Summary of predicted pre-sweep dredging cycle times at South Falls

Disposal time (mins)	5
Sailing (total) time (mins)	23.5
Dredging time (mins)	102
Cycle time (mins)	130.5

The disposal site for the dredging at South Falls is assumed to be 1500 m south of the proposed dredging. Whilst representative in terms of illustrating the effects of disposal, the location is not intended to signify a recommended area for disposal.

To reproduce the effects of the disposal on sediment plumes, only the fine fraction (diameter less than 63 μm) is modelled, which is represented by a release rate of 45 kg/s over the 5 minute period of disposal. This is because the plume produced by the coarser fractions is relatively brief. The dynamic plume caused by the release of the sediment from the hull of the dredger will plummet to the bed and pancake across the seabed with sand settling out as the density current moves radially outwards. The sand will deposit within 100 m of the point of release.

5.5 SCENARIO 5 - TRAILER DREDGING ON BELGIAN SAND BANKS

For the scenario of pre-sweeping on the Belgian Sandbanks a dredger of the same characteristics as the *Brabo* was simulated dredging over a 2.5 km path (see Figure 14). The dredger was assumed to move at 1 m/s, dredging when encountering sandbank features and turning for 5 minutes at the end of every pass. The total dredge identified is about 38,000 m^3.

The *in situ* sediment appears to have a fines content (content of particles less than 63 μm) of 1-10 per cent with an average of 3 per cent (Grabs B7, B17, Vibro-cores VC-15, VC-17; MMT, 2010a, b). The TASS model predicts the total release of sediment in the overflow, including coarser fractions, varies up to 87 kg/s over the course of loading, but is below 40 kg/s for most of the loading period. The results of the TASS overflow model are summarised in Figures 8 and 9. More than 80 per cent of the sediment discharged in the overflow is predicted to be less than 60 μm in diameter.

A summary of the loading and cycle times involved in the pre-sweeping dredging is presented in Table 2. The TASS model predicts that on each loading period the hopper will fill with 7,700 m^3 of dredged material. On this basis 5 loading cycles are required for the pre-sweep along this section of the cable route and the whole operation (at this location) will take 20 hours. The whole 20 hours period of operations is reproduced in the simulation.

Table 2 Summary of predicted pre-sweep dredging cycle times at sandbanks in Belgian territorial waters

Disposal time (mins)	5
Sailing (total) time (mins)	23.5
Dredging time (mins)	216
Cycle time (mins)	244.5

The disposal site for the dredging of this section is assumed to be 1500 m north of the proposed dredging. Whilst representative in terms of illustrating the effects of disposal, the location is not intended to signify a recommended area for disposal.

To reproduce the effects of the disposal on sediment plumes, only the fine fraction (diameter less than 63 μm) is modelled, which is represented by a release rate of 450 kg/s over the 5 minute period of disposal. This is because the plume produced by the coarser fractions is relatively brief. The dynamic plume caused by the release of the sediment from the hull of the dredger will plummet to the bed and pancake across the seabed with sand settling out as the density current moves radially outwards. The sand will deposit within 100m of the point of release.

5.6 SCENARIO 6 - PLOUGHING MUD NEAR ZEEBRUGGE

This scenario was concerned with the effects of non-displacement ploughing of mud between near Zeebrugge. A section of the cable route between KP3 and KP4 was selected to give an example of the potential effects of ploughing in this area. As before the plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of mud ploughed of which 100 per cent is assumed to be released into the water column as fine material. The dry density of the mud was assumed to be 1000 kg/m^3 which is a broad average of the values from vibro-cores in this stretch of the cable route (Tyrens, 2011). This represents a worst case scenario. The release of fines simulated in the plume dispersion model was 1 kg/s. Mud released into the water column was assumed to have a settling velocity of 0.5 mm/s for the purposes of the simulation.

The release of fine material from the ploughing was represented as moving over a 1 km path from east to west as shown later in Figure 16 at 0.05 m/s for a period of approximately half a tide.

5.7 SCENARIO 7 - JETTING MUD NEAR ZEEBRUGGE

This scenario reproduced the effects of jetting by repeating the simulation of Scenario 6 but with the higher rate of release that would result from the jetting process. As discussed in Section 2.3, the jetting process was assumed to disturb 25 per cent of the trench cross-section of 3 m^2 with the jetting machine travelling at 0.05 m/s. As in Section 5.6 the (dry) density of the mud substrate was taken as 1000 kg/m^3. This gives a release rate of about 40 kg/s. Mud released into the water column was assumed to have a settling velocity of 0.5 mm/s for the purposes of the simulation.

For consistency the release of fine material from the jetting was represented as moving over a 1 km path from east to west (see Figure 18) for a period of approximately half a tide.

5.8 SCENARIO 8 - JETTING SAND IN UK WATERS

As discussed in Section 2.3, the release rate corresponding to jetting in the sandy conditions of UK territorial waters, is about 2 kg/s or less. The release rate is much lower for these sandy substrates compared to the muddy conditions in Belgian territorial waters (see Section 5.7), because of the low fines content (i.e. the small proportion of particles less than 63 μm in diameter) of the sand. A release rate of 2 kg/s which, coincidentally, corresponds roughly with the release rate resulting from ploughing of chalk (see Section 5.2). On this basis we will use the result from simulation of chalk ploughing (Scenario 2) to give a reasonable approximation of the fine sediment plumes caused by jetting sand.

It is acknowledged that chalk released into the water column will not settle at slack water, unlike fine sediment, but the general results of Section 6 indicate that deposition from the proposed cable laying operations is generally negligible unless rates of release of sediment are many times higher than 2 kg/s. Therefore, it is reasonable to use Scenario 2 as a basis for evaluating the effects of the release of fine sediment arising from the jetting of sand.

6. Results

6.1 SCENARIO 1 - PLOUGHING SAND NEAR SABELLARIA AREA

The scenario of ploughing sand with 3 per cent fines content is predicted to produce depth-averaged and near bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. On this basis the impacts of ploughing near the Sabelleria Spinosa reef is considered to be negligible.

6.2 SCENARIO 2 - PLOUGHING CHALK

Figures 10 and 11 show the *envelope* of predicted increases in near-bed (Figure 10) and depth-averaged (Figure 11) suspended sediment concentration above background during the simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation. This style of figure is informative for showing the footprint of effect but tends to over-emphasise the size of the plume at any particular instant.

The figures show that the footprint of impact extends up to 700 m from the cable route but that at these distances the predicted increases in suspended concentration above background are less than 1 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable route. The peak predicted increase in concentration is about 20 mg/l.

Deposition of fine sediment is assumed to be negligible.

6.3 SCENARIO 3 - PLOUGHING SAND AT GOODWIN KNOLL

As for Scenario 1, the scenario with ploughing sand with 3 per cent fines content is predicted to produce depth-averaged and near-bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. On this basis the impact of ploughing at Goodwin Knoll in generating plumes is considered to be negligible.

6.4 SCENARIO 4 - TRAILER DREDGING AT SOUTH FALLS

Figures 12 and 13 show the *envelope* of predicted increases in near-bed (Figure 12) and depth-averaged (Figure 13) suspended sediment concentration above background during the pre-sweep simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation. The plume footprint is mainly due to the presence of fine material at the extremities of the plume but closer to the point of release the majority of the plume will be coarser, sandy material.

The figures show that the footprint of impact extends up to 500 m from the cable path but that at these distances the predicted increases in suspended concentration above background are less than 1 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 250 m of the cable path. The peak predicted increase in concentration is about 30 mg/l.

Figures 12 and 13 also show that the plume of fine material arising from a simulation of disposal produces concentration increases of around 2 mg/l of fine material (< 63 μm), owing to the small amount of fines released. There will however be considerably more coarser sediment released than fine sediment and concentration increases will be of the order of 1000's mg/l within one hundred metres of the point of disposal over a period of ten minutes or so while these coarser particles settle to the bed.

Deposition of fine sediment is predicted to be less than 0.1 mm and so is considered to be negligible. Any sandy sediment released from the dredger is estimated to fall to the bed within 200-400 m of the cable route and within 100 m of the point of disposal.

6.5 SCENARIO 5 - TRAILER DREDGING ON BELGIAN SANDBANKS

Figures 14 and 15 show the *envelope* of predicted increases in near-bed (Figure 14) and depth-averaged (Figure 15) suspended sediment concentration above background during the pre-sweep simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation. The plume footprint is mainly due to the presence of fine material at the extremities of the plume, but closer to the point of release the majority of the plume will be coarser, sandy material.

The figures show that the footprint of impact extends up to 13 km NE and up to 11 km SW of the dredging but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur up to 7.5 km NW and up to 4 km SW of the dredging. Increases in suspended sediment concentration of more than 50 mg/l are predicted to be confined to the immediate vicinity of the dredging and up to 2 km from the point of disposal. Locations in the streamline of the dredging and disposal located at a distance of 1 km SW and NE of these locations are predicted to experience increases in (depth-averaged) suspended sediment concentration of more than 10 mg/l

for a total of no more than 20 minutes during the 20 hour period of dredging simulated. No deposition of fine material is predicted.

The peak predicted increase in concentration is in the region of 200 mg/l and arises from the disposal of material locally. Note, however, that this relates to fine sediment only and there will be considerably more coarser sediment released than fine sediment. Concentration increases will be of the order of 1000's mg/l within one hundred metres of the point of disposal over a period of ten minutes or so while these coarser particles settle to the bed.

Deposition of fine sediment is predicted to be less than 0.5 mm and so is considered to be negligible. Sandy sediment released from the dredger is estimated to fall to the bed within 200-400 m of the cable route and within 100 m of the point of disposal.

6.6 SCENARIO 6 - PLOUGHING MUD NEAR ZEEBRUGGE

Figures 16 and 17 show the *envelope* of predicted increases in near-bed (Figure 16) and depth-averaged (Figure 17) suspended sediment concentration above background during the simulation of ploughing.

The figures show that the footprint of impact extends up to 5 km from the cable route but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur near the bed within 150 m of the cable route. The peak predicted increase in concentration is about 25 mg/l.

Deposition of fine sediment is predicted to be negligible.

6.7 SCENARIO 7 - JETTING MUD NEAR ZEEBRUGGE

Figures 18 and 19 show the *envelope* of predicted increases in near-bed (Figure 18) and depth-averaged (Figure 19) suspended sediment concentration above background during the jetting simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation.

The figures show that the footprint of impact extends up to 12 km from the cable route but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur up to 10 km from the jetting Increases in suspended sediment concentration of more than 50 mg/l are predicted to occur within 250 m of the cable route. The peak predicted increase in near bed concentration is predicted to be of the order of a few hundred mg/l in the vicinity of the jetting itself.

The predicted deposition of fine sediment from the simulated jetting is shown in Figure 20. Deposition of fine sediment is predicted to be less than 0.1 mm except within 200 m of the dredge path. Within 100 m of the dredge path, deposition of up to 15 mm is predicted.

6.8 SCENARIO 8 - JETTING SAND IN UK WATERS

As discussed in Section 5.8, the effects of jetting of sand in UK waters broadly correspond to the effects of ploughing of chalk, as presented in Section 6.2.

On this basis it can be expected that the footprint of impact arising from the jetting of sand will extend up to 700 m from the cable route but that at these distances the predicted increases in suspended concentration above background will be less than 1 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable route. The peak predicted increase in concentration is about 20 mg/l. Deposition of fine sediment is assumed to be negligible.

Coarser sand disturbed by the jetting process will also be initially resuspended but will settle out close to the cable route.

7. Conclusions

The generation and dispersion of plumes arising from cable installation activities for Project Nemo. The cable laying operations has been investigated by the computational simulation of the dispersal of plumes arising from ploughing of sand and chalk and from pre-sweep TSHD dredging. The following conclusions have been made:

- The ploughing of the cable into sand at the Sabellaria area and at Goodwin Knoll is predicted to produce negligible increases in concentration and negligible deposition of fine sediment near Goodwin Knoll.
- The ploughing of the cable into chalk is predicted to result in minor (> 10 mg/l) increases in suspended sediment concentration within 100 m of the cable route. No deposition is predicted because the settling velocity of fine suspended chalk particles is very small.
- Pre-sweep dredging at South Falls is predicted to result in minor (> 10mg/l) increases in suspended sediment concentration within 250m of the cable route. No deposition of fine material is predicted. Sand disturbed by the dredging is predicted to settle within a few hundred metres of the cable route.
- Disposal of material dredged from South Falls is predicted to result in negligible plumes of fine sediment and negligible deposition of fine sediment. Sand disturbed by the dredging is predicted to settle within one hundred metres of the cable route. For a short time (of the order of 10 minutes) concentrations will be relatively high (100's to 1000's mg/l) within 100 m of the point of disposal while the coarse sediment released settles to the bed.
- Pre-sweep dredging of sandbanks in Belgian territorial waters and local disposal, is predicted to result in increases in suspended sediment concentration of more than 50 mg/l in the immediate vicinity of the dredging and up to 2 km from the point of disposal. Locations in the streamline of the dredging and disposal located at a distance of 1 km are predicted to experience increases in suspended sediment concentration of more than 10 mg/l for no more than a total of 20 minutes during the period of dredging. No deposition of fine material is predicted.
- Sand disturbed by the pre-sweep dredging and disposal of sandbanks in Belgian territorial waters is predicted to settle within a few hundred metres of the cable route and disposal location. For a short time (of the order of 10 minutes) concentrations will be relatively high (100's to 1000's mg/l) within 100 m of the point of disposal while the coarse sediment released settles to the bed.

- The ploughing of the cable into mud near Zeebrugge is predicted to result in minor (> 10 mg/l) increases in suspended sediment concentration within 150 m of the cable route. No deposition is predicted.
- The jetting of the cable into mud near Zeebrugge is predicted to result in moderate (> 50 mg/l) increases in suspended sediment concentration within 250 m of the cable route although smaller increases of up to 10 mg/l are predicted to occur up to 10 km away from the dredging. Deposition of the order of 10 mm is predicted within 100 m of the cable route but deposition is predicted to be negligible more than 200 m from the cable route.
- The jetting of the cable into sand in UK waters is expected to produce increases in suspended sediment concentrations similar to those of ploughing chalk, i.e. minor (> 10mg/l) increases in suspended sediment concentration within 100 m of the cable route. Deposition of fine sediment is assumed to be negligible on the basis of the modelling work undertaken for the other scenarios.
- Sand initially disturbed by the jetting process is predicted to settle close to the cable route.

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Figures

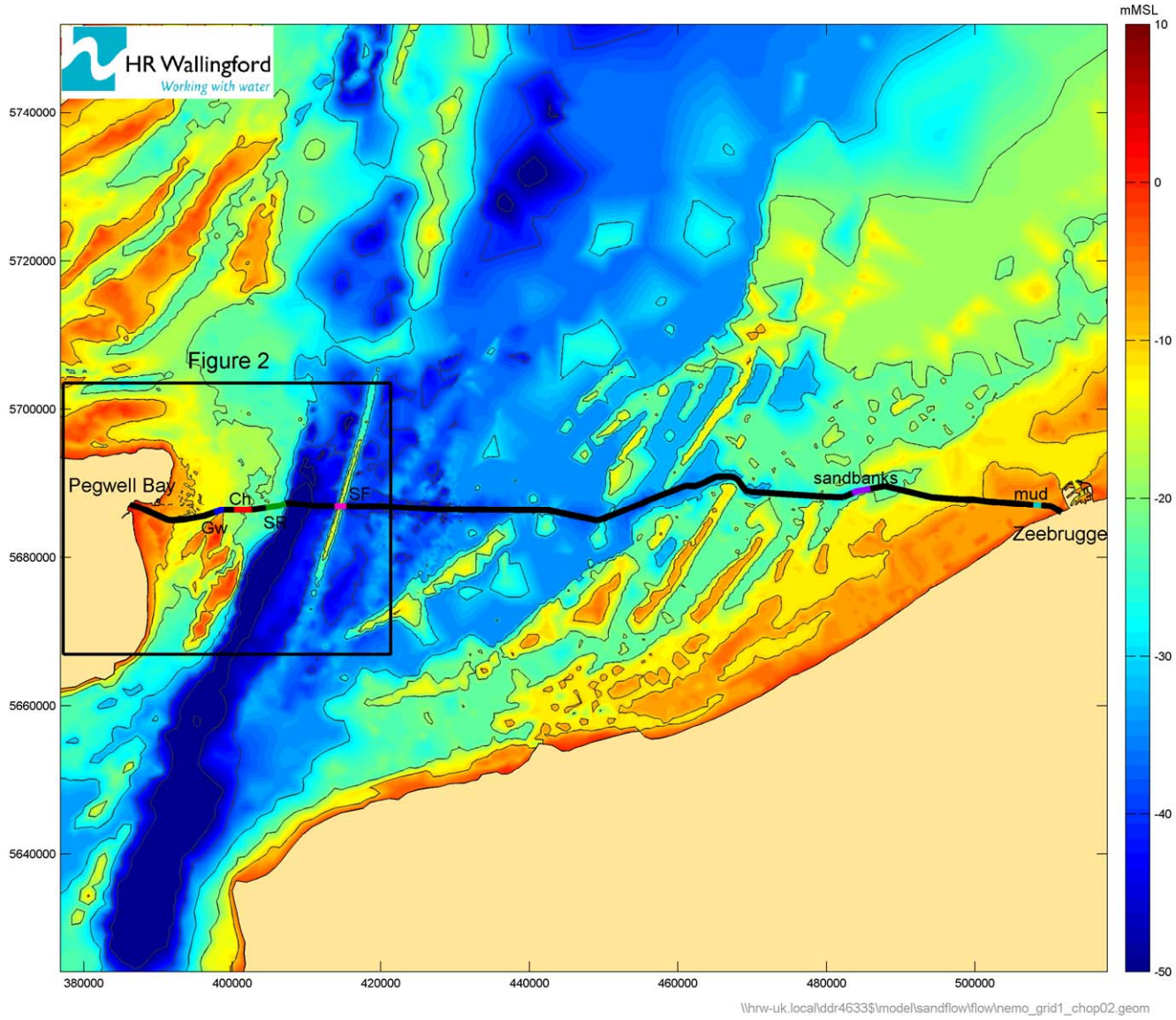

Figure 1 Location of proposed cable route and cable laying sections for which plume dispersion simulations have been undertaken

Gw: Goodwin Knoll. Ch: Chalk section. SR: Sabellaria Reef. SF: South Falls.
The area in the black rectangle is shown in more detail in Figure 2.

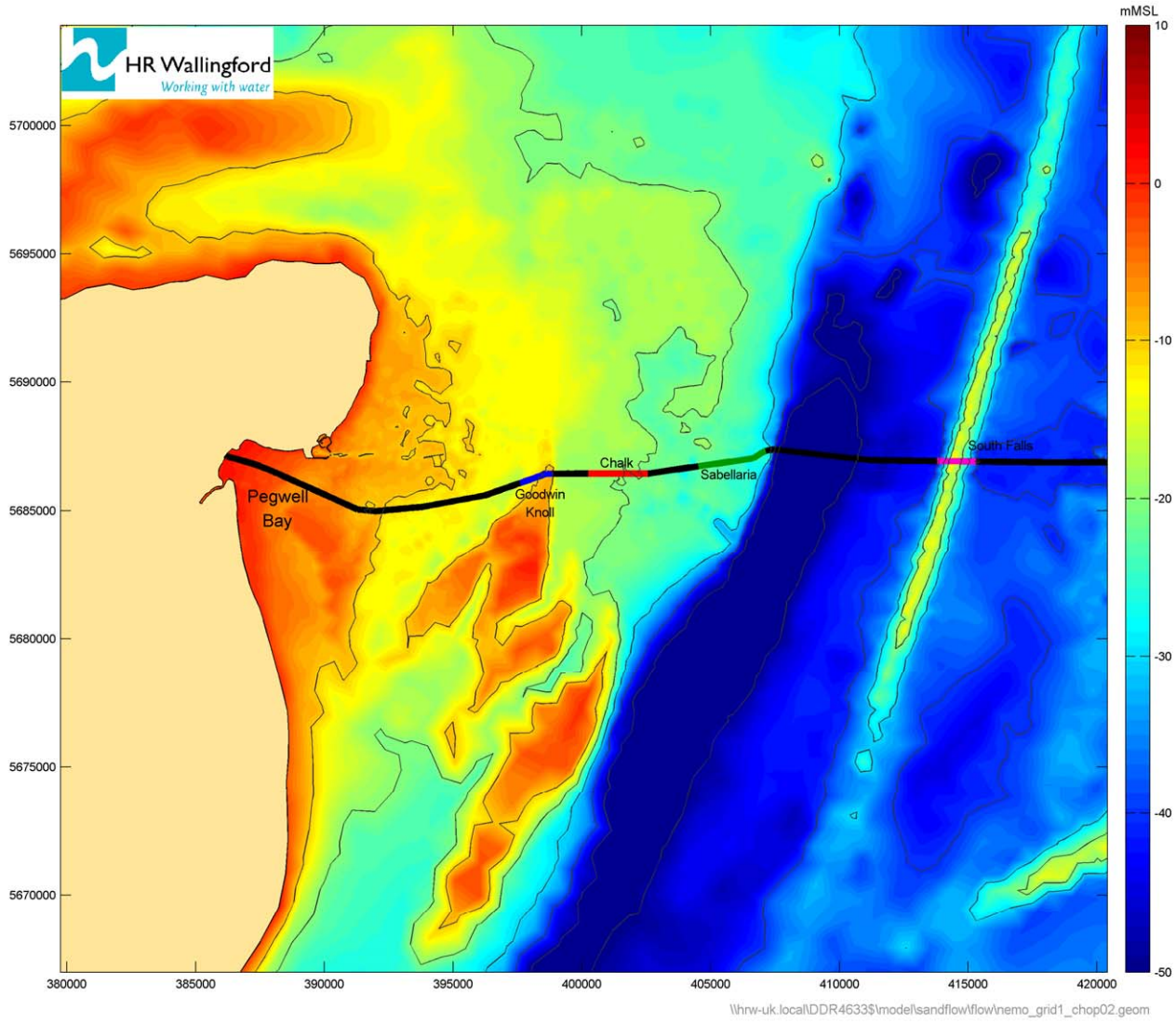

Figure 2 Location of proposed cable route in UK waters and cable laying sections for which plume dispersion simulations have been undertaken

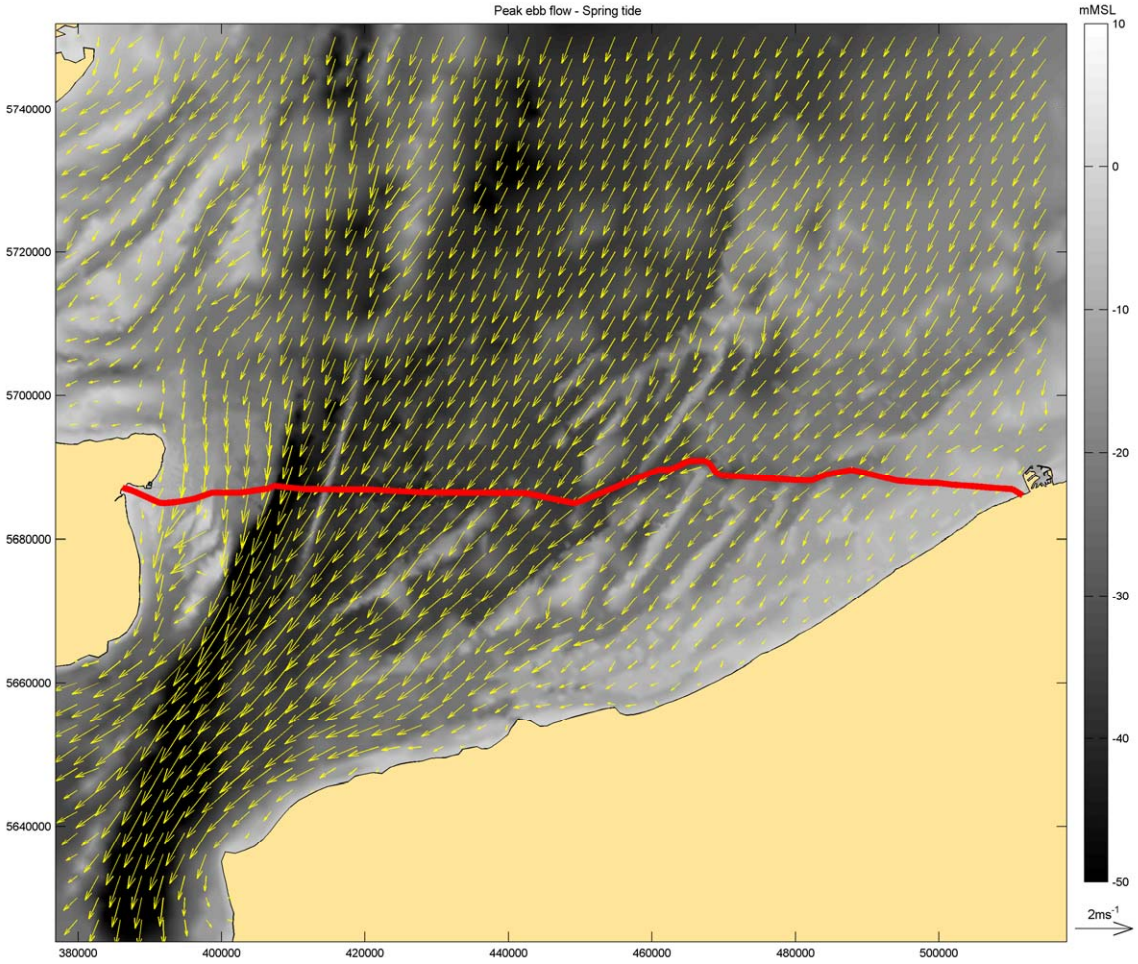

Figure 3 Peak ebb flow velocities – Spring tide

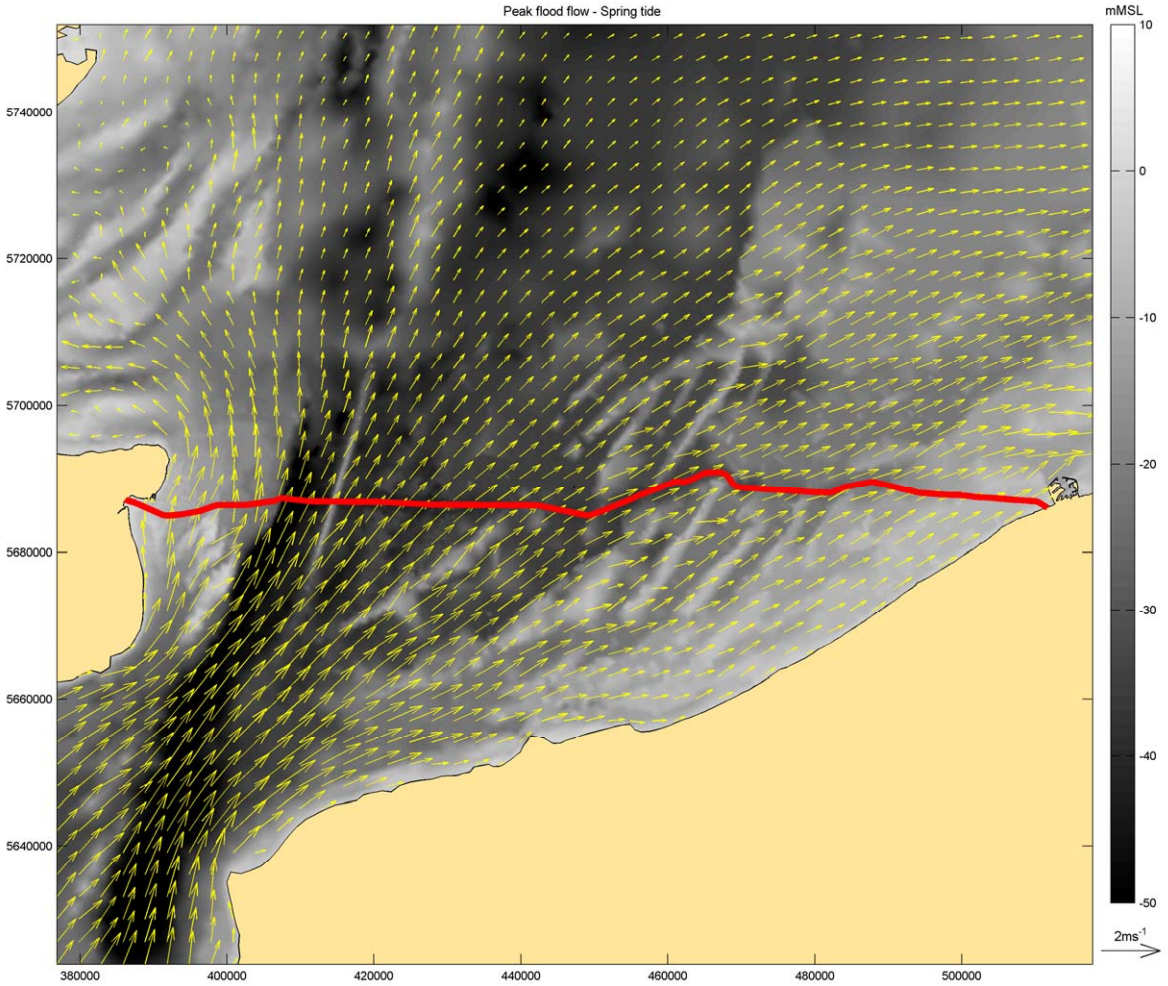

Figure 4 Peak flood flow velocities – Spring tide

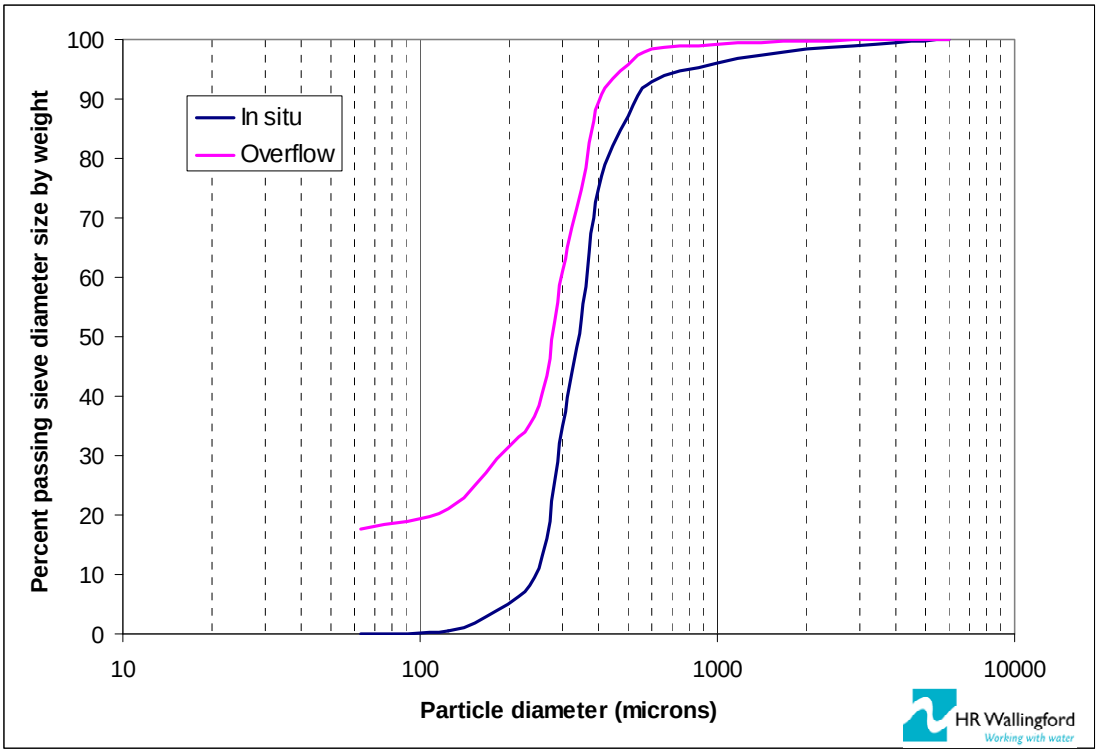

Figure 5 Overflow particle size distribution predicted by the TASS model for pre-sweeping at South Falls

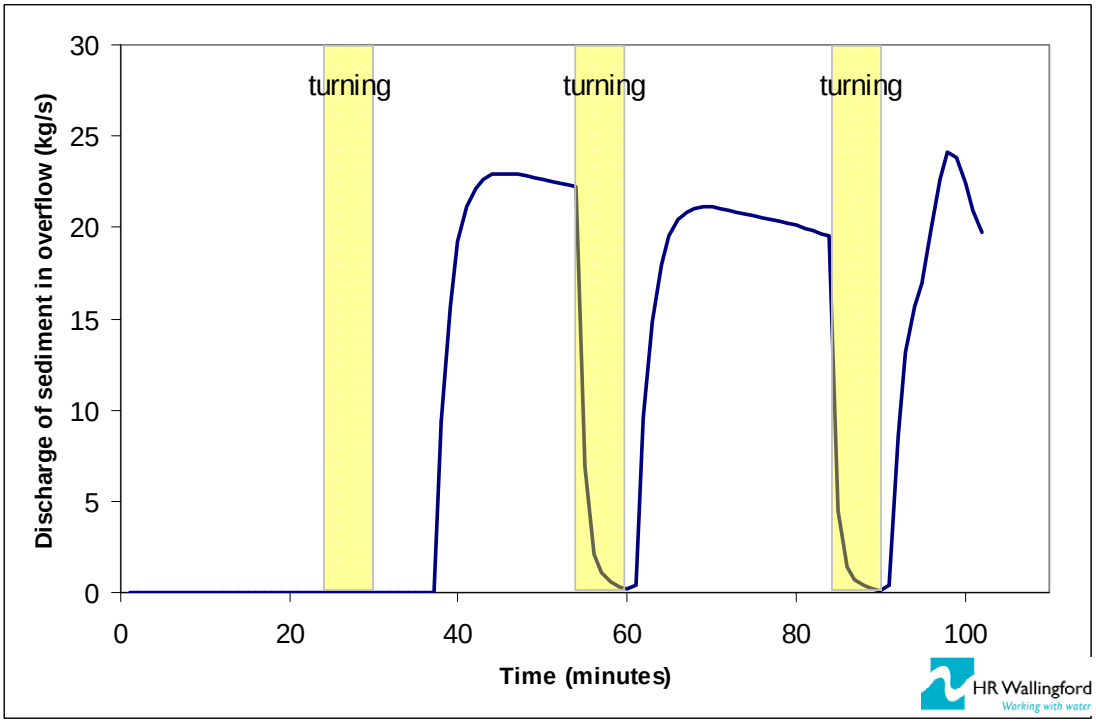

Figure 6 Overflow sediment discharge predicted by the TASS model for pre-sweeping at South Falls

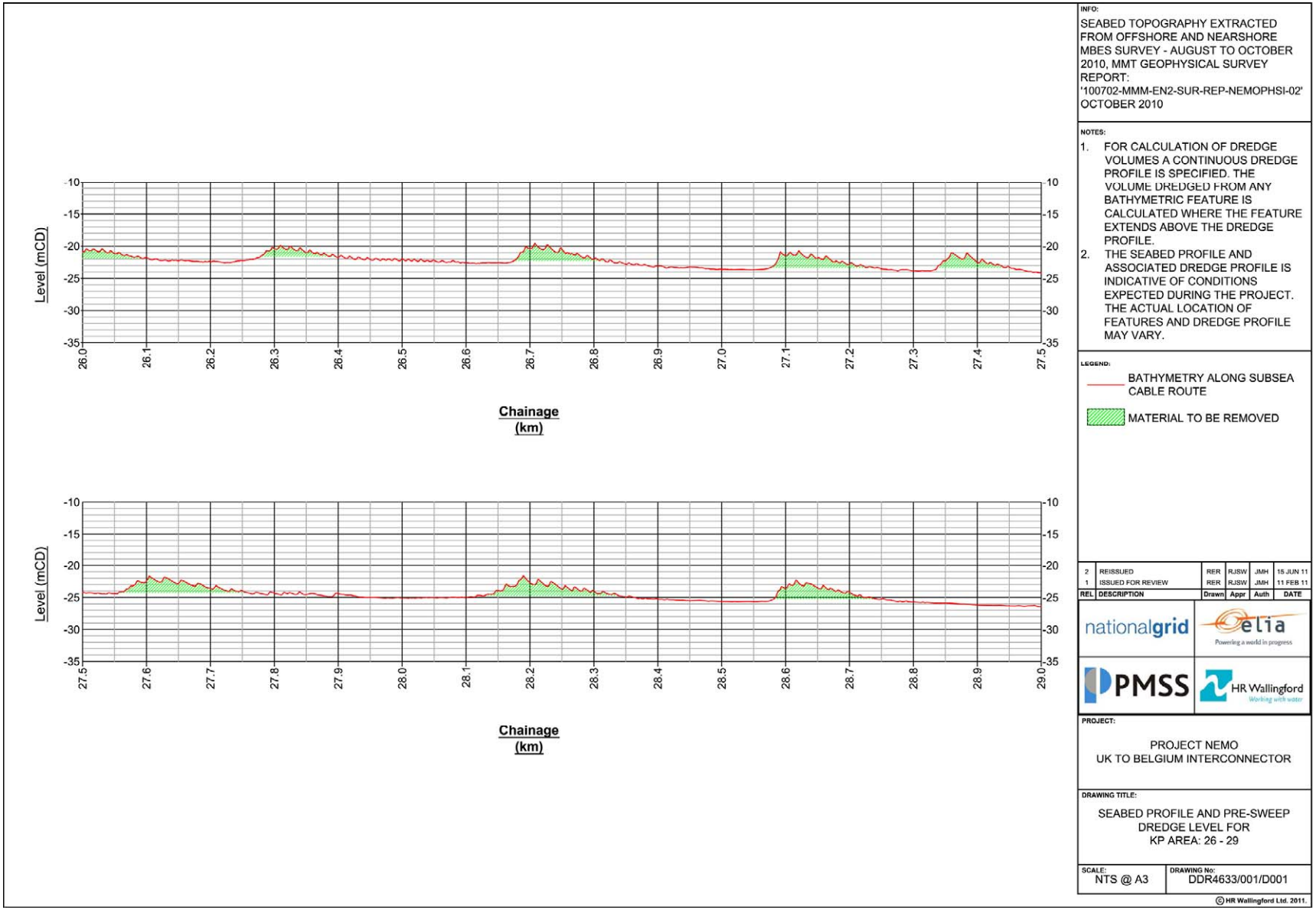

Figure 7 Seabed profile and pre-sweep dredge level for KP26 to KP29

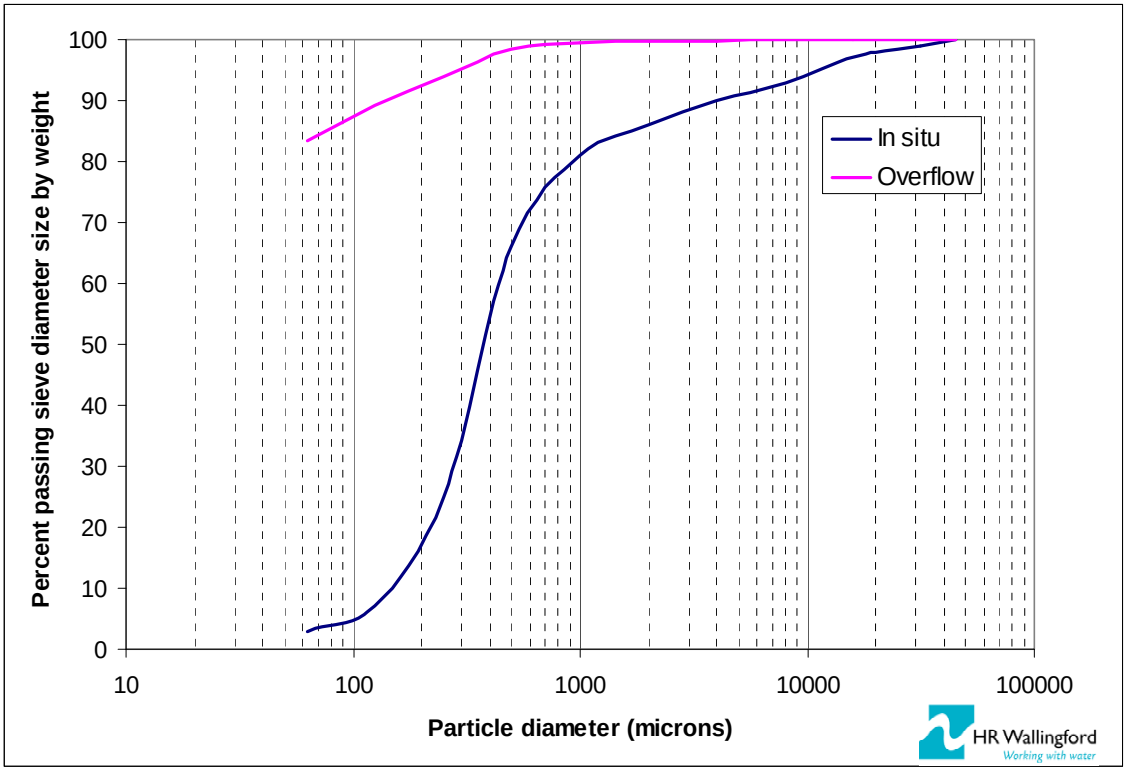

Figure 8 Overflow particle size distribution predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29

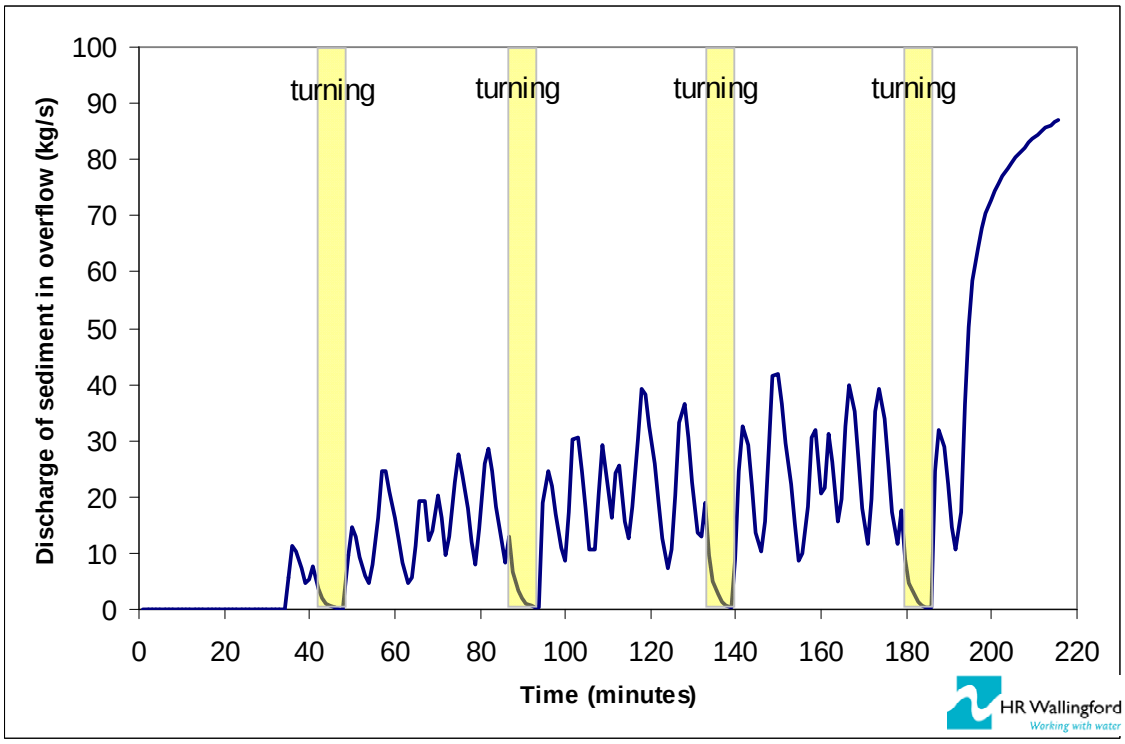

Figure 9 Overflow sediment discharge predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29

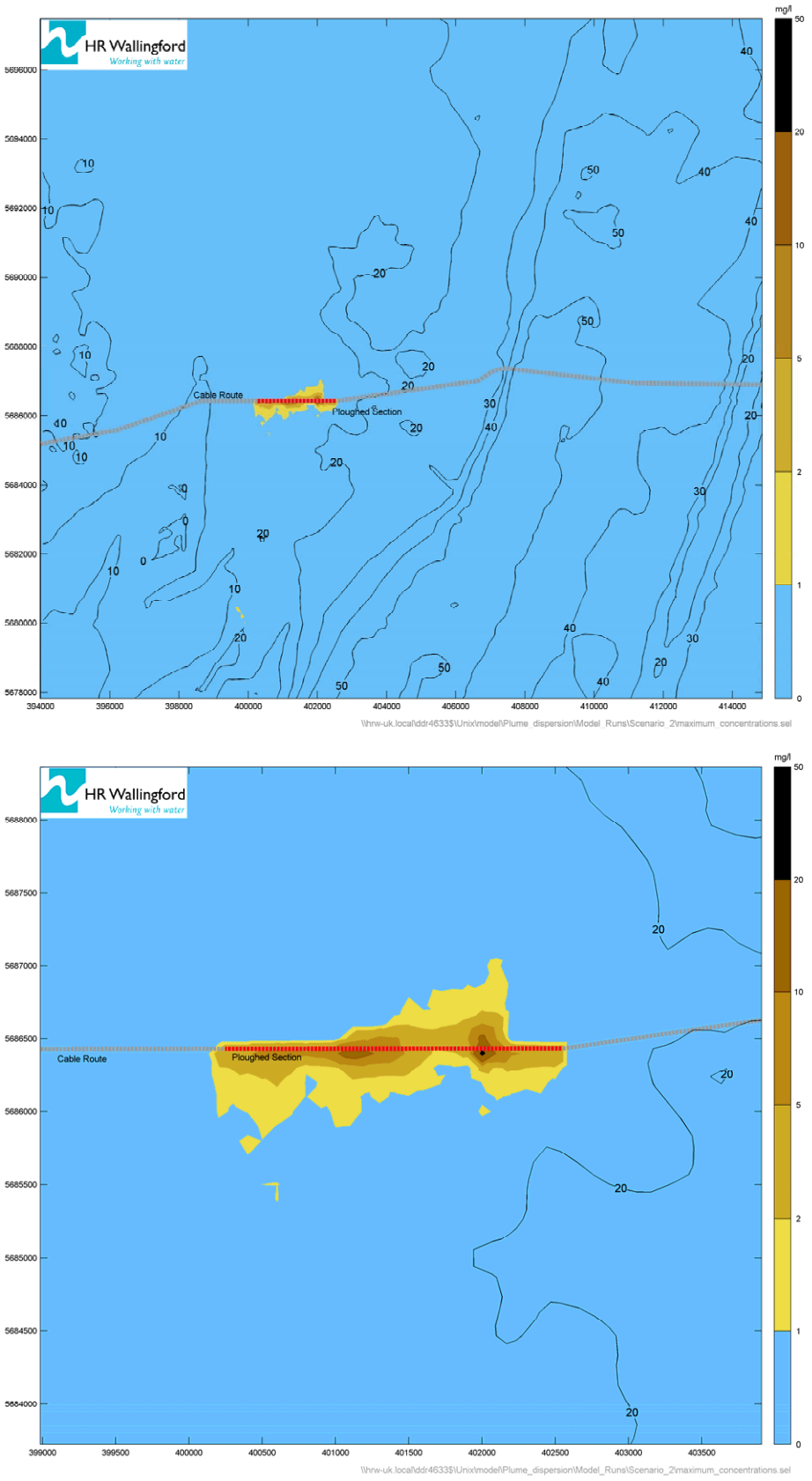

Figure 10 Predicted increase in near-bed suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)

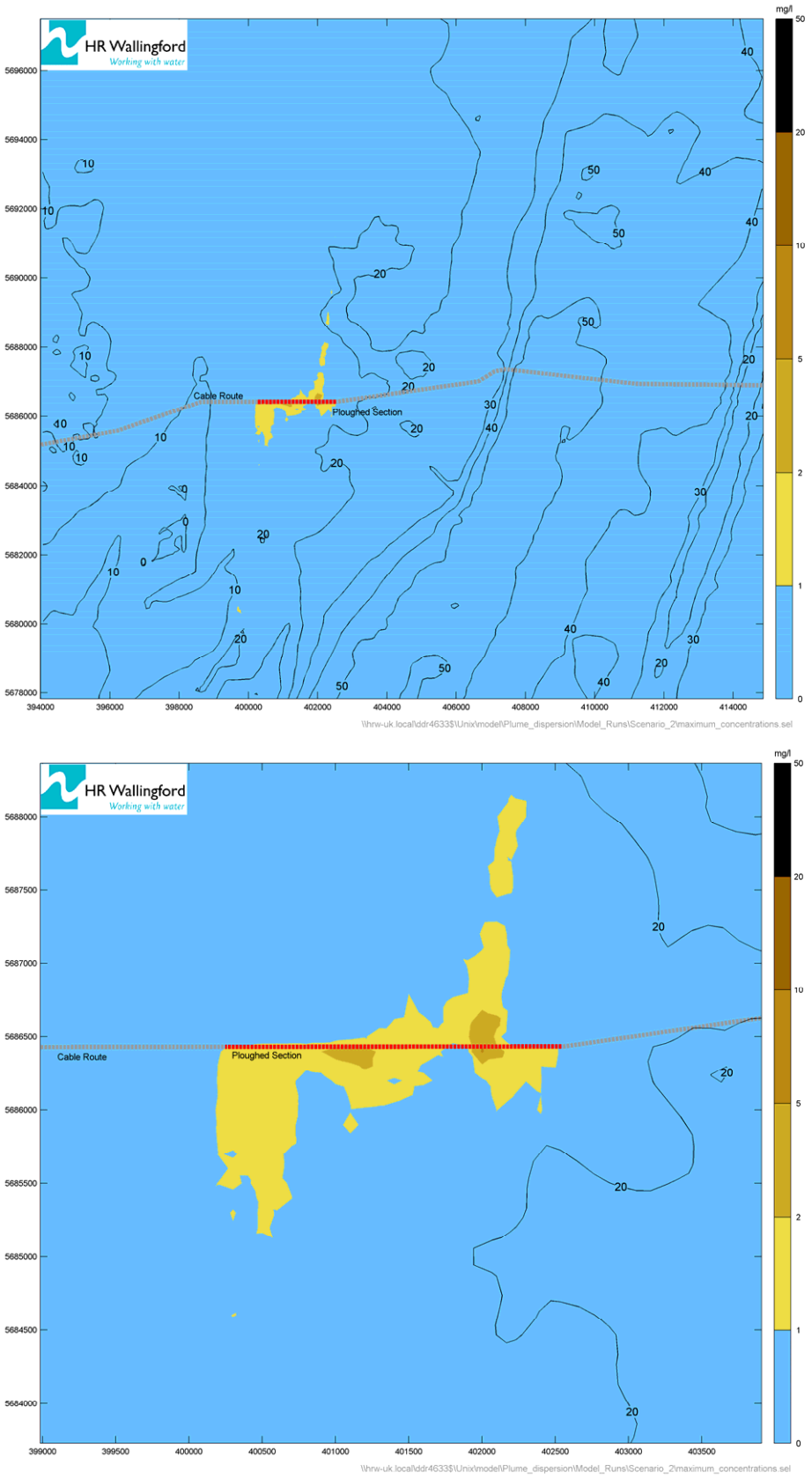

Figure 11 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)

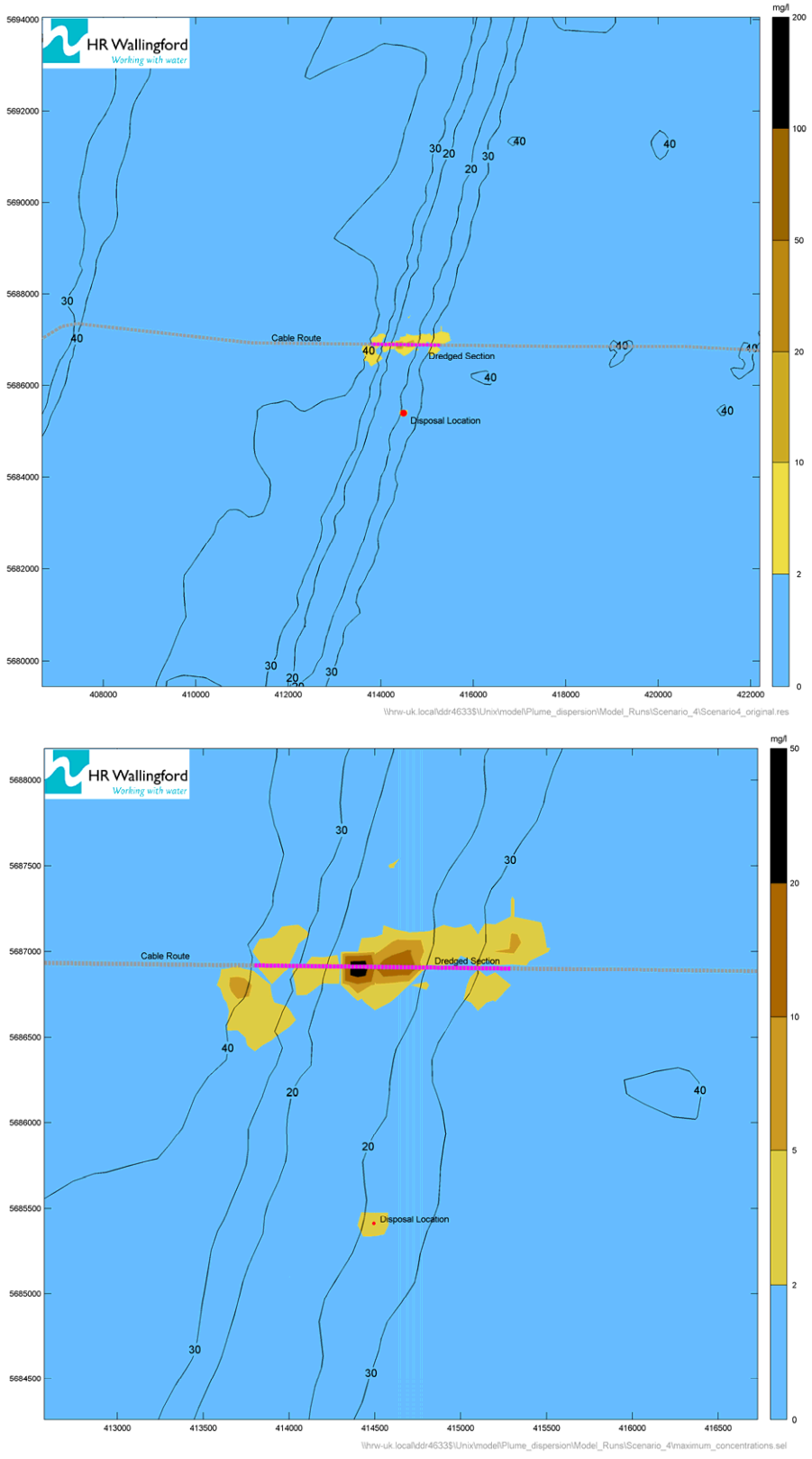

Figure 12 Predicted increase in near-bed suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)

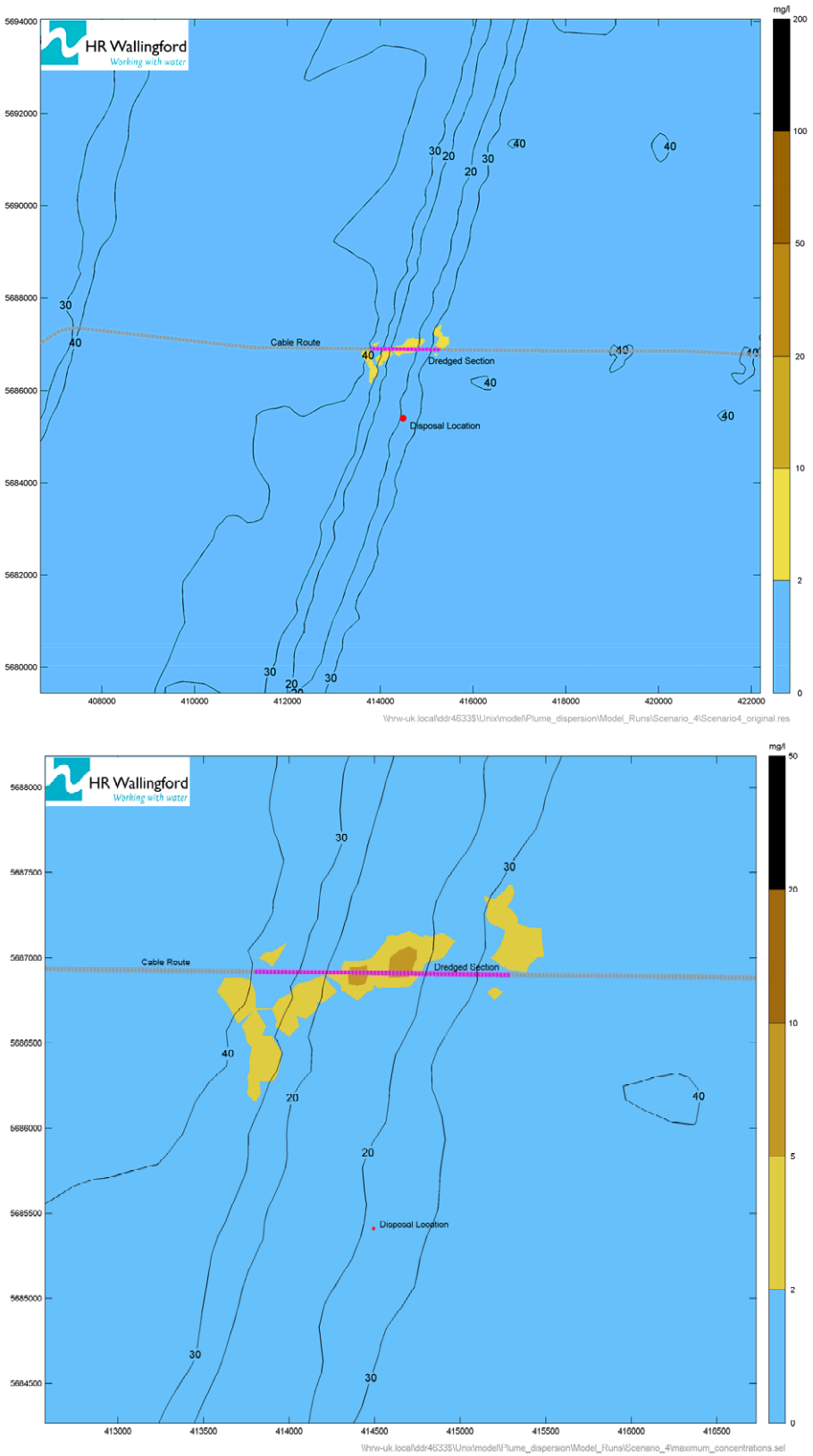

Figure 13 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)

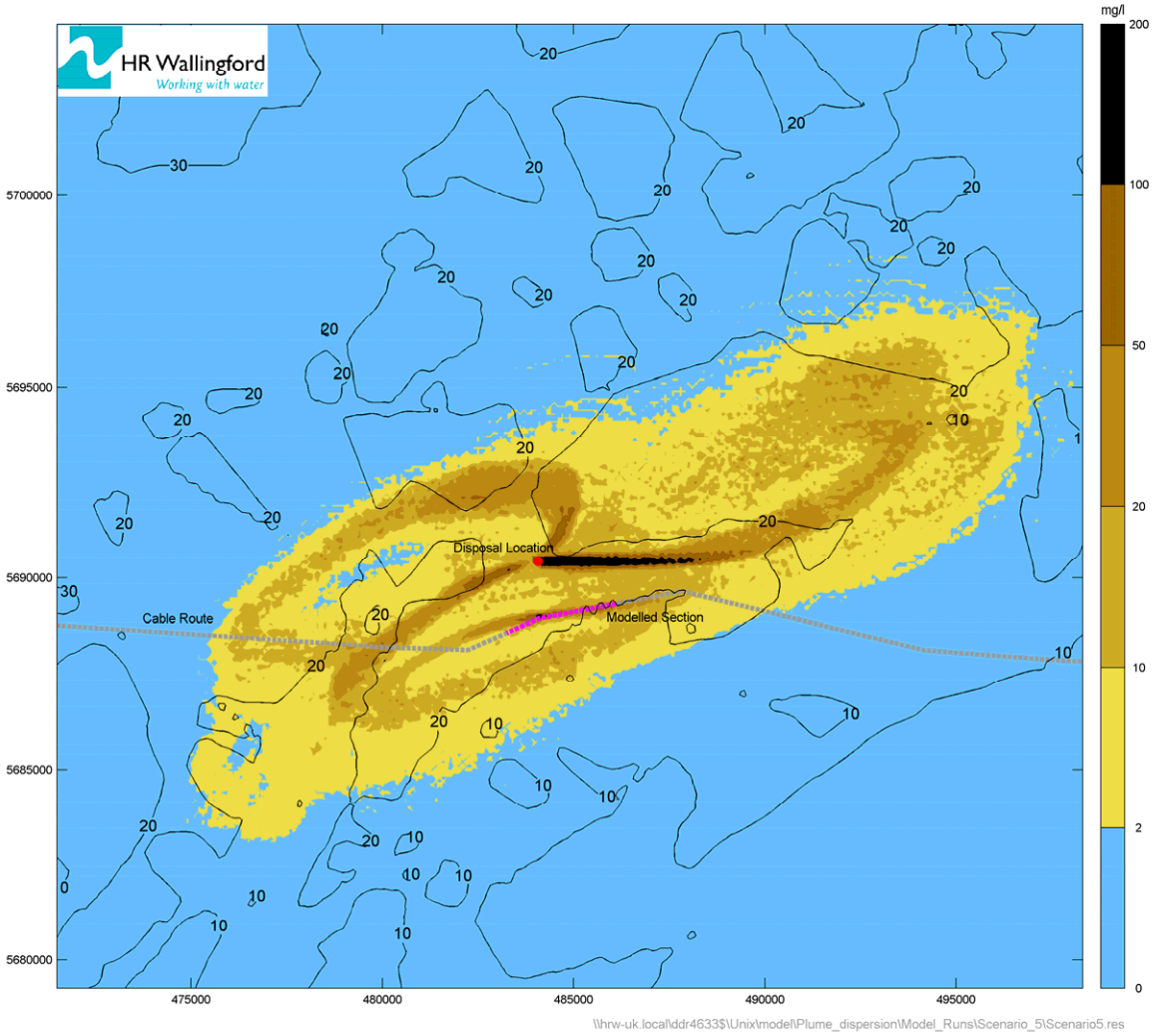

Figure 14 Predicted increase in near-bed suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north

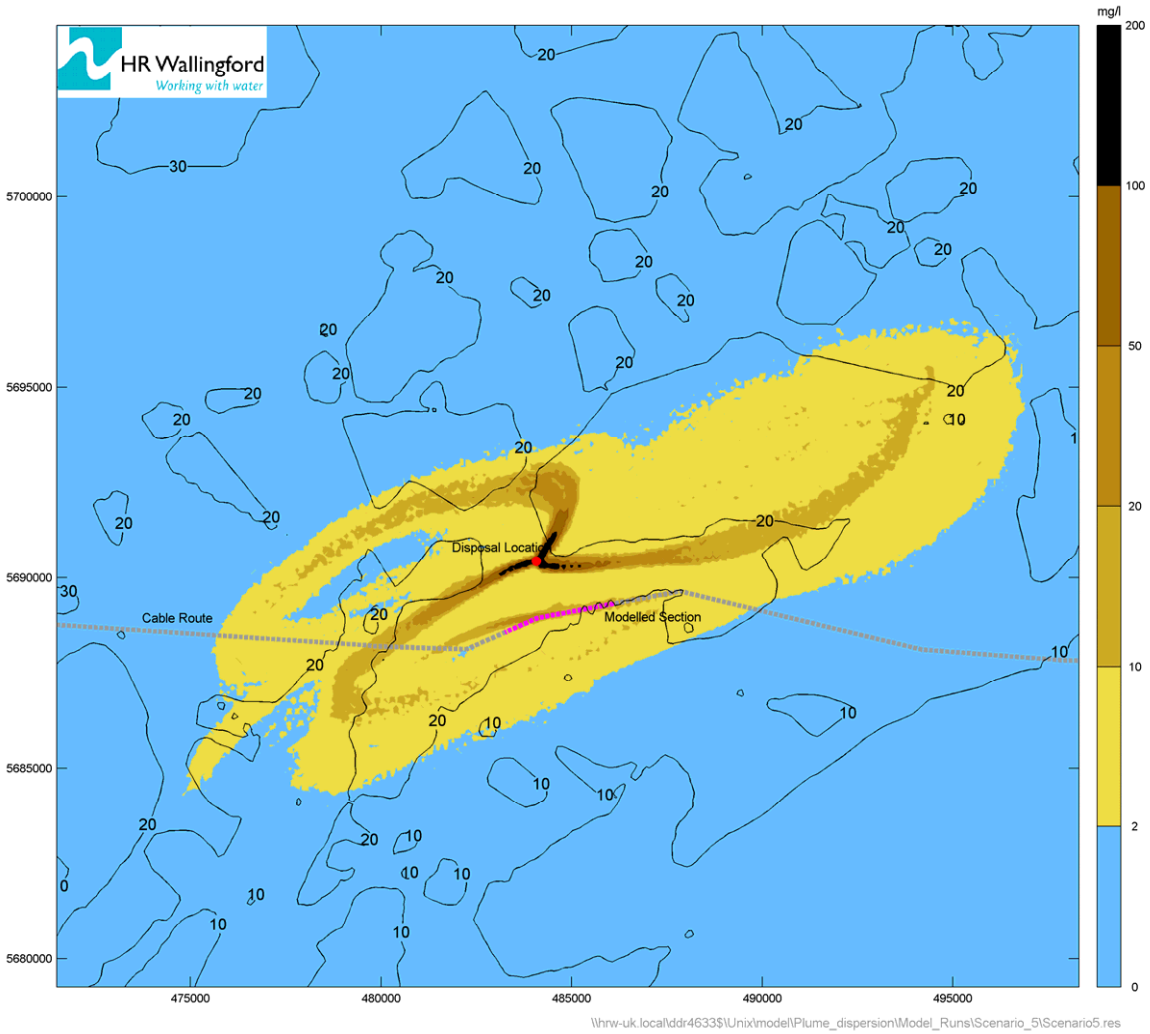

Figure 15 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north

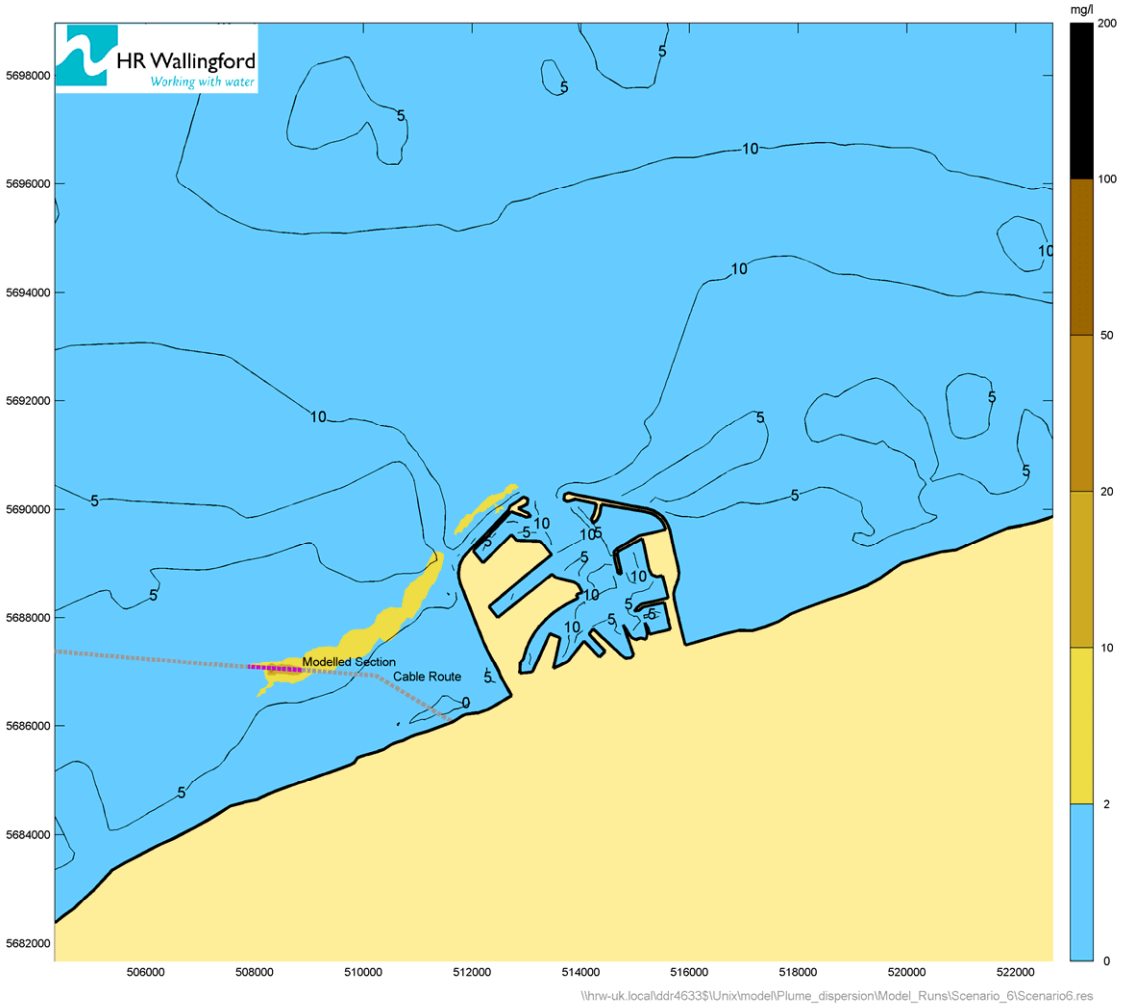

Figure 16 Predicted increase in near-bed suspended sediment concentration above background, Scenario 6, ploughing mud

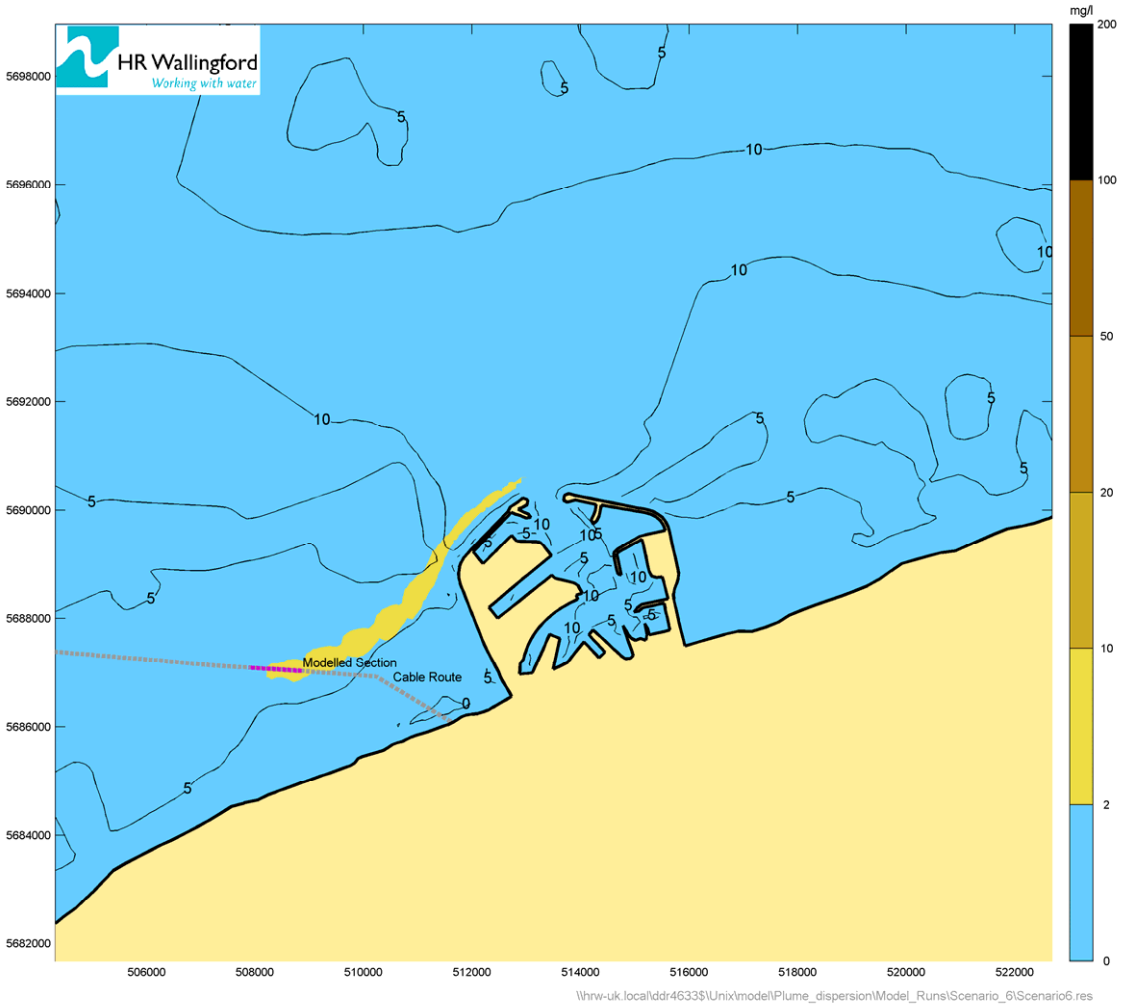

Figure 17 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 6, ploughing mud

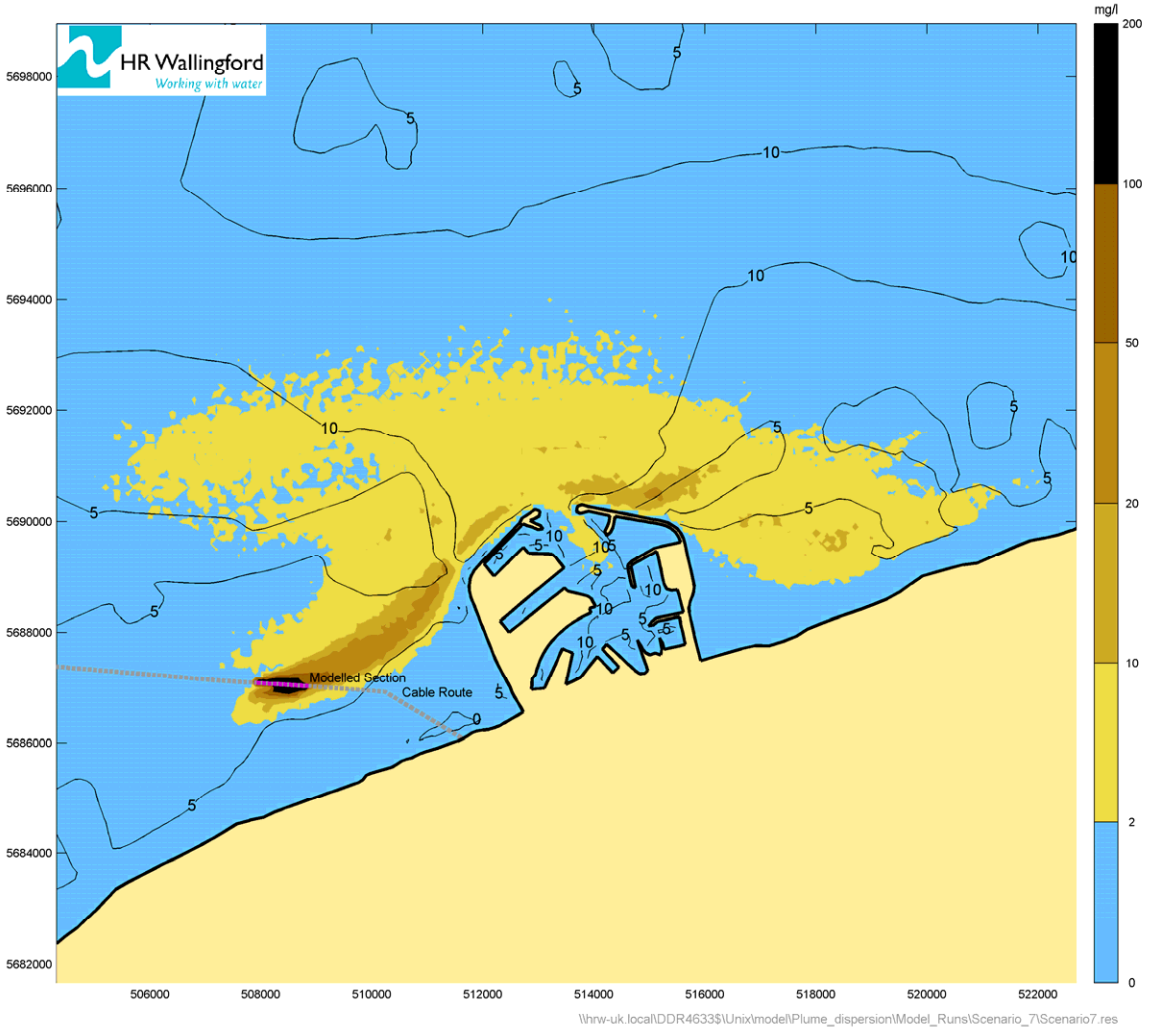

Figure 18 Predicted increase in near-bed suspended sediment concentration above background, Scenario 7, jetting mud

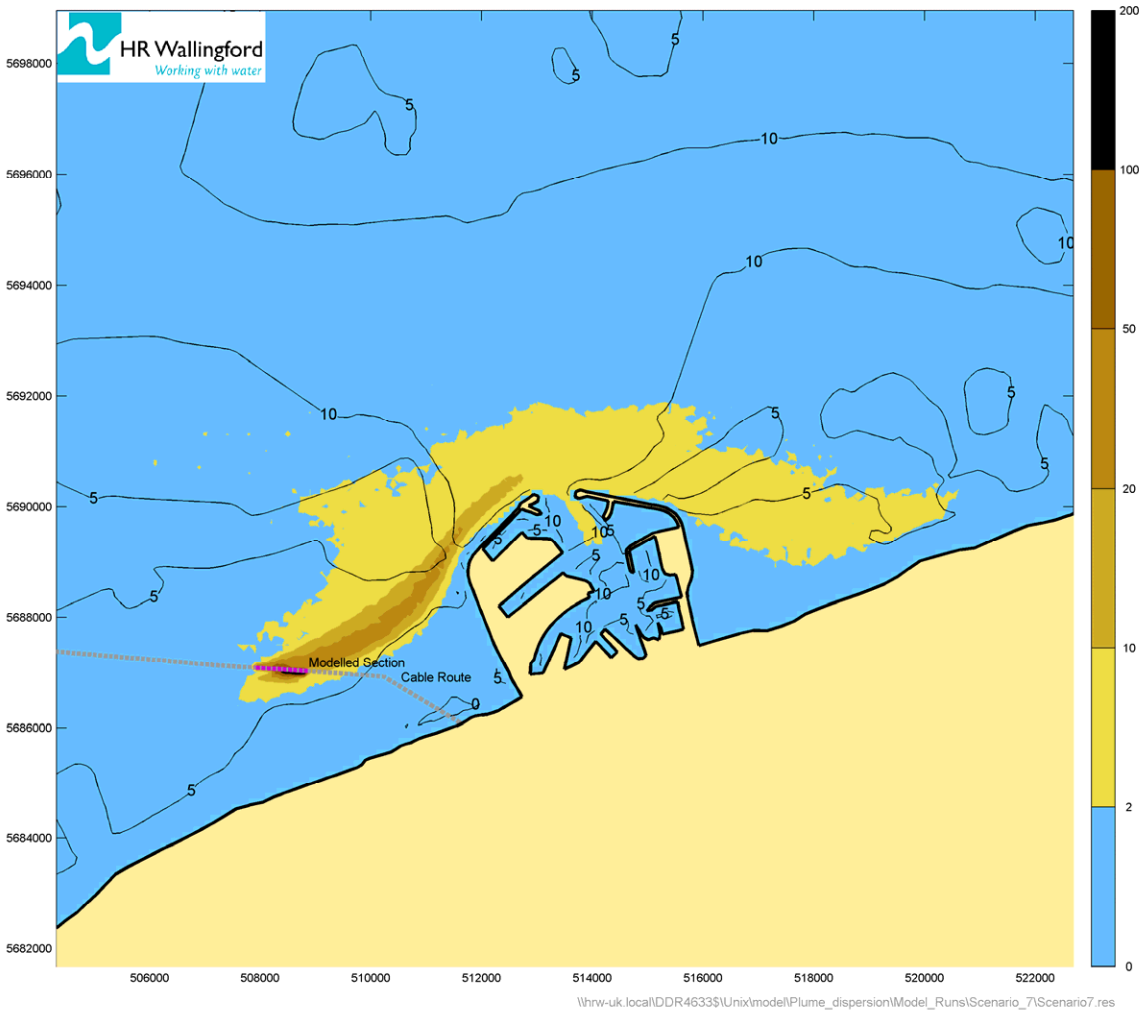

Figure 19 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 7, jetting mud

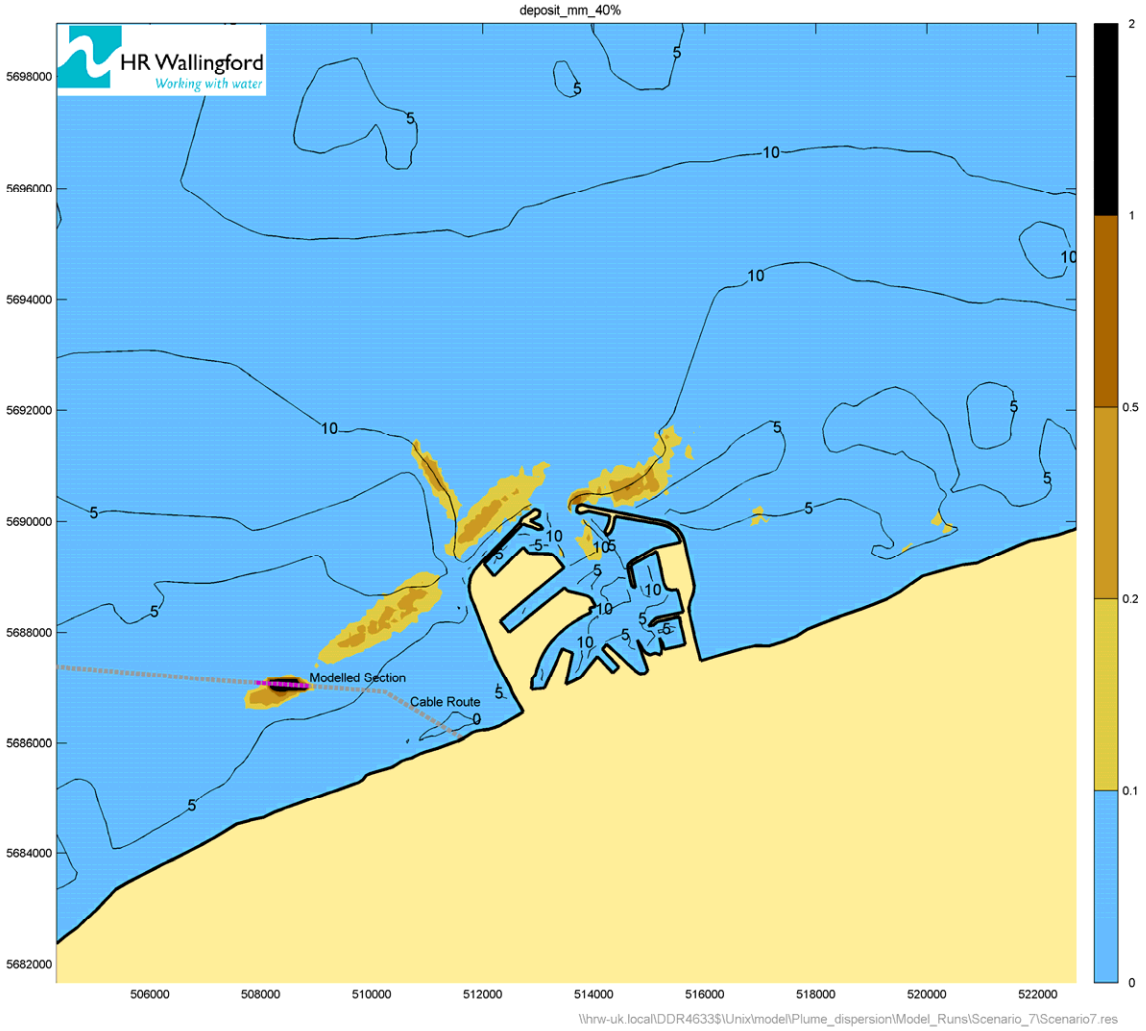

Figure 20 Predicted deposition of fine sediment arising from jetting of mud, Scenario 7

Appendices

Appendix 1 SEDPLUME-RW technical description

Flow in a coastal region consists of large-scale tidal motion, wind-driven currents and small-scale turbulent eddies. In order to model the dispersal of suspended mud in such a region, the effects of these flows on suspended mud plumes must be simulated. The random walk dispersal model, SEDPLUME, represents turbulent diffusion as random displacements from the purely advective motion described by the turbulent mean velocities computed by the depth-averaged free surface flow model, TELEMAC-2D.

Representation of mud disturbance

In SEDPLUME, the release of suspended mud in coastal waters is represented as a regular or intermittent discharge of discrete particles. Particles are released throughout a model run to simulate continuous mud disturbance or for part of the run to simulate mud disturbance over an interval during the tidal cycle, for instance to represent the resuspension of fine sediment during dredging operations. At specified sites a number of particles are released in each model time-step and, in order to simulate the release of suspended mud, the total mud released at each site during a given time interval is divided equally between the released particles. Particles can be released either at the precise coordinates of the specified sites, or distributed randomly, centred on the specified release sites. The particles can be released at the surface or evenly distributed through the water column. This allows the representation of the initial spreading of plumes of material released by a dredger, for example, but SEDPLUME results are generally fairly insensitive to the specified initial spreading radius.

Large scale advection

TELEMAC-2D simulates depth-averaged tidal flows in coastal waters. SEDPLUME converts the depth-averaged current TELEMAC-2D output into a 3D representation of tidal currents using the well-known logarithmic velocity profile:

$$U(z) = \frac{U_*}{\mathrm{K}} \ln\left(\frac{30.1z}{k_s}\right) \qquad (1)$$

where

U	=	current speed (ms^{-1})
U_*	=	friction velocity for a tidal current (ms^{-1})
K	=	von Karman's constant
z	=	distance above sea bed (m)
k_s	=	roughness length (m)

Each particle is then advected by the local flow conditions. Because the three dimensional structure of the flow is calculated by SEDPLUME, effects such as shear dispersion of plumes are automatically represented.

In the case of wind-driven currents, SEDPLUME assumes that the surface wind-driven current is parallel to the wind vector with a speed given by:

$$S = \alpha w \qquad (2)$$

where

S	=	surface wind-driven current speed (ms^{-1})
α	=	an empirical constant
w	=	wind speed at 10m above the sea surface (ms^{-1})

SEDPLUME uses this information to establish a parabolic velocity profile through depth due to wind which is superimposed upon the tidal current profile.

Turbulent diffusion

In order to simulate the effects of turbulent eddies on suspended mud plumes in coastal waters, particles in SEDPLUME are subjected to random displacements in addition to the ordered movements which represent advection by mean currents. The motion of simulated plumes is, therefore, a random walk, being the resultant of ordered and random movements. Provided the lengths of the turbulent displacements are correctly chosen, the random step procedure is analogous to the use of turbulent diffusivity in depth-averaged mud transport models. This is discussed in more detail below.

(a) Lateral diffusion

The horizontal random movement of each particle during a time-step of SEDPLUME consists of a displacement derived from the parameters of the simulation. The displacement of the particle in each of the orthogonal horizontal directions is calculated from a Gaussian distribution, with zero mean and a variance determined from the specified lateral diffusivity. The relationship between the standard deviation of the displacement, the time-step and the diffusivity is defined in Reference 1 as:

$$\frac{\Delta^2}{\Delta t} = 2D \qquad (3)$$

where
Δ = standard deviation of the turbulent lateral displacement (m)
Δt = time-step (s)
D = lateral diffusivity (m^2s^{-1}).

In a SEDPLUME simulation, a lateral diffusivity is specified, which the model reduces to a turbulent displacement using Equation (3). No directional bias is required for the turbulent movements, as the effects of shear diffusion are effectively included through the calculated depth structure in the mean current profile.

(b) Vertical diffusion

Whilst lateral movements associated with turbulent eddies are satisfactorily represented by the specification of a constant diffusivity, vertical turbulent motions can vary significantly horizontally and over the water depth, so that vertical diffusivities must be computed from the characteristics of the mean flow field, rather than specified as constants. In neutral conditions, the vertical diffusivity, K_z, is given by:

$$K_z = 0.16\, h^2 \left(1 - \frac{h}{d}\right) \frac{\partial u}{\partial z} \qquad (4)$$

where
h = height of particle above the bed
d = water depth
0.16 = (von Karman constant)^2
u = current speed
z = vertical coordinate

The value of the vertical diffusivity is calculated at each particle position, then a vertical turbulent displacement is derived for each particle from its K_z value using an equation analogous to (3) for the lateral turbulent displacement.

(c) Drift velocities

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \qquad (5)$$

A particle undergoes a random walk as follows:

where x^n is the position of the particle at time t^n, A is the advection velocity at timestep $n-1$ and B is a matrix giving the diffusivity. ξ is a vector of three random numbers, each drawn from a normal distribution with unit variance and zero mean. In the case of SEDPLUME, B is diagonal, with the first two entries equal to $\sqrt{(2D)}$ (as introduced in the previous section) and the third diagonal entry being equal to the local value of $\sqrt{(2K_z)}$.

The movement of a particle undergoing a random walk as described in equation (5) can be described by the Fokker-Planck equation in the limit of a very large number of particles and a very short timestep, where we introduce subscripts i,j and k running over the three coordinate directions:

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \qquad (6)$$

The probability density function $f(x,t|x_0,t_0)$ is the probability of a particle which starts at position x_0 at time t_0 being at position x at time t.

Equation (6) can be compared with the advection-diffusion equation for the concentration of a pollutant, c:

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \qquad (7)$$

where K_{ik} is the eddy diffusion matrix, diagonal in our case but not necessarily so. Thus identifying f with c, we can see that the two equations are equivalent provided that we take the advection velocity as:

$$A_i = u_i + \frac{\partial}{\partial x_k} K_{ik} \qquad (8)$$

In the case of SEDPLUME, the diffusivity varies only in the vertical and is constant in the horizontal, so the horizontal advection velocity is simply the flow velocity (assuming that the relatively small effects of changing water depth can be neglected). However, when considering the movement of particles in the vertical it is important to include the gradient of the diffusivity (often referred to as a drift velocity) in the advection step. If this term is omitted then particles tend to accumulate in regions of low diffusivity, which in our case means at the surface and at the bed.

This subject is discussed in considerably more detail in References 2, 3, 4, and 5.

Sedimentation processes

(a) Settling

In SEDPLUME, the settling velocity (w_s) of suspended mud is assumed to be related to the mud concentration (c) through an equation of the form:

$$w_s = \max(w_{\min}, Pc^Q) \quad (9)$$

where w_{min}, P and Q are empirical constants. Having computed a suspended mud concentration field, as described subsequently in this section, a settling velocity can be computed in each output grid cell from Equation (7) and used to derive a downward displacement for each particle during each time-step of a model simulation. This displacement is added vectorially to the other computed ordered and random particle displacements. Note that there is a specified minimum value of w_s. This results in settling velocities being constant at low suspended mud concentrations, as indicated by recent research at HR. (Reference 6).

(b) Deposition

SEDPLUME computes bed shear stresses from the input tidal flow fields using the rough turbulent equation, based on a bed roughness length input by the user. If the effects of storm waves on mud deposition and erosion at the sea bed are to be included in a model simulation, a bed shear stress associated with wave orbital motions, computed from the results of mathematical wave model simulations, is added to that resulting from the simulated tidal currents (Reference 7). Where the computed bed stress, τ_b, falls below a specified critical value, τ_d, and the water is sufficiently deep, then deposition is assumed to occur. Mud deposition is represented in SEDPLUME by particles approaching the sea bed becoming inactive when τ_b is below τ_d. Whilst active particles in the water column contribute to the computed suspended mud concentration field, as described subsequently in this appendix, inactive particles contribute to the mud deposit field.

In shallow areas, where tidal currents are sufficiently weak to allow mud accretion, normal wave action can prevent mud deposition. This effect is included empirically in SEDPLUME, by specifying a minimum water depth below which deposition does not occur.

(c) Erosion

The erosion of mud deposits from the sea bed is represented in SEDPLUME by inactive particles returning to the water column (becoming active) when τ_b exceeds a specified erosional shear strength, τ_e. The number of particles which become re-suspended in each cell of the output grid in each time-step of a simulation is determined by the equation:

$$\frac{\partial m_e}{\partial t} = M(\tau_b - \tau_e) \quad (10)$$

where
m_e is the mass eroded (kg)
t is time (s)
M is an empirical erosion constant.

Computation of suspended mud concentrations

In SEDPLUME-RW, suspended mud concentrations are computed on the TELEMAC-2D or TELEMAC-3D grid which can be designed to resolve the essential features of relatively small-scale plumes. In each SEDPLUME grid cell a concentration is derived by dividing the total suspended mud represented by all the active particles in that cell by the volume of the cell.

The model is most suited to simulating detailed distributions of suspended mud and mud deposits near areas of dredging-related activity over a few tidal cycles. The far-field effects of dredging-related activity can be simulated using other models in use at HR Wallingford.

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5. B J Legg and M R Raupach. "Markov-chain simulation of particle dispersion in inhomogeneous flows: the mean drift velocity induced in a gradient in Eulerian velocity variance". Boundary Layer Meteorology Vol 24, pp3-13, 1982.
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Project Nemo – UK to Belgium Interconnector

Modelling of Trench Infill Rates

Technical Note DDR4633-04

HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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Project Manager	John Harris
Project Director	Richard Whitehouse

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Approved

Authorised

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Figure 4 Infill rates at 60 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm) 3

1. Introduction

An assessment of the potential trench infill associated with offshore cable laying operations as part of Project Nemo was made using HR Wallingford's standard trench infill model based on SEDFLUX using bathymetric and hydrodynamic information representative for the cable route. This approach gives estimates of the amount of sediment depositing in the open trench due to suspended and bedload transport.

2. Trench infill calculations using SEDFLUX

The computational sediment transport model SedFlux has been developed at HR Wallingford over a number of years (HR Wallingford 2007). It predicts the magnitudes and directions of bedload, suspended load and total load transport rates for sand or shingle, together with suspended sediment concentrations at specified heights. SedFlux has been updated in successive stages during its development, namely up to its current version, SedFlux2010.

SedFlux2010 includes:

- the method of calculating the bottom orbital velocity under combined waves and currents
- the effect of a rippled bed, based on explicit predictions of ripple geometry and roughness
- the effect of a bed sloping in an arbitrary direction relative to a current, combined with a wave in an arbitrary direction relative to the current
- contributions of wave asymmetry to the sediment transport.

SedFlux2010 has been tested against benchmark observations of suspended concentrations collated for the EC Projects SEDMOC and SANDPIT.

For the case of a uniform current alone (e.g. rivers) reasonable agreement was found with the widely-used methods of Ackers and White, and Engelund and Hansen. A set of "saturation tests" of the model has been performed for a range of coastal conditions, based on a standard set of input values of sediment, water, currents and waves originally produced by van Rijn (1993). SedFlux2010 gives results that are generally similar to those produced by van Rijn's own method.

SEDFLUX is ideally suited to analyse the sediment transport on the continental shelf, and allows for the analysis of the impact of a trench on that transport. For this purpose we calculate the transport rates at a location far away from the trench with the transport rates on the slopes of the channel. The differences in the transport then determine the infill rate of the channel.

This approach has been validated against data from a field experiment near Scheveningen, the Netherlands by Svasek (1965), also in Ribberink *et al*. (2005), where a wide pit was dredged at a location with an 8 m water depth and the morphological change was measured.

3. Trench infill assumptions.

For the calculations, it is assumed that an almost 2m deep trench is created and the resulting spoil is dumped in berms on either side of the trench (Figure 1).

The sediment transport calculations undertaken using SEDFLUX are done for a number of combinations, based on the bathymetry of the cable route and the local flow conditions:

1. 0.75m/s tidal velocity over a 20 m deep location
2. 1.1m/s tidal velocity over a 40 m deep location
3. 1.5m/s tidal velocity over a 60 m deep location

For all locations a 0.1m/s residual current is assumed and waves are varied with heights of 0.5 m, 1 m and 2 m. The median sediment grain sizes are varied between 0.2 mm and 0.5 mm at all locations. The infill calculations assume sediment is available on the seabed to be transported into the trench.

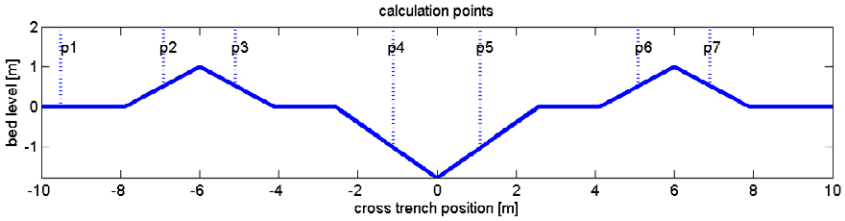

Figure 1 Assumed trench profile

4. Results

Infill rates are calculated in kg/day and in m^3/day per metre run of trench. The results are shown in Figures 2 to 4.

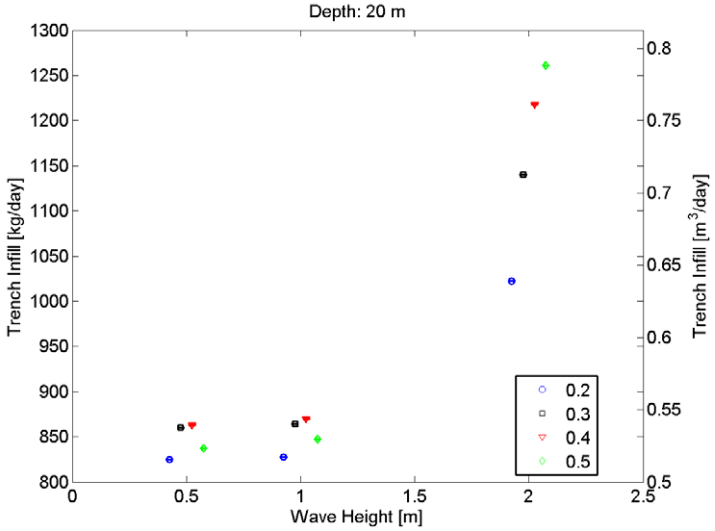

Figure 2 Infill rates at 20 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

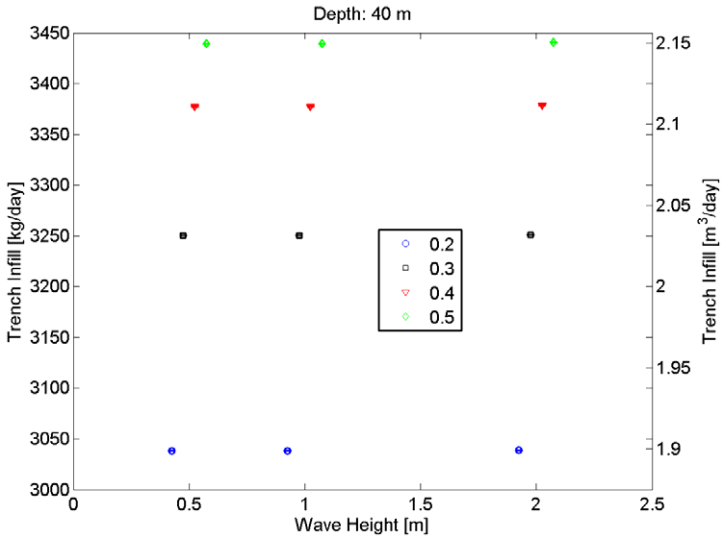

Figure 3 Infill rates at 40 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

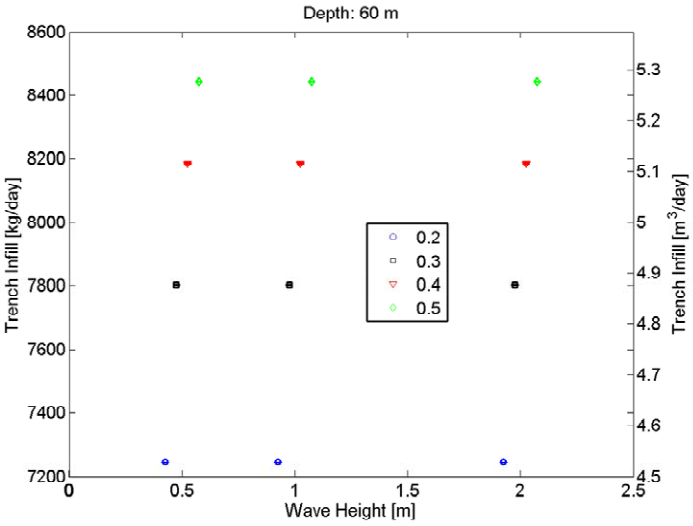

Figure 4 Infill rates at 60 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

4.1 DISCUSSION

The SEDFLUX calculations give the initial trench infill rates. These values are only valid whilst the slopes and depths at the reference points remain unaltered. As long as the cumulative infill is less than 10-20 % of the initial trench depth, this condition can be assumed to be met. If the cumulative infill exceeds this threshold, the infill rates will drop significantly because the effect of the trench depth on the local flow and transport will be reduced.

This implies that for some of the cases considered here, the initial estimates are no longer valid after the first day. Therefore, the infill rates, and in particular the higher valued ones, should only be considered as indications of the initial rate of infill and cannot be extrapolated to estimate the time it takes for the trench to fill completely.

4.2 CONCLUSION

For all conditions the infill rates are sufficiently high in areas of mobile sand to result in the trenches being filled within a period of few weeks. The higher depth-averaged tidal velocities in the deeper water depths result in higher infill rates in those areas. At those locations where sediment is not readily available to be transported on the seabed the rates of infill will be lower than predicted.

5. References

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Project Nemo – UK to Belgium Interconnector

Pre-Sweep Dredging of Sandwaves

Technical Note DDR4633-05

HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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Document Information

Project	Project Nemo – UK to Belgium Interconnector
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Project Manager	John Harris
Project Director	Richard Whitehouse

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Appendix 1

Pre-sweep long profiles

1. Introduction

Project Nemo concerns the installation of an HVDC interconnector between UK and Belgium. Along sections of the cable route pre-sweeping of mobile sandwaves has been identified as a requirement (PMSS, 2010). This is required to facilitate the subsequent burial of the cable to the required depth of installation to reduce the risk of cable exposure from sandwave migration.

This report documents the estimated pre-sweep dredging volumes of sand required as input to the environmental assessment.

2. Identification of pre-sweep areas

The operations report (PMSS, 2010) identified the requirement for pre-sweep dredging of areas of sandwaves along the pipeline route. It is expected this dredging will be performed by a suitable Trailing Suction Hopper Dredger (TSHD).

The geophysical survey in 2010 (MMT, 2010) mapped out the seabed profile in a 500 m wide corridor along the proposed route. Some slight alterations in the course were implemented by PMSS resulting from analysis of this survey. The pre-sweep calculations were based on this survey. The locations have been summarised on Figure 1. Only the crests of sandwaves will be removed, so the locations shown in Figure 1 contain many smaller areas, rather than being contiguous dredging.

Two types of requirement for dredging were identified:

Firstly, to facilitate the subsequent burial of the cable in sand to the required depth of installation, thereby reducing the likelihood of cable exposure due to sandwave migration. The functional description for this requirement has been defined as “Protect cable from sandwave mobility”.

Secondly, removal of significant veneer of sand material overlying bedrock (chalk or clay), thereby facilitating the installation in the underlying material. The functional description for this requirement has been defined as “Allow effective installation”.

The route workshop held by PMSS and HR Wallingford on 1 November 2010 confirmed the locations for pre-sweeping on the basis of these two requirements.

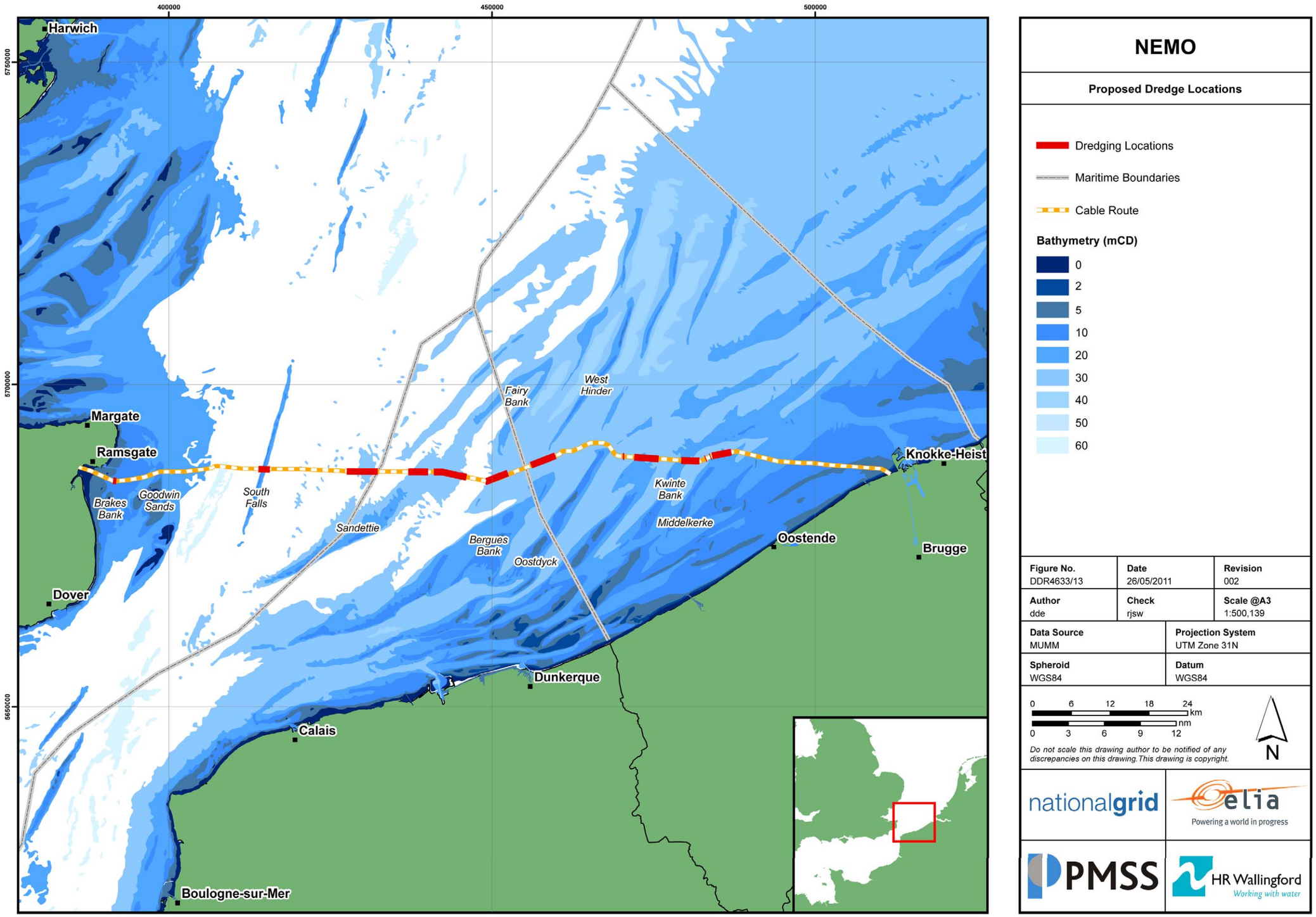


Figure 1 Bathymetry and dredge locations along the cable route

3. Calculation of pre-sweep dredge volumes

For the calculation of pre-sweep dredge volumes the larger sandwaves were identified in the long section as per the routing workshop. The dredge cross-section was determined as follows:

- 2 m vertical depth of dredging
- 20 m bottom width of dredging
- 1:5 side slopes.

The calculations were done in AutoCAD by determining the dredge cut line which meets the requirement to pre-sweep the top off each required sandwave. The 2 m cut line was defined below the mean level of the crest of the sandwave (which had smaller bedforms on it) rather than from the crest of the smaller bedforms. This ensured the dredging related to the form of the larger bedform which could be expected to move on the long-term. Of course the smaller bedforms are included in the dredge volume where they exist in the seabed profile. The AutoCAD Civil application for determining dredge volumes was used to calculate the 3D volumes. An example of the 3D nature of the calculations is shown in Figure 2 based on the pre-sweep profile and using the 2010 survey results. The dredge profile is depicted as "Areas cut" out of the crests of the sandwaves.

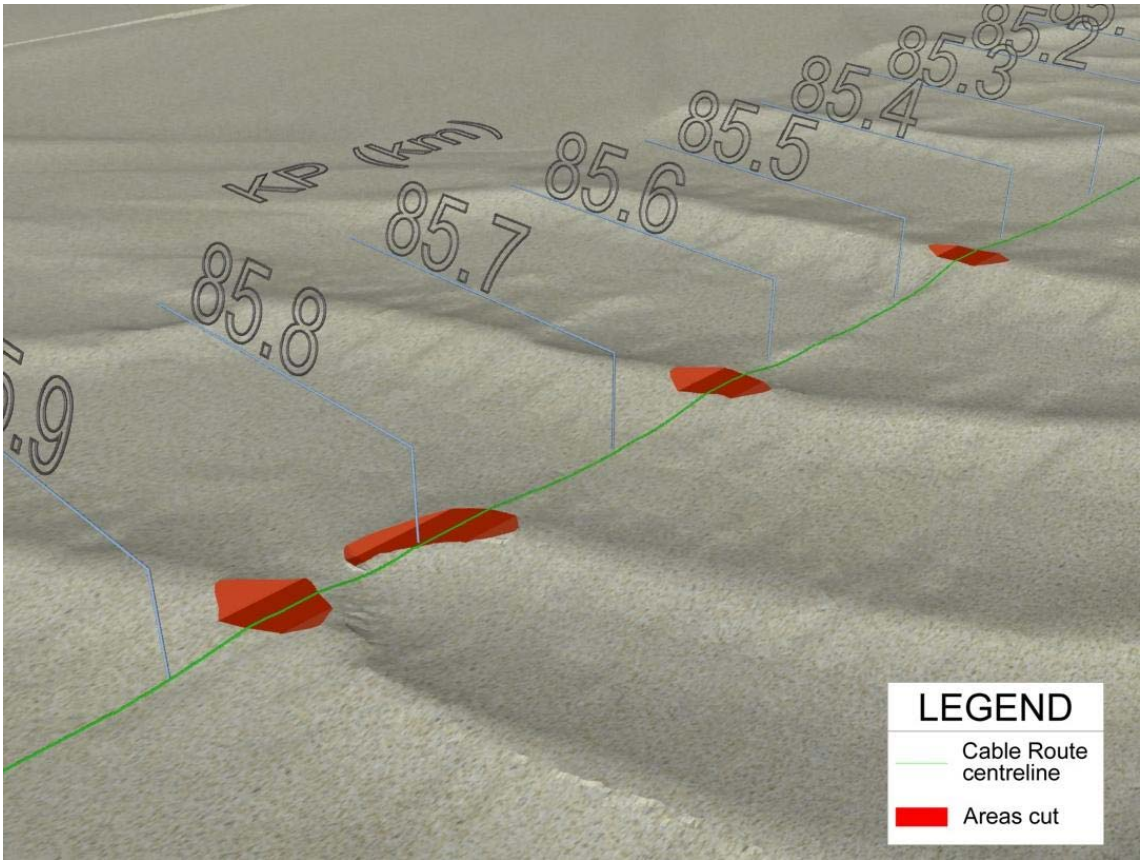


Figure 2 Example of pre-sweep profile through sandwaves

The results of the calculations are summarised in Table 1.

Table 1 Locations and quantity of sediments to be dredged from each location

KP (km from Belgian landfall)	Longitude (°E)	Latitude (°N)	Easting (m)	Northing (m)	Volume (m^3)	Purpose
26 - 29	2.77979	51.35257	484,665	5,689,057	38,273	Protect cable from sandwave mobility
29.25 - 29.35	2.75559	51.34716	482,978	5,688,460	743	Allow effective installation
30.05 - 30.15	2.74507	51.34426	482,245	5,688,140	33	Allow effective installation
31.5 - 34	2.70636	51.34514	479,549	5,688,248	10,829	Protect cable from sandwave mobility
37.5 - 41.25	2.61177	51.34873	472,963	5,688,678	20,479	Protect cable from sandwave mobility
42.8 - 43	2.56172	51.35095	469,479	5,688,944	482	Allow effective installation
54 - 57	2.40024	51.34705	458,230	5,688,590	27,899	Protect cable from sandwave mobility
61.8 - 63	2.30903	51.32294	451,852	5,685,965	48,491	Allow effective installation
63 - 65.4	2.28503	51.31696	450,174	5,685,316	21,330	Protect cable from sandwave mobility
68.5 - 69.2	2.21952	51.32001	445,612	5,685,702	4,593	Allow effective installation
69.2 - 73.6	2.18433	51.32437	443,165	5,686,213	60,249	Protect cable from sand ave mobility
74.5 - 77.5	2.11854	51.32572	438,583	5,686,417	32,614	Protect cable from sandwave mobility
82.3 - 87	1.99369	51.32529	429,883	5,686,480	24,470	Protect cable from sandwave mobility
99 - 100.75	1.77564	51.32706	414,694	5,686,908	93,138	Protect cable from sandwave mobility
123 - 123.5	1.44542	51.30614	391,638	5,685,017	1,170	Allow effective installation
Total quantity of dredging calculated					384,794	

4. Use of results

The results of this assessment have been used to inform the overall pre-sweeping dredging volumes of sand for the project and as input to the assessment of plume dispersion from TSHD operations (HR Wallingford, 2011).

The seabed profile at the time of installation and the KP locations of pre-sweeping may not correspond to those given within this report due to any further adjustments in cable route within the corridor, and also due to the movement of bed features in the period since the 2010 survey used in this study. Therefore, the estimated volume of dredging could vary from the figures quoted in Table 1. Based on the trench profile defined in Section 3, our estimate of the variability in volume for planning purposes is expected to be about ±10 per cent.

For engineering purposes the pre-sweep dredging profile and volumes should be confirmed with:

1. Analysis of the in-survey obtained prior to the cable installation work
2. The contractors proposed method of dredge operation, equipment specification and tolerances.

5. References

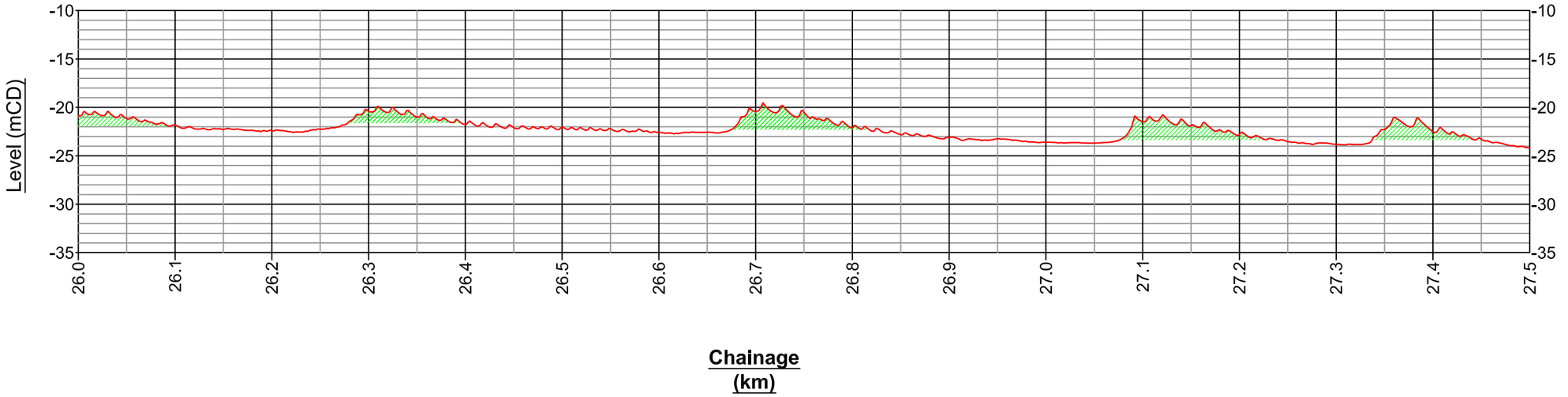
HR Wallingford (2011). Project Nemo – UK to Belgium Interconnector. Plume Dispersion Modelling. HR Wallingford Technical Note DDR4633-03, June 2011 (Release 3.0).

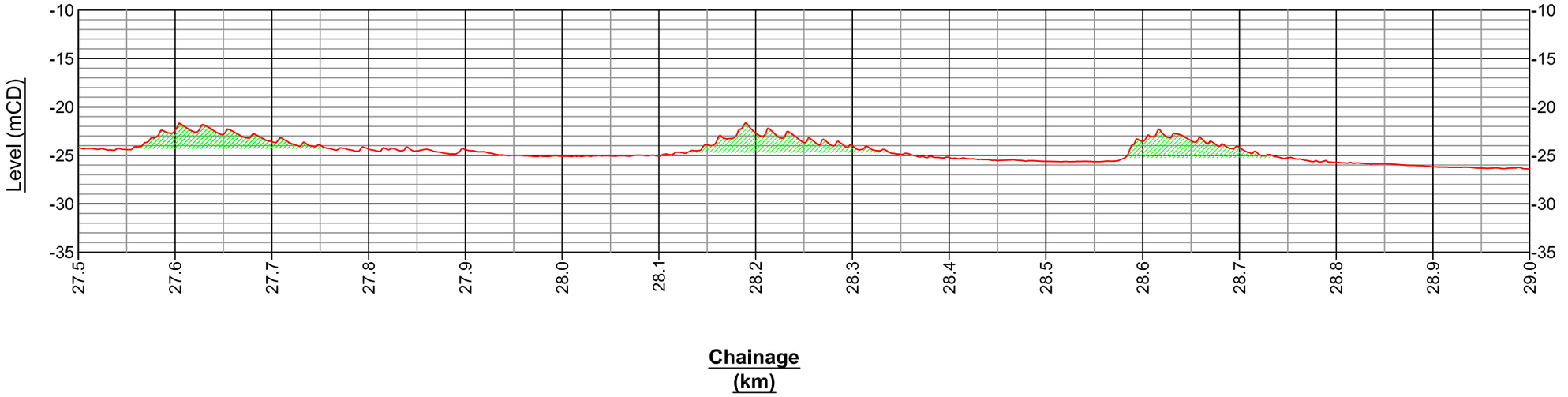
MMT (2010). Marine Survey Report, Project NEMO, Geophysical and Geotechnical Survey 2010, December 2010.

PMSS (2010). Nemo – Project Description, Working Document, PMSS report, Version 1, October 2010.

Appendix 1

Pre-sweep long profiles





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NOTES:

1. FOR CALCULATION OF DREDGE VOLUMES A CONTINUOUS DREDGE PROFILE IS SPECIFIED. THE VOLUME DREDGED FROM ANY BATHYMETRIC FEATURE IS CALCULATED WHERE THE FEATURE EXTENDS ABOVE THE DREDGE PROFILE.
2. THE SEABED PROFILE AND ASSOCIATED DREDGE PROFILE IS INDICATIVE OF CONDITIONS EXPECTED DURING THE PROJECT. THE ACTUAL LOCATION OF FEATURES AND DREDGE PROFILE MAY VARY.

LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
2	REISSUED	RER	RJSW	JMH	15 JUN 11
1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

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PMSS

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 26 - 29

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D001

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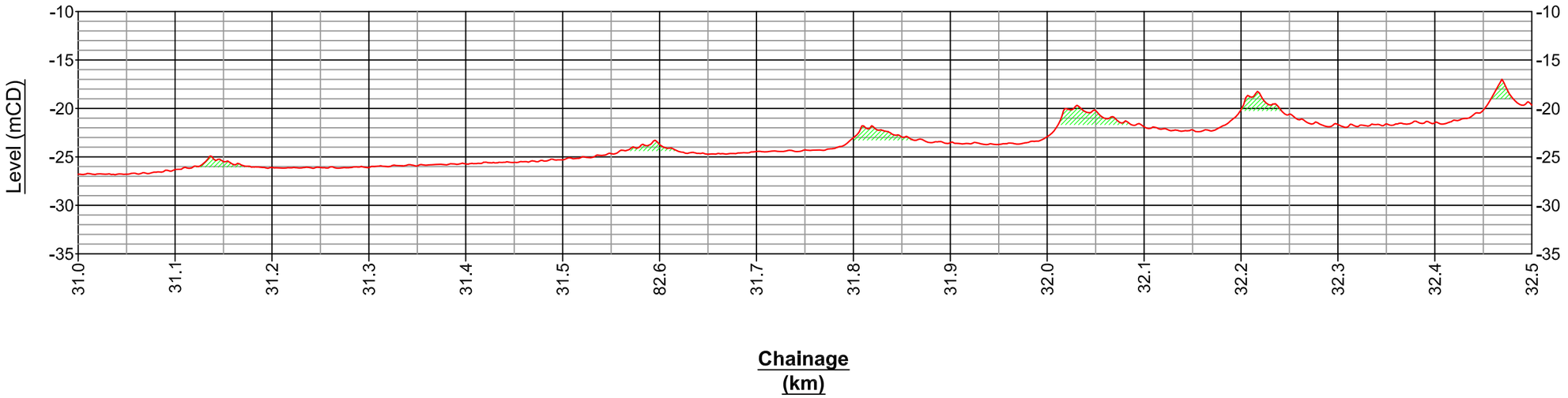

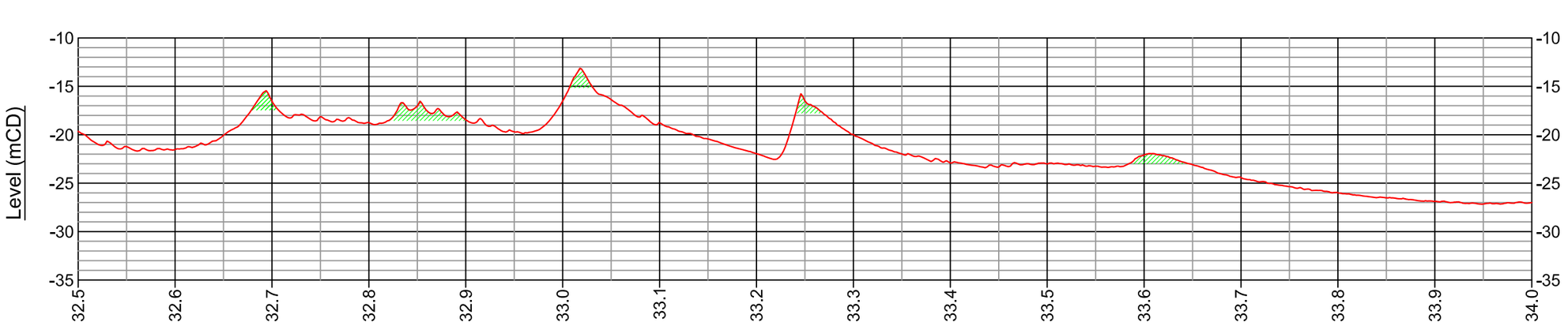

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NOTES:

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
2	REISSUED	RER	RJSW	JMH	15 JUN 11
1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 31 - 34

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D002

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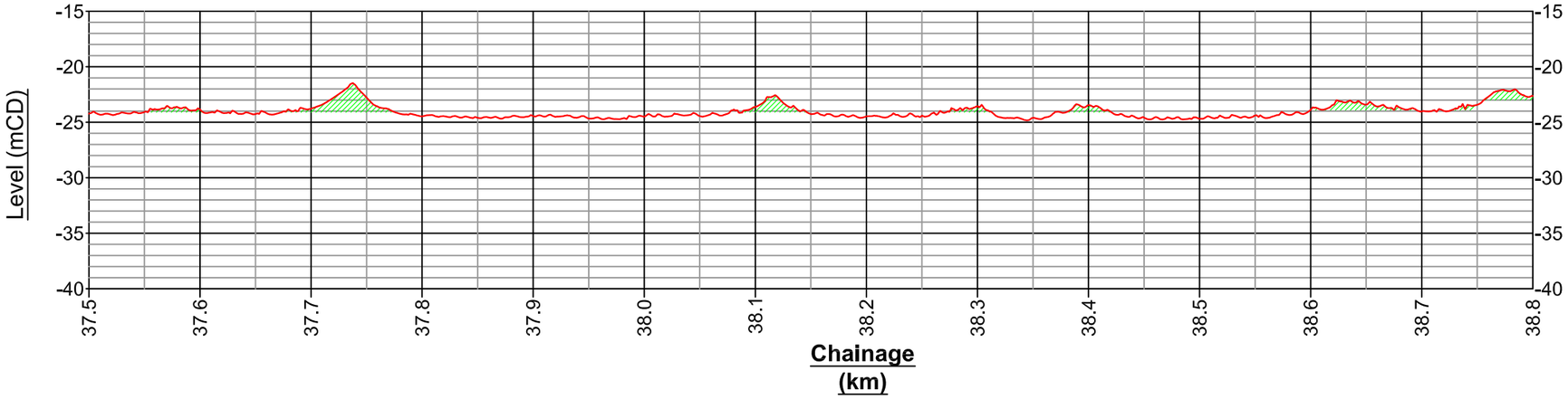

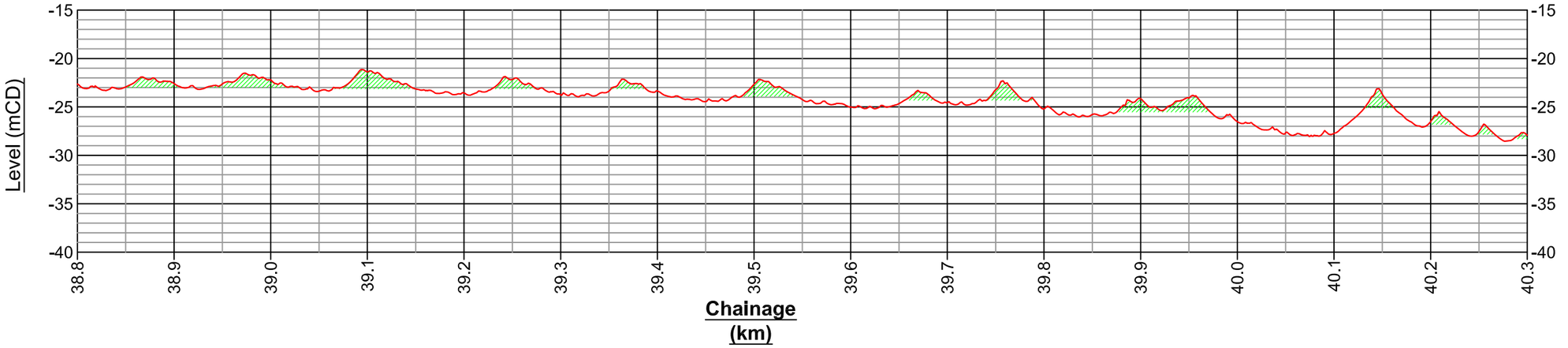

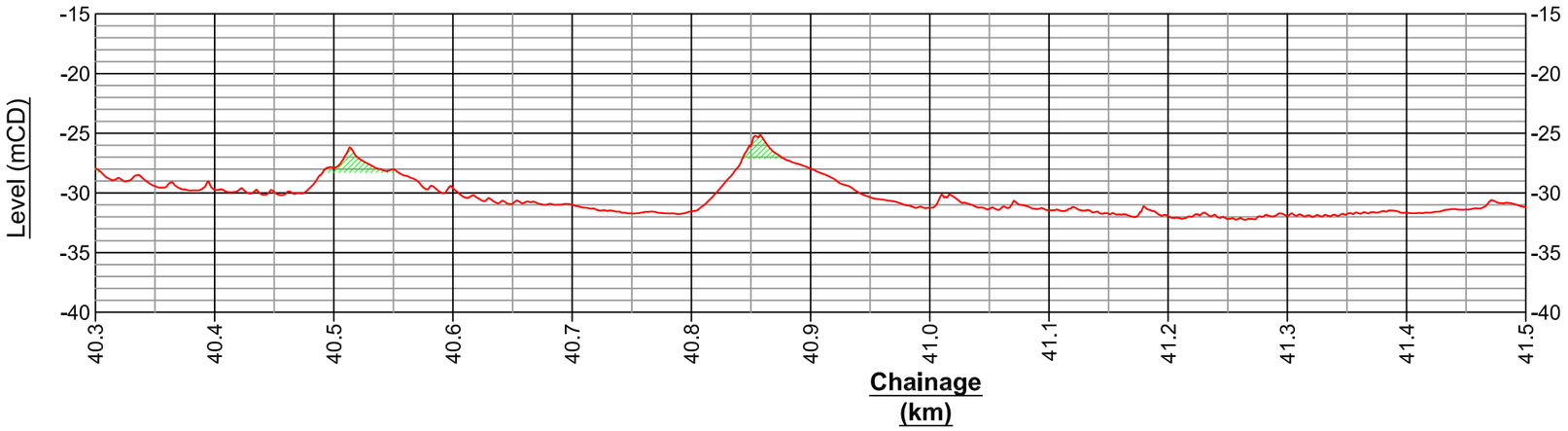

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 37.5 - 41.5

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D003

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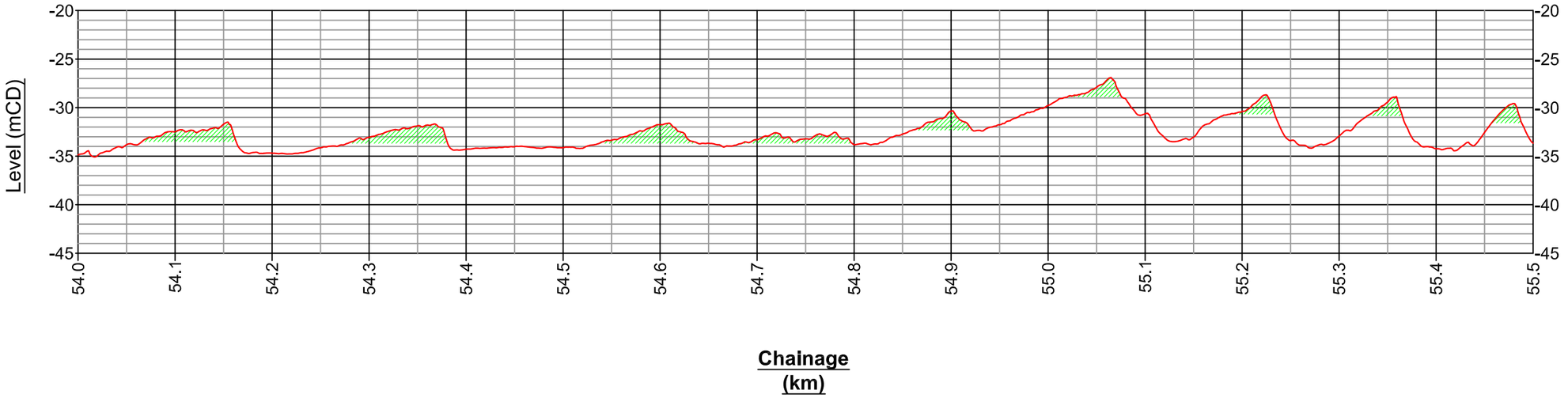

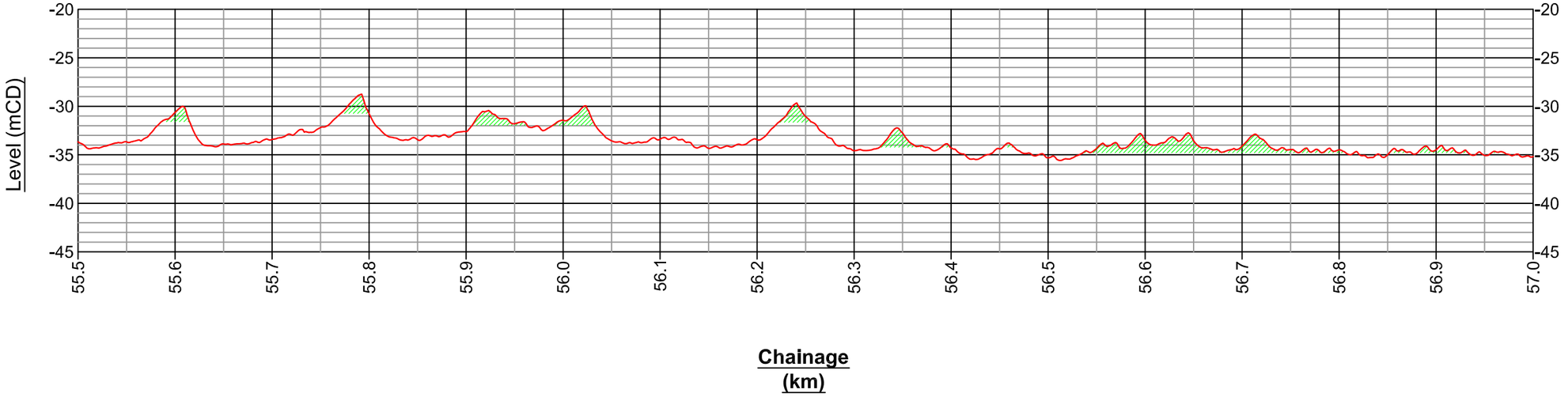

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MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 54 - 57

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D004

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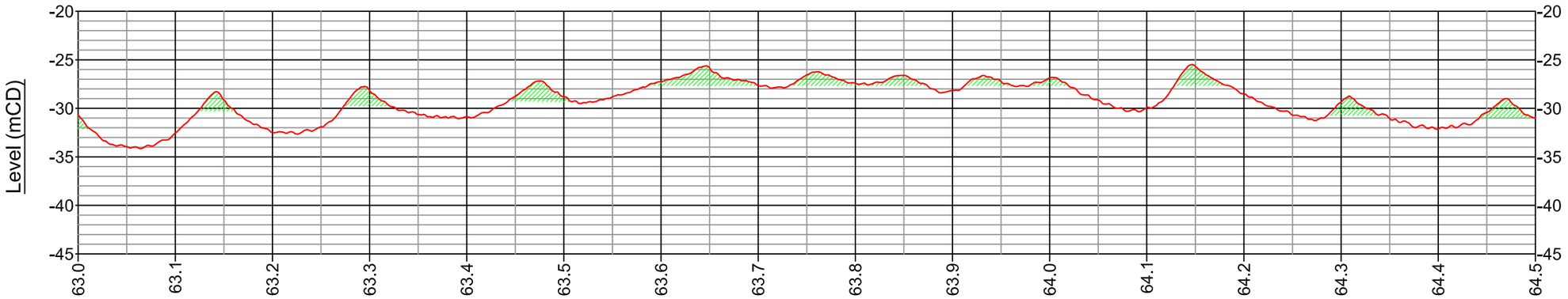

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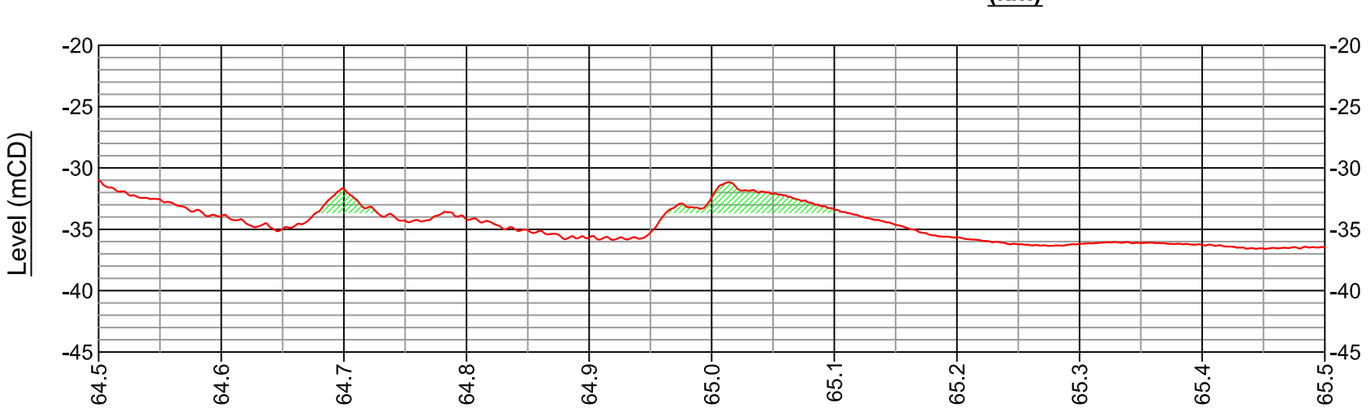

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INFO:

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 63 - 65.5

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D005

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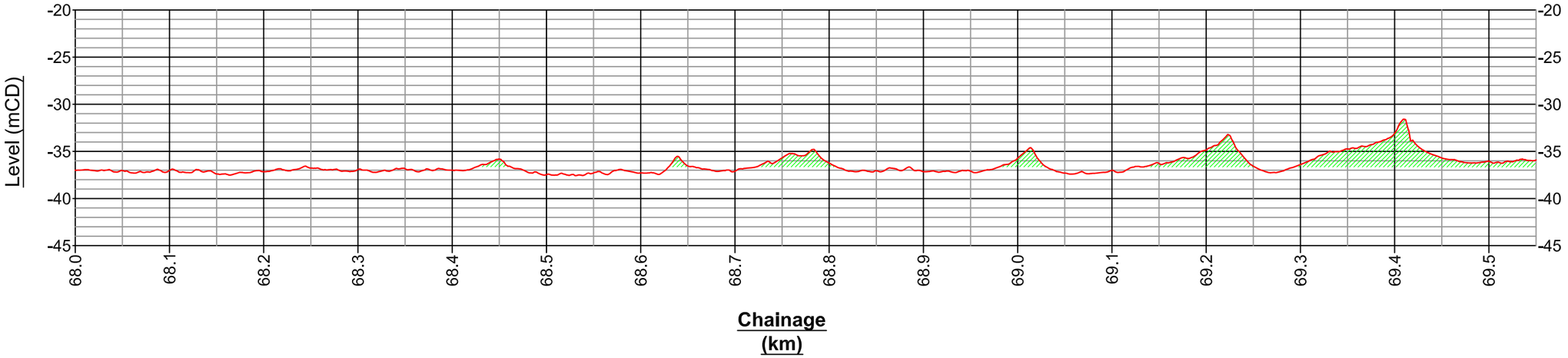

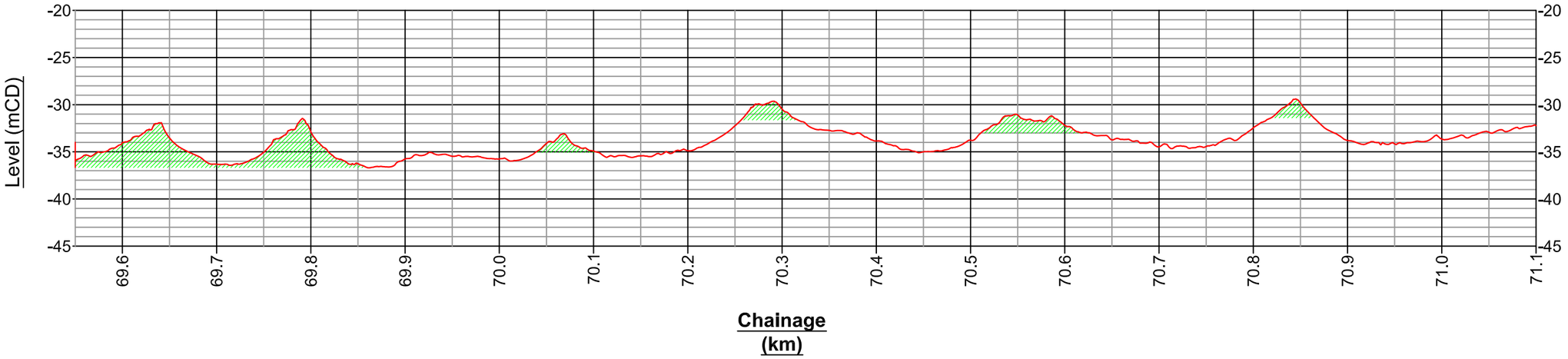

INFO:

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 68 -71.1

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D006

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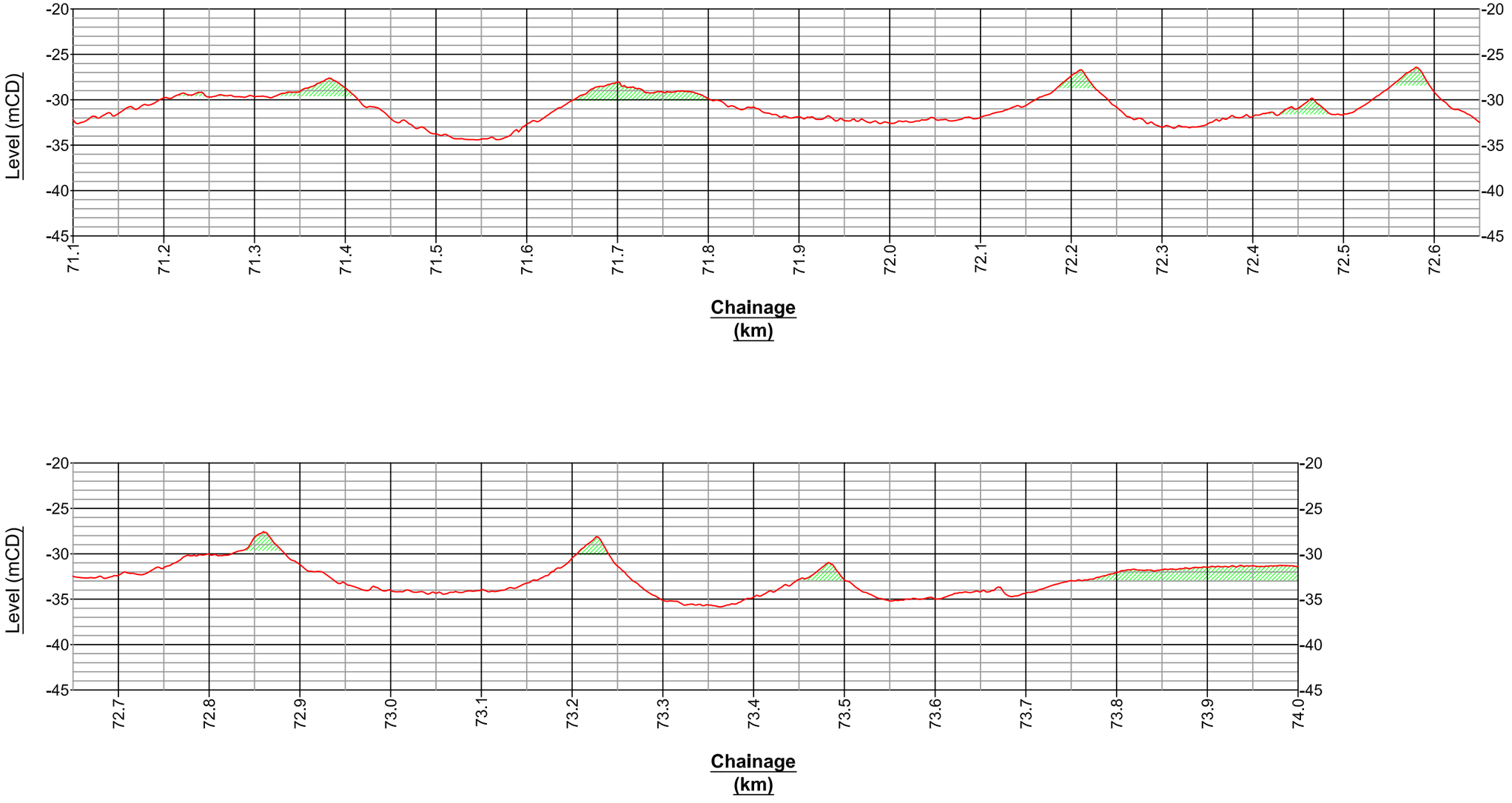

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 71.1 - 74

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D007

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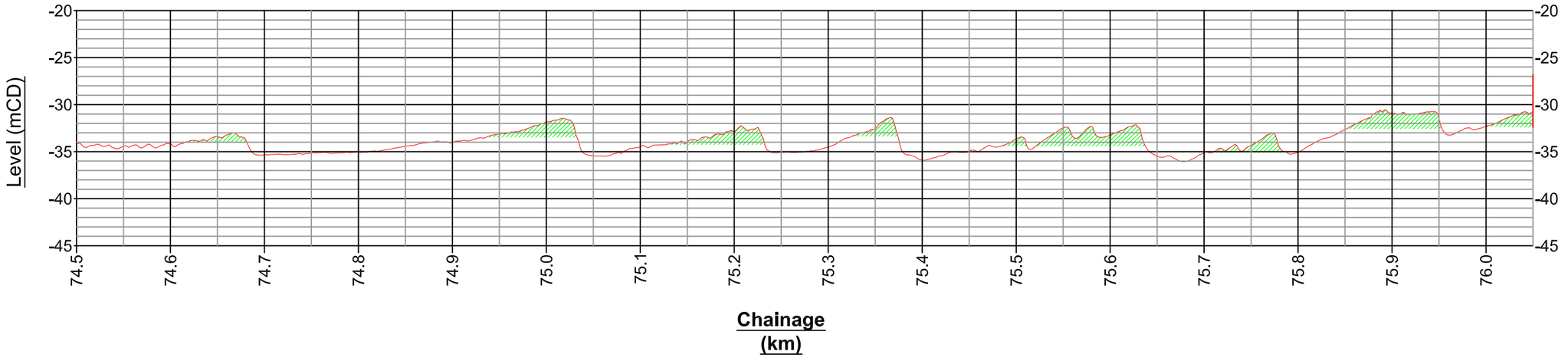

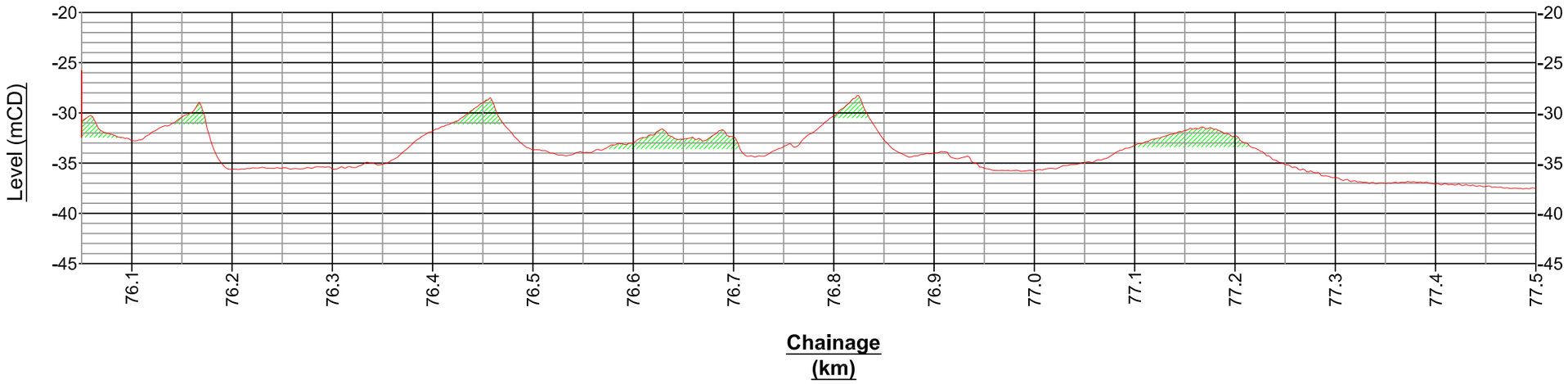

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MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 74.5 - 77.5

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D008

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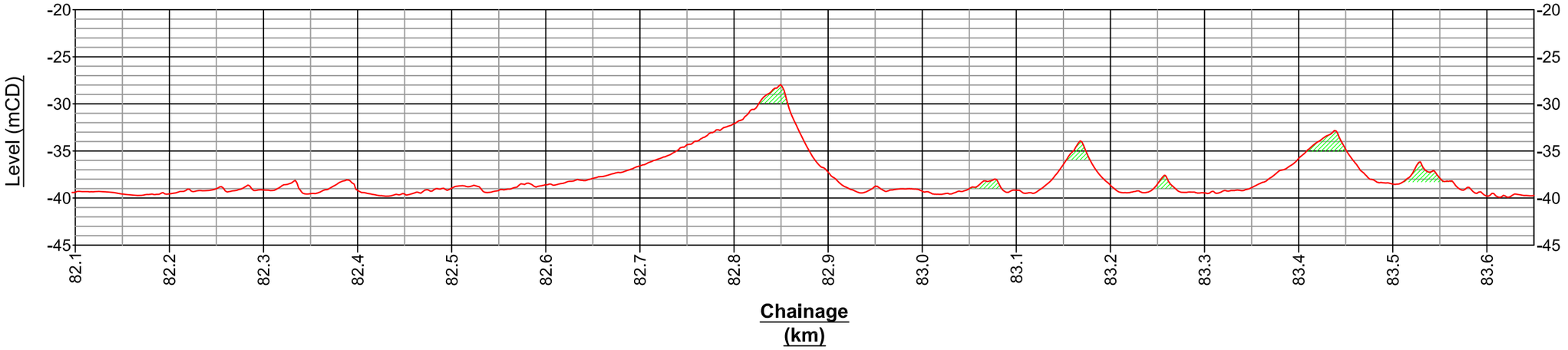

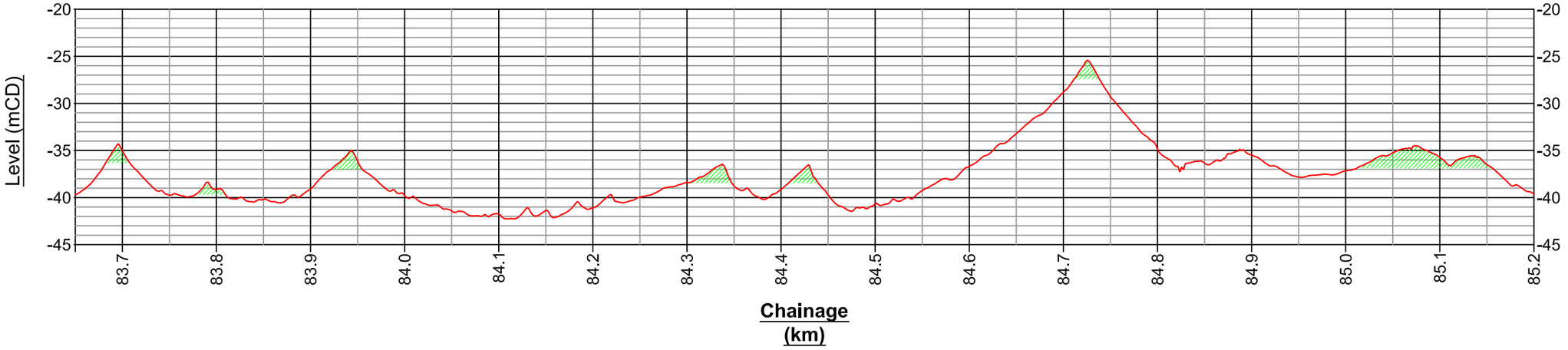

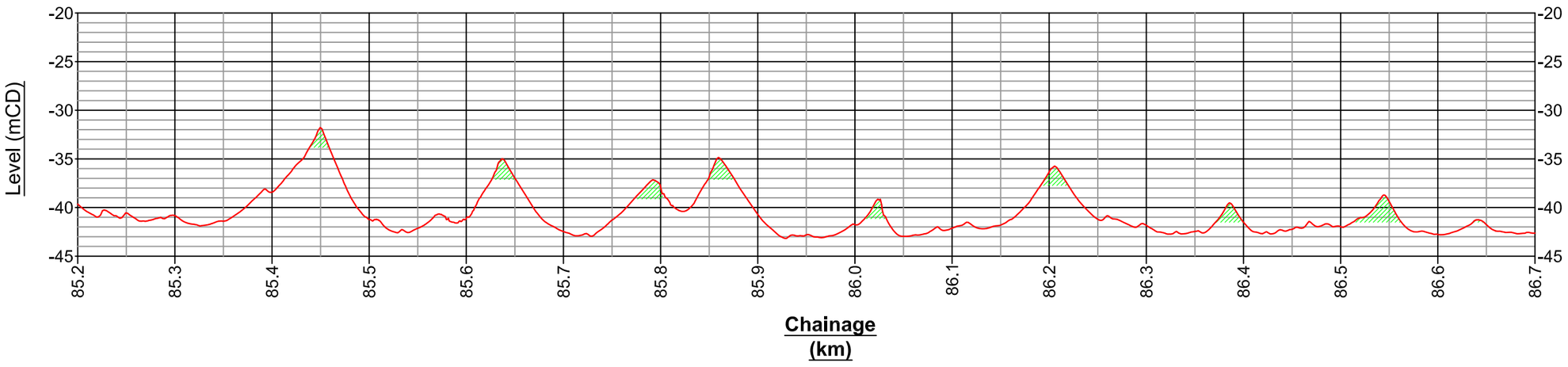

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PROJECT:

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UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR
KP AREA: 83.7 - 86.7

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D009

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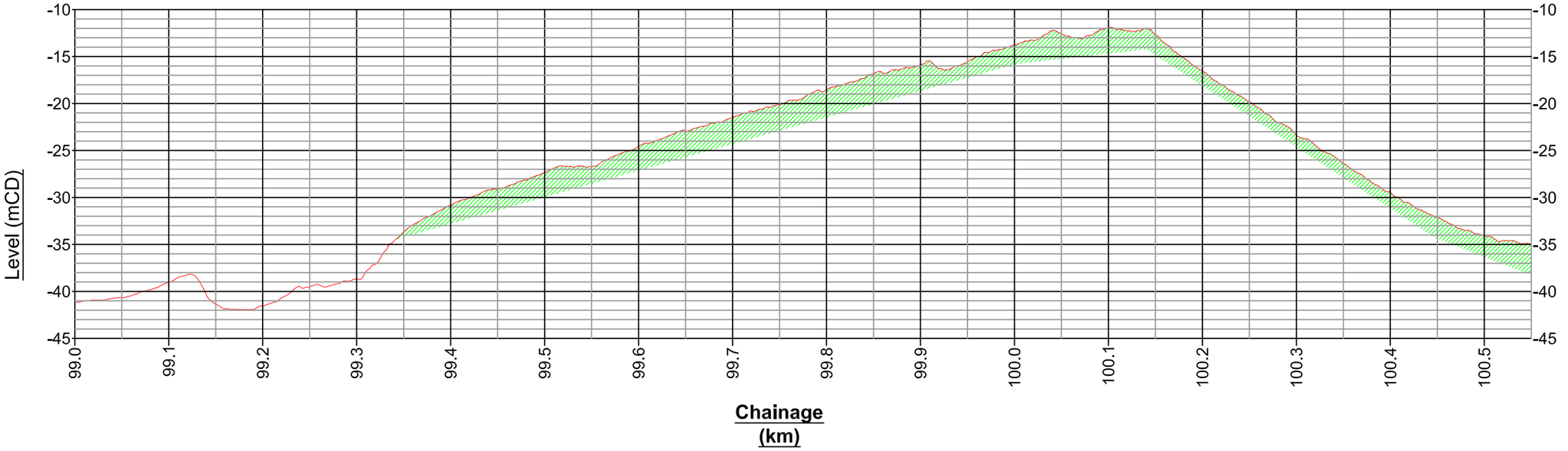

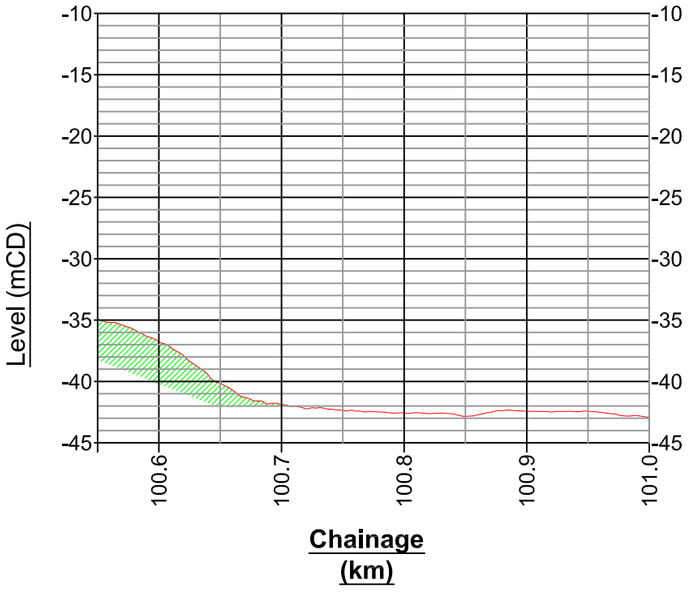

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MATERIAL TO BE REMOVED

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR KP AREA: 99 - 101

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D010

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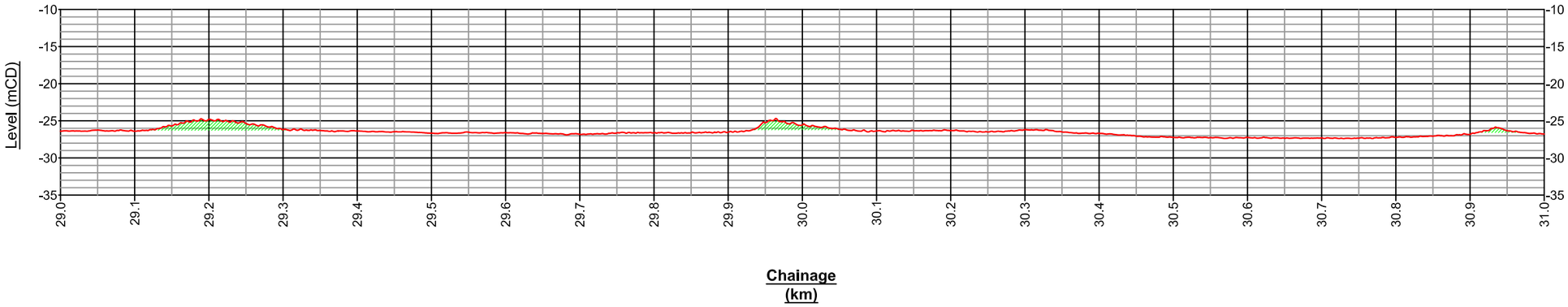

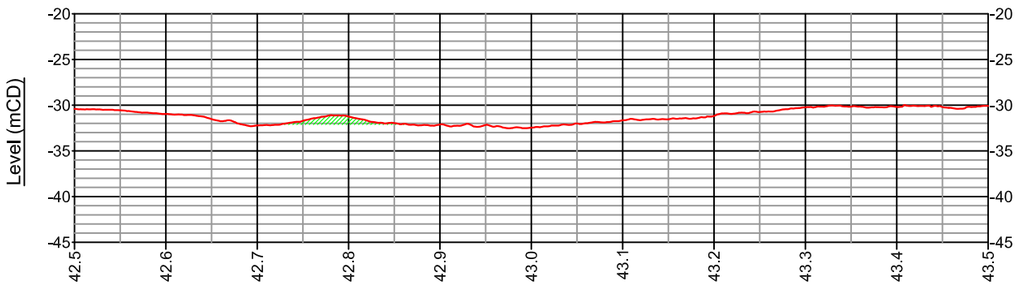

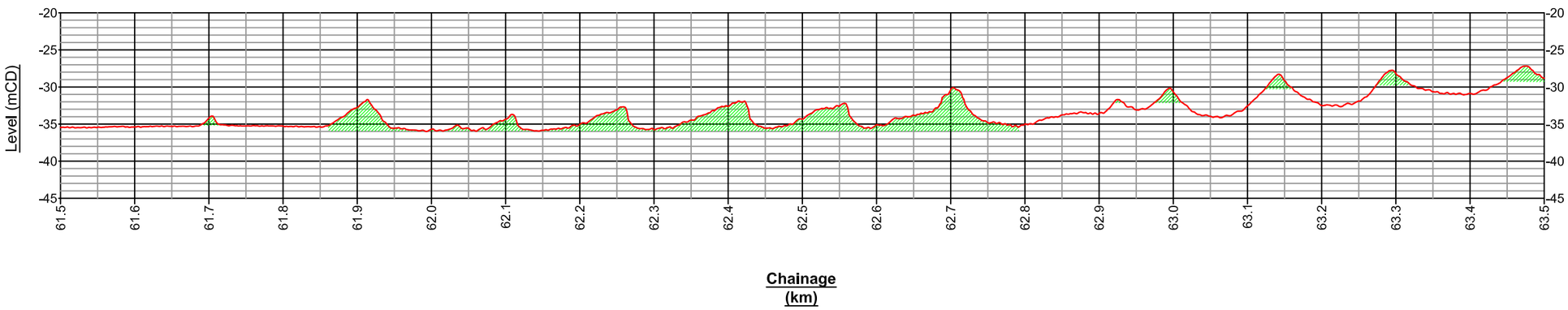

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BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR
KP AREA: 29 - 31 , 42.5 - 43.5 & 61.5 - 63.5

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D011

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Appendix 8: Winter Bird Survey

UK –BELGIUM INTERCONNECTOR
PROJECT NEMO

WINTER BIRD SURVEY

(Doc Ref: TEP 1430.01.024 r1)

February 2010

Prepared by TEP for:

National Grid International Limited
National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Written:	Checked:	Approved:
TR	IJG	IJG

TEP
Genesis Centre, Birchwood Science Park, Warrington, WA3 7BH
Tel: 01925 844004 Fax: 01925 844002 www.tep.uk.com

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APPENDICES

Appendix 1: Desktop survey data and protected site citations
Appendix 2: Survey dates and times 2008-2009
Appendix 3: Pegwell Bay winter bird survey total counts 2008 - 2009

FIGURES

Figure 1: Aerial photograph illustrating site context

DRAWINGS

G1430.01.001 Winter bird survey visit 1 – November 2008
G1430.01.002 Winter bird survey visit 2 – December 2008
G1430.01.003 Winter bird survey visit 3 – January 2009
G1430.01.004 Winter bird survey visit 4 – February 2009 #1
G1430.01.005 Winter bird survey visit 5 – February 2009 #2
G1430.01.006 Winter bird survey visit 6 – March 2009
G1430.01.007 Winter bird survey visit 7 – May 2009

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake winter bird surveys to investigate the ornithological interest of the area known as Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an interconnector cable within the Bay.

1.2 The Sandwich Bay and Hacklinge Marshes SSSI is designated for its nationally important numbers of grey plover and sanderling during the winter period and nationally important numbers of ringed plover during the migration periods. The Thanet Coast and Sandwich Bay SPA supports a migratory turnstone population of European importance.

1.3 The Thanet Coast and Sandwich Bay Ramsar site supports nationally important numbers of greenshank during the migration periods. The 5-year peak mean average counts for lapwing and golden plover within Pegwell Bay (03/04 – 07/08) exceeds the national GB thresholds for these species.

Methods

1.4 The winter bird survey entailed two surveyors mapping wader and wildfowl distributions within the Pegwell Bay on an hourly basis for a complete tide cycle, i.e. high to low tide or low to high tide. Survey visits were undertaken once a month from November 2008 to March 2009 and May 2009 with an additional visit being undertaken in February (six visits).

Results

1.5 The most numerous birds species recorded during the winter bird survey included lapwing and golden plover followed by dunlin and oystercatcher. None of the birds observed within the Pegwell Bay survey area were recorded at numbers exceeding GB thresholds, as defined by the BTO, in winter 2008-09.

1.6 The winter bird survey identified a number of specific areas within the Pegwell Bay which are regularly used by certain specific wader and wildfowl species or a wide range of species for roosting and/or feeding activities. These included the following areas:

- The mudflats near the north bank of the River Stour
- The large area of saltmarsh immediately to the east of Stonelees
- Shellness
- The saltmarsh and grazing marsh on the south bank of the River Stour
- The mudflats to the east of the bird hide at the south end of the Pegwell Bay country park

Implications and Recommendations

1.7 Survey findings and existing desktop information contained within the Pegwell Bay Reports strongly indicate that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February (lapwing, golden plover, turnstone and grey plover) and also in May (turnstone, sanderling and

grey plover). It is recommended construction related activities on the mudflats of the Pegwell Bay avoid these periods where project timescales allow.

1.8 It is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance.

1.9 It is strongly recommended that the sensitive areas described in paragraph 1.6 above are avoided during cable laying activities regardless of time of year since these areas are likely to be of importance for birds throughout the year. Survey findings indicate that the proposed cable laying works would have the least impact on wader and wildfowl if they are restricted to the north half of the Bay.

1.10 The area of shore known as Cliffsend is a turnstone high tide roost of some importance throughout much of the year. Any proposed works in this location should be undertaken in as short a timeframe as possible.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake a winter bird survey to investigate the ornithological interest of the area known as Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an interconnector cable within the Bay.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the winter bird survey involves undertaking monthly visits to Pegwell Bay during winter 2008-09 (November 2008 to March 2009) during which wader and wildfowl bird distributions were mapped every hour for a full tide cycle. The winter bird survey focussed on inter-tidal areas to the north of the River Stour the interconnector cable is only being considered to the north of the River Stour to avoid the need to cross the river on land.

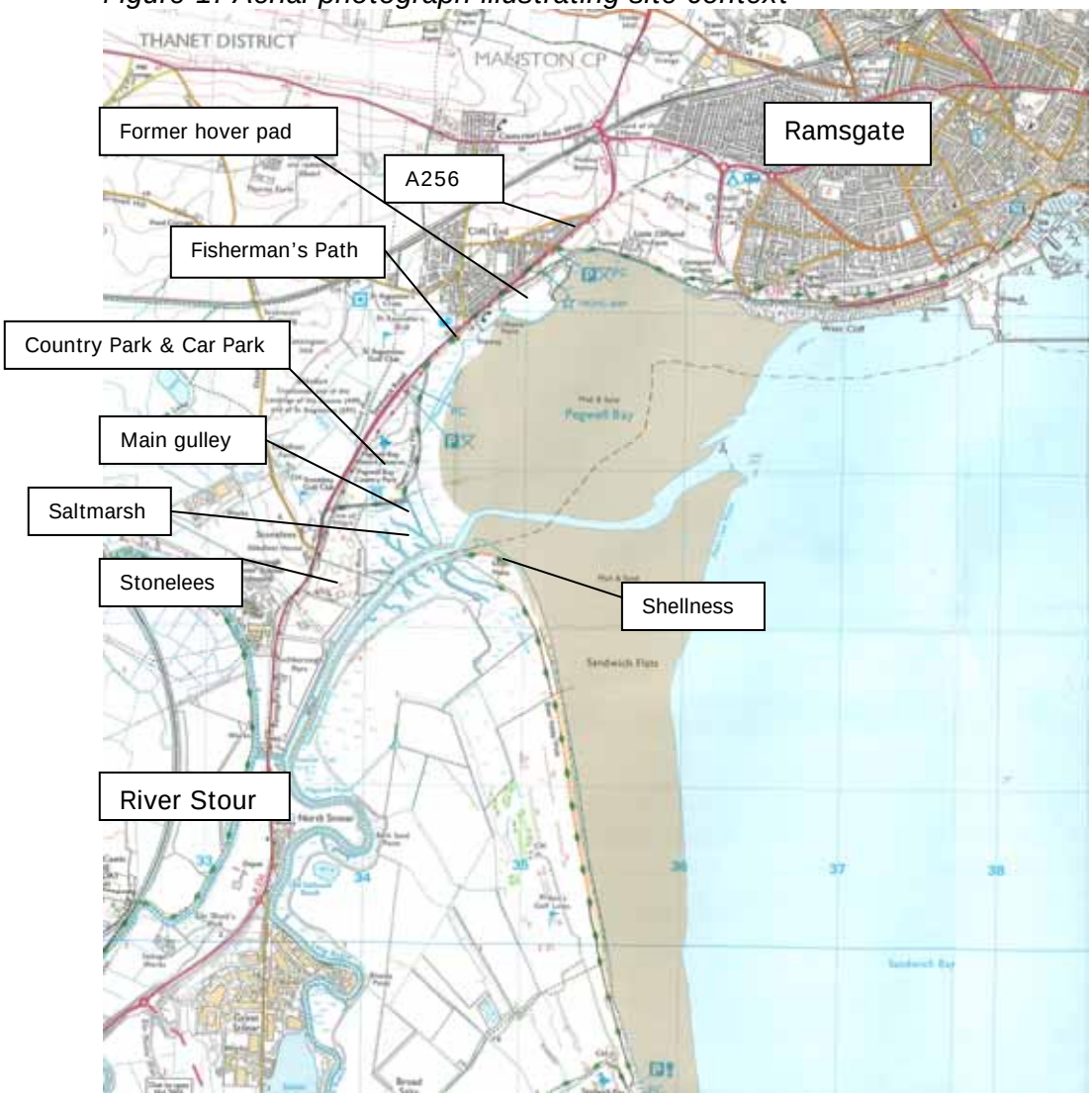
3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh located immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of the Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. The Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay itself.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also covered as a part of the Pegwell Bay winter bird survey.

Figure 1: Aerial photograph illustrating site context



Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods. Waders regularly recorded include dunlin, oystercatchers, curlew and redshank. Grey plover and sanderling overwinter in nationally important numbers, whilst ringed plover occurs in nationally important numbers during migration. Wildfowl that occur on the site include mallard, shelduck and Brent goose. Many of the birds use more that one habitat within the area, for example with birds feeding on the mudflats and roosting on the saltmarsh and grazing marsh.

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The Thanet Coast and Sandwich Bay SPA qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the migratory species, turnstone. The SPA as a whole is used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn.

3.8 The Ramsar citation sheet confirms that the Thanet Coast and Sandwich Bay Ramsar site supports:

- Nationally important numbers of **ringed plover** during the migration periods (649 individuals representing an average of 2% of the GB population – 5 year peak mean 1998/9-2002/3);
- Nationally important numbers of **greenshank** during the migration periods (35 individuals representing an average of 5.8% of the GB population – 5 year peak mean 1998/9-2002/3);
- Nationally important numbers of **red-throated diver** during the winter period (57 individuals representing an average of 1.1% of the GB population – 5 year peak mean 1998/9-2002/3).

3.9 Citation sheets for all designated sites described are included in Appendix 2.

Further updates in the Wetland Bird Survey Report 2007-08

3.10 The 5-year peak mean average count for golden plover within the Pegwell Bay (03/04 – 07/08) is 6,125 birds, which exceeds the national GB threshold of 4,000 birds.

3.11 The 5-year peak mean average count for lapwing within the Pegwell Bay (03/04 – 07/08) is 11,105 birds, which exceeds the national GB threshold of 6,200 birds.

4.0 METHODS

Winter Bird Survey

4.1 The ornithology survey was undertaken by TEP Ornithology Manager Tim Ross MIEEM CEnv and experienced ornithologists Mike Walker and Lee Greenhough MIEEM.

4.2 The winter bird survey entailed two surveyors mapping wader and wildfowl distributions in Pegwell Bay on an hourly basis for a complete tide cycle, i.e. high to low tide or low to high tide. Survey visits were undertaken once a month from November 2008 to March 2009 and May 2009 with an additional visit being undertaken in February to target the mid-winter period when birds are most sensitive to disturbance (six visits). Survey days were chosen to ensure that three surveys were undertaken as the tide was going out (high to low tide) and three surveys were undertaken as the tide was coming in (low to high tide). The precise timing of winter bird surveys on each survey day are given in Appendix 3 along with the weather conditions prevalent on survey days.

4.3 Detailed maps of wader and wildfowl distribution for three different times for each survey day have been provided in this report (3 maps per survey visit). Each of these three maps is representative of either (1) high tide (2) mid-tide or (3) low tide (see Drawings G1430.01.001 to G1430.01.006). Flocks of birds were given a reference number and colour coded according to the size of the flock. Large flocks (over 1,000 birds) are coloured red; medium-sized flocks (over 100 birds) are coloured orange; and small flocks (under 100 birds) are coloured green.

4.4 Ecology survey undertaken in Pegwell Bay have all been undertaken with the kind assistance of the Kent Wildlife Trust who issued a survey works permit to TEP.

5.0 RESULTS

Wader and Wildfowl Numbers and Distributions

November 2008

5.1 The distribution of waders and wildfowl on 19th November 2008 is illustrated in drawing G1430.01.001.

5.2 The most numerous bird recorded at this time was golden plover (2,850 birds) followed by lapwing (2,560 birds) and dunlin (1,090 birds). According to the Pegwell Bay bird report the number of golden plovers recorded in winter 2008-09 (peak count 1,590 birds) during November 2008 was well down on previous years. However it is clearly apparent that 1,590 was not the peak count in November since 2,850 golden plovers were recorded by TEP ecologists.

Low tide

5.3 At low tide (10.25 hrs) the majority of birds were feeding or roosting on the mid and lower shore parts of Pegwell Bay although more than half of the birds were observed close to the River Stour. The largest flock of birds, which was comprised of 1,600 golden plovers and 700 lapwings (Flock 23), was recorded on the mid shore approximately 200 metres to the north of the River Stour.

5.4 One medium-sized flock of birds was observed on the uppershore immediately to the south of the former hoverpad (Flock 13 - 150 golden plovers). A number of bait diggers were working on the upper shore at low tide and this may have displaced some birds at some stage. According to the Pegwell Bay bird report the golden plovers had been displaced from their usual roosting places on the mudflats as a result of disturbance from bait diggers.

5.5 The golden plover was recorded in three large flocks comprised of at least 1,000 birds (Flocks 14, 20 and 23) located either across the midshore but especially near the River Stour. The lapwing was recorded in three medium-sized flocks which were sometimes a part of a larger flock of birds (flocks 4, 21 and 23). Dunlin was also recorded in three medium-sized flocks (flocks 9, 18 and 19), which were located either near the sandy area at the north end of the bay or on the mudflats on the north bank of the River Stour.

Mid tide

5.6 At mid tide the majority of birds was either on the upper shore near the former hoverpad (Flocks 7, 8, 11 and 12 – mostly lapwing, golden plover and dunlin) or on the mudflats on the north or south banks of the River Stour (Flocks 26 and 28 – mostly lapwing with some oystercatcher and dunlin). One other medium-sized flock was comprised of 165 curlews (Flock 20).

High tide

5.7 At high tide (15.43 hrs) the vast majority of birds was near Shellness on the south side of the River Stour with medium-sized flocks of oystercatcher, lapwing and golden plover being recorded (Flocks, 4, 5 and 6). A separate medium-sized flock of just 150 lapwings was also recorded around the main gulley on the saltmarsh on the north side of the River Stour. Counts at high

tide strongly indicate that large numbers of birds which use the Pegwell Bay at low tide leave the bay once the tide has come in.

December 2008

5.8 The distribution of waders and wildfowl on 12th December 2008 is illustrated in drawing G1430.01.002.

5.9 The most numerous bird recorded at this time was golden plover (1,380 birds) followed by lapwing (1,321 birds) and dunlin (751 birds). Counts obtained on 12th December were much lower than those given in the Pegwell Bay bird report which states that peak counts were 3,700 for golden plover, 9,000 for lapwing and 1,240 for dunlin. Survey conditions were moderately good on 12th December indicating that many birds may have been absent from the Pegwell Bay and using other inter-tidal areas in the area.

High tide

5.10 At high tide (09.58 hrs) the vast majority of birds was again observed near Shellness on the south side of the River Stour (Flocks 6 and 7 – mostly lapwing and oystercatcher). Another medium-sized flock of birds, mainly comprised of lapwing with smaller numbers of wigeon and shelduck (Flock 1), was recorded on the strip of saltmarsh immediately east of the country park.

Mid tide

5.11 At mid tide the majority of birds was on mudflats on the upper shore, especially near the country park and near the River Stour. Large numbers of birds were observed immediately east of the bird hide on the country park with three separate flocks of lapwing being recorded, totalling 1,840 lapwing along with 200 dunlin. A medium-sized flock of birds was also present on the upper shore to the north and to the south of the former hoverpad (flocks 7 and 13) where 500 dunlin and 220 lapwing were counted.

Low tide

5.12 The low tide count on 12th December 2008 was undertaken between 14.00hrs and 15.00hrs, which was approximately two and a half hours prior to actual low tide (17.41 hrs). Therefore it is likely that the bird distribution on this count was not fully representative of low tide.

5.13 The majority of birds at this time were still located on the mudflats of the uppershore due east of the bird hide (flocks 4 and 5) where 2,760 golden plover, 525 lapwings and 278 dunlin were present. The largest flock of lapwings was on the mudflats of the uppershore to the north of the hoverpad indicating that lapwings had gradually been moving from the south part of the Pegwell Bay, near the bird hide, to the north part. Many smaller flocks of birds including dunlin, bar-tailed godwit, oystercatcher and shelduck were beginning to move to the north half of the mid shore area at this time.

January 2009

5.14 The distribution of waders and wildfowl on 8th January 2009 is illustrated in drawing G1430.01.003.

5.15 The most numerous bird recorded at this time was golden plover (350 birds) followed by oystercatcher (162 birds) and dunlin (165 birds). Counts obtained on 8th January 2009 were much lower than those given in the Pegwell Bay bird report which states that peak counts were 2,200 for golden plover, 720 for oystercatcher and 1,310 for dunlin. Survey conditions were poor due to the presence of much fog over the Pegwell Bay which affected the ability of the surveyors to record birds at low tide on the south half of the bay. However it is highly likely that many of the waders present in the locality were not in the survey area on 8th January.

High tide

5.16 At high tide (07.45 hrs) the vast majority of birds was observed on the east edge of the saltmarsh located immediately to the east of the country park (Flocks 1 and 3 – mostly golden plover and dunlin). The reason for the different high tide bird distribution on 8th January is unclear but could be related to the foggy conditions providing cover for the birds to roost near the country park. It is also possible that the reduction of disturbance from walkers may have enabled the birds to roost in this different location.

Mid tide

5.17 At mid tide the majority of birds was widely dispersed across the exposed mudflats although there were some larger flocks located both on the tideline and just east of the saltmarsh. The larger flock of birds on the tideline (Flock 19) was made up predominately of oystercatcher and wigeon although some curlew, bar-tailed godwit and dunlin were also present. The flocks nearer to the saltmarsh included a flock of lapwing (Flock 16) near the saltmarsh to the east of the bird hide. A mixed flock of predominately dunlin (Flock 21) was located just to the east of the fisherman's path through the saltmarsh.

Low tide

5.18 At low tide (15.16 hrs) the majority of birds was feeding or roosting on the north bank of the River Stour near the tideline (Flock 10 – predominately oystercatcher and teal) or on the tideline itself (Flock 14 – a mixture of wigeon, dunlin, oystercatcher, curlew, bar-tailed godwit and two grey heron). A separate flock made up mostly of dunlin was feeding and roosting just outside the saltmarsh located to the north of the former hoverpad.

5.19 It is likely that the presence of bait diggers at the centre of the Pegwell Bay on 8th January was influencing bird distributions to some degree. Only very small numbers of sanderling, oystercatcher and redshank were observed feeding within 200 metres of the bait diggers.

<u>February 2009</u>

5.20 The distribution of waders and wildfowl on 12th and 13th February 2009 are illustrated in drawings G1430.01.004 and G1430.01.005.

5.21 The most numerous bird recorded on 12th February was lapwing (4,709 birds) followed by oystercatcher (1,158 birds) and dunlin (502 birds). The following day on 13th February the most numerous bird was lapwing (3,447 birds) followed by golden plover (1,700 birds) and dunlin (550 birds). On both days

reasonable numbers of wigeon were also recorded (330 birds followed by 275 birds).

5.22 Lapwing counts obtained on 12th and 13th February were lower than those given in the Pegwell Bay bird report which states that the peak count for February 2009 was in excess of 8,000 birds. Golden plover and dunlin counts were also much lower than those recorded in the Pegwell Bay bird report, which were 3,140 golden plover and 1,060 dunlin. However the count of 1,158 oystercatcher on 12th February was much higher than the peak count of 510 oystercatcher recorded in the bird report. Numbers of wigeon recorded during the survey were similar to the peak count of 360 wigeon recorded in the bird report.

High tide

5.23 At high tide on the 12th February (13.04 hrs) the vast majority of birds was observed on saltmarsh and grazing marsh on the south bank of the River Stour (Flocks 3, 4 and 5 – 2,907 lapwings). A smaller flock of 170 lapwings was located within the larger area of saltmarsh on the north side of the River Stour. A medium-sized flock of 600 oystercatcher (Flock 7) was recorded roosting at Shellness.

5.24 At high tide on the 13th February (13.45 hrs) large flocks of birds were again observed on the saltmarsh and grazing marsh on the south side of the River Stour although considerably fewer lapwing were recorded and golden plover were the dominant species (Flock 1 – 850 golden plover, 300 curlew and 158 lapwing). A medium-sized flock of lapwing (Flock 3 – 350 birds) was present in place of the oystercatchers in the same location the previous day. In addition to this a large mixed flock of 1,400 birds (Flock 6 – predominately lapwing and dunlin with some bar-tailed godwit and grey plover) was present just to the east of the saltmarsh at the north end of the country park. At one stage a large flock of 3,650 birds (Flock 5 – mostly lapwing with some golden plover) was observed flying in large arcs over the large area of saltmarsh to the north of the Stour.

Mid tide

5.25 At mid tide on the 12th of February large numbers of birds were still roosting or feeding immediately east of the saltmarsh at the south end of the bay. The largest aggregation of birds was roosting on the north bank of the River Stour (Flock 6), birds present including 1,100 oystercatcher. Three medium-sized flocks were also present in this general location (Flocks 7, 9, 10 – a combined total of 1,840 lapwing). Two other medium-sized flocks were in different locations on the mudflats near the saltmarsh edge to the north (Flock 18 – 122 dunlin with smaller numbers of grey plover and knot) and to the south (Flock 22 – 300 lapwing) of the former hoverpad. Finally a dispersed flock of wigeon was present on the sea just to the south of the River Stour (Flocks 1 and 2 – combined total of 330 wigeon).

5.26 At mid tide on the 13th February 2009 the distribution of the larger flocks of birds had shifted northward by approximately 500 metres so that the majority of birds were on the mudflats just east of the country park (Flocks 3 to 6 – 1,500 lapwing and 1,500 golden plover with 150 dunlin). A flock of 400

roosting oystercatcher had moved from Shellness just south of the River Stour. Lapwing and bar-tailed godwit medium-sized flocks were feeding in the centre of the bay (Flocks 8 and 9 – 155 lapwing and 170 bar-tailed godwit). Flocks of wigeon were on the sea (Flock 12) with 120 dunlin and smaller numbers of other waders feeding on the tideline at the north end of the bay as the tide was coming in.

Low tide

5.27 At low tide on 12th February 2009 (0750 hrs – surveyed between 08.30 and 09.30 hours) the vast majority of birds was roosting on the large area of saltmarsh at the south end of the bay (Flocks 1, 2, 3 and 4 – 2,300 lapwings). Small and moderate-sized flocks were also roosting or feeding on the mudflats on the periphery of saltmarsh east of the country park (Flocks 5 and 6 – 345 lapwing and 450 golden plover). A number of small flocks or groups of birds was observed across the intertidal mudflats on both sides of the River Stour. It is not clear why the majority of birds was not feeding on the mudflats at low tide. It is possible that the birds had not yet left their night time roosts since sunrise was at approximately 0714 hrs on the 12th February 2009.

5.28 At low tide on 13th February 2009 (08.29 hrs – surveyed between 08.45 and 09.45 hours, the majority of birds was observed on the mudflats, either along the tideline at the north end of the bay or just beyond the saltmarsh to the east of the country park. The large flock on the tideline consisted predominately of lapwing along with several hundred dunlin, oystercatcher and curlew along with smaller numbers of knot and shelduck (Flock 18). The two large flocks east of the country park included 2,650 lapwing and 1,700 golden plover (Flocks 4 and 5). Three medium-sized flocks were observed in the centre of the Bay; birds present including 650 lapwing, 250 dunlin, 1432 knot and 42 grey plover (Flocks 1, 15 and 16). A flock of 130 oystercatcher was observed on the tideline immediately south of the Stour.

March 2009

5.29 The distribution of waders and wildfowl on 24th March 2009 is illustrated in drawing G1430.01.006.

5.30 The most numerous bird recorded at this time was curlew (208 birds) followed by oystercatcher (150 birds) and redshank (48 birds). Survey conditions on 24th March were good with little wind and good visibility. No lapwings or golden plover were present at Pegwell Bay on 24th March 2009.

5.31 Counts obtained on 24th March 2009 were generally equal to half of the peak counts stated in the Pegwell Bay Bird Report 2009. The peak counts for curlew, oystercatcher and redshank in March 2009 were 340 curlew, 370 oystercatcher and 125 redshank.

High tide

5.32 At high tide on the 24th March (10.01 hrs – observed 10.00 hrs to 11.00hrs) the majority of birds were roosting in a dense flock on the saltmarsh and adjacent grassland on the south bank of the Stour (Flock 1 – 156 curlew and 42 shelduck). Smaller groups on the main area of saltmarsh to the north of the Stour included mostly curlew (Flock 2 – 90 curlew).

Mid tide

5.33 At mid tide (observed 13.00 hrs to 14.00 hrs) the majority of the curlew roosting on the saltmarsh on the south bank of the Stour had not yet moved onto the exposed mudflats (Flock 2 – 121 curlew and 28 shelduck). Numerous small flocks of birds had moved into the bay to feed including 100 oystercatcher and much smaller numbers of shelduck, curlew, dunlin and redshank. Other small aggregations of birds were present on the east fringes of the saltmarsh at the south end of the bay, including 75 oystercatcher and much smaller numbers of curlew, bar-tailed godwit, Brent geese (7 birds) and shelduck.

Low tide

5.34 At low tide (16.54 hrs – observed 15.00 hrs to 16.00 hrs) birds were widely dispersed across much of the bay. Birds appeared to favour the areas of mudflats just north of the Stour and also east of the saltmarsh on the upper shore. Nearly all of the birds using the saltmarsh on the south bank of the Stour had left this area, with the exception of 13 shelduck and smaller numbers of curlew and Brent geese (3 birds).

May 2009

5.35 The distribution of waders and wildfowl on 7th May 2009 is illustrated in drawing G1430.01.007.

5.36 The most numerous bird recorded at this time was oystercatcher (185 birds) followed by shelduck (76 birds) and sandwich tern (43 birds). Counts obtained on 7th May were comparable with those given in the Pegwell Bay bird report which states that peak counts were 151 for oystercatcher and 103 for shelduck although the peak count for sandwich tern was 140 terns on 18th May.

5.37 Spring migrants on 7th May were only recorded in very low numbers with 1 grey plover and 6 ringed plover being recorded. According to the Pegwell Bay Bird Report the peak count for grey plover was 70+ birds on 15th May. The spring passage of ringed plover occurred between 12th and 21st May, with a peak count of 420 birds being recorded on 14th May.

High tide

5.38 At high tide (10.51 hrs) the vast majority of birds was observed near Shellness on the south side of the River Stour (Flock 2 – mostly oystercatcher and sandwich tern). Small numbers of individuals of redshank, curlew, oystercatcher and grey plover were observed within the large area of saltmarsh on both sides of the Stour.

Mid tide

5.39 At mid tide the majority of birds was on mudflats on the tideline, especially within the north half of the Bay where 148 oystercatcher were observed (Flock 10). Small numbers of sanderling (29 birds), dunlin, ringed plover, bar-tailed godwit, curlew and shelduck were also observed along the tideline. Very small numbers of oystercatcher, shelduck and redshank continued to use the large area of saltmarsh at mid tide.

Low tide

5.40 The low tide count on 7th May 2009 was undertaken between 15.30hrs and 16.30hrs, which was approximately one and a half hours prior to actual low tide (17.58 hrs). Therefore it is likely that the bird distribution on this count was not fully representative of low tide.

5.41 The majority of birds at this time were still on the mudflats of the mid shore rather than moving onto the lower shore with the receding tide (Flock 8 – 116 oystercatcher, 43 sandwich terns and 6 bar-tailed godwits). A small group of 43 shelduck had remained on the upper shore to the east of the country park. Several small groups of birds were observed on the south bank of the Stour including dunlin (24 birds) and smaller numbers of curlew, shelduck, oystercatcher and cormorant.

6.0 IMPLICATIONS AND RECOMMENDATIONS

The Ornithological Importance of the Pegwell Bay

6.1 The Sandwich Bay and Hacklinge Marshes SSSI is partly designated because it supports nationally important numbers of grey plover and sanderling during the winter period and nationally important numbers of ringed plover during the migration periods. The Thanet Coast and Sandwich Bay SPA qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the migratory species, turnstone.

6.2 The Thanet Coast and Sandwich Bay Ramsar site supports nationally important numbers of greenshank during the migration periods. In addition to this, the 5-year peak mean average counts for lapwing and golden plover within Pegwell Bay (03/04 – 07/08) exceeds the national GB threshold of 6,200 and 4,000 birds respectively.

The Findings of the 2008-09 Winter Bird Survey

Wader peak counts in winter 2008-09

6.3 None of the birds observed within the Pegwell Bay survey area in winter 2008-09 were recorded at numbers exceeding GB thresholds, as defined by the BTO.

6.4 It is accepted that since wildfowl and wader counts were only undertaken once each survey month, and twice in February 2009, it is unlikely that monthly peak counts were recorded during survey days. It is known that monthly peak counts within the Pegwell Bay Bird Report often exceeded those recorded during survey days. References to peak counts within the Pegwell Bay Bird Reports have occasionally been included to provide more insight into establishing at which times the Pegwell Bay supports large numbers of birds during the typical year. However the detailed information on wader and wildfowl distribution gather during the winter 2008-09 survey has been invaluable in identifying sensitive locations within the Pegwell Bay. These locations should be avoided, where possible, during future cable laying related activities.

6.5 The Pegwell Bay bird populations will be most sensitive to disturbance during certain periods in the year, especially the winter months October to February during which large numbers of important wader species are present (lapwing, golden plover, turnstone and grey plover). The main migratory species which use the Pegwell Bay (turnstone, sanderling and grey plover) tend to peak during the spring migration in May although a more prolonged ringed plover/turnstone autumn migration occurs over several weeks in August and also September.

6.6 This information strongly indicates that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May. It is recommended construction related activities on the mudflats of the Pegwell Bay avoid these periods where timescales allow. Furthermore it is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance.

Wader and wildfowl distribution in winter 2008-09

6.7 It is clearly apparent from the findings of the 2008-09 winter bird survey that although waders and wildfowl make use of the majority of the mudflats and saltmarsh within the Pegwell Bay, certain areas are especially important for feeding and roosting. Each of these sensitive areas is described below.

Mudflats near the north bank of the River Stour

6.8 The areas of mudflat along the north bank of the River Stour are regularly used by large flocks of waders and wildfowl during mid tide and low tide periods. It is recommended that no works are undertaken within 500 metres (minimum) of the north bank of the River Stour to ensure that birds feeding and roosting in this location are not displaced or prevented from feeding.

Large area of saltmarsh located immediately to the east of Stonelees

6.9 The large area of saltmarsh located immediately to the east of the area known as Stonelees is regularly used at high tide by medium-sized flocks of curlew and lapwing. The east extremity of this area, adjacent to the River Stour, also functions as an important roost site for oystercatcher during the mid tide period. It is also known that this large area of saltmarsh is used by breeding redshank during the period April to July.

Saltmarsh and grazing marsh located on the south bank of the River Stour

6.10 The saltmarsh and grazing marsh located on the south bank of the River Stour functions as the main roost site for a range of wader and wildfowl species during high tide, species including golden plover, lapwing, curlew, wigeon and shelduck among other.

Shellness

6.11 The area of sandy/shingle shore known as Shellness on the south bank of the River Stour is an important roosting site for a range of wader species including oystercatcher, lapwing, golden plover and dunlin.

Mudflats located to the east of the bird hide at the south end of the Pegwell Bay country park

6.12 The mudflats to the east of the bird hide at the south end of the Pegwell Bay country park are regularly used by a wide range of wader and wildfowl species for both roosting and feeding. This area is especially important at the stage after high tide when the first areas of mudflats are becoming exposed. This area was subject to intensive management works during the year previous to the survey during which large areas of cordgrass *Spartina* sp. were mown providing access to new areas of mudflats for feeding.

6.13 During the winter 2008-09 survey there was some evidence to suggest that the areas of mudflats near the former hoverpad are sometimes used by roosting golden plover at any time during the tide cycle (see Drawing G1430.01.001 – November 2008). However local ornithologists note that the use of this location during states of the tide other than high tide is uncharacteristic suggesting that the birds were being displaced from the mudflats by bait diggers (Pegwell Bay Bird Report, 2009).

Recommendations

6.14 This information strongly indicates that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May. It is recommended construction related activities on the mudflats of the Pegwell Bay avoid periods October to February and May where timescales allow. Furthermore it is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance (Stillman and Goss-Custard, 2002).

6.15 It is strongly recommended that the sensitive areas described above are avoided during cable laying activities regardless of time of year since these areas are likely to be of importance for birds throughout the year. Considering all of these sensitive areas as a whole strongly indicates that the cable laying activities proposed would be less disturbing for the birds if the works are undertaken in the north half of the Pegwell Bay.

6.16 It should be noted that the area of shore known as Cliffsend is a turnstone high tide roost of some importance throughout much of the year. Therefore any proposed works in this location should be undertaken in as short a timeframe as possible.

7.0 REFERENCES

HOLT, C.; AUSTIN, G.; CALBRADE, N.; MELLAN, H.; THEWLIS, R.; HALL, C.; STROUD, D.; WOTTON, S.; AND MUSGROVE, *A*. (2009) *Waterbirds in the UK 2007/08 - The Wetland Bird Survey,* WEBS.

MILTON, P., (2008) Pegwell *Bay Report 2007 and 2008.*

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STILLMAN, R. A. AND GOSS-CUSTARD, J. D. 2002. *Seasonal changes in the response of oystercatchers Haematopus ostralegus to human disturbance*. – J. Avian. Biol. 33: 358–365.

UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

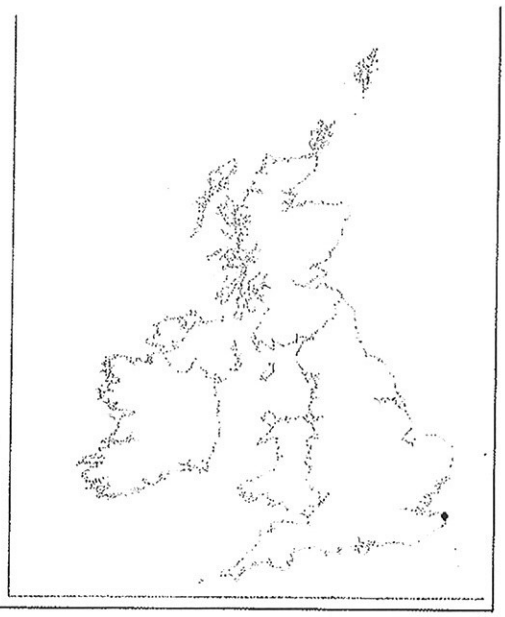
APPENDIX 1
Desktop Information and protected site citations

SPA description

(information as published 2001)

Thanet Coast and Sandwich Bay

Country	England
Unitary Authority	Kent
SPA status	Classified 28/07/1994
Latitude	51 18 18 N
Longitude	01 22 47 E
SPA EU code	UK9012071
Area (ha)	1870.16
Component SSSI/ASSIs	Sandwich Bay to Hacklinge Marshes Thanet Coast



Thanet Coast and Sandwich Bay SPA is located at the north-eastern tip of Kent in southern England. It is a coastal site consisting of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The site holds important numbers of Turnstone *Arenaria interpres*, and is also used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn.

Qualifying species

For individual species accounts visit the Species Accounts section

This site qualifies under **Article 4.2** of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:

Over winter;

Turnstone *Arenaria interpres*, 940 individuals representing at least 1.3% of the wintering Western Palearctic - wintering population (5 year peak mean 1991/2 - 1995/6)

Note:

Many designated sites are on private land: the listing of a site in these pages does not imply any right of public access.

Note that sites selected for waterbird species on the basis of their occurrence in the breeding, passage or winter periods also provide legal protection for these species when they occur at other times of the year.

COUNTY: KENT SITE NAME: SANDWICH BAY AND HACKLINGE MARSHES

DISTRICTS: THANET/DOVER

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: THANET DISTRICT COUNCIL/DOVER DISTRICT COUNCIL

National Grid Reference: TR 353585 Area: 1756.5 (ha.) 4338.6 (ac.)

Ordnance Survey Sheet 1:50,000: 179 1:10,000: TR 35 NE, NW, SE, SW; TR 36 SW, SE

Date Notified (Under 1949 Act): 1951 Date of Last Revision: 1981

Date Notified (Under 1981 Act): 1984 (part) 1985 (part) 1990 Date of Last Revision: 1994

Other Information:
Parts of the site are listed in 'A Nature Conservation Review' and in 'A Geological Conservation Review'[2]. The nature reserve at Sandwich Bay is owned jointly by the Kent Trust for Nature Conservation, National Trust and Royal Society for the Protection of Birds. The site has been extended to include a Kent Trust designated Site of Nature Conservation Interest known as Richborough Pasture and there are several other small amendments.

Reasons for Notification:
This site contains the most important sand dune system and sandy coastal grassland in South East England and also includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. Associated with the various constituent habitats of the site are outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded. Invertebrates are also of interest with recent records including 19 nationally rare[3], and 149 nationally scarce[4] species. These areas provide an important landfall for migrating birds and also support large wintering populations of waders, some of which regularly reach levels of national importance[5]. The cliffs at Pegwell Bay are also of geological interest.

Biological Interest
The sand dunes which stretch from the mouth of the River Stour to Deal comprise the most outstanding botanical habitat within the site. The dunes and associated dune slacks and coastal grassland support a distinctive flora with species including crown garlic *Allium vineale*, viper's bugloss *Echium vulgare*, sea holly *Eryngium maritimum* and restharrow *Ononis repens*, whilst the nationally

rare[3] lizard orchid *Himantoglossum hircinum* and bedstraw broomrape *Orobanche caryophyllacea* have their largest British colonies here. Many continental species have been recorded from the dunes and the dune grassland also support a high diversity of clover *Trifolium* species and many other leguminous plants.

The dunes support a diversity of invertebrates many of which are associated with warm dry conditions and include the nationally rare[3] carthusian snail *Monacha cartusiana* and the nationally scarce[4] grey bush cricket *Platycleis albopunctata.* The nationally rare[3] moths restharrow *Aplasta ononaria*, pygmy footman *Eilema pygmaeola pygmaeola* and brightwave *Idaea ochrata* have also been recorded, whilst one of the damp hollows supports the only British colony of the moth *Stigmella zelleriella*, the larvae of which mine in leaves of creeping willow *Salix repens var. argentea.*

The chalk coastline around Pegwell Bay comprises a considerable diversity of cliff and cave habitats which support a range of marine algal communities. The area is the type locality for one algal genus and three species new to science *Chrysonema, C. littorale*; *Chrysotila lamellosa, Chrysotila stipitata* and is one of the sites where Anand (1937) undertook pioneer ecological investigations. Typical chalk-cliff zonation comprises a 'Chrysophyte' zone (mainly *Apistonema carterae*) at supralittoral levels. *Enteromorpha* spp. and other green algae and the lichen *Arthropyrenia halodites* at upper littoral levels; a turf of small filamentous red, brown and green algae is predominant at lower levels. The caves contain 'Chrysophyte' communities with species such as *Chrysonema litorale* and *Thallochrysis littoralis*, together with other typical cave species such as *Pilinia rimosa* and *Pseudendoclonium submarinum.*

Foreshore algal communities are typical of wave-washed shores, low in species diversity, although a unique feature (not seen on other chalk platforms in southeast England) of lower littoral levels is the dense population (zone-forming) of the Sand-Mason worm *Lanice conchilega* forming a bank extending for 100 m by the Ramsgate Western Esplanade.

The saltmarsh comprises a diversity of characteristic plants dominated by salt-marsh grasses such as *Puccinellia maritima* and common cord-grass *Spartina anglica.* Other abundant species include sea purslane *Halimione portulacoides*, sea aster *Aster tripolium*, sea lavender *Limonium vulgare* and the nationally scarce[4] golden samphire *Inula crithmoides.* South of the River Stour saltmarsh grades into the sand dune system; this is the only Kent site for the long-bracted sedge *Carex extensa*, and also provides suitable conditions for a dense growth of the nationally scarce[4] sharp rush *Juncus acutus.* Below the cliff at Cliffsend Point, where freshwater springs emerge at the foot of the cliff, the saltmarsh grades into a swampy type of vegetation where common reed *Phragmites australis* and common reedmace *Typha latifolia* predominate.

Further inland, the grazing marsh and associated dykes provide suitable conditions for a wide range of plants and animals. The grassland is dominated by

grasses such as meadow barley *Hordeum secalinum*, meadow foxtail *Alopecurus pratensis* and crested dog's tail *Cynosurus cristatus*. Some of the more uncommon broadleaved herbs that have been recorded, especially narrow leave bird's-foot-trefoil *Lotus tenuis*, adder's tongue *Ophioglossum vulgatum*, strawberry clover *Trifolium fragiferum* and divided sedge *Carex divisa*[4]. A more unusual vegetation type found within the site is the relict fen vegetation. This is found in and around the dykes of the farmland and in the marshes at Hacklinge. Fen plants such as ragged robin *Lychnis flos-cuculi*, bog pimpernel *Anagallis tenella* and greater spearwort *Ranunculus lingua* occur here, most of these are now scarce in Kent. In addition the dykes contain a number of scarce aquatic plants including whorled water-milfoil *Myriophyllum verticillatum*[4], fen pondweed *Potamogeton coloratus*[4] and river water-dropwort *Oenanthe fluviatilis*[4]. This area is also the only known locality in SE England for least bur-reed *Sparganium minimum.* The wet alder wood at Ham Brooks also contains uncommon plants including great fen-sedge *Cladium mariscus.*

The ornithological interest of Sandwich Bay and Hacklinge Marshes is centred on the large numbers of waders and wildfowl which use the area in winter and during the Spring and Autumn migrations. Dunlin *Calidris alpina* is usually the most common wader present, found particularly on the mudflats where the rich invertebrate fauna also attracts a wide range of other common species such as oystercatcher *Haematopus ostralegus*, curlew *Numenius arquata*, and redshank *Tringa totanus.* Grey plover *Plurialis squatarola* and sanderling *Calidris alba* both overwinter in nationally important numbers[5], whilst ringed plover *Charadrius hiaticula* also occurs in nationally important numbers[5] during migration. Wildfowl that occur on the site include mallard *Anas platyrhynchos*, shelduck *Tadorna tadorna* and occasionally brent goose *Branta bernicla.*

Many of the birds use more than one habitat, some for example feed on the mudflats at low tide and then move up to roost on the saltmarsh or grazing marsh.

Breeding birds include ringed plover, oystercatcher and little tern *Sterna albifrons*, a species specially protected by law and listed on Schedule 1 of the Wildlife and Countryside Act 1981. Inland areas are also of interest supporting two nationally rare species of breeding birds.

Geological Interest

Parts of the site are also of geological interest. The 16" shell bed at the base of the Reculver Silts (Thanet Formation) contains an important fish fauna. This is preserved as disarticulated fish debris, including a diversity of identifiable shark teeth. There is no other Thanetian site in Western Europe with this diversity of fauna which includes many, as yet, undescribed species plus the earliest records of other known Tertiary forms. The outcrop has very great significance because it is the only outcrop which shows the bottom living fish assemblage which was subsequently destroyed by the North Sea volcanicity, for the ash falls by these volcanoes brought about an extinction event. Interesting conclusions can be drawn from this local extinction and the later recolonisation of the area; for example unspecialised, bottom living sharks survive across the event, presumably because

a stock that was living elsewhere at the time was able to migrate back to this part of the basin and recolonise.

At Pegwell Bay the Upper Chalk is overlain by the basal Tertiary beds of the Thanet Sands. The junction is marked by the celebrated 'Bull-head Bed', an *in situ* weathering residue of unabraded flint nodules. This is a key section showing a demonstrable and regionally significant unconformity. Pegwell Bay is also the most important site for loess studies in Britain. The section shows up to 4 m of Devensian loess overlying Upper Chalk and Thanet Beds. The loess, an accumulation of wind-blown dust produced under periglacial conditions during the Ice Age is probably thicker here than at any other site in Britain, and is certainly the most closely studied example. Although leached in its upper part, the loess is calcareous below, with rootlet tubes and small concretions. Where the loess rests on the Chalk, there is often a highly frost-shattered zone with well developed involutions. In one part of the section where an infilled channel is cut into the frost-shattered chalk, the loess overlies chalky-flinty gravels and loams produced by solifluction. Pegwell Bay provides the best exposures of true loess deposits in Britain. They are exceptional in having escaped modification by solifluction; no other site provides such useful sections in highly calcareous loess that has not been reworked.

[1] '*A Nature Conservation Review*': edited by D A Ratcliffe. Cambridge University Press 1979.

[2] *A Geological Conservation Review*: in preparation.

[3] Species regarded as 'rare' in Britain (recorded from 1–15 10 × 10 km squares) and listed in *British Red Data Books*.

[4] Species regarded as 'scarce' in Britain (recorded from 16–100 10 × 10km squares).

[5] *Wildfowl and Wader Counts* 1988–1989. D G Salmon et al, Wildfowl Trust 1989.

APPENDIX 2
Survey dates and times 2008 - 2009

Appendix 2: **Survey dates and times 2008 - 2009**

Date	Count period	Surveyors	Weather	High tide time	Low tide time
19/11/2008	1030-1530hrs	TR & MW	Dry, cold*, good visibility.	15.40hrs: 5.83 metres	10.25hrs: 1.52 metres
12/12/2008	0900-1500hrs	TR & MW	Dry, mild*, moderate visibility, overcaste 3/8.	09.58hrs: 6.65 metres	17.41hrs: 1.08 metres
08/01/2009	0830-1430hrs	TR & MW	Dry, mild, foggy, poor visibility in afternoon.	07.45hs: 5.94 metres	15.16hrs: 1.69 metres
12/02/2009	0830-1645hrs	TR & LG	Dry, cold, good visibility, wind force 3-4.	13.04hrs: 7.04 metres	07.50hrs: - 0.01 metres
13/02/2009	0845-1645hrs	TR & LG	Dry, cold, moderate visibility, overcaste 6/8, wind force 2.	13.45hrs: 6.84 metres	08.29hrs: 0.19 metres
24/03/2009	0900-1600hrs	TR & LG	Dry, mild, wind force 1, overcaste 7/8, good visibility.	10.01hrs: 5.70 metres	16.54hrs: 1.40 metres
07/05/2009	0930-0630	TR & LG	Dry, warm, wind force 1, good visibility.	10.51hrs	17.58hrs

TR = Tim Ross MIEEM, CEnv; MW = Mike Walker; LG = Lee Greenhough AIEEM.

*Cold means that the temperature was generally 5 degrees Celsius or lower. Mild means that the temperature was generally above 5 degrees Celsius.

APPENDIX 3
Pegwell Bay winter bird survey total counts 2008 - 2009

Appendix 3 - Pegwell Bay winter bird survey total counts 2008-09 - WADERS

Date	Period	Time	OC	RK	SS	DN	KN	BA	GP	L	CU	GV	TT	RP
19/11/2008	1030-1530hrs	Low	112	29	0	1090	70	0	2850	1869	165	29	0	0
		Mid	227	83	0	826	130	0	710	2560	261	15	0	0
		High	624	0	0	0	0	0	750	1150	20	0	0	0
12/12/2008	0900-1500hrs	High	103	12	0	30	0	0	0	715	98	0	0	0
		Mid	76	16	37	741	65	79	600	1242	70	46	0	0
		Low	61	9	63	751	1	31	1380	1321	18	19	0	0
08/01/2009	0830-1430hrs	High	40	71	0	140	0	0	350	45	35	0	0	0
		Mid	151	6	0	146	0	30	0	0	30	58	0	19
		Low	162	1	6	165	0	10	0	0	31	12	0	0
12/02/2009	0830-1645hrs	Low	51	16	0	76	0	0	450	2945	68	0	0	0
		Mid	1158	12	0	502	69	1	220	1400	32	97	0	0
		High	600	3	0	0	0	0	0	4709	50	0	2	0
13/02/2009	0845-1645hrs	Low	454	18	0	550	0	0	1700	3447	291	54	0	0
		Mid	465	12	7	340	45	170	1500	1694	90	190	70	1
		High	0	0	0	500	400	150	850	3100	370	250	0	0
24/03/2009	0900-1600hrs	High	0	0	0	0	0	0	0	0	156	0	0	0
		Mid	150	12	0	5	0	0	0	0	208	0	0	0
		Low	14	21	0	0	0	0	0	0	88	0	0	4
07/05/2009	0930-1630hrs	High	167	5	0	25	1	10	0	0	3	1	0	0
		Mid	185	4	29	22	0	22	0	0	2	0	0	6
		Low	136	0	0	24	0	6	0	0	5	0	0	0

OC=oystercatcher, RK = redshank, SS = sanderling, DN = dunlin, KN = knot, BA = bar-tailed godwit, GP = golden plover, L = lapwing, CU = curlew, GV = grey plover, TT = turnstone, RP = ringed plover. Monthly peak counts for the survey are highlighted in red.

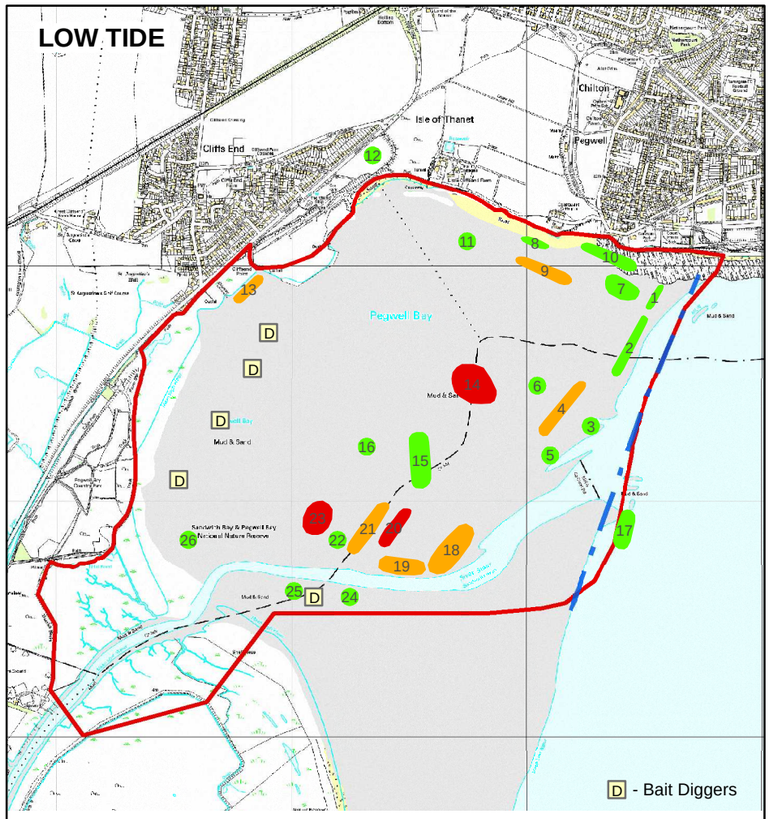
Appendix 3 - Pegwell Bay winter bird survey total counts 2008-09 - WILDFOWL & OTHER SPECIES

Date	Period	Time	T	SU	WN	NB	MA	BG	RH	ET	CA	TE
19/11/2008	1030-1530hrs	Low	0	43	50	0	0	1	0	0	4	0
		Mid	0	64	37	0	5	16	0	1	5	0
		High	0	29	0	0	0	0	0	0	0	0
12/12/2008	0900-1500hrs	High	0	50	90	0	0	1	0	0	0	0
		Mid	100	20	0	0	0	0	0	0	0	0
		Low	0	25	0	0	0	0	0	0	0	0
08/01/2009	0830-1430hrs	High	12	36	0	0	7	0	0	1	0	0
		Mid	0	13	81	0	7	0	4	0	0	0
		Low	13	15	45	0	16	0	0	0	0	0
12/02/2009	0830-1645hrs	Low	15	4	0	0	0	0	0	0	0	0
		Mid	0	12	330	0	0	0	0	0	7	0
		High	60	2	0	0	0	6	0	0	0	0
13/02/2009	0845-1645hrs	Low	0	56	0	0	0	11	0	0	0	0
		Mid	0	20	275	0	0	2	0	0	46	0
		High	4	6	0	0	0	8	0	0	0	0
24/03/2009	0900-1600hrs	High	0	42	0	1	0	3	0	0	3	0
		Mid	0	40	0	0	0	1	0	0	0	0
		Low	0	48	0	0	0	3	0	0	0	0
07/05/2009	0930-1630hrs	High	0	41	0	0	0	0	0	0	0	37
		Mid	0	8	0	0	0	0	0	3	1	5
		Low	0	76	0	0	0	0	0	0	2	43

T = teal, SU = shelduck, WN = wigeon, NB = spoonbill, MA = mallard, BG = Brent goose, RH = red-throated diver, ET = little egret, CA = cormorant.
TE = sandwich tern.

DRAWINGS

LOW TIDE

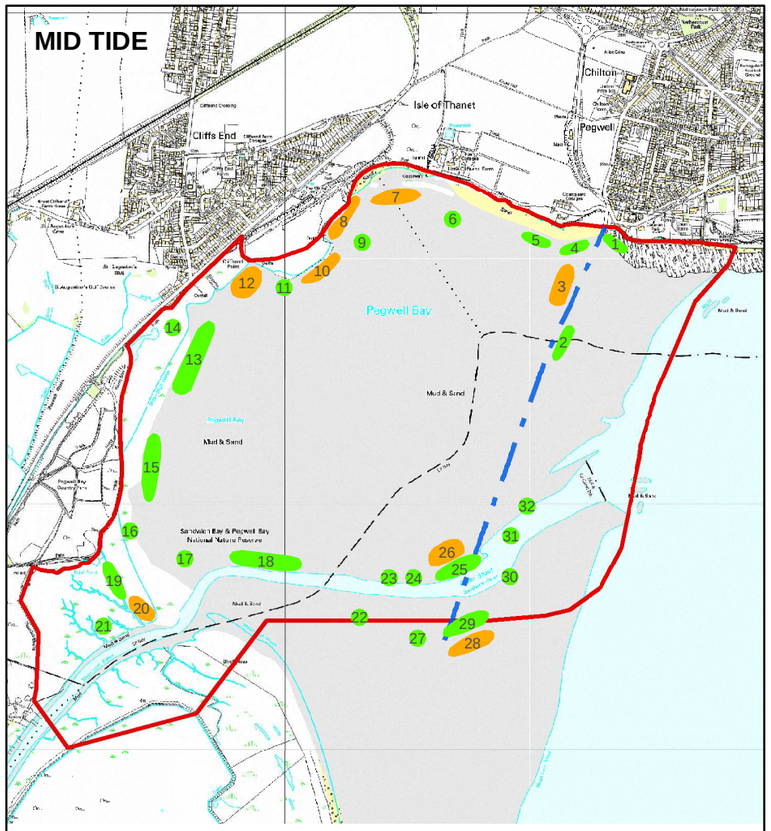


19-11-08 – Low tide (10:26) surveyed 10:30 – 11:30

Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	OC	14		
2	GV	5		
2	CU	26		
2	DN	20		
2	All sp.	65		
3	RK	8		
3	CU	5		
3	GV	3		
3	OC	1		
3	All sp.	17		
4	L	500		
5	GV	10		
5	CU	9		
5	RK	7		
5	CA	4		
5	All sp.	30		
6	SU	30		
7	CU	28		
7	DN	10		
7	All sp.	38		
8	DN	30		
8	CU	1		
8	All sp.	31		
9	CU	3		
9	DN	250		
9	All sp.	253		
10	OC	75		
11	CU	3		
12	L	18		
13	GP	150		

Flock number	Species	Count	Time	Additional notes
14	GP	1000		Increasing to 1900 birds.
14	RK	2		
14	CU	1		
14	OC	2		
14	SU	7		
14	All sp.	1012		
15	L	51		
16	OC	2		
17	WN	50		
18	RK	12		
18	CU	10		
18	DN	320		
18	KN	70		
18	GV	11		
18	All sp.	423		
19	DN	360		
19	CU	4		
19	BG	1		
19	All sp.	365		
20	GP	1100		Same birds as location 14.
21	L	600		
21	OC	13		
21	CU	3		
21	All sp.	616		
22	SU	6		
23	L	700		
23	GP	1600		
23	All sp.	2300		
24	CU	4		
25	OC	5		
26	CU	3		

MID TIDE

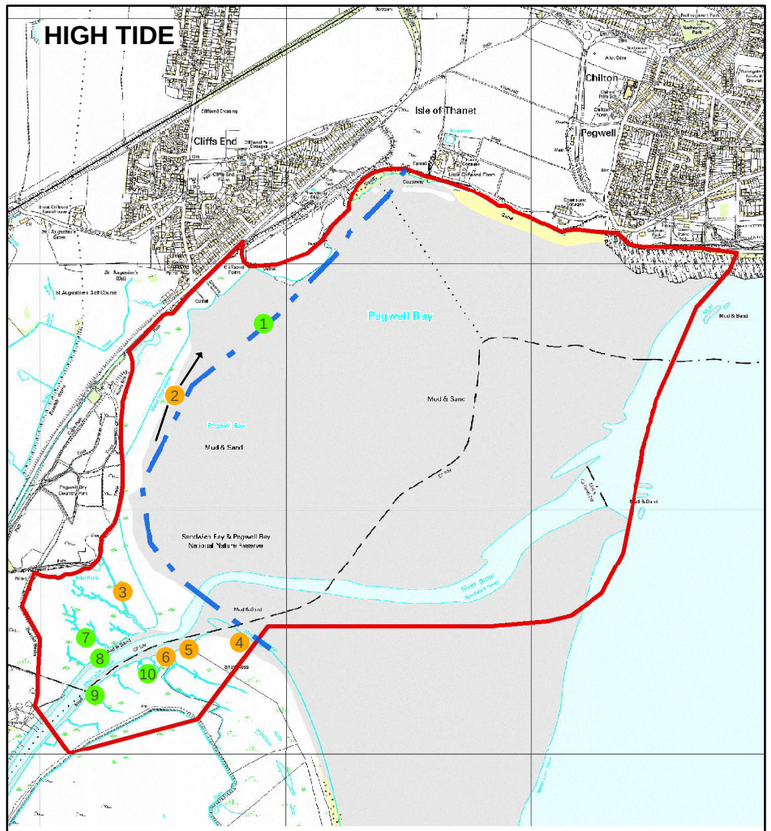


19-11-08 – Mid tide surveyed 12:30 – 13:30

Flock number	Species	Count	Time	Additional notes
1	OC	25		
2	SU	28		
2	BG	12		
2	All sp.	40		
3	CU	18		
3	DN	230		
3	All sp.	248		
4	DN	85		
4	GV	3		
4	All sp.	88		
5	GV	6		
5	CU	5		
5	All sp.	11		
6	GV	2		
6	CU	1		
6	OC	1		
6	All sp.	4		
7	DN	280		
7	GV	2		
7	All sp.	282		
8	L	160		
9	GV	2		
9	CU	2		
9	OC	5		
9	All sp.	9		
10	GP	530		
10	L	50		
10	All sp.	580		
11	OC	10		
11	RK	10		
11	All sp.	20		
12	L	440		
12	GP	180		
12	All sp.	620		
13	L	160		
13	OC	15		
13	CU	2		
13	DN	10		
13	All sp.	187		
14	SN	1		
15	L	650		Flushed at 13:15.
16	OC	16		

Flock number	Species	Count	Time	Additional notes
17	RK	7		
18	RK	55		
18	DN	1		
18	BG	1		
18	All sp.	57		
19	CU	33		
20	CU	165		
21	ET	1		
22	CU	1		
22	SU	5		
22	All sp.	6		
23	CU	11		
23	RK	11		
23	All sp.	22		
24	CU	23		
25	WN	37		
25	MA	5		
25	All sp.	42		
26	L	1100		
26	OC	155		
26	All sp.	1255		
27	KN	60		
28	DN	220		
29	KN	70		
30	CA	2		
31	SU	31		
31	BG	3		
31	All sp.	34		
32	CA	3		

HIGH TIDE



19-11-08 – High tide (15:43) surveyed 15:30 – 16:30

Flock number	Species	Count	Time	Additional notes
1	SG	70	15:39	
2	L	320	15:40	FLYING - northwards.
2	L	300	16:00	FLYING - northwards.
2	All sp.	620		
3	L	150		
4	OC	620		
5	GP	550		
6	GP	200		
6	L	230		
6	All sp.	430		
7	L	40	16:24	
8	SU	29		
9	L	90	16:19	FLYING - northeast.
10	OC	4	16:15	Flew in.
10	L	20	16:15	Flew in.
10	CU	20	16:15	Flew in.
10	All sp.	44	16:15	Flew in.

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 1 - 19/11/2008

Map No. G1430.01.001

Date: 08/02/2010

Scale: 1:25,000 @ A3

Drawn:	Checked:	Approved:
VJG	TR	FBH

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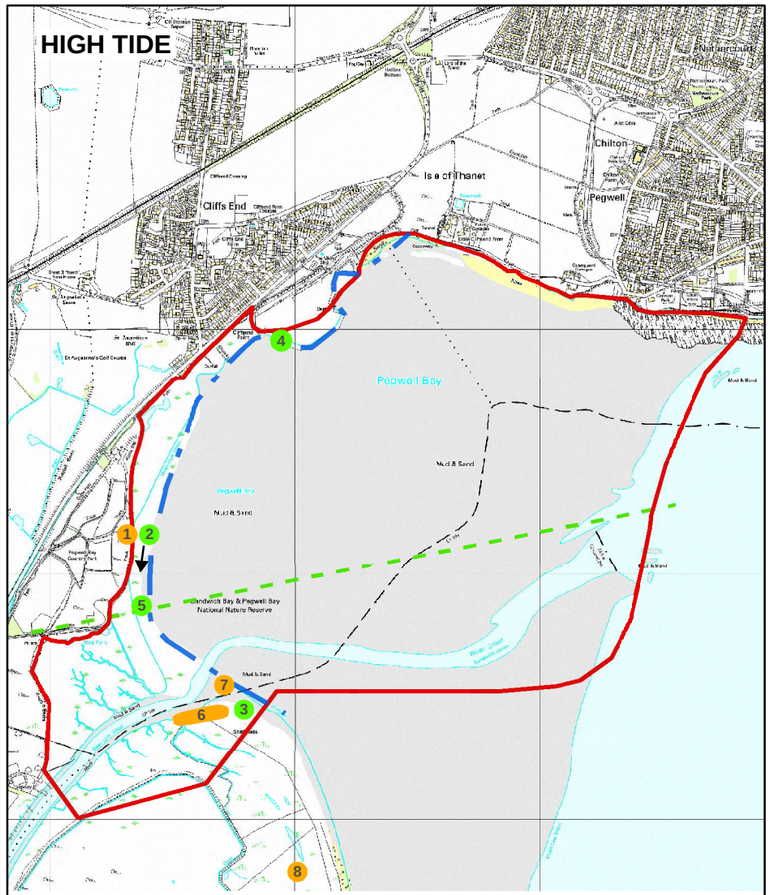
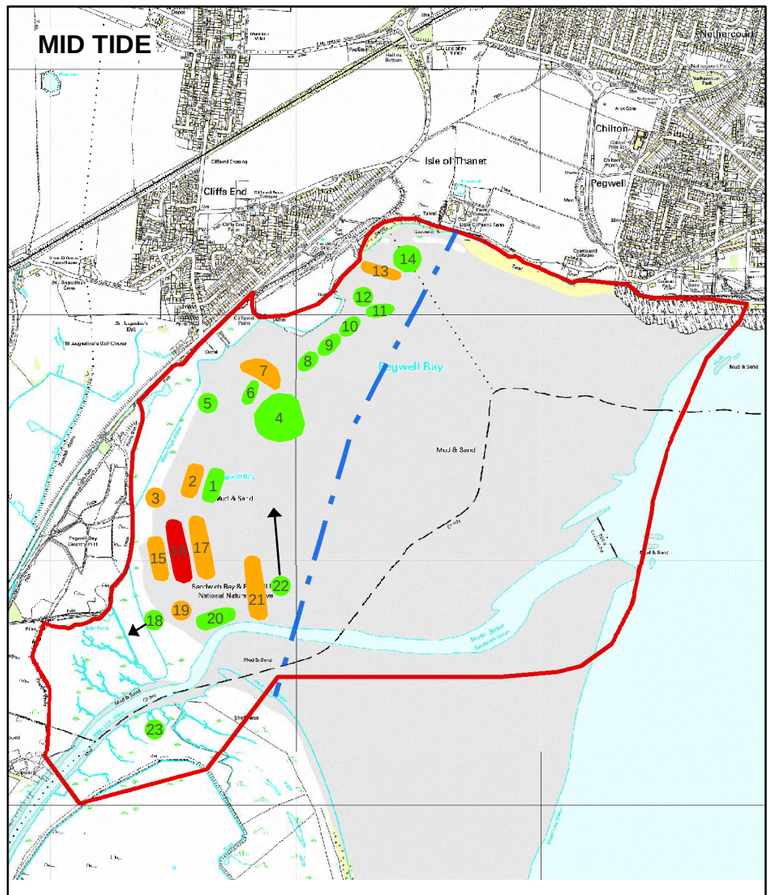
HIGH TIDE



12/12/2008 – High tide (09:58) surveyed 09:00 – 10:00

Flock number	Species (sp.)	Count	Time
1	CU	38	09:09
1	L	205	09:09
1	SU	50	09:09
1	WN	90	09:09
1	DN	10	09:09
1	SN	2	09:09
1	All sp.	395	09:09
2	L	95	09:10
2	SN	2	09:10
2	All sp.	97	09:10
3	L	60	09:12
4	L	240	
4	CU	20	
4	All sp.	260	
5	CU	40	
6	OC	3	
6	L	460	
6	BG	1	
6	AV	1	
6	DN	10	
6	RK	12	
6	All sp.	487	
7	OC	100	
7	DN	10	
7	All sp.	110	
8	L	450	

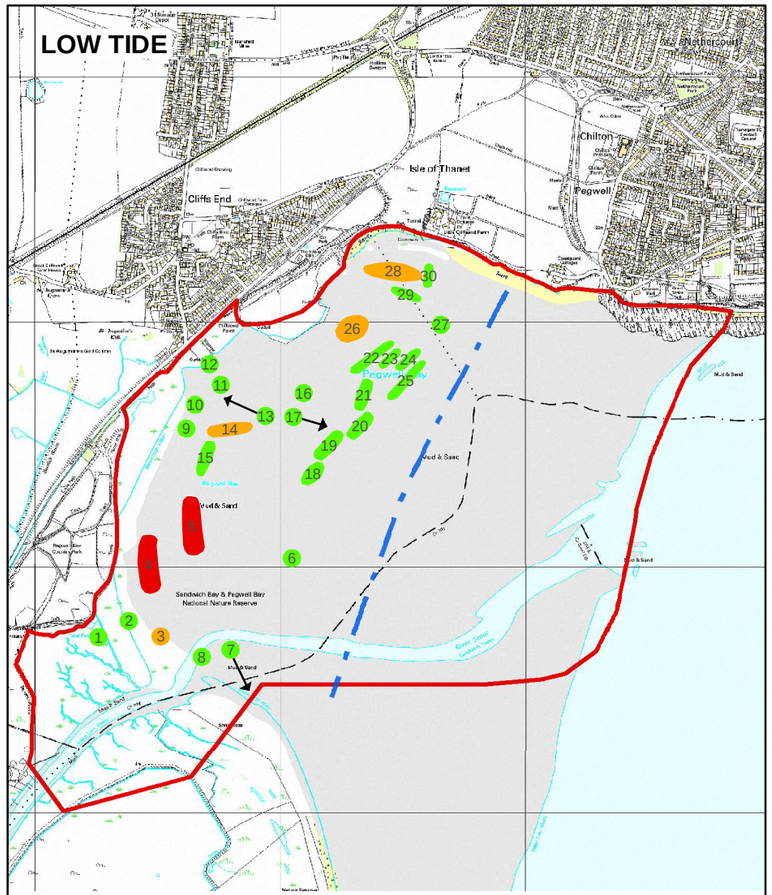
MID TIDE



12/12/2008 – Mid tide 13:00 – 14:00

Flock number	Species	Count	Time	Additional notes
1	SS	32		
2	GP	600		
3	L	7		
4	DN	20		
4	SU	20		
4	BA	9		
4	OC	3		
4	KN	5		
4	CU	14		
4	All sp.	71		
5	DN	9		
5	GV	1		
5	SS	3		
5	All sp.	13		
6	CU	45		
6	GV	3		
6	All sp.	48		
7	DN	500		
7	L	120		
7	All sp.	620		
8	BA	10		
8	SS	1		
8	All sp.	11		
9	BA	60		
10	SU	12		
11	OC	20		
12	OC	12		
13	L	100		
13	CU	1		
13	All sp.	101		
14	OC	28		
15	L	250		
16	L	1380		
17	DN	200		
17	OC	5		
17	L	5		
17	All sp.	210		
18	SS	1		
18	RK	2		
18	All sp.	3		
19	RK	5		
19	DN	12		
19	L	260		
19	KN	12		
19	OC	3		
19	GV	5		
19	All sp.	297		
20	DN	17		
20	GV	2		
20	RK	4		
20	All sp.	23		
21	GV	35		
21	KN	60		
21	OC	5		
21	RK	5		
21	DN	28		
21	All sp.	133		
22	CU	10	13:39	FLYING north.
23	T	100		

LOW TIDE



12/12/2008 – Low tide (17:41) surveyed 14:00 to 15:00

Flock number	Species	Count	Time	Additional notes
1	RK	1	14:59	
2	ET	1		
3	OC	6	14:10	
3	RK	3	14:10	
3	L	212	14:10	
3	CU	1	14:10	
3	DN	5	14:10	
3	All sp	229	14:10	
4	L	280	14:05	
4	DN	190	14:05	
4	GP	1380	14:05	
4	CU	2	14:05	
4	RK	1	14:05	
4	All sp.	1853	14:05	
5	GP	1380		Same birds as location 4.
5	OC	6		
5	L	245		
5	DN	88		
5	All sp.	1719		
6	OC	6	14:15	
6	CU	2	14:15	
6	GV	17	14:15	
6	RK	2	14:15	
6	DN	30	14:15	
6	All sp.	57	14:15	
7	SS	60		
8	ET	1	14:59	
9	OC	3		
10	DN	8		
11	RK	2		
12	OC	4		
13	DN	50		
14	DN	190		
15	OC	5		
16	OC	2		
17	DN	40		
18	BA	31		
19	SU	13		
20	OC	4		
21	SS	3		
22	OC	12		
23	DN	23		
23	KN	1		
23	All sp.	24		
24	SU	12		
25	CU	5		
26	GV	2		
26	DN	70		
26	L	24		
26	All sp.	96		
27	OC	6		
28	L	560		
29	CU	5		
29	DN	40		
29	All sp.	45		
30	CU	3		
30	OC	11		
30	All sp.	14		
31	SS	13	14:40	

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 2 - 12/12/2008

Map No. G1430.01.002

Date: 08/02/2010

Scale: 1:25,000 @ A3

Drawn:	Checked:	Approved:
VJG	TR	FBH

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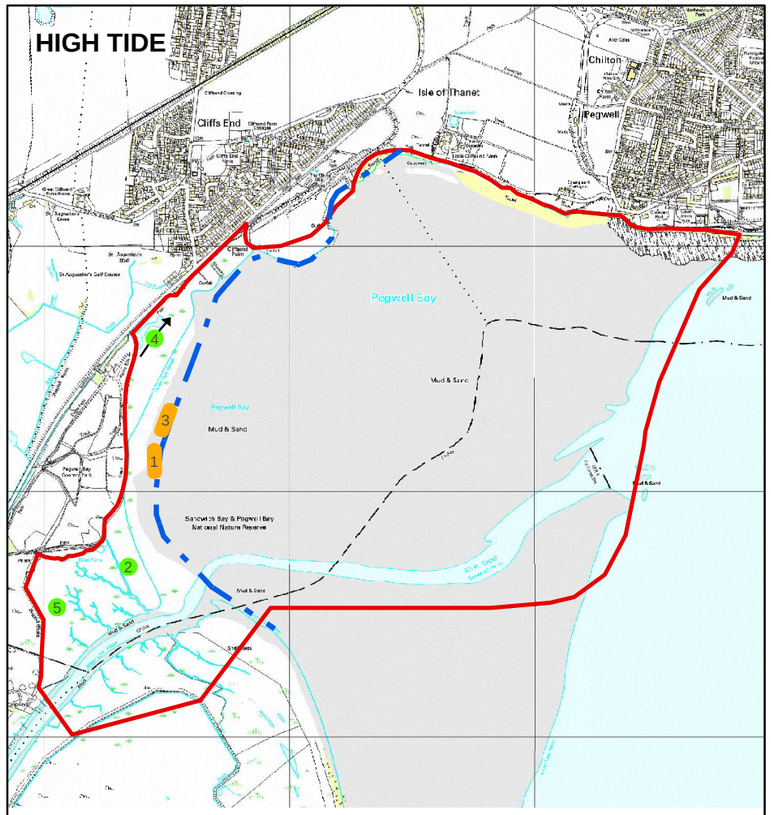
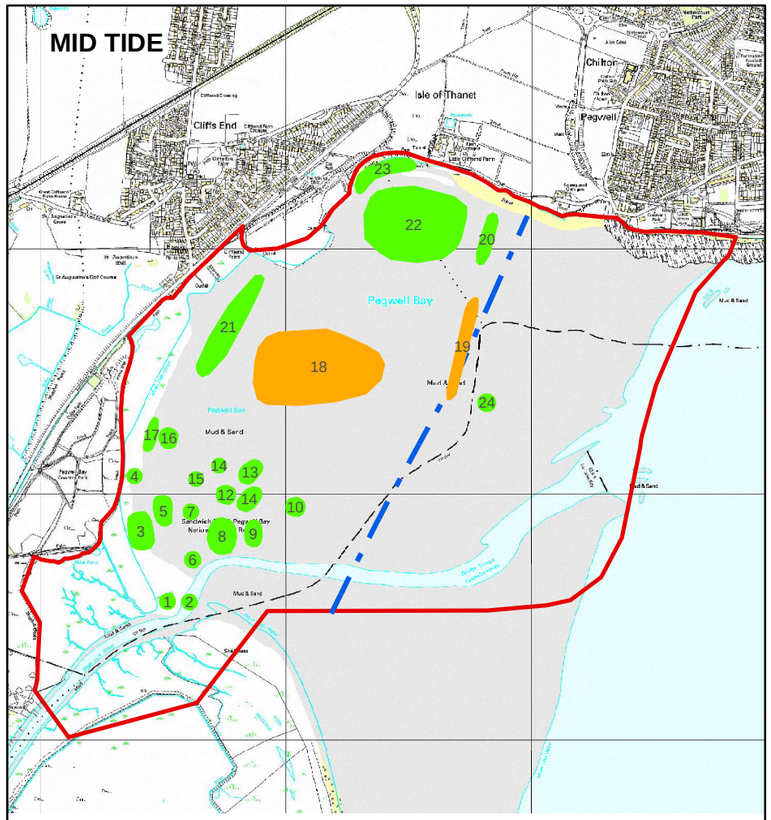
HIGH TIDE



08-01-09 – High tide (07:45) surveyed at 08:30 to 09:30.

Flock number	Species	Count	Time	Additional notes
1	SD	20	08:40	
1	DN	40	08:40	
1	OC	20	08:40	
1	CU	20	08:40	
1	RK	30	08:40	
1	L	30	08:40	
1	GP	300	08:40	
1	All sp.	460	08:40	
2	T	12	08:50	
3	SD	16	09:13	
3	DN	100	09:13	
3	L	15	09:13	
3	GP	50	09:13	
3	OC	20	09:13	
3	CU	15	09:13	
3	RK	40	09:13	
3	All sp.	256	09:13	
4	ET	1	09:30	FLYING – northwards.
5	RK	1	09:16	
5	MA	7	09:04	Flew up and southwards.
5	All sp.	8		

MID TIDE

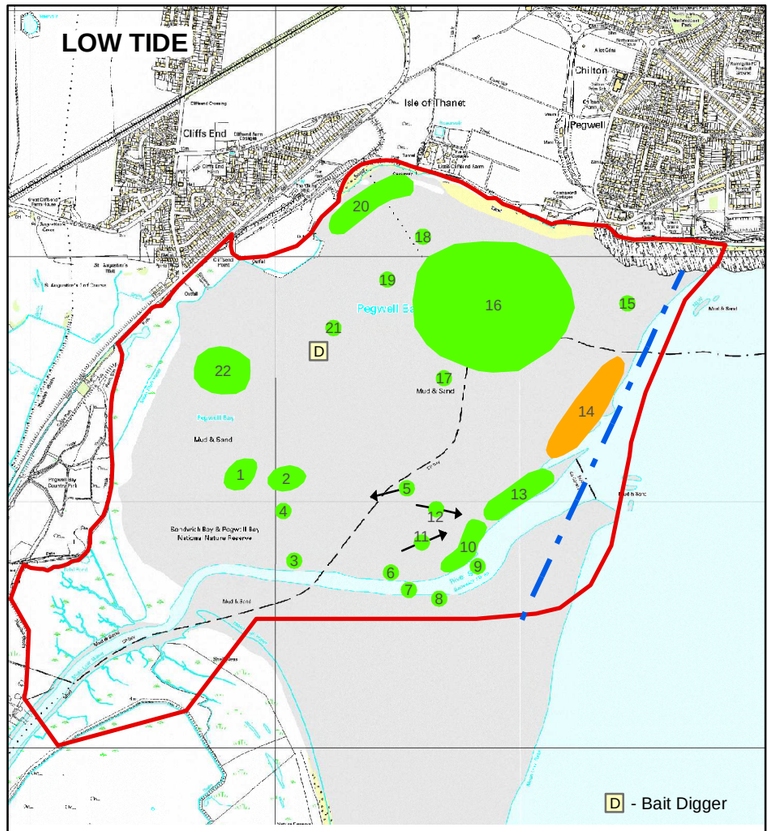


08-01-09 – Mid tide surveyed at 11:30 to 12:30.

Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	SU	4		
3	GV	19		
3	DN	6		
3	All sp.	25		
4	SU	1		
5	DN	6		
5	GV	19		
5	All sp.	26		
6	WN	2		
7	RK	3		
8	DN	9		
8	RP	19		
8	All sp.	28		
9	WN	7		
9	MA	7		
9	All sp.	14		
10	SU	7		
11	DN	50		
12	BA	10		
12	CU	5		
12	All sp.	15		
13	GV	18		
14	OC	5		
15	OC	1		
16	L	70		
17	L	16		
17	DN	5		
17	All sp.	21		
18	OC	10		
18	RK	1		
18	All sp.	11		
19	WN	62		
19	OC	85		
19	CU	18		
19	BA	20		
19	DN	20		
19	All sp.	205		
20	OC	14		
20	CU	6		
20	WN	10		
20	All sp.	30		

Flock number	Species	Count	Time	Additional notes
20	OC	14		
20	CU	6		
20	WN	10		
20	All sp.	30		
21	OC	5		
21	GV	2		
21	DN	50		
21	RK	2		
21	All sp.	119		
22	OC	17		
23	SU	1		
23	OC	14		
23	All sp.	15		
24	RH	4		Swimming south.

LOW TIDE



08-01-09 – Low tide (15:16) surveyed at 13:30 to 14:30.

Flock number	Species	Count	Time	Additional notes
1	OC	6		
2	DN	33		
3	DN	5		
3	OC	2		
3	CU	1		
3	All sp.	8		
4	CU	1		
5	RK	1		Flew up and then went southwest.
6	CU	1		
7	OC	3		
7	CU	1		
7	MA	16		
7	All sp.	20		
8	SU	15		
9	WN	13		
10	DN	8		
10	T	13		
10	OC	21		
10	WN	5		
10	All sp.	47		
11	WN	7		FLYING – east.
12	DN	20		FLYING – southeast.
13	OC	15		
13	GV	12		
13	All sp.	27		
14	WN	20		
14	DN	25		
14	OC	20		
14	CU	25		
14	H	2		
14	BA	10		
14	All sp.	102		

Flock number	Species	Count	Time	Additional notes
15	OC	4		
16	OC	20		
17	SS	3		
18	CU	1		
19	OC	2		
20	SU	2		
20	DN	74		
20	OC	2		
20	CU	1		
20	All sp.	79		
21	SS	3		
21	OC	2		
21	RK	1		
21	All sp.	6		
22	OC	30		

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 3 - 08/01/2009

Map No. G1430.01.003

Scale: 1:25,000 @ A3

Date: 08/02/2010

Drawn: VJG | Checked: TR | Approved: FBH

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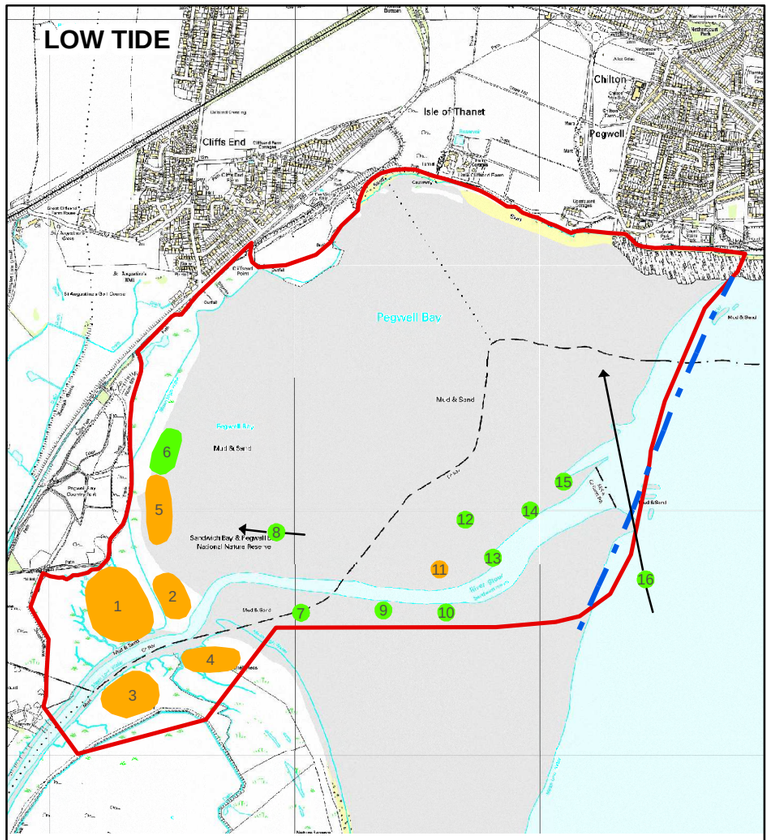
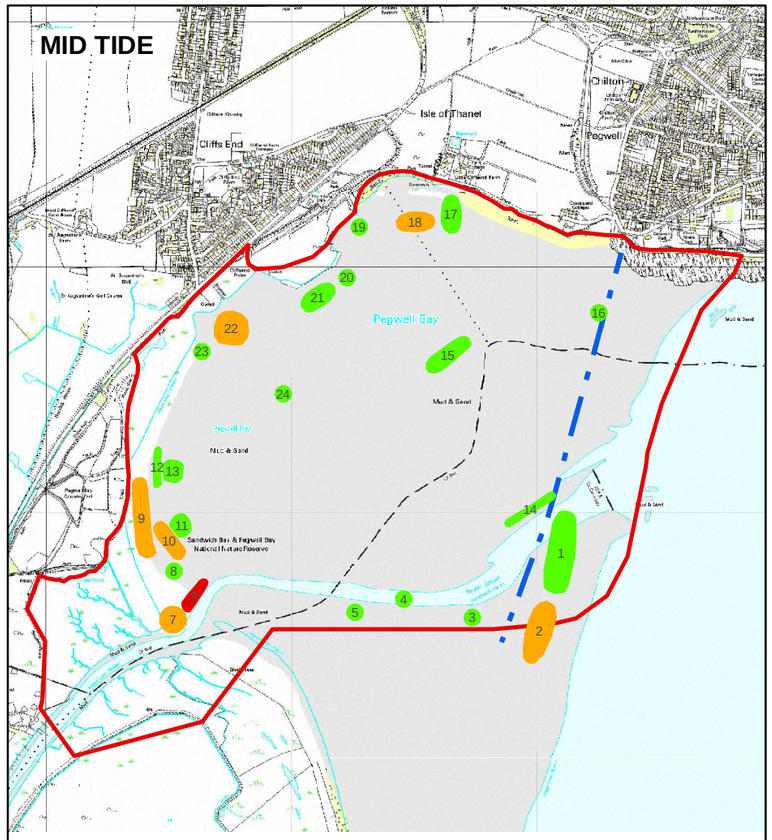
LOW TIDE



12-02-09 – High tide surveyed at 12:30 to 13:30.

Flock number	Species	Count	Time	Additional notes
1	L	60	12:41	
1	L	110	13:28	Flew in from the North.
1	All sp.	170	13:28	
2	CU	50	12:46	
2	L	18	12:46	
2	All sp.	68		
3	L	250	12:47	Flew onto saltmarsh at location 3.
4	L	300	12:48	
5	L	2350	12:53	
5	SD	2		
5	BG	5		
5	All sp/	2357		
2,3,4,5	L	1400		Flushed up. Several hundred L fly across to 1.
2,3,4,5	GP	1000		Flushed up.
6	L	30	12:47	
7	OC	600		
8	TT	2		
8	RK	3		
8	All sp.	5		
9	L	12	12:38	
10	L	55	13:16	
11	L	67	13:20	FLYING – southeast.
12	L	32	13:02	FLYING – south.
13	BG	1	12:50	FLYING – north.
14	T	60		Flushed up and flew northeast.
15	L	15	13:09	FLYING – southeast
16	L	<10		Various movements of small flocks.

MID TIDE

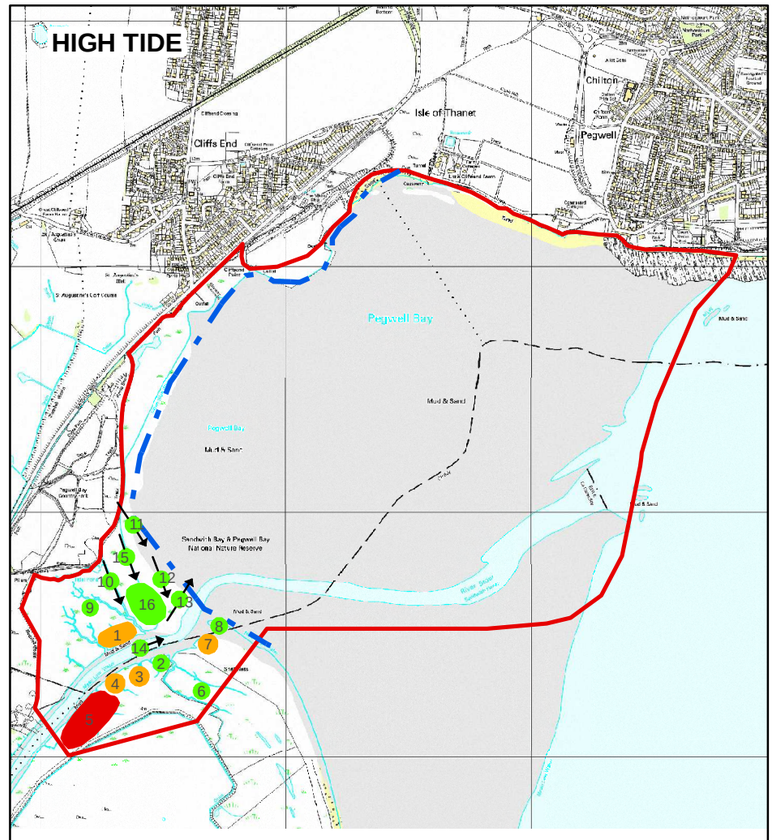


12-02-09 – Mid tide surveyed at 10:45 to 11:45

Flock number	Species	Count	Time	Additional notes
1	WN	80		
2	WN	250		
3	CU	1		
4	OC	8		
5	OC	2		
6	OC	1100		
7	L	300		
8	CU	30		
9	L	800		
10	L	740		
11	GV	2		
11	KN	1		
11	OC	4		
11	BA	1		
11	RK	3		
11	CU	1		
11	DN	2		
11	All sp.	14		
12	GV	10		
12	OC	1		
12	All sp.	11		
13	Gv	10		
13	OC	1		
13	All sp.	11		
14	OC	43		
15	KN	12		
15	DN	18		
15	All sp.	30		
16	CA	3		
16	SU	9		
16	All sp.	72		

Flock number	Species	Count	Time	Additional notes
17	RK	6		
17	CA	4		
17	GP	12		
17	All sp.	22		
18	GP	30		
18	KN	16		
18	DN	122		
18	All sp.	168		
19	RP	1		
20	RK	3		
21	DN	320		
21	KN	25		
21	GV	48		
21	All sp.	565		
22	L	300		
22	GP	8		
22	All sp.	308		
23	SU	3		
24	GV	35		

HIGH TIDE



12-02-09 – Low tide (07:50) surveyed at 08:30 to 09:30

Flock number	Species	Count	Time	Additional notes
1	L	500	08:39	Flushed and flew northwards.
2	L	650	09:12	300 L flushed soon afterwards.
3	L	750	09:14	Flushed soon afterwards.
4	L	400	08:40	250 L flushed soon afterwards.
5	GP	450		
5	L	300		
5	RK	15		
5	All sp.	765		
6	L	45		
6	OC	1		
6	CU	1		
6	All sp.	47		
7	RK	1		
7	OC	1		
7	All sp.	2		
8	DN	26		FLYING - northwest.
9	CU	1		
9	SD	4		
9	All sp.	5		
10	DN	50	08:53	FLYING - west.
11	L	300	09:10	FLYING - east.
12	T	15		FLYING - east
13	CU	2		
13	OC	30		
13	All sp.	32		
14	CU	10		
15	CU	4		
15	OC	19		
15	All sp.	23		
16	CU	50		Flying northwards.

Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 4 - 12/02/2009

Map No. G1430.01.004

Scale: 1:25,000 @ A3

Date: 08/02/2010

Drawn:	Checked:	Approved:
VJG	TR	FBH

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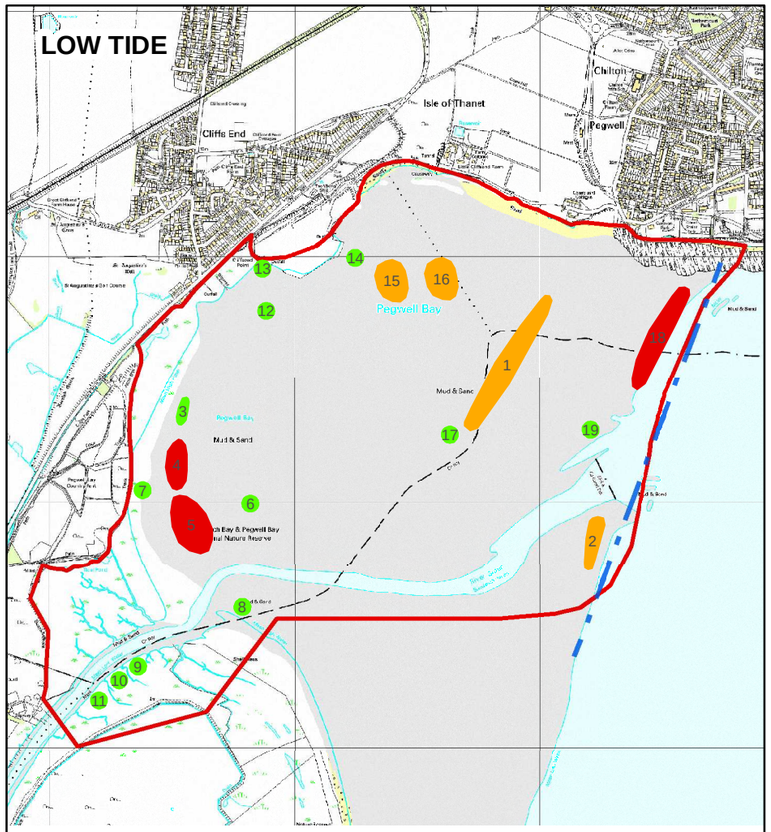
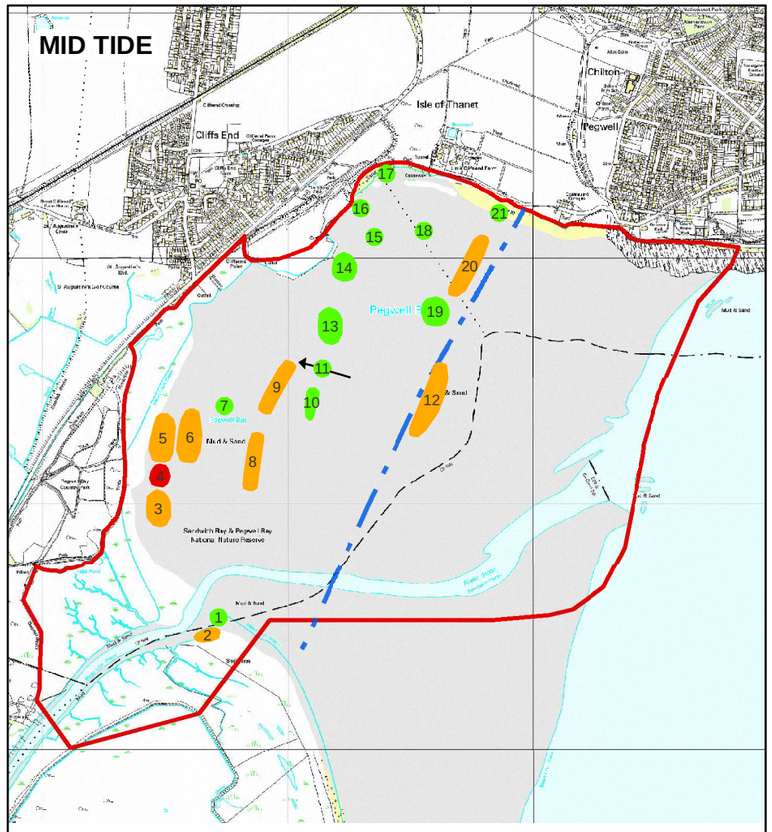
LOW TIDE



13-02-09 – Low tide (08:30) surveyed 08:45 – 09:45

Flock number	Species	Count	Time	Additional notes
1	L	650		
2	OC	130		
3	L	60		
3	RK	1		
3	All sp.	61		
4	L	850		
4	GP	1460		
4	DN	10		
4	All sp.	2520		
5	L	1800		
5	GP	240		
5	All sp.	2040		
6	CU	6		
6	OC	4		
6	All sp	10		
7	RK	5		
8	SU	12		
8	CU	1		
8	All sp.	13		
9	SU	14		
10	CU	35		
11	BG	11		
12	GV	12		
13	L	60		
14	RK	14		
15	GV	42		
15	DN	270		
15	All sp.	312		
16	KN	142		
17	CU	7		
18	DN	270		
18	SU	13		
18	KN	88		
18	OC	320		
18	CU	242		
18	L	677		Same birds as in loc. 1.
18	All sp.	1610		
19	SU	17		

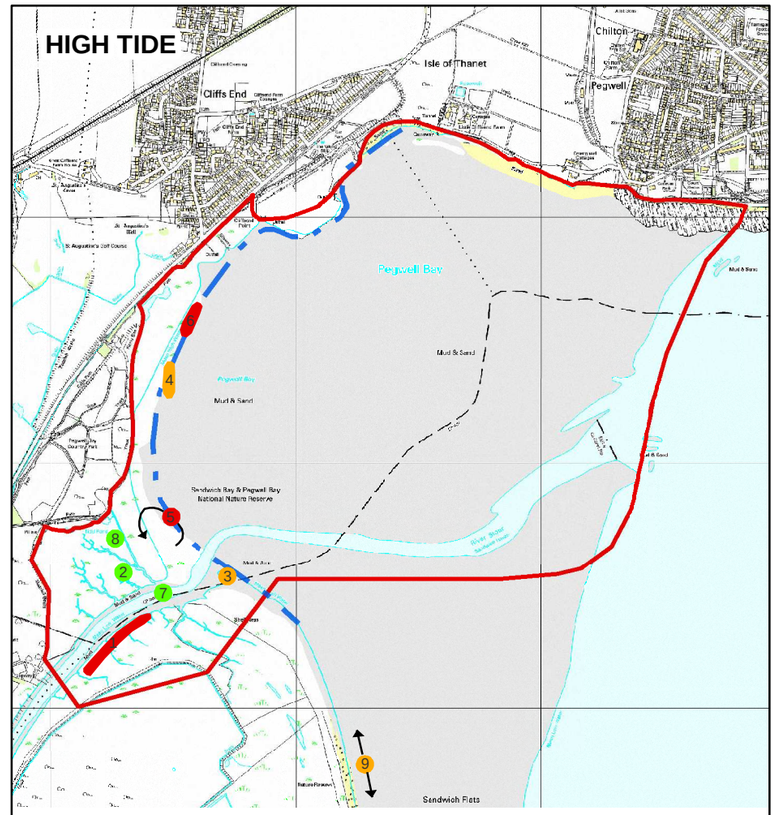
MID TIDE



13-02-09 – Mid tide surveyed 11:30 to 12:30

Flock number	Species	Count	Time	Additional notes
1	CU	90		
1	L	5		
1	All sp.	95		
2	OC	400		
3	L	700		
4	GP	1500		
5	L	800		
6	DN	180		
6	GV	30		
6	OC	5		
6	All sp.	215		
7	KN	10		
8	L	155		
9	BA	170		
10	SU	20		
11	BG	2		Flew southwards.
12	WN	275		Mostly on the sea.
13	GV	45		
14	DN	40		
14	GV	18		
14	All sp.	58		
15	RK	12		
16	L	34		
17	TT	70		
18	GV	42		
19	CA	46		
19	RP	1		
19	BA	5		
19	All sp.	52		
20	OC	60		
20	KN	35		
20	GV	55		
20	DN	120		
20	All sp.	270		
21	SS	7		

HIGH TIDE



13-02-09 – High tide (13:45) surveyed 13:45 – 14:45

Flock number	Species	Count	Time	Additional notes
1	L	148	13:52	
1	CU	300	13:56	
1	BG	8	13:56	
1	SU	6	13:56	
1	L	148	14:04	Flushed.
1	GP	850	14:18	
1	All sp.	1312		
2	CU	70	13:58	
3	L	350	14:04	Flushed.
4	L	130		Flew in.
5	GP	550		FLYING - Circling flight.
5	L	3100		FLYING - Circling flight.
5	All sp.	3650		FLYING - Circling flight.
6	L	500	14:37	
6	GV	250	14:37	
6	DN	500	14:37	
6	BA	150	14:37	
6	All sp.	1400	14:37	
7	T	4	13:58	In river channel.
8	CU	1	13:41	Flew southwards.
9	KN	400	14:07	FLYING - Circling flight.

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 5 - 13/02/2009

Map No. G1430.01.005

Date: 08/02/2010

Scale: 1:25,000 @ A3

Drawn: VJG | Checked: TR | Approved: FBH

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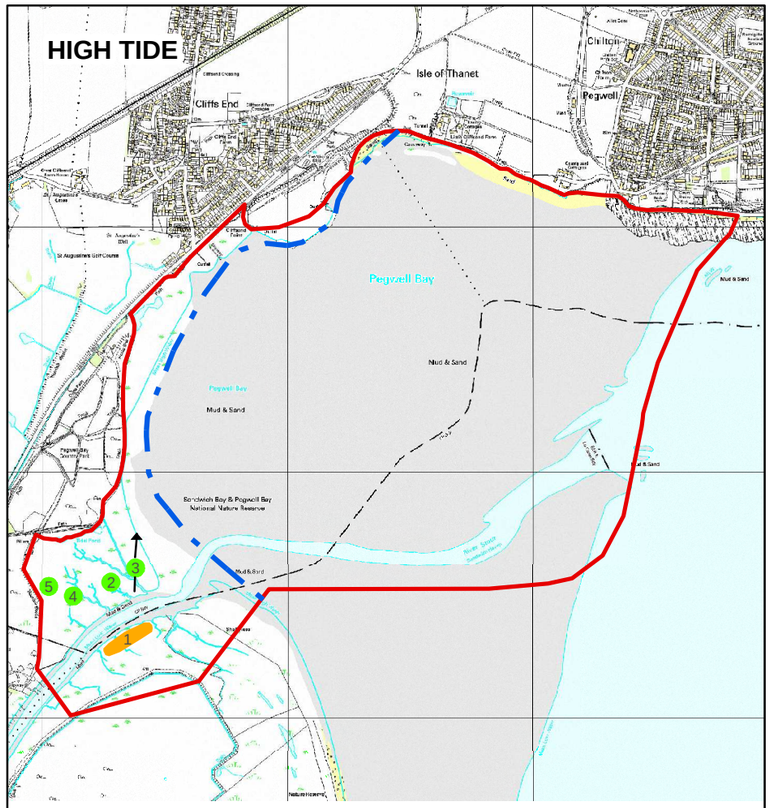
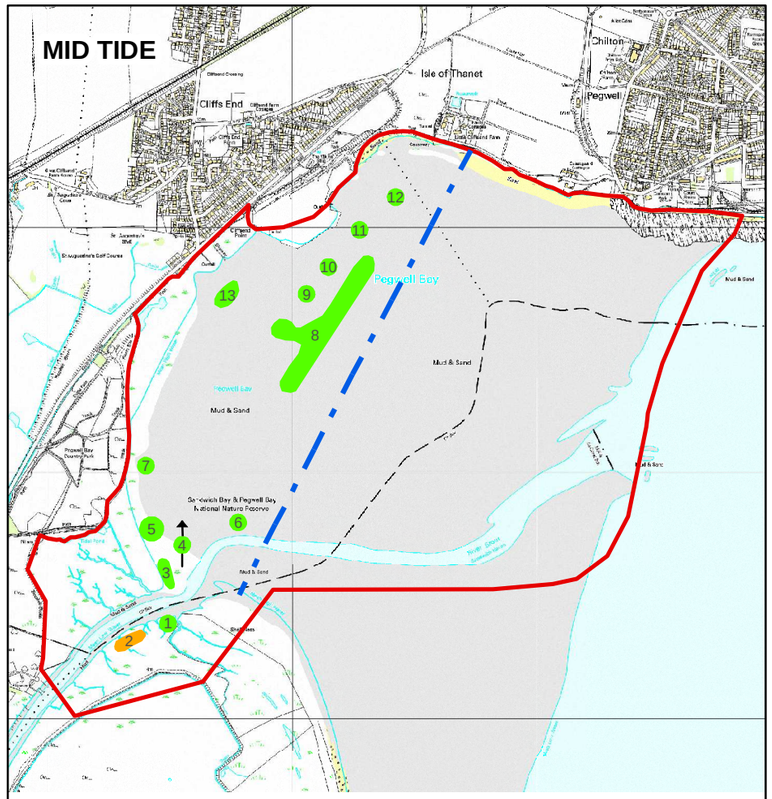
HIGH TIDE



24-03-09 – High tide (10:01) surveyed 10:00 – 11:00

Flock number	Species	Count	Time	Additional notes
1	SU	42	10:46	
1	NB	1	10:46	
1	CU	156	10:46	
1	BG	3	10:46	
1	All sp.	202	10:46	
2	CU	90	10:14	Moved to location 1.
3	CA	2		FLYING - northwards.
4	MR	1	10:39	FLYING - southwards.
5	K	1	10:10	FLYING -Hovering.

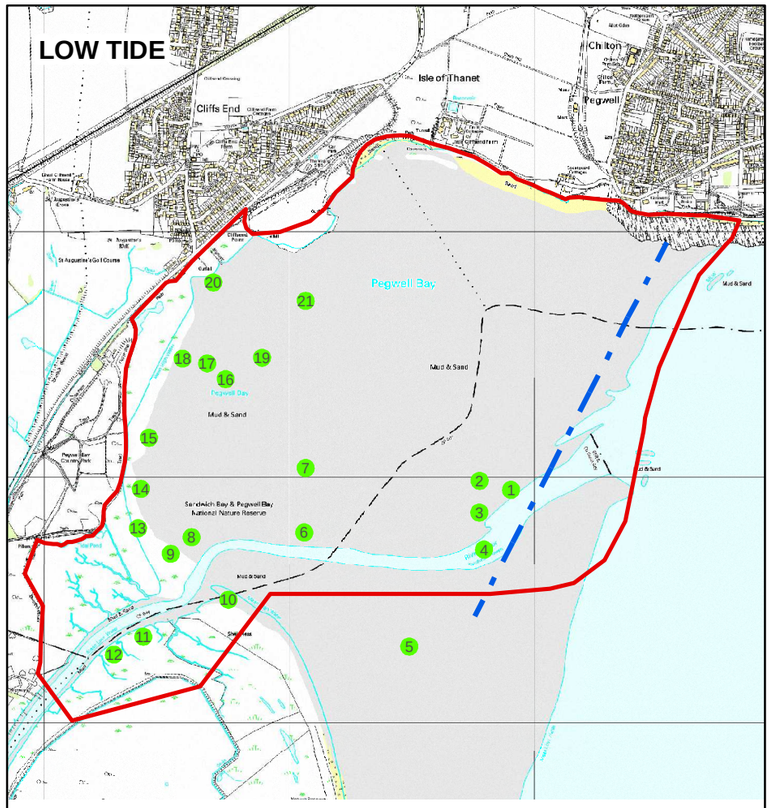
MID TIDE



24-03-09 – Mid tide surveyed 13:00 – 14:00

Flock number	Species	Count	Time	Additional notes
1	SU	7		
2	CU	121		
2	SU	28		
2	All sp.	149		
3	OC	75		Gradually flock broke up with birds flying to centre of Pegwell bay.
4	CU	65		FLYING - north to centre of Pegwell bay.
5	BG	7		
5	CU	1		
5	SU	1		
5	All sp.	9		
6	BA	1		
6	CU	2		
6	All sp.	3		
7	RK	2		
8	OC	75		
9	SU	4		
10	CU	19		
11	OC	25		
12	SV	7		
13	DN	5		
13	RK	10		
13	All sp.	15		

LOW TIDE



24-03-09 – Low tide (16:54) surveyed 15:00 – 16:00

Flock number	Species	Count	Time	Additional notes
1	OC	10		
2	CU	5		
3	SU	3		
3	CU	1		
3	All sp.	4		
4	SU	2		
5	OC	4		
5	CA	1		
5	All sp.	5		
6	SU	9		
6	CU	1		
6	All sp.	10		
7	CU	7		
8	SU	1		
9	CU	10		
10	CU	1		
11	SU	13		
11	CU	2		
11	BG	3		
11	All sp.	18		
12	CU	3		
13	SU	1		
14	RK	1		
14	SU	2		
14	All sp.	3		
15	SU	2		
16	RK	15		
17	SU	13		
18	RP	4		
19	RK	1		
20	DN	5		
20	SU	2		
20	RK	4		
20	All sp.	11		

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 6 - 24/03/2009

Map No. G1430.01.006

Scale: 1:25,000 @ A3

Date: 08/02/2010

Drawn:	Checked:	Approved:
VJG	TR	FBH

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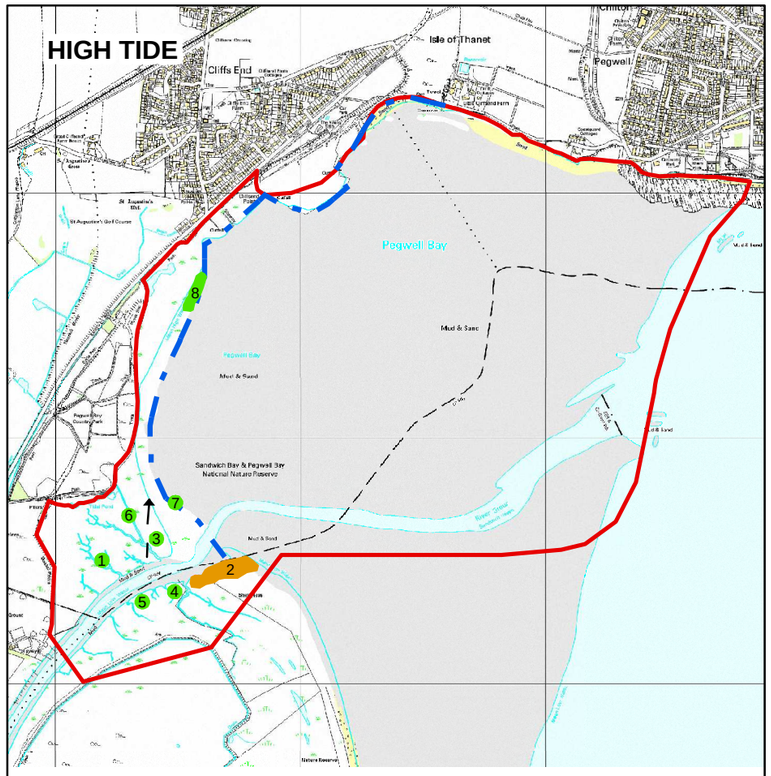
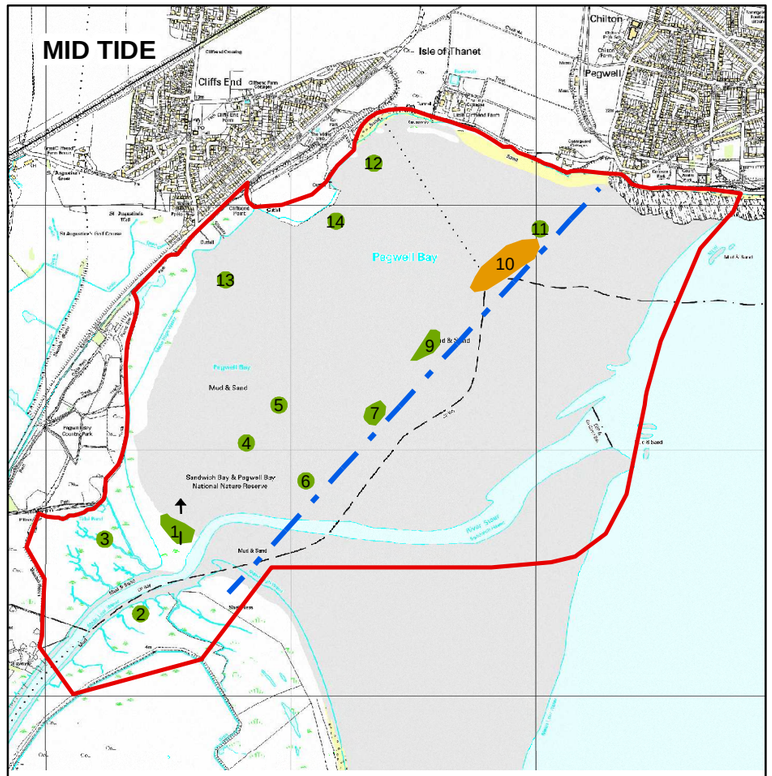
HIGH TIDE



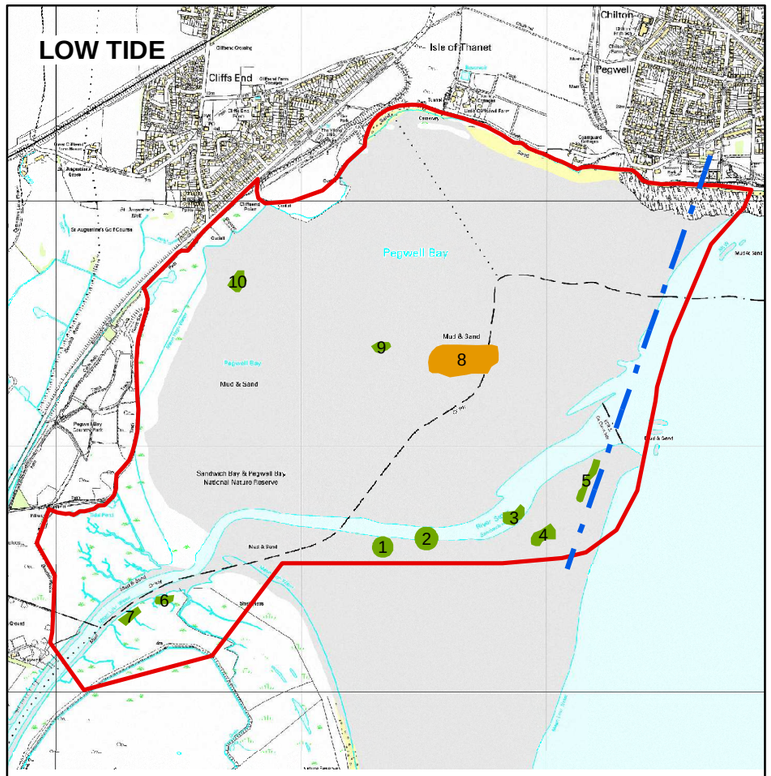
07-05-09 – High tide (10.51) surveyed 10:30 – 11:30				
Flock number	Species	Count	Time	Additional notes
1	RK	1	10:31	Standing on post
2	OC	166	10:35	
2	TE	37	10:35	
2	SU	2	10:35	
2	DN	15	10:35	
2	BA	10	11:00	
2	KN	1	11:00	
2	All sp.	231		
3	RK	3	10:42	Fly in.
3	DN	10	11:12	Fly in.
3	All sp.	13		
4	CU	3	10:43	Fly in.
5	OC	1	10:45	
6	RK	1	10:55	Fly into gulley.
7	GV	1	11:30	
8	SU	39	11:30	

MID TIDE



07-05-09 – Mid tide surveyed 13:30-14:30				
Flock number	Species	Count	Time	Additional notes
1	OC	32	13:54	
1	RK	1	13:54	
1	CU	1	13:54	
1	All sp.	34	13:54	
2	OC	3		
2	SU	3		
2	All sp.	6		
3	RK	3		
4	TE	5	13:50	FLYING
5	RP	3		
6	SU	1		
6	BA	4		
6	All sp.	5		
7	OC	2		
7	DN	15		
7	BA	6		
7	All sp.	23		
8	CA	1		
9	SS	29		
9	RP	3		
9	DN	7		
9	BA	12		
9	All sp.	51		
10	OC	148		
11	SU	2		
11	CU	1		
11	All sp.	3		
12	SU	2		
13	ET	2		
14	ET	1		

LOW TIDE



07-05-09 – Low tide (17:58) surveyed 15:30-16:30				
Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	SU	14		
3	DN	24		
3	SU	2		
3	OC	1		
3	All sp.	27		
4	OC	15		
5	SU	4		
5	CA	2		
5	All sp.	6		
6	OC	4		
6	SU	4		
6	All sp.	8		
7	SU	9		
8	OC	116		
8	BA	6		
8	TE	43		
8	All sp.	165		
9	CU	4		
10	SU	43		

Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project: UK - Belgium Interconnector

Title: Winter Bird Survey Visit 7 - 07/05/2009

Map No. G1430.01.007

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Appendix 9: Inter-tidal Sediment and Invertebrate Surveys

UK – BELGIUM INTERCONNECTOR
PROJECT NEMO

INTER-TIDAL SEDIMENT AND INVERTEBRATE SURVEYS

(Doc Ref: TEP 1430.01.027)

September 2010

Prepared by TEP for:

National Grid International Limited
National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Written:	Checked:	Approved:
TR	HR	IJG

TEP
Genesis Centre, Birchwood Science Park, Warrington, WA3 7BH
Tel: 01925 844004 Fax: 01925 844002 www.tep.uk.com

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FIGURES

Figure 1: Aerial photograph illustrating site context
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Figure 3: Dendogram showing percentage similarity between invertebrate communities from each sample station in Pegwell Bay using average values from 5 replicates.
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DRAWINGS

G1430.01.012 Pegwell Bay inter-tidal sediment and invertebrate surveys: sampling locations A to O
G1430.01.014 Pegwell Bay inter-tidal invertebrate total abundance distribution
G1430.01.015 Pegwell Bay inter-tidal invertebrate species richness distribution

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake inter-tidal sediment and invertebrate surveys to investigate the value of the onshore environment of Pegwell Bay as a feeding resource for waders and wildfowl. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay. TEP commissioned the Centre for Marine and Coastal Studies (CMACS) to assist with surveys and analysis.

1.2 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods.

Methods

1.3 Detailed intertidal sediment and invertebrate surveys of the Pegwell Bay north of the River Stour were undertaken in 2009 by ecologists from TEP and CMACS on 13th and 14th August 2009.

1.4 In total four transects were taken at right angles to the shoreline associated with Cliffs End and the A256 (Transects 1 to 4). Along each transect four sample points were identified which represented the upper, mid-upper, mid-lower and lower shore.

Results

1.5 A total of 42 taxa were recorded across all sites. Most of the species sampled were polychaetes (19 taxa), followed by crustaceans (15 taxa) and molluscs (4 taxa). The average total abundance across all sampling locations was 3,930 individuals per m^2 and the average species richness was 13 species.

1.6 The shore at Pegwell Bay was dominated by well sorted medium to very fine sands which made up at least 75% of the sediment.

1.7 Four separate biotopes were identified by analysing the sediment and invertebrate survey results. These were as follows:

- The mid shore : '*Cerastoderma edule* and polychaetes in littoral muddy sand' (LS.LSa.MuSa.CerPo)
- The upper shore : '*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand' (part) (LS.LSa.MuSa.BatCare)
- The north eastern end of the shore : '*Nephtys cirrosa* dominated littoral fine sand' (LS.LSa.FiSa.PoNcir)
- Lower shore adjacent to north bank of River Stour : '*Cerastoderma edule* and polychaetes in littoral muddy sand' (part) LS.LSa.MuSa.CerPo).

1.8 A range of prey species associated with various wader birds were recorded during the 2009 invertebrate survey including catworms *Nephtys* sp., amphipods *Corophium sp.,* common cockles *C. edule,* sandworms *Hediste* sp*.,*

laver spire shell *H. ulvae,* sand mason worm *Lanice conchilega,* Baltic tellin *M. balthica* and the polychaete *Scoloplos armiger*.

1.9 The polychaete *P. armiger* and the common cockle *C. edule* were widespread and fairly abundant and were found to be particularly abundant at mid shore in the southern half of the Pegwell Bay (Sampling location B) indicating that this location is an important feeding area for waders.

1.10 A number of invertebrates taken by waders were either not recorded during the August 2009 survey or were recorded at low abundances, such as the amphipod *Corophium* sp. and the laver spire shell *Hydrobia ulvae*.

1.11 The amphipod *Bathyporeia sarsi* was the most abundant invertebrate at Pegwell Bay being recorded at every sampling location and being particularly abundant on the upper shore. It is not clear how important *B. sarsi* is as a prey item for waders on the Pegwell Bay although it is known that this species is favoured by some species of fish.

Implications and Recommendations

1.12 Overall it is likely that the patchy distribution of inter-tidal invertebrate prey species within the Pegwell Bay is likely to be influencing the distribution of the principal feeding wader flocks to some extent e.g. sampling location B provides a valuable feeding area for most wader species. However invertebrate prey items were found to be present in all sampling locations across the Pegwell Bay indicating that the waders are generally not dependent on a specific location within the Pegwell Bay for feeding.

1.13 The widespread distribution of various annelid species and the common cockle *C. edule* will help to ensure that waders displaced from parts of the Pegwell Bay affected by the proposed cable development will be able to feed elsewhere within the Bay during the period of cable laying activities.

1.14 It is recommended that the proposed cable laying activities avoid the mudflats near to sampling location B which represents an important feeding area for waders within the Pegwell Bay.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake sediment and invertebrate surveys to investigate the value of the onshore environment of Pegwell Bay as a feeding resource for waders and wildfowl. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay. TEP commissioned the Centre for Marine and Coastal Studies (CMACS) to assist with surveys and analysis.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the sediment and invertebrate surveys involved collecting sediment and invertebrate core samples at five high to low tide transects located across the Pegwell Bay north of the River Stour. Analysis of these samples facilitated the production of a sediment and biotope classification map illustrating the distribution of different sediment types and invertebrate fauna communities across the Pegwell Bay. This information may then be used to determine how variations in inter-tidal sediment and invertebrate types within the Pegwell Bay influence the behaviour and distribution of waders and wildfowl using the Pegwell Bay as a feeding resource. This information can then be used to predict the effects of the proposed development on feeding waders within the Pegwell Bay.

3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1 below.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also included as a part of the Pegwell Bay winter bird survey.

Figure 1: Aerial photograph illustrating site context

Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods (further details including site citations are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (further details are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.8 Citation sheets for all designated sites described are included in Appendix 2 of TEP report '1430.01.024 Winter Bird Survey'.

4.0 METHODS

Inter-tidal Sediment and Invertebrate Surveys

4.1 Detailed intertidal sediment and invertebrate surveys of the Pegwell Bay north of the River Stour were undertaken by ecologists from TEP and CMACS on 13th and 14th August 2009. These specific dates in August were chosen to undertake the survey because the low tides on these dates were known to have a longer duration and extend further down the beach profile, thus revealing a greater amount of inter-tidal shore, as compared to other dates in August.

4.2 In total four transects were taken at right angles to the shoreline associated with Cliffs End and the A256 (Transects 1 to 4). Along each transect four sample points were identified which represented the upper, mid-upper, mid-lower and lower shore. The grid references for each sampling location are given in Table 1 below. The locations of each of the transects and sampling locations is illustrated in Drawing G1430.01.012.

4.3 Only two locations were sampled on Transect 4 (Upper and mid-shore) since it was not possible to collect samples from the lower shore for Transect 4. The lower shore sample locations were located close to the north bank of the River Stour where ground conditions were very poor posing a safety risk to surveyors.

Table 1: Grid references for each of the sites sampled.

Transect Profile	Sample location reference	Section of shore	Distance from MHWL to Site Location (metres)	Grid Reference
1	M	Upper	337	TR35620 64185
1	L	Mid-Upper	619	TR35864 64053
1	J	Mid-lower	924	TR36115 63879
1	I	Lower	1263	TR36385 63681
2	H	Upper	93	TR35140 63893
2	G	Mid-Upper	483	TR35458 63674
2	F	Mid-lower	869	TR35776 63453
2	E	Lower	1253	TR36091 63234
3	D	Upper	429	TR34971 63516
3	C	Mid-Upper	703	TR35160 63313
3	B	Mid-lower	962	TR35320 63116
3	A	Lower	1327	TR35603 62877
4	N	Upper	193	TR34590 63306
4	O	Mid	433	TR34756 63136

Note: MHWL = Mean High Water Level.

4.4 Samples were taken from the 14 locations at grid references listed in Table 1. These were identified using a handheld global positioning system (GPS) device accurate to a few metres.

4.5 Five replicate sediment cores were taken at each sample point, making a total of 70 samples. The corer used had an area of 0.01m^2 and cores were taken to a depth of 15 cm. Therefore, in total 70 replicates were taken.

4.6 Once collected all samples were fixed on site using 10% buffered formalin mixed with seawater. Each replicate sample was analysed by macroinvertebrate taxonomists.

4.7 At each sample point one sediment sample was taken using a hand trowel (fourteen samples in total).

Core sample and sediment analysis

4.8 Following collection, the seventy cores to be analysed were sieved using a 1mm mesh size. Invertebrates retained in the sieve were then sorted and identified to species level where possible. The dry weight of organisms within each sample was also recorded for each sample.

4.9 For each replicate the following information was obtained:

Total number of species
Total number of individuals (0.01 m^{-2})

4.10 Particle size analysis was undertaken to identify the distribution of grain sizes at various locations along the foreshore.

5.0 RESULTS

5.1 The data derived from the inter-tidal sediment and invertebrate samples are provided in Appendices 1 & 2. A total of 42 taxa were recorded across all sites. Most of the species sampled were polychaetes (19 taxa), followed by crustaceans (15 taxa) and molluscs (4 taxa). Small numbers of other animal groups were recorded in some locations including Maldanidae (bamboo worms) at sampling location E on the lower shore of transect 2 and Gobiidae (a fish) at sampling location O on the mid-upper shore of transect 4 among others. Sessile fauna, such as hydroids, sponges, tunicates and barnacles, are almost completely absent from the study area.

5.2 Total abundance ranged from 380 individuals per m^2 at sampling location A (Transect 3 lower shore) up to 16,020 individuals per m^2 at sampling location D (Transect 3 upper shore). The average total abundance across all sampling locations was 3,930 individuals per m^2. This average total abundance is comparable with the findings of a similar study of invertebrate species richness on the Formby Bar, an important wader feeding and roosting area immediately north of the Alt Estuary in Merseyside, which was considered to be a valuable feeding resource for waders. Drawing G1430.01.014 illustrates the total abundance of invertebrate taxa at each sampling location across the shore. The survey results appear to indicate that total abundance was greatest at the sampling locations on the upper shore and total abundance gradually decreased moving along each transect towards the lower shore.

5.3 Species richness ranged from 9 species at sampling locations C (Transect 3 mid-upper shore) and O (Transect 4 mid shore) up to 18 species at sampling location F (Transect 2 mid-lower shore). The average species richness was 13 species. Drawing G1430.01.015 illustrates species richness at each sampling location across the survey area. The survey results appear to indicate that species richness is fairly uniform across the Pegwell Bay.

Sediment and biotope classification of Pegwell Bay

5.4 The shore at Pegwell Bay was dominated by well sorted medium to very fine sands which made up at least 75% of the sediment. There was a mixture of sediments from the stations on the middle shore ranging from predominantly medium sands to predominantly fine sand to very fine sand and silt. However, the midshore stations of B, C, D, G, L, J and O all had similar faunal compositions of moderate numbers of amphipod genus *Bathyporeia* (various species present) with cockles *Cerastoderma edule,* Baltic tellins *Macoma balthica* and spionid worms which led to the biotope classification of '*Cerastoderma edule* and polychaetes in littoral muddy sand' (LS.LSa.MuSa.CerPo) (see ***Figure*** overleaf).

5.5 On the upper shore there was a small proportion of silt with fine and medium sand probably due to deposition from ebb tide flows off the saltmarsh at the top of the shore. The highest abundance of infaunal organisms was found on the upper shore with 14,500 individuals/m^2 for the amphipod *Bathyporeia sarsi*. The dendogram (***Figure***) identified a slight difference in invertebrate community at stations H, M and N compared to the mid-shore stations with the addition of the amphipod *Corophium arenarium*, the isopod *Cyathura carinata* but with

fewer spionid polychaetes. This community on the upper shore was classified as '*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand' (part) (LS.LSa.MuSa.BatCare) (2). The classification does not contain all the typical species of the biotope partly due to the invertebrate community present on the upper shore and it contains some from LS.LSa.MuSa.CerPo. However it was felt that it was sufficiently different from the mid-shore to be classified as a separate biotope.

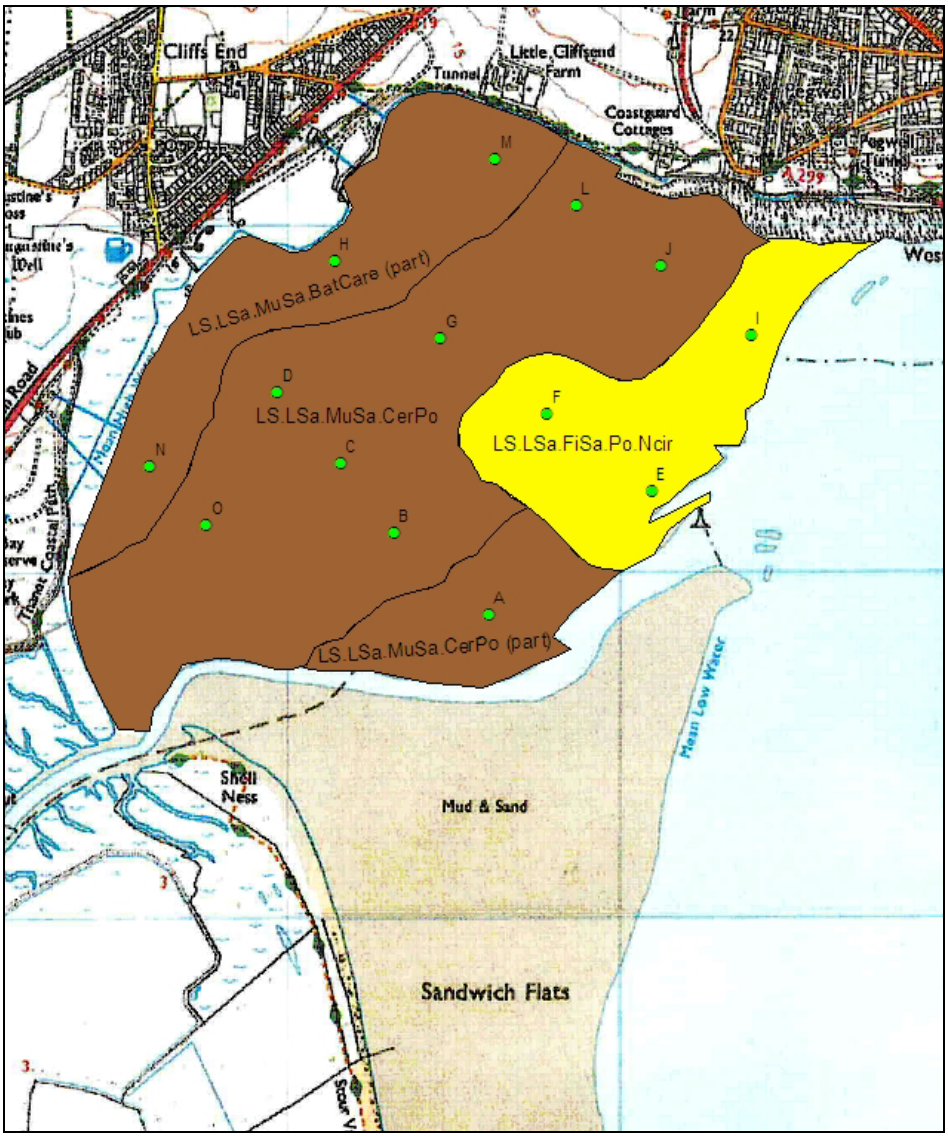

Figure 2. Biotope map and sampling locations (green circles) in Pegwell Bay

5.6 At the north-eastern end of the shore the sediments at stations E, F and I were a mixture of fine sand with some medium sand, a small proportion of very fine sand and less than one percent silt. The dendogram and MDS plot of similarity (***Figure***3 and 4) indicated that these three stations had a distinct community from the rest of the shore with the polychaetes *Nepthys cirrosa*, *Magelona johnstoni* and *Spiophanes bombyx* but with very low abundance of bivalve molluscs leading to a classification of '*Nephtys cirrosa* dominated littoral fine sand' (LS.LSa.FiSa.PoNcir).

5.7 The final area of biotope was centred around station A, adjacent to the river channel where there was a higher proportion of very fine sand and silt compared to other stations. The invertebrate community at Station A was similar to that of the upper and mid shore but with very low abundances of organisms and the addition of low numbers of the mud shrimp *Corophium volutator*. This area was classified as '*Cerastoderma edule* and polychaetes in littoral muddy sand' (part) LS.LSa.MuSa.CerPo, as it probably represents a mixture of muddy sand and sandy mud biotopes.

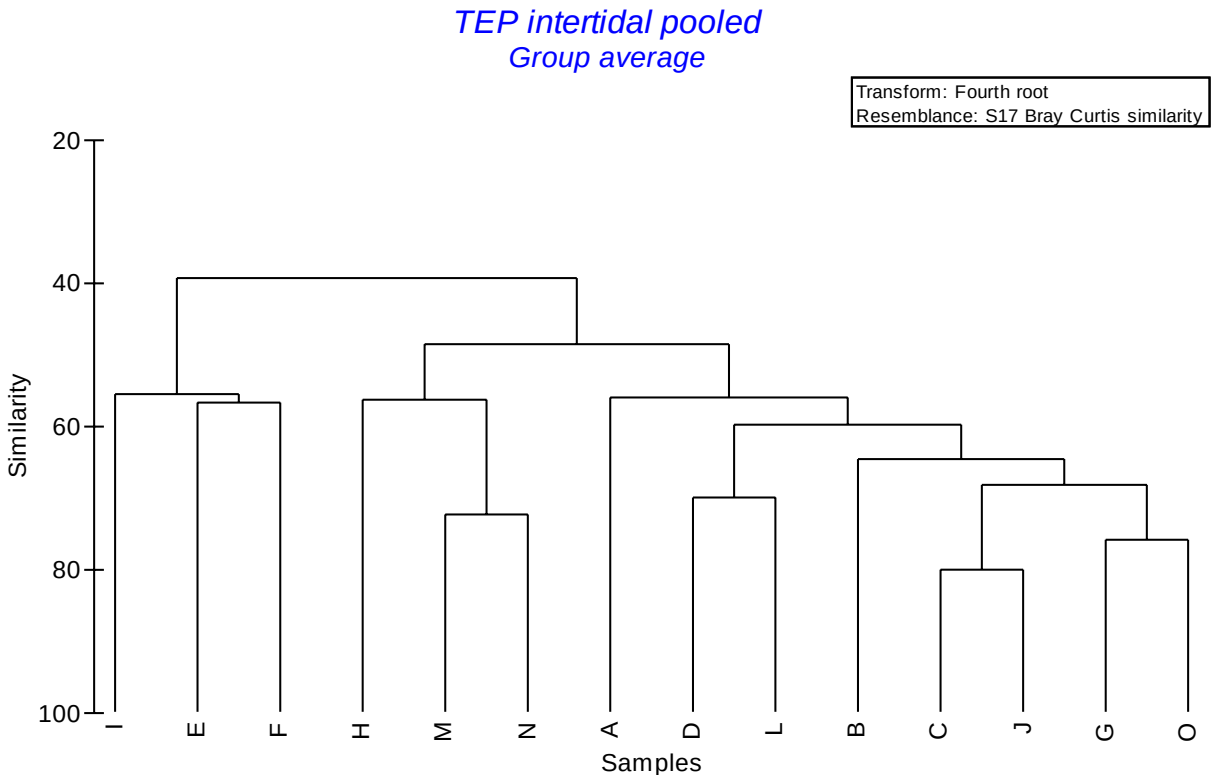

Figure 3. Dendogram showing percentage similarity between invertebrate communities from each sample station in Pegwell Bay using average values from 5 replicates.

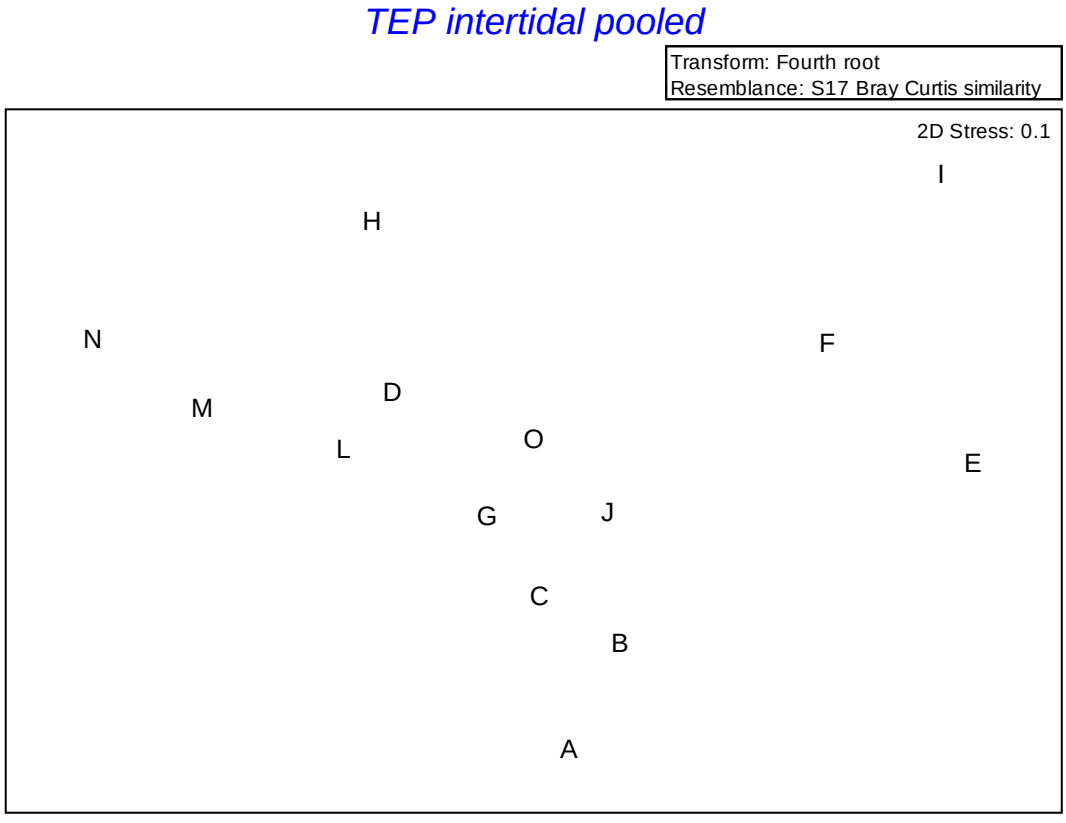

Figure 4. MDS plot of similarity of invertebrate communities from sample stations in Pegwell Bay using mean values from 5 replicates.

6.0 DISCUSSION

The value of the Pegwell Bay as a feeding area for waders

Wader invertebrate prey preferences

6.1 There are a number of scientific studies which have demonstrated the prey preferences for estuarine dwelling wader birds (Jones, E. and Newbery, 1977; West *et al*., unpublished). However, other research also suggests that waders are to some extent opportunistic in their feeding (www.Marlin.ac.uk). For example, bar-tailed godwit have been shown to feed on *Corophium* sp. on the surface of the shore if in sufficient abundance.

6.2 Invertebrate species which are especially important prey items for waders are identified by Prater 1981 and include the species ragworms *Hediste* sp., lugworms *Arenicola marina*, layer spire shell *Hydrobia ulvae*, edible mussel *Mytilus edulius*, cockles *Cerastoderma* sp., Baltic tellin *Macoma balthica*, peppery furrow shell *Scrobicularia plana* and mud shrimp *Corophium* sp.

6.3 Different prey are not equally important to all waders and generally the prey size and burrowing depth are correlated with the bill size of the wader. Plovers with the shortest bills tend to surface peck concentrating on *Hydrobia*. Dunlin and other birds with moderate length bills probe up to 4cm taking various worms and bi-valves as well as *Corophium*. Only long-billed birds are able to take deep burrowing prey such as lugworms *Arenicola* and ragworms *Hediste* (Prater, 1981).

6.4 There is a growing body of evidence to indicate that different wader species feed on different size ranges of each invertebrate prey species (Goss-Custard, in prep.). Therefore in some cases two different wader species will feed on the same invertebrate prey species but of different sizes. For example, the knot will take *Hediste* sp. and various other worms between the size range 10 to 59mm, however bar-tailed godwits will only tend to take worms at least 25mm or more in length. In one specific study Goss-Custard *et al*. (2006b) clearly demonstrated a predictable relationship between intake rate and prey size in shorebirds (*Charadriiformes*) eating macro-invertebrates.

The influence of sediment on invertebrate species richness and abundance

6.5 The inter-tidal invertebrate interest of the Pegwell Bay shore may to some extent be explained by its characteristic sandy sediment. Sandy or muddy sand shores tend to be less interesting compared to muddier shores, particularly on mobile sand shores which are relatively impoverished (Connor *et al*., 2004).

6.6 In all 42 invertebrate species were recorded indicating that the invertebrate communities associated with the Pegwell Bay shore are not impoverished. This finding indicates that there is sufficient invertebrate abundance and biomass to support the current numbers of regularly wintering bird species.

6.7 The significant differences in the number of species and individuals sampled among transects suggests that invertebrates are not evenly distributed along this stretch of shoreline. The varied invertebrate species richness and abundance will therefore influence the distribution of waders feeding on Pegwell Bay.

Pegwell Bay as a feeding resource for waders

6.8 A range of prey species associated with various wader birds were recorded during the 2009 invertebrate survey including catworms *Nephtys* sp., amphipods *Corophium* sp., common cockles *C. edule,* sandworms *Hediste* sp., laver spire shell *H. ulvae,* sand mason worm *Lanice conchilega,* Baltic tellin *M. balthica* and the polychaete *Scoloplos armiger*.

6.9 The distribution of these species was found to be patchy with some of these species being absent from many of the sampling locations. Invertebrate species abundances were also very variable with both high and low numbers of some species being recorded in different sampling locations.

Annelids

6.10 The polychaete *P. armiger* was probably the most important wader prey item annelid species within Pegwell Bay, and was recorded at abundances of up to 420 individuals per m^2 at sampling location B (Transect 3 mid-lower shore) indicating that this location provides good feeding for most of the waders which use Pegwell Bay. However *S. armiger* was fairly widespread in distribution. Catworms *Nephtys* sp. were less abundant with between 0 and 100 individuals per m^2 being recorded, although catworms were absent from most upper shore sampling locations. The important wader prey species *Hediste* sp. was only recorded at sampling location N (Transect 4, upper shore) and at a very low abundance.

6.11 The majority of wader species present at Pegwell Bay will take annelids although the largest annelids will only be taken by bar-tailed godwit, curlew and grey plover. Medium-sized annelids will be taken by oystercatchers and redshank and the smallest annelids will be taken by dunlin, ringed plover and knot.

Molluscs

6.12 The common cockle *C. edule* was present at the majority of sampling locations being recorded at an abundance of 0 to 420 individuals per m^2. This species was recorded at its greatest abundance at sampling location B, the same location where the polychaete *P. armiger* was particularly abundant.

6.13 The common cockle is an important prey item for knot, curlew and oystercatcher.

6.14 The Baltic tellin was also widespread across the survey area occurring at abundances of between 0 and 100 individuals per m^2. However, this species is usually present at higher abundances on the biotopes to which it is normally associated. For example, the '*Cerastoderma edule* and polychaetes in littoral muddy sand' biotope is described by Connor *et al*. (2004) as having a *M. balthica* abundance of 574/m^2.

6.15 The Baltic tellin is taken by a wide range of wader species although the abundances at which this species occurs at Pegwell Bay indicate that the Baltic tellin does not contribute significantly to the diet of waders using the Bay.

6.16 The laver spire shell *H. ulvae* appeared to have a limited distribution across Pegwell Bay being present at some sampling locations on the upper shore as

well as sampling location A (Transect 4 upper shore). This species was generally recorded in very low numbers not exceeding 80 individuals per m^2 at any sampling location. Typical densities for *H. ulvae* in UK estuaries are between 5,000-9,000/m^2 according to Prater (1981), however, the abundance of this species can vary considerably.

6.17 *H. ulvae* are a prey item favoured by knot, ringed plover, dunlin, grey plover and redshank.

Crustaceans

6.18 The amphipod *Corophium* sp. also appeared to have a limited distribution across Pegwell Bay being present at sampling locations on the upper shore in the north half of the Bay as well as sampling location A (Transect 3 lower shore). This species was generally recorded in very low numbers although a maximum count of 700 individuals per m^2 was recorded at sampling location N (Transect 4 upper shore).

6.19 *Corophium* sp. are an important prey item for dunlin, ringed plover and redshank.

6.20 The amphipod *Bathyporeia sarsi* is particularly abundant at Pegwell Bay being recorded at every sampling location at an abundance ranging from 100 to 14,500 individuals per m^2. This species is particularly abundant at the upper shore sampling locations for Transects 1, 2 and 3.

6.21 It is not clear how important *B. sarsi* is as a prey item for waders on the Pegwell Bay although it is known that this species is favoured by some species of fish such as flounder. It is possible that some of the smaller waders take *B. sarsi* however, this species is not considered to be as important a wader prey item as *Corophium* sp.

7.0 IMPLICATIONS AND RECOMMENDATIONS

7.1 In general research into the relationship between wader and prey distribution has shown that waders select areas with sediment types that favour the presence of their preferred prey. A recent study by Pedro *et al.* (2005) on the importance of drainage channels for waders foraging on tidal flat demonstrated that prey abundance corresponded closely with wader abundance, suggesting that the small scale distribution of birds on the tidal flats may be related to the presence of their prey.

7.2 Overall it is likely that the patchy distribution of inter-tidal invertebrate prey species within the Pegwell Bay is likely to be influencing the distribution of the principal feeding wader flocks to some extent. There is some evidence to indicate that the inter-tidal habitat associated with sampling location B (Transect 3 mid-lower shore) provides a valuable feeding area for most wader species, due to the presence of good numbers of the polychaete *P. armiger* and the common cockle *C. edule*. However, invertebrate prey items were found to be present in all sampling locations across the Pegwell Bay, indicating that the waders are generally not dependent on a specific location within the Pegwell Bay for feeding. The single possible exception to this was sampling location A (Transect 3 lower shore), which only supported low abundances of a limited number of wader prey items.

7.3 A recent research study concluded that shorebird survival is strongly influenced by the biomass densities of annelid worms and the bivalve molluscs *C. edule* and *M. balthica* (Stillman *et al*., 2005).

7.4 The widespread distribution of various annelid species and the common cockle *C. edule* will help to ensure that waders displaced from parts of the Pegwell Bay affected by the proposed cable development will be able to feed elsewhere within the Bay during the period of cable laying activities. However, it is recommended that the proposed cable laying activities avoid the mudflats near to sampling location B which represents an important feeding area for waders within the Pegwell Bay.

8.0 REFERENCES

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UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

APPENDIX 1
PSA results

TRANSECT 1 - Higher to Lower Shore

		M	L	J	I
	SAMPLE TYPE:	Trimodal, Moderately Sorted	Bimodal, Moderately Well Sorted	Bimodal, Moderately Well Sorted	Bimodal, Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Sl. Medium Gravelly Very Fine Sand	Sl. Very Fine Gravelly Medium Sand	Sl. Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	180.1	255.8	177.7	181.3
	SORTING (σ_a):	309.7	88.03	75.60	85.51
	SKEWNESS (Sk_a):	26.35	-0.584	4.849	10.51
	KURTOSIS (K_a):	789.6	12.69	123.7	246.9
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	127.9	220.0	158.6	164.7
	SORTING (σ_g):	1.837	1.583	1.446	1.376
	SKEWNESS (Sk_g):	1.051	-1.159	0.442	1.299
	KURTOSIS (K_g):	4.101	3.410	3.755	7.004
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.693	2.065	2.590	2.551
	SORTING (σ_ϕ):	0.859	0.656	0.530	0.459
	SKEWNESS (Sk_ϕ):	-0.157	1.742	-0.070	-0.973
	KURTOSIS (K_ϕ):	3.658	4.612	3.681	6.576
FOLK AND WARD METHOD (μm)	MEAN (M_G):	145.6	235.3	176.4	177.1
	SORTING (σ_G):	1.839	1.571	1.505	1.378
	SKEWNESS (Sk_G):	0.031	-0.679	0.271	0.544
	KURTOSIS (K_G):	0.544	1.141	2.285	1.635
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.780	2.088	2.503	2.497
	SORTING (σ_I):	0.879	0.652	0.590	0.462
	SKEWNESS (Sk_I):	-0.031	0.679	-0.271	-0.544
	KURTOSIS (K_G):	0.544	1.141	2.285	1.635
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Fine Sand	Fine Sand	Fine Sand
	SORTING:	Moderately Sorted	Moderately Well Sorted	Moderately Well Sorted	Well Sorted
	SKEWNESS:	Symmetrical	Very Fine Skewed	Coarse Skewed	Very Coarse Skewed
	KURTOSIS:	Very Platykurtic	Leptokurtic	Very Leptokurtic	Very Leptokurtic

TRANSECT 2 - Higher to Lower Shore

		H	G	F	E
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Unimodal, Very Poorly Sorted	Bimodal, Well Sorted	Bimodal, Moderately Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Muddy Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Fine Gravelly Medium Sand	Clayey Fine Sand	Slightly Medium Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	390.1	125.0	196.9	238.9
	SORTING (σ_a):	1234.4	90.37	241.7	473.2
	SKEWNESS (Sk_a):	14.20	1.255	32.23	13.87
	KURTOSIS (K_a):	213.8	16.20	1213.1	241.9
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	263.0	43.70	170.9	179.5
	SORTING (σ_g):	1.786	3.109	1.452	1.672
	SKEWNESS (Sk_g):	2.279	1.244	1.706	2.748
	KURTOSIS (K_g):	15.62	1.641	12.42	16.02
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	1.906	1.989	2.484	2.445
	SORTING (σ_ϕ):	0.837	0.679	0.536	0.742
	SKEWNESS (Sk_ϕ):	-2.204	1.359	-1.360	-2.617
	KURTOSIS (K_ϕ):	15.41	2.438	11.86	15.57
FOLK AND WARD METHOD (μm)	MEAN (M_G):	243.2	34.11	182.3	183.2
	SORTING (σ_G):	1.587	6.418	1.407	1.496
	SKEWNESS (Sk_G):	-0.190	-0.801	0.532	0.350
	KURTOSIS (K_G):	0.905	0.368	0.675	0.913
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.040	4.873	2.455	2.449
	SORTING (σ_I):	0.666	2.682	0.492	0.581
	SKEWNESS (Sk_I):	0.190	0.801	-0.532	-0.350
	KURTOSIS (K_G):	0.905	0.368	0.675	0.913
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Very Coarse Silt	Fine Sand	Fine Sand
	SORTING:	Moderately Well Sorted	Very Poorly Sorted	Well Sorted	Moderately Well Sorted
	SKEWNESS:	Fine Skewed	Very Fine Skewed	Very Coarse Skewed	Very Coarse Skewed
	KURTOSIS:	Mesokurtic	Very Platykurtic	Platykurtic	Mesokurtic

TRANSECT 3 - Higher to Lower Shore

		D	C	B	A
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Unimodal, Very Well Sorted	Unimodal, Well Sorted	Bimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Sl. Medium Gravelly Fine Sand	Slightly Medium Gravelly Fine Sand	Slightly Medium Gravelly Fine Sand	Sl. Medium Gravelly Clayey Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	197.1	223.0	238.0	121.9
	SORTING (σ_a):	525.0	803.6	814.6	374.9
	SKEWNESS (Sk_a):	17.07	11.14	11.13	21.59
	KURTOSIS (K_a):	301.6	127.9	127.1	531.2
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	149.7	142.5	149.3	38.75
	SORTING (σ_g):	1.546	1.569	1.641	2.964
	SKEWNESS (Sk_g):	3.064	6.416	4.968	1.594
	KURTOSIS (K_g):	28.40	59.44	39.69	3.432
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.648	2.721	2.607	2.338
	SORTING (σ_ϕ):	0.625	0.647	0.708	0.909
	SKEWNESS (Sk_ϕ):	-2.669	-6.084	-4.516	0.634
	KURTOSIS (K_ϕ):	27.27	56.98	37.36	4.545
FOLK AND WARD METHOD (μm)	MEAN (M_G):	169.1	148.0	151.0	27.50
	SORTING (σ_G):	1.488	1.228	1.348	6.332
	SKEWNESS (Sk_G):	0.244	-0.285	0.010	-0.609
	KURTOSIS (K_G):	2.408	1.714	2.560	2.168
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.564	2.756	2.727	5.184
	SORTING (σ_I):	0.573	0.296	0.431	2.663
	SKEWNESS (Sk_I):	-0.244	0.285	-0.010	0.609
	KURTOSIS (K_G):	2.408	1.714	2.560	2.168
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Fine Sand	Fine Sand	Coarse Silt
	SORTING:	Moderately Well Sorted	Very Well Sorted	Well Sorted	Very Poorly Sorted
	SKEWNESS:	Coarse Skewed	Fine Skewed	Symmetrical	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic

TRANSECT 4 - Higher to Lower Shore

		N	O
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Bimodal, Moderately Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Medium Gravelly Fine Sand	Slightly Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	419.0	193.4
	SORTING (σ_a):	1659.9	327.0
	SKEWNESS (Sk_a):	6.913	20.73
	KURTOSIS (K_a):	56.99	523.0
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	131.3	153.8
	SORTING (σ_g):	2.352	1.547
	SKEWNESS (Sk_g):	3.669	2.306
	KURTOSIS (K_g):	18.09	16.58
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.664	2.572
	SORTING (σ_ϕ):	1.221	0.624
	SKEWNESS (Sk_ϕ):	-3.131	-1.754
	KURTOSIS (K_ϕ):	15.85	15.54
FOLK AND WARD METHOD (μm)	MEAN (M_G):	122.7	174.6
	SORTING (σ_G):	1.604	1.514
	SKEWNESS (Sk_G):	-0.200	0.263
	KURTOSIS (K_G):	0.956	2.364
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	3.027	2.518
	SORTING (σ_I):	0.681	0.598
	SKEWNESS (Sk_I):	0.200	-0.263
	KURTOSIS (K_G):	0.956	2.364
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand	Fine Sand
	SORTING:	Moderately Well Sorted	Moderately Well Sorted
	SKEWNESS:	Fine Skewed	Coarse Skewed
	KURTOSIS:	Mesokurtic	Very Leptokurtic

APPENDIX 2
Inter-tidal invertebrate results

APPENDIX 2 - Abundance of individual invertebrate species.

Individuals per m^2 in **bold**. SD is given below in each case.

SPECIES	Transect 3				Transect 2				Transect 1				Trans. 4	
	A	B	C	D	E	F	G	H	I	J	L	M	N	O
Anaitides maculata a bristleworm						**20** 44.7				**20** 44.7				
Bathyporeia elegans an amphipod				**80** 130.4							**20** 44.7	**20** 44.7	**20** 44.7	
Bathyporeia guilliamsoniana an amphipod					**180** 83.7				**40** 54.8					
Bathyporeia pilosa an amphipod				**20** 44.72			**20** 44.7	**20** 44.72				**420** 554	**240** 152	
Bathyporeia sarsi an amphipod	**60** 89.4	**100** 173	**580** 455	**7660** 4893	**200** 187	**380** 593	**1860** 1511	**14500** 4806	**100** 141	**640** 329	**2660** 1422	**3700** 4131	**1040** 896	**1920** 1862
Bathyporeia sp. an amphipod	**20** 44.7			**200** 158.1		**80** 130	**100** 141	**1180** 846.8	**20** 44.7	**60** 134	**520** 327	**220** 192	**100** 122	
Bodotriidae a crustacean					**20** 44.7									
Carcinus maenas a crustacean								**20** 44.72					**20** 44.7	
Capitellidae sp. a bristleworm		**20** 44.7				**40** 89.4						**20** 44.7		
Cerastoderma edule common cockle	**40** 89.4	**420** 130	**140** 114	**60** 54.77		**20** 44.7	**160** 114	**20** 44.72		**60** 89.4	**40** 54.8	**20** 44.7		**40** 54.7
Corophium arenarium an amphipod								**20** 44.72				**120** 164	**660** 483	
Corophium volutator an amphipod	**60** 89.4													
Corophium sp. an amphipod	**20** 44.7												**40** 54.8	
Crangon crangon brown shrimp		**40** 54.8		**20** 44.72	**20** 44.7	**20** 44.7		**20** 44.72	**40** 54.8			**20** 44.7	**20** 44.7	**60** 54.7
Cyathura carinata an isopod												**80** 44.7	**400** 346	
Donax vittatus banded wdge snail									**20** 44.7					
Eteone flava/longa a bristleworm	**20** 44.7	**40** 54.8	**120** 130	**80** 83.67	**40** 89.4	**20** 44.7				**60** 89.4		**20** 44.7		
Gobiidae sp. a fish														**20** 44.7
Hediste diversicolor sandworm													**20** 44.7	
Hydrobia ulvae laver spire shell				**20** 44.72							**80** 179		**60** 89.4	
Lanice conchilega sand mason worm				**20** 44.72		**40** 54.8			**40** 54.8					
Philoscia muscorum common striped woodlouse								**20** 44.72						
Macoma balthica Baltic macoma	**20** 44.7	**40** 54.8	**20** 44.7	**40** 54.77			**20** 44.7	**20** 44.72			**20** 44.7	**60** 134	**100** 100	**40** 54.7
Magelona johnstoni a bristleworm				**20** 44.72	**140** 134	**60** 89.4								

SPECIES	Transect 3				Transect 2				Transect 1				Trans. 4	
	A	B	C	D	E	F	G	H	I	J	L	M	N	O
Magelona sp. a bristleworm						**20** 44.7								
Malacoceros sp. a polychaete									**20** 44.7					
Maldanidae bamboo worm - a polyc.					**20** 44.7									
Nematoda a nemotode												**20** 44.7		
Nemertea ribbon worms											**20** 44.7	**40** 54.8	**20** 44.7	
Nephtys cirrosa a catworm					**40** 54.8	**60** 54.8		**20** 44.72	**60** 54.8					**20** 44.7
Nepthys hombergi a catworm	**40** 54.8	**20** 44.7	**20** 44.7		**20** 44.7	**20** 44.7	**20** 44.7			**20** 44.7				
Nephtys sp (damaged) a catworm						**20** 44.7			**20** 44.7					
Pectiniidae sp. juv. cgalice corals										**20** 44.7				
Phyllodocidae sp a bristleworm					**20** 44.7									
Pygospio elegans a bristleworm	**60** 89.4	**260** 152	**1500** 784	**1240** 669.3	**180** 192		**100** 122	**60** 89.44	**40** 89.4	**980** 622	**120** 83.7	**540** 428	**140** 219	**780** 487
Scoloplos armiger a polychaete	**20** 44.7	**420** 239	**200** 141	**60** 54.77	**80** 83.7	**60** 54.8	**140** 54.8		**80** 44.7	**140** 207	**40** 89.4			
Spiophanes bombyx a polychaete					**20** 44.7	**80** 130			**20** 44.7	**20** 44.7				
Spio martinensis a bristleworm				**20** 44.72							**20** 44.7			
Spio sp. a bristleworm		**20** 44.7			**20** 44.7			**20** 44.72						
Spionidae sp. (damaged) a bristleworm	**20** 44.7	**240** 114	**920** 396	**680** 622.1		**20** 44.7	**100** 141	**40** 54.77		**620** 531	**140** 167	**220** 110	**180** 164	
Tanaissus liljeborgi a crustacean			**40** 54.8		**20** 44.7	**20** 44.7	**40** 89.4	**60** 134.2		**80** 110	**80** 130			**20** 44.7
Urothoe poseidonis an amphipod		**40** 54.8			**20** 44.7	**20** 44.7	**60** 89.4		**40** 54.8					**40** 54.7
TOTAL ABUNDANCE	**380**	**1660**	**3540**	**10220**	**1040**	**1000**	**2620**	**16020**	**540**	**2720**	**3760**	**5520**	**3060**	**2940**
SPECIES RICHNESS	**11**	**12**	**9**	**15**	**16**	**18**	**11**	**14**	**13**	**12**	**12**	**15**	**15**	**9**

AVERAGE TOTAL ABUNDANCE =	**3930**
AVERAGE SPECIES RICHNESS =	**13**

DRAWINGS

KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

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Rev	Description	Dwn	Appvd	Date

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Sediment and Invertebrate Surveys:
Sampling Locations A-O

Map No.
G.1430.01.012

Scale:	Date:
1:10,000 @ A3	13/09/2010

Drawn:	Checked:	Approved:
DH	TR	TR

KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

Total Abundance Chart

10000 *Abundance value*

Bar charts show total values for each sampling location as a percentage of the total value for all locations.

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Rev	Description	Dwn	Appvd	Date

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Invertebrate
Total Abundance Distribution

Map No.
G.1430.01.014

Scale:	Date:
1:10,000 @ A3	14/09/2010

Drawn:	Checked:	Approved:
CB	TR	TR

KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

Species Richness Chart

10 *Species Richness value*

Bar charts show total values for each sampling location as a percentage of the total value for all locations.

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Rev	Description	Dwn	Appvd	Date

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Invertebrate Species Richness Distribution

Map No.
G.1430.01.015

Scale:	Date:
1:10,000 @ A3	14/09/2010

Drawn:	Checked:	Approved:
CB	TR	TR

Appendix 10: Breeding Bird and Redshank Nesting Survey

UK – BELGIUM INTERCONNECTOR
PROJECT NEMO

BREEDING BIRD SURVEY AND RESHANK NESTING SURVEY

(Doc Ref: TEP 1430.01.025 r1)

July 2010

Prepared by TEP for:

National Grid International Limited
National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Written:	Checked:	Approved:
TR	MW	IJG

TEP
Genesis Centre, Birchwood Science Park, Warrington, WA3 7BH
Tel: 01925 844004 Fax: 01925 844002 www.tep.uk.com

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Figure 1: Aerial photograph illustrating site context

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G1430.01.008A Breeding bird survey visit 1 – May 2009
G1430.01.009A Breeding bird survey visit 2 – June 2009
G1430.01.0010A Redshank survey visits 1– May 2009
G1430.01.0011A Redshank survey visits 2 – June 2009

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake breeding bird and redshank nesting surveys to investigate the ornithological interest of part of the onshore environment of Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay.

1.2 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods.

1.3 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years

Methods

1.4 The breeding bird survey entailed two surveyors walking a series of line transects during two survey visits on 8th May and 22nd June 2009. The breeding bird survey focussed on the Pegwell Bay Country Park and the area to the south known as Stonelees as well as some peripheral habitats adjacent to the saltmarsh in the north half of the Bay.

Redshank Nesting Survey

1.5 The redshank nesting survey entailed two surveys walking a series of line transects during two survey visits on 29th May and 22nd June 2009. The redshank nesting bird survey focussed on all saltmarsh habitat within the Pegwell Bay.

1.6 Ecology surveys undertaken within the Pegwell Bay have been undertaken with the assistance of the Kent Wildlife Trust who issued a survey works permit to TEP and provided valuable support during the redshank survey.

Results

1.7 34 bird species were observed during the 2009 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit (some species were recorded on both visits).

1.8 No Schedule 1 species were observed during the 2009 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Dunnock and song thrush have been classified as probable breeders on site. Eight amber list species were also recorded.

1.9 The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds. The site supports good numbers of breeding whitethroat.

1.10 The redshank nesting survey undertaken in 2009 has confirmed that up to 10 pairs of redshank and two oystercatcher pairs bred on saltmarsh habitat within the Pegwell Bay to the north of the River Stour. Nesting takes place within three areas of saltmarsh habitat (Areas A to C).

Implications and Recommendations

1.11 All wild birds and their nests and eggs are protected under the *Wildlife and Countryside Act 1981 (as amended)*. Any removal of vegetation required for the cable installation should be undertaken outside of the nesting bird season (March – August inclusive).

1.12 If it is not possible to avoid habitat clearance works during the breeding season it will be necessary for an ecologist to undertake a pre-clearance check no more than 48 hours prior to the day the clearance works are undertaken. If breeding birds are discovered works will be subject to delay.

1.13 Survey findings contained within the previous TEP report '1430.01.024 Winter Bird Survey', strongly indicated that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May and that construction related activities on the mudflats of the Pegwell Bay avoid these periods.

1.14 Redshank and oystercatcher are sensitive to disturbance during the breeding season. It is also recommended, as a matter of best practice, that no construction related activities are undertaken in areas of saltmarsh used by redshank during the redshank nesting season which begins in mid-April and finishes in mid-July (Area A - including 100 metre buffer, Area B and Area C).

1.15 The practice of clearing vegetation within areas of saltmarsh to discourage nesting is NOT recommended since this could encourage redshank nesting.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake a winter bird survey to investigate the ornithological interest of part of the onshore environment of Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the breeding bird survey involves undertaking two visits during the period April to June inclusive focussing on the Pegwell Bay Country Park and the area of scrub and grassland habitat to the south known as Stonelees. The redshank nesting survey focussed on saltmarsh habitat within the Pegwell Bay.

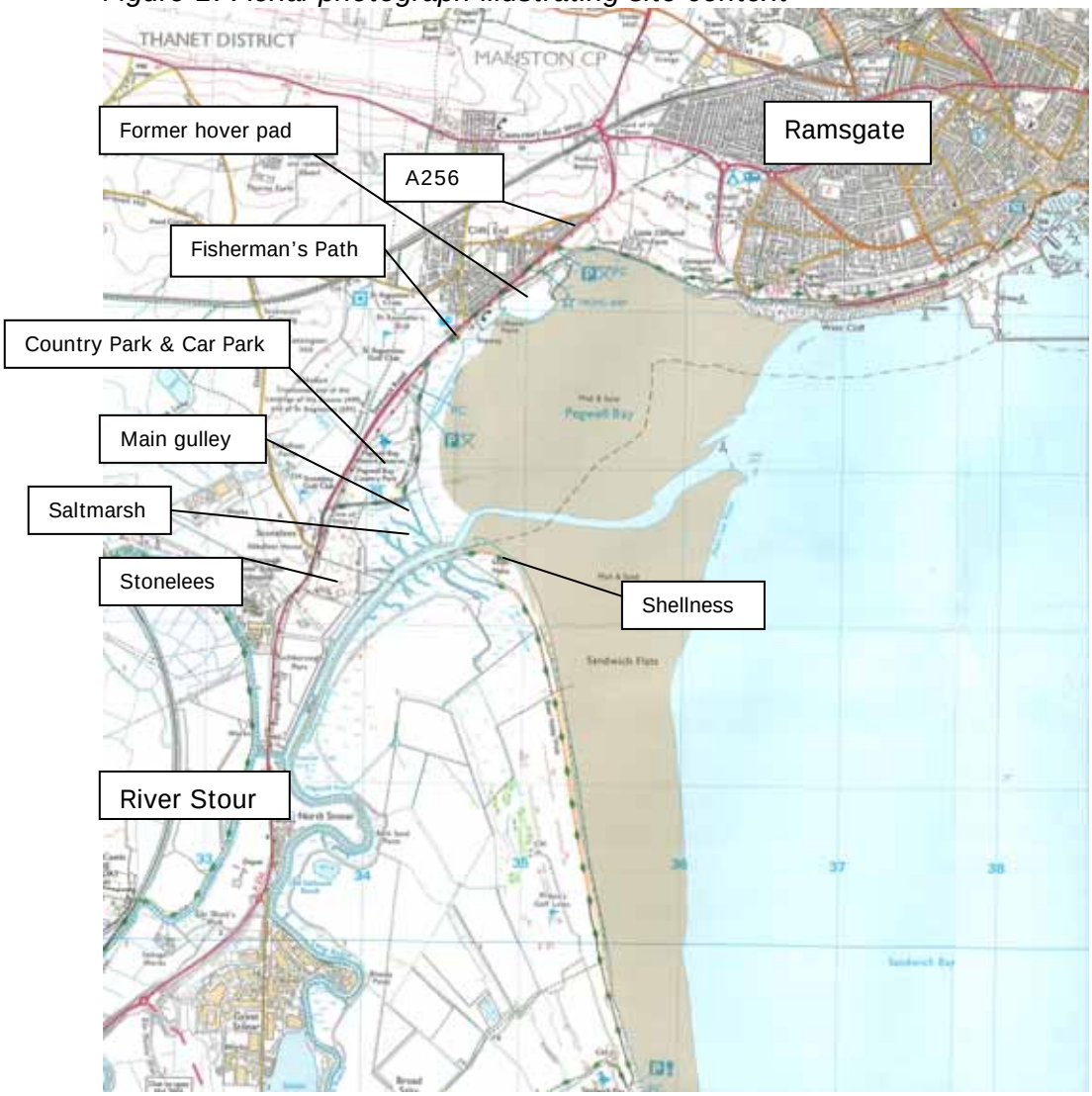
3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1 below.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also included as a part of the Pegwell Bay winter bird survey.

Figure 1: Aerial photograph illustrating site context



Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods (further details including site citations are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (further details are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.8 Citation sheets for all designated sites described are included in Appendix 2 of TEP report '1430.01,024 Winter Bird Survey'.

4.0 METHODS

Breeding Bird Survey

4.1 The breeding bird survey was undertaken by TEP Ornithology Manager Tim Ross MIEEM CEnv and experienced ornithologist Lee Greenhough MIEEM.

4.2 The breeding bird survey entailed two surveyors walking a series of line transects during two survey visits on 8th May and 22nd June 2009. The breeding bird survey focussed on the Pegwell Bay Country Park and the area to the south known as Stonelees as well as some peripheral habitats adjacent to the saltmarsh in the north half of the Bay.

Redshank Nesting Survey

4.3 The redshank nesting survey was undertaken by TEP Ornithology Manager Tim Ross MIEEM CEnv and Kent Wildlife Reserves Manager Jason Mitchell.

4.4 The redshank nesting survey entailed walking a series of line transects during two survey visits on 29th May and 22nd June 2009. The redshank nesting bird survey focussed on all saltmarsh habitat within the Pegwell Bay.

4.5 Ecology surveys undertaken within the Pegwell Bay have been undertaken with the assistance of the Kent Wildlife Trust who issued a survey works permit to TEP.

5.0 RESULTS

Breeding Bird Survey – Pegwell Bay Country Park and Stonelees

5.1 The observations made during the breeding bird survey visits are illustrated in drawings G1430.01.008A and G1430.01.009A.

5.2 The results of the desktop survey undertaken revealed that a range of Birds of Conservation Concern (BoCC) have been recorded within the wider locality around Pegwell Bay since 2008 including 14 UK Biodiversity Action Plan (BAP) species and 26 BoCC amber-listed species.

5.3 A total of 34 bird species were observed during the 2009 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit (some species were recorded on both visits).

5.4 No Schedule 1 species were observed during the 2009 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Dunnock and song thrush have been classified as probable breeders on site.

5.5 Species covered by the Kent BAP recorded during the survey include lapwing, reed bunting and turtle dove.

5.6 Eight amber list species which are not UKBAP species (lapwing, kestrel, housemartin, meadow pipit, mistle thrush, swallow, whitethroat and wheatear), were also recorded during the survey.

5.7 The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds since these sites support a range of bird species including a number of declining BoCC bird species although some species may not be breeding within the survey area. The site supports good numbers of breeding whitethroat.

Redshank Nesting Survey

5.8 The locations of redshank sightings recorded during the survey visits in May and June 2009 are illustrated in Drawings G1430.01.010A and G1430.01.011A.

May 2009

5.9 Three distinct areas of saltmarsh within Pegwell Bay which appear to be used by nesting redshank were identified during the May 2009 visit. Area A is centred on a small brackish pool located on saltmarsh immediately to the north of the Pegwell Bay Country Park.

5.10 Area A was being used by up to 9 individual redshank birds however the majority of birds did not appear to be nesting at the time of this survey visit. One redshank was flushed indicating that it may have been on a nest at the time. Overall it is estimated that 1 or 2 nesting pairs were using Area A in June 2009.

5.11 Area B is centred on an area of saltmarsh which had been subject to mowing in the previous 2 years to reduce the dominance of cord-grass *Spartina* sp. in this location.

5.12 Area B was being used by up to 7 individual redshank birds and 2 oystercatchers. Overall it is estimated that 2 or 3 redshank nesting pairs and 1 oystercatcher nesting pair were using Area B in May 2009.

5.13 Area C constitutes the large area of saltmarsh located immediately east of Stonelees and north of the River Stour.

5.14 Area C was being used by up to 10 individual redshank birds and 2 oystercatchers. Overall it is estimated that up to 3 redshank nesting pairs and possibly 1 oystercatcher nesting pair were using Area C in June 2009.

5.15 Therefore in June 2009 it is estimated that **between 6 and 10 pairs of nesting redshank and 1 or 2 pairs of oystercatcher** were using the saltmarsh habitat within the Pegwell Bay to the north of the River Stour. It is possible that additional redshank pairs were nesting within saltmarsh on the south bank of the River Stour.

June 2009

5.16 Area A was being used by up to 12 individual redshank birds however the majority of birds did not appear to be nesting at the time of this survey visit. Observations of bird behaviour indicated that there were 2 nesting pairs of redshank in Area A.

5.17 Area B was being used by up to 5 individual redshank birds, all of which were displaying strong territorial behaviour, and 2 oystercatchers. Overall it is estimated that 2 or 3 nesting pairs of redshank were using Area B in June 2009.

5.18 Area C was being used by up to 10 individual redshank birds and 2 oystercatchers. Overall it is estimated that 1 or 2 redshank nesting pairs and possibly 1 oystercatcher nesting pair were using Area C in June 2009.

5.19 Therefore in June 2009 it is estimated that **between 5 and 7 pairs of nesting redshank and between 1 and 2 pairs of oystercatcher** were using the saltmarsh habitat within the Pegwell Bay to the north of the River Stour. It is possible that additional redshank pairs were nesting within saltmarsh on the south bank of the River Stour.

6.0 IMPLICATIONS AND RECOMMENDATIONS

The Ornithological Importance of the Pegwell Bay during the breeding season

6.1 The Sandwich Bay and Hacklinge Marshes SSSI is primarily designated because it supports nationally important wader populations during the winter and migration periods. However Pegwell Bay is also important for its breeding redshank, oystercatcher and possibly ringed plover.

2009 Breeding Bird Survey of Pegwell Bay Country Park, Stonelees and adjacent habitats

Breeding bird survey 2009

6.2 Many of the habitats present within Pegwell Bay Country Park, Stonelees and other areas on the periphery of Pegwell Bay have the potential to support breeding birds. These habitats include rough grassland, scrub trees, reedbed and hedgerows.

6.3 None of the birds observed within the Pegwell Bay survey area are Schedule 1 species which require additional protection during the bird breeding season. Neither was any evidence found to indicate that ringed plover bred within the Pegwell Bay north of the River Stour in 2009.

6.4 All wild birds and their nests and eggs are protected under the *Wildlife and Countryside Act 1981 (as amended)*. Any removal of vegetation should be undertaken outside of the nesting bird season (March – August inclusive).

6.5 If it is not possible to avoid trench digging works during the breeding season it will be necessary for an ecologist to undertake a pre-clearance check no more than 48 hours prior to the day the clearance works are undertaken. Delays to the commencement of works may arise if nesting birds are discovered.

Redshank nesting survey 2009

6.6 The redshank nesting survey undertaken in 2009 has confirmed that up to 10 pairs of redshank bred on saltmarsh habitat within the Pegwell Bay to the north of the River Stour. Nesting takes place within three areas of saltmarsh habitat (Areas A to C).

Area A – Pool immediately to the north of Pegwell Bay Country Park and adjacent saltmarsh habitat

6.7 Although this area only supported up to 2 pairs of breeding redshank during 2009 the pool appears to be an important feeding area for redshank breeding in other parts of the bay, as well as non-breeding birds.

Area B – Mown strip of saltmarsh habitat located immediately east of the hide in the Pegwell Bay Country Park

6.8 Area B supported 2 or 3 pairs of breeding redshank in 2009 as well as 1 pair of oystercatcher. The actual nest sites within this area appeared to be on the edge of the mown saltmarsh area where the vegetation could provide some protection for the nest.

Area C – Large area of saltmarsh habitat located to the south of Pegwell Bay Country Park

6.9 Area C supported up to 3 pairs of breeding redshank in 2009 as well as 1 pair of oystercatcher. The nest sites within this area appeared to be well spread across this large area of saltmarsh to the north of the River Stour.

6.10 Under the *Wildlife and Countryside Act 1981, as amended*, redshank and oystercatcher nest sites are protected from destruction however the nesting birds themselves are not protected from disturbance.

6.11 Redshank and oystercatcher are sensitive to disturbance during the breeding season. It is therefore recommended, as a matter of best practice, that no development activities are undertaken within saltmarsh habitat to the south of the Pegwell Bay Country Park (Area C) and east of the hide within Pegwell Bay Country Park (Area B) during the breeding season. The breeding season for redshank and oystercatcher typically starts in mid-April and finishes at the end of July.

6.12 Area A is already subject to some disturbance from the nearby footpath. Since this area provides an important high tide feeding area for redshank during the breeding season it is recommended that a buffer zone of 100 metres is provided around the edge of the pool. This will ensure that redshank are able to nest and feed in this location without being regularly disturbed.

Recommendations

6.13 Survey findings contained within the previous TEP report '1430.01.024 Winter Bird Survey', strongly indicated that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May and that construction related activities on the mudflats of the Pegwell Bay avoid these periods.

6.14 It is also recommended that no construction related activities are undertaken in areas of saltmarsh used by redshank and oystercatcher during the nesting season for these species which begins in mid-April and finishes in mid-July (Area A - including 100 metre buffer, Area B and Area C).

6.15 The practice of clearing vegetation within areas of saltmarsh to discourage redshank nesting is NOT recommended. Undertaking vegetation clearance works across an extended area, i.e. wider than the cable trench footprint, would be likely to encourage redshank nesting rather than discourage nesting.

7.0 REFERENCES

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STILLMAN, R. A. AND GOSS-CUSTARD, J. D. 2002. *Seasonal changes in the response of oystercatchers Haematopus ostralegus to human disturbance*. – J. Avian. Biol. 33: 358–365.

UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

APPENDIX 1
Breeding bird survey form – Pegwell Bay Country Park, Stonelees and peripheral areas of the Pegwell Bay

BREEDING BIRD SURVEY RECORD

General Details:

Site Name	UK- Belgium Interconnector Project Nemo		
Job Number	1430.01	Doc. Ref	1430.01.026
Central NGR	TR340630		
Site Location	Pegwell Bay Country Park and Stonelees		
Date(s)	08.05.09 and 22.06.09		
Surveyor(s)	Tim Ross MIEEM CEnv and Lee Greenhough MIEEM		
Weather	1st visit – Cool with light breezes. 2nd visit – Hot and sunny.		
Seasonal Constraints	None. Timing of survey visits was in line with BTO guidelines for Breeding Bird Survey methodology (BBS).		
Methods	Two morning visits to site using transect method based on BTO Breeding Bird Survey.		
Drawing Ref(s):	See Drawings G1430.01.008 (visit one) G1430.01.009 (visit two)		

Existing Data:

Desktop Records were last updated 2010			
Source			
BTO website (Birdtrack)	The following species were recorded within 1km of km square TR3463 during the breeding season in 2008-2010: Brent goose, lapwing, curlew, herring gull, turtle dove, cuckoo, skylark, dunnock, song thrush, starling, house sparrow, tree sparrow, linnet, reed bunting (all UKBAP species). Shelduck, mallard, eider, fulmar, oystercatcher, ringed plover, grey plover, knot, curlew, common sandpiper, redshank, common gull, great black-backed gull, black-headed gull, lesser black-backed gull, sandwich tern, common tern, swift, swallow, meadow pipit, kestrel, stonechat, mistle thrush, whitethroat, wheatear, willow warbler (all amber-listed Birds of Conservation Concern).		

Habitat Description:

Pegwell Bay Country Park, managed by Kent Wildlife Trust, is located immediately to the west of the Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. The Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay itself.

The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees, an area of rough grassland and scattered scrub trees.

Survey Results:

Visit 1	**Date**	**08.05.09**	**Start time**	**0700hrs**	**End time**	**1100hrs**
Visit 2	**Date**	**22.06.09**	**Start time**	**0700hrs**	**End time**	**1100hrs**

Species	Visit 1 -number recorded	Visit 2 -number recorded	Breeding on site?	Conservation status
B - Blackbird	4	6	Pr (3)	
BC - Blackcap	8	6	Pr (3)	
BT - Blue tit	2	3	Pr (2)	
BF - Bullfinch	0	1	Ps	UK A
CA - Cormorant	1	0	-	
C - Carrion Crow	2	0	Ps	
CC - Chiffchaff	2	3	Pr (2)	
CD - Collared dove	1	2	-	
D - Dunnock	5	4	Pr (3)	UK A
GO - Goldfinch	2	2	Pr (1)	
GR - Greenfinch	0	1	Ps	
GT - Great tit	1	0	Ps	
HG - Herring gull	1	0	-	UK R
JD - Jackdaw	4	0	Ps	
K - Kestrel	0	3	Ps	A
L - Lapwing	0	1	-	A LBAP
LT - Long-tailed tit	0	3	Ps	
LW – Lesser whitethroat	1	1	Pr (1)	
MP – Meadow pipit	1	0	Ps	A
MG - Magpie	5	2	Pr (2)	
M - Mistle thrush	1	0	Ps	A
PW - Pied wagtail	0	1	Ps	
RW – Reed warbler	3	3	Pr (2)	
R - Robin	5	4	Pr (2)	
RB – Reed bunting	1	0	Ps	UK R LBAP
ST - Song thrush	2	1	Pr (1)	UK R
SG - Starling	1	0	Ps	UK R
SW – Sedge warbler	1	0	Ps	
SL - Swallow	1	0	-	A
TD – Turtle dove	1	0	Ps	UK R LBAP
W - Wheatear	0	4	Ps	A
WH - Whitethroat	23	11	Pr (10)	A
WP - Woodpigeon	7	0	Ps	
WR - Wren	20	5	Pr (5)	
TOTAL SPECIES	**27**	**21**		

Key: *C = Confirmed; Pr = Probable; Po = Possible; N = Not;*
LBAP = Local BAP; UK = UK BAP; R = Red List; A = Amber List; Sch 1 = Schedule 1.

Additional Notes:

Drawings

- The locations of all birds recorded during the breeding bird survey are illustrated on Drawings G1430.01.008 (visit one) and G1430.01.009 (visit two).

Summary:

The results of the desktop survey undertaken revealed that a range of BoCC have been recorded within the wider locality around Pegwell Bay since 2008. Important birds of conservation concern included 14 UK BAP species and 26 BoCC amber-listed species.

A total of 34 bird species were observed during the 2010 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit.

No Schedule 1 species were observed during the 2010 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Of these species dunnock and song thrush have been classified as probable breeders on site.

Species covered by the Kent BAP recorded during the survey include lapwing, reed bunting and turtle dove.

Eight amber list species which are not UKBAP species (lapwing, kestrel, housemartin, meadow pipit, mistle thrush, swallow, whitethroat and wheatear), were also recorded during the survey.

The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds since these sites support a range of bird species including a number of declining BoCC bird species although some species may not be breeding within the survey area.

The site supports good numbers of breeding whitethroat. Whitethroats breed in tall herbage or low shrubby growth in open habitats, hedgerows and scrubland. The nest is located in low shrub or tall plants, usually about 30cm above the ground, but rarely on the ground or in thickets up to 5 metres high.

DRAWINGS

B	Blackbird
BC	Blackcap
BT	Blue tit
BF	Bullfinch
CA	Cormorant
C	Carrion Crow
CC	Chiffchaff
CD	Collared dove
D	Dunnock
GO	Goldfinch
GR	Greenfinch
GT	Great tit
HG	Herring gull
JD	Jackdaw
K	Kestrel
L	Lapwing
LT	Long-tailed tit
LW	Lesser whitethroat
MP	Meadow pipit
MG	Magpie
M	Mistle thrush
PW	Pied wagtail
RW	Reed warbler
R	Robin
RB	Reed bunting
ST	Song thrush
SG	Starling
SW	Sedge warbler
SL	Swallow
TD	Turtle dove
W	Wheatear
WH	Whitethroat
WP	Woodpigeon
WR	Wren

KEY

- Breeding birds survey area
- B⟶ Blackbird seen only in flight
- B⟶ Blackbird perched then flying away
- B̲ A calling blackbird
- B̲̲ A blackbird giving alarm calls
- (B) A blackbird in song
- B ---- (B) An aggressive encounter between two blackbirds
- (B B) Two blackbirds in song at the same time
- B_{juv} Juvenile blackbird
- B_{fam} Blackbird family
- B_{food} Blackbird carrying food
- B_{mat} Blackbird carrying nesting material
- *B Blackbird nest
- $B_{♀}$ Female blackbird
- $B_{♂}$ Male blackbird

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Rev	Description	Dwn	Appvd	Date
A	Inserted key & formatting	DH	TR	29/09/2010

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Breeding Bird Survey
Visit 1

Map No.
G.1430.01.008A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR

B	Blackbird
BC	Blackcap
BT	Blue tit
BF	Bullfinch
CA	Cormorant
C	Carrion Crow
CC	Chiffchaff
CD	Collared dove
D	Dunnock
GO	Goldfinch
GR	Greenfinch
GT	Great tit
HG	Herring gull
JD	Jackdaw
K	Kestrel
L	Lapwing
LT	Long-tailed tit
LW	Lesser whitethroat
MP	Meadow pipit
MG	Magpie
M	Mistle thrush
PW	Pied wagtail
RW	Reed warbler
R	Robin
RB	Reed bunting
ST	Song thrush
SG	Starling
SW	Sedge warbler
SL	Swallow
TD	Turtle dove
W	Wheatear
WH	Whitethroat
WP	Woodpigeon
WR	Wren

KEY

- Breeding birds survey area
- B⟶ Blackbird seen only in flight
- B⟶ Blackbird perched then flying away
- B A calling blackbird
- B Alarm A blackbird giving alarm calls
- (B) A blackbird in song
- B ---- (B) An aggressive encounter between two blackbirds
- B B Two blackbirds in song at the same time
- B_{juv} Juvenile blackbird
- B_{fam} Blackbird family
- B_{food} Blackbird carrying food
- B_{mat} Blackbird carrying nesting material
- *B Blackbird nest
- $B_{♀}$ Female blackbird
- $B_{♂}$ Male blackbird

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Rev	Description	Dwn	Appvd	Date
A	Inserted key & formatting	DH	TR	29/09/2010

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

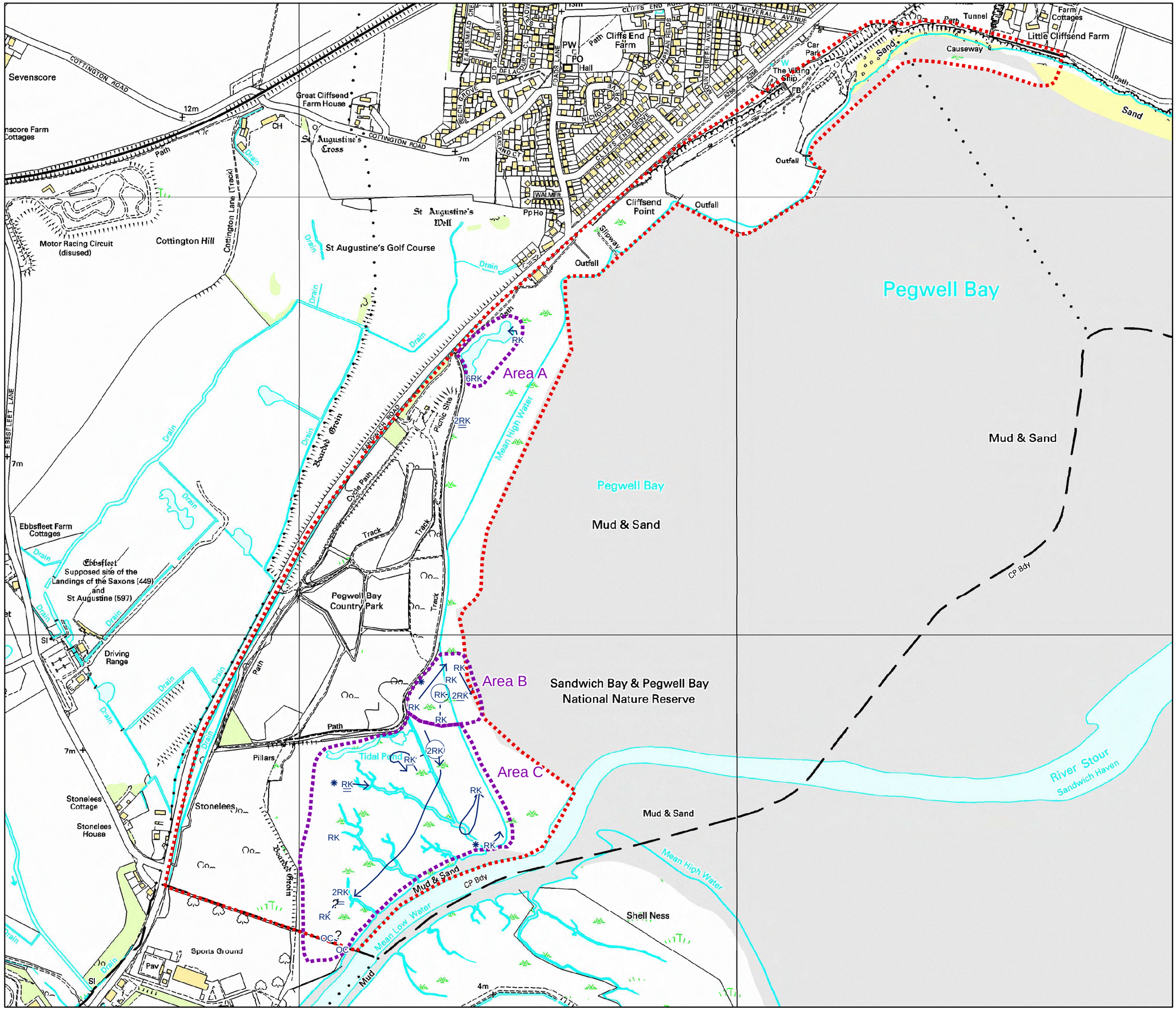
Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Breeding Bird Survey
Visit 2

Map No.
G.1430.01.009A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR



KEY

- Breeding birds survey area
- Redshank nesting areas (A - C)
- RK⟶ Redshank seen only in flight
- RK⟶ Redshank perched then flying away
- RK A calling redshank
- RK A redshank giving alarm calls
- RK A redshank in song
- RK-- RK An aggressive encounter between two redshanks
- RK RK Two redshanks in song at the same time
- RK_{juv} Juvenile redshank
- RK_{fam} Redshank family
- RK_{food} Redshank carrying food
- RK_{mat} Redshank carrying nesting material
- *RK Redshank nest
- $RK_{♀}$ Female redshank
- $RK_{♂}$ Male redshank

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Rev	Description	Dwn	Appvd	Date
A	Amended key, added RS areas	DH	TR	29/09/2010

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Redshank Survey
Visit 1

Map No.
G.1430.01.010A

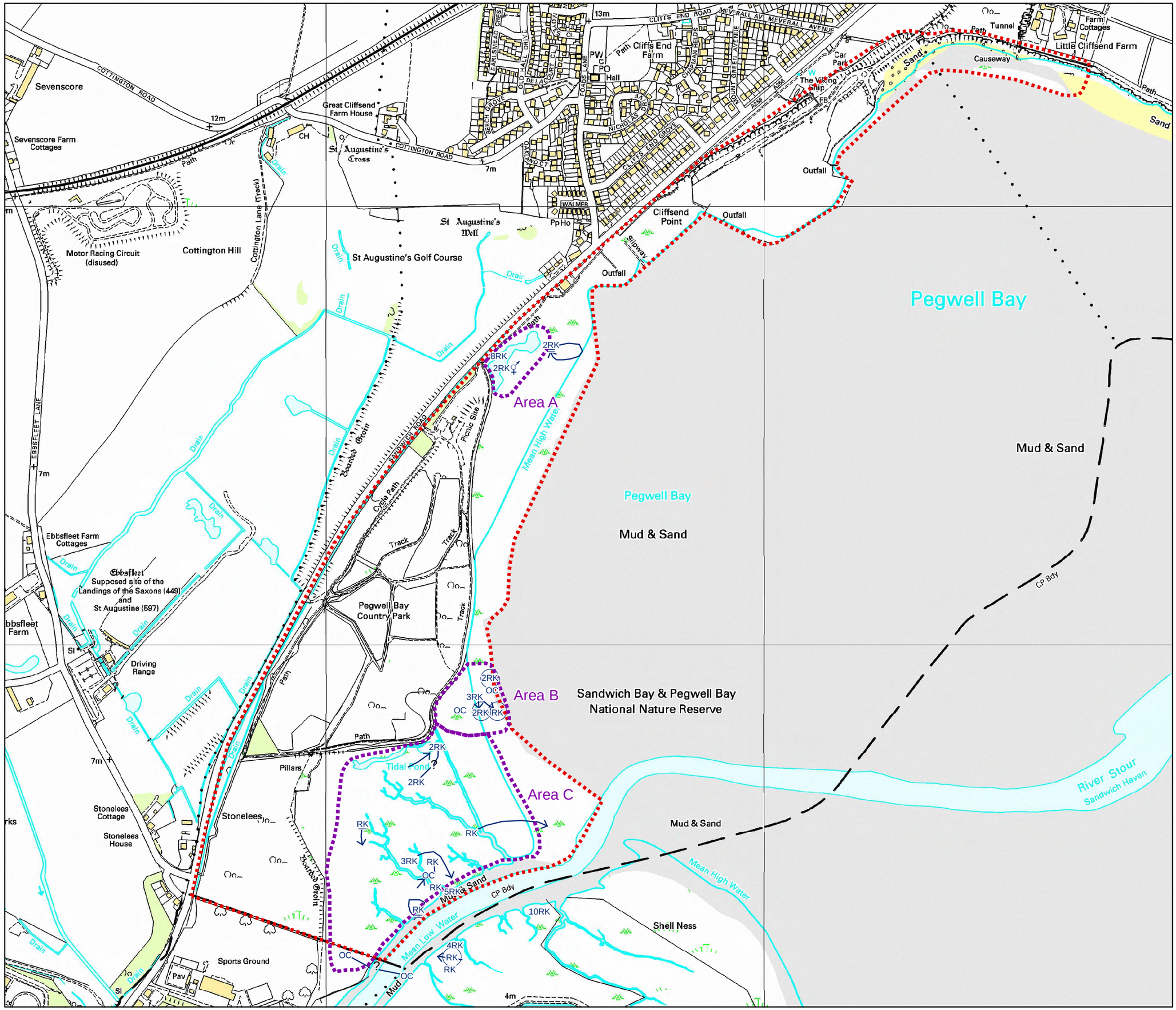
Scale: 1:8000 @ A3

Date: 08/09/10

Drawn: VG

Checked: TR

Approved: TR



KEY

- Breeding birds survey area
- Redshank nesting areas (A - C)
- —RK⟶ Redshank seen only in flight
- RK⟶ Redshank perched then flying away
- RK‾ A calling redshank
- RK= A redshank giving alarm calls
- (RK) A redshank in song
- RK- - (RK) An aggressive encounter between two redshanks
- RK RK Two redshanks in song at the same time
- RK_{juv} Juvenile redshank
- RK_{fam} Redshank family
- RK_{food} Redshank carrying food
- RK_{mat} Redshank carrying nesting material
- *RK Redshank nest
- $RK_{♀}$ Female redshank
- $RK_{♂}$ Male redshank

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Rev	Description	Dwn	Appvd	Date
A	Amended key, added RS areas	DH	TR	29/09/2010

TEP
Genesis Centre
Birchwood Science Park
Warrington WA3 7BH
Tel 01925 844004
Fax 01925 844002
email tep@tep.uk.com

Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Redshank Survey
Visit 2

Map No.
G.1430.01.011A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR

Appendix 11: Benthic Survey Report

Marine Survey Report
Project NEMO

Environmental Survey
2010

HVDC subsea cable link route between

Ramsgate, UK and

Zeebrügge, Belgium

Final Revision
March 2011

Elia / NGIL

MMT | Sven Källfelts Gata 11 | SE-426 71 Västra Frölunda, Sweden
Phone: +46 (0)31 762 03 00 | Fax: +46 (0)31 762 03 01 | E-mail: sales@mmt.se | Web: www.mmt.se

Marine Survey Report

Project NEMO

Clients

Environmental Survey 2010

Final Report 2011

May 2011

HVDC subsea cable link route between
Ramsgate, UK and
Zeebrügge, Belgium

Document control

Answerable for	Position	Name
Content	Marine Biologist	Iris Duranovic
	Marine Biologist	Anna Scherer
	Marine Biologist	Tobias Sundkvist
	Marine Biologist	Andrea Johansson
Check	Senior Biologist	Helena Strömberg
Approval	Project Manager	Stina F Palmeby

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CONTACT INFORMATION

Clients:	Elia Asset and
	National Grid International Ltd
Contractor:	MMT
	Sven Källfelts Gata 11
	SE-426 71 Västra Frölunda
	Sweden
Project:	Nemo HVDC Interconnector
Elia Project Manager:	Tim Schyvens
	tim.schyvens@elia-engineering.com
NGIL Project Manager:	Mark Pearce
	mark.pearce@uk.ngrid.com +44 (0)7979708604
PMSS Project Manager	Jason Cunningham
	jcu@pmss.co.uk +44 (0)7748 98557
MMT Project Manager:	Stina Palmeby
	stina.palmeby@mmt.se
	+46 (0) 708 14 37 01

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SURVEY CHARTS

The survey route habitat charts provide the results within the entire surveyed route. The charts are presented at a scale of 1:5 000.

Block	Chart	KP Start	KP End	Horizontal Scale
1	100702-MMT-EN2-SUR-DWG-ENV00001	0.000	14.776	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00002	14.714	29.393	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00003	29.211	44.212	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00004	42.547	56.814	1:5000
2	100702-MMT-EN2-SUR-DWG-ENV00005	56.721	71.663	1:5000
2	100702-MMT-EN2-SUR-DWG-ENV00006	78.579	86.437	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00007	86.361	101.166	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00008	101.080	115.903	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00009	115.819	129.209	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00010	123.369	128.256	1:5000

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ABBREVIATIONS

Annex	Annex 1 in EC habitat directive (COUNCIL DIRECTIVE 92/43/EEC)
AGDS	Acoustic Ground Discrimination System
ATR	Acceptance Test Report
BAP	Biodiversity Action Plan
DC	Direct Current
DDV	Drop Down Video
DPR	Daily Progress Report
Elia	Elia Asset S.A.
ETA	Estimated Time of Arrival
EIA	Environmental Impact Assessment
GPS	Global Positioning System
HSE	Health Safety Environment
HVDC	High Voltage Direct Current
Ins. Samp. Vol.	Insufficient Sample Volume
KP	Kilometre Post
kn	Knot
M/S	Metre(s) per Second
MAG	Magnetometer
MBES	Multibeam Echo Sonar
MMT	Marin Mätteknik
NGIL	National Grid International Ltd.
PDF	Portable Document Format
PMSS	Project Management Support Services Ltd.
QA	Quality Assurance
QC	Quality Control
RPL	Route Position List
SAC	Special Areas of Conservation
SACFOR	SACFOR Abundance Scale
SBP	Sub-Bottom Profiler
SSS	Side Scan Sonar
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
WGS84	World Geodetic Spheroid 1984

1. EXECUTIVE SUMMARY

This report presents results obtained from the marine environmental survey along the suggested cable corridor, for a planned HVDC electrical interconnector cable between Ramsgate, UK and West Zeebrügge, Belgium planned in collaboration between Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL). The objectives were to identify and classify habitats, biotopes and species diversity for further environmental evaluation.

A geophysical, geotechnical and environmental survey was conducted to map the conditions along the suggested cable corridor, to support the selection of a route for installation of the cable. The environmental sampling stations were selected using information from the geophysical survey. Sampling stations were chosen with emphasis on the variations of the seabed characteristics and areas of interest, such as stations including possible Annex 1 habitats. For detailed information of sample positions see Appendix A and Figure 1.

The surveyed interconnector cable corridor is 500 metres wide and includes offshore, nearshore and onshore operations. The environmental survey included the nearshore and offshore part of the survey. The purpose of the benthic survey is to provide details of the different benthic habitats along the cable route. The habitat classification was performed according to the EUNIS biodiversity database.

The water movement in the survey area is mostly driven by tides that are semi diurnal, in the shallow waters the winds are also influential. The seabed sediment is mainly a composition of sand and gravel. The eastern end of the cable route is dominated by fine sand and some silt whereas in the western area there is mostly medium sand with patches of gravel. Bedrock (Chalk) is present at or near the surface in the western part.

Grab sampling for macrofauna and photographic identification was performed as well as sediment sampling for Particle Size Analysis (PSA). A Day grab was used for the benthic sampling at a total of 50 stations. Each station was sampled with three grabs and photo documentation was executed prior to sampling.

To complement the benthic grab sampling, a beam trawl was used to sample fish and epibenthic mega fauna at four stations. For trawl positions see Appendix B.

Across two of the selected stations, in addition to the still photo and sampling, the drop down photo and video camera was used for recording transects. These were considered to be possible Annex 1 habitat containing *Sabellaria* reefs structures. Transects were recorded to estimate the size of the possible reef structures.

In total almost 281 species were identified from grab sampling together with grab photos along the whole cable corridor. The most diverse animal groups were polychaetes and crustaceans with, 80 and 83 species found in each group respectively. The polychaete *Owenia fusiformis* was the dominating species amongst the polychaetes, forming large habitats followed by *Sabellaria spinulosa* forming reef structures at two stations.

The diversity and species composition varies with the sediment as the main factor but also factors such as currents and depth have an impact on the biological composition. The stations with the most diverse infauna were found in fine sediment mixed with coarser sediment such as shell fragments. The similarities of species composition between sample stations were investigated using statistical methods.

The results of this survey are in line with what can be expected along such a long route and large area, containing both nearshore and offshore habitats.

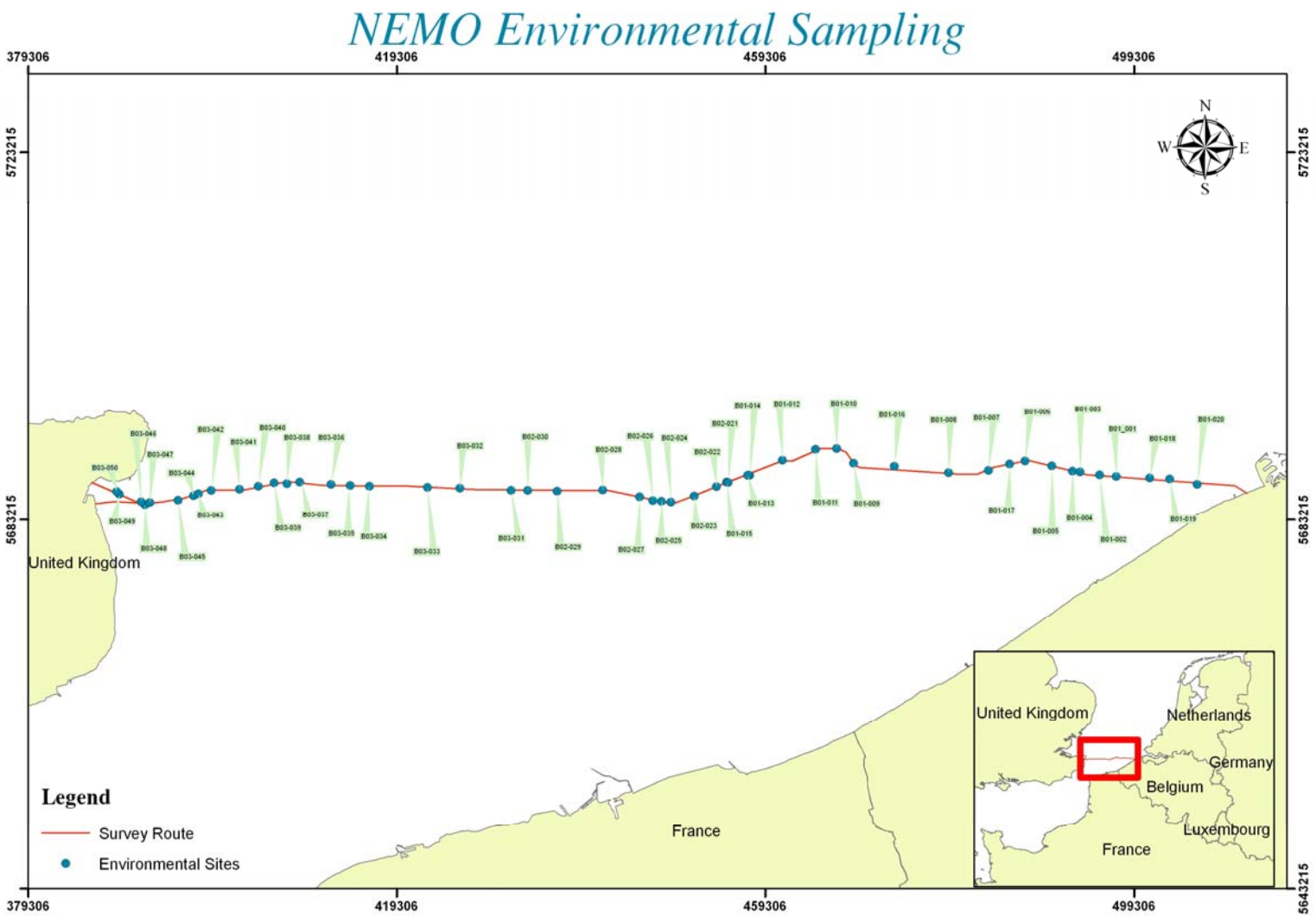


Figure 1. Environmental sampling sites

2. INTRODUCTION

2.1. General Project Information

MMT was contracted by Elia Asset S.A. and National Grid International Ltd, for their jointly planned HVDC electrical interconnector cable between UK (Ramsgate) and Belgium (Zeebrügge). The marine consultant Project Management Support Services Ltd. (PMSS) was appointed by the client as a representative. The geophysical survey covered a 500 m wide corridor. The total route length was approximately 130 km. The corridor between the jointing pit locations was surveyed with geophysical, geotechnical and environmental methods. Due to water depth range along the planned route (2-55m) the survey was divided into offshore, nearshore and inshore/land operations.

The aim of the environmental survey was to ground-truth the geophysical data to identified species and biotopes along the route and to identify sensitive habitats for further habitat mapping and environmental evaluations. The methods for sampling were performed in accordance with guidelines of Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook (Davies J. et al. 2001) and the biotope classification followed European Union Nature Identification System (EUNIS) developed and maintained by the European Topic Centre on Biological Diversity for the European Environment Agency and the European Environmental Information Observation Network.

2.2. General Background Information

The English Channel connects water from the North Sea and water from the Atlantic. The North Sea stretches mainly over the European continental shelf. The coast and nearshore seabed have been shaped by deep geological structures, rises or subsidence depending on location. Atlantic waters with salinities exceeding 35 parts per thousand enter the North Sea through the English Channel, while large quantities of fresh water are coming from rivers e.g. Rhine and Thames. Seabed structures, affecting the benthic community, are shaped by hydrographical factors, such as influence of tidal currents, water temperature and wave exposure.

In this environmental survey a drop camera equipped with a combined video and photo camera was used together with a grab sampler (Day grab). Camera and video recording techniques have been used in a variety of applications and are appropriate for the identification of seabed habitats/biotopes as well as epibenthic fauna. Photo images were used to ground-truth the epibenthic fauna whereas the video was used to assess locations for areas that were of special interest (e.g. Annex 1 areas). This technique has also become quite useful in hard bottom substrates where grab sampling is of limited use, due to possible damage to equipment. At each sampling station three grab samples were collected for further analyses of infauna.

2.3. Scope of Work - Project

The objective for the project was to perform a marine survey campaign for the NEMO HVDC interconnector cable between West Zeebrügge, Belgium and Ramsgate, UK.

The survey campaign included:

- Geophysical route survey (offshore as well as nearshore)
- Geotechnical sampling programme
- Benthic sampling programme
- Onshore survey

The scope of work included, the acquisition, processing, interpretation and reporting of appropriate hydrographical geological and biological data as required to:

- Facilitate installation of a marine high voltage (400 kV) DC power cable
- Establish through Geophysical Survey the nature of the corridor to support the Environmental survey and inform the Geotechnical Campaign
- Establish geotechnical properties of the soil as basis for a conceptual design of the cable, installation methodologies and landfall execution.
- Establish the ecological nature of the corridor to support the Environmental Impact assessment.

The main instruments used during the geophysical survey were multibeam echo sounder (MBES) collecting bathymetrical and Acoustic Ground Discrimination System (AGDS) data, side scan sonar (SSS), magnetometer (MAG) and sub bottom profiler, sparker (SBP). The marine Geophysical survey was performed between August and September 2010 while the Environmental survey was performed between September and October 2010. For detailed information of vessel specification and equipment list see Appendices C and D. For information of personnel attending during the present survey see Appendix E and the survey log in Appendix F.

2.4. Scope Of Work - Environmental Survey

The scope of work for the environmental survey includes identification of habitats along the entire route spanning from Zeebrügge, Belgium to Ramsgate, UK. The survey corridor was 500 m and the length of the route approximately 130 km.

The main aim was to identify and classify habitats, biotopes and species diversity for further evaluation of the area according to Annex I habitat of EC Habitats Directive 92/43 SAC as well as the UK BAP. Habitat classification was performed according to EUNIS classification system.

Prior to the environmental survey, bathymetric and side scan data were collected in the area and used for stratified random selection of stations for further biological sampling.

2.5. Project Execution

Apart from MMT's quality system this report also refers to the following documents:

- Project Nemo Technical Specification Part 1 to 4
- Method_Statement_NEMO_100305A-1.pdf (statement by MMT)
- 2_2_NEMO_Questionnaire_Seabed_Survey-MMT-comment.pdf
- Actions and Confirmations_20100412.pdf
- Actions and Confirmations_Part2.docx
- NEMO-Seabed_Survey-QA.pdf
- Project manual

3. PROJECT PARAMETERS

3.1. Time & Date

All raw data was recorded in UTC.

All display overlays and log books were annotated in UTC.

- Date format: dd mmm yyyy (e.g. 12 Sep 2010)
- Time stamps in: UTC
- Time stamps for time series: apply to the end of the averaging period.

The DPR refers to UTC.

3.2. Geodetic Parameters

Horizontal Datum

All coordinates are based on the following parameters (see Table 1):
Geodetic Datum and Grid Coordinate system
Datum: WGS 84

Projection: Universal Transverse Mercator
UTM zone: 31 North

Table 1. Horizontal Datum

Horizontal Datum	
Projection	UTM 31 North
Ellipsoid	GRS 80
Geodetic Datum	WGS84
Flattening	1/298.25722
Semi major Axis	6378137
Eccentricity Squared	0.00669437999
Central Scale Factor	0.9996
False Easting	500 000 m
False Northing	0 m
Latitude Origin	0°
Central Meridian	03° 00' 00"E

3.3. Documentation and QA / QC

General survey information (including line plan, production, data quality, breakdown, sea level recordings, sound-velocity profiles, etc) is documented according to MMT Quality Plan.

A Project Manual was produced and forwarded to the client during the preparation phase of the survey. Daily and Weekly reports were forwarded by e-mail to the client and the client's consultants offices.

Before commencement of the survey calibrations and acceptance test was performed. The methodologies, procedures and results from this is presented in the Acceptance Test Report document 100702-EN2-MMT-ATR-PRO-ICEBEAM1.

Quality system used during the project consists of the following documents:

- Project Manual
- HSE Plan
- Quality Plan / Plan of Work
- Procedures
- Job descriptions and responsibilities
- Control documents
- Data inventory routines
- Technical Specifications

During the project the QA system was used to:

- Ensure correct logging of data according to the agreed contractual method
- Ensure correct processing of data (e.g. photos)
- Ensure that charts and reports correspond to the Contractor's requirements
- Ensure correct storage of collected data
- Maintain efficient work procedures and make daily work routines as smooth as possible
- Track and improve HSE performance
- Improve the working environment

3.4. Daily Progress Report

The progress of the survey operations is documented in the DPR (Daily Progress Report). The DPRs were produced onboard the vessels for all operating days. The DPR was approved by the Client representative on-board and sent by e-mail to the client as a daily routine.

The offshore environmental survey was performed between the 22nd September and 2nd October 2010 and the nearshore between 14th and 18th of October. The weather was mostly favourable with some exceptions of hard heavy winds which lead to a few days of weather standby, spent in West Zeebrügge harbour.

4. MATERIALS AND METHODS

The environmental survey was carried out by grab sampling and photographic documentation. The stations sampled were selected from reviewing the geophysical data and in agreement with the client. The client also required a habitat map of the cable route corridor with sensitive areas in details (e.g. Annex 1 areas). The stations were selected in a stratified random way in accordance with the requirements of the client and the selection was approved by the client representative before commencement of sampling. Prior to sampling the seabed of all sampling stations was photo documented using the drop down video and still camera system. The areas characterised by a hard bottom or coarse substrate could not be sampled with grab samplers, partly due to difficulty to receive a sufficient sample volume and the risk of damaging the equipment. In this type of area photo documentation is an efficient way of identifying epifauna.

4.1. Video/Photo Camera

The video and still camera system was mounted on a Box Deployment Frame with transponder mounted for positioning (Figure 2). The camera was a Canon EOS 5D Digital Still Camera System, 22 megapixels with inbuilt HD-Video system. The photos were stored in the camera and a low definition video was streamed through the coax cable for live viewing. One LED light Newtsun NS600-S 5600 was used for illumination.

Figure 2. Drop Down Video Camera

The scale is always the same in each still image, as the camera cage is landed on the seafloor.

The scale of the photo was initially tested with two rulers mounted on a board under the camera cage feet (Figure 3). At each station 5 UV photographs were taken. After each recovery the stills were uploaded to the server.

During the photo transect survey the drop frame was towed in the water column just off the sea bed. At intervals of 20 m the camera was landed on the seabed and two photos were taken. The still image size is 0.97 m x 0.64 m with an area of 0.62 m².

Figure 3. Scale

4.2. Sampling and Sieving

The sampling equipment used in the environmental seabed sampling included a 0.1 m² Day grab with sample inspection flaps (Figure 4). The samples were sieved using a 5 mm over 1 mm sieve. Remaining sediment (usually gravel, clays or larger shell fragments) were sorted, using stereo microscopes for the fine fractions. A 0.5 litre sediment sample was stored from each sampling location for further particle size analysis (PSA). The PSA analyses were performed by ALS Environmental (Analytical Chemistry and Testing Services). Fractions > 2 mm-0.063 mm were determined by wet sieving method and fractions < 0.063 mm were determined by laser particle size analyzer using liquid dispersion mode.

A log of sample positions, time, type, water depth together with other field notes was made for later reference. Each grab sample was documented with still photos on landing.

Three grab replicates were collected at each station. Samples with a minimum volume of 5 litres were accepted. If the first attempt was below acceptable volume, another attempt at the station was made with a maximum of five attempts at each station. If none of the five samples had an accepted volume, the sample with the largest volume was saved with a note highlighting the volume. These samples are not included in any statistical analyses.

Figure 4. Day Grab

4.3. Beam Trawling

A beam trawl was used at the UK side at four trawl locations investigating the mega fauna (> 1cm) composition. The trawl is constructed as a net bag mounted between two "runners" which are pulled across the sediment like a sledge (**Fel! Hittar inte referenskälla.**). A metal beam connects the runners. The width of the beam trawl used in this survey was 2 m. The trawling speed was about 1.5 knots and each drag lasted in total 30 minutes with launch and recovery. The distance covered was approximately 600 m for three of the four trawl drags, while the fourth was 1200 m long.

The catch was photographed with sample station identifier and the volume measured, in whole litres and documented. When the catch volume was less than 3 litres, the tow was repeated to ensure that the low volume did not result from the net not fishing properly.

Figure 5 Beam Trawl

Sufficient catches were sorted in order to ensure that rarer species were properly accounted for. The aim was to obtain abundance data for each taxonomic order in the catch. Successive sub-samples of the catch were washed over a large 5 mm sieve to remove any sediment, and then transferred to a sorting bench. Individual taxa were sorted into separate jars and identified while on the vessel. A reference collection was later identified in the laboratory. Larger fauna such as fish were measured, photographed and released, identified if possible.

4.4. Station Selection and Sample Preservation

With the setup of the geophysical survey providing an accurate base-map of the topography, Side Scan Sonar and AGDS data, stratified random sampling is considered the most beneficial method. Stratified random sampling involves dividing the survey area into discrete sections which are allocated a proportional or weighted number of randomly selected stations within the selected areas.

The stratification is selected on the basis of environmental conditions, such as known geophysical and geological data or other variables, including known biotopes, water depth and distance from shore. This method has proven to provide greater precision than a simple random method and allows the use of different sampling techniques (Tucker H.D. 1998). It furthermore provides stabilization in statistical estimates of differences between strata, by sampling equal numbers from strata that can vary in size and enables sufficient sample points to support a separate analysis of any subgroup.

The number of samples and replicates required is subject to the necessity for achieving an accurate description of the fauna, while taking into account natural variation, which is dependent on the sediment type and environmental conditions. With the stratified random method the sample station locations were determined after the geophysical and geological field work, prior to commencement of the environmental survey.

Selection of locations for trawling was based on analyses of geophysical data (SSS, MBES and AGDS). The objective was to sample different types of habitat along the route in UK waters and to make sure that trawling was not performed in any sensitive Annex 1 habitat areas. The trawl lines were also planned never to cross a border between different habitats identified from the geophysical data. Because the proposed cable route is situated in an area where sand dominates the seabed, the trawls were somewhat longer than originally suggested, in order to collect a sufficient amount of epibenthos. The intention was to keep all lines of the same length for the results to be comparable; however this was proved to be impossible due to poor epifauna acquisition.

Samples, from both grab sampling and beam trawling, were preserved in ethanol directly without the use of formalin. This method is considered reliable and has great health and safety benefits compared to using formalin. Biomass loss in the samples (significant in the first three weeks) has been concluded not to differ significantly between the two preservation methods (Rumohr et al. 1987, Wetzel et al. 2005).

The classification codes presented in the habitat maps are based on the European Union Nature Identification System (EUNIS). PSA results, surface sediment interpretation and characteristic species identified from grab sampling formed base for the classification. In addition to this, the photographic documentation was used for verifying habitat changes during final classification.

Quantitative methods were used for the identification of biota in grab samples and still photographs. The results are presented in individuals per m^2 and for colonial species in percentage cover. The semi quantitative SACFOR abundance scale (Table 2) was used for the video analyses. According to the SACFOR scale the abundances are expressed as S - superabundant; A - abundant; C - common; F - frequent; O - occasional; R - rare; P - present. The result of the EUNIS habitat classification is presented in separate charts covering the entire route.

PRIMER 6 (Plymouth Routines in Multivariate Ecological Research) was used for the statistical analyses. This software consists primarily of a wide range of univariate, graphical and multivariate routines for analysing arrays of species-by-samples data from community ecology.

The descriptions of the habitats along the route are divided into three blocks. The block limits coincide with each country border, Belgium represents Block 1, France Block 2 and UK Block 3. Two landfall options were investigated at the UK coast, the northern and the southern landfall (Figure 6). The trawling was only performed in Block 3 (for detailed information see habitat charts).

Kilometre Posts (KP) are commonly used for reference in pipeline and cable route surveys. The numerical value represents the distance in kilometres from the Belgian landfall end of the cable (

Block	KP-Interval
Block 1	0 – 59.02
Block 2	59.02 – 82.27
Block 3	82.27 – 129.21

).

Table 2. SACFOR Scale

Growth form	Size of individuals/ colonies							
% cover	Crust/ meadow	Massive /Turf	<1 cm	1-3 cm	3-15 cm	>15 cm	Density	
>80%	S		S				>1 / 0.001 m^2 (1x1 cm)	>10,000 / m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2	1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10 x 10 cm)	100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2	10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2	
1-5% or density	R	O	R	O	F	C	1-9 / 10m^2 (3.16 x 3.16 m)	
<1% or density		R		R	O	F	1-9 / 100 m^2 (10 x 10 m)	

					R	O	1-9 / 1000 m^2 (31.6 x 31.6 m)	
						R	<1 / 1000 m^2	

Table 3 Intervals for each Survey Block

Block	KP-Interval
Block 1	0 – 59.02
Block 2	59.02 – 82.27
Block 3	82.27 – 129.21

4.5. PSA Methodology

The Particle Size Analysis groups particles into separate sizes and calculates the relative proportion by weight of each size range.

For this survey the different fractions for grain size analysis were, > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50mm, 0.125-0.25 mm and 0.063-0.125 mm which were determined by wet sieving method: Other fractions were determined from "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Wet sieving involves the sediment particles, within a sieve using water to facilitate the mechanical separation of smaller from larger particles. With a mechanical shaker the sieve and sample were placed on the top of it in addition to a water-spray nozzle that controlled the flow of water. The rinsing with water continued until the liquid which was discharged through the receiver was clear. Sample residues on the sieve were dried and weighed.

The method of liquid dispersion is such as that it uses diffracted light that is produced when a laser beam passes through a dispersion of particles in a liquid. As particle size increases so does the angle of diffraction. A mathematical model is then applied to generate a particle size from the angel diffracted and computer software is then used to process the information and to draw appropriate graphs.

4.6. Habitat Classification

The Marine Habitat Classification of the communities of the different habitat types is based on physical characteristics such as benthic geology, wave exposure, tidal current, temperature and salinity together with key species for the area.

The classification is divided into six hierarchical levels. At the first level the Marine habitats are divided from the coastal and terrestrial habitats. At Level 2, the biological zone and presence/absence of rock is a classification criterion and at Level 3 the softer substrata is divided into different sediment types. On these levels the classification is based on physical characters.

Level 4 references to specific taxa, fro rocky substrates major epifauna is used and for softer substrates the classification relies on both zonation and physical attributes. Further at Level 5 the classification is based on both the physical and biological characters of the habitats. Classes are defined with both infauna and epifauna on

different substrates. At the highest level, 6, the different characterizing taxa are associated with differing environmental characteristics of the habitat.

The intention of this report is to give a comprehensive view of the biota along the surveyed area and list the habitats found, as well as identifying habitats included in the definition for UK Biodiversity Action Plan, BAP, or Special Areas of Conservation, SAC, habitats.

The UK Biodiversity Steering Group was created 1995 to develop the UK Biodiversity Action Plan (BAP) in response to the Convention of Biological Diversity signed in Rio de Janeiro in 1992. The BAP was first published in 1995, which identified a list of priority species together with priority habitats within the UK. A revised list of priority species and habitats was approved in June 2007.

Special Areas of Conservation (SACs) is a network of areas identified to conserve biodiversity across the European Union. These areas are identified according to the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, also called the Habitat Directive that came into force on 21 May 1992. The central aim of the Habitat Directive is, through a coherent network of areas, to conserve the biodiversity in the European Union. In Annex 1 of the Directive seven marine habitat types are listed and Annex II specifies animals and plants whose conservation requires special areas of conservation.

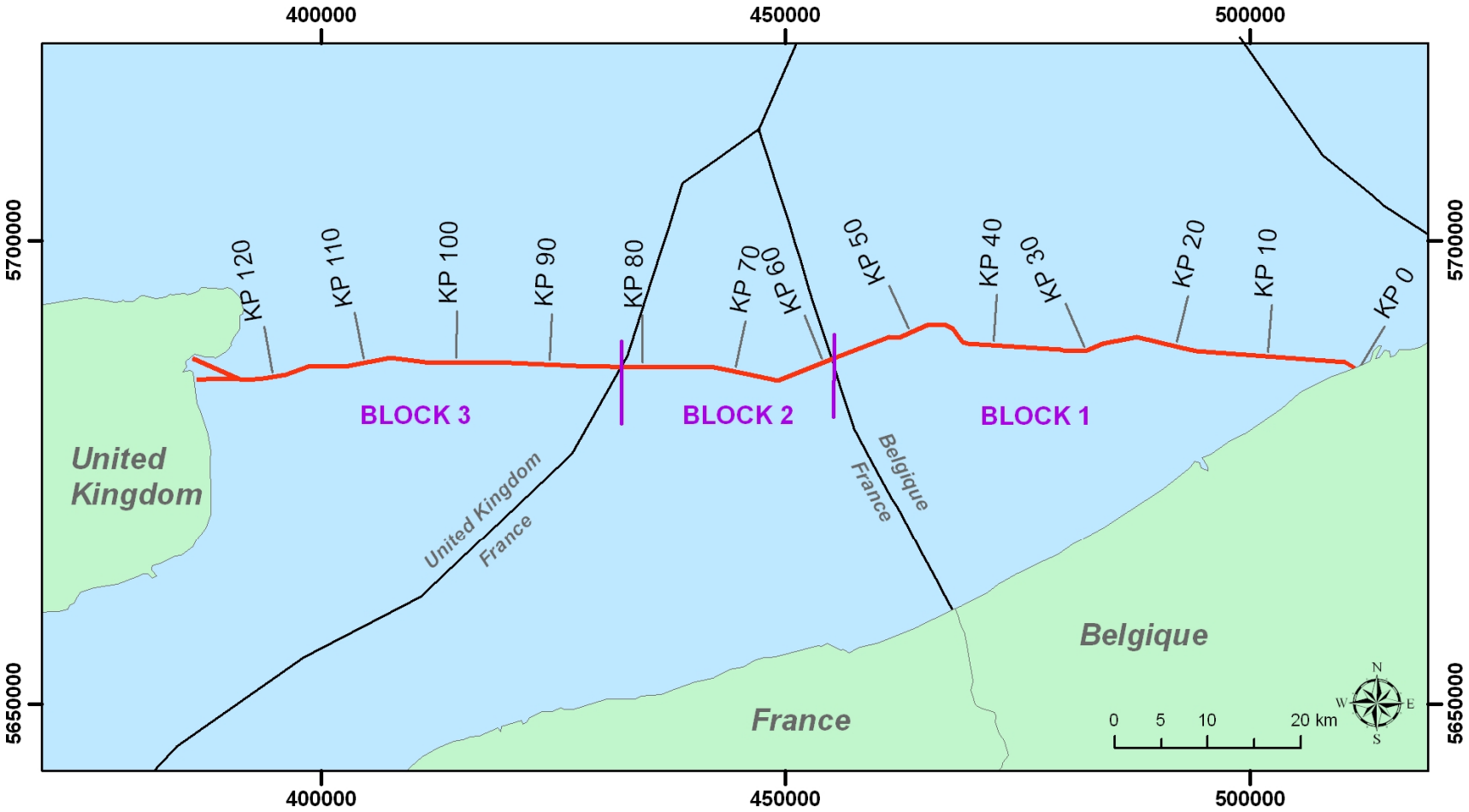


Figure 6. Index Map with Kilometre Posts (KP)

5. RESULTS

5.1. Benthic Fauna

A total of 281 species were identified from grab samples and photo identification along the whole cable corridor (see Appendix G, H, I and J). For detailed information of each sample station see Appendix K. The most dominant taxonomic groups were the polychaetes and crustaceans with 80 and 83 species respectively. The polychaete *Owenia fusiformis* was the dominant species followed by *Sabellaria spinulosa,* which can form large biogenic reef habitats suitable for other epifauna. An overview of the abundance of different higher taxonomic groups is presented in Table 4 and information of the different habitat classes which were identified along the surveyed route can be found in Table 5. The abundance of individuals is also presented for each grab station in Figure 7. For more detailed information of the abundance see Appendix L.

Table 4. Overview of higher taxonomic groups

Higher Taxonomic Groups	Number of taxa	% of total taxa
Cnidaria	18	6.4
Polychaeta	81	28.8
Mollusca – Bivalvia	28	10.0
Mollusca – Gastropoda	11	3.9
Mollusca – Nudibranchia	3	1.1
Mollusca – Cephalopoda	1	0.4
Arthropoda	83	29.5
Arthropoda - Pycnogonida	3	1.1
Bryozoa	7	2.5
Echinodermata	20	7.1
Chordata – Actinopterygii	16	5.7
Chordata – Cephalochordata spp	1	0.4
Chordata – Ascidiacea spp	1	0.4
Cephalorhyncha spp	1	0.4
Ctenophora spp	1	0.4
Echiura spp	1	0.4
Nemertea spp	1	0.4
Nematoda spp	1	0.4
Porifera spp	1	0.4
Sipuncula spp	2	0.7
Total	**281**	100 %

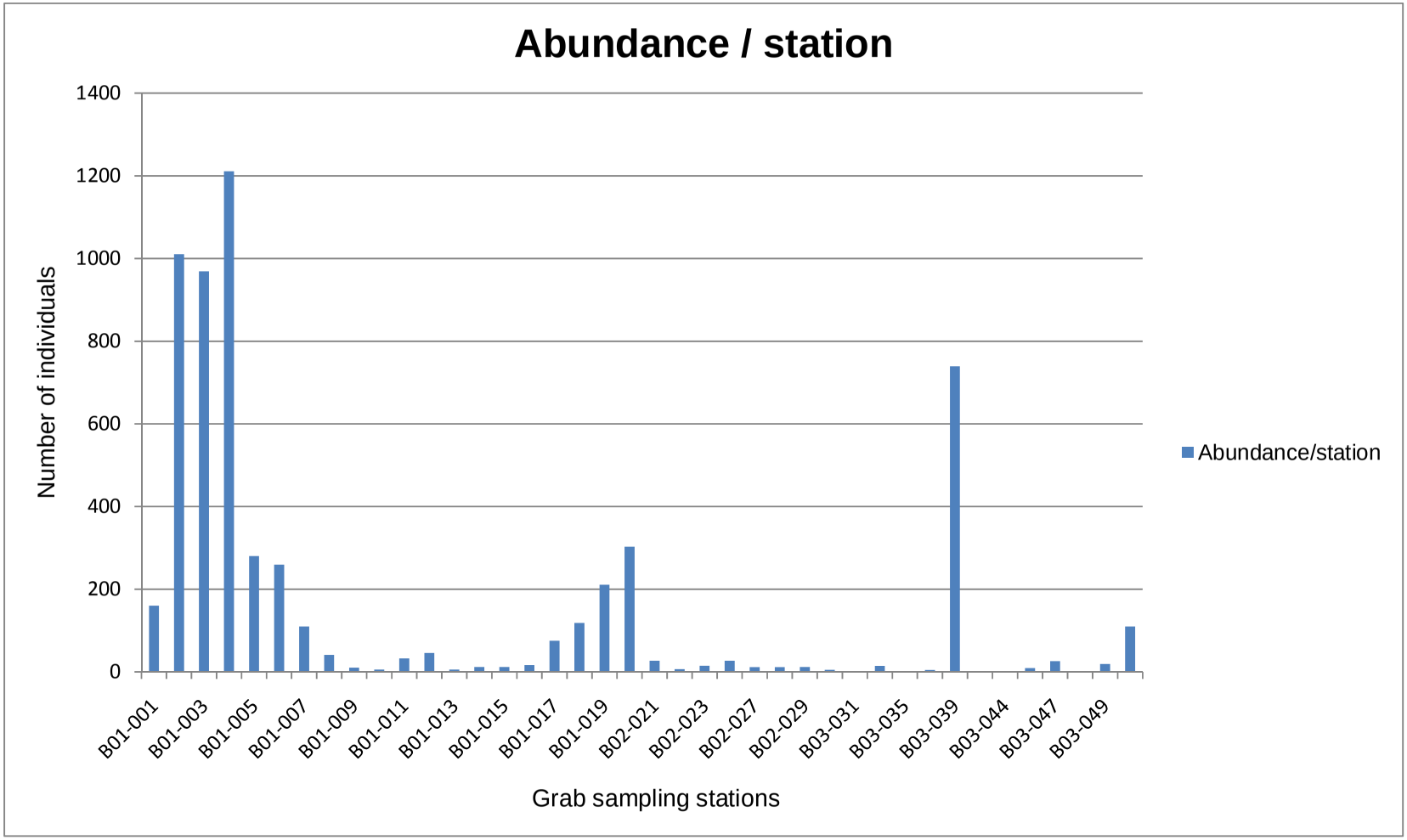
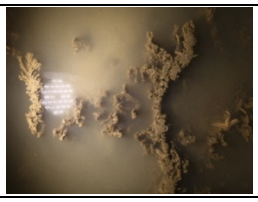


Figure 7 Individual abundance at each station referring to raw data.
(e.g. not extrapolated to square meters).

Table 5. Habitat classes identified in the entire survey area. EUNIS classification code

Example image	Habitat Class	Description
	A5.141	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
	A5.145	*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel
	A5.23	Infralittoral fine sand
	A5.231	Infralittoral mobile clean sand with sparse fauna
	A5.233	*Nephtys cirrosa* and *Bathyporeia spp*. in infralittoral sand
	A5.24	Infralittoral muddy sand
	A5.25	Circalittoral fine sand
image n/a, too shallow and/or turbid waters.	A5.33	Infralittoral sandy mud

Example image	Habitat Class	Description
image n/a, too shallow for survey	A5.34	Infralittoral fine mud
image n/a, too shallow for survey	A5.43	Infralittoral mixed sediments
	A5.611	*Sabellaria spinulosa* on stable circalittoral mixed sediment

5.2. Habitat Description

On the Belgian side and in French waters the habitats are large and more uniform compared to variable and smaller habitats in the west of the survey route (Figure 10). Sand, sand waves and ripples dominate the geological surface over the entire corridor, with occasional patches of cobbles, gravel and sand. Bedrock (Chalk) covered with sand is only present close to the UK coast. (see Transect position list in Appendix M)

Following the survey corridor in Block 1 from the coast of Zeebrügge westwards at depths from 1-16 metres, the dominant habitat is A5.33 described as 'Infralittoral sandy mud'. In this habitat the prevailing species were the polychaetes *Owenia fusiformis* and *Caulleriella killariensis* and the bivalves *Macoma balthica* and *Ensis magnus*. Also a variety of crustaceans and anemones were present. Further westwards at depths between 10-20 m, smaller areas of three other habitats were present. In habitat A5.34 (Infralittoral fine mud) the mussels *M. balthica* and *Abra tenuis*, and polychaetes *Notomastus latericeus* and *C. killariensis* were common. Typical species found in A5.24 (Infralittoral muddy sand) were *O. fusiformis*, *E. magnus and C. killariensis*. Polychaetes were the dominant fauna in habitat A5.23 (Infralittoral fine sand) with *Hesionura elongata*, *Sphaerosyllis bulbosa*, *O. fusiformis*, *Lanice conchilega*, *Spiophanes bombyx* being the most abundant species. The brittle star *Ophiura albida* was also frequent.

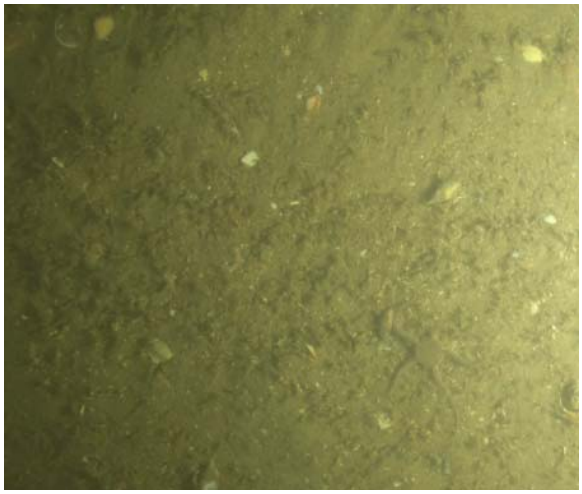


Figure 8. B01_007 tubes of O.fusiformis

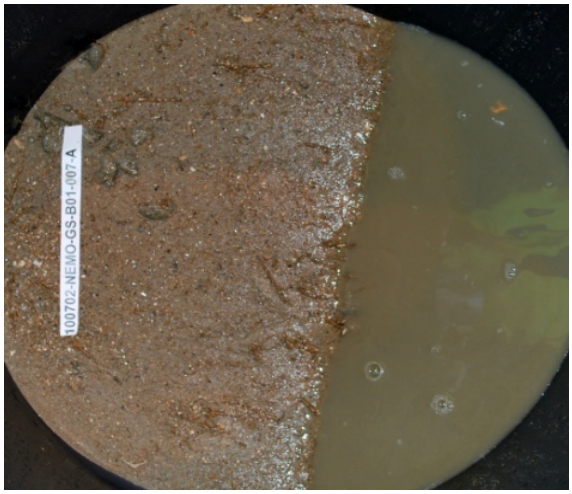


Figure 9. B01_007_GS tubes of O.fusiformis.

The habitat A5.25 (Circalittoral fine sand) stretched over a 65 km section of the route with increasing depth from 19-43 m towards the west, starting at KP 22 in Block 1 continuing through Block 2 until Block 3 at KP 82. Besides sand, the sea bed comprised some shell fragments, gravel and cobbles. This stable environment supports a more diverse community. Samples were dominated by crustaceans and polychaetes, with *L. conchilega*, *O. fusiformis*, *S. bombyx* and *Nephtys cirrosa* being the most frequent species. In Figure 8 and Figure 9 images of *O. fusiformis* tubes are shown from photosample respectively grabsample at station B01_007. Crustaceans were mostly represented by Gammaridae, *Gastrosaccus spinifer*, *Urothoe spp.* and Euphausiacea, and the sea urchin *Echinocyamus pusillus*, peanut worms Sipunculidea and anemones *Actiniaria spp.* were common as well. However, the infaunal abundance within this habitat decreased westwards. Within habitat A5.25, a small patch of A5.23 (Infralittoral fine sand) in Block 1 at KP 33, and two smaller patches of habitat A5.233 (*N. cirrosa* and *Bathyporeia spp.* in infralittoral sand) in Block 2 were identified. In A5.23 the polychaetes *H. elongata* and *Sphaerosyllis bulbosa* dominated the sampled fauna. In A5.233 the most abundant taxa were polychaetes *N. cirrosa* and *O. borealis* and crustaceans Paguridae, *Urothoe spp.* and *Bathyporeia spp.*

Further westwards in Block 3, the habitats were more variable and there were eight different habitats classified from KP 82-128 in the UK waters. In habitat A5.141 (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles) cobbles with tubes of Serpularidae, the sea urchin *P. miliaris* and anemones Actiniaria were common. In A5.145 (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel) mostly polychaetes like *Polycirrus medusa* and *N. latericeus* were present, as well as Nematoda and the lancelet *B. lanceolatum.* Not many species occurred in A5.231 (Infralittoral mobile clean sand with sparse fauna). Among them were the crustacean *Urothoe spp.* and the polychaete *N. cirrosa*. Further segments of A5.25 (Circalittoral fine sand) appear in Block 3 between KP 102.5-118 and this habitat has been described above. Fewer species were found to be in A5.25 in the west of the route. Two areas of reef aggregations of the Ross worm

Sabellaria spinulosa were present in Block 3 classified as habitat A5.611 (*Sabellaria spinulosa* on stable circalittoral mixed sediment). Compared to their surroundings, the *Sabellaria* reefs are inhabited by a higher diversity of species. Some of the associated species are the Long-clawed porcelain crab *Pisidia longicornis* and brittle stars Ophiuroidea and *A. squamata* to mention a few. Habitat A5.23 (Infralittoral fine sand) is situated between KP 115.5-117.5 and closer to UK coast at KP 112.5-127. In these parts the polychaete *Ophelia borealis* and the crustacean *Urothoe brevicornis* were the most abundant species. Unlike the adjacent habitats A5.23 (Infralittoral fine sand) and A5.25 (Circalittoral fine sand), the sea bed in A5.43 (Infralittoral mixed sediments) consisted mainly of gravel where the bivalve Mytilidae was abundant. In habitat A5.24 (Infralittoral muddy sand) the polychaete *N. latericeus*, the bivalves *Nucula nitidosa* and *Abra spp.*, the crustacean Gammaridae spp. and the brittle star *Amphipholis squamata* were abundant. The sea spider *Anoplodactylus petiolatus* was also common in this area.

Along the route the most diverse infauna habitat was A5.24 (Infralittoral muddy sand) at the UK coast with 74 species in one grab sample followed by the *S. spinulosa* reef A5.611 with 46 species. Also habitats A5.23 and A5.25 between KP 21.5-29 in Block 1 were characterised by high species abundance.

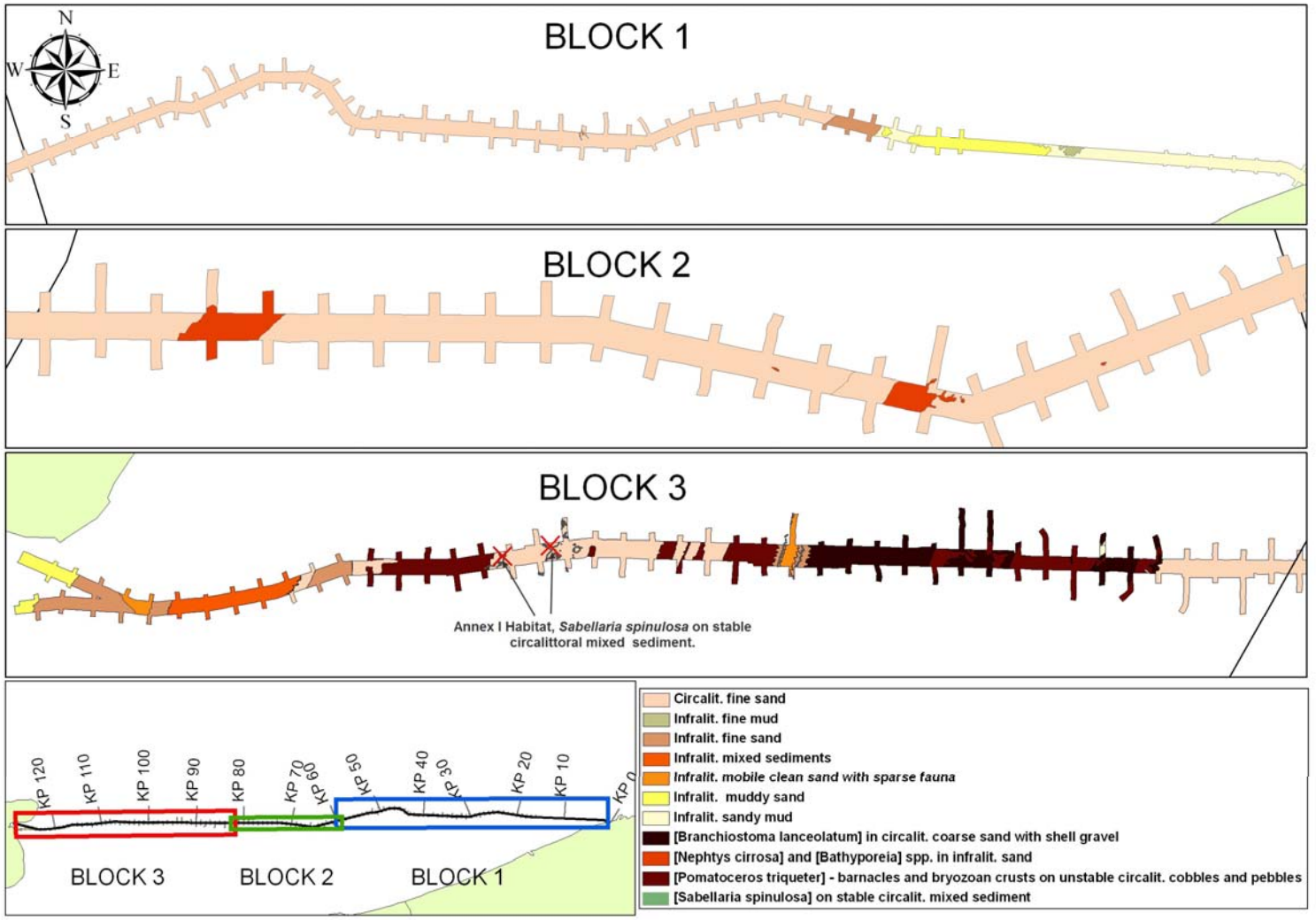


Figure 10. Habitat overview according to the EUNIS classification codes.
Annex I Habitats are marked with red crosses.

5.3. Biogenic Reefs

Biogenic reefs are elevated structures on the seabed created by the species community. One of the most important biogenic reef forming species in UK waters is *S. spinulosa*.

This marine polychaete is often visible/ recorded as individual tubes or in small groups but can also form dense aggregations with elevation above the surrounding seabed in a reef structure which may persist for many years. Such a subtidal reef stabilises otherwise mobile sediment, and thus provides hard substrata and crevices for species which would not otherwise colonize the area. Therefore, biogenic reefs usually have a richer and more diverse associated fauna and flora than its surroundings (Holt et al. 1998, Lancaster and Savage 2008). The formation of extensive reefs by *S. spinulosa* is thought to be relatively scarce around the British Isles (JNCC 2010).

At grab sites B03-036 (A through C) and B03-036 (A and B) some small fractions of old and empty *S. spinulosa* tubes were retrieved. From the still photographs taken prior to grab sampling at the stations B03_039 and B03_040, possible reef structures of the polychaete *S. spinulosa* were observed (Figure 11). In agreement with the client representative, grab samples were collected. The sample taken at station B03_040 contained only few *Sabellaria sp.* tubes attached to stones (Figure 12). However, at station B03_039 over 900 individuals of *S. spinulosa* were present. This biotope also showed a considerable species richness. Dominant species included, among others, the long-clawed porcelain crab *P. longicornis*, brittle stars Ophiuroidea and *A. squamata*, starfish *Leptasterias muelleri* and *Asterias rubens*, mussels *Abra prismatica* and *A. nitida*, snails *Odostomia unidentata*, fish *Gaidropsarus spp.* and cnidarians Actiniaria. The elevation of *S. spinulosa* tubes measured in the day grab was 7 cm.

Accordingly, two cross transects were conducted in Block 3 in order to estimate the extent of *S. spinulosa* reef. Because of poor visibility, instead of video recording the seabed, photographs were taken every 20 m along each transect. For detailed information about these transects, see transect table in Appendix M.

Transects B03_039_001 (E 406212, N 5687069 to E 405865, N 5687311) and B03_039_002 (E 406045, N 5687269 to E 405931, N 5687099) stretch over an area of sand and gravel and lie approximately 20 km off the coast of England (Figure 13). Parts of a *S. spinulosa* reef and some epifauna e.g. starfish *A. rubens*, crustaceans *P. longicornis*, Paguridae, Galatheidae, Caridea, Portunidae spp., anemones Actiniaria and sea urchins *Psammechinus miliaris* were identified. The tubes height varies along the transects and elevation from seabed is between 5-15 cm. This elongated and narrow habitat A5.611 extends from northwest to southeast between KP 108.4 and KP 108.7 at a depth of 23-28 m and is approximately 424 m long and 59 m broad.

Figure 11. B03_039 S. spinulosa reef

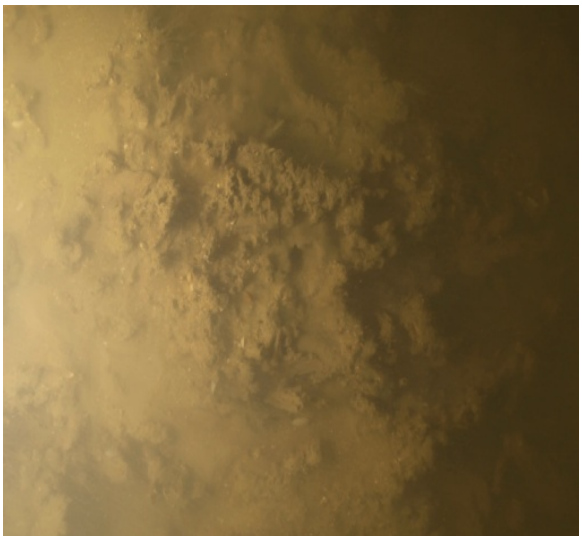


Figure 12. B03_040 S. spinulosa reef

The seabed in transects B03_040_001 (E 404311, N 5686855 to E 404117, N 5686847) and B03_040_002 (E 404296, N 5686929 to E 404305, N 5686811) consisted of mainly sand with some gravel and cobbles (Figure 13). Due to the poor visibility it is difficult to make a reliable statement, but there are probably *Sabellaria sp.* reef structures. Within this area, the reef structure seems to be patchy and scattered. This circular region is situated between KP 110.3 and KP 110.4 at a depth of 26.8 m and is about 31 m in diameter. The *Sabellaria sp*. reef is visible in the side scan sonar data (Figure 14 and Figure 15) and the extent was confirmed from the photo transect survey (the presence of Annex 1 habitats are listed in Appendix N). AGDS data on its own was not sufficient for determining the presence of the *Sabellaria* reef (Figure 16).

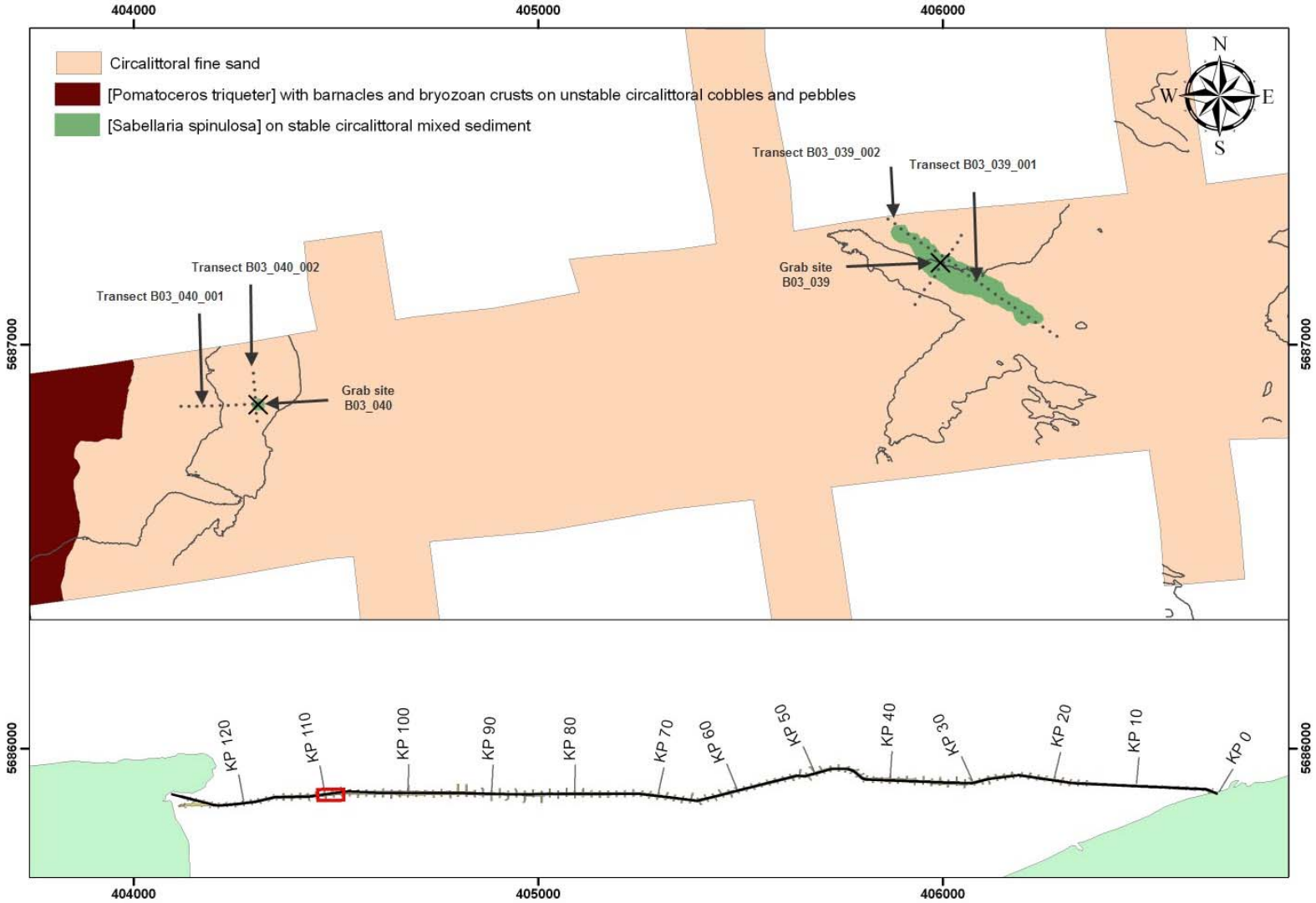


Figure 13. Habitats A5.611 Sabellaria spinulosa reefs in Block 3.
(according to the EUNIS classification codes)

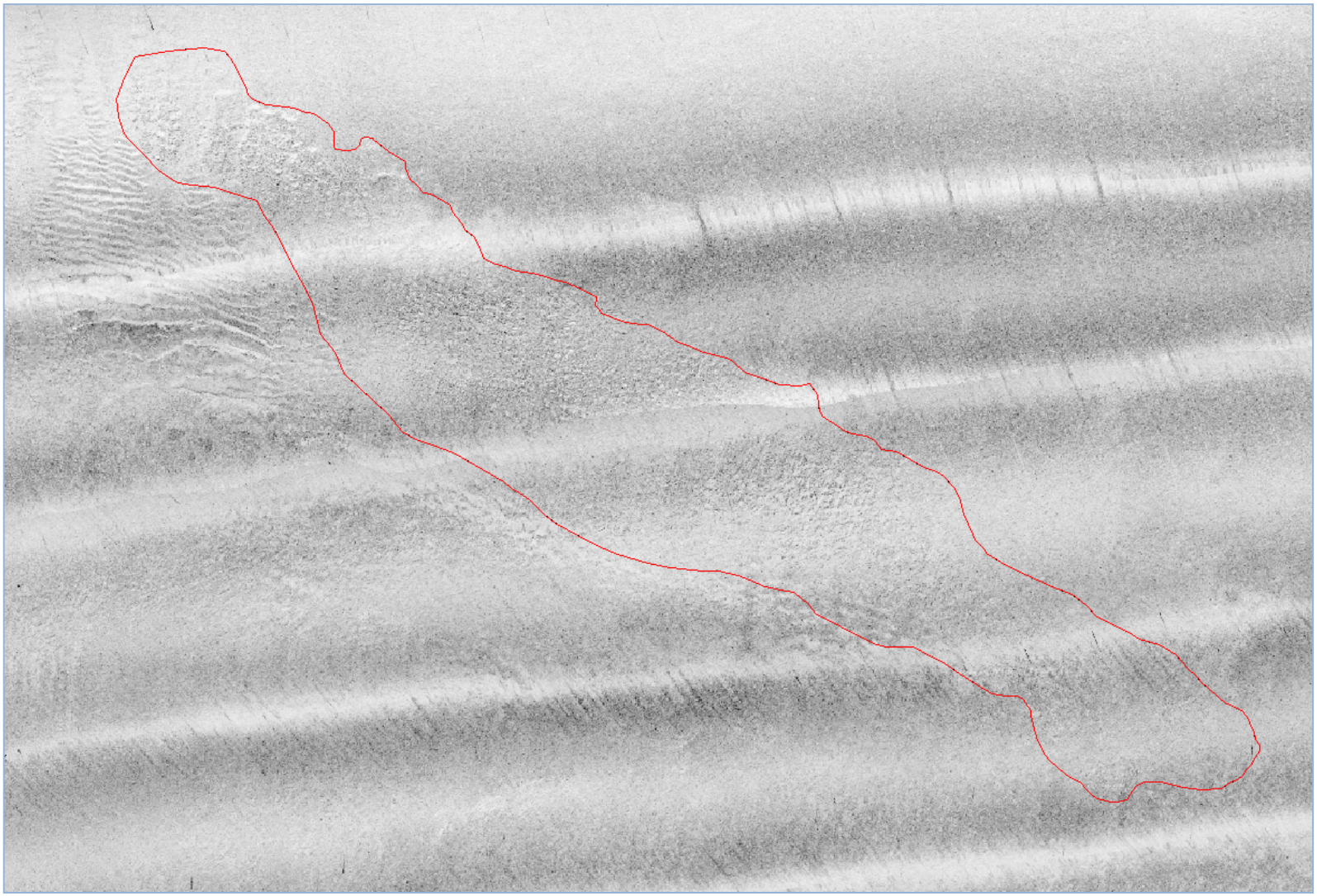


Figure 14. Sabellaria reef from Side Scan Sonar

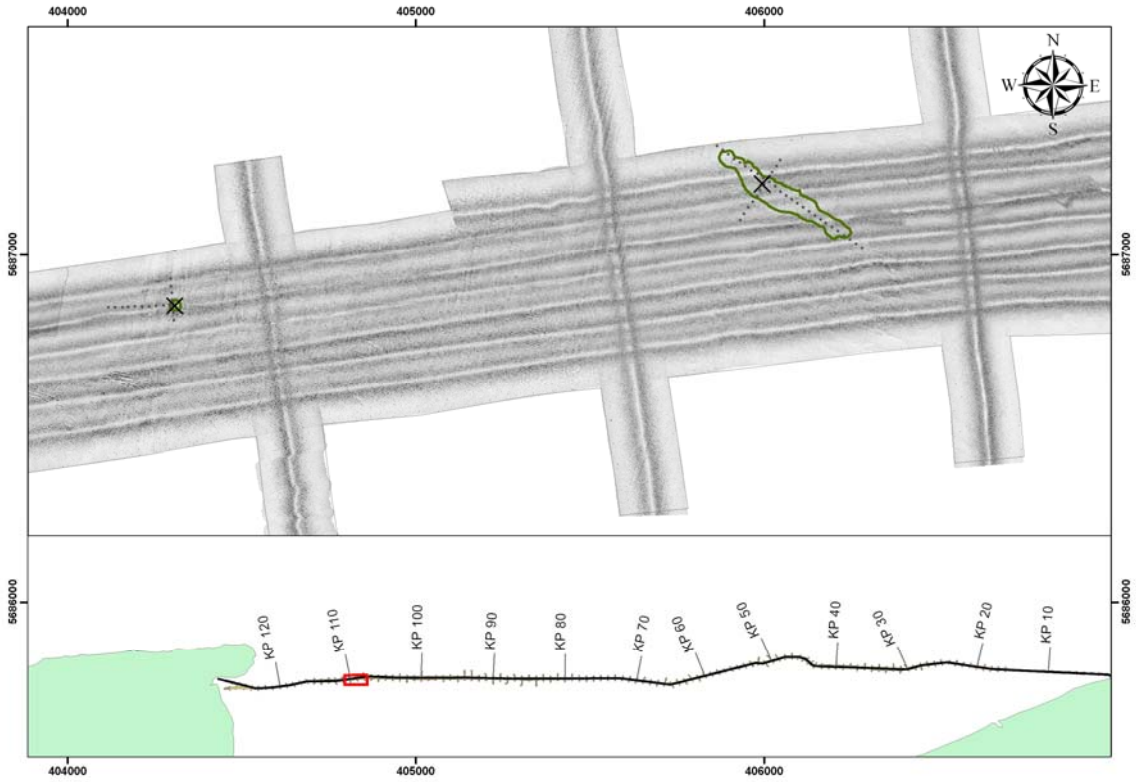


Figure 15. Sabellaria reef overview from Side Scan Sonar

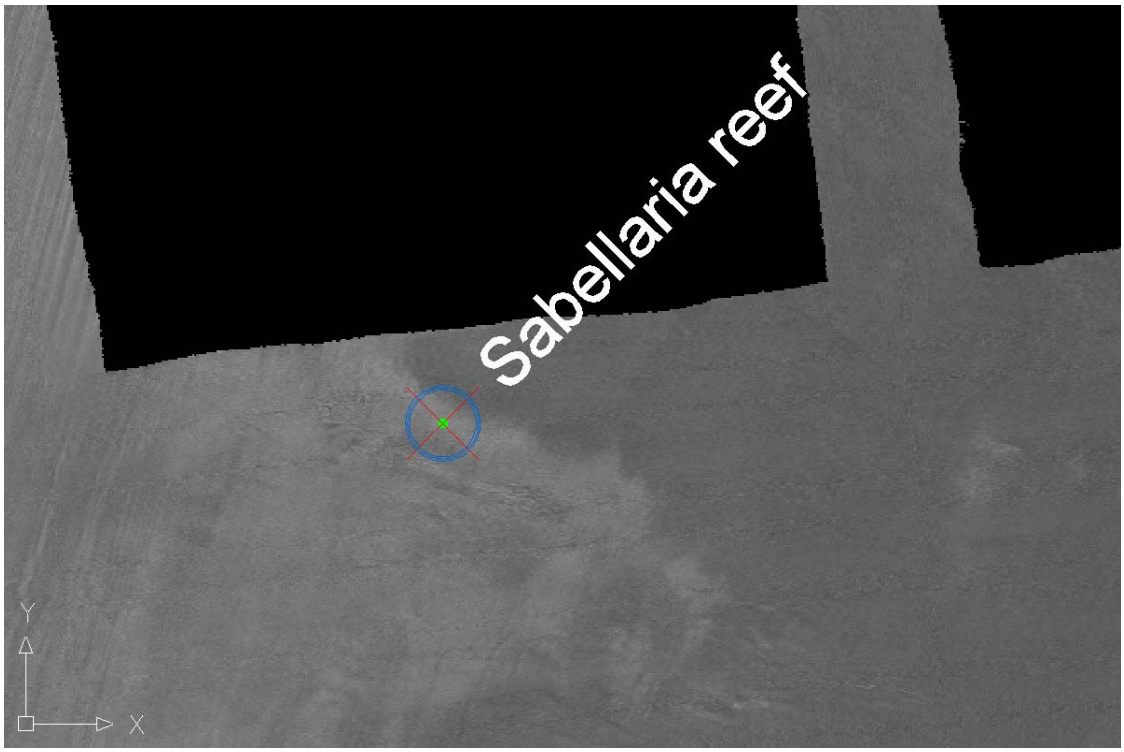


Figure 16. Sabellaria reef from AGDS

5.4. Trawl

Trawling was performed with a Beam trawl at four different stations in Block 3 (UK waters) to register fish and epibenthic megafauna (>1 cm). A total of 65 species were identified from the trawling (see appendix O).

At trawl location 001 (E 431618.45, N 5686686 to E 431195, N 5686686) the trawl passed over sandwaves at depths between 34-40 m covering a distance of 600 m. A sample of 10 litres was retrieved containing 15 species. Plaice *Pleuronectes platessa*, goby *Pomatoschistus spp*., Greater weever *Trachinus draco*, common hermit crab *Pagurus bernhardus*, marbled swimming crab *Liocarcinus marmoreus* and common shrimp *Crangon crangon* were the most abundant species.

At trawl location 002 (E 426267.39, N 5686965 to E 426207, N 5686362) the trawl went 600 m over a seabed with sand and gravel at a depth of 40-42 m, and a sample of 4 litres with 23 species recovered. Dominant species were goby *Pomatoschistus spp*., common dragonet *Callionymus lyra*, common shrimp *C. crangon*, common hermit crab *P. bernhardus* and marbled swimming crab *L. marmoreus*.

The seabed in the area of the trawl location 003 (E 416314, N 5686883 to E 416909, N 5686778) was composed of sand and gravel. The trawl was pulled 600 m at a depth of 40 m over the bottom. During sampling the trawl broke and only 1 litre of sample could be saved. This was however concluded acceptable by the client representative onboard. A total of 47 species were detected of which there were mostly crustaceans, especially the shrimp *Pandalina spp*., and echinoderms like the sea urchin *P. miliaris*.

At trawl location 004 (E 413827, N 5686470 to E 413933, N 5687099) sand and some sand ripples represented the seabed surface at a depth of 34 m. All three trawling trials resulted in trawls containing very small sample volumes. Nevertheless, the third trial was accepted by the client representative. The transect length was 640 m and a sample volume of 2 litres with 13 species was recovered. Crustaceans were the most abundant in this trawl sample like the common hermit crab *P. bernhardus*, shrimp *Crangon spp*. and barnacle *Balanus balanus*. Also the greater weever *T. draco* was abundant.

5.5. UK BAP Species

UK BAP species were found in trawl, grab photo and grab. The plaice, *P. platessa*, was found when trawling in B03_001 and B03_002 and in grab photo B01_011. The sole *Solea solea* was found in trawl stations B03_001, B03_002 and B03_003 and in grab station B01_002. The horse mackerel *T. trachurus* was found in trawl station B03_003.

These species are listed as “Grouped plan species”; they are treated as one species in a group of species for which an action plan is stated. According to the UK BAP homepage very few of the UK commercially exploited fish species are in immediate danger of extinction. However, there are local stocks of fish subject to excessive exploitation even though the species itself may not be in immediate danger.

The overruling threat for these groups are the extensive fishing pressure, as quoted from the UKBAP homepage: “The principal factor causing the decline in spawning stock biomass is summarised simply, but effectively, as `too many boats chasing too few fish`, i.e. the collective fishing power of the EU nations` fishing fleets is much greater than the productivity that the stocks can support”.

5.6. Statistics Habitat Stations/Species

The statistical analysis is based on macrofaunal data derived from the taxonomic analysis of the samples at each station. At some stations, one or two samples had too low sample volume or no sediment recovery on retrieval, mostly due to hard substrates. Samples with a volume of less than 5 litres were not included in the statistical analyses. A total of 50 (at 9 stations sediment recovery failed) stations were sampled and 39 of these stations contained three (A, B, C) samples. In total, 103 samples were used in the statistical analyses from 39 stations. The abundances were expressed as abundance per station (0.1 m^2). The full macrobenthic dataset is presented in Appendix H (Grab station identification table).

5.7. Multivariate Analysis

Multivariate analysis was undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v6.0 statistical package (Clarke and Gorley, 2006). A statistical Bray-Curtis resemblance calculation (Primer 6) was performed. Based on the Bray-Curtis similarity a cluster analysis is performed, which displays a dendrogram with the relationships between data. Multi dimensional scaling (MDS) is also performed with a two-dimensional image of the relationship between the stations.

The factor 'station' was used to visualize the similarities and dissimilarities between grab samples within each station as well as between stations. The data was transformed with square root. The transformation is performed on the data to give dominant and superabundant species a lower weight in order to make rarer species to contribute in the resemblance analyses. SIMPROF, the similarity profiling algorithm was used to identify statistically significant ($P < 0.05$) differences between stations. In Figure 17 the black lines indicate a significant split and the red lines are non-significant splits. The SIMPROF analysis showed eleven statistically different groups where one of the groups includes 64 of the 103 samples (Figure 18).

The low stress value (0.13) for the MDS ordination shows that the data probably has a reliable representation of the area. A resemblance level of 25% was overlaid from the cluster to identify groups with relative similarities. The cluster groups were poorly defined within the plot, with overlap between the groups. However, the statistical significant (SIMPROF) large group was at the resemblance level 25% divided into two groups that are fairly different from the fourth group while the third group is overlapping.

Most of the differences between the first and the fourth group considering species composition (Figure 18 from left to right 2, 1, 3, 4) can be explained by the sediment structure. The sediment at the stations in Block 3 (UK), where most of the samples of group 1 are situated, consists of medium sand forming sand waves. Group 4 sample stations are found in Block 1 (Belgium), apart from sample B03-050 in Block 3, and the seabed comprises fine sand with a silt fraction. Group 2 is similar to group 1, but the seabed was dominated by sand ripples and some patches of sand and gravel. The sediment at the locations from group 3 is made up of medium sand and a mixture of sand, gravel, ripples and waves. This shows that the composition of species and abundance are correlated with the sediment structure. The species are often environment specific. Some species are only found in fine soft sediments with low water motion while others are found in strongly current swept coarse sediment areas. The species niche is dependent on feeding behaviour such as deposit feeders, suspension feeders, predators etc. or shelter from predators or other rough conditions as well as food availability for the specific species in the area. Temperature and salinity can also be a determining factor for a species niche. All together, this determines the species richness and abundance in the different seabed habitats and shows the correlation between sediment structure and species composition.

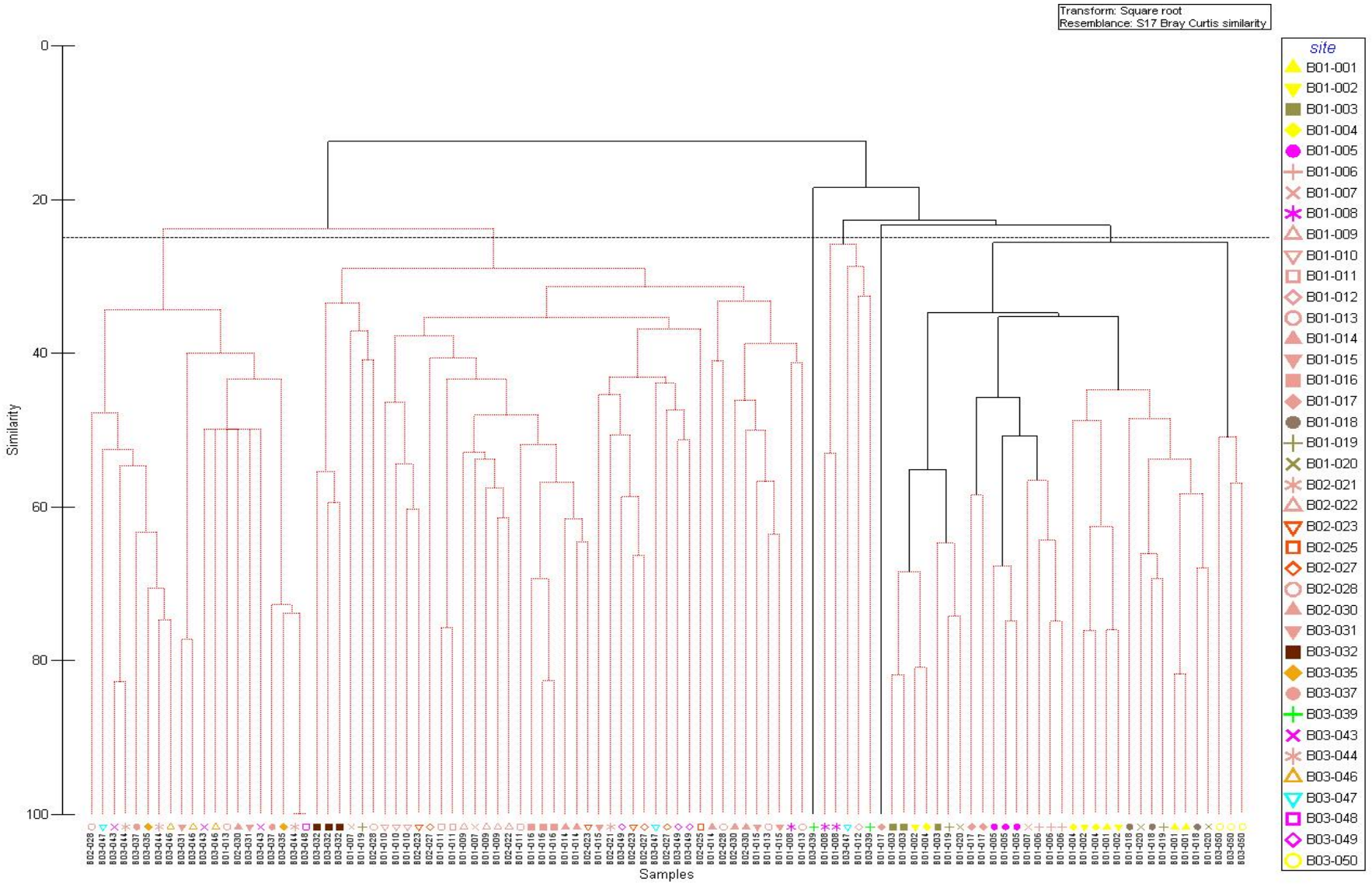


Figure 17. Bray-Curtis resemblance dendrogram.
Comparison of site similarities with square root transformed sample data

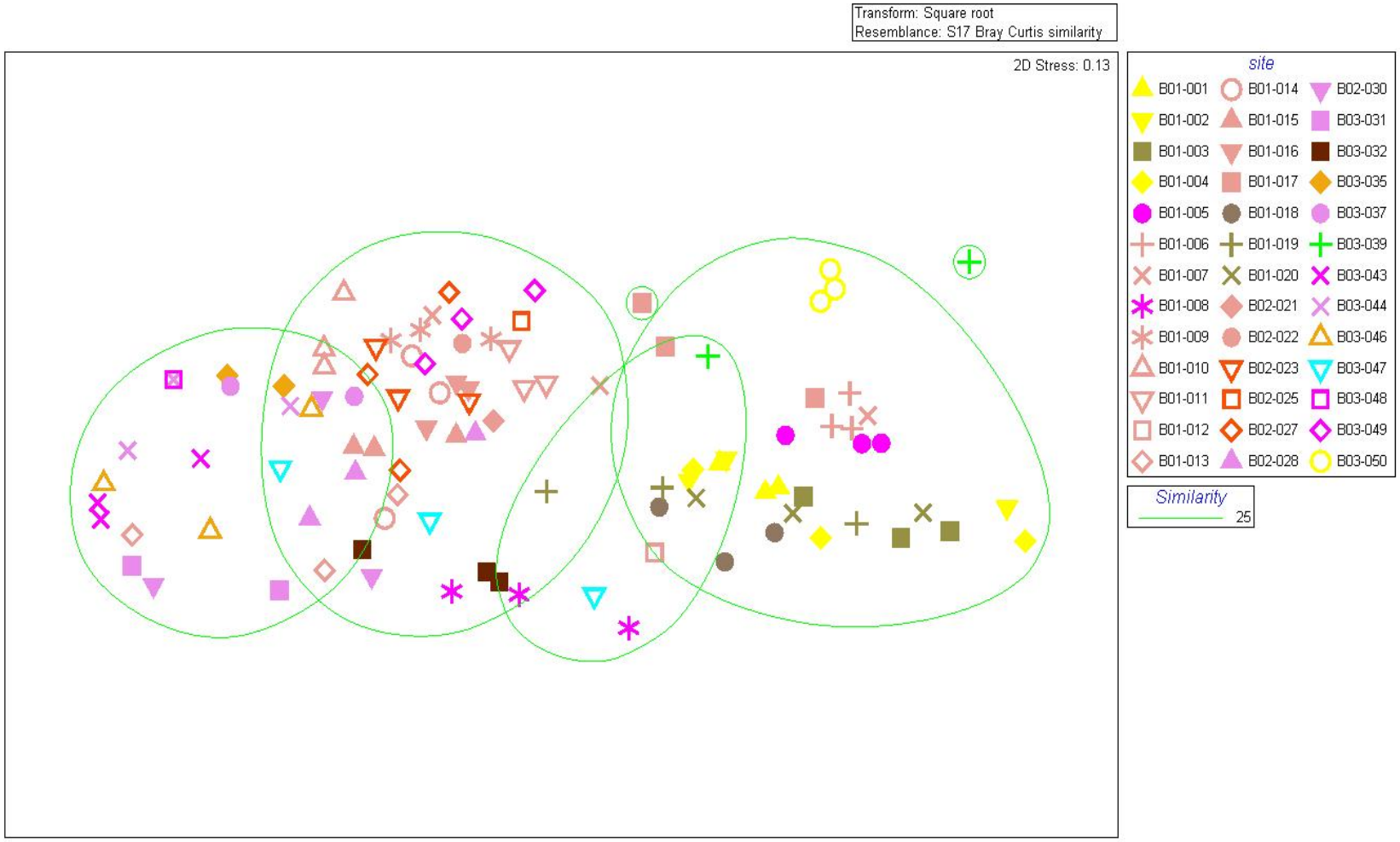


Figure 18. Macrofaunal Station Bray-Curtis resemblance MDS.
Comparison of site similarities with square root transformed grab sample data.

5.8. Particle Size Analysis

At all sample stations particle size analysis (PSA) was conducted. Fractions > 2 mm-0.063 mm were determined by wet sieving method and fractions < 0.063 mm were determined by laser particle size analyzer using liquid dispersion mode. Detailed results for each sample station containing sample weight, fraction weight, fraction percentage part, fraction cumulative part and a graphic depiction of the particle size composition are presented in Appendix P.

The sampled sediments across the surveyed corridor were quite similar; all consisting of mainly sand (Figure 19). Merely the grain composition of sand meaning fine, medium and coarse granules differed between sample stations. Across the route, the proportions of fine sand ranged from 0.48% to 81.73%, and the proportions of medium sand were between 1.7% and 93.84%. Depending on the station, there was either a higher proportion of fine sands or a higher proportion of medium sands. The samples obtained in Block 1 (Belgium) from the KP 5.5 to about KP 19.5 were mainly composed of fine sand. Only close to the Belgian shoreline in KP 5.5-6.0, and at KP18.5, the fine sand was mixed with silt and clay. Some silt may derive from sediment deposition from Zeebrügge Channel. From KP19.5 in Block 1 to the coast of the UK in Block 3, samples essentially consisted of medium sand. A single sample (B01_008) derived from an area with sand waves was found to also contain a comparably high fraction of coarse sand namely 32.44%. At KP 73.0, KP 115.5 and close to Ramsgate at KP 126.5 samples with high fractions of fine sand (60.13-81.73%) were recovered. Only in Block 3 between KP 82.27-88.42 and close to Ramsgate (B03_050) were samples with higher amounts of coarse fractions between 18.24-29.03%.

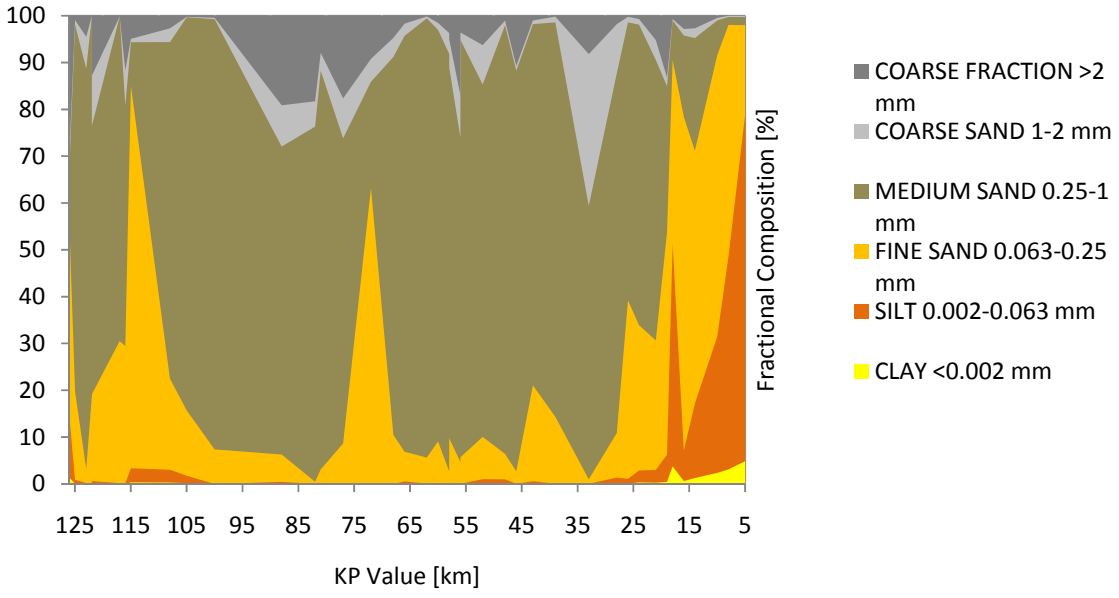


Figure 19. Fractional composition of sediments from England to Belgium

6. CONCLUSIONS

The aim of this survey was to investigate the habitats along the proposed HVDC Subsea cable link route between Zeebrügge, Belgium, and Ramsgate, UK, with emphasis on classifying habitats and species diversity, and on identifying Annex 1 habitats and UK Biodiversity Action Plan (UK BAP) areas. The bottom substrates were investigated with a drop camera and with sediment sampling.

In total 80 close-up photo images were analysed, one at each sample station, together with additional stills along the cross transects. The photo resolution makes it possible to identify biota to lowest taxonomic level practicable at all stations were visibility was acceptable. The fauna at 50 stations with sub samples, where it was possible, was identified to lowest taxonomic level and the abundances were registered in each grab sample. The benthic sediment substrates contain primarily infauna which is preferably sampled using a grab sampler. As a complement to grab sampling, trawling was performed in UK waters only. Benthic species and abundances were noted.

The North Atlantic currents, wind patterns and river runoffs from rivers such as the Rhine and Thames aid in concentrating nutrients near the coasts. These nearshore areas are more diverse than the offshore areas, but they also experience eutrophication with land based nutrients and contaminants. This occurs especially in the southern North Sea due to shallow waters that are surrounded by densely populated countries.

The base for the interpretation and classification of habitats of the entire route are the result from the analyses of photo transects and grab samples together with information from bathymetry and side scan sonar. The findings of this survey are in line with what can be expected in such an area. In the nearshore area habitats are patchier and more species rich than in offshore areas, where long parts of the surveyed route are similar. Along the planned HVDC Subsea cable link route, eleven habitats were identified. The seabed comprises predominantly sand and on occasion cobbles, gravel and silt. The diversity and species composition varies with sediment, but also current and depth have an impact on the biological assemblages.

Two reefs of the Ross worm *S. spinulosa* were found in the surveyed area approximately 20 km off the coast of the UK. The reefs were found at depths between 23 m and 28 m with varying size and density. The larger *Sabellaria* reef is 424 m long and 59 m wide, whereas the smaller is relatively circular, 31 m in diameter. Elevation of tubes was estimated to be between 5-15 cm. Due to strong currents, the visibility in these areas was very poor and the reef and colonies may be patchy.

S. spinulosa reefs have been recorded at several places off the east coast of England, but reefs also exist in the English Channel (Hastings), Dorset and Severn Estuary (OSPAR Commission 2010). *S. spinulosa* is found from the low intertidal to offshore, inhabiting a variety of depths ranging from a few metres to over 40 m depth or even deeper (Holt et al. 1998). The Ross worm is a suspension feeder, and reef communities are often found in areas with weak or moderately strong tidal flows (Jones et al. 2001). Favoured reef locations are areas in proximity to sandwaves (Hendrick and Foster-Smith 2006). These characteristics apply to the reef stations found in this survey.

S. spinulosa reefs are listed under Annex 1 of the Habitats Directive as a marine habitat to be protected by the designation of Special Areas of Conservation. *S. spinulosa* larvae are strongly stimulated to metamorphose and settle on the tubes of both living and dead worms. Nevertheless, the Ross worm is often the first to settle on newly

exposed surfaces and enables the establishment of many other species (OSPAR Commission 2010). Hence, such a biogenic reef contributes to biodiversity and ecosystem function (Limpenny et al. 2010).

Typical of this Annex 1 habitat is that the biodiversity within the reef is higher compared to adjacent areas. Species listed (OSPAR Commission 2010) as often associated with *Sabellaria* reefs such as polychaetes *Harmothoe spp.*, *L. conchilega* and cirratulids, tube-building amphipods e.g. *Ampelisca spp.*, hermit crabs, amphipods and hydroids were also found in the reef at sample station B03_039. Associations between *S. spinulosa* aggregations with high numbers of crustaceans have been observed at other locations including a strong connection with the porcelain crab *P. longicornis* at Hastings Shingle Bank in the English Channel. With regard to the food web, this association is important as *P. longicornis* is likely to become a relevant food source for fish and possibly larger invertebrates (Pearce et al. 2007). Crustaceans, and especially *P. longicornis*, were abundant in the reef at sample station B03_039.

The temporal stability of *S. spinulosa* reefs is still uncertain and only few studies have been conducted on the persistence of colonies. There are indications that suggest that *Sabellaria* reefs generate and degenerate over a time span ranging from months to a few years. Unfortunately, no firm explanation can be offered (OSPAR Commission 2010). Natural variability and storms, changes in circulation patterns caused by tidal currents or ice winters likely also play part in changes in the extent of the *Sabellaria* reefs (Vorberg 2000). *S. spinulosa* does not appear to be particularly sensitive to changes in water quality (Holt et al. 1998), but physical damage deriving from trawling, dredging and net fishing is regarded to have the greatest detrimental effect on the *Sabellaria* reefs (Riesen and Reise 1982). Reports of reef damage caused by benthic trawling are widespread, probably because of the association between *Sabellaria* reefs and the commercially valuable pink shrimp *Pandalus montagui* (Holt et al. 1998).

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ID	Easting	Northing	Depth (m)	Attempt (of 5 possible)	Type of Sampling	Comment
100702-NEMO-GS-B01-001	497417	5687890	11.8	3	Photo/Grab	
100702-NEMO-GS-B01-002	495583	5688054	12.8	3	Photo/Grab	
100702-NEMO-GS-B01-003	493466	5688414	16.4	3	Photo/Grab	
100702-NEMO-GS-B01-004	492663	5688496	16.5	4	Photo/Grab	
100702-NEMO-GS-B01-005	490394	5689065	18.9	5	Photo/Grab	
100702-NEMO-GS-B01-006	487526	5689606	21.5	4	Photo/Grab	
100702-NEMO-GS-B01-007	483541	5688555	26.0	3	Photo/Grab	
100702-NEMO-GS-B01-008	479218	5688336	17.0	3	Photo/Grab	
100702-NEMO-GS-B01-009	468907	5689330	29.0	3	Photo/Grab	
100702-NEMO-GS-B01-010	467066	5690950	29.0	3	Photo/Grab	
100702-NEMO-GS-B01-011	464768	5690840	27.0	4	Photo/Grab	
100702-NEMO-GS-B01-012	461179	5689687	34.5	5	Photo/Grab	Two grabs accepted
100702-NEMO-GS-B01-013	457427	5688051	28.0	3	Photo/Grab	
100702-NEMO-GS-B01-014	457609	5688048	33.0	5	Photo/Grab	
100702-NEMO-GS-B01-015	454992	5687268	38.5	3	Photo/Grab	
100702-NEMO-GS-B01-016	473336	5688994	23.4	4	Photo/Grab	
100702-NEMO-GS-B01-017	485843	5689248	22.4	3	Photo/Grab	
100702-NEMO-GS-B01-018	501049	5687734	10.0	3	Photo/Grab	
100702-NEMO-GS-B01-019	503201	5687622	8.6	4	Photo/Grab	
100702-NEMO-GS-B01-020	506189	5687053	8.0	5	Photo/Grab	
100702-NEMO-GS-B02-021	455282	5687273	42.0	5	Photo/Grab	One grab accepted
100702-NEMO-GS-B02-022	454014	5686799	36.4	5	Photo/Grab	Two grabs accepted
100702-NEMO-GS-B02-023	451605	5685778	38.0	3	Photo/Grab	
100702-NEMO-GS-B02-024	449052	5685125	35.8	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B02-025	448045	5685205	35.9	5	Photo/Grab	Two grabs accepted
100702-NEMO-GS-B02-026	447097	5685290	37.1	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B02-027	445688	5685690	36.1	3	Photo/Grab	
100702-NEMO-GS-B02-028	441671	5686433	31.0	3	Photo/Grab	
100702-NEMO-GS-B02-029	436734	5686299	38.5	5	Photo/Grab	Two grabs accepted
100702-NEMO-GS-B02-030	433539	5686382	40.0	4	Photo/Grab	
100702-NEMO-GS-B03-031	431715	5686388	32.0	3	Photo/Grab	
100702-NEMO-GS-B03-032	426153	5686634	42.2	3	Photo/Grab	
100702-NEMO-GS-B03-033	422672	5686733	40.8	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-034	416374	5686854	40.8	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-035	414266	5686938	18.9	3	Photo/Grab	
100702-NEMO-GS-B03-036	412197	5687033	46.0	5	Photo/Grab	Old sabellaria tubes. No grab accepted
100702-NEMO-GS-B03-037	408771	5687304	53.7	5	Photo/Grab	
100702-NEMO-GS-B03-038	407401	5687145	41.1	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-039	405994	5687202	22.5	3	Photo/Grab	Sabellaria (two grabs accepted)
100702-NEMO-GS-B03-040	404308	5686851	26.5	5	Photo/Grab	Old sabellaria tubes. No grab accepted
100702-NEMO-GS-B03-041	402231	5686507	19.7	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-042	399159	5686401	17.8	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-043	397792	5686013	37.0	3	Photo/Grab	
100702-NEMO-GS-B03-044	397257	5685815	16.0	3	Photo/Grab	
100702-NEMO-GS-B03-045	395600	5685354	12.0	5	Photo/Grab	No grab accepted
100702-NEMO-GS-B03-046	391595	5685158	10.0	3	Photo/Grab	
100702-NEMO-GS-B03-047	392526	5685110	12.0	3	Photo/Grab	
100702-NEMO-GS-B03-048	391993	5684853	9.0	5	Photo/Grab	
100702-NEMO-GS-B03-049	389215	5685981	2.0	3	Photo/Grab	
100702-NEMO-GS-B03-050	388933	5686257	3.0	3	Photo/Grab	Old sabellaria tube fragments

ID	Start Easting	Start Northing	Stop Easting	Stop Northing	Depth (m)	Distance (m)	Type of Sampling	comments
100702-NEMO-TRAWL-B03-001	431618	5686686	431195	5686248	34-40	1200	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-002	426267	5686965	426207	5686362	40-42	610	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-003	416314	5686883	416909	5686778	40	600	Trawl	Trawl damaged due to rough seafloor. No more attempts.
100702-NEMO-TRAWL-B03-004_A	413910	5687172	414005	5686780	34	600	Trawl	Low volume.
100702-NEMO-TRAWL-B03-004_B	413827	5686420	413933	5687099	34	600	Trawl	No sample, low volym.
100702-NEMO-TRAWL-B03-004_C	413827	5686420	413933	5687099	34	640	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-005							Trawl	Sea floor was to rocky to trawl
100702-NEMO-TRAWL-B03-006							Trawl	Too shallow to trawl for Icebeam
100702-NEMO-TRAWL-B03-007							Trawl	Too shallow to trawl for Icebeam

Survey Vessel – Icebeam

Flag	Swedish
Weight	Br.Tonnage 473, Net.Tonnage 141
Length	40 m
Draft	3.5 m
Speed	10 kts

Navigation and Positioning

Primary Positioning System	— Applanix PosMV 320 with C-NAV correction — Fugro Differential GPS utilizing Starfix-XP and Starfix-HP Differential system.
Primary INS system	— Applanix PosMV 320
Secondary INS system	— IXSEA GAPS III
Primary Gyro system	— Applanix PosMV 320
Secondary Gyro system	— IXSEA GAPS III
Aron 2000 navigation survey system	
Underwater positioning	— USBL IXSEA GAPS III

Bathymetry and Geophysics

Echo sounder	— Kongsberg Multibeam EM 3002D
Moving Sound Velocity Profiler	— Valeport Mini SVS
Hull mounted Sound Velocity Profiler	— Valeport Mini SVS
MBES Software SIS v. 3.7	
Side Scan Sonar system	— Edgetech 4200, 300 / 600 kHz
Geophysical acquisition software	— Triton SS-logger (Side Scan Sonar)
Sub-bottom Profiler	— Chirp Edgetech DW-106, 1-6 kHz
Geophysical acquisition software	— Triton ISIS / Edgetech Discover
Sub-bottom profiler Geosparker200	

Sampling Equipment

Day Grab sampler and a beam trawl.

Drop Camera Equipment

MMT made freshwater lens housing with a Canon EOS 5D MK II

Offline Software

Triton Suite digital hydro acoustic interpretation software
Triton map mosaic software
IVS Fledermaus editing software
Caris bathymetrical software
Applanix PosPac
TerraPos
AutoCad 2009 Map presentation software
AutoChart
ArcGIS software package
3 PC work stations
Visual Soft package

Survey Vessel – M.P.R. 1

IMO 9586409

Flag Netherlands

Weight Br. Tonnage 254, Net. Tonnage 76

Length 27 m

Draft 2.63 m

Speed 10 kts

Navigation and Positioning

Positioning System — Fugro starfix

Sampling Equipment

Day Grab sampler

Equipment	Type
Primary Positioning System	Applanix POS/MV 320 with RTG corrections from CNAV
Secondary Positioning System	Fugro HP Starpack with IALA and SBAS.
Heading	Applanix POS/MV 320 (Primary)
Motion Sensor	Applanix POS/MV 320 (Primary)
Heading	GAPS III (Secondary)
Motion Sensor	GAPS III (Secondary)
USBL	GAPS III
Transponder Camera cage	GAPS MT8
Drop camera frame	Box Deployment Frame
Camera	Canon EOS 5D MK II
Illumination POD	NUYTCO NEWTSUN NS 600-PS2-300V
Illumination FLOODLIGHT	NUYTCO NEWTSUN NS 600-S-5600
Freshwater lens	MMT
Biological grab sampler	Day grab 0.1 m^2 sampling area
Sieve	5 mm stainless, 1 mm stainless
Trawl	2 m Lowestoft Beam Trawl, 5 mm mesh
Transponder trawl	MIPS
Stereo Microscope	Zeiss Stemi 2000- C/ Wild M3C/ Olympus
Microscope	Zeiss Axiostar plus Binocular microscope
Statistical software package	PRIMER 6, and STATISTICA

Icebeam Name	 Position
Anders Dahlen	Chief Officer
Andrea Johansson	Marine Biologist
Anna Scherer	Marine Biologist
Fredrik Andrén	Surveyor
Hans Björn	Chief Engineer
Hugo Nielsen	Second Officer
Iris Duranovic	Marine Biologist
Joakim Litzell	Surveyor
Karl Rhedin	Surveyor
Mattias Jansson	Captain
Per Hjelmstedt	Marine Biologist
Peter Krafft	Motorman
Staffan Niemi	Cook
Tobias Sundkvist	Offshore Manager
Tom Wilkins	Surveyor
Zahars Korobicins	Second Officer
Andrew Campbell	Client Representative
MPR1 Name	 Position
Albert Wilson	Engineer
Aleksej Verchotusov	Engineer
Alex Scott	Client Representative
Andrea Johansson	Marine Biologist
Anna Scherer	Marine Biologist
Berry Brink	Survey
Claes Djup	Offshore Manager
Giampaolo De Panfilis	VC tech
Håkan Sundin	Technical Manager
J. W. A. Burgering	Captain
Jens Jörgen Nilsson	CPT and Vibrocore Operator
Jeroen Leendert Vuik	AB
Therese Harrysson	Marine Geologist

SURVEY ONLINE PROTOCOL 100702-NEMO							
Date	**Time UTC**	**Operator**	**Event**	**Result**	**Site-name**	**Comments**	**DL/QC**
2010-09-23	00:00		Mobilisation Zebrugge				
2010-09-23	12:50	TW	Transit to Test				
2010-09-23	15:20	TS	on location B01-002				
2010-09-23	15:20	TS	Breakdown equipment				
2010-09-23	17:12	TW	Launch Camera Cage				
2010-09-23	17:16	TW	Bio sampling Day grab		100702-NEMO-GS-B01-002		
2010-09-23	17:33	TW	Recover Camera cage				
2010-09-23	17:44	TS	Trassit to B01-006, because of low visibility on B01-002				
2010-09-23	18:49	TW	on location B01-006		100702-NEMO-GS-B01-006		
2010-09-23	18:57	TW	Launch Camera Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:10	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:14	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:18	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:20	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:21	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:24	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:26	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:28	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:31	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:40	TW	Recover Camera cage		100702-NEMO-GS-B01-006		TW
2010-09-23	19:55	TW	Breakdown equipment				
2010-09-23	20:44	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_A		
2010-09-23	21:03	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_B		
2010-09-23	21:23	TW	Bio sampling Day grab		100702-NEMO-GS-B01-006_C		
2010-09-23	21:32	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_C2		TW
2010-09-23	21:44	TW	Transit to B01-017				
2010-09-23	22:11	TW	On Location B01-017		100702-NEMO-GS-B01-017		
2010-09-23	22:20	TW	Launch Camera Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:23	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:25	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:30	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:31	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:36	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:37	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:42	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:43	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:48	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:56	TW	Recover Camera cage				TW
2010-09-23	23:12	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_A		

2010-09-23	23:20	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_B		
2010-09-23	23:29	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_C		TW
2010-09-23	23:37	TW	Transit to B01-07				
2010-09-24			New Day				
2010-09-24	00:32	TW	on location B01-0067				
2010-09-24	00:37	TW	Launch Camera Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:40	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:41	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:44	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:45	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:49	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:51	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:53	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:55	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:58	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	01:04	TW	Recover Camera cage				TW
2010-09-24	01:14	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_A		
2010-09-24	01:19	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_B		
2010-09-24	01:24	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_C		TW
2010-09-24	01:25	TW	Transit to B01-008		100702-NEMO-GS-B01-007		
2010-09-24	02:45	KR	On Location B01-008				
2010-09-24	02:46	KR	Launch Camera Cage		100702-NEMO-GS-B01-008		
2010-09-24	05:52	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-008		
2010-09-24	05:54	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	02:59	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:00	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:05	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:08	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:11	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:13	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:20	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:23	KR	Recover Camera cage		100702-NEMO-GS-B01-008		KR
2010-09-24	03:35	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		
2010-09-24	03:42	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		
2010-09-24	03:47	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		KR
2010-09-24	03:50	KR	Transit to B01-009		100702-NEMO-GS-B01-008		
2010-09-24	05:14	KR	On Location B01-009		100702-NEMO-GS-B01-009		
2010-09-24	05:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:26	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:28	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:35	KR	Lift Cage		100702-NEMO-GS-B01-009		

2010-09-24	05:39	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:40	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:45	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:46	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:49	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:50	KR	Recover Camera cage		100702-NEMO-GS-B01-009		KR
2010-09-24	06:07	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		
2010-09-24	06:15	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		
2010-09-24	06:22	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		KR
2010-09-24	06:23	KR	Transit to B01-010		100702-NEMO-GS-B01-009		
2010-09-24	07:15	KR	On Location B01-010		100702-NEMO-GS-B01-010		
2010-09-24	07:17	KR	Launch Camera Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:22	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:24	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:30	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:31	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:43	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:44	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:49	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:50	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:58	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-010		
2010-09-24	08:00	KR	Recover Camera cage		100702-NEMO-GS-B01-010		KR
2010-09-24	08:15	KR	Pic 20104457 in Folder B01-010 - Drawing Failed, download directly from memory card!				
2010-09-24	08:20	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		
2010-09-24	08:27	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		
2010-09-24	08:35	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		KR
2010-09-24	08:36	KR	Transit to B01-011		100702-NEMO-GS-B01-010		
2010-09-24	09:13	KR	On Location B01-011		100702-NEMO-GS-B01-011		
2010-09-24	09:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:18	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:19	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:24	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:25	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:28	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:29	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:32	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:33	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:38	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:40	KR	Recover Camera cage		100702-NEMO-GS-B01-011		KR
2010-09-24	10:00	KR	Bio sampling Day grab_A		100702-NEMO-GS-B01-011		
2010-09-24	10:05	KR	Bio sampling Day grab_A2	X	100702-NEMO-GS-B01-011		

2010-09-24	10:10	KR	GAPS UP				
2010-09-24	10:15	KR	Breaking off due to weather		100702-NEMO-GS-B01-011		
2010-09-24	14:55	TS	along side key411, zeebrugge. Waiting on weather.				
2010-09-25			New Day				
2010-09-25		TW	along side key411, zeebrugge. Waiting on weather.				
2010-09-26			New Day				
2010-09-26	12:20	TW	Transit to B01-011				
2010-09-26	18:10	TW	On Location B01-011		100702-NEMO-GS-B01-011		
2010-09-26	18:15	TW	GAPS DOWN				
2010-09-26	18:46	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-011		
2010-09-26	18:57	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-011		TW
2010-09-26	19:03	TW	Transit to B01-012				
2010-09-26	19:37	TW	On Location B01-012		100702-NEMO-GS-B01-012		
2010-09-26	19:48	TW	Launch Camera Cage		100702-NEMO-GS-B01-012		
2010-09-26	19:53	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-012		
2010-09-26	19:57	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:02	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:03	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:08	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:09	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:13	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:15	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:18	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:28	TW	Recover Camera cage				TW
2010-09-26	20:42	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-012		
2010-09-26	20:54	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-012		
2010-09-26	21:02	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B01-012		
2010-09-26	21:13	TW	Bio sampling Day grab_A4	X	100702-NEMO-GS-B01-012		
2010-09-26	21:25	TW	Bio sampling Day grab_B		100702-NEMO-GS-B01-012		TW
2010-09-26	21:30	TW	Transit to B01-014				
2010-09-26	21:55	TW	On Location B01-014		100702-NEMO-GS-B01-014		
2010-09-26	22:11	TW	Launch Camera Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:14	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:15	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:19	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:20	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:25	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:26	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:31	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:32	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:36	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:43	TW	Recover Camera cage				TW

2010-09-26	22:55	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-014		
2010-09-26	23:02	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-014		
2010-09-26	23:11	TW	Bio sampling Day grab_A3	X	100702-NEMO-GS-B01-014		
2010-09-26	23:18	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-014		
2010-09-26	23:27	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-014		TW
2010-09-26	23:30	TW	Transit to B01-013				
2010-09-26	23:37	TW	On Location B01-013		100702-NEMO-GS-B01-013		
2010-09-26	23:42	TW	Launch Camera Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:46	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:48	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:54	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:55	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:59	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:59	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-27			New Day				
2010-09-27	00:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-013		
2010-09-27	00:04	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-27	00:07	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-013		
2010-09-27	00:15	TW	Recover Camera cage				TW
2010-09-27	00:24	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-013		
2010-09-27	00:30	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-013		
2010-09-27	00:39	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-013		TW
2010-09-27	00:41	TW	Transit to B02-021				
2010-09-27	01:14	TW	On Location B02-21		100702-NEMO-GS-B02-021		
2010-09-27	01:18	TW	Launch Camera Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:23	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:24	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:29	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-021	Moved due to not enough slack so took 2 more in new location	
2010-09-27	01:30	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:33	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:33	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:38	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:39	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:43	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-021		KR
2010-09-27	01:51	TW	Recover Camera cage		100702-NEMO-GS-B02-021		
2010-09-27	02:14	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-021		
2010-09-27	02:23	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-021		
2010-09-27	02:39	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-021		
2010-09-27	02:47	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-021		
2010-09-27	02:58	KR	Bio sampling Day grab_A_5	X	100702-NEMO-GS-B02-021		KR

2010-09-27	03:03	KR	Transit to B01-015		100702-NEMO-GS-B01-015		
2010-09-27	03:10	KR	On Location B01-015		100702-NEMO-GS-B01-015		
2010-09-27	03:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:24	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:25	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:35	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:41	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:42	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:47	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:48	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-015		KR
2010-09-27	03:55	KR	Recover Camera cage		100702-NEMO-GS-B01-015		
2010-09-27	04:11	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-015		
2010-09-27	04:24	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-015		
2010-09-27	04:32	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-015		KR
2010-09-27	04:44	KR	Transit to B01-016		100702-NEMO-GS-B01-015		
2010-09-27	06:40	KR	On Location B01-016		100702-NEMO-GS-B01-016		
2010-09-27	06:41	KR	Launch Camera Cage		100702-NEMO-GS-B01-016		
2010-09-27	06:50	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-016		
2010-09-27	06:51	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	06:57	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-016		
2010-09-27	06:58	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:01	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-016		
2010-09-27	07:02	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:07	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-016		
2010-09-27	07:08	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:12	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-016		KR
2010-09-27	07:13	KR	Recover Camera cage		100702-NEMO-GS-B01-016		
2010-09-27	07:31	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-016		
2010-09-27	07:39	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-016		
2010-09-27	07:46	KR	Bio sampling Day grab_C		100702-NEMO-GS-B01-016		
2010-09-27	07:52	KR	Bio sampling Day grab_C_2	X	100702-NEMO-GS-B01-016		KR
2010-09-27	07:55	KR	Transit to B01-005		100702-NEMO-GS-B01-016		
2010-09-27	09:40	KR	On Location B01-005		100702-NEMO-GS-B01-005		
2010-09-27	09:45	KR	Launch Camera Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:00	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:08	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:13	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:15	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:24	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:25	TW	Lift Cage		100702-NEMO-GS-B01-005		

2010-09-27	10:31	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:33	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:37	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:45	TW	Recover Camera cage				TW
2010-09-27	10:58	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-005		
2010-09-27	11:05	TW	Bio sampling Day grab_A2	X	100702-NEMO-GS-B01-005		
2010-09-27	11:11	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-005		
2010-09-27	11:19	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-005		
2010-09-27	11:25	TW	Bio sampling Day grab_C2	X	100702-NEMO-GS-B01-005	Extra ask for by Biologists	TW
2010-09-27	11:30	TW	Transit to B01-004				
2010-09-27	11:50	TW	On Location B01-004		100702-NEMO-GS-B01-004		
2010-09-27	12:08	TW	Launch Camera Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:17	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:17	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:22	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:23	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:30	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:31	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:36	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:37	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:42	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:47	TW	Recover Camera cage				TW
2010-09-27	12:55	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-004		
2010-09-27	13:02	TW	Bio sampling Day grab_B		100702-NEMO-GS-B01-004		
2010-09-27	13:09	TW	Bio sampling Day grab_B2		100702-NEMO-GS-B01-004		
2010-09-27	13:16	TW	Bio sampling Day grab_B3	X	100702-NEMO-GS-B01-004		
2010-09-27	13:22	TW	Bio sampling Day grab_C		100702-NEMO-GS-B01-004		TW
2010-09-27	13:24	TW	Transit to B01-003				
2010-09-27	13:40	TW	On Location B01-003		100702-NEMO-GS-B01-003		
2010-09-27	13:47	TW	Launch Camera Cage		100702-NEMO-GS-B01-003		
2010-09-27	13:51	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-003		
2010-09-27	13:51	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	13:59	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:02	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:05	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:06	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:14	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:15	KR	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:20	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:21	KR	Recover Camera cage				TW
2010-09-27	14:41	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-003		
2010-09-27	14:48	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-003		

2010-09-27	14:55	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-003		TW
2010-09-27	14:56	KR	Transit to B01-002				
2010-09-27	15:30	KR	On Location B01-002		100702-NEMO-GS-B01-003		
2010-09-27	15:31	KR	Launch Camera Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:35	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-002	4 Photos taken	
2010-09-27	15:36	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:44	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:45	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:48	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:49	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:53	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:54	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	16:00	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-002		
2010-09-27	16:01	KR	Recover Camera cage				TW
2010-09-27	16:41	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-002		
2010-09-27	17:02	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-002		
2010-09-27	17:08	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-002		TW
2010-09-27							
2010-09-27	17:15	KR	Transit to B01-001		100702-NEMO-GS-B01-002		
2010-09-27	17:40	KR	On Location B01-001		100702-NEMO-GS-B01-001		
2010-09-27	17:45	KR	Launch Camera Cage		100702-NEMO-GS-B01-001		
2010-09-27	17:54	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-001		
2010-09-27	17:56	KR	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:00	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:02	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:04	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:06	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:09	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:11	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:13	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:21	TW	Recover Camera cage				TW
2010-09-27	18:32	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-001		
2010-09-27	18:39	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-001		
2010-09-27	18:49	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B01-001	Biologists decided unable to get good samples so called off.	TW
2010-09-27	18:52	TW	GAPS UP				
2010-09-27	18:55	TW	Transit to B02-022				
2010-09-27	22:13	TW	GAPS DOWN				
2010-09-27	22:16	TW	On Location B02-022		100702-NEMO-GS-B02-022		
2010-09-27	22:22	TW	Launch Camera Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:35	TW	Recover Camera cage			Problem with transponder	

2010-09-27	22:46	TW	Launch Camera Cage				
2010-09-27	22:50	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:50	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:54	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:54	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:58	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:59	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	23:05	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-022		
2010-09-27	23:08	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	23:10	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-022		
2010-09-27	23:16	TW	Recover Camera cage				TW
2010-09-27	23:33	TW	Bio sampling Day grab_A		100702-NEMO-GS-B02-022		
2010-09-27	23:41	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B02-022		
2010-09-27	23:48	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B02-022		
2010-09-27	23:56	TW	Bio sampling Day grab_A4	X	100702-NEMO-GS-B02-022		
2010-09-28			New Day				
2010-09-28	00:04	TW	Bio sampling Day grab_B		100702-NEMO-GS-B02-022		TW
2010-09-28	00:06	TW	Transit to B02-023				
2010-09-28	00:31	TW	On Location B02-023		100702-NEMO-GS-B02-023		
2010-09-28	00:35	TW	Launch Camera Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:39	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:40	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:45	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:46	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:50	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:50	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:54	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:54	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	01:05	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-023		
2010-09-28	01:10	TW	Recover Camera cage				KR
2010-09-28	01:26	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-023		
2010-09-28	01:33	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-023		
2010-09-28	01:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-023		KR
2010-09-28	01:40	TW	Transit to B02-024				
2010-09-28	02:23	KR	On Location B02-024		100702-NEMO-GS-B02-024		
2010-09-28	02:24	KR	Launch Camera Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:33	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:24	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:39	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:40	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:43	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:44	KR	Lift Cage		100702-NEMO-GS-B02-024		

2010-09-28	02:48	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:49	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:53	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:55	KR	Recover Camera cage				KR
2010-09-28	03:13	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-024		
2010-09-28	03:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-024		
2010-09-28	03:30	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-024		
2010-09-28	03:45	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-024		
2010-09-28	04:00	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B02-024		KR
2010-09-28	04:01	KR	Transit to B02-025				
2010-09-28	04:20	KR	On Location B02-025		100702-NEMO-GS-B02-025		
2010-09-28	04:25	KR	Launch Camera Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:29	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:30	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:35	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:39	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:40	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:45	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:46	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:52	KR	Recover Camera cage				KR
2010-09-28	05:10	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-025		
2010-09-28	05:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-025		
2010-09-28	05:30	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-025		
2010-09-28	05:41	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-025		
2010-09-28	05:54	KR	Bio sampling Day grab_A_5	X	100702-NEMO-GS-B02-025		KR
2010-09-28	06:00	KR	Transit to B02-026				
2010-09-28	06:20	KR	On Location B02-026		100702-NEMO-GS-B02-026		
2010-09-28	06:30	KR	Launch Camera Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:02	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:03	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:08	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:09	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:11	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:12	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:16	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:17	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:22	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:23	KR	Recover Camera cage				TW
2010-09-28	07:54	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-026		
2010-09-28	08:12	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-026		

2010-09-28	08:18	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-026		
2010-09-28	08:25	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-026		
2010-09-28	08:32	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B02-026		TW
2010-09-28	08:41	KR	Transit to B02-027				
2010-09-28	08:55	KR	On Location B02-027		100702-NEMO-GS-B02-027		
2010-09-28	09:15	KR	Launch Camera Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:25	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:26	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:30	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:31	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:35	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:36	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:42	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:43	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:51	KR	Recover Camera cage				TW
2010-09-28	10:20	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-027		
2010-09-28	10:29	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-027		
2010-09-28	10:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-027		TW
2010-09-28	10:40	TW	Transit to B02-028				
2010-09-28	11:18	TW	On Location B02-028		100702-NEMO-GS-B02-028		
2010-09-28	11:22	TW	Launch Camera Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:49	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-028		
2010-09-28	11:50	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:53	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-028		
2010-09-28	11:53	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:59	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:00	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	12:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:03	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	12:07	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:17	TW	Recover Camera cage				TW
2010-09-28	12:25	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-028		
2010-09-28	12:32	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-028		
2010-09-28	12:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-028		TW
2010-09-28	12:39	TW	Transit to B02-029				
2010-09-28	12:46	TW	GAPS UP				
2010-09-28	13:23	TW	GAPS DOWN				
2010-09-28	13:26	TW	On Location B02-029		100702-NEMO-GS-B02-029		
2010-09-28	13:30	TW	Launch Camera Cage		100702-NEMO-GS-B02-029		
2010-09-28	13:46	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:47	TW	Lift Cage		100702-NEMO-GS-B02-029		

2010-09-28	13:52	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:52	TW	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	13:57	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:57	TW	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	14:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-029		
2010-09-28	14:05	KR	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	14:10	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-029		
2010-09-28	14:13	KR	Recover Camera cage		100702-NEMO-GS-B02-029		KR
2010-09-28	14:24	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-029		
2010-09-28	14:35	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-029		
2010-09-28	14:41	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-029		
2010-09-28	14:48	KR	Bio sampling Day grab_A_4				
2010-09-28	14:59	KR	Bio sampling Day grab_A_5				
2010-09-28	15:03	KR	Transit to B02-030		100702-NEMO-GS-B02-030		
2010-09-28	15:40	KR	On Location B02-030		100702-NEMO-GS-B02-030		
2010-09-28	15:45	KR	Launch Camera Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:02	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:05	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:11	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:12	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:16	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:17	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:21	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:22	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:28	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:30	KR	Recover Camera cage		100702-NEMO-GS-B02-030		KR
2010-09-28	16:45	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-030		
2010-09-28	16:51	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-030		
2010-09-28	16:56	KR	Bio sampling Day grab_C		100702-NEMO-GS-B02-030		
2010-09-28	17:03	KR	Bio sampling Day grab_C_1	X	100702-NEMO-GS-B02-030		
2010-09-28	17:10	KR	Transit to B03-031				
2010-09-28	17:35	KR	On Location B03-031		100702-NEMO-GS-B03-031		
2010-09-28	17:40	KR	Launch Camera Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:48	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-031		
2010-09-28	17:49	KR	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:55	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-031		
2010-09-28	17:56	KR	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-031		
2010-09-28	18:00	TW	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	18:04	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-031		
2010-09-28	18:05	TW	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	18:09	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-031		

2010-09-28	18:16	TW	Recover Camera cage				TW
2010-09-28	18:25	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-031		
2010-09-28	18:30	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-031		
2010-09-28	18:35	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-031		TW
2010-09-28	18:40	TW	Transit to B03-032				
2010-09-28	19:18	TW	On Location B03-032		100702-NEMO-GS-B03-032		
2010-09-28	19:20	TW	Launch Camera Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:25	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:26	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:30	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:30	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:34	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:34	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:38	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:38	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:42	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:46	TW	Recover Camera cage				TW
2010-09-28	19:54	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-032		
2010-09-28	19:59	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-032		
2010-09-28	20:07	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-032		TW
2010-09-28	20:08	TW	Transit to B03-033				
2010-09-28	20:32	TW	On Location B03-033		100702-NEMO-GS-B03-033		
2010-09-28	20:36	TW	Launch Camera Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:39	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:40	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:44	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:44	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:48	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:48	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:52	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:52	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:56	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-033		
2010-09-28	21:00	TW	Recover Camera cage				TW
2010-09-28	21:08	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-033		
2010-09-28	21:14	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-033		
2010-09-28	21:18	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-033		
2010-09-28	21:23	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-033		
2010-09-28	21:29	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-033		TW
2010-09-28	21:31	TW	Transit to B03-034				
2010-09-29	22:03	TW	On Location B03-034		100702-NEMO-GS-B03-034		
2010-09-29	22:09	TW	Launch Camera Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:14	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-034		

2010-09-29	22:15	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:20	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:20	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:27	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:27	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:34	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:34	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:41	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-034		
2010-09-29	20:45	TW	Recover Camera cage				TW
2010-09-29	23:05	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-034		
2010-09-29	23:11	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-034		
2010-09-29	23:18	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-034		
2010-09-29	23:25	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-034		
2010-09-29	23:30	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-034		TW
2010-09-29	23:31	TW	Transit to B03-035				
2010-09-29	23:32	TW	GAPS UP				
2010-09-29	23:49	TW	GAPS DOWN				
2010-09-29	23:49	TW	On Location B03-035		100702-NEMO-GS-B03-035		
2010-09-29	23:55	TW	Launch Camera Cage		100702-NEMO-GS-B03-035		
2010-09-29	23:58	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-035		
2010-09-29	23:58	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29			New Day				
2010-09-29	00:02	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:02	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:06	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:06	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:11	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:11	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:16	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:20	TW	Recover Camera cage				TW
2010-09-29	00:28	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-035		
2010-09-29	00:32	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-035		
2010-09-29	00:36	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-035		TW
2010-09-29	00:37	TW	Transit to B03-036				
2010-09-29	00:57	TW	On Location B03-036		100702-NEMO-GS-B03-036		
2010-09-29	01:00	TW	Launch Camera Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:05	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:05	TW	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:10	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:10	TW	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:14	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:18	TW	Lift Cage		100702-NEMO-GS-B03-036		

2010-09-29	01:32	TW	Recover Camera cage				
2010-09-29	01:32	TW	Breakdown Equipment			Object obstructing camer lens	
2010-09-29	02:35	KR	Launch Camera Cage				
2010-09-29	02:49	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-036		
2010-09-29	02:50	KR	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	02:56	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-036		
2010-09-29	02:57	KR	Lift Cage				
2010-09-29	03:01	KR	Photo 11 and 12 taken		100702-NEMO-GS-B03-036	12 Photos taken	
2010-09-29	03:05	KR	Recover Camera cage		100702-NEMO-GS-B03-036		KR
2010-09-29	03:15	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-036		
2010-09-29	03:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-036		
2010-09-29	03:28	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-036		
2010-09-29	03:36	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-036		
2010-09-29	03:43	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-036		
2010-09-29	03:48	KR	Transit to B03-038				
2010-09-29	04:39	KR	On Location B03-038		100702-NEMO-GS-B03-037		
2010-09-29	04:40	KR	Launch Camera Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:45	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-037		
2010-09-29	04:46	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:53	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-037		
2010-09-29	04:54	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:00	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	05:03	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:04	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	05:09	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:12	KR	Recover Camera cage				KR
2010-09-29	05:27	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-037		
2010-09-29	05:31	KR	Bio sampling Day grab_B		100702-NEMO-GS-B03-037		
2010-09-29	05:37	KR	Bio sampling Day grab_B_2		100702-NEMO-GS-B03-037		
2010-09-29	05:45	KR	Bio sampling Day grab_B_3	X	100702-NEMO-GS-B03-037		
2010-09-29	05:48	KR	Bio sampling Day grab_C		100702-NEMO-GS-B03-037		
2010-09-29	05:50	KR	Transit to B03-038				
2010-09-29	06:20	KR	On Location B03-038		100702-NEMO-GS-B03-038		
2010-09-29	06:21	KR	Launch Camera Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:29	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:30	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:33	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:34	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:38	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:39	KR	Lift Cage		100702-NEMO-GS-B03-038		

2010-09-29	06:44	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:45	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:52	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:55	KR	Recover Camera cage				KR
2010-09-29	06:59	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-038		
2010-09-29	07:11	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-038		
2010-09-29	07:19	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-038		
2010-09-29	07:26	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-038		
2010-09-29	07:30	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-038		
2010-09-29	07:35	KR	Transit to B03-039				
2010-09-29	07:50	KR	On Location B03-039		100702-NEMO-GS-B03-039		
2010-09-29	07:51	KR	Launch Camera Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:00	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:01	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:06	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:07	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:13	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:14	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:20	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:22	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:28	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:30	KR	Recover Camera cage		100702-NEMO-GS-B03-039		KR
2010-09-29	08:31	KR	No samples, Sabellaria reef found		100702-NEMO-GS-B03-039		
2010-09-29	08:55	KR	Launch Camera Cage		100702-NEMO-GS-B03-039		
2010-09-29	09:10	KR	Starting Transect-001 lines to inspect the reef		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:25	KR	Photo 1 and 2 taken, B03-039_001		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:32	KR	Photo 1 and 2 taken, B03-039_002		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:40	KR	Photo 1 and 2 taken, B03-039_003		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:47	KR	Photo 1 and 2 taken, B03-039_004		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:55	KR	Photo 1 and 2 taken, B03-039_005		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:14	TW	Photo 1 and 2 taken, B03-039_006		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:23	TW	Photo 1 and 2 taken, B03-039_007		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:30	TW	Photo 1 and 2 taken, B03-039_008		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:37	TW	Photo 1 and 2 taken, B03-039_009		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:43	TW	Photo 1 and 2 taken, B03-039_010		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:49	TW	Photo 1 and 2 taken, B03-039_011		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:56	TW	Photo 1 and 2 taken, B03-039_012		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:02	TW	Photo 1 and 2 taken, B03-039_013		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:09	TW	Photo 1 and 2 taken, B03-039_014		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:16	TW	Photo 1 and 2 taken, B03-039_015		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:24	TW	Photo 1 and 2 taken, B03-039_016		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:30	TW	Photo 1 and 2 taken, B03-039_017		100702-NEMO-GS-B03-039_Transect-001		

2010-09-29	11:37	TW	Photo 1 and 2 taken, B03-039_018		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:43	TW	Photo 1 and 2 taken, B03-039_019		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:49	TW	Photo 1 and 2 taken, B03-039_020		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:55	TW	Photo 1 and 2 taken, B03-039_021		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:04	TW	Photo 1 and 2 taken, B03-039_022		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:10	TW	Photo 1 and 2 taken, B03-039_023		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:16	TW	Photo 1 and 2 taken, B03-039_024		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:22	TW	Photo 1 and 2 taken, B03-039_025		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:29	TW	Photo 1 and 2 taken, B03-039_026		100702-NEMO-GS-B03-039_Transect-001		TW
2010-09-29	12:36	TW	Recover Camera cage				
2010-09-29	12:53	TW	Launch Camera Cage				
2010-09-29	12:54	TW	Starting Transect-002 lines to inspect the reef		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:04	TW	Photo 1 and 2 taken, B03-039-2_001		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:14	TW	Photo 3 and 4 taken, B03-039-2_002		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:21	TW	Photo 5 and 6 taken, B03-039-2_003		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:30	TW	Photo 7 and 8 taken, B03-039-2_004		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:35	TW	Photo 8 and 9 taken, B03-039-2_005		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:42	TW	Photo 9 and 10 taken, B03-039-2_006		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:52	TW	Photo 11 and 12 taken, B03-039_007		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:01	TW	Photo 13 and 14 taken, B03-039_008		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:09	TW	Photo 15 and 16 taken, B03-039_009		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:15	KR	Photo 17 and 18 taken, B03-039_010		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:23	KR	Photo 19 and 20 taken, B03-039_011		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:25	KR	Recover Camera Cage				KR
2010-09-29	14:30	KR	Transit to B03-040		100702-NEMO-GS-B03-040		
2010-09-29	15:10	KR	On Location B03-040		100702-NEMO-GS-B03-040		
2010-09-29	15:15	KR	Launch Camera Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:24	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-040	4 photos taken	
2010-09-29	15:25	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:28	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-040	3 photos taken	
2010-09-29	15:29	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:37	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-040	Possible reef found	
2010-09-29	15:38	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:41	FA	Photo 7 and 8 taken		100702-NEMO-GS-B03-040		
2010-09-29	15:42	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:48	FA	Photo 9 and 10 taken		100702-NEMO-GS-B03-040		
2010-09-29	15:49	FA	Lift cage		100702-NEMO-GS-B03-040		
2010-09-29	16:16	FA	Photo 11 and 12 taken		100702-NEMO-GS-B03-040		
2010-09-29	16:20	FA	Lift cage		100702-NEMO-GS-B03-040		
2010-09-29	16:29	FA	Photo 13 and 14 taken		100702-NEMO-GS-B03-040		
2010-09-29	16:31	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	16:38	FA	Photo 15 and 16 taken, B03-039_009		100702-NEMO-GS-B03-040		

2010-09-29	16:39	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	16:50	KR	Recover Camera cage				KR
2010-09-29	16:55	KR	No Samples, Reef found		100702-NEMO-GS-B03-040		
2010-09-29	17:08	KR	Transit to B03-041		100702-NEMO-GS-B03-040		
2010-09-29	17:55	KR	On Location B03-041		100702-NEMO-GS-B03-041		
2010-09-29	17:56	KR	Launch Camera Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:06	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:07	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:12	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:13	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:16	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:17	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:20	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:21	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:25	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:33	TW	Recover Camera cage				TW
2010-09-29	18:39	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-041		
2010-09-29	18:43	TW	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-041		
2010-09-29	18:47	TW	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-041		
2010-09-29	18:50	TW	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-041		
2010-09-29	18:54	TW	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-041		TW
2010-09-29	18:58	TW	Transit to B03-042				
2010-09-29	19:35	TW	On Location B03-042		100702-NEMO-GS-B03-042	Freshwater lens contaminated	
2010-09-29	19:38	TW	Launch Camera Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:47	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:48	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:50	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:51	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:54	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:54	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:58	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:58	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	20:03	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-042		
2010-09-29	20:08	TW	Recover Camera cage				TW
2010-09-29	20:15	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-042		
2010-09-29	20:18	TW	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-042		
2010-09-29	20:21	TW	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-042		
2010-09-29	20:26	TW	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-042		
2010-09-29	20:29	TW	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-042		TW
2010-09-29	20:31	TW	GAPS UP				
2010-09-29	20:35	TW	Transit to B03-043				

2010-09-29	21:03	TW	GAPS DOWN				
2010-09-29	21:05	TW	On Location B03-043				
2010-09-29	21:11	TW	Launch Camera Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:16	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:17	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:20	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:20	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:25	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:27	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:30	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:31	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:35	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:45	TW	Recover Camera cage				TW
2010-09-29	21:55	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-043		
2010-09-29	21:58	TW	Bio sampling Day grab_B		100702-NEMO-GS-B03-043		
2010-09-30			New Day				
2010-09-30	22:01	TW	Bio sampling Day grab_C		100702-NEMO-GS-B03-043		TW
2010-09-30	22:06	TW	Transit to B03-044				
2010-09-30	22:20	TW	On Location B03-044				
2010-09-30	22:45	TW	**Equipment breakdown**			**Freshwater lens broke when refilling**	
2010-09-30	23:15	TW	Launch Camera Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:24	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:24	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:30	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:31	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:36	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:36	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:42	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:43	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:48	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:55	TW	Recover Camera cage				KR
2010-09-30	00:04	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-044		
2010-09-30	00:07	TW	Bio sampling Day grab_B		100702-NEMO-GS-B03-044		
2010-09-30	00:11	TW	Bio sampling Day grab_C		100702-NEMO-GS-B03-044		KR
2010-09-30	00:13	TW	Transit to B03-045				
2010-09-30	00:32	TW	On Location B03-045		100702-NEMO-GS-B03-045		
2010-09-30	00:37	TW	Launch Camera Cage		100702-NEMO-GS-B03-045		
2010-09-30	00:42	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:43	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	00:47	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:47	TW	Lift Cage		100702-NEMO-GS-B03-045		

2010-09-30	00:53	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:54	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	01:00	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-045		
2010-09-30	01:01	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	01:09	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-045		
2010-09-30	01:17	TW	Recover Camera cage				KR
2010-09-30	01:19	TW	GAPS UP				
2010-09-30	01:22	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-045		
2010-09-30	01:26	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-045		
2010-09-30	01:29	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-045		
2010-09-30	01:32	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-045		
2010-09-30	01:35	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-045		KR
2010-09-30	01:38	TW	Transit to B03-047				
2010-09-30	02:40	KR	On Location B03-047		100702-NEMO-GS-B03-047		
2010-09-30	02:43	KR	Launch Camera Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:48	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-047		
2010-09-30	02:49	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:54	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-047		
2010-09-30	02:55	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:00	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	03:05	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:06	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	03:10	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:12	KR	Recover Camera cage				KR
2010-09-30	03:21	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-047		
2010-09-30	03:23	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-047		
2010-09-30	03:30	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-047		KR
2010-09-30							
2010-09-30	03:31	KR	Transit to B03-047		100702-NEMO-GS-B03-048		
2010-09-30	03:40	KR	On Location B03-047		100702-NEMO-GS-B03-048		
2010-09-30	03:45	KR	Launch Camera Cage		100702-NEMO-GS-B03-048		
2010-09-30	03:53	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-048		
2010-09-30	03:54	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	03:58	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-048		
2010-09-30	03:59	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:03	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:04	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:08	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:09	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:15	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:16	KR	Recover Camera cage				KR

2010-09-30	04:20	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-048		
2010-09-30	04:24	KR	Bio sampling Day grab_A_2	X	100702-NEMO-GS-B03-048		
2010-09-30	04:28	KR	Bio sampling Day grab_B		100702-NEMO-GS-B03-048		
2010-09-30	04:34	KR	Bio sampling Day grab_B_2		100702-NEMO-GS-B03-048		
2010-09-30	04:37	KR	Bio sampling Day grab_B_3		100702-NEMO-GS-B03-048		KR
2010-09-30							
2010-09-30	04:45	KR	Transit to B03-046				
2010-09-30	05:00	KR	On Location B03-046		100702-NEMO-GS-B03-046		
2010-09-30	05:02	KR	Launch Camera Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:07	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:08	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:09	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:10	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:15	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:16	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:19	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:20	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:23	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:25	KR	Recover Camera cage				KR
2010-09-30	05:35	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-046		
2010-09-30	05:40	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-046		
2010-09-30	05:45	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-046		KR
2010-09-30	05:45	TS	Transit to trawlsite 005				
2010-09-30	07:00	TS	at location trawlsite 005		100702-NEMO-TRAWL-B03-005	Could not trawl due to rocky seafloor	
2010-09-30	07:25	TS	Transit to trawlsite 004				
2010-09-30	08:35	TS	at location trawlsite 004				
2010-09-30	08:48	KR	Trawl_Start_300m		100702-NEMO-TRAWL-B03-004		
2010-09-30	08:57	KR	Trawl_Stop_300m		100702-NEMO-TRAWL-B03-004		
2010-09-30	09:29	KR	Trawl_Start_600m		100702-NEMO-TRAWL-B03-004		
2010-09-30	09:43	KR	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:17	TW	Trawl_Start_600m_2		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:31	TW	Trawl_Stop_600m_2		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:36	TW	Transit to trawlsite 003				
2010-09-30	11:05	TW	at location trawlsite 003		100702-NEMO-TRAWL-B03-003		
2010-09-30	11:08	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-003	Not returning as destroyed trawling net	
2010-09-30	11:22	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-003		
2010-09-30	11:25	TS	Trawl on deck				
2010-09-30	11:25	TS	Transit to B03-40 for Grab and photo transect.				
2010-09-30	12:30	TW	On Location B03-040_Transect		100702-NEMO-GS-B03-040_Transect		
2010-09-30	12:59	TW	GAPS DOWN		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:06	TW	Launch Camera Cage		100702-NEMO-GS-B03-040_Transect		

2010-09-30	13:09	TW	Photo 1 and 2 taken B03-040_001		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:10	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:15	TW	Photo 3 and 4 taken B03-040_002		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:16	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:21	TW	Photo 5 and 6 taken B03-040_003		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:22	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:27	TW	Photo 7 and 8 taken B03-040_004		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:28	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:33	TW	Photo 9 and 10 taken B03-040_005		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:34	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:38	TW	Photo 11 and 12 taken B03-040_006		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:39	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:45	TW	Photo 13 and 14 taken B03-040_007		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:46	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:51	TW	Photo 15 and 16 taken B03-040_008		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:53	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:01	KR	Photo 17 and 18 taken B03-040_009		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:02	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:08	KR	Photo 19 and 20 taken B03-040_010		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:09	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:16	KR	Photo 21 and 22 taken B03-040_011		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:17	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		KR
2010-09-30	14:18	KR	Transectline 1 done		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:30	KR	Start of Transectline 2		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:36	KR	Photo 1 and 2 taken B03-040_001		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:37	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:54	KR	Photo 3 and 4 taken B03-040_002		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:55	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:57	KR	Photo 5 and 6 taken B03-040_003		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:58	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:05	KR	Photo 7 and 8 taken B03-040_004		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:06	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:12	KR	Photo 9 and 10 taken B03-040_005		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:13	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:17	KR	Photo 11 and 12 taken B03-040_006		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:18	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:24	KR	Photo 13 and 14 taken B03-040_007		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:25	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:26	KR	Recover Camera cage		100702-NEMO-GS-B03-040_Transect		KR
2010-09-30	16:05	KR	Grabsampler_A		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:12	KR	Grabsampler_B		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:14	KR	Grabsampler_C		100702-NEMO-GS-B03-040_Transect		

2010-09-30	16:17	KR	Grabsampler_D		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:20	KR	Grabsampler_E		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:25	KR	Transit to B03_039		100702-NEMO-GS-B03-040_Transect		
2010-09-30	17:10	KR	Grabsampler_A		100702-NEMO-GS-B03-039		
2010-09-30	17:12	KR	Grabsampler_B		100702-NEMO-GS-B03-039		
2010-09-30	17:15	KR	Grabsampler_C		100702-NEMO-GS-B03-039	Sabellaria reef in the graber	
2010-09-30	17:26	KR	Transit to Trawl_002				
2010-09-30	18:48	TW	On location Trawl_002		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:01	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:14	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:23	TW	Transit to Trawl_001				
2010-09-30	19:55	TW	On location Trawl_001		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:03	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:18	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:27	TW	Transit to Zeebruggen				

100702-NEMO-GS-B01																				
Photo ID	B01-001	B01-002	B01-003	B01-004	B01-005	B01-006	B01-007	B01-008	B01-009	B01-010	B01-011	B01-012	B01-013	B01-014	B01-015	B01-016	B01-017	B01-018	B01-019	B01-020
Clay	x?		x?	x?	x?															
Sand	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Gravel										x			x		x					
Pebbles and Cobbles											x	x		x	x					
Large Shell fragments						<5%	<5%	<5%			<5%			<5%						
Small Shell fragments						<5%	<5%	<5%	<5%	<5%			35%	<5%						
Comments	Zero visibility.	Poor visibility. Sand bottom.	Zero visibility.	Zero visibility.	Zero visibility.	Holes in the bottom, maybe from *Ensis spp.*	Fine sand with shell fragments.	Coarse sand and shell gravel.	Fine sand with shell fragments.	Fine sand, some smal cobbles and shell fragments.	Fine sand, some smal cobbles and shell fragments.	Sand with a few cobbles.	Fine sand with shell fragments.		Sand, gravel and two bigger cobbles.	Fine sand.	Poor visibility. Fine sand.	No photos taken.	No photos taken	No photos taken
EUNIS habitat classification	A5.24	A5.24	A5.33	A5.24	A5.23	A5.25	A5.25	A5.23	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.34	A5.33	A5.33
Comments EUNIS code																				

SPECIES /m²

CNIDARIA																				
Hydrozoa											P		P		P					
CRUSTACEA																				
Paguridae						3.2	16.1	1.6	1.6				1.6							
Caridea							4.8													
MOLLUSCA-BIVALVIA																				
Ensis spp.							6.5													
ECHINODERMATA																				
Asteroidea							3.2					1.6			1.6					
Asterias rubens		3.2				3.2	3.2										1.6			
Ophiura spp.						6.5	8.1													
Ophiura albida						9.7					1.6									
Ophiura ophiura							1.6		1.6											
VARIA																				
Pleuronectes platessa											1.6									
Callionymus sp.												4.8	1.6	180.6		1.6				

100702-NEMO-GS-B02										
Photo ID	B02-021	B02-022	B02-023	B02-024	B02-025	B02-026	B02-027	B02-028	B02-029	B02-030
Clay										
Sand	x	x	x	x	x	x	x	x	x	x
Gravel								x		x
Pebbles and Cobbles	x	x			x	x				
Boulders										
Bedrock										
Large Shell fragments								<5%	<5%	5%
Small Shell fragments	<5%						<5%	<5%	<5%	5%
Comments		Occasional cobbles.			Occasional cobbles.	Occasional cobbles.				
EUNIS habitat classification	A5.25	A5.25	A5.233	A5.233	A5.233	A5.25	A5.233	A5.25	A5.25	A5.25
Comments EUNIS code			Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233	Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233	Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233					

SPECIES /m²

CNIDARIA										
Hydrozoa		P				P			P	
Actiniaria						6.5			4.8	
CRUSTACEA										
Paguridae	1.6	1.6		4.8	1.6	4.8		1.6		
Portunidae										1.6
ECHINODERMATA										
Asterias rubens	1.6				1.6	1.6				
Ophiura albida					1.6					
Ophiura spp.		1.6								
Psammechinus miliaris						1.6				
VARIA										
Alcyonidium diaphanum						P				
Callionymus spp.					9.7					
Flustra foliacea						P				

100702-NEMO-GS-B03																				
Photo ID	B03-031	B03-032	B03-033	B03-034	B03-035	B03-036	B03-037	B03-038	B03-039	B03-040	B03-041	B03-042	B03-043	B03-044	B03-045	B03-046	B03-047	B03-048	B03-049	B03-050
Clay							x													
Sand	x	x	x	x	x	x	x	x	x	x	x?	x	x	x?	x?	x?	x?	x?		
Gravel	x	x						x	x	x	x		x							
Pebbles and Cobbles			x	x		x		x			x									
Large Shell fragments	15%							20%												
Small Shell fragments	15%							10%					30%							
Comments		Shell gravel. No animalia visible.	Cobbles with serpularidae tubes.	Poor visibility. Cobbles with Serpularidae tubes.	No animalia visible.	Burried cobbles. No animalia visible.	Poor visibility.	Poor visibility.	Poor visibility, tubes of possible Sabellaria is visible. Shell gravel.	Poor visibility, tubes of possible Sabellaria is visible. Shell gravel.	Poor visibility. Cobbles with Serpulidae worms.	No animalia visible.	Shell gravel. No animalia visible.	Zero visibility.	Zero visibility.	Zero visibility.	Zero visibility.	Zero visibility.	No photos taken.	No photos taken.
EUNIS habitat classification	A5.25	A5.145	A5.141	A5.141	A5.231	A5.25	A5.25	A5.25	A5.611	A5.611	A5.141	A5.25	A5.25	A5.23	A5.43	A5.231	A5.43	A5.23	A5.23	A5.24
Comments EUNIS code									Annex 1 area- Sabellaria	Annex 1 area- Sabellaria										

SPECIES /m²

CNIDARIA																				
Actiniaria			4.8					1.6												
Hydrozoa								P												
CRUSTACEA																				
Caridea									1.6											
Ebalia spp.			1.6																	
Porcellinidae									1.6											
Portunidae							1.6		1.6											
ECHINODERMATA																				
Asterias rubens			1.6						1.6											
Asteroidea											1.6									
Ophiura albida			1.6																	
Psammechinus miliaris			8.1																	
MOLLUSCA-BIVALVIA																				
Aequipecten opercularis			1.6																	
MOLLUSCA - GASTROPODA																				
Buccinum undatum			1.6																	
ANNELIDA-POLYCHAETA																				
Tubes of *Sabellaria spp.* (SACFOR)									S	A										
VARIA																				
Bryozoa								P												

100702-NEMO-GS-B01-001			
Easting:	497417	Depth:	11.8
Northing:	5687890		
SPECIES /m²	A	B	C
CRUSTACEA			
Crangon crangon		30	
Diastylis rugosa		10	10
Liocarcinus holsatus	20		
weight (g/m²):	63.9840	43.9450	0.2860
ECHINODERMATA			
Asterias rubens	10		
Ophiura ophiura		10	
weight (g/m²):	47.1240	8.6530	
MOLLUSCA-BIVALVIA			
Abra alba			10
Ensis magnus	710		1190
Ensis spp.		700	
weight (g/m²):	45.9650	42.5250	75.4800
POLYCHAETA			
Caulleriella killariensis	80	10	200
Heteromastus filiformis	10	10	
Nephtys hombergii	30	20	10
Owenia fusiformis	1070	240	400
Spiophanes bombyx	10	10	10
weight (g/m²):	12.9890	4.2530	2.3960

100702-NEMO-GS-B01-003			
Easting:	493466	Depth:	16.4
Northing:	5688414		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria		160	
weight (g/m²):		0.6960	
CRUSTACEA			
Diastylis spp.	20	10	
weight (g/m²):	0.2750	0.2250	
ECHINODERMATA			
Ophiura ophiura	20	20	
Ophiura sarsii			20
weight (g/m²):	15.5380	19.1930	13.7970
MOLLUSCA-BIVALVIA			
Abra alba			10
Abra nitida		20	
Ensis magnus	160	280	210
Ensis spp.		10	
Kurtiella bidentata		10	
Tellimya ferruginosa			10
weight (g/m²):	40.6380	69.1740	32.5760
POLYCHAETA			
Heteromastus filiformis	140		
Nephtys hombergii	20	50	10
Notomastus latericeus	10		
Owenia fusiformis	2560	15200	10120
weight (g/m²):	2.9574	28.7190	44.7210
VARIA			
Porifera spp.			P
weight (g/m²):			0.0500

100702-NEMO-GS-B01-002			
Easting:	495583	Depth:	12.8
Northing:	5688054		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	10		
weight (g/m²):	19.1300		
CRUSTACEA			
Crangon crangon			10
Liocarcinus holsatus	10		
weight (g/m²):	60.9620		9.4860
ECHINODERMATA			
Asterias rubens	30		
Ophiura spp.	50		10
Ophiura ophiura	10	60	20
Ophiura sarsii	10		
weight (g/m²):	92.6650	47.1500	20.3670
MOLLUSCA-BIVALVIA			
Abra alba	80		
Abra spp.	10		10
Ensis magnus	160	30	0
Ensis spp.	110		190
Tellinidae		20	
weight (g/m²):	37.1610	6.9340	22.1390
POLYCHAETA			
Capitellidae			10
Caulleriella killariensis			20
Eunereis longissima	20		
Heteromastus filiformis		10	30
Lanice conchilega	50		
Nephtys hombergii	10		
Owenia fusiformis	27850	750	720
Spiophanes bombyx			10
weight (g/m²):	27.4620	4.9320	4.9040
VARIA			
Solea solea	10		
weight (g/m²):	78.7220		

100702-NEMO-GS-B01-004			
Easting:	492663	Depth:	16.5
Northing:	5688496		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	10		
Anthozoa		230	940
weight (g/m²):	18.4520	0.6680	6.2980
CRUSTACEA			
Liocarcinus holsatus			10
weight (g/m²):			0.7910
ECHINODERMATA			
Ophiura ophiura	20	20	
weight (g/m²):	19.133	21.155	
MOLLUSCA-BIVALVIA			
Bivalvia	10		
Kurtiella bidentata		40	
Mya spp.		60	
Tellimya ferruginosa	10	930	
weight (g/m²):	-	0.1410	2.8480
POLYCHAETA			
Alitta succinea			10
Capitella capitata-complex	80	20	
Caulleriella killariensis		20	
Eunereis longissima			60
Glycera convoluta		10	10
Heteromastus filiformis	20		
Lagis koreni		10	10
Notomastus latericeus			50
Owenia fusiformis	610	1200	31850
Pholoe spp.			20
Sthenelais boa			10
weight (g/m²):	2.519	5.264	106.569
VARIA			
Priapulida			60
weight (g/m²):			175.9000

100702-NEMO-GS-B01-005			
Easting:	490394	Depth:	18.9
Northing:	5689065		
SPECIES /m²	A	B	C
CNIDARIA			
Campanulinidae spp.		P	
Hydrozoa		P	
weight (g/m²):		0.4590	
CRUSTACEA			
Crangon crangon	10	0	10
Pariambus typicus	0	10	0
weight (g/m²):	4.6520	0.0040	4.5440
ECHINODERMATA			
Echinocardium cordatum		20	50
Ophiura albida	180	30	10
Ophiura ophiura	10		10
Ophiura spp.	10	10	
weight (g/m²):	56.2870	161.6630	444.8600
MOLLUSCA-BIVALVIA			
Abra spp.		30	
Bivalvia	20	10	
Ensis spp.	10		
Kurtiella bidentata		20	10
weight (g/m²):	6.1700	0.4000	0.2000
MOLLUSCA-GASTROPODA			
Buccinum undatum			10
Gastropoda		20	
weight (g/m²):		0.1000	0.0500
POLYCHAETA			
Capitella capitata-complex		10	
Cauleriella alata	50		
Caulleriella killariensis			10
Chaetozone setosa	10	10	10
Cirratulidae spp.	30	40	30
Eumida bahusiensis	20		
Eunereis longissima	40	20	20
Glycera convoluta		10	
Heteromastus filiformis	40	20	50
Lagis koreni	20	40	10
Lanice conchilega	210	150	40
Mediomastus fragilis	10	10	10
Notomastus latericeus	10	60	30
Owenia fusiformis	2130	3200	940
Pholoe baltica		10	10
Phyllodoce citrina		10	
Phyllodoce mucosa	60	20	20
Scoloplos armiger	20	10	20
Spio filicornis	0	10	10
Spiophanes bombyx	110	170	20
Sthenelais boa	20		
weight (g/m²):	22.6580	17.8030	5.7240
VARIA			
Nemertea	20	20	10
weight (g/m²):	0.1780	0.1450	0.0280

100702-NEMO-GS-B01-006			
Easting:	487526	Depth:	21.5
Northing:	5689606		
SPECIES /m²	A	B	C
CNIDARIA			
Hydrozoa	P		
weight (g/m²):	-		
CRUSTACEA			
Abludomelita obtusata		10	
Aora gracilis	10		
Brachyura	10		
Gammaridae	40	40	
Leucothoe incisa			10
Liocarcinus pusillus	10		
Pariambus typicus		20	
weight (g/m²):	0.0870	21.9970	0.1480
ECHINODERMATA			
Asterias rubens	10	20	
Echinocardium cordatum	10		
Ophiocten affinis	10		
Ophiura albida	20	40	
Ophiura ophiura	10	20	20
Ophiuroidea spp.	10		
weight (g/m²):	479.3360	444.3000	24.6090
MOLLUSCA-BIVALVIA			
Bivalvia	10	10	
Ensis magnus	380		10
Ensis spp.		680	550
Spisula elliptica			10
weight (g/m²):	720.9170	580.2400	446.2870
MOLLUSCA-GASTROPODA			
Euspira pulchella	10		
Gastropoda		10	
weight (g/m²):	0.0430	0.0090	
POLYCHAETA			
Capitella capitata-complex	10	50	40
Chaetozone setosa	10		
Eteone spp.		10	10
Eumida bahusiensis	10	40	
Eumida sanguinea		20	
Eumida spp.	10		
Eunereis longissima		20	
Heteromastus filiformis			10
Lagis koreni			30
Lanice conchilega	1060	920	900
Nephtys cirrosa		10	
Notomastus latericeus	10	10	
Owenia fusiformis	170	250	130
Phyllodoce groenlandica		10	
Phyllodoce mucosa	70		40
Phyllodoce spp.	20	10	
Pseudopolydora pulchra	30	30	20
Scoloplos armiger			20
Spio filicornis		20	10
Spiophanes bombyx	410	620	630
weight (g/m²):	26.3240	28.3340	24.0750
VARIA			
Bryozoa	P		
Nemertea		10	60
Sipuncula		10	
weight (g/m²):	0.0240	0.2170	1.4660

100702-NEMO-GS-B01-007			
Easting:	483541	Depth:	26.0
Northing:	5688555		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	180		
weight (g/m²):	3.2910		
CRUSTACEA			
Liocarcinus holsatus		10	
Pagurus bernhardus		10	10
Pisidia longicornis		20	
Processa spp.			10
Thia scutellata		10	10
weight (g/m²):		71.8620	6.3930
ECHINODERMATA			
Echinocardium cordatum	40	30	10
Echinocyamus pusillus		10	
Ophiocten affinis	10		
Ophiura albida	40		
Ophiura ophiura	30		
Ophiura sarsii	10		
weight (g/m²):	51.0630	191.3240	124.0000
MOLLUSCA-BIVALVIA			
Abra prismatica	30		
Bivalvia		10	
Mactridae		10	
weight (g/m²):	2.5800	0.4040	
MOLLUSCA-GASTROPODA			
Chauvetia brunnea		10	
Nassarius reticulatus	30		
weight (g/m²):	78.2000	0.0950	
POLYCHAETA			
Aonides paucibranchiata			10
Capitella capitata-complex		10	
Cauleriella alata	10		
Eumida bahusiensis	80		
Eumida spp.	10		
Eunereis longissima	10		
Heteromastus filiformis		10	
Lagis koreni	80	10	
Lanice conchilega	1160		
Nephtys cirrosa		20	20
Notomastus latericeus		30	
Owenia fusiformis	760	20	
Pseudopolydora pulchra	10		
Scoloplos armiger	10		10
Spio decoratus		10	
Spiophanes bombyx	100		10
weight (g/m²):	3.7171	0.6276	0.4397
VARIA			
Ascidiacea	P		10
Electra pilosa		P	
Nematoda		20	
Sipuncula		10	
Sipunculidea	260		
weight (g/m²):	1.1600	0.1980	-

100702-NEMO-GS-B01-008			
Easting:	479218	Depth:	17.0
Northing:	5688336		
SPECIES /m²	A	B	C
CRUSTACEA			
Copepoda		30	
Crustacea	10	20	
Urothoe spp.		40	
weight (g/m²):	0.0060	0.3420	
ECHINODERMATA			
Echinocyamus pusillus		10	20
weight (g/m²):		0.0500	0.1200
MOLLUSCA-BIVALVIA			
Glycymeris glycymeris			20
Mytilidae			30
Tellina pygmaea			20
Tellinidae	30		
weight (g/m²):	1.0420		0.1800
POLYCHAETA			
Eumida bahusiensis	10		
Glycera lapidum	20	10	
Hesionura elongata	10	180	40
Nephtys spp.		10	
Pisione remota	10	10	
Polygordius appendiculatus	10	20	10
Saccocirrus papillocercus		20	
Sphaerosyllis bulbosa		110	20
weight (g/m²):	0.0920	0.3160	0.0020
VARIA			
Nematoda	150	360	
Nemertea	10		
weight (g/m²):	0.0540	0.0180	

100702-NEMO-GS-B01-009			
Easting:	468907	Depth:	29.0
Northing:	5689330		
SPECIES /m²	A	B	C
CNIDARIA			
Diphasia		P	P
weight (g/m²):		0.0080	0.0780
CRUSTACEA			
Bathyporeia elegans	10		
Bathyporeia guilliamsoniana		10	
Diastylis rugosa	10		
Diastylis spp.			10
Oedicerotidae spp.			10
Thia scutellata	10		20
weight (g/m²):	0.3130	0.0360	0.9860
ECHINODERMATA			
Asterias rubens			
Echinocardium cordatum		10	10
Ophiura spp.	10		
weight (g/m²):	87.7850	81.7130	49.3240
POLYCHAETA			
Nephtys cirrosa	20	20	40
Nephtys spp.	10	10	
Spiophanes bombyx	20	10	40
weight (g/m²):	1.3910	0.6210	2.7760
VARIA			
Echiura			10
Nemertea			20
weight (g/m²):			0.2570

100702-NEMO-GS-B01-010			
Easting:	467066	Depth:	29.0
Northing:	5690950		
SPECIES /m²	A	B	C
CNIDARIA			
Tubularia spp.	P		
weight (g/m²):	0.3250		
CRUSTACEA			
Bathyporeia spp.	10		10
Crustacea			10
Leucothoe spp.		10	
Mysidae		10	
Oedicerotidae	10	10	10
Processa spp.	20		
weight (g/m²):	1.3580	0.1760	0.0430
ECHINODERMATA			
Ophiurae			10
Spatangoida			10
weight (g/m²):			0.2340
POLYCHAETA			
Nephtys cirrosa	10	30	
Nephtys spp.			10
Spio armata			10
weight (g/m²):	1.8650	3.4720	0.5190

100702-NEMO-GS-B01-011			
Easting:	464768	Depth:	27.0
Northing:	5690840		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia guilliamsoniana			10
Bathyporeia spp.	20		
Diastylis spp.			10
Processa spp.			10
Urothoe brevicornis			50
Urothoe spp.	190	210	
weight (g/m²):	3.0260	1.2130	2.0560
ECHINODERMATA			
Echinocardium cordatum	50	70	
Echinocardium flavescens			60
Ophiocten affinis	60		
Ophiura albida		30	
Ophiura spp.			10
weight (g/m²):	10.5700	34.2320	23.5050
POLYCHAETA			
Nephtys cirrosa	20	70	90
Spiophanes bombyx		10	10
weight (g/m²):	0.7440	5.5420	5.7650

100702-NEMO-GS-B01-012			
Easting:	461179	Depth:	34.5
Northing:	5689687		
SPECIES /m²	A	B	C Ins. Samp. Vol.
ECHINODERMATA			
Echinocyamus pusillus	780		
Ophiuroidea	30		
Psammechinus miliaris	10		
weight (g/m²):	4.0390		
MOLLUSCA-BIVALVIA			
Arca tetragona	20		
weight (g/m²):	0.3140		
POLYCHAETA			
Aonides paucibranchiata	20		
Glycera lapidum	10		
Glycera spp.	20		
Lagis koreni	10		
Owenia fusiformis	10		
Spio filicornis	10		
weight (g/m²):	0.8970		

100702-NEMO-GS-B01-013			
Easting:	457427	Depth:	28.0
Northing:	5688051		
SPECIES /m²	A	B	C
CRUSTACEA			
Thia scutellata			10
weight (g/m²):			0.1770
ECHINODERMATA			
Echinocyamus pusillus	10		20
weight (g/m²):	0.0070		0.0430
MOLLUSCA-BIVALVIA			
Mytilus spp.		10	
Spisula elliptica			10
weight (g/m²):		0.0160	0.3280
POLYCHAETA			
Glycera lapidum		30	10
Hesionura elongata		10	10
Nephtys cirrosa			10
Phyllodoce citrina			10
Pisione remota			20
Polygordius appendiculatus		10	
weight (g/m²):		0.0150	2.0590
VARIA			
Echiura			10
weight (g/m²):			0.0060

100702-NEMO-GS-B01-014			
Easting:	457609	Depth:	33.0
Northing:	5688048		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia guilliamsoniana		10	
Liocarcinus pusillus		10	
Thia scutellata			10
Urothoe brevicornis		10	
Urothoe spp.	40		
weight (g/m²):	0.4090	0.5860	1.9330
ECHINODERMATA			
Echinocardium spp.	30		
Ophiocten affinis		10	
Ophiura spp.	10		
weight (g/m²):	3.4440	0.0750	
MOLLUSCA-BIVALVIA			
Spisula elliptica			10
weight (g/m²):			0.1780
POLYCHAETA			
Nephtys cirrosa	70	70	
Spio armata	10	10	10
Spio filicornis			10
Spiophanes bombyx			10
weight (g/m²):	4.3390	3.0410	2.4600
VARIA			
Echiichthys vipera			10
Gobiidae			10
Pomatoschistus spp.		10	
weight (g/m²):		2.4060	135.6140

100702-NEMO-GS-B01-015			
Easting:	454992	Depth:	38.5
Northing:	5687268		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea			20
Gastrosaccus spinifer		50	
Processa spp.		20	
Urothoe brevicornis	10		10
Urothoe spp.	10		10
weight (g/m²):	0.0860	2.0710	0.5340
ECHINODERMATA			
Echinocyamus pusillus	20	10	60
weight (g/m²):	0.1140	0.0660	0.0840
MOLLUSCA-BIVALVIA			
Spisula elliptica	10	10	
Tellina pygmaea			10
Tellinidae			
weight (g/m²):	0.1970	0.0120	0.1180
POLYCHAETA			
Glycera lapidum			10
Hesionura elongata	10		
Nephtys cirrosa	10	10	30
Nephtys spp.			10
Spio armata			30
weight (g/m²):	0.1970	0.5010	2.0630

100702-NEMO-GS-B01-016			
Easting:	473336	Depth:	23.4
Northing:	5688994		
SPECIES /m²	A	B	C
CRUSTACEA			
Paguridae			10
Thia scutellata	10		
weight (g/m²):	0.1730		0.0990
ECHINODERMATA			
Echinocardium cordatum		10	
Ophiura albida	10		10
weight (g/m²):	0.4280	61.8420	0.2140
MOLLUSCA-BIVALVIA			
Spisula elliptica		10	
weight (g/m²):		12.8800	
MOLLUSCA-GASTROPODA			
Nassarius reticulatus	10		
weight (g/m²):	28.2920		
POLYCHAETA			
Nephtys cirrosa	100	130	140
Spiophanes bombyx	20		20
weight (g/m²):	4.5870	7.3800	5.6840

100702-NEMO-GS-B01-017			
Easting:	485843	Depth:	22.4
Northing:	5689248		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	20		
Rhizorhagium roseum			
weight (g/m²):	12.9130	1.2320	
CRUSTACEA			
Ampelisca spp.			10
Autonoe longipes			20
Bodotria scorpioides			10
Dendrobranchiata spp.	10		
Gammaridea			20
Gammarus spp.		10	
Haustoriidae			10
Leucothoe incisa			10
Liocarcinus marmoreus		10	
Paguridae		10	
Pagurus bernhardus		10	20
Processa canaliculata			10
Semibalanus balanoides		20	
Stenothoe monoculoides		10	
Thia scutellata	10		
weight (g/m²):	1.9880	64.2500	0.9400
ECHINODERMATA			
Echinocardium cordatum	30	10	30
Ophiura albida	10		10
Ophiuroidea			10
weight (g/m²):	445.2840	54.8000	373.7600
MOLLUSCA-BIVALVIA			
Abra spp.			10
Bivalvia	10	10	
Ensis magnus		10	
Spisula elliptica	10		
Tellina fabula		10	
Tellina pygmaea			10
weight (g/m²):	0.6330	6.6500	0.4680
MOLLUSCA-GASTROPODA			
Nassarius reticulatus	10		
weight (g/m²):	14.1530		
POLYCHAETA			
Chaetozone setosa	30	10	30
Dipolydora flava		10	
Eteone spp.	10		20
Eumida bahusiensis	10		60
Eunereis longissima	0		10
Lanice conchilega	210	70	190
Magelona johnstoni	40	10	60
Nephtys assimilis			10
Nephtys cirrosa	30		
Nephtys hombergii	10		
Nephtys spp.	10		10
Owenia fusiformis	10	10	600
Pseudopolydora pulchra			10
Scoloplos armiger	20	10	10
Spio filicornis	30		20
Spiophanes bombyx	100	20	160
weight (g/m²):	8.4480	5.1584	32.1260
VARIA			
Pomatoschistus minutus			10
weight (g/m²):			1.2280

100702-NEMO-GS-B01-018			
Easting:	501049	Depth:	10.0
Northing:	5687734		
SPECIES /m²	A	B	C
CNIDARIA			
Diphasia spp.	P		
Nemertesia sp.	P		
Sertulariidae			P
weight (g/m²):	0.0180		0.0500
CRUSTACEA			
Crangon allmanni		10	
Diastylis glabra		10	
weight (g/m²):		0.3860	
ECHINODERMATA			
Holothuroidea	10		
Ophiura ophiura		10	
weight (g/m²):	0.6830	0.4100	
MOLLUSCA-BIVALVIA			
Abra tenuis	310		
Ensis magnus		10	10
Macoma balthica		600	370
weight (g/m²):	4.5090	10.9500	8.9260
POLYCHAETA			
Caulleriella killariensis	610	480	180
Heteromastus filiformis			10
Nephtys hombergii		10	
Notomastus latericeus	290	320	
Owenia fusiformis	30	230	40
weight (g/m²):	1.2260	8.0630	0.5810
VARIA			
Nematoda	10		
weight (g/m²):	-		

100702-NEMO-GS-B01-019			
Easting:	503201	Depth:	8.6
Northing:	5687622		
SPECIES /m²	A	B	C
CNIDARIA			
Anthozoa		20	
Hydrozoa	P		
weight (g/m²):	0.1200	0.3040	
CRUSTACEA			
Crangon crangon		20	
Diastylis spp.			30
Pisidia longicornis	10		
weight (g/m²):	0.6920	0.1970	0.2000
MOLLUSCA-BIVALVIA			
Ensis magnus		10	
Macoma balthica	20	110	60
weight (g/m²):	12.5250	6.5960	55.9780
POLYCHAETA			
Caulleriella killariensis		150	230
Cirratulidae		10	
Lagis koreni		10	
Nephtys hombergii		30	
Nephtys spp.			10
Notomastus latericeus			20
Owenia fusiformis	140	5230	220
weight (g/m²):	3.4580	90.1210	5.0410

100702-NEMO-GS-B01-020			
Easting:	506189	Depth:	8.0
Northing:	5687053		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria		10	
Anthozoa	20		
Hydrozoa			P
Obelia spp.	P		
Tubularia indivisa	P		
weight (g/m²):	15.6200	29.8160	1.9600
CRUSTACEA			
Autonoe longipes			10
Carcinus maenas	10		
Crangon crangon	10		
Diastylis spp.	10		
Gammaridae			10
Gammarus spp.	10		
Idotea linearis	10		
Pisidia longicornis			40
weight (g/m²):	9.8500		10.6730
ECHINODERMATA			
Asterias rubens	80		
Ophiura ophiura	10		10
weight (g/m²):	13.3980		7.6940
MOLLUSCA-BIVALVIA			
Abra nitida	20		
Abra prismatica	0		660
Ensis magnus	180	150	
Macoma balthica	770	270	
weight (g/m²):	46.7800	29.9810	80.9830
POLYCHAETA			
Alitta succinea	10		
Caulleriella killariensis	30	10	40
Cirratulidae spp.	30		30
Eunereis longissima	20	10	20
Heteromastus filiformis	80		
Nephtys hombergii		10	
Notomastus latericeus	10	40	260
Owenia fusiformis	5260	140	50
Polydora cornuta	170		
Spiophanes bombyx			10
weight (g/m²):	50.5070	9.8080	10.7130

100702-NEMO-GS-B02-021			
Easting:	455282	Depth:	42.0
Northing:	5687273		
SPECIES /m²	A	B Ins. Samp. Vol.	C Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia guilliamsoniana	70		
Bathyporeia spp.	10		
Bathyporeia tenuipes			
Crangon allmanni	10		
Pinnotheres pisum	10		
Thia scutellata	30		
weight (g/m²):	3.9780		
ECHINODERMATA			
Echinocardium spp.	20		
Echinocyamus pusillus	70		
Ophiura spp.	10		
weight (g/m²):	10.2390		
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		
weight (g/m²):	6.7670		
POLYCHAETA			
Nephtys cirrosa	10		
Ophelia borealis	10		
Spio armata	10		
weight (g/m²):	2.2750		

100702-NEMO-GS-B02-022			
Easting:	454014.11	Depth:	36.4
Northing:	5686798.88		
SPECIES /m²	A	B	C Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia elegans	20		
Urothoe brevicornis	40		
weight (g/m²):	0.867		
ECHINODERMATA			
Echinocardium cordatum	10		
Ophiura spp.	20		
weight (g/m²):	4.788		
MOLLUSCA-BIVALVIA			
Ensis spp.			
weight (g/m²):	0.208		
POLYCHAETA			
Nephtys cirrosa	30		
Spiophanes bombyx	10		
weight (g/m²):	0.656		

100702-NEMO-GS-B02-023			
Easting:	451605	Depth:	38.0
Northing:	5685778		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia elegans			
Bathyporeia guilliamsoniana	30		
Bathyporeia spp.	120	10	10
Mysidae	10	10	
Pontoporeiidae		10	
Urothoe spp.	50		
weight (g/m²):	0.6880	0.2890	0.0320
POLYCHAETA			
Nephtys cirrosa	10	40	60
Nephtys spp.		10	
Ophelia borealis	10		
Scolelepis bonnieri		10	
Spio armata	10		50
weight (g/m²):	1.4650	4.2010	2.8820

100702-NEMO-GS-B02-024			
Easting:	449052	Depth:	35.8
Northing:	5685125		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B02-025			
Easting:	448045	Depth:	35.9
Northing:	5685205		
SPECIES /m²	A Ins. Samp. Vol.	B	C Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia guilliamsoniana	40	20	
Bathyporeia sarsi		40	
Crangon spp.		10	
Gastrosaccus spinifer		20	
Processa spp.		40	
Urothoe brevicornis	40		
weight (g/m²):	0.5020	9.0630	
ECHINODERMATA			
Echinocyamus pusillus	80	140	
Ophiocten affinis		20	
weight (g/m²):	0.4000	1.7810	
MOLLUSCA-BIVALVIA			
Tapes spp.		10	
weight (g/m²):		0.1410	
MOLLUSCA-GASTROPODA		0	
Euspira montagui		10	
weight (g/m²):		0.1980	
POLYCHAETA			
Nephtys cirrosa	10	20	
Ophelia borealis		20	
weight (g/m²):	0.5540	1.1860	

100702-NEMO-GS-B02-026			
Easting:	447097	Depth:	37.1
Northing::	5685290		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B02-027			
Easting:	445688	Depth:	36.1
Northing:	5685690		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia elegans	20		
Bathyporeia guilliamsoniana	10	10	
Bathyporeia nana	20		
Bathyporeia spp.		10	10
Bathyporeia tenuipes	40		
Crustacea			10
Gammaridae	10		0
Gastrosaccus spinifer			10
Liocarcinus pusillus		10	
Urothoe elegans	10		
Urothoe marina	10		
Urothoe spp.		40	10
weight (g/m²):	0.3550	0.1650	0.1580
MOLLUSCA-BIVALVIA			
Spisula elliptica		20	
weight (g/m²):		0.3370	
POLYCHAETA			
Glycera oxycephala			10
Nephtys cirrosa	10		10
Ophelia borealis		10	30
Spio armata		10	
Spiophanes bombyx	10		
Terebellidae spp.			10
weight (g/m²):	0.8770	0.5450	3.5240

100702-NEMO-GS-B02-028			
Easting:	441671	Depth:	31.0
Northing:	5686433		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea	70		
Gammaridae	10		
Gastrosaccus spinifer		30	
Isopoda		10	
Leucothoe incisa			
Pisidia longicornis			40
Thia scutellata		10	
weight (g/m²):	0.9430	0.4130	0.0490
MOLLUSCA-BIVALVIA			
Abra nitida			10
weight (g/m²):			0.2700
POLYCHAETA			
Heteromastus filiformis			10
Nephtys cirrosa			20
Ophelia borealis	10		10
Polycirrus medusa		10	110
weight (g/m²):	0.3260	0.0120	1.3650

100702-NEMO-GS-B02-029			
Easting:	436734	Depth:	38.5
Northing:	5686299		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia spp.		10	
Liocarcinus pusillus	10		
weight (g/m²):	0.1710	0.0280	
ECHINODERMATA			
Echinocyamus pusillus	60	70	
Ophiuroidea		10	
weight (g/m²):	0.2090	0.1810	
MOLLUSCA-GASTROPODA			
Euspira pulchella	10		
weight (g/m²):	0.4420		
POLYCHAETA			
Glycera lapidum		20	
Ophelia borealis	20		
Polycirrus spp.		10	
weight (g/m²):	0.0740	0.0410	

100702-NEMO-GS-B02-030			
Easting:	433539	Depth:	40.0
Northing:	5686382		
SPECIES /m²	A	B	C
ECHINODERMATA			
Echinocyamus pusillus	10	10	
Ophiocten affinis		20	
Ophiura ophiura			10
weight (g/m²):	0.3880	0.5330	7.2140
MOLLUSCA-BIVALVIA			
Glycymeris glycymeris		10	
Glycymeris spp.	10		
Goodallia triangularis	20		
Spisula elliptica	20		
Tellina pygmaea	10		
weight (g/m²):	0.3870	0.2000	
POLYCHAETA			
Glycera lapidum	10		
Nephtys cirrosa		10	
weight (g/m²):	0.0040	2.1340	
VARIA			
Ammodytes tobianus		10	
weight (g/m²):		75.3900	

100702-NEMO-GS-B03-031			
Easting:	431715	Depth:	32.0
Northing:	5686388		
SPECIES /m²	A	B	C
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		
weight (g/m²):	0.1210		
POLYCHAETA			
Glycera lapidum		10	
Owenia fusiformis	10		
weight (g/m²):	0.1090	0.0670	

100702-NEMO-GS-B03-32			
Easting:	426153	Depth:	42.2
Northing:	5686634		
SPECIES /m²	A	B	C
CNIDARIA			
Hydrozoa			P
weight (g/m²):			0.0700
CRUSTACEA			
Liocarcinus marmoreus			10
Monoculodes carinatus			20
weight (g/m²):			3.7700
ECHINODERMATA			
Echinocyamus pusillus			10
weight (g/m²):			0.1620
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		10
Tellina pygmaea	10		
Tellinidae			
weight (g/m²):	0.4770		0.5170
POLYCHAETA	0		
Aonides paucibranchiata	20		
Glycera lapidum			30
Lumbrineris latreilli	10		
Notomastus latericeus	30		30
Polycirrus medusa	50	10	
weight (g/m²):	5.7530	0.1310	0.6450
VARIA			
Branchiostoma lanceolatum	20	20	20
Nematoda	20	50	60
weight (g/m²):	0.4260	1.6330	1.5280

100702-NEMO-GS-B03-033			
Easting:	422672	Depth:	40.8
Northing:	5686733		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-034			
Easting:	416374	Depth:	40.8
Northing:	5686854		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-035			
Easting:	414266	Depth:	18.9
Northing:	5686938		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea		10	
Hippomedon denticulatus		10	
weight (g/m²):		0.5040	
POLYCHAETA			
Glycera oxycephala	10		
Nephtys cirrosa	10	10	
Ophelia borealis		10	
weight (g/m²):	0.5230	1.2240	

100702-NEMO-GS-B03-036			
Easting:	412197	Depth:	46.0
Northing:	5687033		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-037			
Easting:	408771	Depth:	53.7
Northing:	5687304		
SPECIES /m²	A	B Ins. Samp. Vol.	C
CNIDARIA			
Diphasia spp.		P	
weight (g/m²):		0.0690	
ECHINODERMATA			
Ophiuroidea	10		
weight (g/m²):	0.0070		
MOLLUSCA-GASTROPODA			
Nassarius nitidus			10
weight (g/m²):			14.7450
POLYCHAETA			
Lagis koreni		10	30
Nephtys cirrosa	10		10
Nephtys spp.		10	
Ophelia borealis			20
weight (g/m²):	0.0130	1.1620	2.9300
VARIA			
Ctenophora		10	
weight (g/m²):		0.0220	

100702-NEMO-GS-B03-038			
Easting:	407401	Depth:	41.1
Northing:	5687145		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-039			
Easting:	405926	Depth:	22.5
Northing:	5687038		
SPECIES /m²	A	B	C Ins. Samp. Vol.
CNIDARIA			
Actiniaria		30	
Anthozoa	10		
Diphasia		P	
Hydrallmania falcata		P	
weight (g/m²):	70.9260	4.2810	
CRUSTACEA			
Abludomelita obtusata		10	
Ampelisca spinipes		10	
Galathea intermedia		20	
Galathea spp.		10	
Gammaridae		10	
Gammaropsis maculata		40	
Liocarcinus spp.		10	
Mysidae	10		
Pilumnus spp.		10	
Pisidia longicornis		1600	
Upogebia stellata		10	
weight (g/m²):	0.2640	11.8600	
ECHINODERMATA			
Amphipholis squamata		110	
Asterias rubens		30	
Leptasterias muelleri		10	
Ophiura spp.	10		
Ophiuroidea		340	
weight (g/m²):	0.0030	257.3080	
MOLLUSCA-BIVALVIA			
Abra nitida	30		
Abra prismatica		170	
weight (g/m²):	0.1980	0.9010	
MOLLUSCA-GASTROPODA			
Odostomia unidentata		20	
weight (g/m²):		10.0990	
POLYCHAETA			
Cauleriella alata		10	
Cirratulidae	10		
Eulalia viridis		10	
Eunereis longissima		10	
Glycera alba		10	
Harmothoe aspera		30	
Harmothoe clavigera		50	
Harmothoe extenuata		30	
Harmothoe spp.	10	110	
Heteromastus filiformis		30	
Lanice conchilega	10		
Mysta picta		10	
Nephtys cirrosa		10	
Notomastus latericeus		10	
Ophelia borealis	30	10	
Pherusa plumosa		10	
Sabellaria spinulosa	1080	10630	
Scalibregma inflatum	10		
Spio filicornis	10		
Spiophanes bombyx	60	10	
Sthenelais boa		30	
weight (g/m²):	6.9190	155.1690	
VARIA			
Gaidropsarus spp.		10	
Sipuncula spp.		10	
weight (g/m²):		67.3580	

100702-NEMO-GS-B03-040			
Easting:	404309	Depth:	26.5
Northing:	5686851		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-041			
Easting:	402231	Depth:	19.7
Northing:	5686507		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-042			
Easting:	399159	Depth:	17.8
Northing:	5686401		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-043			
Easting:	397792	Depth:	37.0
Northing:	5686013		
SPECIES /m²	A	B	C
CRUSTACEA			
Porcellanidae			10
weight (g/m²):			0.0210
POLYCHAETA			
Ophelia borealis		20	
Pholoe inornata	10		
weight (g/m²):	0.0060	0.9910	

100702-NEMO-GS-B03-044			
Easting:	397257	Depth:	16.0
Northing:	5685815		
SPECIES /m²	A	B	C
POLYCHAETA			
Nephtys cirrosa	10		10
Ophelia borealis	30	10	
weight (g/m²):	7.7710	1.2360	0.1370

100702-NEMO-GS-B03-045			
Easting:	395600	Depth:	12.0
Northing:	5685354		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-046			
Easting:	391595	Depth:	10.0
Northing:	5685158		
SPECIES /m²	A	B	C
CRUSTACEA			
Gastrosaccus spinifer		10	
Urothoe spp.	30		
weight (g/m²):	0.4400	0.2500	
MOLLUSCA-BIVALVIA			
Mytilidae			20
Spisula elliptica			20
weight (g/m²):			0.1800
POLYCHAETA			
Nephtys cirrosa	10		
Ophelia borealis	10		
weight (g/m²):	0.0660		

100702-NEMO-GS-B03-047			
Easting:	392526	Depth:	12.0
Northing:	5685110		
SPECIES /m²	A	B	C
CRUSTACEA			
Balanus spp.			200
Bathyporeia spp.	20		
Lysianassidae			10
Pagurus spp.			10
Podoceridae			10
weight (g/m²):	0.0170		20.1830
ECHINODERMATA			
Amphiuridae		10	
Ophiuroidea			10
weight (g/m²):		0.0400	0.0090
MOLLUSCA-BIVALVIA			
Corbula gibba		10	
Goodallia triangularis			10
Mytilidae	70		300
Spisula elliptica	10		30
weight (g/m²):	0.3900	0.1290	0.3430
POLYCHAETA			
Glycera lapidum	10		
Macrochaeta helgolandica	20		
Ophelia borealis	20	20	
Terebellidae spp.		10	
weight (g/m²):	2.3980	0.5180	

100702-NEMO-GS-B03-048			
Easting:	391993	Depth:	9.0
Northing:	5684853		
SPECIES /m²	A	B Ins. Samp. Vol.	C Ins. Samp. Vol.
Nephtys cirrosa	10		10
Ophelia borealis		20	10
weight (g/m²):	0.2050	1.9040	0.3079

100702-NEMO-GS-B03-049			
Easting:	389215	Depth:	2.0
Northing:	5685982		
SPECIES /m²	A	B	C
CNIDARIA			
Tubularia spp.			P
weight (g/m²):			0.0110
CRUSTACEA			
Bathyporeia guilliamsoniana		20	
Bathyporeia nana		10	
Bathyporeia spp.			20
Dexaminidae			10
Urothoe brevicornis		60	70
Urothoe spp.	20	10	
weight (g/m²):	0.1360	0.7630	0.4070
MOLLUSCA-BIVALVIA			
Abra nitida		10	
Mytilidae	20		10
weight (g/m²):	0.0130	0.1150	0.0170
POLYCHAETA			
Ampharete spp.	10		
Glycera capitata	20		
Glycera oxycephala	20		10
Lagis koreni	10		10
Lumbrineris aniara	10		
Nephtys cirrosa	10	20	10
Notomastus latericeus	10	0	
Ophelia borealis	30	10	20
Phyllodoce mucosa	10		
Spio armata	20	10	10
Spiophanes kroyeri	10		
Travisia forbesii			10
weight (g/m²):	2.4570	2.6820	1.6430
VARIA			
Pycnogonida	50		
Vesicularia spinosa	P	P	
weight (g/m²):	30.8190	0.2370	

100702-NEMO-GS-B03-050			
Easting:	387873	Depth:	3.0
Northing:	5685179		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	40	20	
Anthozoa			70
weight (g/m²):	15.1210	13.4680	42.8030
CRUSTACEA			
Ampelisca brevicornis	10		30
Ampelisca spp.		30	
Aoridae	30	20	
Balanus balanus			10
Campylaspis spp.	10		
Carcinus maenas	10		
Corophium spp.		20	
Diastylis glabra	20		
Diastylis spp.			10
Gammaridae	100		120
Pagurus bernhardus		10	
Pisidia longicornis	30	20	
Portunidae spp.	10		
weight (g/m²):	1.9680	6.6040	1.5660
ECHINODERMATA			
Amphipholis squamata	80	70	
Ophiura albida		10	
Ophiura spp.	20	40	10
Psammechinus miliaris			10
weight (g/m²):	0.1400	1.4210	0.5100
MOLLUSCA-BIVALVIA			
Abra alba	50		50
Abra spp.		100	
Bivalvia			10
Corbula gibba	20	10	
Ensis magnus		20	40
Macoma balthica	10		
Nucula nitidosa	40	100	140
Nucula sulcata		10	
Spisula elliptica		20	
Tellimya ferruginosa	10		
weight (g/m²):	17.7710	11.1840	36.7340
MOLLUSCA-GASTROPODA			
Buccinum undatum		10	10
Gibbula spp.		10	10
Nassarius nitidus			10
weight (g/m²):		5.3120	25.1480
MOLLUSCA-NUDIBRANCHIA			
Nudibranchia	10		
weight (g/m²):	0.0960		

100702-NEMO-GS-B03-050			
POLYCHAETA			
Ampharete spp.	10		10
Ampharete finmarchica	20	10	
Aphrodita aculeata		20	10
Cauleriella alata	10	10	
Caulleriella killariensis	10		
Cirratulidae		50	10
Eteone spp.			10
Eumida sanguinea	10		
Eunereis longissima	10	10	20
Gattyana cirrhosa	10		
Glycera alba		20	
Glycera spp.			10
Harmothoe clavigera		10	
Harmothoe extenuata	10		
Heteromastus filiformis	70	50	20
Lagis koreni	50	20	40
Lanice conchilega	10	70	
Lepidonotus squamatus			10
Lumbrineris aniara		20	10
Mysta picta		10	
Neoamphitrite spp.	10		
Nephtys hombergii			10
Nephtys kersivalensis	10		
Nephtys spp.	20	10	80
Notomastus latericeus	100	160	100
Pholoe baltica			10
Phyllodoce mucosa		10	20
Polycirrus medusa	20	20	
Pygospio elegans			10
Scalibregma inflatum	40	10	
Scolelepis bonnieri			
Scoloplos armiger	10	30	30
Spiophanes bombyx			20
Sthenelais boa		10	
weight (g/m²):	8.8990	14.7350	5.6910
VARIA			
Achelia echinata	10		
Alcyonidium diaphanum	P		P
Ammothella longipes		10	
Anoplodactylus petiolatus	50	70	70
Flustra foliacea			P
Nemertea	10		
Pycnogonida	10		
weight (g/m²):	8.3850	0.0010	5.4420

100702-NEMO-DDV-B03-039_001									
Photo ID	039-001_001	039-001_002	039-001_003	039-001_004	039-001_005	039-001_006	039-001_007	039-001_008	039-001_009
X	406212	406229	406247	406265	406281	406195	406178	406162	406146
Y	5687069	5687056	5687044	5687032	5687020	5687080	5687092	5687103	5687114
Sand	x			x	x	x	x	x	x
Gravel				x	x				
Large Shell fragments				<20%	<10%				
Small Shell fragments							X		
Comments	Poor visibility. *Sabellaria* reef.	Zero visibility due to strong current.	Poor visibility. Maybe cobbles covered with *Serpulidae*.	Poor visibility due to strong current.	Poor visibility due to strong current.	*Sabellaria* reef	*Sabellaria* reef with leftovers of fishing gear.	*Sabellaria* reef with fishing net	*Sabellaria* reef.
EUNIS habitat classification	A5.611					A5.611	A5.611	A5.611	A5.611
Comments EUNIS code	Annex 1 area-Sabellaria					Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria

SPECIES /m²

CNIDARIA									
Actiniaria									
CRUSTACEA									
Crustacea									
Paguridae								1.6	
Galatheidae									
Caridea									
Brachyura									
Liocarcinus spp.									
Portunidae									
Pisidia longicornis								4.8	
ECHINODERMATA									
Asterias rubens	1.6					1.6			
Psammechinus miliaris									
POLYCHAETA									
Tubes of *Sabellaria spp.* (SACFOR)	A					S	S	A	A

100702-NEMO-DDV-B03-039_001									
Photo ID	039-001_010	039-001_011	039-001_012	039-001_013	039-001_014	039-001_015	039-001_016	039-001_017	039-001_018
X	406129	406112	406096	406080	406064	406048	406032	406015	405998
Y	5687125	5687137	5687149	5687159	5687171	5687181	5687196	5687208	5687219
Sand	x		x			x	x	x	x
Gravel			x						
Large Shell fragments									
Small Shell fragments			x			x	x	x	
Comments	*Sabellaria* reef.	Zero visibility.	*Sabellaria* reef with shell gravel.	Zero visibility.	Zero visibility.	*Sabellaria* reef.	*Sabellaria* reef.	*Sabellaria* reef.	Poor visibility. *Sabellaria* reef.
EUNIS habitat classification	A5.611		A5.611			A5.611	A5.611	A5.611	A5.611
Comments EUNIS code	Annex 1 area-Sabellaria		Annex 1 area-Sabellaria			Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria

SPECIES /m²

CNIDARIA									
Actiniaria			1.6				3.2	6.5	
CRUSTACEA									
Crustacea			1.6			1.6		6.5	
Paguridae									
Galatheidae						1.6			
Caridea							3.2	1.6	
Brachyura						1.6		4.8	
Liocarcinus spp.								1.6	
Portunidae								1.6	
Pisidia longicornis						1.6		8.1	
ECHINODERMATA									
Asterias rubens	3.2		3.2			3.2	1.6	3.2	
Psammechinus miliaris								16.1	
POLYCHAETA									
Tubes of *Sabellaria spp.* (SACFOR)	S		S			S	S	S	A

100702-NEMO-DDV-B03-039_001								
Photo ID	039-001_019	039-001_020	039-001_021	039-001_022	039-001_023	039-001_024	039-001_025	039-001_026
X	405981	405963	405946	405930	405914	405897	405881	405865
Y	5687232	5687240	5687252	5687263	5687273	5687286	5687299	5687311
Sand		x		x	x	x	x	x
Gravel								
Large Shell fragments								
Small Shell fragments								
Comments	Zero visibility.	Poor visibility. *Sabellaria* reef.	Zero visibility.	A few *Sabellaria* tubes.	Poor visibility. *Sabellaria* reef.	Poor visibility. *Sabellaria* reef.	Very poor visibility. Probably sandy bottom .	Very poor visibility. Probably sandy bottom .
EUNIS habitat classification		A5.611		A5.611	A5.611	A5.611		
Comments EUNIS code		Annex 1 area-Sabellaria		Annex 1 area-Sabellaria		Annex 1 area-Sabellaria		

SPECIES /m²

CNIDARIA								
Actiniaria								
CRUSTACEA								
Crustacea								
Paguridae								
Galatheidae								
Caridea					1.6			
Brachyura								
Liocarcinus spp.								
Portunidae								
Pisidia longicornis								
ECHINODERMATA								
Asterias rubens								
Psammechinus miliaris								
POLYCHAETA								
Tubes of *Sabellaria spp.* (SACFOR)		C		F	S	C		

100702-NEMO-DDV-B03-039_002											
Photo ID	039-002_001	039-002_002	039-002_003	039-002_004	039-002_005	039-002_006	039-002_007	039-002_008	039-002_009	039-002_010	039-002_011
X	406046	406036	406023	406012	406000	405989	405980	405968	405955	405943	405932
Y	5687270	5687253	5687236	5687219	5687203	5687186	5687169	5687152	5687137	5687118	5687100
Clay										x?	x?
Sand	x	x	x	x	x	x	x?	x?	x?	x	x
Gravel											
Pebbles and Cobbles	x	x	x	x						x	x
Small Shell fragments											
Comments	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. *Sabellaria* reef.	Poor visibility. *Sabellaria* reef.	Zero visibility. Probably sand bottom.	Zero visibility. Probably sand bottom.	Zero visibility. Probably sand bottom.	Poor visibility. Cobbles on sand bottom.	Poor visibility. Cobbles on sand bottom.
EUNIS habitat classification					A5.611	A5.611					
Comments EUNIS code					Annex 1 area-Sabellaria	Annex 1 area-Sabellaria					

SPECIES /m²

CRUSTACEA											
Paguridae	1.6										
MOLLUSCA											
Gastropoda					1.6						
ECHINODERMATA											
Echinidea	1.6										
POLYCHAETA											
Tubes of *Sabellaria spp.* (SACFOR)					A	A					

100702-NEMO-DDV-B03-040_001											
Photo ID	040-001_001	040-001_002	040-001_003	040-001_004	040-001_005	040-001_006	040-001_007	040-001_008	040-001_009	040-001_010	040-001_011
X	404311	404294	404275	404254	404234	404214	404194	404174	404157	404137	404117
Y	5686856	5686853	5686853	5686851	5686850	5686850	5686849	5686849	5686848	5686848	5686848
Clay			x?								
Sand	x	x	x	x	x	x	x	x	x	x	x
Gravel	x		x	x			x				
Pebbles and Cobbles						x					
Small Shell fragments				<1%							
Comments	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility. A few cobbles.	Poor visibility. Maby old *sabellaria* tubes with epifauna.	Poor visibility. Maby old *sabellaria* tubes with epifauna.	Poor visibility. Maby old *sabellaria* reef.	Zero visibility.	Poor visibility. Maby old *sabellaria* reef.
EUNIS habitat classification									A5.611		
Comments EUNIS code									Annex 1 area-Sabellaria		

SPECIES /m²

CNIDARIA											
Hydrozoa								P			
ECHINODERMATA											
Asterias rubens			1.6				1.6				1.6
POLYCHAETA											
Tubes of *Sabellaria spp.* (SACFOR)									A		

100702-NEMO-DDV-B03-040_002							
Photo ID	040-002_001	040-002_002	040-002_003	040-002_004	040-002_005	040-002_006	040-002_007
X	404296	404297	404299	404301	404302	404304	404305
Y	5686930	5686908	5686888	5686870	5686849	5686831	5686811
Clay							
Sand	x	x?	x?	x?	x?	x	x
Gravel							
Boulders							
Small Shell fragments							
Comments	Poor visibility. No visible reef structures	Zero visibility	Zero visibility	Zero visibility	Zero visibility	Poor visibility. No visible reef structures, sand and shell fragments.	Poor visibility. No visible reef structures
EUNIS habitat classification							

Group	Phylum	Species	Group	Phylum	Species
CNIDARIA	CNIDARIA	*Abietinaria abietina*	CRUSTACEA	ARTHROPODA	Gammaridae
CNIDARIA	CNIDARIA	Actiniaria	CRUSTACEA	ARTHROPODA	Gammaridea
CNIDARIA	CNIDARIA	*Alcyonium spp.*	CRUSTACEA	ARTHROPODA	*Gammaropsis maculata*
CNIDARIA	CNIDARIA	Anthozoa	CRUSTACEA	ARTHROPODA	*Gammarus spp.*
CNIDARIA	CNIDARIA	Campanulariidae	CRUSTACEA	ARTHROPODA	*Gastrosaccus spinifer*
CNIDARIA	CNIDARIA	*Clytia hemisphaerica*	CRUSTACEA	ARTHROPODA	Haustoriidae
CNIDARIA	CNIDARIA	*Diphasia spp.*	CRUSTACEA	ARTHROPODA	*Hippolyte varians*
CNIDARIA	CNIDARIA	*Hydrallmania falcata*	CRUSTACEA	ARTHROPODA	*Hippomedon denticulatus*
CNIDARIA	CNIDARIA	Hydrozoa	CRUSTACEA	ARTHROPODA	*Idotea linearis*
CNIDARIA	CNIDARIA	*Nemertesia spp.*	CRUSTACEA	ARTHROPODA	*Iphimedia spp.*
CNIDARIA	CNIDARIA	*Obelia spp.*	CRUSTACEA	ARTHROPODA	Isopoda
CNIDARIA	CNIDARIA	Plumulariidae	CRUSTACEA	ARTHROPODA	Ischyroceridae
CNIDARIA	CNIDARIA	*Rhizorhagium roseum*	CRUSTACEA	ARTHROPODA	*Leucothoe incisa*
CNIDARIA	CNIDARIA	*Sertularia cupressina*	CRUSTACEA	ARTHROPODA	*Leucothoe spp.*
CNIDARIA	CNIDARIA	Sertulariidae	CRUSTACEA	ARTHROPODA	*Liocarcinus holsatus*
CNIDARIA	CNIDARIA	*Tubularia indivisa*	CRUSTACEA	ARTHROPODA	*Liocarcinus marmoreus*
CNIDARIA	CNIDARIA	*Tubularia spp.*	CRUSTACEA	ARTHROPODA	*Liocarcinus pusillus*
CRUSTACEA	ARTHROPODA	*Abludomelita obtusata*	CRUSTACEA	ARTHROPODA	*Liocarcinus spp.*
CRUSTACEA	ARTHROPODA	*Ampelisca brevicornis*	CRUSTACEA	ARTHROPODA	Lysianassidae
CRUSTACEA	ARTHROPODA	*Ampelisca spinipes*	CRUSTACEA	ARTHROPODA	*Macropodia tenuirostris*
CRUSTACEA	ARTHROPODA	*Ampelisca spp.*	CRUSTACEA	ARTHROPODA	*Monoculodes carinatus*
CRUSTACEA	ARTHROPODA	*Anopladactylus petiolatus*	CRUSTACEA	ARTHROPODA	Mysidae
CRUSTACEA	ARTHROPODA	*Aora gracilis*	CRUSTACEA	ARTHROPODA	Oedicerotidae
CRUSTACEA	ARTHROPODA	Aoridae	CRUSTACEA	ARTHROPODA	Paguridae
CRUSTACEA	ARTHROPODA	*Autonoe longipes*	CRUSTACEA	ARTHROPODA	*Pagurus bernhardus*
CRUSTACEA	ARTHROPODA	*Balanus balanus*	CRUSTACEA	ARTHROPODA	*Pagurus spp.*
CRUSTACEA	ARTHROPODA	*Balanus crenatus*	CRUSTACEA	ARTHROPODA	*Pandalina spp.*
CRUSTACEA	ARTHROPODA	*Balanus spp.*	CRUSTACEA	ARTHROPODA	*Pariambus typicus*
CRUSTACEA	ARTHROPODA	*Bathyporeia elegans*	CRUSTACEA	ARTHROPODA	*Pilumnus spp.*
CRUSTACEA	ARTHROPODA	*Bathyporeia guilliamsoniana*	CRUSTACEA	ARTHROPODA	*Pinnotheres pisum*
CRUSTACEA	ARTHROPODA	*Bathyporeia nana*	CRUSTACEA	ARTHROPODA	*Pisidia longicornis*
CRUSTACEA	ARTHROPODA	*Bathyporeia sarsi*	CRUSTACEA	ARTHROPODA	Podoceridae
CRUSTACEA	ARTHROPODA	*Bathyporeia spp.*	CRUSTACEA	ARTHROPODA	Pontoporeiidae
CRUSTACEA	ARTHROPODA	*Bathyporeia tenuipes*	CRUSTACEA	ARTHROPODA	Porcellanidae
CRUSTACEA	ARTHROPODA	*Bodotria scorpioides*	CRUSTACEA	ARTHROPODA	Portunidae
CRUSTACEA	ARTHROPODA	*Brachyura spp.*	CRUSTACEA	ARTHROPODA	*Processa canaliculata*
CRUSTACEA	ARTHROPODA	*Campylaspis spp.*	CRUSTACEA	ARTHROPODA	*Processa spp.*
CRUSTACEA	ARTHROPODA	*Carcinus maenas*	CRUSTACEA	ARTHROPODA	*Semibalanus balanoides*
CRUSTACEA	ARTHROPODA	Caridea	CRUSTACEA	ARTHROPODA	*Stenothoe monoculoides*
CRUSTACEA	ARTHROPODA	Copepoda	CRUSTACEA	ARTHROPODA	*Thia scutellata*
CRUSTACEA	ARTHROPODA	*Corophium spp.*	CRUSTACEA	ARTHROPODA	*Upogebia stellata*
CRUSTACEA	ARTHROPODA	*Crangon allmanni*	CRUSTACEA	ARTHROPODA	*Urothoe brevicornis*
CRUSTACEA	ARTHROPODA	*Crangon crangon*	CRUSTACEA	ARTHROPODA	*Urothoe elegans*
CRUSTACEA	ARTHROPODA	*Crangon spp.*	CRUSTACEA	ARTHROPODA	*Urothoe marina*
CRUSTACEA	ARTHROPODA	Crustacea	CRUSTACEA	ARTHROPODA	*Urothoe spp.*
CRUSTACEA	ARTHROPODA	Dendrobranchiata	ECHINODERMATA	ECHINODERMATA	*Amphipholis squamata*
CRUSTACEA	ARTHROPODA	Dexaminidae	ECHINODERMATA	ECHINODERMATA	Amphiuridae
CRUSTACEA	ARTHROPODA	*Diastylis glabra*	ECHINODERMATA	ECHINODERMATA	*Asterias rubens*
CRUSTACEA	ARTHROPODA	*Diastylis rugosa*	ECHINODERMATA	ECHINODERMATA	*Echinocardium cordatum*
CRUSTACEA	ARTHROPODA	*Diastylis spp.*	ECHINODERMATA	ECHINODERMATA	*Echinocardium flavescens*
CRUSTACEA	ARTHROPODA	Euphausiacea	ECHINODERMATA	ECHINODERMATA	*Echinocardium spp.*
CRUSTACEA	ARTHROPODA	*Galathea intermedia*	ECHINODERMATA	ECHINODERMATA	*Echinocyamus pusillus*
CRUSTACEA	ARTHROPODA	*Galathea spp.*	ECHINODERMATA	ECHINODERMATA	Echinidea
CRUSTACEA	ARTHROPODA	Galatheidae	ECHINODERMATA	ECHINODERMATA	Holothurioidea

Group	Phylum	Species	Group	Phylum	Species
ECHINODERMATA	ECHINODERMATA	*Leptasterias muelleri*	MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	Nudibranchia
ECHINODERMATA	ECHINODERMATA	*Ophiocten affinis*	POLYCHAETA	ANNELIDA	*Alitta succinea*
ECHINODERMATA	ECHINODERMATA	*Ophiothrix fragilis*	POLYCHAETA	ANNELIDA	*Ampharete spp.*
ECHINODERMATA	ECHINODERMATA	*Ophiura albida*	POLYCHAETA	ANNELIDA	*Ampharete finmarchica*
ECHINODERMATA	ECHINODERMATA	*Ophiura ophiura*	POLYCHAETA	ANNELIDA	*Aonides paucibranchiata*
ECHINODERMATA	ECHINODERMATA	*Ophiura sarsii*	POLYCHAETA	ANNELIDA	*Aphrodita aculeata*
ECHINODERMATA	ECHINODERMATA	*Ophiura spp.*	POLYCHAETA	ANNELIDA	*Capitella capitata-complex*
ECHINODERMATA	ECHINODERMATA	Ophiurida	POLYCHAETA	ANNELIDA	*Capitellidae spp.*
ECHINODERMATA	ECHINODERMATA	Ophiuroidea	POLYCHAETA	ANNELIDA	*Cauleriella alata*
ECHINODERMATA	ECHINODERMATA	*Psammechinus miliaris*	POLYCHAETA	ANNELIDA	*Caulleriella killariensis*
ECHINODERMATA	ECHINODERMATA	Spatangoida	POLYCHAETA	ANNELIDA	*Chaetozone setosa*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra alba*	POLYCHAETA	ANNELIDA	Cirratulidae
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra nitida*	POLYCHAETA	ANNELIDA	*Dipolydora flava*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra prismatica*	POLYCHAETA	ANNELIDA	*Eteone spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra spp.*	POLYCHAETA	ANNELIDA	*Eulalia viridis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra tenuis*	POLYCHAETA	ANNELIDA	*Eumida bahusiensis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Aequipecten opercularis*	POLYCHAETA	ANNELIDA	*Eumida sanguinea*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Arca tetragona*	POLYCHAETA	ANNELIDA	*Eumida spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	Bivalvia	POLYCHAETA	ANNELIDA	*Eunereis longissima*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Corbula gibba*	POLYCHAETA	ANNELIDA	*Eusyllis blomstrandi*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Ensis magnus*	POLYCHAETA	ANNELIDA	*Gattyana cirrhosa*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Ensis spp.*	POLYCHAETA	ANNELIDA	*Glycera alba*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Glycymeris glycymeris*	POLYCHAETA	ANNELIDA	*Glycera capitata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Glycymeris spp.*	POLYCHAETA	ANNELIDA	*Glycera convoluta*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Goodallia triangularis*	POLYCHAETA	ANNELIDA	*Glycera lapidum*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Kurtiella bidentata*	POLYCHAETA	ANNELIDA	*Glycera oxycephala*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Macoma balthica*	POLYCHAETA	ANNELIDA	*Glycera spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	Mactridae	POLYCHAETA	ANNELIDA	*Harmothoe aspera*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Mya spp.*	POLYCHAETA	ANNELIDA	*Harmothoe clavigera*
MOLLUSCA-BIVALVIA	MOLLUSCA	Mytilidae	POLYCHAETA	ANNELIDA	*Harmothoe extenuata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Mytilus spp.*	POLYCHAETA	ANNELIDA	*Harmothoe spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Nucula nitidosa*	POLYCHAETA	ANNELIDA	*Hesionura elongata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Nucula sulcata*	POLYCHAETA	ANNELIDA	*Heteromastus filiformis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Spisula elliptica*	POLYCHAETA	ANNELIDA	*Lagis koreni*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tapes spp.*	POLYCHAETA	ANNELIDA	*Lanice conchilega*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellimya ferruginosa*	POLYCHAETA	ANNELIDA	*Lepidonotus squamatus*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellina fabula*	POLYCHAETA	ANNELIDA	*Lumbrineris aniara*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellina pygmaea*	POLYCHAETA	ANNELIDA	*Lumbrineris latreilli*
MOLLUSCA-BIVALVIA	MOLLUSCA	Tellinidae	POLYCHAETA	ANNELIDA	*Macrochaeta helgolandica*
MOLLUSCA-CEPHALOPODA	MOLLUSCA	*Sepiola atlantica*	POLYCHAETA	ANNELIDA	*Magelona johnstoni*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Buccinum undatum*	POLYCHAETA	ANNELIDA	*Mediomastus fragilis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Chauvetia brunnea*	POLYCHAETA	ANNELIDA	*Mysta picta*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Crepidula fornicata*	POLYCHAETA	ANNELIDA	*Neoamphitrite spp.*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Cryptonatica affinis*	POLYCHAETA	ANNELIDA	*Nephtys assimilis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Euspira montagui*	POLYCHAETA	ANNELIDA	*Nephtys cirrosa*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Euspira pulchella*	POLYCHAETA	ANNELIDA	*Nephtys hombergii*
MOLLUSCA-GASTROPODA	MOLLUSCA	Gastropoda	POLYCHAETA	ANNELIDA	*Nephtys kersivalensis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Gibbula spp.*	POLYCHAETA	ANNELIDA	*Nephtys longosetosa*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Nassarius nitidus*	POLYCHAETA	ANNELIDA	*Nephtys spp.*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Nassarius reticulatus*	POLYCHAETA	ANNELIDA	*Notomastus latericeus*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Odostomia unidentata*	POLYCHAETA	ANNELIDA	*Ophelia borealis*
MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	*Adalaria proxima*	POLYCHAETA	ANNELIDA	*Owenia fusiformis*
MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	*Aeolidiella spp.*	POLYCHAETA	ANNELIDA	*Pherusa plumosa*

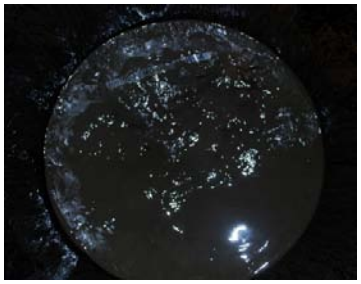
Group	Phylum	Species	Group	Phylum	Species
POLYCHAETA	ANNELIDA	*Pholoe baltica*	VARIA	BRYOZOA	Calloporidae
POLYCHAETA	ANNELIDA	*Pholoe inornata*	VARIA	BRYOZOA	*Electra pilosa*
POLYCHAETA	ANNELIDA	*Pholoe spp.*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce citrina*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce groenlandica*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce mucosa*	VARIA	BRYOZOA	*Vesicularia spinosa*
POLYCHAETA	ANNELIDA	*Phyllodoce spp.*	VARIA	CEPHALORYNCHA	Priapulida
POLYCHAETA	ANNELIDA	*Pisione remota*	VARIA	CHORDATA	Actinopterygii
POLYCHAETA	ANNELIDA	*Polycirrus medusa*	VARIA	CHORDATA	*Ammodytes tobianus*
POLYCHAETA	ANNELIDA	*Polycirrus spp.*	VARIA	CHORDATA	*Arnoglossus laterna*
POLYCHAETA	ANNELIDA	*Polydora cornuta*	VARIA	CHORDATA	Ascidiacea
POLYCHAETA	ANNELIDA	*Polygordius appendiculatus*	VARIA	CHORDATA	*Branchiostoma lanceolatum*
POLYCHAETA	ANNELIDA	*Pseudopolydora pulchra*	VARIA	CHORDATA	*Callionymus lyra*
POLYCHAETA	ANNELIDA	*Pygospio elegans*	VARIA	CHORDATA	*Echiichthys vipera*
POLYCHAETA	ANNELIDA	*Sabellaria spinulosa*	VARIA	CHORDATA	*Gaidropsarus spp.*
POLYCHAETA	ANNELIDA	*Saccocirrus papillocercus*	VARIA	CHORDATA	Gobiidae
POLYCHAETA	ANNELIDA	*Scalibregma inflatum*	VARIA	CHORDATA	*Hyperoplus lanceolatus*
POLYCHAETA	ANNELIDA	*Scolelepis bonnieri*	VARIA	CHORDATA	*Pleuronectes platessa*
POLYCHAETA	ANNELIDA	*Scoloplos armiger*	VARIA	CHORDATA	*Pomatoschistus minutus*
POLYCHAETA	ANNELIDA	*Sphaerosyllis bulbosa*	VARIA	CHORDATA	*Pomatoschistus spp.*
POLYCHAETA	ANNELIDA	*Spio armata*	VARIA	CHORDATA	*Solea solea*
POLYCHAETA	ANNELIDA	*Spio decoratus*	VARIA	CHORDATA	*Trachinus draco*
POLYCHAETA	ANNELIDA	*Spio filicornis*	VARIA	CHORDATA	*Trachurus trachurus*
POLYCHAETA	ANNELIDA	*Spiophanes bombyx*	VARIA	CHORDATA	*Trisopterus minutus*
POLYCHAETA	ANNELIDA	*Spiophanes kroyeri*	VARIA	CTENOPHORA	Ctenophora spp.
POLYCHAETA	ANNELIDA	*Sthenelais boa*	VARIA	ECHIURA	Echiura spp.
POLYCHAETA	ANNELIDA	Terebellidae	VARIA	NEMATODA	Nematoda
POLYCHAETA	ANNELIDA	*Travisia forbesii*	VARIA	NEMERTEA	Nemertea
VARIA	ARTHROPODA	*Achelia echinata*	VARIA	PORIFERA	Porifera
VARIA	ARTHROPODA	*Ammothella longipes*	VARIA	SIPUNCULA	Sipuncula
VARIA	ARTHROPODA	Pycnogonida	VARIA	SIPUNCULA	Sipunculidea
VARIA	BRYOZOA	*Alcyonidium diaphanum*			

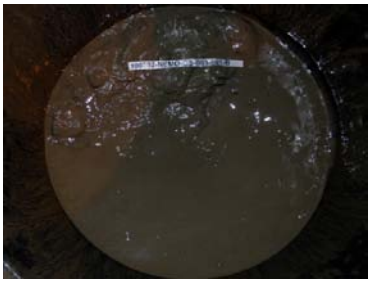
100702-NEMO-GS-B01-001

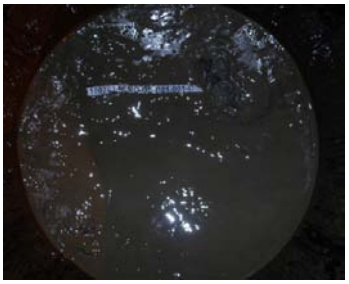
Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 12m

Sampled by:
Andrea Johansson







Grab id.	B01-001A	**Grab id.**	B01-001B	**Grab id.**	B01-001C
Easting	497417	**Easting**	497417	**Easting**	497417
Northing	5687890	**Northing**	5687890	**Northing**	5687890
Sample volume	6,5L	**Sample volume**	6L	**Sample volume**	7L

EUNIS Code: A5.24

Geo observation: Sand and silt dominating.

Habitat description:
Poor visibility, mostly sand and silt. Laminated composition, top layer covered with coarser silt/sand and shell fragments.

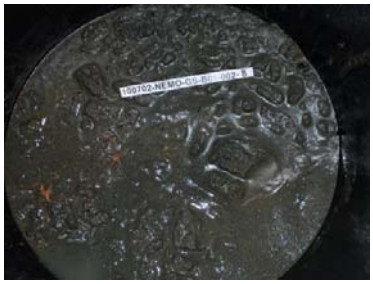
Additional note:

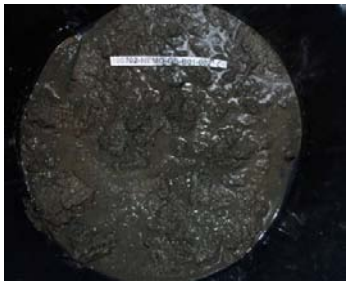
100702-NEMO-GS-B01-002

Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 19m

Sampled by:
Andrea Johansson





Grab id. B01-002A	**Grab id.** B01-002B	**Grab id.** B01-002C
Easting 4955582	**Easting** 4955582	**Easting** 4955583
Northing 5688054	**Northing** 5688055	**Northing** 5688055
Sample volume 6L	**Sample volume** 6L	**Sample volume** 7L

EUNIS Code: A5.24

Geo observation: Fine sand, rather stiff and unsorted.

Habitat description:
Poor visibility, mostly fine sand and silt.

Additional note:

100702-NEMO-GS-B01-003

Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 19m

Sampled by:
Andrea Johansson

Grab id. B01-003A	**Grab id.** B01-003B	**Grab id.** B01-003C
Easting 493466	**Easting** 493466	**Easting** 493466
Northing 5688414	**Northing** 5688413	**Northing** 5688491
Sample volume 11L	**Sample volume** 11L	**Sample volume** 11L

EUNIS Code: A5.24

Geo observation: Fine sand, rather stiff and unsorted.

Habitat description:
Poor visibility, mostly fine sand and silt.

Additional note:

100702-NEMO-GS-B01-004

Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 17m

Sampled by:
Per Hjelmstedt

Grab id. B01-004A	**Grab id.** B01-004B	**Grab id.** B01-004C
Easting 492662	**Easting** 492662	**Easting** 492662
Northing 5688496	**Northing** 5688495	**Northing** 5688495
Sample volume 5L	**Sample volume** 6L	**Sample volume** 9L

EUNIS Code: A5.24

Geo observation: Very soft silt and fine sand. Presence of hydrosulphide.

Habitat description:
Poor visibility, probably fine sand and silt. Samples quite anoxic.

Additional note: Five attempts were necessary to acquire sufficient samples. Attempt 2 and 3 were insufficient in sample size and were therefore discarded.

100702-NEMO-GS-B01-005

Date: 2010 - 09 - 27
Sampler: Day grab
Vessel: Ice Beam
Water depth: 18m

Sampled by:
Per Hjelmstedt
Iris Duranovic

Grab id. B01-005A	**Grab id.** B01-005B	**Grab id.** B01-005C
Easting 490393	**Easting** 490391	**Easting** 490391
Northing 5689065	**Northing** 5689065	**Northing** 5689065
Sample volume 5L	**Sample volume** 5L	**Sample volume** 4,5L

EUNIS Code: A5.23

Geo observation: Fine sand and silt, medium sorted.

Habitat description:
Poor visibility, probably fine sand and silt. Currents at 1,7 kn.

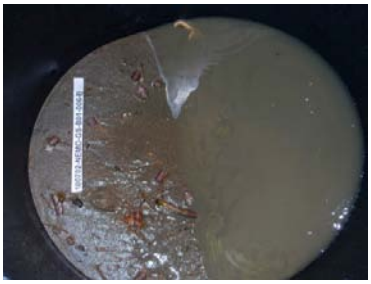
Additional note: Five attempts were necessary to acquire sufficient samples, these due to strong currents.

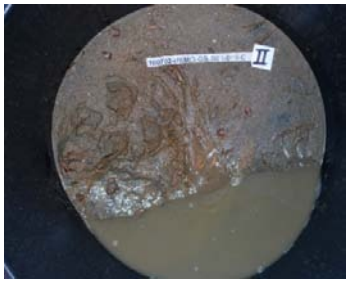
100702-NEMO-GS-B01-006

Date: 2010 - 09 - 23
Sampler: Day grab

Vessel: Ice Beam
Water depth: 21m

Sampled by:
Andrea Johansson
Anna Scherer





Grab id. B01-006A	**Grab id.** B01-006B	**Grab id.** B01-006C
Easting 487525	**Easting** 487526	**Easting** 487526
Northing 5689606	**Northing** 5689607	**Northing** 5689606
Sample volume 8,5L	**Sample volume** 8L	**Sample volume** 8L

EUNIS Code: A5.25

Geo observation: Fine sand appears to be well sorted.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish.

Additional note: For grab C the first sample was not sufficient and was discarded.
A second sample was of sufficient volume.

100702-NEMO-GS-B01-007

Date: 2010 - 09 - 24
Sampler: Day grab

Vessel: Ice Beam
Water depth: 26m

Sampled by:
Andrea Johansson
Anna Scherer

Grab id. B01-007A	**Grab id.** B01-007B	**Grab id.** B01-007C
Easting 483541	**Easting** 483539	**Easting** 483541
Northing 5688555	**Northing** 5688555	**Northing** 5688554
Sample volume 10L	**Sample volume** 12L	**Sample volume** 11L

EUNIS Code: A5.25

Geo observation: Well sorted, coarser sand.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish. Strong currents.

Additional note:

100702-NEMO-GS-B01-008

Date: 2010 - 09 - 24
Sampler: Day grab

Vessel: Ice Beam
Water depth: 17m

Sampled by:
Per Hjelmstedt
Iris Duranovic

Grab id. B01-008A	**Grab id.** B01-008B	**Grab id.** B01-008C
Easting 479217	**Easting** 479218	**Easting** 479217
Northing 5688335	**Northing** 5688335	**Northing** 5688334
Sample volume 12,5L	**Sample volume** 12,5L	**Sample volume** 11L

EUNIS Code: A5.23

Geo observation: Sand, silt. Sediment stirs up when DC is moved.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish. Strong currents.

Additional note:

100702-NEMO-GS-B01-009

Date: 2010 - 09 - 24
Sampler: Day grab

Vessel: Ice Beam
Water depth: 29m

Sampled by:
Per Hjelmstedt
Iris Duranovic

Grab id. B01-009A	**Grab id.** B01-009B	**Grab id.** B01-009C
Easting 468906	**Easting** 468906	**Easting** 468906
Northing 5689329	**Northing** 5689329	**Northing** 5689330
Sample volume 5L	**Sample volume** 5L	**Sample volume** 6L

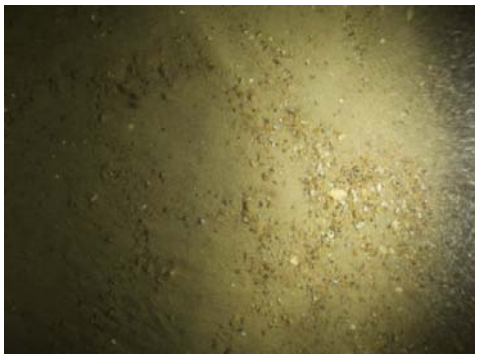
EUNIS Code: A5.25

Geo observation: Sand and silt.

Habitat description:
Visibility sufficient, fine sand and silt, medium sorted with occasional pebbles.
Strong currents.

Additional note:

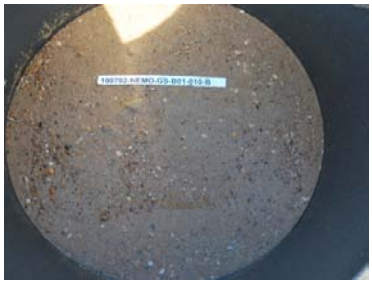
100702-NEMO-GS-B01-010



Date: 2010 - 09 - 24
Sampler: Day grab

Vessel: Ice Beam
Water depth: 29m

Sampled by:
Per Hjelmstedt
Iris Duranovic



Grab id. B01-010A	**Grab id.** B01-010B	**Grab id.** B01-010C
Easting 467065	**Easting** 467067	**Easting** 467065
Northing 5690950	**Northing** 5690951	**Northing** 5690949
Sample volume 7L	**Sample volume** 6L	**Sample volume** 6L

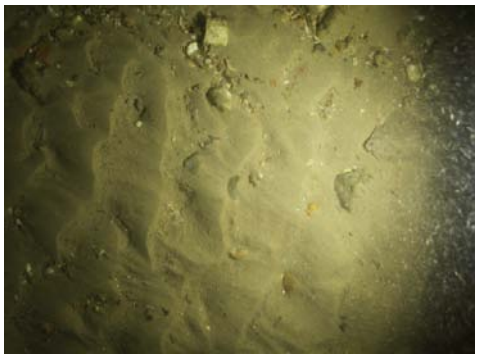
EUNIS Code: A5.25

Geo observation: Fine sand and some gravel.

Habitat description:
Visibility sufficient, fine sand and not much visible epifauna, well sorted.
Strong currents.

Additional note:

100702-NEMO-GS-B01-011



Date: 2010 - 09 - 24
Sampler: Day grab

Vessel: Ice Beam
Water depth: 29m

Sampled by:
Per Hjelmstedt
Anna Scherer
Andrea Johansson

Grab id. B01-011A	**Grab id.** B01-011B	**Grab id.** B01-011C
Easting 464767	**Easting** 464765	**Easting** 464765
Northing 5690839	**Northing** 5690840	**Northing** 5690839
Sample volume 10L	**Sample volume** 10L	**Sample volume** 9L

EUNIS Code: A5.25

Geo observation: Fine sand and some gravel.

Habitat description:
First attempt of sampling was aborted due to poor weather conditions. Second sampling had sufficient visibility, moderate currents. Some pebbles, fine sand and soft composition.

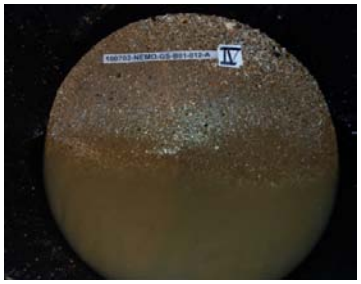
Additional note:

100702-NEMO-GS-B01-012

Date: 2010 - 09 - 26
Sampler: Day grab

Vessel: Ice Beam
Water depth: 38m

Sampled by:
Anna Scherer
Andrea Johansson



No sample photo was possible

Grab id. B01-012A	**Grab id.** B01-012B	**Grab id.** B01-012C
Easting 461178	**Easting** 461177	**Easting**
Northing 5689687	**Northing** 5689687	**Northing**
Sample volume 8L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Sand with ripples, shell fragments with a couple of stones

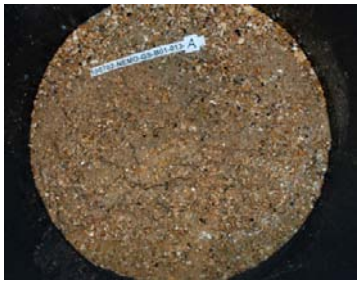
Additional note:
Sampling was difficult and five attempts were made. Only one sufficient sample was retrieved. 012B contained a stone, one attempt contained only water due to top lock being open. The other two attempts recovered insufficient sample volume due to stones being trapped in the opening when the Day grabber shut closed.

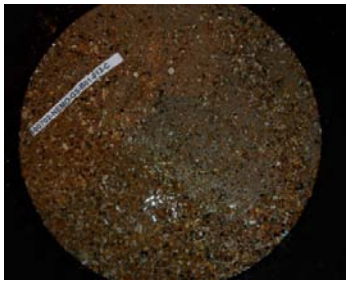
100702-NEMO-GS-B01-013

Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 28m

Sampled by:
Anna Scherer
Andrea Johansson





Grab id. B01-013A	**Grab id.** B01-013B	**Grab id.** B01-013C
Easting 457427	**Easting** 457427	**Easting** 457426
Northing 5688051	**Northing** 5688051	**Northing** 5688051
Sample volume 12L	**Sample volume** 11L	**Sample volume** 11L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

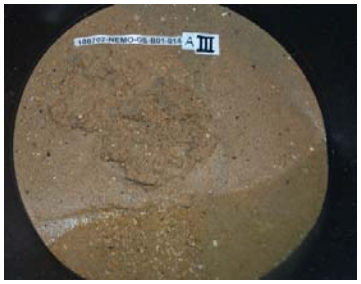
Habitat description:
Sand with few shell fragments with a couple of stones, slight ripples.

Additional note:

100702-NEMO-GS-B01-014

Date: 2010 - 09 - 26
Sampler: Day grab
Vessel: Ice Beam
Water depth: 33m

Sampled by:
Anna Scherer
Andrea Johansson



Grab id. B01-014A	**Grab id.** B01-014B	**Grab id.** B01-014C
Easting 457608	**Easting** 457609	**Easting** 457609
Northing 5688048	**Northing** 5688047	**Northing** 5688047
Sample volume 9L	**Sample volume** 12L	**Sample volume** 9L

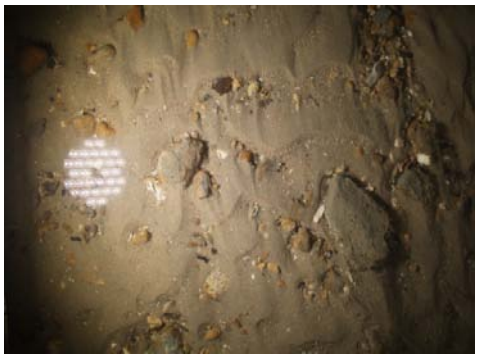
EUNIS Code: A5.24

Geo observation: Fine sand and soft.

Habitat description:
Sand with ripples, shell fragments with a couple of stones.

Additional note: Sampling was difficult and five attempts were made to attain three samples.

100702-NEMO-GS-B01-015



Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 40m

Sampled by:
Per Hjelmstedt
Iris Duranovic

Grab id. B01-015A	**Grab id.** B01-015B	**Grab id.** B01-015C
Easting 454992	**Easting** 454991	**Easting** 454992
Northing 5687268	**Northing** 5687268	**Northing** 5687268
Sample volume 9L	**Sample volume** 9,5L	**Sample volume** 10L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Fine sand with occasional stones, very strong currents.

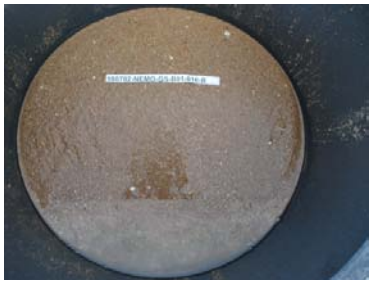
Additional note:

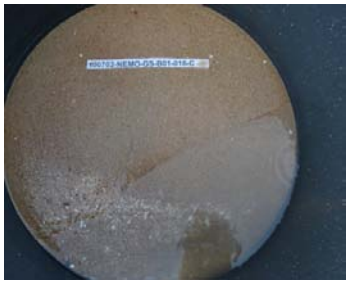
100702-NEMO-GS-B01-016

Date: 2010 - 09 - 27
Sampler: Day grab

Vessel: Ice Beam
Water depth: 22m

Sampled by:
Per Hjelmstedt
Iris Duranovic





Grab id. B01-016A	**Grab id.** B01-016B	**Grab id.** B01-016C
Easting 473336	**Easting** 473336	**Easting** 473337
Northing 5688993	**Northing** 5688993	**Northing** 5688993
Sample volume 5L	**Sample volume** 7L	**Sample volume** 6L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Very fine sand but low visibility appears to be well sorted.

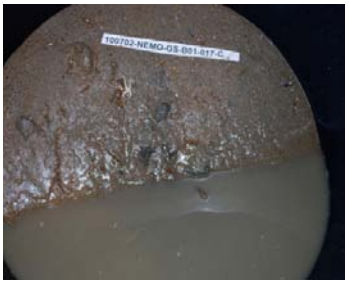
Additional note: Sampling was difficult, success after four trials.

100702-NEMO-GS-B01-017

Date: 2010 - 09 - 23
Sampler: Day grab

Vessel: Ice Beam
Water depth: 24m

Sampled by:
Andrea Johansson
Anna Scherer



Grab id. B01-017A	**Grab id.** B01-017B	**Grab id.** B01-017C
Easting 485842	**Easting** 485843	**Easting** 485842
Northing 5689248	**Northing** 5689248	**Northing** 5689248
Sample volume 8L	**Sample volume** 5L	**Sample volume** 9L

EUNIS Code: A5.25

Geo observation: Fine sand and well sorted.

Habitat description:
Sand with irregular ripples, brittle stars. No sign of shell fragments.
Low visibility due to high particular content in the water column.

Additional note:

100702-NEMO-GS-B01-018

No photo was possible

Date: 2010 - 10 - 14
Sampler: Day grab
Vessel: MPR1
Water depth: 10m

Sampled by:
Andrea Johansson

Grab id. B01-018A
Easting 501049
Northing 5687734
Sample volume 10L

Grab id. B01-018B
Easting 501049
Northing 5687734
Sample volume 9L

Grab id. B01-018C
Easting 501049
Northing 5687734
Sample volume 11L

EUNIS Code: A5.34

Geo observation: Fine sand and clay, very soft.

Habitat description:
No ability to describe site from sea floor photos due to murky water.

Additional note: No photo identification was possible.

100702-NEMO-GS-B01-019

No photo was possible

Date: 2010 - 10 - 14 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 8.6m

Sampled by:
Andrea Johansson

Grab id. B01-019A	**Grab id.** B01-019B	**Grab id.** B01-019C
Easting 503201	**Easting** 503201	**Easting** 503201
Northing 5687622	**Northing** 5687622	**Northing** 5687622
Sample volume 14L	**Sample volume** 7L	**Sample volume** 7L

EUNIS Code: A5.33

Geo observation: Sandy clay and silt, very soft.

Habitat description:
No photos were taken due to zero visibility on the previous station B01_018.
This station is situated in the same area and the same depth.

Additional note: Several attempts were necessary to retrieve samples.
No photo identification was possible.

100702-NEMO-GS-B01-020

No photo was possible

Date: 2010 - 10 - 14 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 8m

Sampled by:
Andrea Johansson

Grab id. B01-020A
Easting 503201
Northing 5687622
Sample volume 8L

Grab id. B01-020B
Easting 503201
Northing 5687622
Sample volume 10L

Grab id. B01-020C
Easting 503201
Northing 5687622
Sample volume 11L

EUNIS Code: A5.33

Geo observation: Sandy clay and silt, very soft.

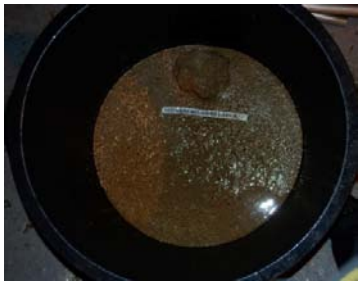
Habitat description:
No photos were taken due to zero visibility on the previous station B01-018.
This station is situated in the same area and about the same depth.

Additional note: Several attempts were necessary to retrieve samples.
No photo identification was possible.

100702-NEMO-GS-B02-021

Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 42m

Sampled by:
Andrea Johansson
Per Hjelmstedt
Anna Scherer



No sample for photo identification

Grab id. B02-021A	**Grab id.** B02-021B	**Grab id.** B02-021C
Easting 455282	**Easting**	**Easting**
Northing 5687273	**Northing**	**Northing**
Sample volume 8L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.25

Geo observation: Medium sorted, stones and sand.

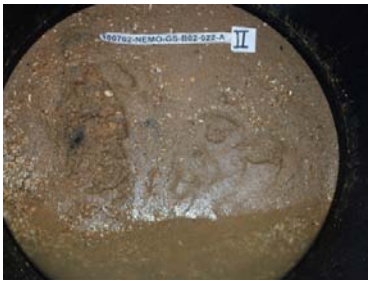
Habitat description:
Sand with high ridges and stones.

Additional note: Several attempts were necessary to retrieve samples, only one sufficient sample was retrieved.

100702-NEMO-GS-B02-022

Date: 2010 - 09 - 27
Sampler: Day grab
Vessel: Ice Beam
Water depth: 37m

Sampled by:
Anna Scherer



Grab id. B02-022A
Easting 454016
Northing 5686802
Sample volume 5L

Grab id. B02-022B
Easting 454016
Northing 5686804
Sample volume 6L

Grab id. B02-022C
Easting 454016
Northing 5686803
Sample volume 0L

EUNIS Code: A5.25

Geo observation: Fine sand

Habitat description:
Sand, stones and few shell fragments. Some hermit crabs.

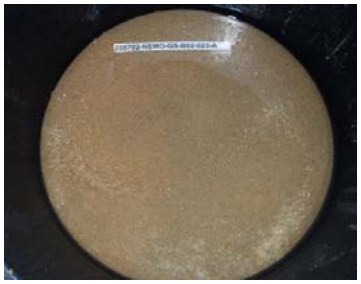
Additional note: Several attempts were necessary to retrieve samples, only two sufficient samples were retrieved.

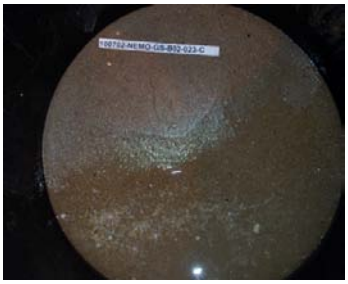
100702-NEMO-GS-B02-023

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 38m

Sampled by:
Anna Scherer





Grab id. B02-023A	**Grab id.** B02-023B	**Grab id.** B02-023C
Easting 451605	**Easting** 451605	**Easting** 451605
Northing 5686778	**Northing** 5686777	**Northing** 5686777
Sample volume 10L	**Sample volume** 11L	**Sample volume** 9L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Soft and fine sand.

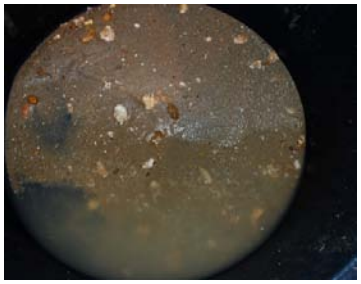
Additional note: Eunis code indicates infralittoral although its deeper then 20m this is because the fauna resembles that of code A5.233.

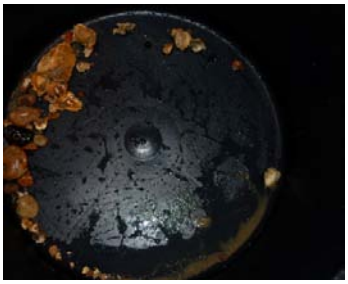
100702-NEMO-GS-B02-024

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 38m

Sampled by:
Per Hjelmstedt





Grab id. B02-024A	**Grab id.** B02-024B	**Grab id.** B02-024C
Easting 449052	**Easting** 449052	**Easting** 449053
Northing 5685125	**Northing** 5685125	**Northing** 5685127
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Fine sand and some cobble areas.

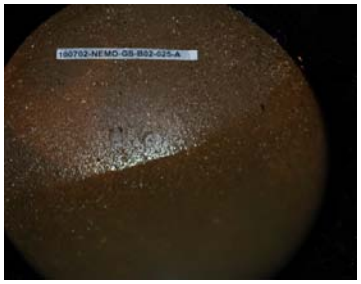
Additional note: Several attempts were necessary to retrieve samples, but no sufficient samples were possible. Eunis code indicates infralittoral although its deeper then 20m, this is because the fauna resembles that of code A5.233.

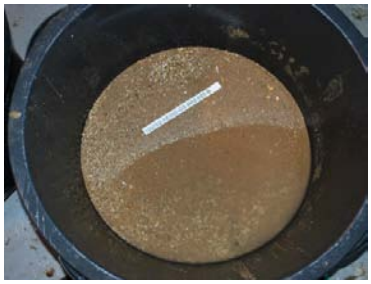
100702-NEMO-GS-B02-025

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 27m

Sampled by:
Per Hjelmstedt
Iris Duranovic





Grab id.	B02-025A	**Grab id.**	B02-025B	**Grab id.**	B02-025C
Easting	448045	**Easting**	448043	**Easting**	
Northing	5685205	**Northing**	5685205	**Northing**	
Sample volume	3L	**Sample volume**	6L	**Sample volume**	0L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Fine sand and some gravel and stones.

Additional note: Several attempts were necessary to retrieve samples, only two were possible. Eunis code indicates infralittoral although its deeper then 20m, this is because the fauna resembles that of code A5.233. Occasional stones.

100702-NEMO-GS-B02-026

Date: 2010 - 09 - 28
Sampler: Day grab
Vessel: Ice Beam
Water depth: 36m

Sampled by:
Per Hjelmstedt
Iris Duranovic

Grab id. B02-026A	**Grab id.** B02-026B	**Grab id.** B02-026C
Easting 4487096	**Easting**	**Easting**
Northing 5685290	**Northing**	**Northing**
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand and cobbles.

Habitat description:
Fine sand and some gravel with a lot of stones.

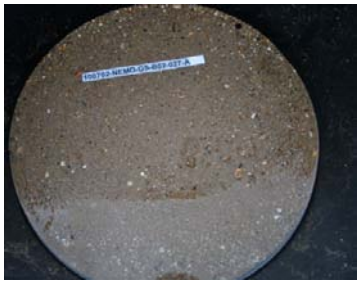
Additional note: Several attempts were necessary to retrieve samples, none were possible due to cobbles that got stuck in the grabber and prevented it from closing.

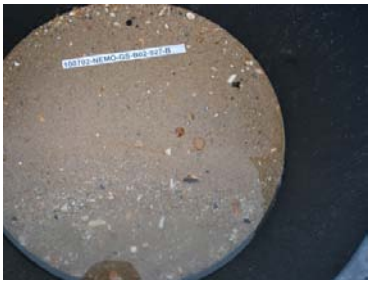
100702-NEMO-GS-B02-027

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 35m

Sampled by:
Per Hjelmstedt
Iris Duranovic





Grab id. B02-027A	**Grab id.** B02-027B	**Grab id.** B02-027C
Easting 445688	**Easting** 445688	**Easting** 445687
Northing 5685690	**Northing** 5685690	**Northing** 5685690
Sample volume 7L	**Sample volume** 6L	**Sample volume** 9L

EUNIS Code: A5.233

Geo observation: Sand and gravel.

Habitat description:
Well sorted, soft fine sand with some gravel. Good visibility,

Additional note:

100702-NEMO-GS-B02-028

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 32m

Sampled by:
Iris Duranovic

Grab id. B02-028A	**Grab id.** B02-028B	**Grab id.** B02-028C
Easting 441671	**Easting** 441671	**Easting** 441671
Northing 5686432	**Northing** 5686432	**Northing** 5686432
Sample volume 9L	**Sample volume** 7L	**Sample volume** 7L

EUNIS Code: A5.25

Geo observation: Sand and gravel.

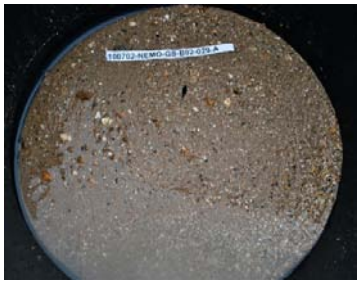
Habitat description:
Coarser sand, gravel and pebbles.

Additional note:

100702-NEMO-GS-B02-029

Date: 2010 - 09 - 28
Sampler: Day grab
Vessel: Ice Beam
Water depth: 37m

Sampled by:
Iris Duranovic



Grab id.	B02-029A	**Grab id.**	B02-029B	**Grab id.**	B02-029C
Easting	436734	**Easting**	436736	**Easting**	
Northing	5686299	**Northing**	5686299	**Northing**	
Sample volume	3L	**Sample volume**	2L	**Sample volume**	0L

EUNIS Code: A5.25

Geo observation: Sand and gravel.

Habitat description:
Fine sand and gravel, coarser substrate. Current at 1.7kn with good visibility.

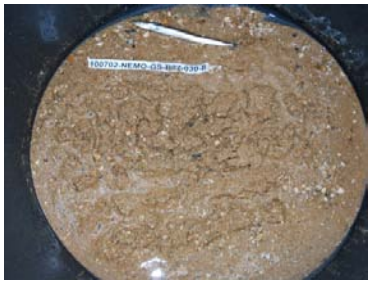
Additional note: Five attempts were performed and two sufficient samples were collected.

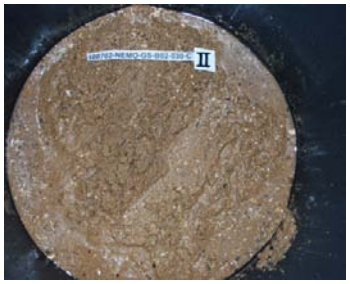
100702-NEMO-GS-B02-030

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 40m

Sampled by:
Anna Scherer





Grab id. B02-030A	**Grab id.** B02-030B	**Grab id.** B02-030C
Easting 433539	**Easting** 433538	**Easting** 433538
Northing 5686381	**Northing** 5686382	**Northing** 5686382
Sample volume 11L	**Sample volume** 9L	**Sample volume** 8L

EUNIS Code: A5.25

Geo observation: Fine sand.

Habitat description:
Fine sand and coarser sand with some shell fragments. Well sorted.

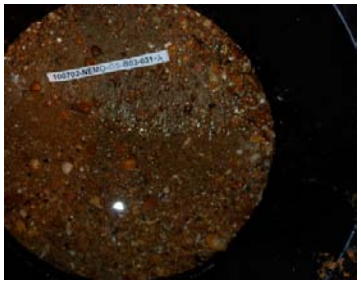
Additional note:

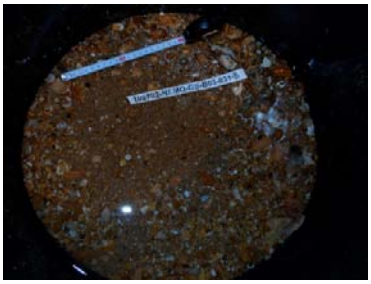
100702-NEMO-GS-B03-031

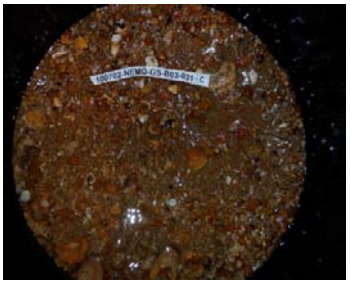
Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 32m

Sampled by:
Andrea Johansson







Grab id. B03-031A	**Grab id.** B03-031B	**Grab id.** B03-031C
Easting 431714	**Easting** 431714	**Easting** 431714
Northing 5686388	**Northing** 5686388	**Northing** 5686387
Sample volume 8L	**Sample volume** 8L	**Sample volume** 8L

EUNIS Code: A5.25

Geo observation: Fine sand and gravel.

Habitat description:
Fine sand and coarser sand with some shell fragments, unsorted.

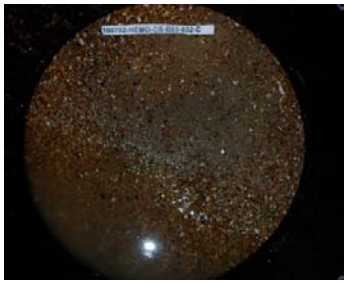
Additional note:

100702-NEMO-GS-B03-032

Date: 2010 - 09 - 28
Sampler: Day grab

Vessel: Ice Beam
Water depth: 42m

Sampled by:
Andrea Johansson



Grab id. B03-032A	**Grab id.** B03-032B	**Grab id.** B03-032C
Easting 427106	**Easting** 427106	**Easting** 427106
Northing 5686538	**Northing** 5686538	**Northing** 5686538
Sample volume 6L	**Sample volume** 11L	**Sample volume** 6L

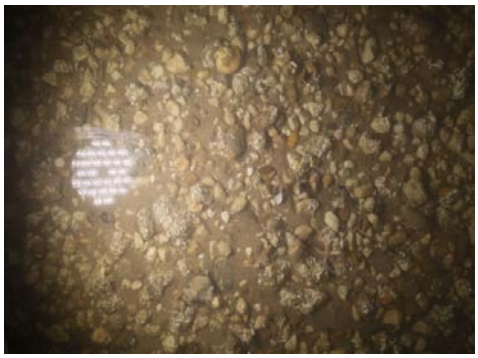
EUNIS Code: A5.145

Geo observation: Fine sand and coarse sand.

Habitat description:
Fine sand and coarser sand, soft.

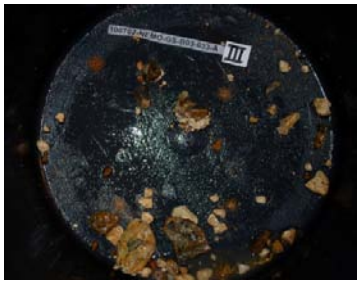
Additional note:

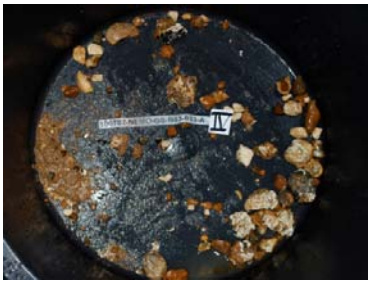
100702-NEMO-GS-B03-033



Date: 2010 - 09 - 28
Sampler: Day grab
Vessel: Ice Beam
Water depth: 40m

Sampled by:
Anna Scherer





Grab id. B03-033A
Easting 422672
Northing 5686733
Sample volume <1L

Grab id. B03-033B
Easting 422672
Northing 5686733
Sample volume <1L

Grab id. B03-033C
Easting 422672
Northing 5686733
Sample volume <1L

EUNIS Code: A5.141

Geo observation: Fine sand and silt.

Habitat description:
Fine sand, some silt and stones.

Additional note: No samples were possible due to the stones.

100702-NEMO-GS-B03-034

Date: 2010 - 09 - 28
Sampler: Day grab
Vessel: Ice Beam
Water depth: 40m

Sampled by:
Anna Scherer

Grab id. B03-034A	**Grab id.** B03-034B	**Grab id.** B03-034C
Easting 416373	**Easting** 416374	**Easting** 416373
Northing 5686853	**Northing** 5686853	**Northing** 5686852
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.141

Geo observation: Fine sand and silt.

Habitat description:
Fine sand, some silt and stones.

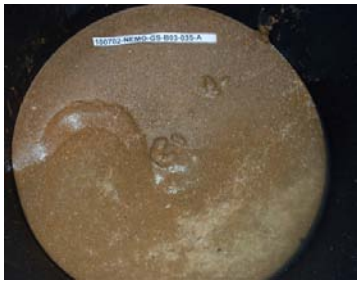
Additional note: No samples were possible due to the stones that got stuck in the grabber.

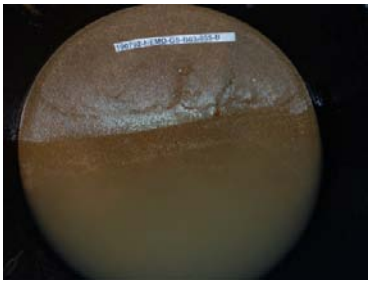
100702-NEMO-GS-B03-035

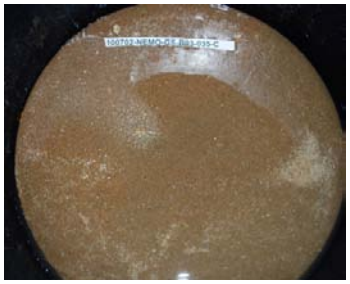
Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 20m

Sampled by:
Anna Scherer
Andrea Johansson







Grab id. B03-035A
Easting 414266
Northing 5686937
Sample volume 8L

Grab id. B03-035B
Easting 414265
Northing 5686937
Sample volume 8L

Grab id. B03-035C
Easting 414265
Northing 5686936
Sample volume 8L

EUNIS Code: A5.231

Geo observation: Fine sand.

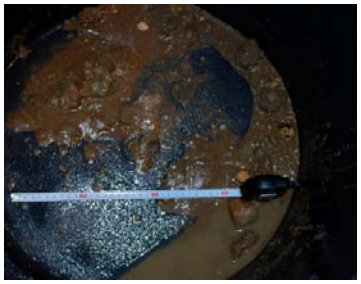
Habitat description:
Fine sand and ridges.

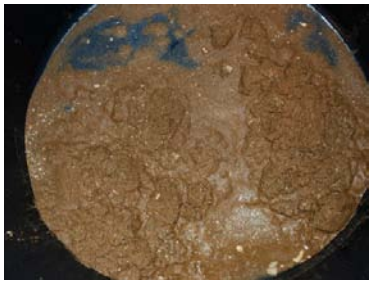
Additional note: No samples were possible due to the stones that got stuck in the grabber.

100702-NEMO-GS-B03-036

Date: 2010 - 09 - 29
Sampler: Day grab
Vessel: Ice Beam
Water depth: 48m

Sampled by:
Per Hjelmstedt





Grab id. B03-036A	**Grab id.** B03-036B	**Grab id.** B03-036C
Easting 412196	**Easting** 412198	**Easting** 412199
Northing 5687033	**Northing** 5687032	**Northing** 5687035
Sample volume <1L	**Sample volume** **<1**L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand.

Habitat description:
Sand bottom with stones and some silt, maybe some hydroids, poor visibility.
Currents at 2kn.

Additional note: Clumps of empty Sabellaria tubes. Difficult to retrieve any samples.

100702-NEMO-GS-B03-037

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 55m

Sampled by:
Per Hjelmstedt

Grab id. B03-037A	**Grab id.** B03-037B	**Grab id.** B03-037C
Easting 408770	**Easting** 408771	**Easting** 408770
Northing 5687304	**Northing** 5687303	**Northing** 5687304
Sample volume 8L	**Sample volume** 4L	**Sample volume** 7L

EUNIS Code: A5.25

Geo observation: Fine sand and silt.

Habitat description:
Poor visibility due to currents at 2kn. Sediments very soft with some stones buried under the loose upper layer.

Additional note: Clumps of empty Sabellaria tubes.

100702-NEMO-GS-B03-038

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 36m

Sampled by:
Per Hjelmstedt

Grab id. B03-038A	**Grab id.** B03-038B	**Grab id.** B03-038C
Easting 407401	**Easting** 407402	**Easting** 407405
Northing 5687145	**Northing** 5687144	**Northing** 5687141
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Stones and sand.

Habitat description:
Possibly Sabellaria, currents at 0,5kn.

Additional note: Stones made it hard to retrieve a sufficient sample.

100702-NEMO-GS-B03-039_0

Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 22m

Sampled by:
Iris Duranovic

Grab id. B03-039_0A	**Grab id.** B03-038_0B	**Grab id.** B03-038_0C
Easting 405998	**Easting**	**Easting**
Northing 5687204	**Northing**	**Northing**
Sample volume 0L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.611

Geo observation: Silt and fine sand.

Habitat description:
Currents at 1kn, low visibility. Possible reef structures of Sabellaria. In photos reef is dominating, appears to be 5-10 cm rise above sediment surface.

Additional note: No grab was retrieved due to Sabellaria reef but a transect was made. See transect DDV-B03-039_001, Appendix K.

100702-NEMO-GS-B03-039_2

Date: 2010 - 09 - 30
Sampler: Day grab

Vessel: Ice Beam
Water depth: 28m

Sampled by:
Andrea Johansson
Anna Scherer

Grab id. B03-039_2A	**Grab id.** B03-039_2B	**Grab id.** B03-039_2C
Easting 0405993	**Easting** 0405993	**Easting**
Northing 5687202	**Northing** 5687202	**Northing**
Sample volume 6L	**Sample volume** 9.5L	**Sample volume** <1L

EUNIS Code: A5.611

Geo observation: Fine sand, well sorted.

Habitat description:
Sabellaria reef, silt and sand. Reef structure approximately 7cm above sediment surface.

Additional note: Sabellaria reef was sampled, with only two successful samples.

100702-NEMO-GS-B03-040_0

Date: 2010 - 09 - 29
Sampler: Day grab
Vessel: Ice Beam
Water depth: 28m

Sampled by:
Anna Scherer
Andrea Johansson

Grab id. B03-040-0A	**Grab id.** B03-040_0B	**Grab id.** B03-040_0C
Easting 404304	**Easting**	**Easting**
Northing 5686851	**Northing**	**Northing**
Sample volume 0L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.611

Geo observation: Fine sand and Sabellaria.

Habitat description:
Sand and silt.

Additional note: Sabellaria reef apparent, no samples were taken at this point.

100702-NEMO-GS-B03-040_2

Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 28m

Sampled by:
Andrea Johansson
Anna Scherer

Grab id. B03-040_2A	**Grab id.** B03-040_2B	**Grab id.** B03-040_2C
Easting 404309	**Easting** 404309	**Easting** 404309
Northing 5686851	**Northing** 5686851	**Northing** 5686851
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.611

Geo observation: Fine sand, well sorted.

Habitat description:
Stones, covered with Sabellaria tubes.

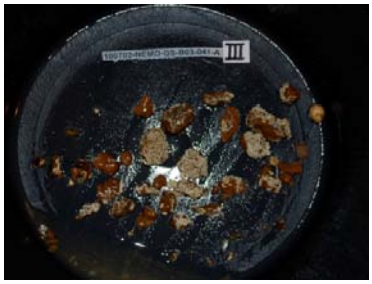
Additional note: Returned to position for B03_040 for attempted grab.

100702-NEMO-GS-B03-041

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 19m

Sampled by:
Andrea Johansson



Grab id. B03-041A	**Grab id.** B03-041B	**Grab id.** B03-041C
Easting 402231	**Easting** 402231	**Easting** 402231
Northing 5686507	**Northing** 5686507	**Northing** 5686508
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.141

Geo observation: Stones and coarse sand.

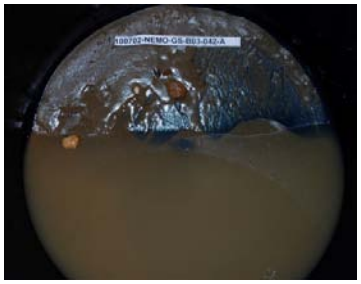
Habitat description:
Stones, covered with Serpulids. Visibility sufficient with currents at 1,3kn.

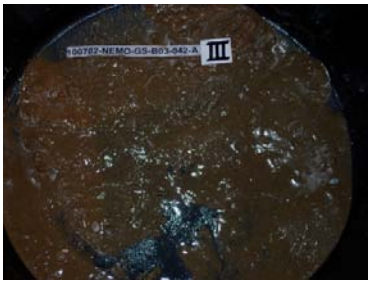
Additional note:

100702-NEMO-GS-B03-042

Date: 2010 - 09 - 29
Sampler: Day grab
Vessel: Ice Beam
Water depth: 43m

Sampled by:
Anna Scherer





Grab id. B03-042A	**Grab id.** B03-042B	**Grab id.** B03-042C
Easting 399159	**Easting** 399159	**Easting** 399159
Northing 5686401	**Northing** 5686401	**Northing** 5686400
Sample volume <1L	**Sample volume** <1L	**Sample volume** **<1**L

EUNIS Code: A5.25

Geo observation: Stones and fine sand.

Habitat description:
Poor to none visibility. Sand and stones, well sorted and soft sediment

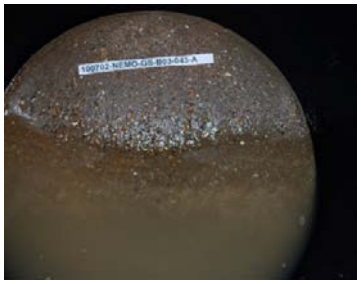
Additional note:

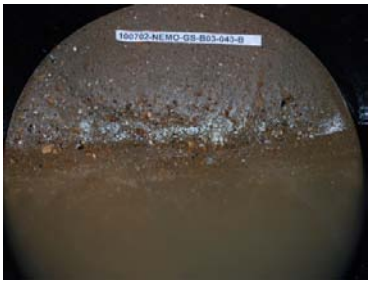
100702-NEMO-GS-B03-043

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 37m

Sampled by:
Anna Scherer





Grab id. B03-043A
Easting 397791
Northing 5686013
Sample volume 7L

Grab id. B03-043B
Easting 397791
Northing 5686013
Sample volume 6L

Grab id. B03-043C
Easting 397791
Northing 5686013
Sample volume 8L

EUNIS Code: A5.25

Geo observation: Stones and fine sand.

Habitat description:
Sand, well sorted and soft sediment.

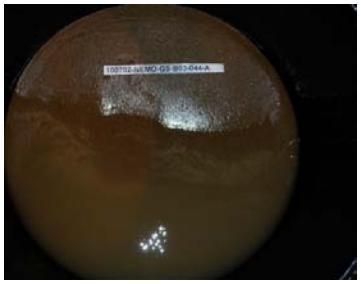
Additional note:

100702-NEMO-GS-B03-044

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 16m

Sampled by:
Andrea Johansson



Grab id. B03-044A
Easting 397256
Northing 5685814
Sample volume 6,5L

Grab id. B03-044B
Easting 397256
Northing 5685815
Sample volume 6L

Grab id. B03-044C
Easting 397255
Northing 5685815
Sample volume 6,5L

EUNIS Code: A5.23

Geo observation: Fine sand and well sorted sand.

Habitat description:
No visibility at all.

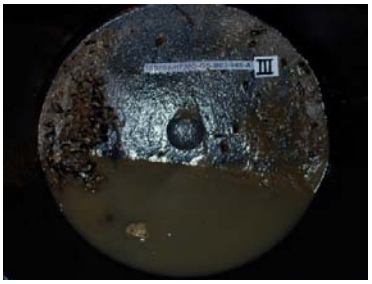
Additional note:

100702-NEMO-GS-B03-045

Date: 2010 - 09 - 29
Sampler: Day grab

Vessel: Ice Beam
Water depth: 12m

Sampled by:
Andrea Johansson



Grab id.	B03-045A	**Grab id.**	B03-045B	**Grab id.**	B03-045C
Easting	395600	**Easting**	395602	**Easting**	395602
Northing	5685353	**Northing**	5685353	**Northing**	5685356
Sample volume	<1L	**Sample volume**	<1L	**Sample volume**	<1L

EUNIS Code: A5.43

Geo observation: Fine sand and stones.

Habitat description:
Currents at 1,2kn and 6,6m/s wind resulting in low visibility.

Additional note: Sampling was difficult and did not result in any samples of sufficient volume.

100702-NEMO-GS-B03-046

Date: 2010 - 09 - 30
Sampler: Day grab
Vessel: Ice Beam
Water depth: 10m

Sampled by:
Iris Duranovic
Per Hjelmstedt

Grab id. B03-046A	**Grab id.** B03-046B	**Grab id.** B03-046C
Easting 391595	**Easting** 391595	**Easting** 391595
Northing 5685157	**Northing** 5685159	**Northing** 5685159
Sample volume 8L	**Sample volume** 11L	**Sample volume** 8L

EUNIS Code: A5.231

Geo observation: Fine sand and gravel.

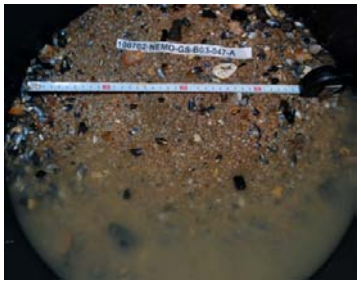
Habitat description:
No visibility at all, expects soft sand and silt.

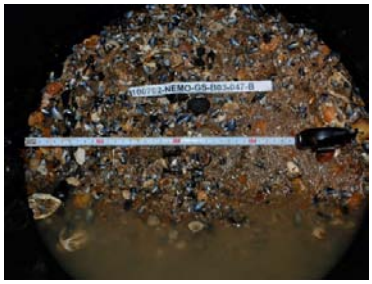
Additional note:

100702-NEMO-GS-B03-047

Date: 2010 - 09 - 30
Sampler: Day grab
Vessel: Ice Beam
Water depth: 12m

Sampled by:
Per Hjelmstedt





Grab id. B03-047A	**Grab id.** B03-047B	**Grab id.** B03-047C
Easting 392525	**Easting** 392524	**Easting** 392526
Northing 5685110	**Northing** 5685110	**Northing** 5685109
Sample volume 10L	**Sample volume** 6L	**Sample volume** 9L

EUNIS Code: A5.43

Geo observation: Unsorted, sand and gravel.

Habitat description:
No visibility at all, expect soft sand and silt.

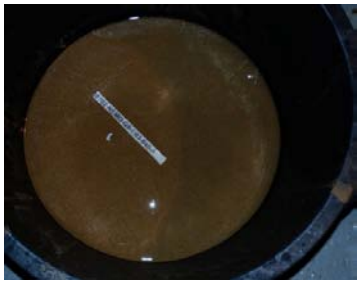
Additional note:

100702-NEMO-GS-B03-048

Date: 2010 - 09 - 30
Sampler: Day grab

Vessel: Ice Beam
Water depth: 9m

Sampled by:
Per Hjelmstedt
Iris Duranovic



Grab id. B03-048A	**Grab id.** B03-048B	**Grab id.** B03-048C
Easting 391993	**Easting** 391994	**Easting** 391995
Northing 5684854	**Northing** 5684853	**Northing** 5684853
Sample volume 5L	**Sample volume** 4L	**Sample volume** 4L

EUNIS Code: A5.23

Geo observation: Well sorted and soft fine sand.

Habitat description:
No visibility at all, expected soft sand and silt.
High currents and harsh wind.

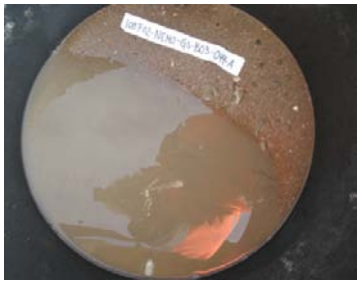
Additional note:

100702-NEMO-GS-B03-049

No photo was possible

Date: 2010 - 10 - 18
Sampler: Day grab
Vessel: MPR1
Water depth: 2m

Sampled by:
Andrea Johansson



Grab id.	B03-049A	**Grab id.**	B03-049B	**Grab id.**	B03-049C
Easting	389215	**Easting**	389215	**Easting**	389215
Northing	5685981	**Northing**	5685981	**Northing**	5685981
Sample volume	7L	**Sample volume**	8L	**Sample volume**	9L

EUNIS Code: A5.23

Geo observation: Mixed sediment.

Habitat description:

Not able to describe site from sea floor photos,
due to only 2m depth, which was to shallows for the camera.

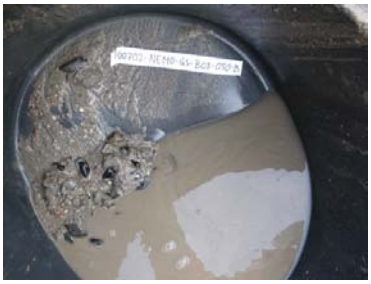
Additional note:

100702-NEMO-GS-B03-050

No photo was possible

Date: 2010 - 10 - 18 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 3m

Sampled by:
Andrea Johansson



Grab id. B03-050 A	**Grab id.** B03-050 B	**Grab id.** B03-050 C
Easting 388933	**Easting** 388933	**Easting** 388933
Northing 5686257	**Northing** 5686257	**Northing** 5686257
Sample volume 7L	**Sample volume** 6.5L	**Sample volume** 7L

EUNIS Code: A5.24

Geo observation: Mixed sediment.

Habitat description:
Not able to describe site from sea floor photos due to murky water.
Old Sabellaria reef fragments, no sign of living Sabellaria.

Additional note:

	Raw data Abundance Block 01				Comment							
	RED=Grab not approved **YELLOW=Grab low volume, but analysed** **BLUE=Grab approved** **P=Present**											
Phylum	**Species**	**B01-001-A**	**B01-001-B**	**B01-001-C**		**B01-002-A**	**B01-002-B**	**B01-002-C**		**B01-003-A**	**B01-003-B**	**B01-003-C**
Cnidaria	Actinaria spp.					1					16	
Cnidaria	Anthozoa spp.											
Cnidaria	Campanulinidae spp.											
Cnidaria	Diphasia spp.											
Cnidaria	Hydrallmania falcata											
Cnidaria	Hydrozoa spp.											
Cnidaria	Nemertesia sp.											
Cnidaria	Obelia spp.											
Cnidaria	Rhizorhagium roseum											
Cnidaria	Sertulariidae											
Cnidaria	Tubularia indivisa											
Cnidaria	Tubularia spp.											
	Individuals	0	0	0		1	0	0		0	16	0
	Taxa	**0**	**0**	**0**		**1**	**0**	**0**		**0**	**1**	**0**
Arthropoda	Abludomelita obtusata											
Arthropoda	Ampelisca brevicornis											
Arthropoda	Ampelisca spinipes											
Arthropoda	Ampelisca spp.											
Arthropoda	Aora gracilis											
Arthropoda	Aoridae spp.											
Arthropoda	Autonoe longipes											
Arthropoda	Balanus balanus											
Arthropoda	Balanus spp.											
Arthropoda	Bathyporeia elegans											
Arthropoda	Bathyporeia guilliamsoniana											
Arthropoda	Bathyporeia nana											
Arthropoda	Bathyporeia sarsi											
Arthropoda	Bathyporeia spp.											
Arthropoda	Bathyporeia tenuipes											
Arthropoda	Bodotria scorpioides											
Arthropoda	Brachyura spp.											
Arthropoda	Campylaspis spp.											
Arthropoda	Carcinus maenas											
Arthropoda	Copepoda spp.											

Phylum	Species	B01-001-A	B01-001-B	B01-001-C	B01-002-A	B01-002-B	B01-002-C	B01-003-A	B01-003-B	B01-003-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon		3				1			
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa		1	1						
Arthropoda	Diastylis spp.							2	1	
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus	2			1					
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	2	4	1		1	0	1		2	1	0	
	Taxa	**1**	**2**	**1**		**1**	**0**	**1**		**1**	**1**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens	1				3							
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura		1			1	6	2		2	2		
Echinodermata	Ophiura sarsii					1						2	
Echinodermata	Ophiura spp.					5		1					
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	1	1	0		10	6	3		2	2	2	
	Taxa	**1**	**1**	**0**		**4**	**1**	**2**		**1**	**1**	**1**	
Mollusca	Abra alba			1		8						1	
Mollusca	Abra nitida										2		
Mollusca	Abra prismatica												
Mollusca	Abra spp.					1		1					
Mollusca	Abra tenuis												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus	71		119		16	3			16	28	21	
Mollusca	Ensis spp.		70			11		19			1		
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata										1		
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa											1	
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.						2						
	Individuals	71	70	120		36	5	20		16	32	23	
	Taxa	**1**	**1**	**2**		**4**	**2**	**2**		**1**	**4**	**3**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.							1					
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis	8	1	20				2					
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima					2							
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis	1	1				1	3		14			
Annelida	Lagis koreni												
Annelida	Lanice conchilega					5							
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii	3	2	1		1				2	5	1	
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus									1			
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	107	24	40		2785	75	72		256	1520	1012	
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx	1	1	1				1					
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	120	29	62		2793	76	79		273	1525	1013	
	Taxa	**5**	**5**	**4**		**4**	**2**	**5**		**4**	**2**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.											P	
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea					1							
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		1	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**1**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Cnidaria	Actinaria spp.	1								
Cnidaria	Anthozoa spp.		23	94						
Cnidaria	Campanulinidae spp.					P				
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.					P		P		
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	1	23	94	0	0	0	0	0	0
	Taxa	**1**	**1**	**1**	**0**	**2**	**0**	**1**	**0**	**0**
Arthropoda	Abludomelita obtusata								1	
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis							1		
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.							1		
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon				1		1			
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.							4	4	
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									1
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus			1						
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus							1		
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus					1			2	
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.									
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis									
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.									
	Individuals	0	0	1	1	1	1	7	7	1
	Taxa	**0**	**0**	**1**	**1**	**1**	**1**	**4**	**3**	**1**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens							1	2	
Echinodermata	Echinocardium cordatum					2	5	1		
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus									
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis							1		
Echinodermata	Ophiura albida				18	3	1	2	4	
Echinodermata	Ophiura ophiura	2	2		1		1	1	2	2
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.				1	1				
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.							1		
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	2	2	0	20	6	7	7	8	2
	Taxa	**1**	**1**	**0**	**3**	**3**	**3**	**6**	**3**	**1**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.					3				
Mollusca	Abra tenuis									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C		B01-005-A	B01-005-B	B01-005-C		B01-006-A	B01-006-B	B01-006-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.	1				2	1			1	1		
Mollusca	Corbula gibba												
Mollusca	Ensis magnus									38		1	
Mollusca	Ensis spp.					1					68	55	
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata		4				2	1					
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.		6										
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica											1	
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa	1	93										
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	2	103	0		3	6	1		39	69	57	
	Taxa	**2**	**3**	**0**		**2**	**3**	**1**		**2**	**2**	**3**	
Mollusca	Buccinum undatum							1					
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella									1			
Mollusca	Gastropoda spp.						2				1		
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	2	1		1	1	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**1**		**1**	**1**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea			1									
Annelida	Ampharete												

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex	8	2			1		1	5	4
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata				5					
Annelida	Caulleriella killariensis		2				1			
Annelida	Chaetozone setosa				1	1	1	1		
Annelida	Cirratulidae spp.				3	4	3			
Annelida	Dipolydora flava									
Annelida	Eteone spp.								1	1
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis				2			1	4	
Annelida	Eumida sanguinea								2	
Annelida	Eumida spp.							1		
Annelida	Eunereis longissima			6	4	2	2		2	
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta		1	1		1				
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis	2			4	2	5			1
Annelida	Lagis koreni		1	1	2	4	1			3
Annelida	Lanice conchilega				21	15	4	106	92	90
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis				1	1	1			
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Annelida	Nephtys cirrosa								1	
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									
Annelida	Notomastus latericeus			5	1	6	3	1	1	
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis	61	120	3185	213	320	94	17	25	13
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica					1	1			
Annelida	Pholoe inornata									
Annelida	Pholoe spp.			2						
Annelida	Phyllodoce citrina					1				
Annelida	Phyllodoce groenlandica								1	
Annelida	Phyllodoce mucosa				6	2	2	7		4
Annelida	Phyllodoce spp.							2	1	
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra							3	3	2
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger				2	1	2			2
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis					1	1		2	1
Annelida	Spiophanes bombyx				11	17	2	41	62	63
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa			1	2					
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	71	126	3202	278	385	126	184	205	184
	Taxa	**3**	**5**	**8**	**15**	**16**	**15**	**11**	**14**	**11**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum							P		

Phylum	Species	B01-004-A	B01-004-B	B01-004-C		B01-005-A	B01-005-B	B01-005-C		B01-006-A	B01-006-B	B01-006-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.					2	2	1			1	6	
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.			6									
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.										1		
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	6		2	2	1		0	2	6	
	Taxa	**0**	**0**	**1**		**1**	**1**	**1**		**1**	**2**	**1**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Cnidaria	Actinaria spp.	18											
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.										P	P	
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	18	0	0		0	0	0		0	0	0	
	Taxa	**1**	**0**	**0**		**0**	**0**	**0**		**0**	**1**	**1**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans									1			
Arthropoda	Bathyporeia guilliamsoniana										1		
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.						3						

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.					1	2						
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa									1			
Arthropoda	Diastylis spp.											1	
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus		1										
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.											1	
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus		1	1									
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis		2										
Arthropoda	Podoceridae spp.												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.			1									
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata		1	1						1		2	
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.						4						
	Individuals	0	5	3		1	9	0		3	1	4	
	Taxa	**0**	**4**	**3**		**1**	**3**	**0**		**3**	**1**	**3**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum	4	3	1							1	1	
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus		1				1	2					
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis	1											
Echinodermata	Ophiura albida	4											
Echinodermata	Ophiura ophiura	3											
Echinodermata	Ophiura sarsii	1											
Echinodermata	Ophiura spp.									1			
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	13	4	1		0	1	2		1	1	1	
	Taxa	**5**	**2**	**1**		**0**	**1**	**1**		**1**	**1**	**1**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica	3											
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.		1										
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris							2					
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.		1										
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.							3					
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea							2					
Mollusca	Tellinidae spp.					3							
	Individuals	3	2	0		3	0	7		0	0	0	
	Taxa	**1**	**2**	**0**		**1**	**0**	**3**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea		1										
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus	3											
Mollusca	Odostomia unidentata												
	Individuals	3	1	0		0	0	0		0	0	0	
	Taxa	**1**	**1**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata			1									
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex		1										
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata	1											
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis	8				1							
Annelida	Eumida sanguinea												
Annelida	Eumida spp.	1											
Annelida	Eunereis longissima	1											
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum					2	1						
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata					1	18	4					
Annelida	Heteromastus filiformis		1										
Annelida	Lagis koreni	8	1										
Annelida	Lanice conchilega	116											
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Annelida	Nephtys cirrosa		2	2						2	2	4	
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.						1			1	1		
Annelida	Notomastus latericeus		3										
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	76	2										
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota					1	1						
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus					1	2	1					
Annelida	Pseudopolydora pulchra	1											
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus						2						
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger	1		1									
Annelida	Sphaerosyllis bulbosa						11	2					
Annelida	Spio armata												
Annelida	Spio decoratus		1										
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx	10		1						2	1	4	
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	230	14	5		6	36	7		5	4	8	
	Taxa	**10**	**7**	**4**		**5**	**7**	**3**		**3**	**3**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.	P		1									
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.											1	
Bryozoa	Electra pilosa		P										
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.		2			15	36						
Nemertea	Nemertea spp.					1						2	
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.		1										
Sipuncula	Sipunculidea spp.	26											
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	26	3	1		16	36	0		0	0	3	
	Taxa	**2**	**3**	**1**		**2**	**1**	**0**		**0**	**0**	**2**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

B01-012 resulted in two approved grabs.

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.	P								
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana						1			
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.	1		1	2					
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.			1						
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.						1			
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.		1							
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.		1							
Arthropoda	Oedicerotidae spp.	1	1	1						
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.	2					1			
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis						5			
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.				19	21				
	Individuals	4	3	3	21	21	8	0	0	0
	Taxa	**3**	**3**	**3**	**2**	**1**	**4**	**0**	**0**	**0**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens									
Echinodermata	Echinocardium cordatum				5	7				
Echinodermata	Echinocardium flavescens						6			
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus							78		
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis				6					
Echinodermata	Ophiura albida					3				
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.						1			
Echinodermata	Ophiurae spp.			1						
Echinodermata	Ophiuroidea spp.							3		
Echinodermata	Psammechinus miliaris							1		
Echinodermata	Spatangoida spp.			1						
	Individuals	0	0	2	11	10	7	82	0	0
	Taxa	**0**	**0**	**2**	**2**	**2**	**2**	**3**	**0**	**0**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Mollusca	Arca tetragona							2		
Mollusca	Bivalvia spp.									
Mollusca	Corbula gibba									
Mollusca	Ensis magnus									
Mollusca	Ensis spp.									
Mollusca	Glycymeris glycymeris									
Mollusca	Glycymeris spp.									
Mollusca	Goodallia triangularis									
Mollusca	Kurtiella bidentata									
Mollusca	Macoma balthica									
Mollusca	Mactridae spp.									
Mollusca	Mya spp.									
Mollusca	Mytilus spp.									
Mollusca	Mytilidae spp.									
Mollusca	Nucula nitidosa									
Mollusca	Nucula sulcata									
Mollusca	Spisula elliptica									
Mollusca	Tapes spp.									
Mollusca	Tellimya ferruginosa									
Mollusca	Tellina fabula									
Mollusca	Tellina pygmaea									
Mollusca	Tellinidae spp.									
	Individuals	0	0	0	0	0	0	2	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Mollusca	Buccinum undatum									
Mollusca	Chauvetia brunnea									
Mollusca	Euspira montagui									
Mollusca	Euspira pulchella									
Mollusca	Gastropoda spp.									
Mollusca	Gibbula spp.									
Mollusca	Nassarius nitidus									
Mollusca	Nassarius reticulatus									
Mollusca	Odostomia unidentata									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mollusca	Nudibranchia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annelida	Alitta succinea									
Annelida	Ampharete									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata							2		
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum							1		
Annelida	Glycera oxycephala									
Annelida	Glycera spp.							2		
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni							1		
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Annelida	Nephtys cirrosa	1	3		2	7	9			
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.			1						
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis							1		
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata			1						
Annelida	Spio decoratus									
Annelida	Spio filicornis							1		
Annelida	Spiophanes bombyx					1	1			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	1	3	2	2	8	10	8	0	0
	Taxa	**1**	**1**	**2**	**1**	**2**	**2**	**6**	**0**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C		B01-011-A	B01-011-B	B01-011-C		B01-012-A	B01-012-B	B01-012-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana					1				
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									2
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer								5	
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus					1				
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.								2	
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata			1			1			
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis					1		1		1
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.				4			1		1
	Individuals	0	0	1	4	3	1	2	7	4
	Taxa	**0**	**0**	**1**	**1**	**3**	**2**	**2**	**2**	**3**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens									
Echinodermata	Echinocardium cordatum									
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.				3					
Echinodermata	Echinocyamus pusillus	1		2				2	1	6
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis					1				
Echinodermata	Ophiura albida									
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.				1					
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.									
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	1	0	2	4	1	0	2	1	6
	Taxa	**1**	**0**	**1**	**2**	**1**	**0**	**1**	**1**	**1**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C		B01-014-A	B01-014-B	B01-014-C		B01-015-A	B01-015-B	B01-015-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.		1										
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica			1				1		1	1		
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea											1	
Mollusca	Tellinidae spp.												
	Individuals	0	1	1		0	0	1		1	1	1	
	Taxa	**0**	**1**	**1**		**0**	**0**	**1**		**1**	**1**	**1**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum		3	1						1
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata		1	1				1		
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni									
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Annelida	Nephtys cirrosa			1	7	7		1	1	3
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									1
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina			1						
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota			2						
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus		1							
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata				1	1	1			3
Annelida	Spio decoratus									
Annelida	Spio filicornis						1			
Annelida	Spiophanes bombyx						1			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	0	5	6	8	8	3	2	1	8
	Taxa	**0**	**3**	**5**	**2**	**2**	**3**	**2**	**1**	**4**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C		B01-014-A	B01-014-B	B01-014-C		B01-015-A	B01-015-B	B01-015-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera							1					
Echiura	Echiura spp.			1									
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.							1					
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.						1						
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	1		0	1	2		0	0	0	
	Taxa	**0**	**0**	**1**		**0**	**1**	**2**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Cnidaria	Actinaria spp.					2							
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.									P			
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.									P			
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum						P						
Cnidaria	Sertulariidae											p	
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		2	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**1**	**0**		**2**	**0**	**1**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.							1					
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes							2					
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides							1					
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni								1	
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.				1					
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra								1	
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.						2			
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.					1				
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.						1			
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa						1			
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus					1				
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.			1		1				
Arthropoda	Pagurus bernhardus					1	2			
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata							1					
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides						2						
Arthropoda	Stenothoe monoculoides						1						
Arthropoda	Thia scutellata	1				1							
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	1	0	1		2	7	11		0	2	0	
	Taxa	**1**	**0**	**1**		**2**	**6**	**8**		**0**	**2**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum		1			3	1	3					
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.									1			
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida	1		1		1		1					
Echinodermata	Ophiura ophiura										1		
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.							1					
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	1	1	1		4	1	5		1	1	0	
	Taxa	**1**	**1**	**1**		**2**	**1**	**3**		**1**	**1**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.							1					
Mollusca	Abra tenuis									31			

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.					1	1						
Mollusca	Corbula gibba												
Mollusca	Ensis magnus						1				1	1	
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica										60	37	
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica		1			1							
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula						1						
Mollusca	Tellina pygmaea							1					
Mollusca	Tellinidae spp.												
	Individuals	0	1	0		2	3	2		31	61	38	
	Taxa	**0**	**1**	**0**		**2**	**3**	**2**		**1**	**2**	**2**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus	1				1							
Mollusca	Odostomia unidentata												
	Individuals	1	0	0		1	0	0		0	0	0	
	Taxa	**1**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis							61	48	18
Annelida	Chaetozone setosa				3	1	3			
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava					1				
Annelida	Eteone spp.				1		2			
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis				1		6			
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima						1			
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									1
Annelida	Lagis koreni									
Annelida	Lanice conchilega				21	7	19			
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni				4	1	6			
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis						1			

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Annelida	Nephtys cirrosa	10	13	14	3					
Annelida	Nephtys hombergii				1				1	
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.				1		1			
Annelida	Notomastus latericeus							29	32	
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis				1	1	60	3	23	4
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra						1			
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger				2	1	1			
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis				3		2			
Annelida	Spiophanes bombyx	2		2	10	2	16			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	15	13	16	54	14	119	93	104	23
	Taxa	**2**	**1**	**2**	**12**	**7**	**13**	**3**	**4**	**3**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.									1			
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus							1					
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	1		1	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**1**	**0**	**0**	

	Raw data Abundan							
	RED=Grab not approved **YELLOW=Grab low volume, but ana** **BLUE=Grab approved** **P=Present**							
Phylum	**Species**	**B01-019-A**	**B01-019-B**	**B01-019-C**		**B01-020-A**	**B01-020-B**	**B01-020-C**
Cnidaria	Actinaria spp.						1	
Cnidaria	Anthozoa spp.		2			2		
Cnidaria	Campanulinidae spp.							
Cnidaria	Diphasia spp.							
Cnidaria	Hydrallmania falcata							
Cnidaria	Hydrozoa spp.	P						P
Cnidaria	Nemertesia sp.							
Cnidaria	Obelia spp.					P		
Cnidaria	Rhizorhagium roseum							
Cnidaria	Sertulariidae							
Cnidaria	Tubularia indivisa					P		
Cnidaria	Tubularia spp.							
	Individuals	0	2	0		2	1	0
	Taxa	**1**	**1**	**0**		**3**	**1**	**1**
Arthropoda	Abludomelita obtusata							
Arthropoda	Ampelisca brevicornis							
Arthropoda	Ampelisca spinipes							
Arthropoda	Ampelisca spp.							
Arthropoda	Aora gracilis							
Arthropoda	Aoridae spp.							
Arthropoda	Autonoe longipes							
Arthropoda	Balanus balanus							
Arthropoda	Balanus spp.							
Arthropoda	Bathyporeia elegans							
Arthropoda	Bathyporeia guilliamsoniana							
Arthropoda	Bathyporeia nana							
Arthropoda	Bathyporeia sarsi							
Arthropoda	Bathyporeia spp.							
Arthropoda	Bathyporeia tenuipes							
Arthropoda	Bodotria scorpioides							
Arthropoda	Brachyura spp.							
Arthropoda	Campylaspis spp.							
Arthropoda	Carcinus maenas					1		
Arthropoda	Copepoda spp.							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Arthropoda	Corophium spp.							
Arthropoda	Crangon allmanni							
Arthropoda	Crangon crangon		2			1		1
Arthropoda	Crangon spp.							
Arthropoda	Crustacea spp.							
Arthropoda	Dendrobranchiata spp.							
Arthropoda	Dexaminidae spp.							
Arthropoda	Diastylis glabra							
Arthropoda	Diastylis rugosa							
Arthropoda	Diastylis spp.			3		1		
Arthropoda	Euphausiacea spp.							
Arthropoda	Galathea intermedia							
Arthropoda	Galathea spp.							
Arthropoda	Gammaridae spp.							
Arthropoda	Gammaridea spp.							
Arthropoda	Gammaropsis maculata							
Arthropoda	Gammarus spp.					1		
Arthropoda	Gastrosaccus spinifer							
Arthropoda	Haustoriidae spp.							
Arthropoda	Hippomedon denticulatus							
Arthropoda	Idotea linearis					1		
Arthropoda	Isopoda spp.							
Arthropoda	Leucothoe incisa							
Arthropoda	Leucothoe spp.							
Arthropoda	Liocarcinus holsatus							
Arthropoda	Liocarcinus marmoreus							1
Arthropoda	Liocarcinus pusillus							
Arthropoda	Liocarcinus spp.							
Arthropoda	Lysianassidae spp.							
Arthropoda	Monoculodes carinatus							
Arthropoda	Mysidae spp.							
Arthropoda	Oedicerotidae spp.							
Arthropoda	Paguridae spp.							
Arthropoda	Pagurus bernhardus							
Arthropoda	Pagurus spp.							
Arthropoda	Pariambus typicus							
Arthropoda	Pilumnus spp.							
Arthropoda	Pinnotheres pisum							
Arthropoda	Pisidia longicornis	1						
Arthropoda	Podoceridae spp.							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Arthropoda	Pontoporeiidae spp.							
Arthropoda	Porcellanidae spp.							
Arthropoda	Portunidae spp.							
Arthropoda	Processa canaliculata							
Arthropoda	Processa spp.							
Arthropoda	Semibalanus balanoides							
Arthropoda	Stenothoe monoculoides							
Arthropoda	Thia scutellata							
Arthropoda	Upogebia stellata							
Arthropoda	Urothoe brevicornis							
Arthropoda	Urothoe elegans							
Arthropoda	Urothoe marina							
Arthropoda	Urothoe spp.							
	Individuals	1	2	3		5	0	2
	Taxa	**1**	**1**	**1**		**5**	**1**	**2**
Echinodermata	Amphipholis squamata							
Echinodermata	Amphiuridae spp.							
Echinodermata	Asterias rubens					8		4
Echinodermata	Echinocardium cordatum							
Echinodermata	Echinocardium flavescens							
Echinodermata	Echinocardium spp.							
Echinodermata	Echinocyamus pusillus							
Echinodermata	Holothurioidea spp.							
Echinodermata	Leptasterias muelleri							
Echinodermata	Ophiocten affinis							
Echinodermata	Ophiura albida							
Echinodermata	Ophiura ophiura					1		
Echinodermata	Ophiura sarsii							
Echinodermata	Ophiura spp.							
Echinodermata	Ophiurae spp.							
Echinodermata	Ophiuroidea spp.							
Echinodermata	Psammechinus miliaris							
Echinodermata	Spatangoida spp.							
	Individuals	0	0	0		9	0	4
	Taxa	**0**	**0**	**0**		**2**	**1**	**1**
Mollusca	Abra alba							1
Mollusca	Abra nitida					2		
Mollusca	Abra prismatica							
Mollusca	Abra spp.							
Mollusca	Abra tenuis							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Mollusca	Arca tetragona							
Mollusca	Bivalvia spp.							
Mollusca	Corbula gibba							
Mollusca	Ensis magnus		1			18	15	57
Mollusca	Ensis spp.							
Mollusca	Glycymeris glycymeris							
Mollusca	Glycymeris spp.							
Mollusca	Goodallia triangularis							
Mollusca	Kurtiella bidentata							
Mollusca	Macoma balthica	2	11	6		77	27	66
Mollusca	Mactridae spp.							
Mollusca	Mya spp.							
Mollusca	Mytilus spp.							
Mollusca	Mytilidae spp.							
Mollusca	Nucula nitidosa							
Mollusca	Nucula sulcata							
Mollusca	Spisula elliptica							
Mollusca	Tapes spp.							
Mollusca	Tellimya ferruginosa							
Mollusca	Tellina fabula							
Mollusca	Tellina pygmaea							
Mollusca	Tellinidae spp.							
	Individuals	2	12	6		97	42	124
	Taxa	**1**	**2**	**1**		**3**	**2**	**3**
Mollusca	Buccinum undatum							
Mollusca	Chauvetia brunnea							
Mollusca	Euspira montagui							
Mollusca	Euspira pulchella							
Mollusca	Gastropoda spp.							
Mollusca	Gibbula spp.							
Mollusca	Nassarius nitidus							
Mollusca	Nassarius reticulatus							
Mollusca	Odostomia unidentata							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Mollusca	Nudibranchia spp.							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Annelida	Alitta succinea					1		
Annelida	Ampharete							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Annelida	Ampharete finmarchica							
Annelida	Aonides paucibranchiata							
Annelida	Aphrodita aculeata							
Annelida	Capitella capitata-complex							
Annelida	Capitellidae spp.							
Annelida	Cauleriella alata							
Annelida	Caulleriella killariensis		15	23		3	1	4
Annelida	Chaetozone setosa							
Annelida	Cirratulidae spp.		1			3		3
Annelida	Dipolydora flava							
Annelida	Eteone spp.							
Annelida	Eulalia viridis							
Annelida	Eumida bahusiensis							
Annelida	Eumida sanguinea							
Annelida	Eumida spp.							
Annelida	Eunereis longissima					2	1	2
Annelida	Gattyana cirrhosa							
Annelida	Glycera alba							
Annelida	Glycera capitata							
Annelida	Glycera convoluta							
Annelida	Glycera lapidum							
Annelida	Glycera oxycephala							
Annelida	Glycera spp.							
Annelida	Harmothoe aspera							
Annelida	Harmothoe clavigera							
Annelida	Harmothoe extenuata							
Annelida	Harmothoe spp.							
Annelida	Hesionura elongata							
Annelida	Heteromastus filiformis					8		
Annelida	Lagis koreni		1					
Annelida	Lanice conchilega							
Annelida	Lepidonotus squamatus							
Annelida	Lumbrineris aniara							
Annelida	Lumbrineris latreilli							
Annelida	Macrochaeta helgolandica							
Annelida	Magelona johnstoni							
Annelida	Mediomastus fragilis							
Annelida	Mysta picta							
Annelida	Neoamphitrite spp.							
Annelida	Nephtys assimilis							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Annelida	Nephtys cirrosa							
Annelida	Nephtys hombergii		3				1	
Annelida	Nephtys kersivalensis							
Annelida	Nephtys spp.			1				
Annelida	Notomastus latericeus			2		1	4	26
Annelida	Ophelia borealis							
Annelida	Owenia fusiformis	14	523	22		526	14	5
Annelida	Pherusa plumosa							
Annelida	Pholoe baltica							
Annelida	Pholoe inornata							
Annelida	Pholoe spp.							
Annelida	Phyllodoce citrina							
Annelida	Phyllodoce groenlandica							
Annelida	Phyllodoce mucosa							
Annelida	Phyllodoce spp.							
Annelida	Pisione remota							
Annelida	Polycirrus medusa							
Annelida	Polycirrus spp.							
Annelida	Polydora cornuta					17		
Annelida	Polygordius appendiculatus							
Annelida	Pseudopolydora pulchra							
Annelida	Pygospio elegans							
Annelida	Sabellaria spinulosa							
Annelida	Saccocirrus papillocercus							
Annelida	Scalibregma inflatum							
Annelida	Scolelepis bonnieri							
Annelida	Scoloplos armiger							
Annelida	Sphaerosyllis bulbosa							
Annelida	Spio armata							
Annelida	Spio decoratus							
Annelida	Spio filicornis							
Annelida	Spiophanes bombyx							1
Annelida	Spiophanes kroyeri							
Annelida	Sthenelais boa							
Annelida	Terebellidae spp.							
Annelida	Travisia forbesii							
	Individuals	14	543	48		561	21	41
	Taxa	**1**	**5**	**4**		**8**	**5**	**6**
Arthropoda	Achelia echinata							
Bryozoa	Alcyonidium diaphanum							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Chordata	Ammodytes tobianus							
Arthropoda	Anoplodactylus petiolatus							
Arthropoda	Ammothella longipes							
Chordata	Ascidiacea spp.							
Chordata	Branchiostoma lanceolatum							
Ctenophora	Ctenophora spp.							
Chordata	Echiichthys vipera							
Echiura	Echiura spp.							
Bryozoa	Electra pilosa							
Bryozoa	Flustra foliacea							
Chordata	Gaidropsarus spp.							
Chordata	Gobiidae spp.							
Nematoda	Nematoda spp.							
Nemertea	Nemertea spp.							
Chordata	Pomatoschistus minutus							
Chordata	Pomatoschistus spp.							
Porifera	Porifera spp.							
Cephalorhyncha	Priapulida spp.							
Arthropoda	Pycnogonida spp.							
Sipuncula	Sipuncula spp.							
Sipuncula	Sipunculidea spp.							
Chordata	Solea solea							
Bryozoa	Vesicularia spinosa							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**

	Raw data Abundance Block 02				Comment							
	RED=Grab not approved YELLOW=Grab low volume, but analysed BLUE=Grab approved P=Present				B02-021 resulted in one approved grab.		B02-022 resulted in two approved grabs.					
Phylum	**Species**	**B02-021-A**	**B02-021-B**	**B02-021-C**	**B02-022-A**	**B02-022-B**	**B02-022-C**	**B02-023-A**	**B02-023-B**	**B02-023-C**		
Cnidaria	Actinaria spp.											
Cnidaria	Anthozoa spp.											
Cnidaria	Campanulinidae spp.											
Cnidaria	Diphasia spp.											
Cnidaria	Hydrallmania falcata											
Cnidaria	Hydrozoa spp.											
Cnidaria	Nemertesia sp.											
Cnidaria	Obelia spp.											
Cnidaria	Rhizorhagium roseum											
Cnidaria	Sertulariidae											
Cnidaria	Tubularia indivisa											
Cnidaria	Tubularia spp.											
	Individuals	0	0	0	0	0	0	0	0	0		
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
Arthropoda	Abludomelita obtusata											
Arthropoda	Ampelisca brevicornis											
Arthropoda	Ampelisca spinipes											
Arthropoda	Ampelisca spp.											
Arthropoda	Aora gracilis											
Arthropoda	Aoridae spp.											
Arthropoda	Autonoe longipes											
Arthropoda	Balanus balanus											
Arthropoda	Balanus spp.											
Arthropoda	Bathyporeia elegans				2							
Arthropoda	Bathyporeia guilliamsoniana	7						3				
Arthropoda	Bathyporeia nana											
Arthropoda	Bathyporeia sarsi											
Arthropoda	Bathyporeia spp.	1						12	1	1		
Arthropoda	Bathyporeia tenuipes											
Arthropoda	Bodotria scorpioides											
Arthropoda	Brachyura spp.											
Arthropoda	Campylaspis spp.											
Arthropoda	Carcinus maenas											
Arthropoda	Copepoda spp.											

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni	1											
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.									1	1		
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum	1											
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Arthropoda	Pontoporeiidae spp.										1		
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata	3											
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis					4							
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.									5			
	Individuals	13	0	0		6	0	0		21	3	1	
	Taxa	**5**	**0**	**0**		**2**	**0**	**0**		**4**	**3**	**1**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum					1							
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.	2											
Echinodermata	Echinocyamus pusillus	7											
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.	1				2							
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	10	0	0		3	0	0		0	0	0	
	Taxa	**3**	**0**	**0**		**2**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.					1							
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica	1											
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	1	0	0		1	0	0		0	0	0	
	Taxa	**1**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C	B02-022-A	B02-022-B	B02-022-C	B02-023-A	B02-023-B	B02-023-C
Annelida	Nephtys cirrosa	1			3			1	4	6
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.								1	
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis	1						1		
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri								1	
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata	1						1		5
Annelida	Spio decoratus									
Annelida	Spio filicornis									
Annelida	Spiophanes bombyx				1					
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	3	0	0	4	0	0	3	6	11
	Taxa	**3**	**0**	**0**	**2**	**0**	**0**	**3**	**3**	**2**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

	Raw data Abundan										
	RED=Grab not approved YELLOW=Grab low volume, but ana BLUE=Grab approved P=Present	B02-024 resulted in no approved grab.			B02-025 resulted in one approved grab and one with low volume but analysed (A 3L).			B02-026 resulted in no approved grab.		
Phylum	**Species**	**B02-024-A**	**B02-024-B**	**B02-024-C**	**B02-025-A**	**B02-025-B**	**B02-025-C**	**B02-026-A**	**B02-026-B**	**B02-026-C**
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana				4	2				
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi					4				
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.					1				
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer					2				
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.						4						
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis					4							
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		8	13	0		0	0	0	
	Taxa	**0**	**0**	**0**		**2**	**5**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus					8	14						
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis						2						
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		8	16	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**2**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.						1						
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	1	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui						1						
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	1	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni									
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Annelida	Nephtys cirrosa				1	2				
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis					2				
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis									
Annelida	Spiophanes bombyx									
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	0	0	0	1	9	0	0	0	0
	Taxa	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

B02-029 resulted in one approved grab and two with low volume but analysed (A 3L and B 2L)

Phylum	Species	B02-027-A	B02-027-B	B02-027-C	B02-028-A	B02-028-B	B02-028-C	B02-029-A	B02-029-B	B02-029-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans	2								
Arthropoda	Bathyporeia guilliamsoniana	1	1							
Arthropoda	Bathyporeia nana	2								
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.		1	1					1	
Arthropoda	Bathyporeia tenuipes	4								
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B02-027-A	B02-027-B	B02-027-C	B02-028-A	B02-028-B	B02-028-C	B02-029-A	B02-029-B	B02-029-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.			1						
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.				7					
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.	1			1					
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer			1		3				
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.					1				
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus		1					1		
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis						4			
Arthropoda	Podoceridae spp.									

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata						1						
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans	1											
Arthropoda	Urothoe marina	1											
Arthropoda	Urothoe spp.		4	1									
	Individuals	12	7	4		8	5	4		1	1	0	
	Taxa	**7**	**4**	**4**		**2**	**3**	**1**		**1**	**1**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus									6	7		
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.										1		
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		6	8	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**2**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida							1					
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica		2										
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	2	0		0	0	1		0	0	0	
	Taxa	**0**	**1**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella									1			
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		1	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		3	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum										2		
Annelida	Glycera oxycephala			1									
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis							1					
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C	B02-028-A	B02-028-B	B02-028-C	B02-029-A	B02-029-B	B02-029-C
Annelida	Nephtys cirrosa	1		1			2			
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis		1	3	1		1	2		
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa					1	11			
Annelida	Polycirrus spp.								1	
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata		1							
Annelida	Spio decoratus									
Annelida	Spio filicornis									
Annelida	Spiophanes bombyx	1								
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.			1						
Annelida	Travisia forbesii									
	Individuals	2	2	6	1	1	15	8	3	0
	Taxa	**2**	**2**	**4**	**1**	**1**	**4**	**1**	**2**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

	Raw data Abundan			
	RED=Grab not approved **YELLOW=Grab low volume, but ana** **BLUE=Grab approved** **P=Present**			
Phylum	**Species**	**B02-030-A**	**B02-030-B**	**B02-030-C**
Cnidaria	Actinaria spp.			
Cnidaria	Anthozoa spp.			
Cnidaria	Campanulinidae spp.			
Cnidaria	Diphasia spp.			
Cnidaria	Hydrallmania falcata			
Cnidaria	Hydrozoa spp.			
Cnidaria	Nemertesia sp.			
Cnidaria	Obelia spp.			
Cnidaria	Rhizorhagium roseum			
Cnidaria	Sertulariidae			
Cnidaria	Tubularia indivisa			
Cnidaria	Tubularia spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	
Arthropoda	Abludomelita obtusata			
Arthropoda	Ampelisca brevicornis			
Arthropoda	Ampelisca spinipes			
Arthropoda	Ampelisca spp.			
Arthropoda	Aora gracilis			
Arthropoda	Aoridae spp.			
Arthropoda	Autonoe longipes			
Arthropoda	Balanus balanus			
Arthropoda	Balanus spp.			
Arthropoda	Bathyporeia elegans			
Arthropoda	Bathyporeia guilliamsoniana			
Arthropoda	Bathyporeia nana			
Arthropoda	Bathyporeia sarsi			
Arthropoda	Bathyporeia spp.			
Arthropoda	Bathyporeia tenuipes			
Arthropoda	Bodotria scorpioides			
Arthropoda	Brachyura spp.			
Arthropoda	Campylaspis spp.			
Arthropoda	Carcinus maenas			
Arthropoda	Copepoda spp.			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Arthropoda	Corophium spp.			
Arthropoda	Crangon allmanni			
Arthropoda	Crangon crangon			
Arthropoda	Crangon spp.			
Arthropoda	Crustacea spp.			
Arthropoda	Dendrobranchiata spp.			
Arthropoda	Dexaminidae spp.			
Arthropoda	Diastylis glabra			
Arthropoda	Diastylis rugosa			
Arthropoda	Diastylis spp.			
Arthropoda	Euphausiacea spp.			
Arthropoda	Galathea intermedia			
Arthropoda	Galathea spp.			
Arthropoda	Gammaridae spp.			
Arthropoda	Gammaridea spp.			
Arthropoda	Gammaropsis maculata			
Arthropoda	Gammarus spp.			
Arthropoda	Gastrosaccus spinifer			
Arthropoda	Haustoriidae spp.			
Arthropoda	Hippomedon denticulatus			
Arthropoda	Idotea linearis			
Arthropoda	Isopoda spp.			
Arthropoda	Leucothoe incisa			
Arthropoda	Leucothoe spp.			
Arthropoda	Liocarcinus holsatus			
Arthropoda	Liocarcinus marmoreus			
Arthropoda	Liocarcinus pusillus			
Arthropoda	Liocarcinus spp.			
Arthropoda	Lysianassidae spp.			
Arthropoda	Monoculodes carinatus			
Arthropoda	Mysidae spp.			
Arthropoda	Oedicerotidae spp.			
Arthropoda	Paguridae spp.			
Arthropoda	Pagurus bernhardus			
Arthropoda	Pagurus spp.			
Arthropoda	Pariambus typicus			
Arthropoda	Pilumnus spp.			
Arthropoda	Pinnotheres pisum			
Arthropoda	Pisidia longicornis			
Arthropoda	Podoceridae spp.			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Arthropoda	Pontoporeiidae spp.			
Arthropoda	Porcellanidae spp.			
Arthropoda	Portunidae spp.			
Arthropoda	Processa canaliculata			
Arthropoda	Processa spp.			
Arthropoda	Semibalanus balanoides			
Arthropoda	Stenothoe monoculoides			
Arthropoda	Thia scutellata			
Arthropoda	Upogebia stellata			
Arthropoda	Urothoe brevicornis			
Arthropoda	Urothoe elegans			
Arthropoda	Urothoe marina			
Arthropoda	Urothoe spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Echinodermata	Amphipholis squamata			
Echinodermata	Amphiuridae spp.			
Echinodermata	Asterias rubens			
Echinodermata	Echinocardium cordatum			
Echinodermata	Echinocardium flavescens			
Echinodermata	Echinocardium spp.			
Echinodermata	Echinocyamus pusillus	1	1	
Echinodermata	Holothurioidea spp.			
Echinodermata	Leptasterias muelleri			
Echinodermata	Ophiocten affinis		2	
Echinodermata	Ophiura albida			
Echinodermata	Ophiura ophiura			1
Echinodermata	Ophiura sarsii			
Echinodermata	Ophiura spp.			
Echinodermata	Ophiurae spp.			
Echinodermata	Ophiuroidea spp.			
Echinodermata	Psammechinus miliaris			
Echinodermata	Spatangoida spp.			
	Individuals	1	3	1
	Taxa	**1**	**2**	**1**
Mollusca	Abra alba			
Mollusca	Abra nitida			
Mollusca	Abra prismatica			
Mollusca	Abra spp.			
Mollusca	Abra tenuis			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Mollusca	Arca tetragona			
Mollusca	Bivalvia spp.			
Mollusca	Corbula gibba			
Mollusca	Ensis magnus			
Mollusca	Ensis spp.			
Mollusca	Glycymeris glycymeris		1	
Mollusca	Glycymeris spp.	1		
Mollusca	Goodallia triangularis	2		
Mollusca	Kurtiella bidentata			
Mollusca	Macoma balthica			
Mollusca	Mactridae spp.			
Mollusca	Mya spp.			
Mollusca	Mytilus spp.			
Mollusca	Mytilidae spp.			
Mollusca	Nucula nitidosa			
Mollusca	Nucula sulcata			
Mollusca	Spisula elliptica	2		
Mollusca	Tapes spp.			
Mollusca	Tellimya ferruginosa			
Mollusca	Tellina fabula			
Mollusca	Tellina pygmaea	1		
Mollusca	Tellinidae spp.			
	Individuals	6	1	0
	Taxa	**4**	**1**	**0**
Mollusca	Buccinum undatum			
Mollusca	Chauvetia brunnea			
Mollusca	Euspira montagui			
Mollusca	Euspira pulchella			
Mollusca	Gastropoda spp.			
Mollusca	Gibbula spp.			
Mollusca	Nassarius nitidus			
Mollusca	Nassarius reticulatus			
Mollusca	Odostomia unidentata			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Mollusca	Nudibranchia spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Annelida	Alitta succinea			
Annelida	Ampharete			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Annelida	Ampharete finmarchica			
Annelida	Aonides paucibranchiata			
Annelida	Aphrodita aculeata			
Annelida	Capitella capitata-complex			
Annelida	Capitellidae spp.			
Annelida	Cauleriella alata			
Annelida	Caulleriella killariensis			
Annelida	Chaetozone setosa			
Annelida	Cirratulidae spp.			
Annelida	Dipolydora flava			
Annelida	Eteone spp.			
Annelida	Eulalia viridis			
Annelida	Eumida bahusiensis			
Annelida	Eumida sanguinea			
Annelida	Eumida spp.			
Annelida	Eunereis longissima			
Annelida	Gattyana cirrhosa			
Annelida	Glycera alba			
Annelida	Glycera capitata			
Annelida	Glycera convoluta			
Annelida	Glycera lapidum	1		
Annelida	Glycera oxycephala			
Annelida	Glycera spp.			
Annelida	Harmothoe aspera			
Annelida	Harmothoe clavigera			
Annelida	Harmothoe extenuata			
Annelida	Harmothoe spp.			
Annelida	Hesionura elongata			
Annelida	Heteromastus filiformis			
Annelida	Lagis koreni			
Annelida	Lanice conchilega			
Annelida	Lepidonotus squamatus			
Annelida	Lumbrineris aniara			
Annelida	Lumbrineris latreilli			
Annelida	Macrochaeta helgolandica			
Annelida	Magelona johnstoni			
Annelida	Mediomastus fragilis			
Annelida	Mysta picta			
Annelida	Neoamphitrite spp.			
Annelida	Nephtys assimilis			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Annelida	Nephtys cirrosa		1	
Annelida	Nephtys hombergii			
Annelida	Nephtys kersivalensis			
Annelida	Nephtys spp.			
Annelida	Notomastus latericeus			
Annelida	Ophelia borealis			
Annelida	Owenia fusiformis			
Annelida	Pherusa plumosa			
Annelida	Pholoe baltica			
Annelida	Pholoe inornata			
Annelida	Pholoe spp.			
Annelida	Phyllodoce citrina			
Annelida	Phyllodoce groenlandica			
Annelida	Phyllodoce mucosa			
Annelida	Phyllodoce spp.			
Annelida	Pisione remota			
Annelida	Polycirrus medusa			
Annelida	Polycirrus spp.			
Annelida	Polydora cornuta			
Annelida	Polygordius appendiculatus			
Annelida	Pseudopolydora pulchra			
Annelida	Pygospio elegans			
Annelida	Sabellaria spinulosa			
Annelida	Saccocirrus papillocercus			
Annelida	Scalibregma inflatum			
Annelida	Scolelepis bonnieri			
Annelida	Scoloplos armiger			
Annelida	Sphaerosyllis bulbosa			
Annelida	Spio armata			
Annelida	Spio decoratus			
Annelida	Spio filicornis			
Annelida	Spiophanes bombyx			
Annelida	Spiophanes kroyeri			
Annelida	Sthenelais boa			
Annelida	Terebellidae spp.			
Annelida	Travisia forbesii			
	Individuals	1	1	0
	Taxa	**1**	**1**	**0**
Arthropoda	Achelia echinata			
Bryozoa	Alcyonidium diaphanum			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Chordata	Ammodytes tobianus		1	
Arthropoda	Anoplodactylus petiolatus			
Arthropoda	Ammothella longipes			
Chordata	Ascidiacea spp.			
Chordata	Branchiostoma lanceolatum			
Ctenophora	Ctenophora spp.			
Chordata	Echiichthys vipera			
Echiura	Echiura spp.			
Bryozoa	Electra pilosa			
Bryozoa	Flustra foliacea			
Chordata	Gaidropsarus spp.			
Chordata	Gobiidae spp.			
Nematoda	Nematoda spp.			
Nemertea	Nemertea spp.			
Chordata	Pomatoschistus minutus			
Chordata	Pomatoschistus spp.			
Porifera	Porifera spp.			
Cephalorhyncha	Priapulida spp.			
Arthropoda	Pycnogonida spp.			
Sipuncula	Sipuncula spp.			
Sipuncula	Sipunculidea spp.			
Chordata	Solea solea			
Bryozoa	Vesicularia spinosa			
	Individuals	0	1	0
	Taxa	**0**	**1**	**0**

	Raw data Abundance Block 03				Comment								
	RED=Grab not approved YELLOW=Grab low volume, but analysed BLUE=Grab approved P=Present							B03-033 resulted in no approved grab.					
Phylum	**Species**	**B03-031-A**	**B03-031-B**	**B03-031-C**		**B03-032-A**	**B03-032-B**	**B03-032-C**		**B03-033-A**	**B03-033-B**	**B03-033-C**	
Cnidaria	Actinaria spp.												
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.												
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.							P					
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus							1					
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus							2					
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	0	3		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**2**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus							1					
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	1		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica	1				1		1					
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea					1							
Mollusca	Tellinidae spp.												
	Individuals	1	0	0		2	0	1		0	0	0	
	Taxa	**1**	**0**	**0**		**2**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata					2							
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum		1					3					
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli					1							
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus					3		3					
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	1											
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa					5	1						
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	1	1	0		11	1	6		0	0	0	
	Taxa	**1**	**1**	**0**		**4**	**1**	**2**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum					2	2	2					
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.					2	5	6					
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		4	7	8		0	0	0	
	Taxa	0	0	0		2	2	2		0	0	0	

Raw data Abundanc

	RED=Grab not approved YELLOW=Grab low volume, but analy BLUE=Grab approved P=Present	B03-034 resulted in no approved grab.							B03-036 resulted in no approved grab.		
Phylum	**Species**	**B03-034-A**	**B03-034-B**	**B03-034-C**		**B03-035-A**	**B03-035-B**	**B03-035-C**	**B03-036-A**	**B03-036-B**	**B03-036-C**
Cnidaria	Actinaria spp.										
Cnidaria	Anthozoa spp.										
Cnidaria	Campanulinidae spp.										
Cnidaria	Diphasia spp.										
Cnidaria	Hydrallmania falcata										
Cnidaria	Hydrozoa spp.										
Cnidaria	Nemertesia sp.										
Cnidaria	Obelia spp.										
Cnidaria	Rhizorhagium roseum										
Cnidaria	Sertulariidae										
Cnidaria	Tubularia indivisa										
Cnidaria	Tubularia spp.										
	Individuals	0	0	0		0	0	0	0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata										
Arthropoda	Ampelisca brevicornis										
Arthropoda	Ampelisca spinipes										
Arthropoda	Ampelisca spp.										
Arthropoda	Aora gracilis										
Arthropoda	Aoridae spp.										
Arthropoda	Autonoe longipes										
Arthropoda	Balanus balanus										
Arthropoda	Balanus spp.										
Arthropoda	Bathyporeia elegans										
Arthropoda	Bathyporeia guilliamsoniana										
Arthropoda	Bathyporeia nana										
Arthropoda	Bathyporeia sarsi										
Arthropoda	Bathyporeia spp.										
Arthropoda	Bathyporeia tenuipes										
Arthropoda	Bodotria scorpioides										
Arthropoda	Brachyura spp.										
Arthropoda	Campylaspis spp.										
Arthropoda	Carcinus maenas										
Arthropoda	Copepoda spp.										

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.						1						
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus						1						
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**2**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**			**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C	B03-035-A	B03-035-B	B03-035-C	B03-036-A	B03-036-B	B03-036-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala				1					
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni									
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Annelida	Nephtys cirrosa					1	1						
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis						1						
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	0	0	0		2	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**2**	**2**	**0**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

	RED=Grab not approved YELLOW=Grab low volume, but analy BLUE=Grab approved P=Present	B03-037 resulted in two approved grabs and one with low volume but analysed (B 3L)				B03-038 resulted in no approved grab.				B03-039 resulted in two approved grabs.			
Phylum	**Species**	**B03-037-A**	**B03-037-B**	**B03-037-C**		**B03-038-A**	**B03-038-B**	**B03-038-C**		**B03-039-A**	**B03-039-B**	**B03-039-C**	
Cnidaria	Actinaria spp.										3		
Cnidaria	Anthozoa spp.									1			
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.		P								P		
Cnidaria	Hydrallmania falcata										P		
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		0	0	0		1	3	0	
	Taxa	**0**	**1**	**0**		**0**	**0**	**0**		**1**	**3**	**0**	
Arthropoda	Abludomelita obtusata										1		
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes										1		
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia								2	
Arthropoda	Galathea spp.								1	
Arthropoda	Gammaridae spp.								1	
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata								4	
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.								1	
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.							1		
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.								1	
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis								160	
Arthropoda	Podoceridae spp.									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.									
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata								1	
Arthropoda	Urothoe brevicornis									
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.									
	Individuals	0	0	0	0	0	0	1	173	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**10**	**0**
Echinodermata	Amphipholis squamata								11	
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens								3	
Echinodermata	Echinocardium cordatum									
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus									
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri								1	
Echinodermata	Ophiocten affinis									
Echinodermata	Ophiura albida									
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.							1		
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.	1							34	
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	1	0	0	0	0	0	1	49	0
	Taxa	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**
Mollusca	Abra alba									
Mollusca	Abra nitida							3		
Mollusca	Abra prismatica								17	
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C		B03-038-A	B03-038-B	B03-038-C		B03-039-A	B03-039-B	B03-039-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		3	17	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**1**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus			1									
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata										2		
	Individuals	0	0	1		0	0	0		0	2	0	
	Taxa	**0**	**0**	**1**		**0**	**0**	**0**		**0**	**1**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	3		0	0	0		0	5	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata								1	
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.							1		
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis								1	
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima								1	
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba								1	
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera								3	
Annelida	Harmothoe clavigera								5	
Annelida	Harmothoe extenuata								3	
Annelida	Harmothoe spp.							1	11	
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis								3	
Annelida	Lagis koreni		1	3						
Annelida	Lanice conchilega							1		
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta								1	
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Annelida	Nephtys cirrosa	1		1					1	
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.		1							
Annelida	Notomastus latericeus								1	
Annelida	Ophelia borealis			2				3	1	
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa								1	
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa							108	1063	
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum							1		
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis							1		
Annelida	Spiophanes bombyx							6	1	
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa								3	
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	1	2	12	0	0	0	122	1111	0
	Taxa	**1**	**2**	**3**	**0**	**0**	**0**	**8**	**17**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C		B03-038-A	B03-038-B	B03-038-C		B03-039-A	B03-039-B	B03-039-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.		1										
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.										1		
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.										1		
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	1	0		0	0	0		0	2	0	
	Taxa	0	1	0		0	0	0		0	2	0	

Raw data Abundanc

	RED=Grab not approved YELLOW=Grab low volume, but analy BLUE=Grab approved P=Present		B03-040 resulted in no approved grab.			B03-041 resulted in no approved grab.			B03-042 resulted in no approved grab.		
Phylum	**Species**	**B03-040-A**	**B03-040-B**	**B03-040-C**	**B03-041-A**	**B03-041-B**	**B03-041-C**	**B03-042-A**	**B03-042-B**	**B03-042-C**
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

B03-045 resulted in no approved grab.

Phylum	Species	B03-043-A	B03-043-B	B03-043-C	B03-044-A	B03-044-B	B03-044-C	B03-045-A	B03-045-B	B03-045-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.			1									
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	1		0	0	0		0	0	0	
	Taxa	**0**	**0**	**1**		**0**	**0**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Annelida	Nephtys cirrosa					1		1					
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis		2			3	1						
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata	1											
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	1	2	0		4	1	1		0	0	0	
	Taxa	**1**	**1**	**0**		**2**	**1**	**1**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

B03-048 resulted in one approved grab and two with low volume but analysed (B 4L and C 4L)

Phylum	Species	B03-046-A	B03-046-B	B03-046-C	B03-047-A	B03-047-B	B03-047-C	B03-048-A	B03-048-B	B03-048-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.						20			
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.				2					
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer		1										
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.							1					
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.							1					
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.							1					

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.	3											
	Individuals	3	1	0		2	0	23		0	0	0	
	Taxa	**1**	**1**	**0**		**1**	**0**	**4**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.						1						
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.							1					
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	1	1		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**1**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba						1						
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis							1					
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.			20		7		30					
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica			2		1		3					
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	22		8	1	34		0	0	0	
	Taxa	**0**	**0**	**2**		**2**	**1**	**3**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum					1							
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica					2							
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Annelida	Nephtys cirrosa	1								1		1	
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis	1				2	2				2	1	
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.						1						
Annelida	Travisia forbesii												
	Individuals	2	0	0		5	3	0		1	2	2	
	Taxa	**2**	**0**	**0**		**3**	**2**	**0**		**1**	**1**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Cnidaria	Actinaria spp.					4	2	
Cnidaria	Anthozoa spp.							7
Cnidaria	Campanulinidae spp.							
Cnidaria	Diphasia spp.							
Cnidaria	Hydrallmania falcata							
Cnidaria	Hydrozoa spp.							
Cnidaria	Nemertesia sp.							
Cnidaria	Obelia spp.							
Cnidaria	Rhizorhagium roseum							
Cnidaria	Sertulariidae							
Cnidaria	Tubularia indivisa							
Cnidaria	Tubularia spp.			P				
	Individuals	0	0	0		4	2	7
	Taxa	**0**	**0**	**1**		**1**	**1**	**1**
Arthropoda	Abludomelita obtusata							
Arthropoda	Ampelisca brevicornis					1		3
Arthropoda	Ampelisca spinipes							
Arthropoda	Ampelisca spp.						3	
Arthropoda	Aora gracilis							
Arthropoda	Aoridae spp.					3	2	
Arthropoda	Autonoe longipes							
Arthropoda	Balanus balanus							1
Arthropoda	Balanus spp.							
Arthropoda	Bathyporeia elegans							
Arthropoda	Bathyporeia guilliamsoniana		2					
Arthropoda	Bathyporeia nana		1					
Arthropoda	Bathyporeia sarsi							
Arthropoda	Bathyporeia spp.			2				
Arthropoda	Bathyporeia tenuipes							
Arthropoda	Bodotria scorpioides							
Arthropoda	Brachyura spp.							
Arthropoda	Campylaspis spp.					1		
Arthropoda	Carcinus maenas					1		
Arthropoda	Copepoda spp.							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Arthropoda	Corophium spp.						2	
Arthropoda	Crangon allmanni							
Arthropoda	Crangon crangon							
Arthropoda	Crangon spp.							
Arthropoda	Crustacea spp.							
Arthropoda	Dendrobranchiata spp.							
Arthropoda	Dexaminidae spp.			1				
Arthropoda	Diastylis glabra					2		
Arthropoda	Diastylis rugosa							
Arthropoda	Diastylis spp.							1
Arthropoda	Euphausiacea spp.							
Arthropoda	Galathea intermedia							
Arthropoda	Galathea spp.							
Arthropoda	Gammaridae spp.					10		12
Arthropoda	Gammaridea spp.							
Arthropoda	Gammaropsis maculata							
Arthropoda	Gammarus spp.							
Arthropoda	Gastrosaccus spinifer							
Arthropoda	Haustoriidae spp.							
Arthropoda	Hippomedon denticulatus							
Arthropoda	Idotea linearis							
Arthropoda	Isopoda spp.							
Arthropoda	Leucothoe incisa							
Arthropoda	Leucothoe spp.							
Arthropoda	Liocarcinus holsatus							
Arthropoda	Liocarcinus marmoreus							
Arthropoda	Liocarcinus pusillus							
Arthropoda	Liocarcinus spp.							
Arthropoda	Lysianassidae spp.							
Arthropoda	Monoculodes carinatus							
Arthropoda	Mysidae spp.							
Arthropoda	Oedicerotidae spp.							
Arthropoda	Paguridae spp.							
Arthropoda	Pagurus bernhardus						1	
Arthropoda	Pagurus spp.							
Arthropoda	Pariambus typicus							
Arthropoda	Pilumnus spp.							
Arthropoda	Pinnotheres pisum							
Arthropoda	Pisidia longicornis					3	2	
Arthropoda	Podoceridae spp.							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Arthropoda	Pontoporeiidae spp.							
Arthropoda	Porcellanidae spp.							
Arthropoda	Portunidae spp.					1		
Arthropoda	Processa canaliculata							
Arthropoda	Processa spp.							
Arthropoda	Semibalanus balanoides							
Arthropoda	Stenothoe monoculoides							
Arthropoda	Thia scutellata							
Arthropoda	Upogebia stellata							
Arthropoda	Urothoe brevicornis		6	7				
Arthropoda	Urothoe elegans							
Arthropoda	Urothoe marina							
Arthropoda	Urothoe spp.	2	1					
	Individuals	2	10	10		22	10	17
	Taxa	**1**	**4**	**3**		**8**	**5**	**4**
Echinodermata	Amphipholis squamata					8	7	
Echinodermata	Amphiuridae spp.							
Echinodermata	Asterias rubens							
Echinodermata	Echinocardium cordatum							
Echinodermata	Echinocardium flavescens							
Echinodermata	Echinocardium spp.							
Echinodermata	Echinocyamus pusillus							
Echinodermata	Holothurioidea spp.							
Echinodermata	Leptasterias muelleri							
Echinodermata	Ophiocten affinis							
Echinodermata	Ophiura albida						1	
Echinodermata	Ophiura ophiura							
Echinodermata	Ophiura sarsii							
Echinodermata	Ophiura spp.					2	4	1
Echinodermata	Ophiurae spp.							
Echinodermata	Ophiuroidea spp.							
Echinodermata	Psammechinus miliaris							1
Echinodermata	Spatangoida spp.							
	Individuals	0	0	0		10	12	2
	Taxa	**0**	**0**	**0**		**2**	**3**	**2**
Mollusca	Abra alba					5		5
Mollusca	Abra nitida		1					
Mollusca	Abra prismatica							
Mollusca	Abra spp.						10	
Mollusca	Abra tenuis							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Mollusca	Arca tetragona							
Mollusca	Bivalvia spp.							1
Mollusca	Corbula gibba					2	1	
Mollusca	Ensis magnus						2	4
Mollusca	Ensis spp.							
Mollusca	Glycymeris glycymeris							
Mollusca	Glycymeris spp.							
Mollusca	Goodallia triangularis							
Mollusca	Kurtiella bidentata							
Mollusca	Macoma balthica					1		
Mollusca	Mactridae spp.							
Mollusca	Mya spp.							
Mollusca	Mytilus spp.							
Mollusca	Mytilidae spp.	2		1				
Mollusca	Nucula nitidosa					4	10	14
Mollusca	Nucula sulcata						1	
Mollusca	Spisula elliptica						2	
Mollusca	Tapes spp.							
Mollusca	Tellimya ferruginosa					1		
Mollusca	Tellina fabula							
Mollusca	Tellina pygmaea							
Mollusca	Tellinidae spp.							
	Individuals	2	1	1		13	26	24
	Taxa	**1**	**1**	**1**		**5**	**6**	**4**
Mollusca	Buccinum undatum						1	1
Mollusca	Chauvetia brunnea							
Mollusca	Euspira montagui							
Mollusca	Euspira pulchella							
Mollusca	Gastropoda spp.							
Mollusca	Gibbula spp.						1	1
Mollusca	Nassarius nitidus							1
Mollusca	Nassarius reticulatus							
Mollusca	Odostomia unidentata							
	Individuals	0	0	0		0	2	3
	Taxa	**0**	**0**	**0**		**0**	**2**	**3**
Mollusca	Nudibranchia spp.					1		
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Annelida	Alitta succinea							
Annelida	Ampharete	1				1		1

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Annelida	Ampharete finmarchica					2	1	
Annelida	Aonides paucibranchiata							
Annelida	Aphrodita aculeata						2	1
Annelida	Capitella capitata-complex							
Annelida	Capitellidae spp.							
Annelida	Cauleriella alata					1	1	
Annelida	Caulleriella killariensis					1		
Annelida	Chaetozone setosa							
Annelida	Cirratulidae spp.						5	1
Annelida	Dipolydora flava							
Annelida	Eteone spp.							1
Annelida	Eulalia viridis							
Annelida	Eumida bahusiensis							
Annelida	Eumida sanguinea					1		
Annelida	Eumida spp.							
Annelida	Eunereis longissima					1	1	2
Annelida	Gattyana cirrhosa					1		
Annelida	Glycera alba						2	
Annelida	Glycera capitata	2						
Annelida	Glycera convoluta							
Annelida	Glycera lapidum							
Annelida	Glycera oxycephala	2		1				
Annelida	Glycera spp.							1
Annelida	Harmothoe aspera							
Annelida	Harmothoe clavigera						1	
Annelida	Harmothoe extenuata					1		
Annelida	Harmothoe spp.							
Annelida	Hesionura elongata							
Annelida	Heteromastus filiformis					7	5	2
Annelida	Lagis koreni	1		1		5	2	4
Annelida	Lanice conchilega					1	7	
Annelida	Lepidonotus squamatus							1
Annelida	Lumbrineris aniara	1					2	1
Annelida	Lumbrineris latreilli							
Annelida	Macrochaeta helgolandica							
Annelida	Magelona johnstoni							
Annelida	Mediomastus fragilis							
Annelida	Mysta picta						1	
Annelida	Neoamphitrite spp.					1		
Annelida	Nephtys assimilis							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Annelida	Nephtys cirrosa	1	2	1				
Annelida	Nephtys hombergii							1
Annelida	Nephtys kersivalensis					1		
Annelida	Nephtys spp.					2	1	8
Annelida	Notomastus latericeus	1				10	16	10
Annelida	Ophelia borealis	3	1	2				
Annelida	Owenia fusiformis							
Annelida	Pherusa plumosa							
Annelida	Pholoe baltica							1
Annelida	Pholoe inornata							
Annelida	Pholoe spp.							
Annelida	Phyllodoce citrina							
Annelida	Phyllodoce groenlandica							
Annelida	Phyllodoce mucosa	1					1	2
Annelida	Phyllodoce spp.							
Annelida	Pisione remota							
Annelida	Polycirrus medusa					2	2	
Annelida	Polycirrus spp.							
Annelida	Polydora cornuta							
Annelida	Polygordius appendiculatus							
Annelida	Pseudopolydora pulchra							
Annelida	Pygospio elegans							1
Annelida	Sabellaria spinulosa							
Annelida	Saccocirrus papillocercus							
Annelida	Scalibregma inflatum					4	1	
Annelida	Scolelepis bonnieri							
Annelida	Scoloplos armiger					1	3	3
Annelida	Sphaerosyllis bulbosa							
Annelida	Spio armata	2	1	1				
Annelida	Spio decoratus							
Annelida	Spio filicornis							
Annelida	Spiophanes bombyx							2
Annelida	Spiophanes kroyeri	1						
Annelida	Sthenelais boa						1	
Annelida	Terebellidae spp.							
Annelida	Travisia forbesii			1				
	Individuals	16	4	7		44	61	52
	Taxa	**11**	**3**	**6**		**19**	**19**	**18**
Arthropoda	Achelia echinata					1		
Bryozoa	Alcyonidium diaphanum					P		P

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Chordata	Ammodytes tobianus							
Arthropoda	Anoplodactylus petiolatus					5	7	7
Arthropoda	Ammothella longipes						1	
Chordata	Ascidiacea spp.							
Chordata	Branchiostoma lanceolatum							
Ctenophora	Ctenophora spp.							
Chordata	Echiichthys vipera							
Echiura	Echiura spp.							
Bryozoa	Electra pilosa							
Bryozoa	Flustra foliacea							P
Chordata	Gaidropsarus spp.							
Chordata	Gobiidae spp.							
Nematoda	Nematoda spp.							
Nemertea	Nemertea spp.					1		
Chordata	Pomatoschistus minutus							
Chordata	Pomatoschistus spp.							
Porifera	Porifera spp.							
Cephalorhyncha	Priapulida spp.							
Arthropoda	Pycnogonida spp.	5				1		
Sipuncula	Sipuncula spp.							
Sipuncula	Sipunculidea spp.							
Chordata	Solea solea							
Bryozoa	Vesicularia spinosa	P	P					
	Individuals	5	0	0		8	8	7
	Taxa	2	1	0		5	2	3

Photo transect ID	Easting	Northing	Type of Sampling	Comments
100702-NEMO-DDV-B03_039_001, South to North				
100702-NEMO-DDV-B03-039_001_001	406212	5687069	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_002	406229	5687056	Photo	
100702-NEMO-DDV-B03-039_001_003	406247	5687044	Photo	
100702-NEMO-DDV-B03-039_001_004	406265	5687032	Photo	
100702-NEMO-DDV-B03-039_001_005	406281	5687020	Photo	
100702-NEMO-DDV-B03-039_001_006	406195	5687080	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_007	406178	5687092	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_008	406162	5687103	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_009	406146	5687114	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_010	406129	5687125	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_011	406112	5687137	Photo	
100702-NEMO-DDV-B03-039_001_012	406096	5687149	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_013	406080	5687159	Photo	
100702-NEMO-DDV-B03-039_001_014	406064	5687171	Photo	
100702-NEMO-DDV-B03-039_001_015	406048	5687181	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_016	406032	5687196	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_017	406015	5687208	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_018	405998	5687219	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_019	405981	5687232	Photo	
100702-NEMO-DDV-B03-039_001_020	405963	5687240	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_021	405946	5687252	Photo	
100702-NEMO-DDV-B03-039_001_022	405930	5687263	Photo	A few sabellaria tubes
100702-NEMO-DDV-B03-039_001_023	405914	5687273	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_024	405897	5687286	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_025	405881	5687299	Photo	
100702-NEMO-DDV-B03-039_001_026	405865	5687311	Photo	
100702-NEMO-DDV-B03_039_002, East to west				
100702-NEMO-DDV-B03-039-002_001	406046	5687270	Photo	
100702-NEMO-DDV-B03-039-002_002	406036	5687253	Photo	
100702-NEMO-DDV-B03-039-002_003	406023	5687236	Photo	
100702-NEMO-DDV-B03-039-002_004	406012	5687219	Photo	
100702-NEMO-DDV-B03-039-002_005	406000	5687203	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039-002_006	405989	5687186	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039-002_007	405980	5687169	Photo	
100702-NEMO-DDV-B03-039-002_008	405968	5687152	Photo	
100702-NEMO-DDV-B03-039-002_009	405955	5687137	Photo	
100702-NEMO-DDV-B03-039-002_010	405943	5687118	Photo	
100702-NEMO-DDV-B03-039-002_011	405932	5687100	Photo	

Photo transect ID	Easting	Northing	Type of Sampling	Comments
100702-NEMO-DDV-B03_040-001, East to west				
100702-NEMO-DDV-B03-040-001_001	404311	5686856	Photo	
100702-NEMO-DDV-B03-040-001_002	404294	5686853	Photo	
100702-NEMO-DDV-B03-040-001_003	404275	5686853	Photo	
100702-NEMO-DDV-B03-040-001_004	404254	5686851	Photo	
100702-NEMO-DDV-B03-040-001_005	404234	5686850	Photo	
100702-NEMO-DDV-B03-040-001_006	404214	5686850	Photo	
100702-NEMO-DDV-B03-040-001_007	404194	5686849	Photo	
100702-NEMO-DDV-B03-040-001_008	404174	5686849	Photo	
100702-NEMO-DDV-B03-040-001_009	404157	5686848	Photo	
100702-NEMO-DDV-B03-040-001_010	404137	5686848	Photo	
100702-NEMO-DDV-B03-040-001_011	404117	5686848	Photo	
100702-NEMO-DDV-B03-040_002, North to south				
100702-NEMO-DDV-B03-040-002_001	404296	5686930	Photo	
100702-NEMO-DDV-B03-040-002_002	404297	5686908	Photo	
100702-NEMO-DDV-B03-040-002_003	404299	5686888	Photo	
100702-NEMO-DDV-B03-040-002_004	404301	5686870	Photo	
100702-NEMO-DDV-B03-040-002_005	404302	5686849	Photo	
100702-NEMO-DDV-B03-040-002_006	404304	5686831	Photo	
100702-NEMO-DDV-B03-040-002_007	404305	5686811	Photo	

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-GS-B01-001	No		No		No	Sand and silt
100702-NEMO-GS-B01-002	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-003	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-004	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-005	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-006	No		No		No	Fine sand and silt. Shell fragments
100702-NEMO-GS-B01-007	No		No		No	Sand with shell fragments
100702-NEMO-GS-B01-008	No		No		No	Sand and silt. Shell fragments
100702-NEMO-GS-B01-009	No		No		No	Fine sand and silt with occasional pebbles
100702-NEMO-GS-B01-010	No		No		No	Fine sand and gravel
100702-NEMO-GS-B01-011	No		No		No	Fine sand and gravel
100702-NEMO-GS-B01-012	No		No		No	Fine sand
100702-NEMO-GS-B01-013	No		No		No	Sand and shell fragments
100702-NEMO-GS-B01-014	No		No		No	Sand and a couple of cobbles
100702-NEMO-GS-B01-015	No		No		No	Sand and a couple of cobbles
100702-NEMO-GS-B01-016	No		No		No	Fine sand
100702-NEMO-GS-B01-017	No		No		No	Fine sand
100702-NEMO-GS-B01-018	No		No		No	Fine sand and very soft clay

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-GS-B01-019	No		No		No	Sandy clay and silt
100702-NEMO-GS-B01-020	No		No		No	Sandy clay and silt
100702-NEMO-GS-B02-021	No		No		No	Sand and cobbles
100702-NEMO-GS-B02-022	No		No		No	Fine sand and occasional cobbles
100702-NEMO-GS-B02-023	No		No		No	Fine sand
100702-NEMO-GS-B02-024	No		No		No	Fine sand and occasional cobbles
100702-NEMO-GS-B02-025	No		No		No	Fine sand, gravel and occasional cobbles
100702-NEMO-GS-B02-026	No		No		No	Sand, gravel and cobbles
100702-NEMO-GS-B02-027	No		No		No	Sand and gravel
100702-NEMO-GS-B02-028	No		No		No	Sand, gravel and pebbles
100702-NEMO-GS-B02-029	No		No		No	Sand and gravel
100702-NEMO-GS-B02-030	No		No		No	Sand and shell fragments
100702-NEMO-DDV-B03-031	No		No		No	Sand and gravel with shell fragments
100702-NEMO-DDV-B03-032	No		No		No	Fine and coarse sand
100702-NEMO-DDV-B03-033	No		No		No	Sand and pebbles
100702-NEMO-DDV-B03-034	No		No		No	Sand and pebbles
100702-NEMO-DDV-B03-035	No		No		No	Fine sand
100702-NEMO-DDV-B03-036	No		No		No	Fine sand and occasional cobbles

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-DDV-B03-037	No		No		No	Fine sand and silt
100702-NEMO-DDV-B03-038	No		No		No	Sand and cobbles
100702-NEMO-DDV-B03-039	Yes	50%	No		No	Sabellaria reef
100702-NEMO-DDV-B03-040	Yes	40%	No		No	Sabellaria reef
100702-NEMO-DDV-B03-041	No		No		No	Cobbles and coarse sand
100702-NEMO-DDV-B03-042	No		No		No	Pebbles and fine sand
100702-NEMO-DDV-B03-043	No		No		No	Pebbles and fine sand
100702-NEMO-DDV-B03-044	No		No		No	Fine sand
100702-NEMO-DDV-B03-045	No		No		No	Probably cobbles and sand
100702-NEMO-DDV-B03-046	No		No		No	Fine sand and gravel
100702-NEMO-DDV-B03-047	No		No		No	Sand and shell gravel
100702-NEMO-DDV-B03-048	No		No		No	Fine sand
100702-NEMO-DDV-B03-049	No		No		No	Sand
100702-NEMO-DDV-B03-050	No		No		No	Soft mixed sediment and shell fragments

100702-NEMO-TRAWL-B03-001				
Depth:	34 - 40 m		Start	Stop
Distance:	1200 m	Easting	431618	431195
Sample volume:	10 L	Northing	5686686	5686248

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CRUSTACEA			**VARIA**		
Crangon crangon	80		*Pleuronectes platessa*	12	22
Gastrosaccus spinifer	2		*Pleuronectes platessa*		22
Liocarcinus holsatus	7		*Pleuronectes platessa*		24
Liocarcinus marmoreus	26		*Pleuronectes platessa*		16
Pagurus bernhardus	1		*Pleuronectes platessa*		34
Processa spp.	4		*Pleuronectes platessa*		24
ECHINODERMATA			*Pleuronectes platessa*		14
Asterias rubens	2		*Pleuronectes platessa*		22
Ophiura ophiura	1		*Pleuronectes platessa*		20
MOLLUSCA-GASTROPODA			*Pleuronectes platessa*		20
Buccinum undatum	1		*Pleuronectes platessa*		26
POLYCHAETA			*Pleuronectes platessa*		16
Nepthys longosetosa	1		*Pomatoschistus spp.*	55	~3
VARIA			*Solea solea*	3	20
Arnoglossus laterna	3	12	*Solea solea*		18
Arnoglossus laterna		10	*Solea solea*		18
Arnoglossus laterna		10	*Trachinus draco*	13	~6
Callionymus lyra	2	6			
Callionymus lyra		2			

100702-NEMO-TRAWL-B03-002				
Depth:	40 - 42 m		Start	Stop
Distance:	610 m	Easting	426267	426207
Sample volume:	4L	Northing	5686965	5686362

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CNIDARIA			**VARIA**		
Flustra foliacea	1		*Arnoglossus laterna*	1	
Nemertesia spp.	P*		*Callionymus lyra*	6	14
Hydrallmania falcata	P		*Callionymus lyra*		6
CRUSTACEA			*Callionymus lyra*		4
Pagurus bernhardus	55		*Callionymus lyra*		3
Balanus balanus	1		*Callionymus lyra*		6
Crangon spp.	80		*Callionymus lyra*		4
Liocarcinus holsatus	1		*Hyperoplus lanceolatus*	1	6
Liocarcinus marmoreus	14		*Pleuronectes platessa*	5	20
Processa spp.	4		*Pleuronectes platessa*		18
ECHINODERMATA			*Pleuronectes platessa*		18
Asterias rubens	2		*Pleuronectes platessa*		18
Ophiuroidea	3		*Pleuronectes platessa*		18
MOLLUSCA-BIVALVIA			*Pomatochistus spp.*	140	~3
Aequipecten opercularis	6		*Solea solea*	3	25
Spisula elliptica	1		*Solea solea*		24
MOLLUSCA-GASTROPODA			*Solea solea*		14
Cryptonatica affinis	1		*Trisopterus minutus*	1	12
Crepidula fornicata	11				
MOLLUSCA-CEPHALOPODA					
Sepiola atlantica	4				

100702-NEMO-TRAWL-B03-003				
Depth:	40 m		Start	Stop
Distance:	600 m	Easting	416314	416909
Sample volume:	2L	Northing	5686883	5686778

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CNIDARIA			**ECHINODERMATA**		
Abietinaria abietina	P*		*Amphipholis squamata*	1	
Actiniaria	2		*Asterias rubens*	3	
Alcyonium spp.	P		Holothurioidea	1	
Campanulariidae	P		*Ophiothrix fragilis*	2	
Clytia hemisphaerica	P		Ophiuroidea	11	
Hydrallmania falcata	P		*Psammechinus miliaris*	48	
Obelia sp.	P		**MOLLUSCA-BIVALVIA**		
Plumulariidae	P		*Aequipecten opercularis*	2	
Sertularia cupressina	P		**MOLLUSCA-NUDIBRANCHIA**		
CRUSTACEA			*Adalaria proxima*	P	
Pisidia longicornis	6		*Aeolidiella sp.*	1	
Ampelisca sp.	1		**MOLLUSCA-CEPHALOPODA**		
Aoridae	4		*Sepiola atlantica*	1	~0.5
Balanus crenatus	12		**POLYCHAETA**		
Caridea	6		*Eusyllis blomstrandi*	1	
Crangon allmanni	2		*Harmothoe extenuata*	1	
Crangon crangon	4		*Lepidonotus squamatus*	2	
Crangon sp.	1		**VARIA**		
Galathea intermedia	2		*Actinopterygii sp.*	1	
Galathea spp.	4		*Alcyonidium diaphanum*	P	
Gammaridea	1		Ascidiacea	4	
Gastrosaccus spinifer	2		Calloporidae	P	
Hippolyte varians	1		*Flustra foliacea*	P	
Iphimedia sp.	1		*Solea solea*	1	21
Ischyroceridae	1		*Trachurus trachurus*	1	9.5
Liocarcinus holsatus	1		*Trisopterus minutus*	1	12
Macropodia tenuirostris	6				
Pandalina spp.	44				

** P refers to present*

100702-NEMO-TRAWL-B03-004_C				
Depth:	34 m		Start	Stop
Distance:	640 m	Easting	413827	413933
Sample volume:	2L	Northing	5686470	5687099

SPECIES	Count	length (cm)	SPECIES	Count	length (cm)
CRUSTACEA			**VARIA**		
Pagurus bernhardus	28		*Trachinus draco*	9	12
ECHINODERMATA			*Trachinus draco*		9.5
Asterias rubens	2		*Trachinus draco*		10.5
MOLLUSCA-CEPHALOPODA			*Trachinus draco*		13
Sepiola atlantica	2		*Trachinus draco*		11
VARIA			*Trachinus draco*		9
Hyperoplus lanceolatus	2	17	*Trachinus draco*		8
Hyperoplus lanceolatus		12.5	*Trachinus draco*		8
			Trachinus draco		3.5

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-001	B01-002	B01-003	B01-004	B01-005
Total weight of sample:		[g]	432.99	516.02	325.72	555.64	678.93
FW	**< 0.063 mm**	[g]	74.36	36.90	167.17	34.84	20.55
FW	**0.063-0.250 mm**	[g]	20.69	18.97	11.28	13.11	13.33
FW	**0.125-0.250 mm**	[g]	213.20	348.91	116.54	251.10	174.42
FW	**0.250-0.500 mm**	[g]	82.96	75.58	26.25	158.03	331.99
FW	**0.500-1.000 mm**	[g]	21.26	13.95	1.27	14.97	74.63
FW	**1.000-2.000 mm**	[g]	9.00	7.31	1.03	10.28	28.68
FW	**> 2.000 mm**	[g]	11.52	14.40	2.18	73.31	35.33
q	**< 0,002 mm**	[%]	1.26	0.61	3.76	0.44	0.29
q	**0.002-0.004 mm**	[%]	1.68	0.87	5.75	0.68	0.44
q	**0.004-0.008 mm**	[%]	2.70	1.30	9.46	1.16	0.64
q	**0.008-0.016 mm**	[%]	3.86	1.78	14.12	1.75	0.80
q	**0.016-0.032 mm**	[%]	3.65	1.38	10.45	1.23	0.48
q	**0.032-0.063 mm**	[%]	4.02	1.21	7.78	1.01	0.37
q	**0.063-0.125 mm**	[%]	4.78	3.68	3.46	2.36	1.96
q	**0.125-0.250 mm**	[%]	49.24	67.62	35.78	45.19	25.69
q	**0.250-0.500 mm**	[%]	19.16	14.65	8.06	28.44	48.90
q	**0.500-1.000 mm**	[%]	4.91	2.70	0.39	2.69	10.99
q	**1.000-2.000 mm**	[%]	2.08	1.42	0.32	1.85	4.22
q	**> 2.000 mm**	[%]	2.66	2.79	0.67	13.19	5.20
Q	**< 0,002 mm**	[%]	1.26	0.61	3.76	0.44	0.29
Q	**< 0.004 mm**	[%]	2.94	1.48	9.51	1.12	0.73
Q	**< 0.008 mm**	[%]	5.65	2.78	18.98	2.28	1.37
Q	**< 0.016 mm**	[%]	9.50	4.56	33.10	4.03	2.18
Q	**< 0.032 mm**	[%]	13.15	5.94	43.55	5.26	2.65
Q	**< 0.063 mm**	[%]	17.17	7.15	51.32	6.27	3.03
Q	**< 0.125 mm**	[%]	21.95	10.83	54.79	8.63	4.99
Q	**< 0.250 mm**	[%]	71.19	78.44	90.57	53.82	30.68
Q	**< 0.500 mm**	[%]	90.35	93.09	98.62	82.26	79.58
Q	**< 1.000 mm**	[%]	95.26	95.79	99.01	84.96	90.57
Q	**< 2.000 mm**	[%]	97.34	97.21	99.33	86.81	94.80

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-006	B01-007	B01-008	B01-009	B01-010
Total weight of sample:		[g]	631.88	677.41	675.83	733.31	689.40
FW	**< 0.063 mm**	[g]	18.20	9.20	0.29	4.26	0.26
FW	**0.063-0.250 mm**	[g]	8.88	8.92	0.73	2.82	0.55
FW	**0.125-0.250 mm**	[g]	187.23	55.59	5.74	147.50	17.80
FW	**0.250-0.500 mm**	[g]	326.84	334.58	103.03	532.53	562.29
FW	**0.500-1.000 mm**	[g]	78.78	185.65	291.66	33.07	27.73
FW	**1.000-2.000 mm**	[g]	7.71	71.42	219.23	5.84	7.02
FW	**> 2.000 mm**	[g]	4.24	12.04	55.16	7.29	73.74
q	**< 0,002 mm**	[%]	0.34	0.11	0.00	0.05	0.00
q	**0.002-0.004 mm**	[%]	0.50	0.18	0.00	0.07	0.00
q	**0.004-0.008 mm**	[%]	0.67	0.28	0.01	0.12	0.01
q	**0.008-0.016 mm**	[%]	0.77	0.38	0.01	0.17	0.01
q	**0.016-0.032 mm**	[%]	0.40	0.23	0.01	0.11	0.01
q	**0.032-0.063 mm**	[%]	0.19	0.18	0.01	0.07	0.01
q	**0.063-0.125 mm**	[%]	1.41	1.32	0.11	0.38	0.08
q	**0.125-0.250 mm**	[%]	29.63	8.21	0.85	20.11	2.58
q	**0.250-0.500 mm**	[%]	51.73	49.39	15.24	72.62	81.56
q	**0.500-1.000 mm**	[%]	12.47	27.41	43.16	4.51	4.02
q	**1.000-2.000 mm**	[%]	1.22	10.54	32.44	0.80	1.02
q	**> 2.000 mm**	[%]	0.67	1.78	8.16	0.99	10.70
Q	**< 0,002 mm**	[%]	0.34	0.11	0.00	0.05	0.00
Q	**< 0.004 mm**	[%]	0.84	0.29	0.01	0.12	0.01
Q	**< 0.008 mm**	[%]	1.51	0.57	0.01	0.24	0.01
Q	**< 0.016 mm**	[%]	2.28	0.95	0.03	0.40	0.02
Q	**< 0.032 mm**	[%]	2.69	1.18	0.04	0.51	0.03
Q	**< 0.063 mm**	[%]	2.88	1.36	0.04	0.58	0.04
Q	**< 0.125 mm**	[%]	4.29	2.68	0.15	0.97	0.12
Q	**< 0.250 mm**	[%]	33.92	10.88	1.00	21.08	2.70
Q	**< 0.500 mm**	[%]	85.64	60.27	16.24	93.70	84.26
Q	**< 1.000 mm**	[%]	98.11	87.68	59.40	98.21	88.29
Q	**< 2.000 mm**	[%]	99.33	98.22	91.84	99.01	89.30

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-011	B01-012	B01-013	B01-014	B01-015
Total weight of sample:		[g]	630.27	587.73	637.86	663.84	826.48
FW	**< 0.063 mm**	[g]	6.34	6.13	0.41	0.26	0.60
FW	**0.063-0.250 mm**	[g]	1.04	2.74	0.64	0.76	0.41
FW	**0.125-0.250 mm**	[g]	33.20	50.23	28.83	36.99	21.21
FW	**0.250-0.500 mm**	[g]	558.31	315.68	303.81	539.08	589.72
FW	**0.500-1.000 mm**	[g]	18.66	126.70	137.96	52.70	147.35
FW	**1.000-2.000 mm**	[g]	6.27	49.48	57.73	10.44	36.83
FW	**> 2.000 mm**	[g]	6.45	36.77	108.47	23.61	30.36
q	**< 0,002 mm**	[%]	0.09	0.09	0.00	0.00	0.01
q	**0.002-0.004 mm**	[%]	0.14	0.15	0.00	0.00	0.01
q	**0.004-0.008 mm**	[%]	0.22	0.22	0.00	0.01	0.02
q	**0.008-0.016 mm**	[%]	0.29	0.30	0.01	0.01	0.02
q	**0.016-0.032 mm**	[%]	0.20	0.22	0.01	0.01	0.01
q	**0.032-0.063 mm**	[%]	0.06	0.06	0.04	0.01	0.01
q	**0.063-0.125 mm**	[%]	0.17	0.47	0.10	0.11	0.05
q	**0.125-0.250 mm**	[%]	5.27	8.55	4.52	5.57	2.57
q	**0.250-0.500 mm**	[%]	88.58	53.71	47.63	81.21	71.35
q	**0.500-1.000 mm**	[%]	2.96	21.56	21.63	7.94	17.83
q	**1.000-2.000 mm**	[%]	0.99	8.42	9.05	1.57	4.46
q	**> 2.000 mm**	[%]	1.02	6.26	17.01	3.56	3.67
Q	**< 0,002 mm**	[%]	0.09	0.09	0.00	0.00	0.01
Q	**< 0.004 mm**	[%]	0.23	0.24	0.01	0.01	0.02
Q	**< 0.008 mm**	[%]	0.45	0.46	0.01	0.01	0.03
Q	**< 0.016 mm**	[%]	0.74	0.76	0.02	0.02	0.05
Q	**< 0.032 mm**	[%]	0.94	0.98	0.03	0.03	0.07
Q	**< 0.063 mm**	[%]	1.01	1.04	0.06	0.04	0.07
Q	**< 0.125 mm**	[%]	1.17	1.51	0.17	0.15	0.12
Q	**< 0.250 mm**	[%]	6.44	10.06	4.69	5.73	2.69
Q	**< 0.500 mm**	[%]	95.02	63.77	52.32	86.93	74.04
Q	**< 1.000 mm**	[%]	97.98	85.32	73.94	94.87	91.87
Q	**< 2.000 mm**	[%]	98.98	93.74	82.99	96.44	96.33

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-016	B01-017	B01-018	B01-019	B01-020
Total weight of sample:		[g]	671.42	617.21	26.26	21.00	21.21
FW	**< 0.063 mm**	[g]	0.56	6.80	8.27	10.21	16.72
FW	**0.063-0.250 mm**	[g]	1.67	80.06	3.83	1.55	1.00
FW	**0.125-0.250 mm**	[g]	94.16	155.11	11.96	8.83	3.07
FW	**0.250-0.500 mm**	[g]	521.89	283.78	1.61	0.28	0.25
FW	**0.500-1.000 mm**	[g]	43.76	82.73	0.33	0.08	0.11
FW	**1.000-2.000 mm**	[g]	8.26	7.46	0.14	0.05	0.06
FW	**> 2.000 mm**	[g]	1.12	1.27	0.12	0.00	0.00
q	**< 0,002 mm**	[%]	0.01	0.11	2.35	3.11	4.86
q	**0.002-0.004 mm**	[%]	0.01	0.17	3.67	5.04	7.72
q	**0.004-0.008 mm**	[%]	0.01	0.26	6.41	9.78	13.87
q	**0.008-0.016 mm**	[%]	0.02	0.33	8.97	14.86	21.58
q	**0.016-0.032 mm**	[%]	0.02	0.21	5.65	9.32	17.17
q	**0.032-0.063 mm**	[%]	0.01	0.02	4.44	6.51	13.64
q	**0.063-0.125 mm**	[%]	0.25	12.97	14.58	7.38	4.70
q	**0.125-0.250 mm**	[%]	14.02	25.13	45.55	42.05	14.48
q	**0.250-0.500 mm**	[%]	77.73	45.98	6.13	1.33	1.18
q	**0.500-1.000 mm**	[%]	6.52	13.40	1.26	0.38	0.52
q	**1.000-2.000 mm**	[%]	1.23	1.21	0.53	0.24	0.28
q	**> 2.000 mm**	[%]	0.17	0.21	0.46	0.00	0.00
Q	**< 0,002 mm**	[%]	0.01	0.11	2.35	3.11	4.86
Q	**< 0.004 mm**	[%]	0.02	0.29	6.02	8.15	12.58
Q	**< 0.008 mm**	[%]	0.03	0.55	12.43	17.93	26.45
Q	**< 0.016 mm**	[%]	0.06	0.87	21.40	32.79	48.03
Q	**< 0.032 mm**	[%]	0.08	1.08	27.05	42.11	65.20
Q	**< 0.063 mm**	[%]	0.08	1.10	31.49	48.62	78.84
Q	**< 0.125 mm**	[%]	0.33	14.07	46.07	56.00	83.54
Q	**< 0.250 mm**	[%]	14.36	39.20	91.62	98.05	98.02
Q	**< 0.500 mm**	[%]	92.09	85.18	97.75	99.38	99.20
Q	**< 1.000 mm**	[%]	98.60	98.59	99.01	99.76	99.72
Q	**< 2.000 mm**	[%]	99.83	99.79	99.54	100.00	100.00

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-022	B02-021	B02-023	B02-025	B02-027
Total weight of sample:		[g]	652.80	828.78	668.15	640.82	691.15
FW	**< 0.063 mm**	[g]	1.38	1.92	0.41	3.64	0.00
FW	**0.063-0.250 mm**	[g]	0.85	0.96	0.29	0.68	1.01
FW	**0.125-0.250 mm**	[g]	57.24	78.15	36.93	39.84	71.35
FW	**0.250-0.500 mm**	[g]	539.40	522.74	616.59	483.87	465.53
FW	**0.500-1.000 mm**	[g]	34.53	133.87	10.39	85.37	92.54
FW	**1.000-2.000 mm**	[g]	9.57	49.60	2.59	16.77	28.19
FW	**> 2.000 mm**	[g]	9.83	41.54	0.94	10.65	32.21
q	**< 0,002 mm**	[%]	0.02	0.02	0.00	0.05	0.00
q	**0.002-0.004 mm**	[%]	0.03	0.03	0.01	0.08	0.00
q	**0.004-0.008 mm**	[%]	0.04	0.05	0.01	0.13	0.00
q	**0.008-0.016 mm**	[%]	0.06	0.07	0.02	0.17	0.00
q	**0.016-0.032 mm**	[%]	0.04	0.04	0.02	0.11	0.00
q	**0.032-0.063 mm**	[%]	0.02	0.02	0.01	0.03	0.00
q	**0.063-0.125 mm**	[%]	0.13	0.12	0.04	0.11	0.15
q	**0.125-0.250 mm**	[%]	8.77	9.43	5.53	6.22	10.32
q	**0.250-0.500 mm**	[%]	82.63	63.07	92.28	75.51	67.36
q	**0.500-1.000 mm**	[%]	5.29	16.15	1.56	13.32	13.39
q	**1.000-2.000 mm**	[%]	1.47	5.98	0.39	2.62	4.08
q	**> 2.000 mm**	[%]	1.51	5.01	0.14	1.66	4.66
Q	**< 0,002 mm**	[%]	0.02	0.02	0.00	0.05	0.00
Q	**< 0.004 mm**	[%]	0.05	0.05	0.01	0.13	0.00
Q	**< 0.008 mm**	[%]	0.09	0.10	0.02	0.26	0.00
Q	**< 0.016 mm**	[%]	0.15	0.17	0.03	0.43	0.00
Q	**< 0.032 mm**	[%]	0.19	0.21	0.05	0.54	0.00
Q	**< 0.063 mm**	[%]	0.21	0.23	0.06	0.57	0.00
Q	**< 0.125 mm**	[%]	0.34	0.35	0.11	0.67	0.15
Q	**< 0.250 mm**	[%]	9.11	9.78	5.63	6.89	10.47
Q	**< 0.500 mm**	[%]	91.74	72.85	97.92	82.40	77.83
Q	**< 1.000 mm**	[%]	97.03	89.00	99.47	95.72	91.22
Q	**< 2.000 mm**	[%]	98.49	94.99	99.86	98.34	95.29

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B02-028	B02-029	B02-030	B03-031	B03-032
Total weight of sample:		[g]	834.37	550.32	640.25	570.16	544.29
FW	**< 0.063 mm**	[g]	0.16	0.95	0.39	0.00	2.37
FW	**0.063-0.250 mm**	[g]	0.56	0.76	0.54	0.10	0.57
FW	**0.125-0.250 mm**	[g]	526.95	45.94	19.04	2.61	31.26
FW	**0.250-0.500 mm**	[g]	142.17	270.37	465.64	240.80	231.67
FW	**0.500-1.000 mm**	[g]	46.91	88.41	79.63	191.78	126.37
FW	**1.000-2.000 mm**	[g]	40.83	46.85	24.47	30.84	48.08
FW	**> 2.000 mm**	[g]	76.79	97.04	50.54	104.03	103.97
q	**< 0,002 mm**	[%]	0.00	0.01	0.00	0.00	0.03
q	**0.002-0.004 mm**	[%]	0.00	0.02	0.01	0.00	0.05
q	**0.004-0.008 mm**	[%]	0.00	0.03	0.01	0.00	0.08
q	**0.008-0.016 mm**	[%]	0.00	0.05	0.02	0.00	0.12
q	**0.016-0.032 mm**	[%]	0.01	0.04	0.01	0.00	0.08
q	**0.032-0.063 mm**	[%]	0.00	0.03	0.01	0.00	0.06
q	**0.063-0.125 mm**	[%]	0.07	0.14	0.08	0.02	0.10
q	**0.125-0.250 mm**	[%]	63.16	8.35	2.97	0.46	5.74
q	**0.250-0.500 mm**	[%]	17.04	49.13	72.73	42.23	42.56
q	**0.500-1.000 mm**	[%]	5.62	16.07	12.44	33.63	23.22
q	**1.000-2.000 mm**	[%]	4.89	8.51	3.82	5.41	8.83
q	**> 2.000 mm**	[%]	9.20	17.63	7.89	18.24	19.10
Q	**< 0,002 mm**	[%]	0.00	0.01	0.00	0.00	0.03
Q	**< 0.004 mm**	[%]	0.00	0.03	0.01	0.00	0.08
Q	**< 0.008 mm**	[%]	0.01	0.06	0.02	0.00	0.17
Q	**< 0.016 mm**	[%]	0.01	0.11	0.04	0.00	0.29
Q	**< 0.032 mm**	[%]	0.01	0.14	0.05	0.00	0.37
Q	**< 0.063 mm**	[%]	0.02	0.17	0.06	0.00	0.44
Q	**< 0.125 mm**	[%]	0.09	0.31	0.15	0.02	0.54
Q	**< 0.250 mm**	[%]	63.24	8.66	3.12	0.48	6.28
Q	**< 0.500 mm**	[%]	80.28	57.79	75.85	42.70	48.85
Q	**< 1.000 mm**	[%]	85.90	73.85	88.28	76.34	72.06
Q	**< 2.000 mm**	[%]	90.80	82.37	92.11	81.74	80.90

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B03-035	B03-037	B03-039	B03-042	B03-043
Total weight of sample:		[g]	588.24	715.91	633.93	458.63	693.53
FW	**< 0.063 mm**	[g]	0.00	12.52	19.25	15.35	0.95
FW	**0.063-0.250 mm**	[g]	0.51	6.79	18.98	34.50	4.13
FW	**0.125-0.250 mm**	[g]	42.98	93.01	104.40	340.33	199.41
FW	**0.250-0.500 mm**	[g]	523.07	600.19	407.69	39.48	261.08
FW	**0.500-1.000 mm**	[g]	17.71	1.15	48.11	3.14	94.74
FW	**1.000-2.000 mm**	[g]	1.90	0.82	18.70	3.32	52.35
FW	**> 2.000 mm**	[g]	2.07	1.42	16.80	22.51	80.88
q	**< 0,002 mm**	[%]	0.00	0.18	0.30	0.35	0.01
q	**0.002-0.004 mm**	[%]	0.00	0.25	0.44	0.49	0.02
q	**0.004-0.008 mm**	[%]	0.00	0.32	0.60	0.67	0.02
q	**0.008-0.016 mm**	[%]	0.00	0.40	0.73	0.81	0.03
q	**0.016-0.032 mm**	[%]	0.00	0.26	0.45	0.50	0.03
q	**0.032-0.063 mm**	[%]	0.00	0.34	0.52	0.52	0.03
q	**0.063-0.125 mm**	[%]	0.09	0.95	2.99	7.52	0.60
q	**0.125-0.250 mm**	[%]	7.30	12.99	16.47	74.21	28.75
q	**0.250-0.500 mm**	[%]	88.88	83.84	64.31	8.61	37.64
q	**0.500-1.000 mm**	[%]	3.01	0.16	7.59	0.68	13.66
q	**1.000-2.000 mm**	[%]	0.32	0.11	2.95	0.72	7.55
q	**> 2.000 mm**	[%]	0.35	0.20	2.65	4.91	11.66
Q	**< 0,002 mm**	[%]	0.00	0.18	0.30	0.35	0.01
Q	**< 0.004 mm**	[%]	0.00	0.43	0.73	0.84	0.03
Q	**< 0.008 mm**	[%]	0.00	0.75	1.33	1.51	0.05
Q	**< 0.016 mm**	[%]	0.00	1.15	2.06	2.32	0.08
Q	**< 0.032 mm**	[%]	0.00	1.41	2.51	2.82	0.11
Q	**< 0.063 mm**	[%]	0.00	1.75	3.04	3.35	0.14
Q	**< 0.125 mm**	[%]	0.09	2.70	6.03	10.87	0.73
Q	**< 0.250 mm**	[%]	7.39	15.69	22.50	85.08	29.48
Q	**< 0.500 mm**	[%]	96.27	99.53	86.81	93.68	67.13
Q	**< 1.000 mm**	[%]	99.28	99.69	94.40	94.37	80.79
Q	**< 2.000 mm**	[%]	99.60	99.80	97.35	95.09	88.34

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B03-044	B03-046	B03-047	B03-048	B03-049
Total weight of sample:		[g]	602.03	844.02	569.89	826.62	79.22
FW	**< 0.063 mm**	[g]	0.98	1.69	3.48	1.17	0.72
FW	**0.063-0.250 mm**	[g]	5.51	5.35	3.06	5.60	1.60
FW	**0.125-0.250 mm**	[g]	177.41	20.24	102.54	148.56	13.33
FW	**0.250-0.500 mm**	[g]	416.41	503.69	112.17	670.58	55.02
FW	**0.500-1.000 mm**	[g]	0.88	217.79	214.58	0.61	7.03
FW	**1.000-2.000 mm**	[g]	0.09	57.60	61.11	0.10	0.80
FW	**> 2.000 mm**	[g]	0.75	37.66	72.95	0.00	0.72
q	**< 0,002 mm**	[%]	0.01	0.02	0.05	0.01	0.07
q	**0.002-0.004 mm**	[%]	0.02	0.03	0.09	0.02	0.11
q	**0.004-0.008 mm**	[%]	0.03	0.04	0.11	0.02	0.15
q	**0.008-0.016 mm**	[%]	0.04	0.05	0.17	0.03	0.22
q	**0.016-0.032 mm**	[%]	0.03	0.03	0.13	0.03	0.17
q	**0.032-0.063 mm**	[%]	0.03	0.03	0.06	0.03	0.19
q	**0.063-0.125 mm**	[%]	0.91	0.63	0.54	0.68	2.02
q	**0.125-0.250 mm**	[%]	29.47	2.40	17.99	17.97	16.83
q	**0.250-0.500 mm**	[%]	69.17	59.68	19.68	81.12	69.45
q	**0.500-1.000 mm**	[%]	0.15	25.80	37.65	0.07	8.87
q	**1.000-2.000 mm**	[%]	0.01	6.82	10.72	0.01	1.01
q	**> 2.000 mm**	[%]	0.12	4.46	12.80	0.00	0.91
Q	**< 0,002 mm**	[%]	0.01	0.02	0.05	0.01	0.07
Q	**< 0.004 mm**	[%]	0.03	0.05	0.13	0.03	0.18
Q	**< 0.008 mm**	[%]	0.06	0.08	0.24	0.05	0.33
Q	**< 0.016 mm**	[%]	0.10	0.13	0.42	0.08	0.54
Q	**< 0.032 mm**	[%]	0.13	0.17	0.55	0.11	0.71
Q	**< 0.063 mm**	[%]	0.16	0.20	0.61	0.14	0.91
Q	**< 0.125 mm**	[%]	1.08	0.83	1.15	0.82	2.93
Q	**< 0.250 mm**	[%]	30.55	3.23	19.14	18.79	19.75
Q	**< 0.500 mm**	[%]	99.71	62.91	38.82	99.91	89.21
Q	**< 1.000 mm**	[%]	99.86	88.71	76.48	99.99	98.08
Q	**< 2.000 mm**	[%]	99.88	95.54	87.20	100.00	99.09

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B03-050
Total weight of sample:		[g]	30.35
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FW	0.500-1.000 mm	[g]	1.34
FW	1.000-2.000 mm	[g]	0.93
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q	< 0,002 mm	[%]	1.34
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Q	< 0.500 mm	[%]	63.49
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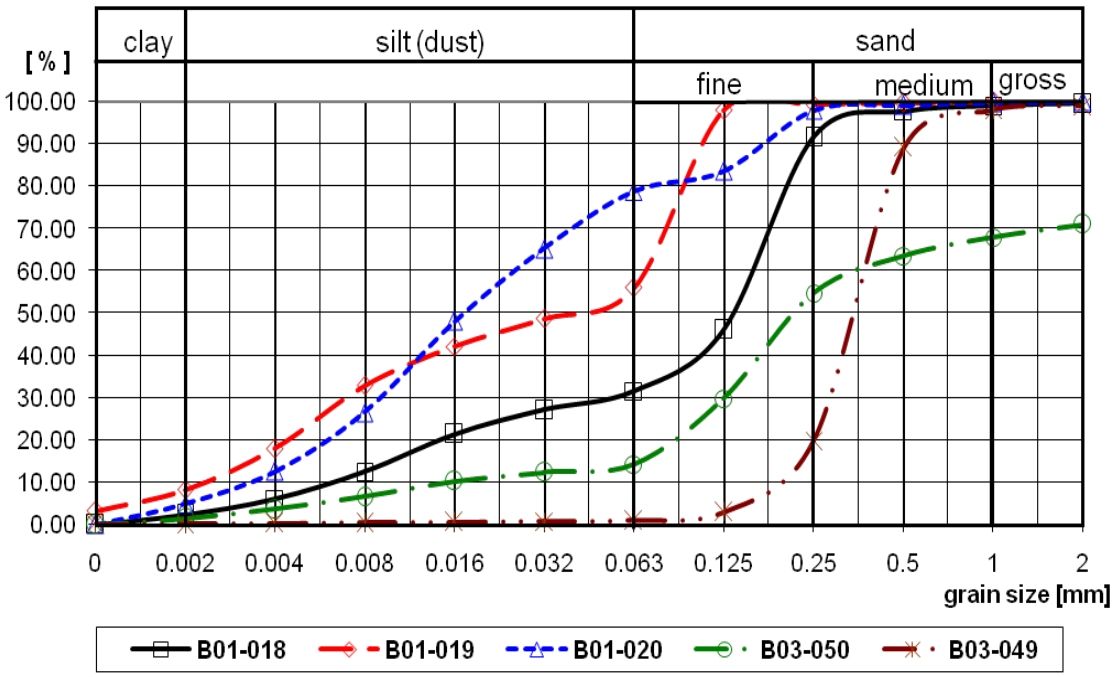
Q	< 2.000 mm	[%]	70.97

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.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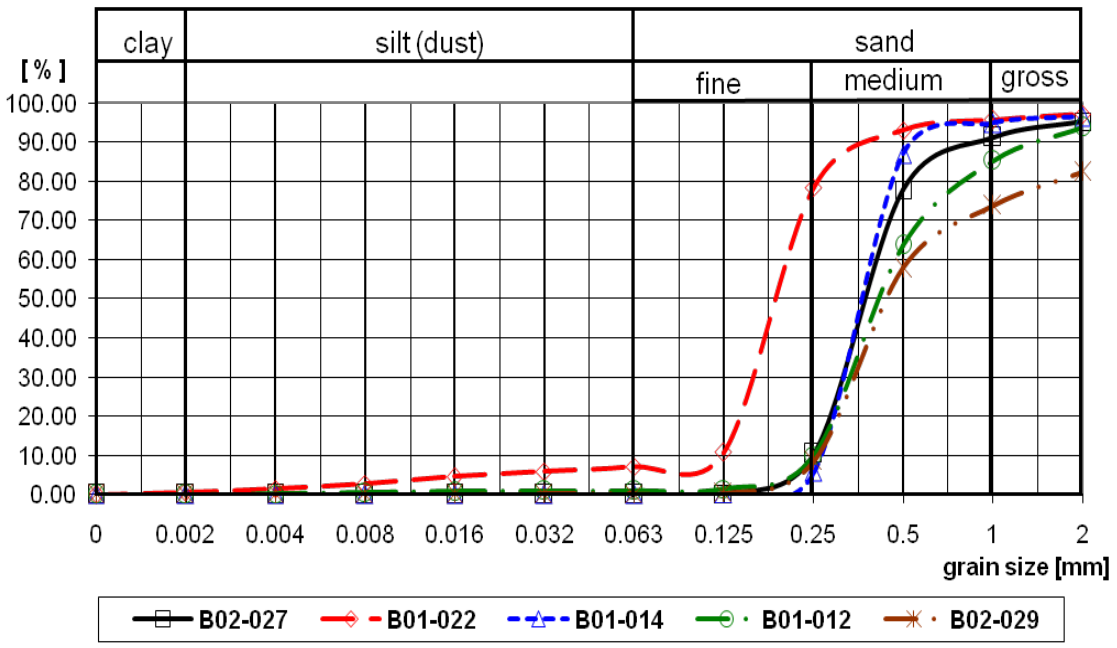
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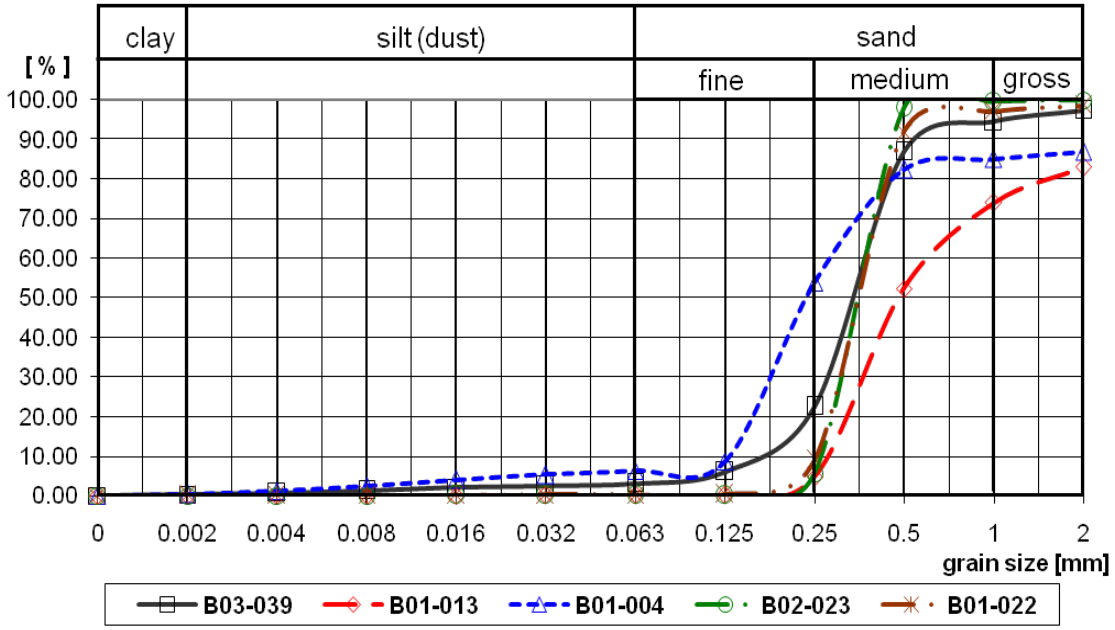
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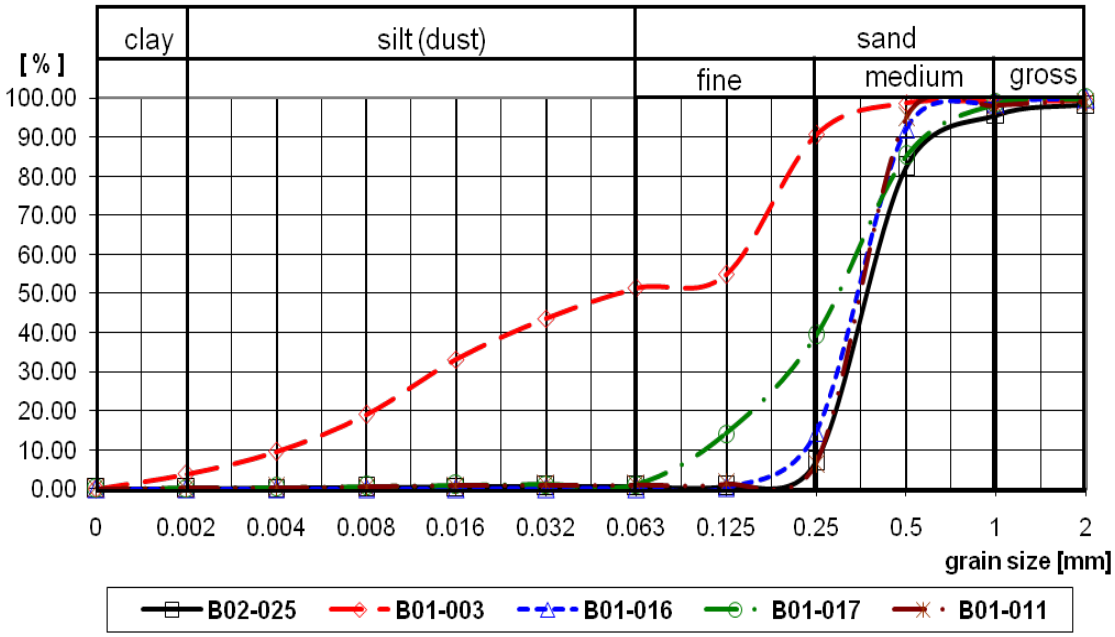
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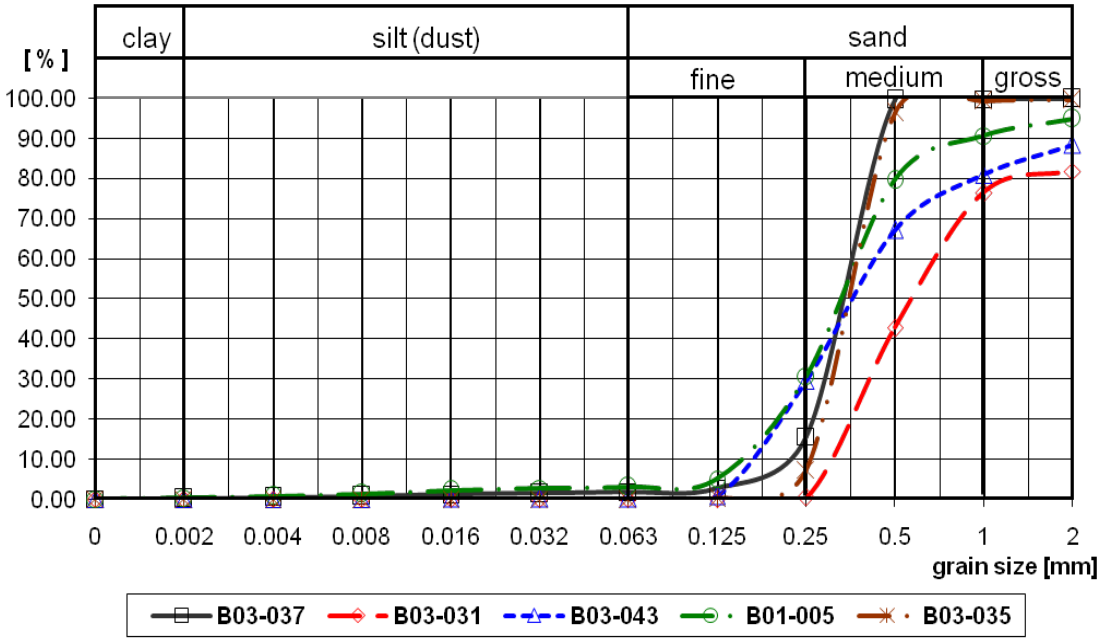
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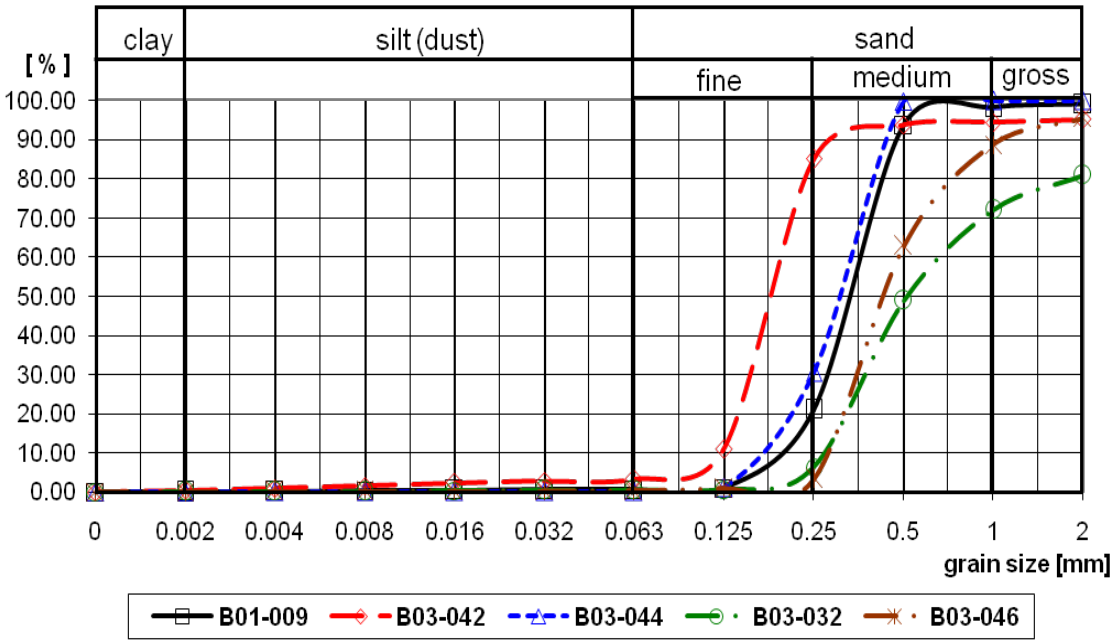
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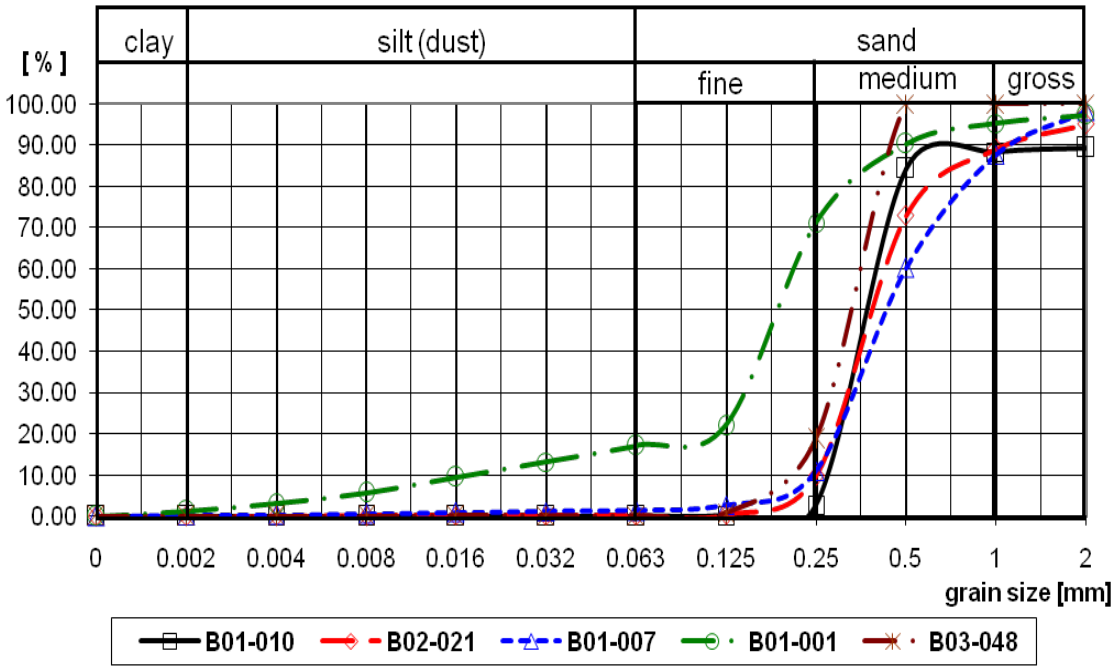
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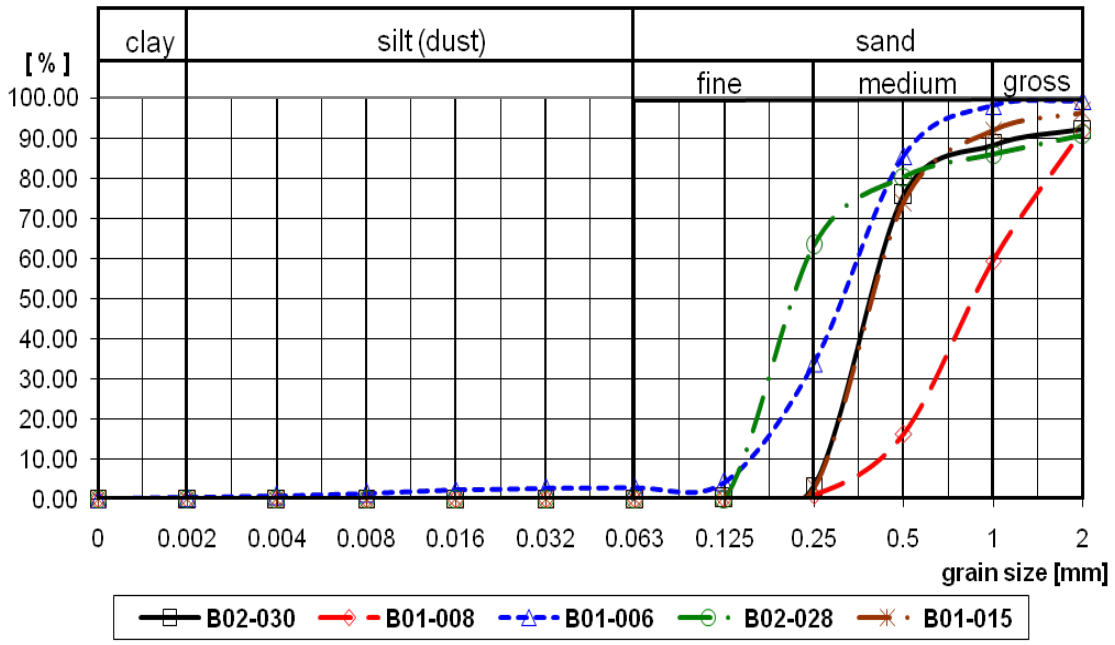
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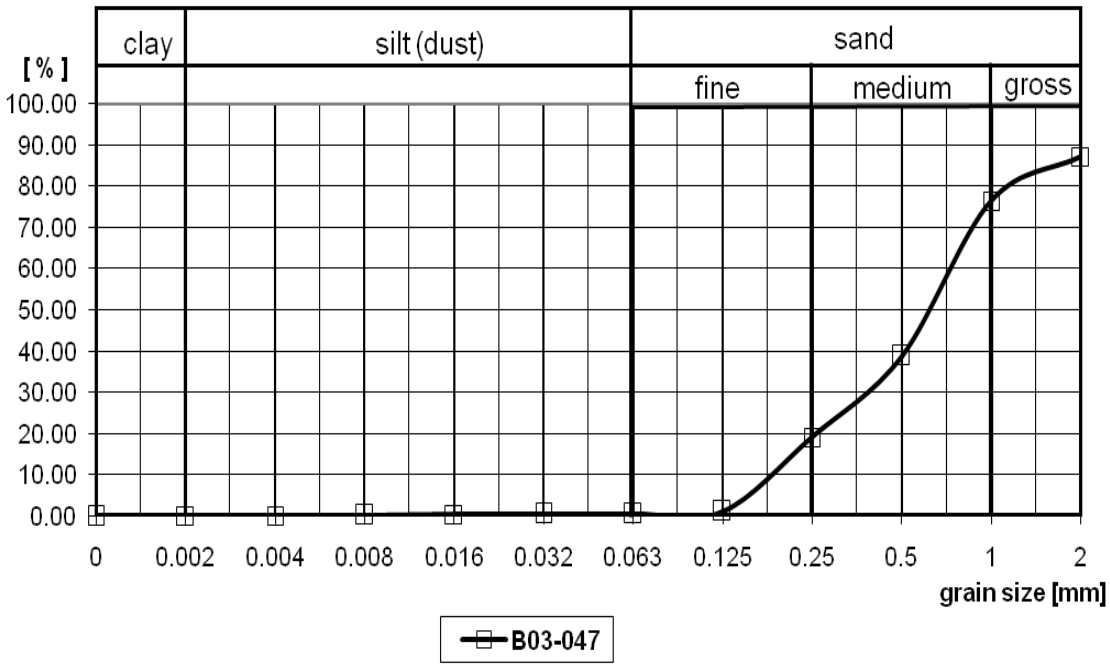
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Appendix 12: Archaeological EIA

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR
RICHBOROUGH TO WEST-ZEEBRUGGE

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

Volume I: Report

(*cf.* Volume II: Appendices)

Prepared for:

PMSS

by
Wessex Archaeology
Portway House
Old Sarum Park
Salisbury
SP4 6EB

Report reference: 73390.03

March 2011

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Title:	Project Nemo: UK-Belgium Electrical Interconnector – Richborough to West-Zeebrugge Archaeological Environmental Impact Assessment
Principal Author(s):	Andrea Hamel, Nicolas Bigourdan
Managed by:	Euan McNeill
Origination date:	March 2011
Date of last revision:	March 2011
Version:	73390.03 – Volume I
Wessex Archaeology QA:	Caroline Budd
Status:	Final Report
Summary of changes:	Final Report produced from first draft with client comments as well as additional amendments received the 24/03/2011
Associated reports:	73390.01 – Volume I, 73390.02 – Volume I, 73390.03 – Volume II
Client Approval:	Jason Cunningham/ Rachel McCall PMSS

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PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

Summary

Wessex Archaeology was commissioned by PMSS, on behalf of Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL), to carry out an archaeological desk-based assessment for the Project Nemo UK-Belgium Electrical Interconnector cable route.

This assessment comprises an archaeological baseline study, including an archaeological assessment of geophysical and geotechnical data and an assessment of the effects of the cable route development on archaeological receptors. This will ultimately form part of the Environmental Statement for the proposed Project Nemo development. This present assessment does not include an evaluation of the intertidal data because they have not been made available at the writing stage of this report, however once accessible these data will be archaeologically assessed and included in an updated report.

The cable route extends from the English Landfall at Pegwell Bay in Kent to the Belgian Landfall in West-Zeebrugge, and a wide variety of local, regional, national, and international guidance and legislation applies. Therefore, this report has been structured to facilitate the interpretation of the archaeological resource within this legislative framework. The Study Areas comprised the Kent Landfall (inland of the mean high water mark level), English Waters (from mean high water, including the 12 nm limit and EEZ), French Waters (EEZ), Belgian Waters (from mean high water, including the 12 nm limit and EEZ), and the Belgian Landfall (inland of the mean high water mark level). Within this report, the known and potential archaeological resource of each area is individually examined. The combined results of the desk-based assessment of archaeological data sources and archaeological geophysical and geotechnical assessments revealed:

- At the Kent Landfall:
  - 2 Listed Buildings
  - 67 other archaeological sites and findspots, dating from the Neolithic to modern period
- In English, French and Belgian Waters:
  - 8 sites of anthropogenic origin of archaeological interest identified or confirmed with the archaeological assessment of geophysical survey data including:
    - 3 wreck sites recorded by the UKHO, SHOM and VIOE;
    - 1 previously unrecorded wreck (located in the English Exclusive Economic Zone),;
    - 4 further geophysical anomalies of anthropogenic origin and archaeological interest, including a live obstruction recorded by the UKHO;
  - 254 additional geophysical anomalies of possible archaeological interest;

  - A number of channels of probable prehistoric date and potential archaeological interest; and
  - 24 additional wrecks recorded by the UKHO, SHOM and VIOE but outside of the geophysical survey coverage.
- At the Belgian Landfall:
  - 37 archaeological sites and findspots dating from the Roman period to the modern period, plus numerous findspots on the beach.

The baseline study also revealed further potential for as yet undiscovered sites and material dating from the Palaeolithic to modern period, including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material.

The impact assessment outlines the nature of the likely direct, indirect and secondary impacts on the known and potential archaeological sites during the course of the construction, operation and decommissioning of the Project Nemo interconnector cable. With the exception of a few modern wrecks, the effects of all potential direct and secondary impacts on the known archaeological receptors (including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material) are judged to be significant where an unmitigated impact occurs. The effects resulting from all potential indirect or cumulative impacts are expected to be negligible.

Although it is not possible to assess the significance of impacts on potential archaeological sites and material, as the magnitude of effects and the sensitivity of the receptor cannot be evaluated until further details regarding the presence/absence and nature of each receptor have been established, any damage or destruction to them would be permanent and effects are likely to be judged to be significant. If sites or findspots are discovered during the development, each would need to be considered on a site by site basis.

All known wrecks were avoided during the cable route design phase, but further mitigation measures proposed in the impact assessment include:

- Temporary Archaeological Exclusion Zones with a 50 m diameter around the extents of 8 known wreck sites and geophysical anomalies of anthropogenic origin identified in the geophysical survey data:

WA ID	Easting	Northing	Description	Study Area
7024	389786	5685532	Previously unrecorded wreck	English Waters
7027	391279	5685143	Geophysical anomaly of anthropogenic origin	English Waters
7047	394777	5685245	Geophysical anomaly of anthropogenic origin	English Waters
7049	395957	5685445	Geophysical anomaly of anthropogenic origin – recorded by the UKHO as a live obstruction	English Waters
7098	416527	5686440	Geophysical anomaly of anthropogenic origin	English Waters
7141	438175	5686526	Live wreck, possibly the HMS *Westella*, recorded by the UKHO and SHOM	French Waters
7151	446702	5685213	Live wreck recorded by the UKHO and SHOM	French Waters
7200	460851	5689298	Live wreck, *Tringa*, recorded in by the UKHO and VIOE	Belgian Waters

- Buffers around the location of 18 wrecks or archaeological importance recorded by the UKHO, SHOM or VIOE, which are located outside of the

geophysical survey data area. The buffers provide a guide as to the potential extents of the wrecks, in order to protect them from secondary impacts such as vessel anchorages. A full list can be found in **Table 12.2**;

- Further investigation of identified anomalies (rated High or Medium) that are likely to be impacted along the cable route, as specified in the WSI, including in the intertidal zone during watching briefs, in the offshore area during a pre-lay grapnel run, and by the Archaeological Reporting Protocol;
- The establishment of a Written Scheme of Investigation and an Archaeological Reporting Protocol, in order to minimise impact on potential sites, which will ensure that any finds are promptly reported, archaeological advice is obtained, and any recovered material is stabilised, recorded and conserved;
- A watching brief for intertidal works, pre-lay grapnel runs, and cable installation;
- Further examination of potential prehistoric deposits identified in the geoarchaeological investigations, including Stage 3 to 5 geoarchaeological recording of recovered sub-samples, and archaeological input into any future sampling programme, particularly in the intertidal or foreshore areas; and
- Should they be planned, then archaeological assessment of any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo.

It is expected that with the implementation of mitigation, based on the assessment outlined in this report, the residual effects of the development on any archaeological receptors will be minor.

Glossary

Dead wreck: according to the UKHO it refers to a wreck which has not been detected by repeated surveys and is considered to not exist (or be absent) from the designated location.

Devensian: this term is used by British geologist and archaeologist in order to refer to the most recent glacial period.

Eocene: it refers to a geological epoch comprised between 55.8 Ma and 33.9 Ma.

Holocene: is a geological period beginning approximately 11700 years BP.

Live wreck: according to the UKHO this terms gather all wrecks which are not dead of which have not been lifted, either charted or uncharted.

Mesolithic: is a period in the human development of human technology between the Palaeolithic and the Neolithic.

Neolithic: this is a period of human evolution and specifically which sees the passage from a nomadic to sedentary life style.

Palaeocene: it refers to a geological epoch comprised between 65.5 Ma and 55.8 Ma.

Pleistocene: is the name of a geological period that spans over the recent repeated glaciations between 2.588 Ma and 12000 years BP.

Palaeolithic

Lower Palaeolithic: this term comprise the first subdivision of the Palaeolithic from 2.5 Ma until approximately 300,000 years BP.

Middle Palaeolithic: it refers to the second subdivision of the Palaeolithic which spans from 300,000 years BP to 30,000 years BP.

Abbreviations

BP: Before Present

EEZ: Exclusive Economic Zone

HER: Historic Environment Record

NMR: National Monuments Record

UKHO: United Kingdom Hydrographic Office

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

Acknowledgments

This study was commissioned by PMSS, on behalf of Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL). Special thanks to Jason Cunningham and Rachel McCall at PMSS for their assistance.

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-Rebecca Tye (Deputy Receiver of Wreck, MCA)
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-Ben Croxford (Kent HER)
-Lorraine Beale (UKHO)
-Angharad Wicks (NMR)

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-Marnix Pieters (VIOE)
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-Patricia De Bruyne (Vlaamse Hydrowinkel)

France:
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-Stephane Revillion (SRA Nord-Pas-de-Calais)
-Aurelie Counil (Creocean)

This report was compiled by Andrea Hamel and Nic Bigourdan, the archaeological geophysical assessment was undertaken by David Howell and the archaeological assessment of geotechnical work was undertaken by Kevin Stratford and Jack Russell. Illustrations were prepared by Kitty Brandon. The project was managed for Wessex Archaeology by Euan McNeil and quality control was provided by Caroline Budd.

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

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PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

1 INTRODUCTION

1.1.1 Wessex Archaeology was commissioned by PMSS, on behalf of Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL), to carry out an archaeological desk-based assessment of the Project Nemo UK-Belgium Electrical Interconnector.

1.1.2 The aim of the archaeological assessment is to inform the overall Environmental Statement for the Project. The assessment comprises a baseline study, incorporating a review of existing geophysical and geotechnical data, an assessment of the impact of the cable route on the known and potential archaeological resource, and suggested mitigation measures.

1.1.3 Due to the unavailability of intertidal data, this report does not provide such assessment, but once accessible these data will be archaeologically assessed and the results included in an updated report.

2 STUDY AREA

2.1.1 The proposed Nemo electrical interconnector cable will extend approximately 130 km between Pegwell Bay in Kent to the West-Zeebrugge in Belgium.

2.1.2 The archaeological Study Area comprises a composite of the original route and further iterations buffered to 500 m on either side (**Figure 1**). Additional buffers were applied to the potential landfalls. The buffers provide confidence that all relevant sites are considered, given the relatively poor positional data of known marine and terrestrial archaeological sites and material.

2.1.3 A Regional Archaeological Overview provides a backdrop and context for the general area, however, to assist with regulatory divisions the known and potential archaeological resource has been examined in more detail within five sub-study-areas: Kent Landfall, English Waters, French Waters, Belgian Waters, Belgian Landfall.

3 METHODOLOGY

3.1 APPROACH

3.1.1 This assessment was carried out in a manner consistent with available guidance, including the Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development, in line with Defra's *Explanatory Memorandum to The Marine Works* (*Environmental Impact Assessment) Regulations 2007 No. 1518*, and European Directives for Environmental Impact Assessments (85/337/EEC, 97/11/EC 2003/35/EC), DETR 02/99, Meylemans *et al.* 2005, and with the Institute

for Archaeologists (IfA) Standard and Guidance for Desk-based Assessment (IfA 2008).

3.2 SOURCES

3.2.1 The principal sources consulted in drafting this desk-based assessment comprised:

- United Kingdom Hydrographic Office (UKHO) wreck record;
- English Heritage's National Monuments Record (NMR);
- Kent Historic Environment Record (Kent HER);
- Service Hydrographique et Oceanographique de la Marine (SHOM) wreck record;
- Vlaams Instituut voor het Onroerent Erfgoed (VIOE) wreck record;
- Centrale Archeologische Inventaris (CAI) terrestrial sites record;
- previous archaeological studies in the area;
- a wide range of secondary sources, including those providing an overview of the historical and archaeological resources of Kent, France, Belgium and the Southern North Sea, and with particular reference to:
    - sources related to historic shipping patterns and potential wreck sites and casualties, specifically *England's Shipping* (Wessex Archaeology 2004) and *Navigational Hazards* and *Areas of Marine Archaeological Potential* projects (Bournemouth University 2007, 2008, Seazone ongoing);
    - sources related to historic aviation patterns and the potential for aircraft crash sites, specifically *Aircraft Crash Sites at Sea* (Wessex Archaeology 2008) which provided an understanding of the potential density and general distribution of wartime aircraft activity across the English Channel;
    - sources relating to the palaeoenvironment of the Southern North Sea, with specific reference to submerged palaeolandscapes and coastal change; and
    - sources related to the terrestrial and marine historic environment of Kent, including the South East Research Framework (Kent County Council), the Maritime and Marine Historic Environment Research Framework (University of Southampton, ongoing); the Isle of Grain to South Foreland Shoreline Management Plan (South East Coastal Group 2010).
- Geophysical data provided by Marin Mätteknik (MMT) AB that had been gathered from the Study Area during the summer of 2010, including: sidescan sonar, sub-bottom profiler (sparker and boomer), multibeam bathymetry and marine magnetometer datasets; and
- Geotechnical data provided by Marin Mätteknik (MMT) AB including 100 vibrocore logs and 10 actual vibrocores acquired from the Study Area during the summer of 2010.

3.3 LEGISLATION

3.3.1 The Cable Route Study Area falls within several different jurisdictions, each covered by different legislation and guidance and under the responsibility of different curators

and heritage agencies. The Kent Landfall to low water is covered by English Heritage, Kent County Council and local councils. English Heritage is responsible for the archaeological resource within England's Territorial Waters (to the 12 nm limit) and is consultee for the resource in the UK Exclusive Economic Zone (EEZ). The Study Area is located beyond French Territorial Waters (the 12 nm limit), and the archaeological resource in the French EEZ is administered by Pas de Calais, with the support of DRASSM if requested. In the Belgian EEZ and within Belgian Territorial Waters (to the 12 nm limit), the archaeological resource is administered by VIOE. At the Belgian Landfall to low water, the archaeological resource is also administered by VIOE with local councils.

3.3.2 Details about the applicable legislation and guidance for England, France, Belgium, the Exclusive Economic Zones are presented in **Appendix I** in **Volume II**.

3.4 PRODUCTION OF BASE-LINE – RESEARCH AND ASSESSMENT

3.4.1 Searches of third party data sources, outlined above, were carried out to establish the archaeological baseline. These searches requested data regarding known terrestrial sites and marine sites (including ship and aircraft wrecks) and documented losses (casualties). Further information was obtained from published sources and available unpublished reports relevant to the study areas.

3.4.2 The spatial data has been imported into ESRI ArcGIS 9.3 software package. The use of GIS allows spatial comparison of the data in relation to mapping, charts and bathymetry and facilitated interpretation of the known sites with respect to the available secondary sources. Information that could not be mapped in the GIS was compiled in a project archive and used qualitatively.

3.4.3 The spatial data from the Kent Landfall were supplied in British National Grid, and have been conserved in that format in the GIS, appendices and figures. The spatial data for English Waters were supplied in WGS84 lat/long, French Waters in WGS84 lat/long and French National Grid (RGF 1993 Lambert 93), Belgian Waters in WGS84 lat/long and the Belgium Landfall in Belgium National Grid Projection (Belge Lambert 72 datum). These spatial data were converted to WGS84 UTM Zone 31N using Quest Geodetic calculator by Quest Geo Solutions, and are presented in WGS84 UTM Zone 31N in the GIS, appendices and figures, although the Belgian Landfall co-ordinates are also presented in Belgium National Grid in the appendices. Further details about the transformation parameters are included in Volume II Appendix X.

3.4.4 The known archaeology has been examined in five separate areas to facilitate review by statutory consultees and to best manage and assess the terrestrial and marine data and the potential development impacts. The areas are the English Landfall, English Waters (from high water including the English 12 nm limit and English EEZ), French Waters (comprising the French EEZ), Belgian Waters (from high water including the Belgian 12 nm limit and Belgian EEZ), and Belgian Landfall. The known archaeological data was queried in combination with secondary sources in order to contribute to the assessment of the archaeological potential of the area.

3.5 ARCHAEOLOGICAL INTERPRETATION OF GEOPHYSICAL DATA

Data Sources

3.5.1 As part of the EIA of the proposed scheme, Wessex Archaeology (WA) carried out an archaeological assessment of marine geophysical data previously collected by Marin Mätteknik (MMT) AB.

3.5.2 The aims of this assessment were to carry out an archaeological interpretation of the marine geophysical data acquired from the survey area. This has resulted in an archaeological review of the effects of the proposed development upon sites of archaeological interest. The objectives were as follows:

- To assess geophysical data acquired by MMT in order to identify any material of archaeological interest lying within the limits of the survey area.
- To locate, identify and characterise any previously unrecorded archaeological sites, and confirm the presence and condition of any known sites within the survey area.
- To identify the presence of any sedimentary deposits of archaeological potential.
- To propose future mitigation for material of archaeological interest within the survey area.

3.5.3 The geophysical data used for this report were assessed for quality and were rated as variable using the following criteria (**Table 3.1**):

Table 3.1: Criteria for assigning data quality rating.

Data Quality	Description
Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in the data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good to average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

3.5.4 A particular issue which adversely affected the quality of all data sets appears to have been variable weather conditions encountered during the survey. This has resulted in varying degrees of noise being present on both the sub-bottom profiler and sidescan sonar data sets. Additionally, a large amount of periodic noise from an unknown source, possibly electrical noise or interference from the other geophysical equipment, was visible on the marine magnetometer data set, though it proved possible to remove a large portion of this during data processing. As a result of these factors, it is not possible to guarantee that all the potential archaeological features in the data have been correctly identified during archaeological assessment at WA.

Geophysical Data – Technical Specifications

3.5.5 The data assessed were obtained by MMT between the 15th and 29th August 2010 on the *MV IceBeam* (offshore) and the *MV Ping* (near shore), and consisted of

sidescan sonar, sub-bottom profiler (sparker and boomer), multibeam bathymetry and marine magnetometer data sets.

3.5.6 MMT used an Edgetech 4200 dual frequency sidescan sonar system operated at 75 m (near shore) and 100 m (offshore) ranges, with towfish positioning provided by a USBL system offshore and by fixed layback near shore. The data were digitally recorded using Edgetech Discover software, and provided to WA as *.xtf* files.

3.5.7 The sub-bottom profiler data were acquired using a boomer system for the near shore, and a sparker for the offshore section. The data were digitally recorded using Triton software as *.SGY* files. These were converted into *.cod* files by WA using Coda File Utilities software.

3.5.8 The magnetometer data were acquired using a Geometrics G-882 caesium vapour marine magnetometer.

3.5.9 The multibeam bathymetry data were acquired using a Kongsberg EM3002D system. The data were digitally recorded by Kongsberg SIS acquisition software and provided to WA as *.txt* files.

3.5.10 Both near shore and offshore vessel positioning was provided by a POS MV 320 system with a C-Nav RTG IALA, with an additional Fugro Starfix system used offshore (this would give a submeter accuracy for the vessel position).

Geophysical Data - Processing

3.5.11 The sidescan sonar data were processed by WA using Coda Geosurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were initially scanned to give an understanding of the geological nature of the area and were then interpreted for any objects of possible anthropogenic origin: the position and dimensions of any such objects were recorded in a gazetteer, and an image of each anomaly was acquired. Only the key anomalies are illustrated within the present report, however the remaining images are held in the project archive for future reference).

3.5.12 During this stage of the interpretation, the sidescan sonar anomalies were ascribed an archaeological flag in order to record the geophysicist's initial assessment of each anomaly. These flags were ascribed as follows (**Table 3.2**):

Table 3.2: Criteria for assigning archaeological potential rating

Flag	Description
High	Ascribed only where the geophysical anomalies clearly represent a wreck site or were very near to a previously known site.
Medium	Geophysical anomalies with no directly corroborating data but being of a size, shape or amplitude such as to suggest that they possibly relate to archaeological sites or features.
Low	Small, isolated, geophysical anomalies of uncertain origin, which are likely to be 'artefacts' in the data or natural features.
Very Low	Anomalies that are known or are highly likely to be of modern origin, and which are not archaeologically interesting (e.g. moorings, etc)

3.5.13 The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. A single, small, but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges

of a buried but intact feature, or it may be all that remains of a feature as a result of past impacts from, for example, dredging or fishing. The application of a ratings system is therefore a means of prioritising sites in order to inform further staged of the interpretation process, and on its own is not definitive.

3.5.14 The shallow seismic data were studied in order to detect any in-filled palaeochannels, ravinement surfaces and peat/fine-grained sediment horizons that may have archaeological potential.

3.5.15 The shallow seismic data were processed by WA using Coda Seismic+ software. This software allows the data to be visualised with user selected filters and gain settings in order to optimise the appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting a sedimentary boundary that might be of archaeological interest.

3.5.16 The shallow seismic data were interpreted with a two-way travel time (TWTT) along the z-axis. In order to convert from TWTT to depth, the velocity of the seismic waves was estimated to be 1,600 ms^{-1}. This is a standard estimate for shallow, unconsolidated sediments.

3.5.17 Any small reflectors which appear to be buried material, such as a wreck site covered by sediment were also recorded, the position and dimensions of any such objects noted in a gazetteer, and an image of each anomaly acquired. It should be noted that anomalies of this type are rare, as the sensors must pass directly over such an object in order to produce an anomaly.

3.5.18 The magnetometer data were processed by WA using Geometrics MagPick software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures such as wrecks.

3.5.19 The software enables both visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map. Smoothed averages of the data were first calculated, and then subtracted from the raw data values in order to reduce the effect of natural variations in the magnetic field such as changes in geology or water depth.

3.5.20 The multibeam bathymetry data were used to provide a vertical reference for the sub-bottom profiler data, and were fully analysed to identify any unusual seabed structure that could be shipwrecks or other anthropogenic debris. The data were gridded and analysed using Fledermaus software, which enables 3-D visualisation of the acquired data and geo-picking of seabed anomalies.

Geophysical Data – Anomaly Grouping and Discrimination

3.5.21 The previous section describes the initial interpretation of all available geophysical data sets, which were conducted independently of each other. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different data sets and apparently overstating the number of archaeological features in the study area.

3.5.22 To address this fact, the anomalies were grouped together along with the results of the desk-based study of known archaeological sites. This allows one ID number to be assigned to a single object for which there may be, for example, a UKHO record, a magnetic anomaly, and multiple sidescan sonar anomalies.

3.5.23 Once all the geophysical anomalies and desk-based information have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed as follows (**Table 3.3**):

Table 3.3: Criteria discriminating relevance of feature to proposed scheme.

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

3.5.24 All the sites that have been identified within the study areas are presented in gazetteers in **Volume II** and discussed in this report. Recommendations have been made for mitigation measures should the sites be impacted by the proposed development scheme.

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

3.5.26 All the geophysical data sets are handled in the same way, beginning by discerning what is present, then qualifying the initial interpretation and finally characterising the output. For sidescan sonar and magnetic data sets this results in point data, while sub-bottom profiler data produces an interpretation with a wider spatial extent. However, including the start and end co-ordinates for each reflector in the sub-bottom profile gazetteer would be misleading as the anomalies are not simply straight lines between these points. The spatial distribution and extent of these sub-bottom anomalies is shown in the report figures and can be made available as a shapefile. The sidescan sonar, magnetometer and sub-bottom profile anomalies are all taken as screen dumps with an associated ID and stored within the project folder. This allows us to view the image for any WA# when requested. This applies to all anomalies identified during the initial interpretation, not just those later classified as A1 or A2's. Also the sidescan sonar and sub-bottom profile tags are stored within the Coda project. The original data can then be replayed and skip to any given anomaly if there are questions which can't be answered by looking at the screen dump, without the need to replay the entire data set.

3.6 ARCHAEOLOGICAL INTERPRETATION OF GEOTECHNICAL DATA

3.6.1 The geoarchaeological investigation of geotechnical data followed a staged approach, where each stage of the process is dependent on the results from the preceding stage, including recommendations as to the need for further work. For this assessment, Stage 1, Stage 2 and part of Stage 3 were completed, comprising:

- Stage 1: archaeological assessment of geotechnical logs – a review of all the vibrocore fieldwork logs (100) upon completion of the geotechnical ground investigation. Of these, ten were positioned specifically to assess sediments identified as having archaeological potential. The sediments described within the vibrocores were then grouped into a number of sedimentary units (and sub-units) based on the observed sedimentary characteristics;
- Stage 2: archaeological recording of available vibrocores (10) – detailed description of the sediments contained within the cores; examination of the sediments for a range of palaeoenvironmental indicators and dating material; identification of sediments with archaeological potential; interpretation of sedimentary descriptions to place them within a stratigraphic framework. The sediments described within the vibrocores were then grouped into a number of sedimentary units based on the observed sedimentary characteristics, and compared with the sub-bottom profiler geophysical survey data;
- Stage 3: subsampling of vibrocores to retain material of archaeological interest for potential further assessment.

3.6.2 Vibrocore logs were provided for 92 core logs, and 10 vibrocores were physically provided for geoarchaeological assessment. All of the vibrocore locations were plotted in the GIS (see **Figure 3**), and all of the vibrocore logs were assessed by Wessex Archaeology.

3.6.3 The 10 vibrocores (acquired in clear liners) were split longitudinally using an angle grinder and carefully prised open with a knife in order to preserve sedimentary structure. One half of each core was cleaned where necessary and photographed.

3.6.4 Each of the 10 vibrocores were then geoarchaeologically recorded and the descriptions are given in full in **Appendix III** in **Volume II.** The vibrocore descriptions provided details to the depth to each sediment horizon and the character of the sediment. Sedimentary characteristics were recorded including texture, colour, stoniness and depositional structure (*cf.* Hodgson 1976).

3.6.5 The 92 core logs generated on board by the geotechnical contractor during vibrocore sampling provide basic sedimentary detail noted whilst the vibrocores were cut into 1 metre lengths. These basic core logs have been compared to the interpreted sub-bottom geophysical data in order to gain further detail upon the interpreted sedimentary sequence. The 92 vibrocore logs confirm the geophysical interpretation of sedimentary units detailed in **Section 4.4**.

3.7 IMPACT ASSESSMENT

3.7.1 This section sets out the method of Environmental Impact Assessment used to determine the significance of the effects of the installation and operation of the Project Nemo cable system. There is no specific archaeological guidance that refers to laying power interconnector cables, however, as cable laying is a routine part of offshore wind farm construction, the impact assessment refers to guidance developed for the Offshore Renewable Energy sector (COWRIE 2007, 2008, 2010). This methodology has been applied in similar cable laying situations, such as for the BritNed Interconnector on the Isle of Grain, Kent. In addition, development impacts on the terrestrial archaeological resource have been assessed using the guidance on the assessment of the impacts of road projects (DoT 2007). The assessment has also been based on professional archaeological judgement and best practice that has been applied to numerous consented offshore wind farms and cable routes.

This situation stands for England Exclusive Economic Zone, but there is not similar type of guidance for France and Belgium.

Nature of Effect

3.7.2 The magnitude of the effect is assessed using the following criteria (**Table 3.4**):

Table 3.4: Nature of Effect

Effect Factor	Classification	Definition	Score
Likelihood	Certain	Will occur as a result of the project	100
	Possible	Likely to occur	10
	Unlikely	Not likely to occur	1
Spatial Extent	Regional	Regional to national/international (e.g. entire English Channel	100
	Local	Within range (few km) of the source of impact	10
	Immediate vicinity	At source of impact only	1
Level of Change	High	Large change compared to natural variations in baseline	100
	Medium	Change will or may be noticeable/measurable against the natural variation in the baseline	10
	Low	Change will not be noticeable or measurable against natural variation in baseline	1
Duration	Long-term	Effect will occur for >5 years	100
	Medium-term	Effect will occur for between 6 months and 5 years	10
	Short-term	Effect will occur up to 6 months	1

These effects are defined as:

- Likelihood – the probability of the impact occurring
- Spatial Extent – the spatial extent over which the impact may occur
- Level of Change – the potential level of change from baseline conditions, taking into account known information on natural variation
- Duration – the length of time over which the impact may occur

3.7.3 Using these criteria, an impact is given a value of magnitude using the scoring system below (**Table 3.5**). For example, for a long term effect that will definitely occur, at a regional scale with a large change from the baseline, the score is 400. The Magnitude (Severe, Moderate or Low) of the effect is determined using the thresholds below (the magnitude of the impact described above would be Severe):

Table 3.5: Magnitude of Effect

Magnitude of Effect	Score Threshold
Severe	400 - 211
Moderate	202 - 22
Low	13 – 4

Description of Receptor

3.7.4 In order to identify the level of impact on each receptor or feature, the following will be described (**Table 3.6**):

- Sensitivity – the sensitivity or tolerance of the receptor to the effect
- Recoverability – how rapidly the receptor recovers to baseline state following effect
- Importance – receptor's importance in terms of its occurrence in the UK, its national/international significance and its conservation or commercial value.

Table 3.6: Description of Receptor

Receptor Aspect	Classification	Definition
Sensitivity	High	Receptor or feature is highly sensitive to effect and will be detrimentally damaged (in ecological terms killed/destroyed) by effect
	Moderate	Some damage may occur to the receptor or feature
	Low	Some minor damage to receptor or feature
Recoverability	Low	No recovery
	Moderate	Recovery to baseline conditions within years
	High	Recovery to baseline conditions within weeks or months
Importance	High	Receptor is either rare, and/or significant in conservation or commercial terms
	Low	Receptor is neither rare or significant in conservation or commercial terms

3.7.5 Using the criteria above, a Receptor Value has been determined. The definition of Value (High, Medium, Low) has been defined by reference to the three aspects of Sensitivity, Recoverability and Importance (**Table 3.7**).

Table 3.7: Receptor Value

Receptor Value	Definition
High	Damage or loss to the structure/integrity of an archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material) identified as being of high importance. Feature will not recover.
Medium	Damage or loss to the structure/integrity of an archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material). Small-scale, peripheral disturbance to sites identified as being of moderate archaeological importance.
Low	No measurable direct or indirect impacts that would affect an existing archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material).

Impact Assessment

3.7.6 The impact significance is a function of the Magnitude of the effect and the Value of the receptor, as illustrated below (**Table 3.8**):

Table 3.8: Impact Assessment

	Value of Receptor		
Sensitivity	High	Medium	Low
High	Significant	Significant	Moderate
Moderate	Significant	Moderate	Minor
Low	Moderate	Minor	Minor

3.7.7 The significance of each impact is assessed as being minor, moderate or major. Impacts of 'major' or 'moderate' significance' are considered to be 'significant' in EIA terms. Potential impacts may be positive (beneficial) or negative (adverse).

3.7.8 The effects of impacts on known and potential archaeological receptors are complex and subjective, and therefore do not generally fit neatly into tables of value or significance. Because of this, a subjective scale based on professional judgement and good practice guidelines has also been used, and to provide transparency, the **Impact Assessment** section further discusses the reasoning behind the assessment of effect, value and significance.

4 REGIONAL ARCHAEOLOGICAL OVERVIEW

4.1 INTRODUCTION

4.1.1 The Study Area extends between England and Belgium, crossing the French EEZ. There has been hominin (humans and our ancestors) presence in the area for almost a million years: in the Palaeolithic and early Mesolithic, populations occupied, when habitable, vast plains that extended between England and the Continent, and since the inundation of the Southern North Sea and English Channel, people have travelled across the waters in a variety of ever increasingly technologically advanced watercraft. Since the Neolithic, settlements on both sides of the Channel have flourished. Although both landfalls and each area of territorial sea and EEZ will be examined individually in the following sections, providing details about the specific known and potential archaeological receptors of each area, the data needs to be seen within a wider context, where the historic environment of the Kent coast, Belgian coast and waters in between are viewed as more of a continuum, since the

activities that shaped the cultural heritage land and seascape are intertwined. This Regional Archaeological Overview not only provides context for the known archaeological receptors, but also indicates archaeological potential, by examining land use patterns, trade routes, military conflicts and the ideologies that governed human activity.

4.2 CHRONOLOGIES

4.2.1 Archaeological material is generally studied within a framework of 'Periods' or 'Ages' which reflect the activities and cultural changes taking place over time. However, because of geographical and cultural differences, the chronologies are defined slightly differently by each country. The following table provides a rough overview of the chronologies (**Table 4.1**). Note that for archaeological studies of the Palaeolithic period, dates are expressed in terms of years Before Present (BP), whereas from the Mesolithic period onwards, absolute (or calendar) dates are used, either in Before Christ (BC) or *Anno Domini* (AD).

Table 4.1: Chronologies

	England	France	Belgium
Palaeolithic	~900,000 BP-9500 BC	1,000,000 BP – 10500 BC	500,000 BP -11500 BC
Mesolithic	9500-4000BC	10500 BC – 7000 BC	11500 BC – 8200 BC
Neolithic	4000-2200 BC	7000 BC – 2500 BC	8200 BC – 2300 BC
Copper Age		2500 BC – 1800 BC	
Bronze Age	2200-700 BC	1800 BC – 1100 BC	2300 BC – 900 BC
Iron Age	700 BC – AD 43	1100 BC – 52 BC	900 BC – 52 BC
Romano-British/Gallo-Roman	AD 43- AD 410	52 BC – AD 476	52 BC – AD 476
Anglo-Saxon	AD 410-1066		
Medieval	1066 – 1500	476 – 1492	476 - 1600
post-medieval	1500 – 1800	1492 – 1789	1600 - 1800
Modern	1800 – present	1789 - Present	1800 - present

4.3 OVERVIEW

Palaeolithic

4.3.1 The occupation of the Study Areas by hominins (humans and early ancestors) during the Palaeolithic was dependent on sea level fluctuations, and the numerous glacial and marine transgressions and regressions that determined when the area was habitable. There were several periods during the Lower and Middle Palaeolithic (1,000,000 BP to 18,000 BP) when the Study Areas would have been dry land, areas that are now submerged would have been part of a vast plain, and the temperatures would have been moderate enough to be habitable (Panels A, B, C **Figure 2**). The glaciations and sea level changes also affect whether archaeological evidence survives, as glacial outwash and rising sea levels cause erosion or deposition of sediment, which often moves artefacts from their primary (original) locations to secondary locations.

4.3.2 The Lower Palaeolithic begins with the earliest hominin occupation of an area: in Britain, evidence from the site at Happisburgh suggest that it could have begun over 900,000 years ago (Parfitt *et al*. 2010, Roberts and Grün 2010); in the northern tip of France (Nord-Pas de Calais), the first attested known appearance of hominins is

dated from 700,000 BP and was found in the vicinity of present day Wimereux (Region NPC website); and in Belgium the earliest evidence dates to around 500,000 BP from the Belle-Roche cave at Sprimont.

4.3.3 The Happisburgh site, in Norwich, Norfolk, was revealed by coastal erosion. The analysis of plant and animal remains, as well as knapped flint artefacts, indicate that hominins occupied a forest-fringed estuary of the ancient River Thames. The climate during this warm interglacial period was similar to Britain today, indicating that hominins could live in the cooler-than-Mediterranean climes previously thought to be uninhabitable (Roberts and Grün 2010). The site joins a list of sites dating to around a million years ago in Germany and northern France (Roberts & Grün 2010). Closer to the Study Area, there is extensive evidence for Lower Palaeolithic activity in Kent, particularly from the Thames gravels and other rivers, where artefacts were deposited as glaciers melted forming high energy meltwater rivers that deposited enormous spreads of gravel in their lower courses from which much of the evidence of the activities of Palaeolithic people have been recovered (Scott 2004: 7). The commonest surviving material from this period is worked flint from the Acheulean tradition, including flake production and hand-axe manufacture. At Swanscombe, the remains of an early hominin were discovered close to a series of Acheulian worked flint tools (Wymer 1982: 9).

4.3.4 The discoveries near Wimereux, France, like Happisburgh, were also from a present day coastal location with high cliffs. They represent the oldest Acheulean industry within the Septentrional part of France, where unifacial and bifacial flint tools as well as bones have been recovered (Somme & Tuffereau 1978).

4.3.5 The stone tools from the cave of Belle-Roche at Sprimont, Belgium, are the earliest example of tools within the whole Benelux regional complex, and are thought to have been made by *Homo Erectus*.

4.3.6 Although the ice sheets of the Anglian or Elsterian Glaciation (478,000 – 423,000 BP) did not reach as far south as the Study Area, major changes to the landscape were caused as the Thames and its tributaries were diverted southwards, and the Yser and Leie were also redirected (Quaternary Palaeoenvironmental Group website). A massive ice-dammed lake formed in the southern North Sea (Marine Isotope Stage 12), and the overspill of this lake initiated the Dover Straits and greatly enlarged the Channel River System (*ibid*).

4.3.7 At the end of the glaciation, as temperatures had begun to rise, there is evidence for hominin occupation in Kent, as three pieces of skull were found in the Upper Middle Gravels at Swanscombe (dated to c. 423,000 BP) (Scott 2004: 7).

4.3.8 According to Somme & Tuffreau (1978), it is important not to separate the remains of lithic industries from the North of France from those of the Picardy region, because during the Lower and Middle Palaeolithic, the Septentrionale regions of France (located on the north side of the River Seine) present a certain unity, and informative sites from the River Somme valley in the vicinity of the city of Amiens have been used to develop the Palaeolithic chronology and classification of the region. This unity helped the identification of the transition period showing a degree of contemporaneousness between Acheulean and Levallois industries.

4.3.9 The emergence of *Homo neanderthalensis* (Neanderthals) in the Middle Palaeolithic (around 300,000 – 40,000 BP) led to European-wide changes in technology and the emergence of 'Levallois' flaking (Scott 2004: 7) and the Mousterian tool traditions.

4.3.10 Middle Palaeolithic deposits dating to around 320,000 BP have been found at the site of Biache-St-Vaast, France (Biache-St-Vaast website), which revealed Levallois tools and an animal bone assemblage made by hunting, not scavenging, implying a greater social cohesion within the group. Also in France, Neanderthal skull fragments have been discovered, dating to approximately 250,000 BP). The presence of Neanderthals in Belgium is attested by the cave of Scladina and Spy. In Kent, assemblages of 'Levallois' tools found during quarrying are some of the most prolific in Britain (Scott 2004: 7).

4.3.11 In Picardy, France, lithic remains have been found underwater (Scuvee & Verague, 1988), and represent important but not well known examples of the presence of submerged prehistoric remains along the French coast of the English Channel. Located on the North side of the Cotentin Peninsula (Normandy, France), from the Anse de la Mondree at Fermanville near Cherbourg, the finds comprised more than 2000 Levallois-Mousterian lithic artefacts discovered at a depth of 20m. The finds date to around 45,000 BP, and indicate that Neanderthals had developed strategies that enabled them to endure a harsher climate – thus extending the window of opportunity for exploitation of other nearby areas. At the date of occupation, the site strategically overlooked the confluence of the extension of the Seine River and the Great Channel River, which met 15 km to the north. The site is unique in Europe, as it contains primary context archaeological material embedded in peat and clay within a submerged location that pre-dates the last glacial maximum. Not only did it survive the periglacial worsening conditions as the climate deteriorated, but the artefacts survived the rising sea level around 7-8,000 BP and modern oceanographic conditions of coastal currents and waves. The site demonstrates both the potential of the prehistoric archaeological resource within the area and the ability for such sites to withstand climatic changes and transgressive/regressive events witnessed during past glacial cycles.

4.3.12 The Upper Palaeolithic (roughly 40,000 BP to 10,500 BP) provides evidence for the emergence of *Homo Sapiens* in northern Europe. Traces of *Homo Sapiens* in France have been recovered in Nord Pas de Calais dating to approximately 40,000 BP. In Belgium, evidence of the Aurignacien culture has been found in caves such as La Princess, and the Gravettian culture, which spread all over Europe with only small regional variations, is visible at the rich site of Maisieres-canal.

4.3.13 During the Devensian glacial maximum (roughly from 20,000 - 15,000 BP), sea levels in Belgium were approximately 120 m lower than today (Pieters *et al.* 2010: 81). However, although the ice sheets did not reach as far south as the Study Area, the cold climactic conditions would have rendered the area difficult to occupy; at this time, the landscape in Britain would have resembled Arctic tundra. As glaciers began to melt, the area would have been impacted by major changes to river systems as a result of meltwater. However, as soon as climatic conditions ameliorated, humans reoccupied the landscape.

4.3.14 In Belgium, the Magdalanian culture flourished from 14,000 BP to the Mesolithic period, and although most of the Upper Palaeolithic discoveries have been localised around the Meuse valley and in the Hainault and Hesbaye regions, evidence from Flanders to Gent suggest that Neanderthals occupied the wider region. In Britain reoccupation appears to have begun around 13,000 BP (Scott 2004: 8). The similarity of 'Cresswell' and 'Cheddar' points to the Magdalenian industries on the Continent and illustrates the geographic continuity of the region (Scott 2004: 8). However, some of the differences between the assemblages may reflect limited sharing of ideas and techniques.

4.3.15 Considerable quantities of flint artefacts have been recovered from the beach at Raversijde and at neighbouring Mariakerke (Pieters *et al.* 2010: 182). Flint artefacts have also been recovered from the beaches at Westende, Middlekerke, Oostende, Bredende, Wenduine and Blankenberge, although the assemblage from Blankenberge and the mouth of the River Zwin has been called into question and may be natural (*ibid*: 183). Although difficult to date, the finds appear to date to the latest stages of the stone ages, and similar finds to the east of the Belgian border have been dated to the Middle Palaeolithic (*ibid*).

Mesolithic

4.3.16 At the beginning of the Mesolithic, sea levels were still considerably lower than present with the sea level in Kent thought to be 40-65 m lower (Young 2004: 3; BGS 1992: 116). As a result of these lower sea levels, the Southern North Sea was a vast plain which comprised a habitable landscape, intersected by strongly flowing rivers (Scott 2004: 9). However, as sea levels rose the landscape became increasingly difficult to traverse, and human groups in Britain became increasingly isolated. By around 6700 BC, sea levels reached around 25 m lower than present, and the North Sea and the Channel flooded, breaching the Dover Straights. Britain was finally isolated from Europe around 6300 BC.

4.3.17 A considerable amount of this now-drowned landscape is preserved underwater, and has been explored through projects such as Doggerland (Gaffney *et al.* 2009). No such intensive investigation has taken place in the Study Area, however, geological assessments suggest considerable potential, and Mesolithic sites located on the present coast or further inland have been explored in greater detail.

4.3.18 Many coastal sites in northern Europe are marked by shell-middens, the accumulated rubbish from many generations. In addition to gathering shell fish, line fishing and fishing nets were used, and evidence of the nets has survived. The period corresponds to the last hunter-gatherers in northern Europe, with the lithic tools and weapons becoming increasingly smaller and more suitable for the new forest environment (Scladina website). With the increasing management of woodland and its wildlife and the concentration in coastal areas on marine resources, some settlements seem to have become more permanent. At the site of Verrebroek in Belgium, several small huts, supported by wooden poles at the corners and with hollowed out floors, have been found in the same location.

4.3.19 In Belgium, the most well known occupation site is located at the Remouchamps cave. In France, additional work has been undertaken in the Somme Bassin area of northern France, where Mesolithic settlement sites have been identified on silt formation plateaux as well as at the bottom of slopes or valleys, and although most of the sites were located well inland, some sites have also been identified under the coastal sand dunes of Equihen and Hardelot (Dutertre, 1936). In Kent, find types include stone, antler and bone tools possibly for tree felling and woodworking, however, there is little direct evidence for hunting and gathering activities (such as bone assemblages or plant remains). Although, further work in marshy areas such as east Kent could increase the body of evidence (Scott 2004: 9).

4.3.20 At the end of the Mesolithic period, there are further signs of permanent settlement in the form of pottery. Because pottery is cumbersome to transport, it is normally associated with settled farming communities. The pottery is perhaps the first indication of the transfer of new ideas from farming populations in southern and central Europe.

4.3.21 By the end of the Mesolithic, the majority of the cable route would have been completely submerged, and further human activity would have been of a maritime nature. The southern part of the Kent Landfall would also have been submerged, as part of the Wantsum Channel, which was not reclaimed until the post-medieval period. However, the northern part of the Kent Landfall (on the historic Thanet Island) remained dry land, and at the Belgian Landfall, the habitable land surface would have extended quite some ways seawards beyond the present Mean Low Water.

4.3.22 Although there is no direct archaeological evidence for seafaring during the Mesolithic, the technologies in place would have been sufficient for the construction of skin boats made of hides and bent small-wood (Cunliffe 2009: 81).

Neolithic

4.3.23 The Neolithic saw a fundamental shift across Europe in the way people lived. Over the period, agriculture and the domestication of animals spread across the continent and beyond the sea to England; most of the population slowly stopped relying on hunting and gathering and instead invested in farming as their main form of subsistence. Regional variations appeared as each area adopted farming, however, broad patterns appear indicating the development of long distance trade networks.

4.3.24 In Belgium, the earliest evidence for agriculture comes from around 8200 BC (Scladina website). At this time, the first communities gathered in villages, with massive collective houses such as the one found in the site of Darion. The late Neolithic (starting around 6300 BC) is mainly characterised by the presence of megaliths which could be seen in many locations, such as the site of Weris. By about 5000 BC, the large scale cultivation of cereal crops the herding of domestic animals had become widespread on the Continent by about 5000 BC.

4.3.25 Flint tools were still dominant. In some areas, such as Grimes Graves in England, mines were dug to exploit the resource, while in other areas, such as at Grand Pressingny, Indre-et-Loire in France, flint closer to the surface could be quarried from outcrops. In Belgium, flint mines appear around 7,500 BC, and the site of Spiennes is one of the most well known examples in Europe. Material from these quarries could then be traded, as flint does not naturally occur in all areas across the region, and communities unable to obtain it locally acquired raw materials as well as finished goods through trade and exchange networks. Some flint is very distinctive, and it is often possible to trace how far an object has travelled from its source. The flint from Grand Pressigny has a particular honey colour and was distributed over hundreds of kilometres, in some areas it was evidently preferred to the local materials.

4.3.26 During the Neolithic, there is considerable evidence for cross channel traffic, such as the transport of material (including the many species of plants and animals that were used for food production but were not native to Britain) as well as the ideas of farming and animal domestication. It is not surprising that Kent was one of the first regions in England to undergo the economic, technological and social changes associated with the Neolithic period, as its proximity to the Continent was no doubt a great influence. The Neolithic period began in England around 4000 BC, and evidence includes particular styles of earthworks, causewayed enclosures, long barrows, evidence for pottery and the emergence of henges. There is evidence for pottery and a causewayed enclosure near Ramsgate (Ashbee 2004: 11).

4.3.27 During the Neolithic, maritime transport was characterised by log boats and skin boats which are likely to have continued in use. Some of the oldest archaeological

examples of logboats in Europe are from Noyen-sur-Seine, France, and date to c. 7190-6540 BC, and other examples of early logboats have been found from Denmark, through north-west Germany and the Low Countries to north-west France (McGrail 2004: 173). These early logboats are from a time when sizeable trees and appropriate tools were just becoming available. The earliest logboat in Britain dates to the fourth millennium BC (Delgado 1997: 438).

Copper Age (Chalcolithic) and Bronze Age

4.3.28 The Copper Age, or Chalcolithic, is characterised by the use of early copper tools alongside the use of stone tools and the first appearance in Europe of unequal, hierarchical societies (Carozza & Mille 2007: 195). A few early metal finds have been discovered in the northern half of France, with the oldest recovered from the Paris Basin, dating to the second half of the fourth millennium BC. However, metal use appears to have been relatively localised, with the use of metal in the Paris Basin remaining a secondary phenomenon which had little or no effect on the mutation of the local cultural groups.

4.3.29 The Bronze Age is characterised by more widespread use of metal tools and social change, as well as the expansion of trade networks. From the beginning of the Bronze Age, the expansion of trade in metals involved cultural contact through a system of sea routes which connected a network of rivers and roads used as the dominant way of transporting goods and people (Philippe, 2009, Lebecq, 1994). By the late second and early first millennia BC, active trade networks focussed on the transport of bronze implements (Cunliffe 2009, Muckelroy, 1981; O'Connor, 1980).

4.3.30 Possibly as a result of this exchange, there was cultural continuity from Normandy to Flanders with strong connections on both sides of the Channel and North Sea (Bourgeois & Talon, 2005, 2009; Marcigny & Guesniere 2003), and cultural similarities include pottery styles and decoration, and architectural similarities in dwellings and funerary enclosures (Samson, 2006; Bourgeois & Talon, 2005). In addition to metalwork, the archaeological evidence from ceramics confirms maritime trade and the movement of goods across the Dover Straights area and the southern North Sea (Piningre, 2005). For example, pottery from the River Canche and its estuary displays characteristics of an original British tradition and indicates a close relationship with the British Isles. The settlement where the pottery was discovered dates to between 2000 and 1800 BC, and may have been a centre of Bronze Age maritime trade, playing an important role in the route across the Southern North Sea, within the established trading relations between the coastal settlements of the Continent and the British Isles.

4.3.31 The archaeological evidence from Kent shows that there were clear advantages to being on the western side of this 'outward looking world', as the eastern and southern shorelines dominated both coastal and cross-Channel traffic, leading to strong long-distance alliances (Yates 2004:13). The coastal communities in Kent benefited directly from contacts as far west as Cornwall and from trade and the movement of people along the Thames valley and with mainland Europe. Settlements in Kent were focussed on coastal locations, major river valleys and estuary foreshores, particularly on either side of Wantsum Channel, which would have been a key navigation route for regional exchange (Yates 2004: 14). Concentrations of deliberately placed finds recovered from the Wantsum Channel and Great Stour valley, including a wide variety of weapons and ornaments originating from the great river communities of North West Europe (particularly along the Seine and the Somme) suggest close relationships between peoples on either side of the Channel.

4.3.32 Trade across the Channel was accomplished using boats such as the Dover boat (Clark 2004), a 3000 year old sewn plank boat capable of crossing the channel while carrying a substantial cargo of supplies, livestock and passengers. Such watercraft were especially adapted to the coastal and riverine environment of this area (Pomey & Rieth, 2005). However, the hazardous nature of these journeys is represented by the Langdon Bay wreck, which is thought to have been carrying a cargo of scrap metal from France to Britain. The cargo comprised a collection of bronze artefacts, including the types of tools, weapons and ornaments made in France but rarely found in Britain, dating to around 1100 BC.

4.3.33 The study of Bronze implements in the Low Countries, an area that was far removed from copper and tin sources, shows that trade networks were even further reaching, with copper and bronze implements being imported not only from Britain but also from other sources on the Continent, and that trade was established by at least 2300 BC (Fontijn 2009: 130). In Belgium, finds in the intertidal zone from the period include worked flints discovered along the beach between Westende and Knokke. Additionally, a possible Bronze Age paddle or shovel has been found underwater, although this seems more likely to have been a baker's shovel, maybe re-used as a paddle (Pieters *et al.* 2010).

4.3.34 At the end of the Bronze Age, cross-Channel exchange appears to have collapsed, resulting in widespread social dislocation, which reflects wider European disruption (Yates 2004: 15).

Iron Age

4.3.35 The Iron Age is characterised by the spread of iron making and iron tools, which gradually replaced bronze as the preferred material, and was accompanied by a significant growth in population and the introduction of wheel made pottery and coinage. Although some cross-Channel trade networks continued into the Early Iron Age (between the 8th and 6th centuries BC), the decreasing numbers of elite exchange items found in Britain suggests that the intensity of cross-Channel traffic had slowed down by the Middle Iron Age. However, by the Late Iron Age, contact between Britain and the Roman Empire had increased (Parfitt 2004: 16). The distribution of Late Iron Age Gallo-Belgic coins type A&B around the Thames Estuary illustrates contact between the Continent and Britain.

4.3.36 As maritime trade increased, so did the importance of settlements along the Kent coastline, and there was a concentration of Late Iron Age settlements in the east of Kent and on the Isle of Thanet (Parfitt 2004: 17). Settlements at sheltered inlets would have provided convenient ports of entry and access, with major rivers providing further access inland (Parfitt, 2004: 17). Finds of Italian amphorae on Late Iron Age settlements in Kent, which indicate wine imports, illustrate trade links with the Mediterranean (Parfitt, 2004:17). While the numerous coastal creeks and inlets would have provided conditions suitable for saltmaking (*ibid*). In Belgium, coastal sites were also important, and the rim of an Iron Age pot was discovered on the beach at Bredene (Pieters *et al.* 2010: 186).

4.3.37 In 55 and 54 BC, Julius Caesar led Roman expeditions to Kent, and provided one of the earliest written accounts of the native population (Parfitt 2004: 16). In addition, the historical record indicates that during one of the expeditions, many of the ships were lost during a storm, and possibly indicate the first recorded shipwrecks on the Kent coast.

Romano-British/Gallo-Roman Period

4.3.38 The Romano-British/Gallo-Roman period in each area began with Roman conquest. In Belgium, around Bruges, the first Roman fortifications were built after Julius Caesar's conquest in the first century BC. A Gallo-Roman colony developed, and the Roman military presence continued until the end of the 3rd century AD or the beginning of the 4th century AD (Bruges city website). Numerous Gallo-Roman artefacts have been recovered from the beaches of Raversijde-Mariakerke and Wenduine, and in both cases finds and features suggest the location of settlements that go back to the Flavian period (Pieters *et al.* 2010: 192). A wide variety of features have been identified at Raversijde-Mariakerke, including rubbish pits, a wooden trackway, ploughmarks, traces of saltings (including wooden construction in connection with a ditch system), features related to the production of iron (including slag filled pits) as well as an oven flue filled with limestone from Tournai (*ibid*). More isolated finds, predominantly scatters of pottery fragments, have been reported from the beaches at Nieuwport, Westende, Oostende, Bredende, Zeebrugge, Heist and Knokke, indicating Roman activity across the area. Discoveries of Roman finds made during the first half of the 20th century indicate that there had been peat banks along the coast, which some years were covered in sand. This, and the fact that A. Chocqueel has observed Roman artefacts and structures located 266 m seawards from the dyke of the church at Mariakerke demonstrates beyond a doubt that the Roman coastline in this area was considerably further seawards than at present (Pieters *et al.* 2010: 193). Furthermore, the potential for Roman military fortifications along the coast of Belgium must be considered.

4.3.39 In Britain, Claudius' invasion force arrived at Richborough in AD 43, and Kent rapidly became the industrial heartland of *Britannia*, producing a considerable quantity of iron with pottery and building tiles also important (Andrews 2004: 20). Estimates suggest that between AD 120 and the middle of the 3rd century, 400 tons of iron were transported each year from Britain to the continent (Seillier *et al.* 2004). In addition, towns emerged, coastal fortifications and new transportation infrastructure were built, and various religious centres developed (Andrews 2004: 20). The large concentration of fortifications around Kent's coast reflects its vulnerability to threats from the Continent and the need to secure the shortest Channel crossing routes, and Richborough comprised a major settlement with coastal fortification (Andrews 2004: 21).

4.3.40 In France, too, coastal settlements were the key to trade and defence. Following Roman conquest, the town of Boulogne-sur-mer (Nord Pas de Calais), known as *Bononia-Gesioracum*, became a trading centre and the main customs post of the Dover Straits area (Phillipe 2009), and hence a compulsory stop en-route to Dover and Richborough. It was a port of call for the Roman military fleet *Classis Britannica*, (City of Boulogne website) and until AD 85, the fleet participated in combat missions in the adjacent area, and later, in logistic missions such as the control of coal transportation from the mines of the Weald.

4.3.41 The shortest travelling distance between the Continent and Britain was between Wissant or Boulogne and Dover, and likely became the most used sailing route. Although the two terminal areas were probably more the focus of military activities than commercial ones, the stretches of coastline to either side had landing places which would have satisfied the seamen, traders and political authorities (Mc Grail 1987). While the locations of settlement sites in the terminal areas can only be tentatively identified, the locations of landing places associated with international trading settlements are even more difficult to determine (*ibid*).

4.3.42 Roman finds have been recovered from the sea point to Gallo-Roman and Romano-British trade. In Belgian waters, an intact amphora from the Westhinderbank (Pieters *et al.* 2010) and fragments of a pottery bowl from Kwinte Bank (Wessex Archaeology 2008) have been discovered. The pottery bowl fragments were recovered during dredging operations on the Kwinte Bank, and were reported through the BMAPA/EH Protocol. The fragments are Rheinzabern ware, a type of Samian ware, stamped with 'CATULLUZ' which suggests they were made by Catallus V between AD 170 and 260. Samian ware was manufactured in central Gaul from the Augustan period onwards, and the height of the industry was during the 2nd century AD, when products were widely distributed across Gaul, the Danube provinces, and across the English Channel to Britain. The fact that these two pottery fragments are similar in form and bare identical stamps may suggest that they come from the same cargo. Both the amphora and the pottery finds could indicate the presence of yet-to-be-discovered Roman shipwrecks.

4.3.43 In addition to international trade, there was considerable traffic along the coast as well, for example Ragstone, a building material quarried in the Maidstone area (Kent), was not only widely used locally, but also transported by barge to *Londinium* for the construction of its walls in the 3rd century (Andrews 2004: 20). Kent's marine resources were also exploited probably by small local fishing and oyster dredging boats, and salt production was undertaken in coastal areas by evaporating seawater in large shallow reservoirs of unfired clay (*ibid*).

4.3.44 The remains of a Roman shipwreck were discovered near Bruges in 1899, during the construction work for Bruges' seaport and were radiocarbon dated to the 2nd or early 3rd century AD (Marsden 1976, Pieters 2010). The boat is representative of regional Romano-Celtic shipbuilding characteristics of the west of the Rhine (*ibid*): with close spaced framing, large nails and sewn planking laid flush, edge to edge, but not joined together (McGrail 2004). While the designs of some of the Romano-Celtic vessels likely restricted them to use in estuaries or other sheltered waters, others, such as 'Blackfriars I' from London and 'St Peter Port I' from Guernsey are thought to be have been seagoing (*ibid*). Boats of the 1st century BC are described by Julius Caesar in an account of the Venetic fleet as solidly built with high sided and square rigged sails of raw hide, and representations of such vessels can been seen on coins of Cunobelin, suggesting the type was widespread (Cunliffe 2001). In addition, wooden fragments of watercraft discovered in 2005 on the beach of the Chatelet (Tardinghen, Nord Pas-de-Calais) are the only known remains of a watercraft from the antiquity conserved along the septentrional shore of France. This assemblage is dated from the 2nd century AD and, as it has evidence for paddles, it may represent the remains of a Roman galley from the Classis Britannicus fleet, based in Boulogne and having been involved in maritime traffic in the Channel and North Sea.

4.3.45 The shipwreck of Ploumanac'h is also relevant. It lies five nautical miles from the French coast, in front of Perros-Guirec (Côte d'Armor, Brittany). The wreck of Ploumanac'h has been studied by the Département des Recherches Archéologiques Subaquatiques et Sous-Marines (DRASSM) since 1983 (DRASSM website). The wreck lies at a depth of 10 m, and its cargo of lead ingots bears witness to the maritime trade of raw material in the English Channel during antiquity. An epigraphic study of the ingot's inscriptions has enabled the identification of some of the names of Celtic Tribes from Great Britain and date the wreck to a period between the High Roman Empire and the Late Roman Empire (between 2nd and 4th century AD).

Anglo-Saxon & Medieval

4.3.46 At the end of Roman rule, both Belgium and France entered the medieval period, however, in Britain, there was an intermediate period known as the Anglo-Saxon period. The Anglo-Saxon period was characterised by an influx of Anglo-Saxon peoples and material culture from Germany and southern Scandinavia in the 5th and early 6th centuries, followed by Viking raids and later settlement in the 8th and 9th centuries.

4.3.47 The traditional landing place of the Saxons in Kent is at Ebbsfleet, in Pegwell Bay, in AD 449. During the early part of the period, Anglo-Saxon activity in eastern Kent is identified through cemeteries and burials, with the majority of evidence confined to rivers and the coast (Riddler 2004: 25-28). In AD 597, St. Augustine and the Christian missionaries arrived. With the reign of King Aethelberht in the later 6th century, Kent emerged as a political entity. The distribution of luxury goods in Kent throughout the 6th and 7th centuries, including glassware and wheel-thrown pottery, suggests that of all the Anglo-Saxon kingdoms in England, Kent had a near monopoly on certain elements of Continental trade and exchange (*ibid*). The trade and production centres of Kent in the Middle-Saxon period (*c*. AD 650 – 850) are small and, in relation to comparable sites such as Southampton, have not been well excavated, although there is thought to be an Anglo-Saxon settlement at Sandwich, it is probably situated within the medieval and modern town, and little evidence has been uncovered.

4.3.48 The finds of ceramics in Kent highlight changes in maritime trade – in the 6th and 7th centuries, in addition to local ware, ceramics were also imported from north France, and around AD 750, Ipswich ware was being 'imported' (Riddler 2004: 28). Most of the sites where Ipswich ware has been found are coastal or have strong links with the coast, emphasising the importance of maritime trade. The ware itself reflects the importance of monasteries which appear to have formed a part of the same trading network (*ibid).* The pottery could have been transported in boats similar to the 7th century clinker-built wooden boat discovered in the ship burial at Sutton Hoo near Ipswich.

4.3.49 The earliest Viking landings on the Kent coast took place by the end of the 8th centuries, and the first substantial raid took place in 835 on Sheppey (Lawson 2004: 23). For the next 30 years, the coast was under threat and monastic sites were pillaged, and in 851 and 865, the Vikings had a strong enough hold to overwinter on Sheppey and Thanet (*ibid*). However, in 851, the Anglo-Saxons won a victory against the Vikings in a seabattle in Sandwich Harbour. There were additional naval engagements around Stourmouth in 885, and Vikings plundered Thanet's Minster Abbey in 980 and 1009 (*ibid*). Scandinavian ships in the 9th and 10th centuries are represented by the archaeological discoveries at Gokstad, and comprise double-ended clinker built wooden boats (McGrail 2004: 216). But it appears that England may also have had a distinctive shipbuilding tradition in the 9th to 14th centuries, as indicated by the Graveney boat, excavated from a former tidal creek of the River Thames, east of Faversham Kent (McGrail 2004: 218). Similar to the Nordic or Scandinavian boats, the Graveney boat was a also a clinker-built, double-ended boat that possibly had a square sail however, she is almost flat-bottomed and much more heavily built, and was built with plank-fastening nails driven through treenails, demonstrating a mix of boat building traditions.

4.3.50 Viking activity on the Kent coast ceased in 1017, and the medieval period began with Duke William's Conquest in 1066. The Domesday Book from 1086 mentions that there were more than 200 households at Minster, and Sandwich, a port mentioned under the manor to which it was subordinate, had a population of around

2,500 (Lawson 2004: 36-38). There was a Carmelite Friary at Sandwich, and it was also a market town. By the 13th and early 14th century, local markets had begun to play a significant role in the development of the economy (Lawson 2004: 50). Stonar, to the north of Sandwich, was also a market town by 1350 (*ibid*: 51).

4.3.51 Around 1050, the Cinque Ports developed in Kent and East Sussex, and comprised Sandwich, Dover, Hythe, New Romney and Hastings. These were based on an informal coastal defence arrangement made in the reign of Edward the Confessor, where in return for substantial constitutional fiscal and trading privileges, the Ports were required to furnish, for limited periods, ships and crews for the King's service (Lawson 2004: 52). Dover port was by far the longest established, having begun in the Roman period, but their height of influence was in the period 1150-1350 when the Ports worked to suppress piracy and were on occasion called on to transport soldiers. Sandwich was a transhipment point for goods from the Mediterranean, and fishing also played an important economic role (Lawson 2004: 52). Some authors have described Sandwich in the medieval period as 'the principle port in the South East outside London (Bower 2004: 66). As a result of heavy French raiding on the English coast, the Ports themselves became vulnerable, but their greatest threat was due to coastal change: by 1500, all of the Cinque Ports had been seriously affected, as their harbours silted up or were cut off by the growth of shingle banks (Lawson 2004: 52).

4.3.52 In France, from the post-Roman period onwards, the history of maritime related activities and events in Nord Pas-de-Calais is best followed by the developments and engagements of the city of Dunkerque, which played a strategic role for the various sovereignties that governed this fortified place (City of Dunkerque website). The first settlement was set on the shore of a natural cove in the 7th century for the purpose of fishing. The place quickly became a mariner's community, from its origin and during the first centuries of its existence, it was under the Flanders rule. Because of its strategic location, the city needed defences, and a fortified wall was erected in 960. However, the sheltered and strategic position of Dunkerque contrasts with the fact that the population had to continually fight the natural elements with the development of drainage and tidal protection which were initiated in the 12th century. Progressively, Dunkerque became a privileged port for the interior lands as an essential access to Holland or across the Channel to England. The true commercial expansion of the city and in effect the whole region began during the second half of the 14th century. At this time shipping traffic involved in importation expanded rapidly, with goods being imported from England and Holland (such as beer), South of France (wine), Denmark and Sweden (wood and iron). This prosperity was symbolised in the construction of a new fortified wall of protection in the 15th century.

4.3.53 The City of Gravelines, France, also expanded rapidly due to an active herring fishery in addition to being the first location in the region to serve as a transit port for salt, fruits and wine. However, by the beginning of the 14th century, Gravelines predominance faded as a result of multiple and consecutive military attacks and the increasing importance of Dunkerque (City of Gravelines website).

4.3.54 Bruges may have been continuously inhabited during the transition period between the Roman period and the medieval period, and could have been the most important fortification in the Flemish coastal area by around AD 650, when St Eligius arrived to spread Christianity (Bruges city website). In the 8th and 9th century, a commercial relationship with Scandinavia began, and in fact, the name 'Bruges' comes from the old Norse 'Bryggia' which means landing stage (*ibid*). The city developed into an international port and was considered one of the main European business centres.

Around 1050, gradual siltation resulted in the city losing its direct access to the sea but, in 1134 a storm re-established access by creating a natural channel at the Zwin, and the city was linked to the coast until the 15th century by a canal. Outer harbours, such as Damme and Sluis developed at this time to cope with the quantity of commercial traffic (*ibid*). During the medieval period, Flanders was one of the most urbanised areas of Europe, with between 40,000 and 45,000 inhabitants in the sole city of Bruges. By the 14th century, Bruges was a rich port city, with merchants coming from all over Europe to engage in commercial negotiations. The city was famed for its high quality textiles, but it was also a centre for artisanal art. However, during the 14th century, the city suffered multiple crises, insurrections, epidemics, political instabilities and wars, which ended in 1384 with the start of the Burgundian era. The textile industry was gradually replaced by high value products, banking services and the artisanal industry, and Bruges reinforced its international economic power, developing impressive prosperity and wealth. The Burgundian era ended just before the turn of the 16th century, and was accompanied by diminishing presence of international merchants and the start of political instability and military violence.

4.3.55 On the coast, the village of Ostend became a city in 1265 when the construction of a market hall was allowed. In 1359, the city was relocated further inland, and was protected from threats of the North Sea by the establishment of large dykes. Fishing was a major source of income for coastal communities, such as Ostend as well as Heist, Bredene, Wenduine and Revrsijde-Mariakerke (Pieters *et al.* 2010). Blankenberge developed as a small fishing village on the coast and the Saint-Anthony church was established in the 14th century, although the church was destroyed during the religious troubles in the 16th and 17th centuries (Trabel website).

4.3.56 Medieval finds have been recovered from the beaches between Middekerke and Raversijde, largely as a result of coastal erosion. Finds have included a golden tremisses of the Byzantine emperor Justinian II (AD527-565) as well as fragments of Badorf-pottery and red-painted ware. Late medieval coastal settlements are indicated by archaeological finds, and were located on the beaches and adjacent areas of Walraversijde-Mariakerke, Bredene, Wenduine and Heist (Pieters *et al.* 2010: 195-196).

4.3.57 In the medieval period, there were former islands off the mouth of the River Schelde, and although no archaeological traces of them have been recovered, their location is indicated by coastline reconstruction (Pieters *et al.* 2010: 195).

4.3.58 Belgian medieval finds from the sub-tidal zone of the North Sea include a globular grey ware pot that has been dated to the 10th or 11th century, and its high level of preservation could suggest the location of a previously undiscovered shipwreck (Pieters *et al.* 2010: 195). Other finds include a late medieval tripod skillet caught by fishermen near Raversijde-Mariakerke, a mortar in purbeck marble, a sherd of red-ware pottery found by a fishing boat c. 1.6 km to the north of Mariakerke, a stoneware jar fished up between the Plate-diep and the buoy of de Geule and two metal pitchers and a bronze skillet discovered by a fishing vessel near Nieuwport (*ibid*). All of the medieval finds were recovered within 10 km of the coast, and these may suggest that medieval shipping was, to a large extent, characterised by coastal traffic.

4.3.59 The Nordic or 'Keel' tradition of boat building, with double-ended clinker built wooden vessels, continued into the later medieval period. Examples of ship's timbers have been recovered from re-use-locations such as waterfront structures in

London (McGrail 2004: 223). In addition, ships of this tradition are depicted on the 11th to 12th century Bayeux tapestry, and later on town seals. However, from the 13th and 14th centuries, vessels of the Nordic tradition become rarer.

4.3.60 The 'Cog' appears to have developed in the 9th century and early documentary examples are associated with Frisian shipping and trade (McGrail 2004: 232). References to cogs increase considerably in the 13th and 14th centuries; the vessels were widely used by the Hanseatic League in northern Europe and traded between Britain and Ireland and the Continent. The Bremen cog, discovered in Bremen, Germany, provides a famous example of this type of vessel, and ships similar to that cog appear on the 13th to 15th century seals from many ports, from Elbing in the east to Damm, near Bruges and possibly Ipswich in the west (McGrail 2004: 233).

4.3.61 In France, the EPI-Canche wreck was discovered within the River Canche approximately 5 km from the estuary where the port of Etaples-sur-Mer (Nord Pas-de-Calais) is located (Rieth, 2009). The remains of the wreck are those of a clinker-built boat that has been radiocarbon dated to 1426. According to its structures and shape, the boat seems to have been adapted to coastal and fluvial navigation, and could belong to a regional architectural group of cogs.

4.3.62 Two medieval Doel Cogs were discovered in 2000 on the left bank of the river Scheldt in Antwerp, during an excavation for a construction site (MUA website). The larger of the two measures 20 m in length and 7 m in width. Since historical information concerning Doel Cogs is rare, these examples are of great importance, and in addition, they symbolise the trading role these ships played across Europe throughout the medieval period.

Post-medieval

4.3.63 The post-medieval period is well documented historically, however, archaeological discoveries continue to provide additional information. The period encompassed rapid population growth, urban expansion, colonisation, intensification of international trade, and major political struggles.

4.3.64 As a result of English privateering against French and Spanish vessels and the ensuing diplomatic rows, the Elizabethan government conducted a national survey of ports in 1566 in order to assess the tonnages of shipping and maritime employment (Lawson 2004: 91). In 1566, the shipping tonnage of Sandwich was 500 tons, and in Ramsgate the shipping tonnage was around 200 tons and fishing employment around 50. Some 293 vessels were counted in the survey, most of which were fairly small (under 10 tons). At Dover, the largest vessel of the time was 120 tons, and of the 1,000 mariners, about 600 were employed in fishing and roughly 400 in cargo carrying (Lawson 2004: 91). In the 16th century, maritime trade in Sandwich began to decline, as Sandwich Haven was increasingly restricted by the silting of the Stour (Bower 2004: 68, Lawson 2004: 91), however, some trade did continue with the Low Countries and the Baltic through the 17th century (Bower 2004: 66). As Sandwich's port declined, the economy of Sandwich developed in new directions with the arrival of Flemish, Walloon and German immigrants (Bower 2004: 66, Edwards 2004: 86).

4.3.65 Around 1700, the merchant ships in service were still relatively small - ships in London averaged 150 tons, and those for Kent ports were considerably less (Killingray & Compton 2004: 129 onwards). However, by this time, Ramsgate and Margate had easily overtaken Sandwich in the tonnage of vessels based there, and in 1701, shipping tonnage in Sandwich had increased to around 1000 tons, while at Ramsgate it had increased to 2500 tons (Lawson 2004: 91). The ships from

Ramsgate were involved in the Baltic trade, bringing help and timber for the increasingly busy royal dockyards, and handled coal imports from the North East, while Margate was prominent for coastal trade (Lawson 2004: 91). Fishing also remained important with mackerel and herring the chief catches (Lawson 2004: 92). When trade with the Baltic began to decline in the 18th century, trade expanded to the Mediterranean, West Indies and the Americas (Killingray & Compton 2004: 129). Although it was generally the larger ships that made international journeys, occasionally even the smaller ships that were usually engaged in coastal trade would turn to deeper waters if economic conditions made it worthwhile (*ibid*). In the 18th century, fisheries in Kent operated on a small scale, and most boats operated in local waters, but some, principally from the Thanet ports worked the North Sea for herring and even Icelandic waters for cod (Killingray & Crompton 2004: 129).

4.3.66 Despite the difficulties at the end of the 15th century, Bruges succeeded in maintaining a regional commercial importance, with a multitude of foreign contacts and an expanding artistic sector. But the definitive split with the Netherlands precipitated the decline of Bruges. During the 16th century, Bruges' international importance decreased, and only a modest maritime function remained. However, in the 17th and 18th century, trade increased again, with local merchants trading mainly with the Spanish empire and the British West and East Indian colonies (Bruges city website).

4.3.67 The coastal location of Ostend had advantages as a strategic point, but was also seen as an easy access for conquering armies. Ostend was taken or destroyed on numerous occasions, such as the three year siege between 1601 and 1604. In the early 18th century, Ostend took advantage of the closing of the harbour of Antwerp by the Dutch in 1722 to provide an alternative route to the sea. The Austrian Emperor Charles VI granted a trade monopoly for the Ostend Trade Company with Africa and the Far East to found colonies overseas. But the Dutch and British pressure on international trade forced the city to put an end to this activity in 1727.

4.3.68 The small fishing village of Blankenberge continued to develop, and the oldest preserved civil building in the town is the Old Town Hall which was built between 1679 and 1680, and was constructed using materials from a former Spanish fortress (Trabel website).

4.3.69 At the end of the 16th century, the herring fishing fleet of Dunkerque was destroyed as a result of a Dutch revolt (Dunkerque city website), and fishing crews took up the 'course', also known as piracy or privateer activity for the Spanish crown from 1567 onwards. The strategy involved taking property of a seized ship's cargo in order to be sold. This new maritime activity became legalised by the Dunkerque's magistrate as a method of war in 1585, and regulated by the Spanish 'code of catches' in 1590. During the first half of the 17th century, between 600 and 1000 Dutch herring vessels were destroyed, and during the reign of Louis XIV (1643-1715) this type of war intensified.

4.3.70 In 1679, a royal arsenal was created in Dunkerque and further fortification developed under the lead of Vauban. During the early 18th century, the port of Dunkerque remained the first pirate port of France, and during the American War for Independence, Dunkerque was an American pirate base in order to conduct operations against England. However, piracy was not the only activity of the port, and mariners from Dunkerque were involved in commercial activity from Cap North to Sicily, and the Icelandic cod fishing industry developed rapidly, generating intense economic activity. In April 1792, the French Revolution declared war on the hostile

European monarchies, which disturbed the maritime relationships in the Dover Straits area.

4.3.71 The post-medieval period witnessed some major battles at sea – and many of them took place within the vicinity of the Study Area. For example: the English versus the Spanish in the Spanish Armada (1588); the English versus the French during the 100 years war in the Battle of Sandwich/Battle of Dover (1217) and the Battle of Damme (1213); and the English versus the Dutch in battles from the second Anglo-Dutch war, including the St. James Day Battle (1666) and the Four Days Battle (1666).

4.3.72 Three post-medieval sites in Belgian waters dating from the 16th to 18th centuries have been archaeologically investigated (Pieters *et al.* 2010: 196): the Zeebrugge site, the wreck of the *'t Vliegend Hert* and a wreck on the Buiten Ratel sandbank. All three sites have been examined by divers and a large number of finds have been recovered. Despite the lack of hull remains at the Zeebrugge site, many hundreds of finds have been recovered, most of which date to the late 15th to early 16th century. The most outstanding find is a wrought-iron bombard, which was found strapped to its gun-carriage with the original ropework. The *'t Vliegend Hert* was built in 1729 on the Dutch East India Company (VOC) wharf at Middelburg and sank, along with the *Anna Catharina*, on its second journey in the night of 3-4 February 1735, in the area of the 'Vlakte van de Raan. Shortly after the sinking, the vessel's cargo of barrels of ginever, beer and oil washed up on beaches at Blankenberge and Nieuwport. The day after the accident, a pilot boat reported that the masts were still sticking out of the water, and the VOC undertook a number of salvage attempts. The 18th century wreck on the Buiten Ratel sandbank likely carried a Dutch cargo, and has been archaeologically investigated since 1997.

4.3.73 In England, a carvel built vessel known as the 'Gresham Wreck' because of its possible connection with Sir Thomas Gresham (1518-1579), a successful merchant and entrepreneur who served Henry VIII, Edward IV and Elizabeth I, was discovered in 2003 in the Princes Channel in the Thames Estuary, and recovered in 2004 (Wessex Archaeology website). A small to medium sized ocean-going armed merchantman, the vessel was carrying a cargo of iron bars when it sank. Four cannons were recovered from the site. Another wreck site, with artefacts and bronze cannon that appear to date to the 16th century has been found in the Goodwin Sands.

4.3.74 The nearest archaeologically investigated shipwrecks of this period to the French Study Area were five vessels wrecked during the battle of la Hougue (DRASSM website). These vessels are associated with Louis XIV and his plans to regain his throne in 1692. The plan was to gather an invasion army, and admiral Trouville was asked to go to Saint-Vaast-la-Hougue with a 44 vessel squadron. It is there in the close vicinity of the Ile de Tatihou that 12 French vessels disappeared on the 3rd of June 1692, after engaging in a battle against the Anglo-Dutch fleet. The underwater excavation of the five shipwrecks of First Rate vessels revealed the characteristics of the French Navy vessels from the end of the 17th century. The detailed analysis of the ships' hulls showed a trend at the time for improvement and homogenisation of vessels' construction.

4.3.75 Also located along the French coast of the English Channel, is the site of the shipwreck of la Natiere (Adramar, 2010), a significant archaeological example from the post-medieval period. The site comprises two wrecks and is located on the immediate border of the main shipping channel accessing the port of Saint-Malo. It was discovered in 1995 by a spear fisher. The wrecks have been identified as two

privateers' frigates from the beginning of the 18th century, *la Dauphine* from the port of Le Havre, lost on its return voyage from a campagne in 1704, and *l'Aimable Grenot* from Granville foundered in 1749 whilst on its way to Cadix. The abundance of information generated by the study of artefacts in context and the preserved hulls offers data relative to the naval construction techniques used, trades undertaken, and life on board these frigates that sailed in European waters at the beginning of the 18th century. The study of these vessels has put into perspective their role in the increasing commercial exchanges and the emergence of a common material culture for the entire Atlantic maritime area during the post-medieval period.

Modern

4.3.76 The modern period witnessed unprecedented change and development, driven by the Industrial Revolution, increased international trade and communication, and considerable upheaval and military action during the two World Wars.

4.3.77 During the first half of the 19th century, Bruges remained quiet and passive in the commercial context. Around 1850, Bruges was the poorest city in Belgium, and had not been reached by the Industrial Revolution. The rebirth of the city was initiated by the construction of the new maritime port of Zeebrugge, inaugurated in 1907 (Bruges city website).

4.3.78 Conversely, Ostend continued to grow. In 1810, Napoleon ordered the construction of a fort in the vicinity of Ostend, which was completed in 1814 after the fall of his empire (Ostend Tourisme website). The wall had been built in preparation of an anticipated English invasion which never happened. As a result of transportation improvements with the 1838 connection of Ostend to Brussels by rail, the harbour continued to expand, and in 1846, Ostend became a transit harbour for ferries from England.

4.3.79 The modern history of Dunkerque is representative of the main events that took place in the Nord-Pas-de-Calais region. The Icelandic cod fishing industry from Dunkerque and Gravelines reached its peak between 1850 and 1870, partly because of the use of a new and more rapid schooner (*Geolette Balaou*) derived from an American schooner, which became the emblematic boat of Dunkerque. During this time, more than 35,000 mariners worked at Dunkerque, however, soon after the traditional way of fishing was overtaken by more modern techniques, which from 1880 started the decline of the Dunkerque cod fishing industry. During this period, the region was central in industrial Europe, and with the development of railways in the second half of the 19th century, Dunkerque was rapidly connected to the metropolis of Paris. Additionally, the creation of modern shipyards in Dunkerque allowed the intensive construction of steel and steam ships, such as cargo ships, ferries and fishing vessels in great numbers until the start of World War I.

4.3.80 In the late 18th and through the 19th centuries in Kent, ports and harbours were constructed and improved and piers were built to facilitate sea-borne freight and passenger landings (Killingray & Crompton 2004: 129). In 1800, merchant ships and fishing boats were being built at Ramsgate and Sandwich, and although Sandwich ceased to build ships in the 1830s, construction at other ports increased between 1800 and 1860 (*ibid*: 130). Resorts developed along the north coast, and after 1820, steamships carried millions of passengers down the Thames to the resorts. The import of coal from Wales and the North East for domestic use, gas works and later the railways was a major focus of maritime trade in Kent. With the development of the railways in the 1830s, there were considerable changes to settlement patterns and the transport of people and goods (Andrews & Crompton 2004: 124). Dover developed as the main cross-Channel ferry point, with regular cross-Channel

steamboat services from the 1820s, and became a major shipping centre in terms of tonnage. However, not all trade was with ports and harbours, and small ships continued to be beached at low tide on open beaches to discharge cargoes for local markets (Killingray & Crompton 2004: 129). The towns in East Kent provided numerous services to shipping: these included everything from gathering marine intelligence such as the news of arrivals and departures, to supplying able seamen or embarking passengers. The towns could also provide ships with supplies or repairs, and made available the pilots who navigated the ships past the Goodwin Sands and the shallows of the Thames Estuary. Fishing slumped during the Napoleonic Wars (1792-1815) and did not recover until after the 1850s when railways enabled fresh catches to be sent directly to the market (*ibid*: 130). By the 1850s, Ramsgate had a fishing fleet 147 boats strong, each 35 tons or more, many of them were engaged in deep-sea fishing. The typical trawlers were still sailing vessels, and in 1914, Ramsgate had 172 sailing smacks (*ibid*), however, steam trawlers grew in popularity after 1919. From Broadstairs to Sandwich, the main catch included cod, lobsters, herring, turbot, sole, cod and halibut. Faversham concentrated on oysters and had a brisk export trade with the Low Countries (*ibid*). The lifeboat station at Ramsgate attests to the potentially hazardous nature of the sea and the Kent coast. The village of Cliffsend, Kent, developed in the 20th century within 3 km of Ramsgate.

4.3.81 Kent's long sea coast facing France and many north shore inlets made it a popular place for smugglers, and smuggling was a regular occupation of Kent sailors and fishermen. In the 18th and 19th centuries, smuggling increased, and the government made concerted efforts to suppress it. From 1817-1831, a Royal Naval preventative force was stationed at regular points (Killingray & Crompton 2004: 130).

4.3.82 During the 19th century, ship technology underwent a revolution. The advent of steamships meant that ships were no longer at the mercy of wind and tide, and further advances such as the early steel-hulled ships meant that ships were stronger than ever.

4.3.83 Political conflicts continued to be played out on the seas, including the Napoleonic Wars (1803-1815). An archaeological example of a shipwreck from the American Civil War (1861-1865) has been located off Cherbourg: the CSS (Confederate State Ship) *Alabama* was built in 1862 at Birkenhead by the naval shipyard John Laird & Sons, and during the American Civil War (1861-1865), after having sunk 64 Union commercial and war vessels, the *Alabama* sank during a naval battle with the USS (United State Ship) Kearsarge. Discovered in 1985 at a depth of 58 m, the wreck, which is the property of the United States of America, is being excavated by a Franco-American team, and the work is being followed by the "Comité scientifique paritaire franco-américain de l'Alabama" (DRASSM website).

4.3.84 A wooden shipwreck was exposed on the beach of Knokke, Belgium as a result of changing currents on the beach (Pieters *et al.* 2010: 200). The wreck is thought to be the brig *Manning of London,* which was built in 1809 and which ran ashore in 1831. The ship was recorded while it was exposed, however, it was later re-covered by sand. The vast majority of known wreck sites from the Belgian part of the North Sea date to the 20th century (Pieters *et al.* 2010: 198). In the UK as well, the vast majority of known shipwrecks date to the modern period.

World War I

4.3.85 In World War I, trade was disrupted, but economic and social changes were accelerated, as wartime industries expanded rapidly (Smith & Killingray 2004: 140). A vast number of Belgian refugees arrived in Kent between 1914 and 1915.

Although aircraft were only just coming into their own, World War I saw the development of numerous airfields across Kent, such as at Ramsgate, Manston and Westgate (*ibid*: 141).

4.3.86 During World War I, the coast of the Nord Pas-de-Calais region escaped many of the direct effects of the war, but the front line was only 40 km away. Dunkerque, which was bombed over 200 times, became an English logistic rear base with 200 seaplanes and a fleet squadron in charge of maintaining the collaboration with the British navy in order to avoid the German U-boats and marine mines. All along the coast, defences were reinforced. The 'Dove Patrol', composed of requisitioned and armed fishing trawlers, monitored the Dover Straights and cruised along the Nord Pas-de-Calais coast. It is also important to mention that from the beginning of September 1914, boats of refugees coming from Belgium were arriving by the thousands to the French ports of the region. Additionally, since the coal mines of Belgium and Northern France were occupied by the Germans, coal had to be imported by maritime convoys.

4.3.87 During World War I, Zeebrugge port was the main German Navy base for U-boats in the southern North Sea region, which were a major threat to the Allied forces, especially in the English Channel. On 23 April 1918, the Royal British Navy made an attempt to neutralise the port entrance, by sinking three old cruisers to block the flow of traffic in and out of the port. However, the blockade ships only managed to stop the flow for two days.

4.3.88 A small number of German U-boats from World War I have been identified from Belgian waters, including *U-11, U-37, UB-13, UB-20, UC-3, UC-7, UC-14* and the *UC-62* (Pieters *et al.* 2010: 198). All of these vessels were lost as a result of enemy action, having either been mined, bombed or rammed. Other World War I wrecks in Belgian waters include the British destroyer HMS *Maori* which ran into a mine in 1915, and the German Torpedo boat *A10* which ran into a mine in 1918. The most documented shipwreck from World War I is the German outpost boat (*Vorpostenboot)* SMS *Prangenhof*. The ship was recovered and dismantled onshore. It provided a detailed example of the changes and adaptations made to the fishing vessel to convert it into a warship.

World War II

4.3.89 When war was declared in September 1939, Kent once again became the frontline against German attack or invasion. The front line comprised beach defences such as mines and scaffolding, pillboxes, gun batteries, trenches, and anti-tank obstacles. Piers were breached, and coastal hotels were commandeered. There were considerable coastal defences around Pegwell Bay, Richborough and Ramsgate.

4.3.90 A coastal defence battery was located in the north of Pegwell Bay, and there were anti-aircraft batteries at Pegwell Bay, near Broadstairs and at Manston (Smith & Killingray 2004: 141). The anti-aircraft gun batteries were situated to protect vital infrastructure targets inland, such as the industries in Thameside, and they defended the enemy air routes to London. During the war Ramsgate was one of the 'most-raided parts of England' by air attacks (Whyman 2004: 179). In addition to being intermittently shelled by German guns from 1940-1944, roughly 1000 High Explosive Bombs were dropped on the city between 1939 and 1946 (Smith & Killingray 2004: 144-145). Airfields that had developed in World War I were revived, and Manston, located just inland from Pegwell Bay, was one of the main airfields during the Battle of Britain.

4.3.91 The city of Ostende also suffered aerial bombardment during the war (Trabel website).

4.3.92 In France and Belgium, an extensive system of coastal fortifications was built by Nazi Germany between 1942 and 1944 in order to defend the coast against Allied attack and invasion. The 'Atlantic Wall' extended along the entire western coast of Europe and was comprised of pillboxes, marine and terrestrial minefields and antitank obstacles.

4.3.93 As a city of high strategic importance in World War II, Dunkerque was a prime target and was bombed during the Blitzkrieg (18-19 May 1940). As a response, the British initiated a gigantic rescue called 'Operation Dynamo' from the port of Dunkerque between 26 May and 4 June 1940, under the constant bombing of the Luftwaffe. An article in the *Scotsman* from the time wrote that an Admiralty communiqué stated that 222 naval vessels and 665 other British craft took part in the evacuation of the British Expeditionary Force from Dunkerque, and these numbers did not include the French naval and merchant ships that took part (4 June 1940). Shallow water, narrow channels and strong tides all made the operation more difficult. As the evacuation by sea took place, three swept navigational channels were maintained, these were located between Dover and Calais; north of the Goodwin Sands to west of Dunkerque; and north of the Goodwin Sands around Kwinte Buoy and south to Dunkerque (Devine 1959). Overall, 338,000 soldiers were rescued and sent to England. During the German occupation, the city remained a strategic point and was reinforced to the point of being a total fortress.

4.3.94 The long list of ships that took part in 'Operation Dynamo' can be found in Devine (1959) and in Pieters (2010: 199), and the Annuaire des Epaves de la Manche (2010) lists a vast number of vessels which were sunk during the operation. Mainly, the vessels were of French or English origin, and were either requisitioned civilian vessels or military ships. Most of the wreck sites are now known and are regularly dived recreationally. One example is the French torpedo ship *Bourrasque* that was hit by a German coastal gun on 30 May 1940, and sank in front of Nieuwpoort with 600 men on board. The site is of significance not only for its involvement in the World War II 'Operation Dynamo' but also for its graveyard status. A number of wrecks relating to 'Operation Dynamo' have been discovered in Belgian waters in addition to the *Bourrasque*, including, three British Destroyers: HMS *Wakeful*, HMS *Basilisk*, and HMS *Grafton,* and the French *Sirocco*. The vessels lost during the operation represent a snapshot of British and French military and non-military vessels: British and French destroyers, British paddle minesweepers, one British ferry, one French merchant vessel and a whole range of British trawlers.

4.3.95 Shipwrecks in Belgian waters also represent a number of ships of the Kriegsmarine, including sweepers, blockade runners (*Sperrbrecher),* outpost boats, minesweepers, tug boats and yachts. The end of the war is also represented, by landing vessels, so-called Liberty ships and other merchant vessels.

4.3.96 Wrecks of World War I and World War II are not limited to ships – many of the aircraft responsible for aerial bombardment were lost, often as a result of enemy fire from other aircraft or the strategically situated anti-aircraft gun batteries.

4.3.97 World War II airplane material has been recovered from the beach at Oostende (Pieters *et al. 2010: 200).*

4.3.98 A German Dornier 17 of the 'Blitz' Geschwader, KG3 crashed on the Sandwich Flats on 31 August 1940 after attacking Manston, and a photograph of the air craft crash

site in Pegwell Bay has been uploaded onto flickr (www.flickr.com, http://forum.12oclockhigh.net). Locals have mentioned that the bent propeller blades used to be visible in the intertidal zone at low tide, and parts of the aircraft may have found their way to the Spitfire Memorial Museum at Manston. Another German Dornier 17 has been discovered in the Goodwin Sands (Wessex Archaeology in press).

4.4 REGIONAL MARINE GEOLOGICAL ASSESSMENT – FROM SUB-BOTTOM PROFILER AND GEOTECHNICAL VIBROCORE DATA

4.4.1 A chirp system, a boomer and a sparker system were used by MMT to acquire the shallow seismic data from the survey area, with the boomer used for the near shore sections and the sparker used offshore. Of this data, only the centre line along the entire route was interpreted for this report. A towed chirp was used by MMT for the inshore sections of the survey, however, these data were not evaluated by WA.

4.4.2 102 vibrocore samples were also taken along the route. The location of 10 of these were chosen by WA and examined in detail, whilst the offshore logs from the remainder were also examined. The results from all of these core samples have been used as ground-truthing to aid the geophysical interpretation for this report.

4.4.3 The broad geological sequence across the entire survey area can be summarised as follows (**Table 4.2**) (interpreted from the current geophysical and core sample data, Cameron *et al*. 1992 and BGS 1992).

Table 4.2: General geological sequence from the survey area

Unit	Description
1	Recent (Holocene) seabed sediments, gravelly shelly sand.
2	Post-Devensian terrestrial (UK sector) and estuarine (Belgian sector) clay, silt and fine sand with organic inclusions and peat layers
3	Eocene clay (**London Clay Formation**)
4	Palaeocene sand and sandy clay (**Thanet Formation**)
5	Campanian (Upper Cretaceous) chalk

4.4.4 Not all of the sequence described above is present across the entire survey area, with some being only sporadically present. More detail about the geological sequence of each area is found in each the following sections on the individual cable route segments.

4.5 REGIONAL SEABED FEATURES ASSESSMENT – FROM MAGNETOMETER, SIDESCAN AND MULTIBEAM DATA

4.5.1 A total of 223 sidescan sonar anomalies plus 242 magnetometer anomalies and 12 bathymetric anomalies were individually identified within the geophysical survey area along the entire proposed route. These were grouped, together with any recorded wrecks and obstructions within the area covered by the geophysical data, to produce a list of 270 sites of potential archaeological interest. Additionally, 38 recorded wrecks or obstructions were found by UKHO, NMR, VIOE and SHOM searches to be located outside of the geophysical survey area. These were all assigned archaeological potential ratings as follows (**Table 4.3**):

Table 4.3: Archaeological Potential Ratings

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	46	Anthropogenic origin of archaeological interest
A2	254	Uncertain origin of possible archaeological interest
A3	8	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**308**	

4.5.2 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 4.4**):

Table 4.4 Anomaly Classifications

Anomaly Classification	Number of Anomalies
Recorded Wreck / Obstruction	8
Wreck	4
Debris	50
Seafloor Disturbance	1
Dark Reflector	48
Bright Reflector	3
Rope / chain	13
Magnetic	143
Recorded Wreck / Obstruction outside of geophysical survey area	38
Total	**308**

4.5.3 The sites identified in the geophysical survey are discussed below, with full details provided in **Appendix V, VII, VIII** in **Volume II** and **Figures 8, 11, 13**. The data will be examined in more detail in the **English Waters Study Area, French Waters Study Area** and **Belgian Waters Study Area** sections that follow.

5 KENT LANDFALL, ENGLAND

5.1 INTRODUCTION

5.1.1 The Kent Landfall Study Area comprises a loosely-C-shaped polygon that covers a strip of coast between Ramsgate and the Sand Hills extending roughly 1 km inland from Mean High Water (**Figure 4, Figure 5**). It was designed to cover a range of potential landfall options and to provide additional detail about the local heritage resource.

5.1.2 The selected Nemo cable route Kent Landfall location is within a 200 m wide strip of land between the Service Station North and Service Station South potential landfall locations (PMSS 2010).

- Service Station North: This is the area to the north of the petrol station located at the west of Pegwell Bay on the A256. The Thanet Offshore Wind Farm cables make landfall in this area and therefore it is expected that

installation of the cables is technically feasible using similar open cut trenching methods as used by the Thanet Offshore Wind Farm Project (Wessex Archaeology 2007).

- Service Station South: This is the area to the south of the petrol station located at the west of Pegwell Bay on the A256. Installation of the cables may require HDD underneath a standing pool of water in this area.

5.1.3 Because the intertidal data have not been received at the writing stage of this report, the later does not include such assessment, but once available these data will be archaeologically assessed and the results included in the present report.

5.2 GEOLOGY

5.2.1 The majority of the geology at the landfall comprises alluvium with some Thanet sand (Oxford Archaeological Unit 2001). These comprise Blackheath/Oldhaven/Woolwich and Thanet Beds, laid down between 65 to 45 Ma during the Palaeocene and Eocene, although a small area of the northern part of the Kent Landfall Study Area consists of Cretaceous chalk laid down between 140 to 65 Ma (Young 2004: 1).

5.3 COASTAL CHANGE

5.3.1 The historic environment at the Kent Landfall is intrinsically linked with the area's geography and coastal change. The northern two-thirds of the Kent Landfall Study Area are part of the historic Isle of Thanet, which was cut off from the mainland by the Wantsum Channel (Young 2004: 5). The southern third of the Kent Landfall Study Area is situated at the eastern mouth of the Wantsum Channel, where in the distant past a narrow shingle bank extended southwards from the Isle of Thanet towards the mainland. During the late medieval period, the Wantsum Channel began to silt up, and additional sea defences were constructed to reclaim the low lying marsh land, thus rendering the area suitable for occupation. By the 1700's, much of the former channel had been reclaimed, although further reclamation activities at the mouth of the River Stour, in the southern part of the Kent terrestrial area, are visible on the 1872, 1896, 1908 and 1938 Ordnance Survey maps (**Figure 4**).

5.4 HISTORIC LANDSCAPE CHARACTER

5.4.1 An Historic Landscape Character (HLC) assessment has been developed by Oxford Archaeological Trust (2001) and by Jacobs Babtie (2004) for Kent County Council. The Kent Landfall Study Area forms part of three Historic Landscape Character Areas defined by Oxford Archaeological Trust as 34 (Wantsum Coastal Belt), the edges of 18 (Isle of Thanet) and 19 (Wantsum Channel).

5.4.2 HLC area 34 is located immediately on the coast, and comprises a small distinct area of coastal land types, such as coastal wetlands, saltmarsh, salterns, reclaimed land, marshes, shingle and dunes, mudflats, wave-cut platforms and creeks, with significant expanses of recreational land use.

5.4.3 HLC area 18 comprises the Isle of Thanet, which is characterised by two Historic Landscape types: post-1801 settlement and irregular fields bounded by roads, tracks and paths. After Wantsum Channel silted up, the Isle of Thanet joined the mainland, however, it still retains an island feel, resulting from the way the landscape of Thanet rises out of the marshes. The sloping edge of the flat plateau runs around the south and west of the chalk outlier from Cliffsend and Minster

onwards, and the slope and plateau top give long views over Pegwell Bay and the adjacent marshes.

5.4.4 HLC area 19 is slightly inland of 34, and is comprised of a well-defined area composed almost entirely of marshland reclaimed from the sea. Reclamation in this area began in the 12th or 13th century in connection with the ecclesiastical estates in the region.

5.4.5 The silted up course of the Wantsum Channel and the former mouth of the River Stour have formed marshlands, and the flat and open landscape continues around the coast to the Sandwich flats. The marshes around Sandwich have a more coastal influence, with views open to the sea. This area is bordered by the sand dunes and coastal mudflats of Sandwich Bay. Sandwich itself was an important port and still has a remarkably complete medieval town centre. Nearby Richborough has been strategically important since Roman invaders built a castle on a promontory within the marshes. Over the last 100 years, a major port has developed. Along the coast, a long barrier of Aeolian sand dunes lie between the marshes and the sea, forming a small but individual character area on the edge of the marsh, and are characterised by grasses and maritime influences. The coastal mudflats of Pegwell Bay and Sandwich Bay are designated within the Site of Special Scientific Interest (SSSI) which covers the Hacklinge marshes and the sand dunes.

5.5 KNOWN TERRESTRIAL SITES

5.5.1 The following section is only a preliminary examination intended to provide information on the archaeological potential of the intertidal zone. A complete terrestrial archaeological assessment is being undertaken by TEP and the results will form a separate report.

5.5.2 A complete gazetteer of terrestrial sites at the Kent Landfall can be found in **Appendix IV** in **Volume II**. The gazetteer is derived from information provided by the NMR and Kent HER, and the sites are numbered (**WA1001 – WA1069**) (**Figure 5**). The following section provides a brief synopsis to establish the known archaeological resource and to provide context for the identification and understanding of any potential components of the historic environment which may survive. The **WA** is not included on the figure to assist drawing clarity.

5.5.3 There are no Scheduled Ancient Monuments within the Kent Landfall Study Area, however, there are **2 listed buildings**:

- **WA1039:** 53 and 55 Foad's Lane
- **WA1040:** Saint Augustine's Cross

Prehistoric Period (Palaeolithic to AD 43)

5.5.4 The earliest known archaeological evidence in the Kent Landfall Study Area dates to the Neolithic. All of the sites are located on the historic Isle of Thanet, and many are clustered on areas of higher ground that would have been dry land throughout the period. The density and richness of sites indicates relatively intensive occupation of the area from the Neolithic onwards, probably as a result of this being a prime location for landing material and people from the Continent. This section will examine the known archaeological material from the Neolithic to the end of the Iron Age by site, starting from the north end of the Study Area, as many of the sites were either occupied continuously or reoccupied several times throughout the Prehistoric period.

5.5.5 A range of late Neolithic or early Bronze Age features and archaeological material have been discovered across the Kent Landfall Study Area, and include late Neolithic or early Bronze Age barrows (**WA1001 – WA1004**), a crouched inhumation (**WA1005**), a late Neolithic or Bronze Age settlement (**WA1006**), a Bronze Age enclosure and ring ditch visible as crop marks (**WA1007**) and two Bronze Age hoards (**WA1008-WA1009**). Sites **WA1002, WA1005** and **WA1007** may be associated, and they are situated within a wider landscape of barrows, enclosures and a system of field ditches indicating Neolithic and Bronze Age activity throughout the area. To the north-west of Hollins Bottom, post-holes and pits (**WA1011**) were located within a late-Neolthic / early Bronze Age barrow (**WA1004**).

5.5.6 The combined quarry working and funerary deposits encountered at the nearby Cliffsend Meadows development could be related to the possible settlement (**WA1006**). Remains indicating a possible long-lived domestic settlement, dating between the late Neolithic and medieval period, were discovered during an excavation at Oaklands nursery north of Cliffsend (**WA1061**). The late Neolithic material from the site included ditches, pits, flint objects and Late Neolithic Peterborough ware, and the site may have been part of a ditched enclosure. Finds include Late Bronze Age pottery sherds, and a curved ditch revealed an Iron Age pot. An Iron Age burial was discovered in Mount Green Avenue, Cliffsend, Ramsgate in 1959 (**WA1019**), and the site included skeletal remains and pottery. Archaeological excavations at Cliffs End Farm have revealed abundant evidence that the site was used for funerary and ceremonial purposes in the Bronze Age (**WA1062**). The evidence included four early Bronze Age round barrows; and a series of horseshoe shaped enclosures containing disarticulated skeletons and ritual deposits has been dated to the later Bronze Age.

5.5.7 Neolithic flakes and worked flints have also been recovered from farmed fields after ploughing, and rare prehistoric pottery was discovered in pits (**WA1023**).

5.5.8 Prehistoric pottery and worked flint were discovered during an excavation at Cottington Hill (**WA1059**). Cottington Hill remained an important site throughout the prehistoric period, and Iron Age and Romano-British artefacts have also been found (**WA1063,** Andrews *et al.* 2009: 104-105). Metal detectorists have discovered numerous Iron Age coins on the hill, representing a range of dates, from 100 BC to AD 20 (**WA1012 – WA1018**). To the south of Cottington Hill, a late Bronze Age or early Iron Age midden included pottery sherds and associated material (**WA1010**).

5.5.9 There has been occupation around the present-day Ebbsfleet farm since at least the Bronze Age, when the site would have occupied a coastal position on the edge of the Wantsum Channel. Finds at the site have included a Bronze Age founder's hoard (**WA1009**), comprising 181 weapons and implements, and excavations at the site have revealed another Late Bronze Age hoard, comprising five copper alloy objects and a range of other artefacts (**WA1060**). Nearby, two middens with Bronze Age pottery have been excavated (**WA1058**). Iron Age finds have also been recovered from the area around Ebbsfleet Farm. Excavations in 1990 revealed a Bronze Age beaker burial and Iron Age occupation site (**WA1064**). The Iron Age site comprised pits, ditches a possible hut and occupation layers dating to c. 200-50BC.

5.5.10 There are a number of undated, but possibly prehistoric, sites within the Kent Landfall Area, including the remains of possible late Bronze Age hut circles with a boundary ditch near Cliffs End Hall (**WA1065**). Other sites include an undated crouched inhumation burial found during a watching brief at Cliffsend (**WA1066**),

ring ditch cropmarks identified from aerial photographs (**WA1067-WA1068**) and a large area of cropmark features also identified from aerial photographs (**WA1069**).

Romano-British (AD 43-410)

5.5.11 The Kent Landfall Study Area was also intensively occupied during the Romano-British Period. A large number of ditches in the vicinity of Ebbsfleet farm have been dated to the prehistoric, Romano-British and medieval periods, and are thought to be enclosure and boundary ditches (**WA1058**). The site was excavated as part of the Margate to Weatherlees Hill Wastewater Treatment Works Twin Pipeline. Other excavations at Ebbsfleet farm have identified remains and traces of a Romano-British or medieval structure (**WA1060**).

5.5.12 At Ebbsfleet farm, occupation of an Iron Age site appears to have continued into the Romano-British period (**WA1064**), and Iron Age occupational layers are overlain by a large Roman building dating to the late 2nd century AD. Surface finds from the surrounding area included Romano-British pottery, brick, tile, a coin, rotary quern and buckles. The site may be the same as or related to the find of a Romano-British building and associated pottery at Cottington Hill (**WA1063**). The remains of a Romano-British building and associated pottery, dating to the late 2nd century, were discovered at Cottington Hill, and they are located within a Romano-British landscape of ditches forming a rectilinear enclosure system (**WA1056**).

5.5.13 Three further Romano-British sites are located immediately to the east of Cottington Hill. Site **WA1020** comprised drainage ditches, a hearth and two inhumations, and excavations at the site revealed an area of rammed chalk and flint which is thought to have been used to consolidate an area of boggy ground, and excavations around the graves indicate that they were dug into an area of marshy ground (Andrews *et al.* 2009: 104-105), indicating that these relatively low-lying areas remained quite marshy prior to reclamation activities in the medieval and post-medieval periods. Site **WA1021** comprised pits and associated materials. An occupation site that could indicate a possible villa (**WA1022**) had evidence for building materials, Samian pottery and other fine wares, and the Belgic material that highlights trade links with the Continent during the Romano-British period. Romano-British ditches, a sunken featured building and two cemeteries (**WA1023**) were discovered less than 300 m to the north.

5.5.14 A sherd of Samian ware was recovered during excavations at Oaklands nursery north of Cliffsend (**WA1061**). A Romano-British grave and associated material including a nail, a Belgic sherd, animal bones and shells (**WA1024**) was discovered to the east of Cliffsend. Nearby, Romano-British coins, a brooch and key were recovered (**WA1025**).

5.5.15 The discovery of a Samian cup, dredged up in Pegwell Bay in 1902 (**WA1026**) probably represents material discarded in the bay from shore or thrown overboard from a Romano-British vessel, rather than evidence for a previously undiscovered shipwreck. However, the discovery of further material in the bay could represent a shipwreck, as often the hard finds, like pottery, are all that survive.

Anglo-Saxon (410–1066)

5.5.16 Pegwell Bay represents the traditional landing site of the Saxons in AD 449 (**WA1027**), according to the Anglo-Saxon Chronicle, and it is thought that St Augustine may also have landed there in AD 597. A natural spring marks the traditional spot where St Augustine camped with his monks on reaching England (**WA1028**). Although the shape of the bay has changed considerably since the

Saxon period as a result of land-reclamation activities, these traditions indicate that the bay has historically been an optimal spot for landing the typical boats of the time.

5.5.17 Anglo-Saxon archaeological evidence has also been discovered in the Kent Landfall Study Area. Finds include an Ipswich Ware pot dated to AD 700-900, discovered during excavations at Oaklands nursery, north of Cliffsend (**WA1061**). The excavations also revealed pits, postholes, animal bone, pottery, comb fragments and building material, possibly suggesting a domestic settlement. Excavations at Cliffs End Farm have revealed 24 Saxon burials and more than 60 pits dated to the Middle Saxon period (**WA1062**).

Medieval (1066-1499)

5.5.18 On the eastern side of the Kent Landfall Study Area, around Little Cliffsend farm, there are a number of medieval features, including two well-shafts (**WA1029 – WA1030**), with **WA1030** associated with a small cave entrance leading northward into a complex system of tunnels reputed to be smugglers caves. A possible medieval wall (**WA1031**) and medieval remains dating to the 13th and 14th century which were discovered when a pipe trench was being excavated (**WA1036**), were located nearby.

5.5.19 A domestic settlement, with evidence for occupation dating back to the Neolithic, was located at Oaklands nursery, north of Cliffsend (**WA1061**). Medieval finds from the site include a dyke/bund of flint pebbles and cobbles, which has been interpreted as a possible revetment or seawall or 'boarded groin'. This indicates that the medieval coast could have been as much as 500 m further inland than at present.

5.5.20 To the south of Cottington Hill, there are a number of other sites, including an early medieval pit (**WA1032**), a possible medieval farmstead indicated by infilled ditches and pottery sherds (**WA1033**), a possible sunken medieval building with associated 12th to 13th century pottery and shellfish remains (**WA1034**), and the remains of a ditch enclosing a 13th and 14th century farmstead (**WA1035**).

5.5.21 During the medieval period, the land at the Kent Landfall Study Area was being reclaimed from the sea, and a seawall (**WA1037**) was built as the result of an inundation of the sea between Cliffsend and Stonar in 1365. The remains of boarded groin structures and earthen embankment extend over 1.5 km, and are located between the eastern extent of Minster parish on the border with Thanet and the northern area of Sandwich parish. Although the seawall is no longer continuous, it is recorded to be in reasonable condition where it survives.

Post-Medieval (1500-1800)

5.5.22 The Ordnance Survey maps record a number of former landscape features, such as a post-medieval chalk pit to the north of Cliffsend (**WA1038**) and areas of saltings located on either side of the mouth of the River Stour (**WA1057**).

5.5.23 A pair of cottages built in 1737 in Cliffsend are Listed (**WA1039**).

5.5.24 Post-medieval material, including the remains of flint wall foundations, iron-working artefacts and 16th-17th century pottery has also been recovered at excavations at Cottington Hill (**WA1059**).

Modern (1800 – present)

5.5.25 Ordnance Survey maps illustrate that even in the modern period, the coastline was continuing to change. Slight changes to the main channel of the River Stour are visible around No Man's Island in the southern part of the Kent Landfall Study Area

on the 1877, 1898, and 1908 Ordnance Survey maps. However, by 1946, the river channel had changed considerably: its course had been straightened, with relict channels infilled, and No Man's Island along with a considerable area of intertidal area had been reclaimed and joined the mainland.

5.5.26 In addition, the landscape was transformed by military activities during the two World Wars. The majority of sites and monuments in the modern period relate to the two Wars, with a single exception: a carved celtic cross that was erected in 1884 to commemorate the landing of St Augustine in AD 597 (**WA 1040**).

5.5.27 Military sites likely related to the two World Wars, but without date ranges specified in the Kent HER include the Richborough RAF Salvage Yard (**WA1055**) and an area of slit trenches (**WA1054**) identified from aerial photographs.

5.5.28 During World War I, a train ferry dock (**WA1043**) located on the banks of the River Stour was part of a secret 'Q' port, the starting point of a ferry service for troops and munitions sent to France and Flanders (www.open-sandwich.co.uk).

5.5.29 During World War II, a vast array of coastal defences blanketed the landscape. The Kent HER records numerous pillboxes (**WA1041-WA1051**) that dotted the coast and surrounded Cliffsend. In addition, there was a coastal battery (**WA1052**), gun emplacements (**WA1053**), slit trenches (**WA1055**), a possible World War II anti-aircraft station at Cottington Hill (**WA1056**) and a minefield on the coast at the mouth of the River Stour (**WA1057**). In addition, the South East Rapid Coastal Zone Assessment Survey (Wessex Archaeology, in progress) has identified and mapped numerous other defences, including lines of anti-tank cubes, barbed wire obstructions, additional gun pits and gun batteries, lines of posts representing anti-landing obstacles in the intertidal zone, possible beach scaffolding, bomb craters, and to the south of the River Stour, there was a rifle range and fields of anti-landing obstructions.

5.5.30 Aerial photographs taken in the 1940s illustrate the extent of the World War II beach defences (**Figure 6**) at the immediate terminus of the cable route landfall, including lines of anti-tank cubes immediately to the south-east of the petrol station buildings, as well as lines of beach scaffolding extending across the intertidal zone. In addition, the aerial photographs illustrate that the intertidal marsh area has developed since the 1940s, as in the aerial photographs, the area comprises a sandy beach that is covered at high tide.

5.5.31 The walkover survey for the landfall of the Thanet Offshore Wind Farm cable route (Wessex Archaeology 2007) followed the A256 between the north side of Pegwell Bay and the disused Richborough Power Station. The survey identified a number of archaeological features, including World War II coastal defences including a line of anti-tank pimples, an earthen bank and a pillbox.

Walkover Survey

5.5.32 A walkover survey was conducted in November 2010. The walkover survey started at the carpark on the A256 (Sandwich Road) south of the Jet petrol station, and continued north-east towards the cliffs at the northern side of Pegwell Bay. Access to the foreshore around the petrol station is prohibited by Kent Wildlife Trust as it is a Sensitive Wildlife Area (**Plate 1**). However, limited access was gained to the area on a concrete footpath. The area comprises overgrown marshland mudflats (**Plate 2, Plate 3**). No archaeological material was readily visible, however, it could be obscured by vegetation or buried in the mudflats. An area marked 'danger unstable

ground' is located in the marshland immediately to the north-east of the petrol station (**Plate 4**).

5.5.33 The walkover survey continued to the former hoverport, in order to photograph the site from the north (**Plate 5, Plate 6**), and continued along the cliffs. A line of posts was visible leading up to the cliff (**Plate 7**).

5.5.34 The walkover survey then returned along the coast and continued following the coastal path beyond the car park to the south until the path turned to the west. No further material was discovered, however, the remains of the World War I train ferry were photographed across the estuary (**Plate 8**).

5.6 POTENTIAL

5.6.1 As illustrated in the **Regional Archaeological Overview** and highlighted by the known sites in the area, there is high potential for discoveries of archaeological finds, sites and deposits. Many of the known sites were discovered through development activities: out of the 69 sites and findspots identified in the Kent HER and NMR records, 23 (about a third) are attributed to development.

5.6.2 In the northern part of the Kent Landfall Study Area, there is potential for the discovery of material dating from the Palaeolithic to the modern period. Although no Palaeolithic or Mesolithic material has previously been discovered on this part of the coast, finds of these periods have been recovered from other sites on the Isle of Thanet. The density of sites and findspots from the Neolithic to the Romano-British period also emphasises the potential for sites from these periods, and there is also potential for Anglo-Saxon, medieval, post-medieval and modern material.

5.6.3 In the southern part of the Study Area there is also potential for Palaeolithic or Mesolithic material, and any evidence from the Neolithic to medieval period would likely be of a maritime nature. There is also potential for post-medieval and modern material in the area of the in-filled Wantsum Channel and adjacent to the now settled course of the River Stour.

6 ENGLISH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

6.1 INTRODUCTION

6.1.1 The English Waters Study Area extends roughly 48 km in an irregular linear corridor surrounding the cable route between Mean Low Water and the French Waters Study Area (**Figure 7, Figure 8**). It comprises English Territorial Waters (within 12 nm) and the UK EEZ.

6.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

6.2.1 The basement geology across the entire UK sector of the cable route is expected to comprise Campanian Chalk (**Unit 5**) (**Figure3** & **7**). This basement is also the shallowest geological unit along a large portion of the route, and is often directly overlain by only the superficial seabed sediments (**Unit 1**) (Section 4.4.3 and **Table 4.2**).

6.2.2 **Unit 4** (**Thanet Formation**) is restricted to the near shore section of the route, where it forms an offshore extension of the same formation observed on land (Cameron *et al.* 1992). The unit is expected to comprise sand and sandy clay and to directly overlay **Unit 5**, though no ground truthing has yet been undertaken along

this section of the route, so this is unconfirmed. In this area, **Unit 4** is directly overlain by **Unit 1**. As the **Thanet Formation** is Palaeocene (Thanetian) in age, it is considered to be too old to be of possible archaeological importance.

6.2.3 **Unit 3** (**London Clay Formation**) has only been observed at the far eastern end of the UK sector. The unit is characterised on seismic records by numerous sub-parallel internal reflectors, and has been observed as a relatively thin unit which steadily thickens towards the east. Ground truthing has confirmed the unit to comprise stiff clay. In this area, **Unit 3** is directly overlain by **Unit 1**. As the **London Clay Formation** is Eocene (Ypresian) in age, it is not considered to be of possible archaeological importance.

6.2.4 **Unit 2** in the UK sector of the cable route comprises a sequence of terrestrial deposits located directly west of the Lobourg Channel (see below). A complex of under filled palaeochannels has been observed in this area on both the multibeam bathymetry and sub-bottom profiler records (**WA7500** and **WA7501**) (**Figure 7**). Samples from core **VC WA VC7** have confirmed the presence of sandy clay with organic inclusions, and at least one peat layer containing fresh water molluscs, directly overlying the chalk bedrock within channel **WA7500**.

6.2.5 This unit is interpreted as being a fluvial/flood plain deposit, probably of post-Devensian (early Holocene) age, overlain by possible estuarine sediments (**Appendix II, III** in **Volume II**). These deposits therefore have the potential to contain both *in-situ* and derived archaeological material, alongside preserved organic remains of potential importance to palaeoenvironmental studies.

6.2.6 Although the Lobourg Channel marks the eastern most edge of **Unit 2**, the basal reflector is very poorly defined and inconsistent (**WA7502**) (**Figure 7**) and the western extent of the unit could not be identified. Coring has not yet been carried out along this portion of the route to aid with the interpretation.

6.2.7 **Unit 1** is present across most of the UK Waters Study Area of the proposed cable route, where it generally comprises shelly gravelly sands and sandy gravels. It is of varying thickness along the route, ranging from a thin veneer to sand waves and banks a few metres in height. Of particular note is the South Falls, a large sand bank approximately 30 m in height which crosses the proposed route at the eastern edge of the Lobourg Channel. The seabed sediments are not considered of archaeological importance in themselves, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

6.2.8 A final feature of note is the Lobourg Channel (**Figure 7**), a large, broad, roughly north-south trending channel that cuts across the proposed route. The western edge of this channel is marked by a large, rapid bathymetry change, with water depths suddenly increasing by approximately 30 m whilst the eastern edge is tentatively marked by the South Falls bank. This is a large, under filled palaeochannels feature which is interpreted as being intermittently active throughout the Pleistocene. It is a major bathymetric feature, though the sub-bottom profiler data and core samples indicate there are no surviving terrestrial deposits at the base of the channel and so it is of limited archaeological interest.

6.3 KNOWN WRECKS AND OBSTRUCTIONS IN ENGLISH WATERS

6.3.1 Records of wrecks and seabed obstructions within the UK Territorial Waters Marine Study Areas were collated using information provided by the UKHO, the NMR, and through the archaeological interpretation of geophysical survey data (**Table 6.1**)

(**Figure 8**). A total of 129 sites of possible archaeological potential were identified along the UK section of the proposed cable route. Of these, five were classified as A1 sites, 123 classified as A2 and 1 was classified as A3.

Table 6.1: Sites in English Waters

Description	Number
'A1' previously unrecorded wreck	1
'A1' geophysical anomalies of anthropogenic origin and of archaeological interest - observed in geophysical data	4
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	123
'A3' wreck recorded as 'Live' by the UKHO but not observed in geophysical data	1
'A3' wrecks recorded as 'Live' by the UKHO, outside of the geophysical survey area	8
'A3' wrecks recorded as 'Lift' by UKHO, outside geophysical survey area	2
'A3' obstructions recorded as 'Live' by UKHO, outside of the geophysical survey area	8
'A3' obstruction recorded as 'Dead' by the UKHO, outside geophysical survey area	1
TOTAL	**148**

6.3.2 A complete list of wrecks and obstructions (**WA7000 – WA7128, WA7270 – WA7288)** can be found in **Appendix V** in **Volume II**.

Geophysical Survey Data

6.3.3 Only one definite wreck, site **WA7024**, was observed along within the English Waters Study Area. The wreck was identified by all of the geophysical equipment, and appears as a mostly buried structure measuring 31.4 m x 4.8 m x 0.8 m with a 66nT magnetic anomaly. The wreck itself is orientated approximately NNE – SSW, and is located on the edge of a large sand wave within a scour measuring approximately 30 m x 11 m x 0.4 m. The wreck appears to be previously unrecorded, and it's location on the edge of a sand wave suggests it is periodically buried and exposed as the sand waves in the area move. Due to the wreck being mostly buried little can be said about its structure, though the magnetic anomaly observed suggest it is at least partially ferrous in construction. The wreck is illustrated on **Figure 9**.

6.3.4 The *Pisces* (**WA7017**) was a British motor fishing vessel that sunk on the 8t^{h} December 1995. The single crew member was recovered alive. The UKHO record indicates that there were plans for a salvage attempt. The *Pisces* measured 5.5 m by 2.4 m. Diver reports have indicated that the hull lies flat on the seabed in sand, and the engine block lies in a trench by a chalk ridge. However, although site **WA7017** is the given location of the wreck of the fishing vessel *Pisces*, the wreck was not identified by any of the geophysical survey equipment during the archaeological geophysical assessment. As with wreck **WA7024**, a number of large sand waves were observed at the site indicating the structure could be in the correct location but completely buried at the present time. Given that the UKHO report the wreck to be very small (5.5 m x 2.4 m), this is considered to be possible.

6.3.5 A total of 30 sites have been classified as debris within the UK sector of the proposed route. Most of these have been classified as A2 sites, though four (**WA7027**, **WA7047**, **WA7049** and **WA7098**) have been designated as A1. Site **WA7027** is an area of dark reflectors with shadows measuring 21.9 m x 17.6 m, and associated with a 59nT magnetic anomaly. The site is located in an area of sand

ripples, indicating a larger, at least partially ferrous, structure could be buried beneath the seabed.

6.3.6 **WA7047** is an area of angular bright reflectors approximately 22.2 m x 10.7 m and associated with a 43nT magnetic anomaly (**Figure 10**). This has been interpreted as a debris field, which potentially represents the remains of a degraded wreck or other structure. The magnetic anomaly suggests the debris is at least partially ferrous in nature.

6.3.7 **WA7049** is a large dark reflector with a large shadow measuring approximately 7.2 m x 6.5 m x 0.9 m and associated with a 6nT magnetic anomaly (**Figure 10**). Multibeam bathymetry data indicate the structure to be located within a large depression measuring 22 m x 15 m x 0.5 m. The site is at the location of a known obstruction recorded as foul ground, though the results from the data here indicate it could be the remains of a wreck or other anthropogenic structure.

6.3.8 **WA7098** has been identified as two short, parallel, linear alignments of dark reflectors with shadows measuring 9.3 m x 9.4 m x 0.6 m and associated with a 16nT magnetic anomaly. This has been interpreted as an area of debris or potentially a partially buried, badly degraded structure of an at least partially ferrous nature.

6.3.9 Of the remaining debris sites, 17 (**WA7010**, **WA7016**, **WA7029**, **WA7030**, **WA7034**, **WA7041**, **WA7044**, **WA7051**, **WA7057**, **WA7075**, **WA7079**, **WA7080**, **WA7088**, **WA7091**, **WA7102**, **WA7109** and **WA7116**) appear as individual large, angular dark reflectors with large acoustic shadows and are interpreted as possible individual pieces of debris rather than debris fields or structures. **WA7075**, **WA7079**, **WA7088** and **WA7091** are associated with small magnetic anomalies and so are probably ferrous in nature, whilst the rest are interpreted as being non-ferrous. **WA7080** is also associated with a mound identified on the multibeam bathymetry data and so is probably a substantial feature, though its appearance in the data and lack of a magnetic anomaly mean that it may not represent a wreck site.

6.3.10 Five of the debris sites (**WA7031**, **WA7035**, **WA7043**, **WA7059** and **WA7067**) comprise relatively short, linear alignments of closely spaced dark reflectors with shadows, and could represent separate pieces of debris or the same piece of linear, partially buried debris. None have been found associated with a magnetic anomaly and so all are interpreted as non-ferrous in nature.

6.3.11 **WA7038**, **WA7045**, **WA7061** and **WA7074** are small areas containing numerous irregular dark reflectors, and are interpreted as small debris fields. Only one (**WA7038**) is associated with a magnetic anomaly and so is interpreted as being ferrous in nature, whilst the rest are interpreted as areas of non-ferrous debris.

6.3.12 Eight of the sites (**WA7022**, **WA7052**, **WA7053**, **WA7054**, **WA7058**, **WA7066**, **WA7089** and **WA7092**) comprise curvilinear dark reflectors, generally with small shadows, and have been interpreted as lengths of rope or chain. **WA7022**, **WA7089** and **WA7092** are associated with magnetic anomalies, and so are likely to be chains, whilst the remainder are more likely to be non-ferrous in nature. **WA7052** has a large dark reflector located at one end, possibly indicative of an anchor.

6.3.13 Sites **WA7056** and **WA7070** are both relatively small, elongated bright reflectors without any associated magnetic anomalies. These are of an uncertain origin, and could be either natural features or non-ferrous debris composed of a material that absorbs acoustic waves rather than reflects them.

6.3.14 A total of 20 sites (**WA7011**, **WA7019**, **WA7020**, **WA7037**, **WA7042**, **WA7050**, **WA7055**, **WA7060**, **WA7063**, **WA7064**, **WA7073**, **WA7077**, **WA7085**, **WA7086**, **WA7087**, **WA7090**, **WA7100**, **WA7108**, **WA7120** and **WA7127**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is either non-ferrous in nature or has a magnetic field which was too small to be detected by the survey.

6.3.15 The remaining 67 sites (see **Appendix V** in **Volume II** for full list) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but 16 (**WA7002**, **WA7004**, **WA7014**, **WA7025**, **WA7033**, **WA7040**, **WA7046**, **WA7072**, **WA7082**, **WA7084**, **WA7094**, **WA7095**, **WA7096**, **WA7107**, **WA7125** and **WA7126**) are considerably larger and more likely to represent pieces of buried ferrous debris than natural features. **WA7002**, **WA7004** and **WA7094** are particularly large (87nT, 140nT and 80nT respectively) and suggest the presence of large pieces or scatters of debris buried within the seabed sediments.

Live and Lifted Wrecks not observed in the Geophysical Data

6.3.16 Additional live and lifted wrecks recorded in the UKHO, NMR and HER records, but not observed in the geophysical data, are detailed below. Many of these wrecks were not observed because they lay outside of the geophysical survey area. Although wrecks recorded as 'Lifts' by the UKHO have been salvaged, they are included here because material from the wreck may still be located on the seabed.

6.3.17 The *Harvest Moon* (**WA7270**) was a British Blockship, formerly a trawler, recorded in the Kent HER for UKHO wreck data. It was lost 9 September 1940. The record indicates that the wreck was largely intact apart from a broken stern, and that it showed at low water, partially buried in mud. The wreck of the *Alfred Colebrook* is also thought to be located nearby. Wrecksite website records the vessel as 'dead'.

6.3.18 **WA7271** is an abandoned four wheel drive vehicle, largely reclaimed by the mud. It was surveyed in 2007. Despite the possibility of the vehicle being recovered, it has been charted as an obstruction.

6.3.19 **WA7272** is an unknown wood and iron wreck mostly buried in sand. First surveyed in 1959, the vessel dries at 11 feet (3.4 m). A survey in 1974 indicated that the vessel measured 42 feet (12.8 m) in length, and a survey in 1995 indicated that the wreck was spread over an area 20 m by 10 m, with three distinct structures protruding up to 0.6 m above the seabed.

6.3.20 **WA7273** is a steel tank sunk into the seabed that was discovered during a 1974 geophysical survey and examined by divers. The tank measured 7.3 m by 7.3 m. A geophysical survey in 1982 did not locate the tank, and there are local reports of the tank having been salvaged. However, a geophysical survey in 1995 rediscovered the tank.

6.3.21 *LCP 586* (**WA7274**) was a British landing craft that broke away from alongside SS *Asa Lothrop* and sunk in 1946. The craft measured 11 m by 3 m with a draught of 0.9 m. The LCP (Landing Craft Personnel) were wooden assault craft or sometimes also used for ferry work and ancillary services (Royal Marines Museum website). Landing craft were flat-bottomed and designed to be able to run up onto suitable

beaches. Geophysical surveys in 1960, 1969, 1974 and 1995 revealed no trace of the wreck, and it is thought to have either broken up or become buried in sand.

6.3.22 The *Bravore* (**WA7275**) was a Norwegian merchant steamship that struck an aerial mine 4 nautical miles off Ramsgate on 22 April 1940. The *Bravore*, previously named the *Belibrook, Polberg* and *Bergvik*, was built in 1916 by Kockums Mekaniska Verkstads A/B in Malmo Sweden (Wrecksite website). The vessel had a triple expansion engine of 156 HP for a maximum speed of 9 knots, two boilers and single screw propulsion. It measured 71.63 m in length by 11.49 m in width with a draught of 4.97 m. At time of loss, the *Bravore* was operated by A/S Vore, and was en-route from Tyne to Rouen as part of a convoy, carrying a cargo of 1993 tons of coal. At the mouth of the Thames, the convoy split up with some of the ships heading for London, while the *Bravore* and four other vessels continued to The Downs. Four passengers and 14 crew were lost. Geophysical surveys undertaken by the UKHO indicate that the wreckage is dispersed over an area 100 m by 55 m with its highest point roughly 1 m above the seabed. A geophysical survey in 1991 indicated that the scattered wreckage lay just proud of the seabed.

6.3.23 The *Rydal Force* (**WA7276**) was a British steamship collier with a gross tonnage of 1101. The *Rydal Force* was built in 1924 by Caledon Shipbuilders in Dundee, a company that throughout the 1920s built large cargo-liners, tankers, coastal steamers and ferries (British Coastal Shipping website, Grace's Guide website). The vessel was owned by Kennaugh W.S. & Co (Wrecksite website), a company that began owning steamships in 1883, moved to Liverpool in the 1890s, and was consolidated into West Coast Shipping Ltd. in 1905 (Fenton 1979: 3). Their ships continued to be registered at Whitehaven, and many of the names of the ships were taken from the Lake District, followed by 'Force', a North Country name for waterfall that derives from Old Norse (*ibid*). The *Rydal Force* was mined on 24 April 1940 while carrying 1250 tons of coal. The vessel was on passage from Sunderland for Cowes when it was lost, and 11 men lost their lives. Geophysical surveys have indicated scattered wreckage in a seabed depression measuring 65 m by 38 m with a shadow height of 1.7 m. The wreck was wire swept in 1950 and 1961. Surveys in 1968 and 1971 did not locate the wreck, however, surveys in 1974, 1981, 1986, 1991, 1995 and 1997 located the wreck, noting that it was a small, dispersed wreck sitting in an area of scour that only just showed above the general seabed level.

6.3.24 **WA 7277** is a Dutch schooner that was sunk 30 May 1940. Surveys in 1940 did not locate the wreck, however, it was located in 1949 and swept clear. In 1959 the survey indicated a pronounced scour extending at least a mile roughly north-south. Survey in 1979 indicated a wreck measuring 69 m in length with a height of 6.31 m. The wreck was swept clear again in 1995, and the survey indicated that the wreck had a length of 58 m, width of 11 m and that it lay in pronounced scour that extended 500 m south and 100 m north. The wreck has a strong magnetometer deflection.

6.3.25 An abandoned Suzuki Jeep (**WA7286**) surveyed in 2007. In August 2007, the vessel was located in the intertidal area in Pegwell Bay, and as it was submerged at Mean High Water, it posed a hazard to small craft operating in the Bay. Once the insurance claims were dealt with, the vehicle was removed. It had been salvaged by 14 September 2007, and is recorded by the UKHO as a 'Lift'.

6.3.26 A dredger hopper barge (**WA7287**) sunk 30 August 1986 while in tow of the tug *Influence*. A salvage attempt in October 1986 failed, however, the barge was raised in November 1986.

6.4 POTENTIAL

Submerged prehistory

6.4.1 There is potential for archaeological evidence of now submerged terrestrial deposits. The geophysical survey revealed a complex of palaeochannels directly to the west of the Lobourg Channel. Vibrocore **VC-WA-VC7 (Figure 3),** taken from this area, contained the sedimentary **Unit 2** comprising at least one peat layer and interpreted as being a fluvial/flood plain deposit of probable post-Devensian (early Holocene) age. The presence of peat highlights the time when this area was dry land and suitable for human occupation, and its survival suggests high potential for the survival of other archaeological material. The deposits have the potential to contain both *in situ* and derived archaeological material, alongside preserved organic remains of potential importance to palaeoenvironmental studies.

6.4.2 However, as **Unit 2** directly overlaid bedrock eroded by glacial action, it is unlikely that earlier Palaeolithic material will be found *in situ*, although it could be discovered in secondary contexts.

Shipwrecks

6.4.3 There is high potential for archaeological remains of watercraft from the Mesolithic to the present. Near shore, the **Regional Archaeological Overview** has indicated the importance of maritime trade for the coast of Kent, and Pegwell Bay and Sandwich have been important landing places for goods for thousands of years. The mud flats of the bay present a considerable navigational hazard, but also provide an opportunity for high levels of preservation. Within the Bay, there are also numerous obstructions, posts and stakes across the Sandwich Flats and Pegwell Bay that may prove to be of archaeological interest (Admiralty Chart 1825 from 1965).

6.4.4 There are two Named Locations to which Recorded Losses have been ascribed, and details of the Recorded Losses can be found in **Appendix VI** in **Volume II**. Although the exact location of these wrecks is not known, they indicate the potential to discover previously unrecorded wrecks in the area. The first Named Location indicates the loss of 10 French fishing vessels that were stranded in Pegwell Bay during a hurricane in 1752. The second Named Location represents 25 Recorded Losses. The earliest date to the Roman period, when an unknown number of Roman transport vessels and warships were lost during a sudden storm during Caesar's first invasion in 55BC (**WA1201-WA1202**) (**Figure 8**). The three medieval wrecks were cargo vessels of English, French and Spanish nationality that were lost in the 14th century, illustrating the importance of European trade during the period (**WA1203 -1205**). The post-medieval wrecks indicate the wide variety of ships operating in the area, including a British Fourth or Fifth rate ship of the line, a Dutch East Indiaman, a brigantine and various cargo vessels (**WA1206 – 1226**). Their destinations also highlight important issues of the period, with expanding trade networks indicated by a wreck en-route from Jamaica to London, military activity denoted by the British warship, and the dangerous nature of shipping illustrated by a possible privateer and a prize of Ostend privateers. There is little information available about the wrecks from the modern period (**WA1227 – WA1234**), however, they include a galliot and a variety of cargo vessels. Across the periods, the most common causes for loss were due stranding/beaching and to weather events, such as the storm that sunk the Roman ships.

6.4.5 In addition, the wider area comprises a navigational route that provides a relatively short distance between England and Europe, and thus has been key in maritime trade since the Mesolithic. Once naval technology had improved to the level where battles at sea were truly a possibility, this area of sea became a battleground,

witnessing, for example, the Spanish Armada (English vs Spanish 1588), the St. James Day and Four Days battles (Second Anglo-Dutch war, 1666), and the Battle off Sandwich / Battle of Dover (100 years war, English vs French, 1217).

6.4.6 The Goodwin Sands represent an area of very shallow mobile sandbanks that are a hazard to shipping of all types, and in English waters, it has one of the greatest reputations for ship losses (Bournemouth University 2007). Current work undertaken by Wessex Archaeology for English Heritage has revealed considerable quantities of shipwreck material dating from the medieval period onwards. The seabed in the Goodwin Sands area has a predominance of fine grained sediments indicating the area also has a high potential for preservation, and although the mobility of the sandbanks may counteract this to some degree, this area is considered to be an Area of Maritime Archaeological Potential (Bournemouth University 2007). In addition, the shifting sands also have the potential to reveal previously undiscovered wrecks.

6.4.7 In addition, the cable route will cross the South Falls, a large sand bank approximately 30 m high. Large sand waves and banks have the potential to cover archaeological material such as shipwrecks.

6.4.8 The geophysical survey has identified numerous geophysical anomalies of potential anthropogenic origin and archaeological potential, however, it must also be recognised that it is difficult to identify wooden shipwrecks, scattered shipwrecks or buried shipwrecks through geophysical survey methods, and therefore there is the potential to discover previously unidentified sites.

Aircraft

6.4.9 The **Regional Archaeological Overview** above has indicated the high potential for previously undiscovered aircraft crash sites in the Study Area. The skies over the Study Area saw considerable air-borne action during the two World Wars, and there were several important airfields in Kent.

6.4.10 One of the Recorded Losses is a British Spitfire MK IIA P7386 from 1940 (**WA1235**), and the distribution of World War II British Air/Sea Rescue Operations indicates hot spots of activity around the coast of Kent throughout the war (Wessex Archaeology 2008) (**Figure 8**). The locations of these lost aircraft are unknown, but they indicate the considerable potential for the discovery of other 20th century aircraft lost in the study area as a result of military activities during the two World Wars. Aircraft lost while in military service are automatically protected under the Protection of Military Remains Act (1986).

6.4.11 The Dornier 17 that is known to have crashed in Pegwell Bay is not recorded in the NMR, HER or UKHO records, and while material from this wreck could be encountered, it also underscores the potential for other unrecorded wrecks in the area.

6.4.12 The Goodwin Sands protect not only shipwrecks, but also aircraft, as attested by the discovery of an incredibly intact Dornier 17 (Wessex Archaeology). The South Falls sand bank could also protect aircraft material.

6.4.13 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

7 FRENCH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

7.1 INTRODUCTION

7.1.1 The French Waters Study Area extends roughly 20 km across the French EEZ in an irregular linear corridor surrounding the cable route across French Territorial Waters between the English and Belgian Waters Study Areas (**Figure 13**).

7.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

7.2.1 The French sector is the shortest section of the proposed cable route, and it is also the least complex geologically. The underlying basement of this section of the route is expected to be **Unit 5**, but, though it was identified on the sub-bottom profiler data, it is present at depth and was not sampled during the coring program in this area.

7.2.2 **Unit 3** directly overlies **Unit 5**, and is the dominant shallow geology type within this area. Identified on seismic records by numerous sub-parallel internal reflectors, the unit is relatively thin in the west but rapidly thickens to the east. Ground truthing has confirmed the unit to comprise stiff clay. As the unit is Eocene (Ypresian) in age, it is not considered of potential archaeological importance.

7.2.3 Recent seabed sediments (**Unit 1**) directly overlay **Unit 3**, and generally comprise shelly gravelly sands and sandy gravels. The sediments are of varying thickness across the route, ranging from a thin veneer in some areas to sand waves a few metres in height. The seabed sediments themselves are not considered of archaeological importance, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

7.2.4 No geological features of possible archaeological potential were observed within the French sector of the cable route.

7.3 KNOWN WRECKS AND OBSTRUCTIONS IN FRENCH WATERS

7.3.1 Records of wrecks and seabed obstructions within the French Waters Study Area were collated using information from the UKHO and SHOM as well as the archaeological assessment of geophysical data (**Table 7.1**). The French sector is the shortest section of the proposed cable route and subsequently contains the smallest number of sites of potential archaeological interest. 34 sites have been identified along this section, with two being classified as A1 sites, 30 as A2, and two as A3 (**Figure 13**).

Table 7.1: Sites in French Waters

Description	Number
'A1' wrecks recorded by the UKHO and SHOM, observed in geophysical data	2
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	30
'A3' Wrecks recorded as 'Live' by the UKHO outside of the geophysical survey area	1
'A3' Obstructions recorded as 'Live' by UKHO, outside of the geophysical survey area	2
'A3' Obstruction recorded as 'Dead' by the UKHO, outside geophysical survey area	2
TOTAL	**37**

7.3.2 A complete list of wrecks and obstructions (**WA7129 – WA7162, WA7289 – 7291**) can be found in **Appendix VII** in **Volume II**. Details about the live wrecks can be found below.

Geophysical Survey Data

7.3.3 Two know wrecks were observed by the geophysical equipment. Site **WA7141** is the given location of the wreck possibly identified as the HMS *Westella*, which was only detected as a 149nT magnetic anomaly. Multibeam bathymetry data show large sand waves are currently located at the position of the wreck, indicating it is completely buried, but still present, at the given location. The wreck has previously been located by the UKHO, SHOM and VIOE through geophysical survey. The HMS *Westella* was a British steam trawler 36.6 m in length with a gross tonnage of 413. The vessel was built in 1934 by Cochrane & Sons Shipbuilders Ltd, a shipyard founded in 1884 that moved to Selby in 1898 (Uboat.net website; Wrecksite website). Cochrane & Son made their reputation building trawlers and coasters for the Hull and Grimbsy fishing fleets. In 1965, control of the yard passed to Ross Group Ltd. The *Westella* had a triple expansion engine by Amos Smith of Hull, a single boiler and single screw propulsion (Wrecksite website). The vessel was purchased as an anti-submarine trawler in August 1939. The HMS *Westella* sunk 2 June 1940, approximately an hour and a half after the *Blackburn Rovers* (**WA7289**), possibly having been hit by a torpedo from the same U-boat or having also hit a mine (Divine 1959: 215, Hulltrawler website). Survivors were recovered by the trawler *Saon* (Wrecksite website). Past geophysical surveys indicated that the steel wreck lies on a seabed of gravel, sand and shell, close to a large sandwave, which now appears to have covered the wreck.

7.3.4 **WA7151** is the location of the known but unidentified wreck. The actual UKHO location for this wreck lies outside of the geophysical survey area, but it was partially imaged by multibeam bathymetry data and associated with a 13nT magnetic anomaly. As it was only partially imaged, the provided position for this structure should be used with caution as the extent of the wreck is unknown, though a large NE – SW trending scour, measuring 74 m x 40 m x 2 m was clearly identified on the northern side of the structure. Wreck records from the UKHO indicate that **WA7151** was a freighter lost in 1940 that lies on its starboard side, with its stern badly damaged. Past geophysical surveys have suggested that the wreck site measures 130 m in length by 18 m in width. A survey in 1967 indicated that the wreck lies on a seabed of fine sand, gravel and shell, and it appears to be sanded in. That same year, the wreck was cleared at 73 feet (22 m). A geophysical and diver survey in 1971 indicated that the wreck was almost buried.

7.3.5 Two recorded obstructions (**WA7148** and **WA7162**) were not identified by any of the geophysical equipment. **WA7148** is recorded as an unidentified obstruction, and could either be covered by seabed sediments at the present time or was an ephemeral feature that now no longer exists.

7.3.6 **WA7162** is recorded by the UKHO as an 'unclassified non-sub contact', however, in the surveying details it is described as a 'probable wreck' with sonar dimensions 137.2 m in length with a shadow height of 1.8 m. The surveying details from 1945 indicate that the site had a moderate echo, and that the identification was 'rather woolly'. This description and the fact that geophysical survey data and the relative positional accuracy of the co-ordinates based on surveys in the 1940s suggest that this point may not, in fact, be a wreck, and/or that the wreck material could actually be located at some distance away. There are no records of later geophysical surveys in the area either proving or disproving the wreck, there is no record of a wreck or an obstruction at this location in the SHOM dataset, and the recent MMT

multibeam bathymetry data show large sand waves at the site at the present time, so if any structure exists at this location, it is likely to be completely buried.

7.3.7 Four sites (**WA7143**, **WA7154**, **WA7156** and **WA7157**) have been interpreted as pieces of debris. All are isolated, angular dark reflectors with acoustic shadows, though none have been found associated with any magnetic anomalies so are interpreted as pieces of non-ferrous debris.

7.3.8 Site **WA7159** is characterised as a linear alignment of short, linear dark reflectors with small shadows. It is interpreted and classified as a length of rope or chain, periodically buried and exposed by a series of large sand ripples. The presence of an 18nT magnetic anomaly indicates it is possibly more likely to be a length of chain.

7.3.9 Six sites (**WA7129**, **WA7130**, **WA7134**, **WA7149**, **WA7150** and **WA7155**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is expected to be non-ferrous in nature.

7.3.10 The remaining 19 sites (**WA7131**, **WA7132**, **WA7133**, **WA7135**, **WA7136**, **WA7137**, **WA7138**, **WA7139**, **WA7140**, **WA7142**, **WA7144**, **WA7145**, **WA7146**, **WA7147**, **WA7152**, **WA7153**, **WA7158**, **WA7160** and **WA7161**) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but **WA7146**, **WA7158** and **WA7160** are noticeably larger (54nT, 36nT and 45nT respectively) and more likely to represent pieces of buried ferrous debris than natural features.

Live Wrecks not observed in the Geophysical Data

7.3.11 The wreck of the HMS *Blackburn Rovers* (**WA7289**) lies just outside of the French Waters Study Area. It has been included in this assessment because although it lies outside of the geophysical survey data area, its wreckage could extend into the French Waters Study Area. The British steam trawler measured 45.7 m in length and 422 gross tons. It was built in 1934 by Smiths Dock Co. Ltd (South Bank-on-Tees, UK) for Consolidated Fisheries and was one of a group of trawlers known as the 'Football Fleet' (Uboat.net website, Wrecksite website). The vessel was requisitioned by the Admiralty in 1939 and was used as an anti-submarine trawler. The HMS *Blackburn Rovers* took part in the Dunkerque evacuation with a crew of 17, during which, on 2 June 1940, the vessel was torpedoed by a U-boat or mined (UKHO, Wrecksite website, Divine 1959: 214). One crew member died (Wrecksite website). At the time of sinking, the *Blackburn Rovers*' depth charges were primed, and many of the survivors were injured in the resulting explosion (U-boat.net website). Survivors were rescued by HMT *Saon*. Geophysical and diver surveys undertaken by the UKHO in 1971 and 1972 indicate a small steel wreck 45 m in length, with a gun on the fo'c'sle, laying on a seabed of fine sand and broken shell. French and Dutch surveys have also covered the wreck.

7.4 POTENTIAL SITES IN FRENCH WATERS

Submerged prehistory

7.4.1 This part of the Study Area was once dry land, with hominin occupation during inhabitable periods. However, the archaeological geophysical and geotechnical

assessments did not reveal sediments of potential archaeological importance. Additionally there are no geological features of possible archaeological potential.

7.4.2 Any Palaeolithic or Mesolithic material discovered in the area would derive from secondary contexts having been transported in the shallow seabed sediments.

Shipwrecks

7.4.3 The Study Area has been crossed by ships from the Mesolithic to the modern period, and there is potential for previously undiscovered wrecks. The area is part of a major shipping route between England and the Continent, and as such has seen considerable levels of maritime activity. As this is an area of open sea with no known navigational hazards, the main causes of wrecking would be due to storm events, technical difficulties, collision, naval engagements or human error. The types of ships, levels of shipping, and maritime conflicts have been discussed in more detail in the **Regional Archaeological Overview** above. However, notable military events that could have caused wrecks in the area are detailed below:

- A number of post-medieval maritime battles took place in the area, including the Spanish Armada (English vs Spain 1588), and the St. James Day and Four Days battles (Second Anglo-Dutch war 1666).
- During World War I and World War II there was considerable maritime activity. All three of the known wrecks were lost during World War II, two as a result of direct military action including mines or torpedoes. Although there is insufficient data to indicate the manner of loss of the third wreck, a military cause is likely.

7.4.4 In some areas of the Study Area, the seabed comprises sand waves up to a few metres in height. In these areas, the sand waves could potentially cover archaeological sites such as shipwrecks.

7.4.5 The geophysical survey has identified geophysical anomalies of potential anthropogenic origin and archaeological potential, however, it must also be recognised that it is difficult to identify wooden shipwrecks, scattered shipwrecks or buried shipwrecks, particularly in areas of sandwaves, through geophysical survey methods, and therefore there is the potential to discover previously unidentified sites.

Aircraft

7.4.6 The **Regional Archaeological Overview** has indicated the high potential for previously unidentified aircraft crash sites in the Study Area. Although there are no known aircraft crash sites or Recorded Losses of aircraft in the French Territorial Waters Study Area, the skies would have been full of activity during the two World Wars with aircraft crossing the Channel between England and the Continent. The proximity of Dunkerque, and the military aviation activities related to the city's strategic importance and attacks on the city indicate a peak in potential for aircraft losses in the vicinity.

7.4.7 In some areas of the Study Area, the seabed comprises sand waves up to a few metres in height. In these areas, the sand waves could potentially cover archaeological sites such as aircraft crash sites.

7.4.8 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

8 BELGIAN WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

8.1 INTRODUCTION

8.1.1 The Belgian Waters Study Area extends roughly 60 km in an irregular linear corridor surrounding the cable route between the Belgian Landfall west of Zeebrugge and French Territorial Waters (**Figure 16, Figure 17**). It comprises Belgian Territorial waters (to the 12 nm limit) and Belgian EEZ.

8.1.2 The geophysical data for the Belgian Waters Study Area was not yet available when this report was written. However, as there has been no information from the Belgian authorities or curators regarding a requirement for the archaeological assessment of the Belgian intertidal geophysical data, it is unlikely that it will be archaeologically assessed.

8.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

8.2.1 The dominant shallow geology in the Belgian sector of the cable route is the **London Clay Formation** (**Unit 3**) (**Table 4.2**). It is expected that **Unit 5** lies at depth below this, but it is present beyond the depth of penetration of both the geophysical and coring equipment and so was not sampled. Ground truthing has confirmed **Unit 3** to comprise stiff clay. As the unit is Ypresian (Eocene) in age (between 56-48.6 Ma), it is not considered of potential archaeological importance.

8.2.2 One isolated cut and fill (**WA7503**) (**Figure 16**) has been identified cutting into the top of **Unit 3**, the fill of which has been found by coring (**VC-0046**) to comprise fine silty sand. This feature is possibly part of a terrestrial palaeochannels system created during a period of low sea level, and could potentially contain both *in situ* and derived archaeological material.

8.2.3 **Unit 2** is possibly present in two areas towards the eastern end of the Belgian sector. Features **WA7505** and **WA7508** are strong, sub-horizontal reflectors interpreted as erosion surfaces and the basal reflectors of **Unit 2**. In this sector, the unit has been found by coring to comprise well-sorted fine sand and is interpreted as a possible post-Devensian estuarine deposit. Above surface **WA7508** the unit appears complex, with obvious internal structure and a palaeochannels (**WA7507**, below) cutting into it, whilst above surface **WA7505** the presence of the unit is less certain and has not been confirmed by coring. Here, the reflector identified could just represent the base of the Holocene seabed sediments (**Figure 16).**

8.2.4 Two possible small channels (**WA7504** and **WA7506**) have been identified below surfaces **WA7505** and **WA7508** respectively. The nature of the features has not been definitively determined by coring, though they could represent palaeochannels cut into the surface of the **London Clay** and could therefore contain deposits of both archaeological and palaeoenvironmental potential. Their relatively deeper position within the stratigraphy, however, possibly places them beyond the vertical footprint of the proposed scheme.

8.2.5 Channel feature **7507** cuts into **Unit 2** above erosion surface **WA7508** and has been interpreted as a terrestrial palaeochannels deposit of post-Devensian age (**Figure 16**). Core samples have confirmed the channel fill to comprise silty fine sand and clayey silt with flood couplets and organic material (**VC WA VC3**) and an organic odour (**VC-0003**). The presence of organic material is supported by gas blanking within the channel identified on the sub-bottom profiler records.

8.2.6 Both feature **WA7507** and **Unit 2** are considered of possible archaeological and palaeoenvironmental potential.

8.2.7 Recent seabed sediments (**Unit 1**) form the uppermost unit over this entire sector, and generally comprise shelly gravelly sands and sandy gravels. The sediments are of varying thickness across the route, ranging from a thin veneer in some areas to sand waves a few metres in height. The seabed sediments themselves are not considered of archaeological importance, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

8.3 KNOWN WRECKS AND OBSTRUCTIONS IN BELGIAN WATERS

8.3.1 Records of wrecks and seabed obstructions within the Belgian Territorial Waters Marine Study Area were collated using information from the UKHO and VIOE as well as the archaeological assessment of geophysical data (**Table 8.1**). A total of 106 sites of possible archaeological potential were identified within the geophysical survey coverage along the Belgian section of the proposed route. Of these, 1 was designated an A1 site, 101 were designated A2, and 4 were designated A3.

Table 8.1: Sites in Belgian Waters

Description	Number
'A1' wrecks and geophysical anomalies of anthropogenic origin and of archaeological interest - observed in geophysical data	1
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	101
'A3' obstruction recorded as 'Dead' by UKHO and/or VIOE, not visible in geophysical survey data	4
'A3' wrecks recorded as 'Live' by the UKHO and/or VIOE, **outside** of the geophysical survey area	6
'A3' wrecks recorded as 'Dead' by UKHO and/or VIOE, **outside** geophysical survey area	6
'A3' obstructions recorded as 'Live' by UKHO and/or VIOE, **outside** of the geophysical survey area	2
'A3' obstruction recorded as 'Dead' by UKHO and/or VIOE, **outside** of geophysical survey area	3
TOTAL	**123**

8.3.2 A complete list of wrecks and obstructions (**WA7163 – 7269, WA7292 – 7307**) can be found in **Appendix VIII** in **Volume II**. Details about the live and dead wrecks can be found below.

Geophysical Survey Data

8.3.3 Only one wreck (**WA7200**) was located along this section of the route. The structure was identified by all of the geophysical equipment at the known location of the wreck of the *Tringa*, data examples of which are illustrated in **Figure 18**. The wreck site measures approximately 90.7 m x 32.1 m x 4.4 m and is associated with a 64nT magnetic anomaly, and appears badly broken up with little coherent structure remaining, though still exhibits significant height. The structure is orientated approximately NE – SW, and is located in an area with very little superficial seabed sediment so no scour was identified. The *Tringa* was a British steamship measuring 88.7 m in length by 13.1 m in width, with a draught of 5.8 m and 1930 gross tons. The vessel was built in 1925 by Van Der Giesson & Zonen, and had a triple expansion engine of 335 NHP for a maximum speed of 11 knots. At the time of loss, the vessel was owned by British & Continental Steamship Co, and was carrying a cargo of potash and iron ore from Antwerp to Glasgow (Mercantile Marine website).

On 11 May 1940, the *Tringa* was torpedoed and sunk by *U9*, with a loss of the Captain, 15 crew and a Belgian pilot. Six crew were rescued by the Destroyer HMS *Malcolm* and landed at Ramsgate. In May 1940, the wreck's position was estimated from floating wreckage recovered in the areas. In 1944, the wreck was swept clear at 42 feet (12.8 m).

8.3.4 **WA7259** is the recorded location of the wreck of a fishing vessel (also described as 'foul ground' by the UKHO and as a submerged wreck by the VIOE), though it was not identified by any of the geophysical equipment. The wreck is situated right at the edge of the geophysical survey area, so is possibly located just outside of the range of the equipment used. The wreck site was first surveyed in 1952, and again in 1956, 1958, 1979, 1990 and 1995, however, no additional details about the site are provided in the UKHO or VIOE records.

8.3.5 Four previously recorded obstructions (**WA7189**, **WA7206**, **WA7207** and **WA7242**) were also not identified by the geophysical equipment. All are recorded by UKHO as dead and so are probably either ephemeral features that no longer exist or inaccurately positioned obstructions that are actually located elsewhere.

8.3.6 Of the sites, 16 (**WA7163**, **WA7164**, **WA7177**, **WA7182**, **WA7183**, **WA7188**, **WA7191**, **WA7195**, **WA7225**, **WA7228**, **WA7234**, **WA7237**, **WA7256**, **WA7258**, **WA7263** and **WA7265**) have been classified as debris. Out of these, only **WA7195**, **WA7234** and **WA7237** have been found associated with magnetic anomalies and so are interpreted as at least partially ferrous in nature. The rest are likely to be non-ferrous. Most are isolated, angular dark reflectors with large acoustic shadows, many of which are present on the edges of sand waves and so are potentially only small parts of larger buried features. **WA7182**, **WA7237** and **WA7263** are short, curvilinear dark reflectors that could represent short sections of rope or chain or other linear debris. **WA7188**, **WA7191** and **WA7265** are small areas of angular dark reflectors, interpreted as small scatters of debris.

8.3.7 Four long, curvilinear dark reflectors with small shadows have been identified and classified as probable lengths of rope or chain. **WA7247**, **WA7248** and **WA7246** have all been found associated with magnetic anomalies, and so are likely to be lengths of chain, whilst **WA7230** has not and is therefore more likely to be non-ferrous in nature.

8.3.8 **WA7232** is a relatively small, elongated bright reflector without any associated magnetic anomaly. This is of uncertain origin, and could be either a natural feature or non-ferrous debris composed of a material that absorbs acoustic waves rather than reflects them. Similarly, **WA7257** is a small area of seafloor disturbance which could be natural or indicate the presence of buried debris. No magnetic anomaly has been identified associated with this site, so any debris present is likely to be non-ferrous in nature.

8.3.9 Some 22 of the sites (**WA7165, WA7166, WA7168, WA7169, WA7170, WA7171, WA7172, WA7173, WA7174, WA7175, WA7176, WA7178, WA7180, WA7181, WA7186, WA7193, WA7196, WA7199, WA7202, WA7203, WA7266** and **WA7268**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is expected to be non-ferrous in nature.

8.3.10 The remaining 57 sites (see **Appendix VIII** in **Volume II** for full list) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or

multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but 17 (**WA7179**, **WA7185**, **WA7201**, **WA7209**, **WA7210**, **WA7211**, **WA7214**, **WA7215**, **WA7224**, **WA7226**, **WA7229**, **WA7233**, **WA7235**, **WA7240**, **WA7243**, **WA7244** and **WA7245**) are considerably larger and more likely to represent pieces of buried ferrous debris than natural features. **WA7226**, **WA7229**, **WA7243** and **WA7244** are particularly large (109nT, 93nT, 109nT and 83nT respectively) and suggest the presence of large pieces or scatters of debris buried within the seabed sediments.

Live and Dead Wrecks in the Belgian Territorial Waters Study Area

8.3.11 A wreck, possibly the *Mariner* (**WA7292**), sank 17 December 1979 after taking water during a storm while on its way home from a three week fishing trip. The *Mariner* was a Belgian motor stern trawler, built in 1969, with a length of 29.3 m, a beam of 7.3 m, a draught of 3.0 m and a gross tonnage of 150. The ship was powered by a 500 HP engine. The wreck was not found on the initial survey in 1980, however, subsequent surveys the same year located and identified the wreck. A note in 1980 indicates that there was no intention to salvage the wreck. The wreck has undergone further geophysical and diver surveys.

8.3.12 A wreck (**WA7293**) possibly identified as the *A-15* in the UKHO records, is recorded as a very small object, possibly a sunken buoy in the VIOE records. The *A-15* was a World War I German torpedo boat, measuring 41.8 m in length, with a beam of 4.6 m and a draught of 1.5 m. The vessel had a displacement of 137 tons. The *A-15* was an *A-1* class torpedo boat, built by Stettiner Oderwerke, Stettin, Germany, Ships number 668 (Wrecksite website). The vessel was armed with one 5.2 cm SKL/55, two 45 cm T.T., four mines and sweeping material. The vessel had a single propeller, 1.8 m in diameter. The torpedo boat was owned by the Imperial-Kaiserliche (the name for the German Navy between 1903 and 1919). The *A-15* was sunk on 23 August 1915, although the cause of sinking is disputed. The *Warships of World War I* (referenced in the UKHO Record) notes that the *A-15* was sunk by gunfire from British destroyers, however, other sources suggest that it was sunk by gunfire and torpedoes from the French destroyers *Oriflamme* and *Branlebas* (Worldwar1 website, R. Verpoorte, referenced in the UKHO Record). Nine crew were rescued near the Oostendbank by *A-12*.

8.3.13 The *Empire Path* (**WA7294**) was a British steam ship that measured 123.7 m in length, with a beam of 16.2 m, a draught of 10.1 m and was 6410 gross tons. The vessel was built by Readhead John & Sons Ltd (Readhead Standard Design), South Shields, as part of the Liberty EC2-S-C1 class (Wrecksite website). John Readhead started the shipbuilding company in 1865, and built the *Empire Path* in 1943 (John Readhead website). The ship had two oil-fired boilers, a triple expansion steam engine, single screw propulsion and 2,500 HP. The ship first operated for the Moller Line which was founded in 1882 in Shanghai (Wrecksite website). At the time of loss, the vessel was armed with a single stern mounted 4”/102 mm deck gun, and was owned by the Ministry of War Transport (MOWT) of London. From November to December 1944, the ship sailed from London through the Scheldt and arrived in Antwerp, Belgium and unloaded its cargo. On the 24th December 1944, the vessel left to return to the UK, but was mined by a ratchet mine in the Scheldt Estuary off Ostend while in ballast. Five people were killed. The survivors (44 crew and 10 DEMS gunners) were taken to Ostende and billeted in an army transit camp and on 27 December, they were taken by LST back to England (Gordon Mumford website). A book about the wrecking has been written by one of the survivors of the incident: *The Black Pit and Beyond* (Mumford 2000). The *Empire Path* had sunk almost on top of the *Boscobel* (**WA7302**), and initial survey reports in 1945 indicated that two

masts were visible above high water. On 5 July 1945, the *Emeraude* collided with part of the wreckage and wrecked nearby. In order to prevent further accidents, the *Empire Path* wreck site was levelled with dynamite (Gordon Mumford website) and in 1953, the wreck was drift swept clear at 28 feet (8.5 m). The wreck lies on a seabed of even sand, and in 1953 there was no scour around the wreck. In 1961, salvage operations were completed and the wreck was swept clear at 15 m. A 1996 geophysical survey indicated that the wreck was in two pieces.

8.3.14 An unnamed wreck (**WA7295**) surveyed in September 2010 has recently been added to the UKHO wreck database. No other data is presently available.

8.3.15 The *Gold Shell* (**WA7296**) was a British motor tanker measuring 137.5 m in length with a beam of 8.9 m and a draught of 10.4 m. The *Gold Shell* was built in 1931 by Bremen Vulkan, a German shipbuilding company, and at the time of loss was owned by Anglo-Saxon Petroleum Co. (Shell/British Petroleum). The vessel had an oil engine of 714 NHP for a speed of 12.5 knots. The vessel had a gross tonnage of 8208 and was carrying 8300 tons of high octane fuel when it was mined or torpedoed on 16 April 1945. 35 men were lost. The tanker had been part of convoy ATM 126, consisting of 30 ships, en-route from England to Antwerp (Wrecksite website). During the war, tankers were priority targets for enemy attacks, and they were described as 'floating volcanoes' when transporting fuel (mercantile-marine.org website). The *Gold Shell* is just one of 44 British Petroleum tankers sunk during the war, and of the 44 British Petroleum tankers, 657 crew were lost and with 260 others taken prisoner of war (British Petroleum website). The wreck has been surveyed a number of times since 1945, and in 1960 a salvage operation was undertaken. It is now recorded as a live foul on Belgian charts, however, as wreck material likely still remains on the seabed, it is considered a live wreck for this assessment.

8.3.16 The following wrecks are considered to be 'dead' by the UKHO as they have not been discovered during recent surveys. However, as the wreck material could be buried or material could remain on the seabed from salvaged or dispersed wrecks, they are included here.

8.3.17 The record of the SS *Kilmare* & *West Hinder* LTV (**WA7299**) comprises the loss locations of two vessels. In 1905, records indicate that a vessel reported hitting an obstruction in the area, and in 1906 a wreck with mast still showing was reported, thought to be the SS *Kilmare*. The *West Hinder* LTV sunk in the area on 14 December 1912, and in 1913, the SS *Wiedand* reported hitting a wreck. There are numerous wrecks and obstructions known to exist in the vicinity, and the UKHO record was amended to 'several obstructions hereabouts'. In 1930 the record was amended to 'dead'.

8.3.18 The *FL5* German motor launch (**WA7300**) has been described as a remote controlled vessel that sank on the 25th September 1916 following a fire (R. Verpoorte referenced in UKHO record). The *FL5* had petrol engines of 420 HP capable of 30 knots and twin screw propulsion. The vessel measured 13.3 m in length, 1.8 m in breadth and had a 6 ton displacement. The area was surveyed in 1969 and the record was amended to 'for filing only'.

8.3.19 The *FL8* (**WA7301**) was a German motor launch 13.3 m in length, 1.8 m in width with 6 ton displacement. The vessel was described as a remote controlled vessel that was sunk by gunfire during an attack by a British monitor (R. Verpoorte, referenced in UKHO record). The launch had petrol engines of 420 HP capable of 30 knots and twin screw propulsion. The vessel sunk the 6th September 1917. In 1969, the record was amended to 'for filing only.

8.3.20 The *Boscobel* (**WA7302**) was a British Coaster of 232 gross tons carrying a cargo of pig iron or iron fence wire when it foundered on the 29th May 1937. It was lost near Wanelaar Lightship while on passage from Antwerp for London. The *Boscobel* was built as a steel steam trawler in 1906 by J. Duthie & Sons, Aberdeen for Tettenhall Steam Fishing Co of Fleetwood Ltd (Aberdeen Ships website; Fleetwood Trawlers website). The yard's output from the 1880s onwards was mostly trawlers, and the yard closed in 1907. In 1913 *Boscobel* was mortgaged to J. Marr & Son Ltd, Fleetwood, and in 1914, the tonnage was altered to 92.13 net under provision of the Merchant Shipping Act 1907. In 1915, the vessel was requisitioned and converted to a minesweeper. In 1918, *Boscobel* was sold to the Active Fishing Co Ltd, Fleetwood, then sold in 1928 to Thomas Walker & John Falconer, Aberdeen, and again in 1934 to John W. Johnstone, Aberdeen. In 1934 the vessel was converted to a cargo vessel. The record was charted in 1937, but was amended to 'dead' in 1962.

8.3.21 A yacht (**WA7303**) is recorded to have sunk in the vicinity – 285 degrees / 725 m from Promenade Pier, Blankenberge. The record was created in 1974 when the site was marked with a buoy.

8.3.22 The *Saint Patrice* (**WA7306**) was a British steam tanker built in 1920 by Antwerp Engineering Co, Hoboken for Societe Navale de L'Ouset, Harve (Wrecksite website). It measured 87 m in length and 14 m in width, with gross tonnage of 1968 tons. The vessel had a triple expansion engine with single screw propulsion and a maximum speed of 11 knots. On the 17th June 1923, the vessel ran aground. In 1972, a small wreck in two pieces was found during survey work for a proposed cable route. Later surveys in 1972 and 1973 did not relocate the wreck, and the record was amended to 'dead'. In spite of this, a diver has reported that he has recovered the bell near the wreck's original location (Wrecksite website), suggesting that more wreckage could still remain on the seabed.

8.4 POTENTIAL

Submerged Landscapes

8.4.1 There is high potential for the discovery of submerged prehistoric material dating from the Palaeolithic to the Mesolithic. Palaeozoological remains have been discovered in Belgian waters, and are particularly frequent between the Brown Bank and the Deep Water Channel (Pieters *et al.* 2010: 181-184). Although there have not yet been any discoveries in Belgian waters of hominin remains or worked flints, a worked core dating from the Palaeolithic to Neolithic has been recovered from Dutch waters, and there are numerous finds of lithic artefacts on Belgian beaches.

8.4.2 The extent of the drowned landscape and evidence for palaeochannels has been revealed by archaeological assessment of geophysical and geotechnical data. Core **VC-0046** contained an isolated sedimentary unit cutting into the top of **Unit 3**, which has been interpreted as part of a terrestrial palaeochannels system created during a period of low sea level and could potentially contain both *in situ* and derived archaeological material. In addition, sedimentary **Unit 2,** (exhibited in **VC WA VC3**) which has been interpreted as a terrestrial palaeochannel deposit of post-Devensian age, is also considered to be of possible archaeological and palaeoenvironmental potential.

8.4.3 The archaeologically interesting material in core **VC WA VC3** was located relatively close to the surface of the seabed (0.29 m below seabed), indicating the high potential for the discovery of additional archaeological and palaeoenvironmental material along the cable route trench in this area.

8.4.4 Even within the historic period, the land surface extended into what is now the intertidal zone. Roman artefacts and structures have been observed 266 m into the intertidal zone, and indicate the potential for further discoveries of archaeological sites and material in a now drowned landscape.

Shipwrecks

8.4.5 Searches of Belgian data did not reveal an easily accessible 'Recorded Losses' dataset indicating ships recorded as having been lost off the coast through history, and therefore, as the information would be costly and time consuming to obtain, it has not been included in this section. However, despite not having names and dates of ships lost off the coast, it is still possible to provide an overview of the types of ships, shipping hazards, and areas of potential for the discovery of shipwrecks.

8.4.6 These waters have been busy with shipping traffic from the Neolithic to present, as indicated in the **Regional Archaeological Overview** however, the majority of known wrecks in the area date to the modern period. It is difficult to discover post-medieval and earlier wrecks on the seabed, as they are generally made of wood and buried beneath the seafloor, making them difficult to detect by magnetometer, sidescan sonar or other means (Pieters *et al.* 2010: 197). However, the discovery of Roman pottery on Kwinte Bank (Wessex Archaeology 2008), Roman roof tiles from Wenduinebank or Smal Bank (Pieters *et al.* 2010: 187), and medieval pottery from Wenduinebank (*ibid:* 194), could indicate the presence of shipwrecks, and highlight the potential for further discoveries of all periods in the wider area.

8.4.7 Most of the known shipwrecks are modern, and have arrived on the seabed as a result of warfare, although it remains to be seen whether this conclusion can also be inferred for earlier periods (Pieters *et al.* 2010: 197). There were numerous losses during the two World Wars, and as Pieters notes, earlier maritime engagements in the area, such as the Battle of Damme (English vs French 1213), could have also resulted in a number of losses.

8.4.8 The intertidal zone comprises considerable tidal flats and the banks offshore could constitute navigational hazards. There are also likely hazards associated with the approaches to the Zeebrugge harbour. Additionally, the geology in these areas indicates that they could represent areas with high levels of preservation, and therefore much of the area can be considered an Area of Maritime Archaeological Potential.

8.4.9 The seabed in the Belgian Waters Study Area comprises areas of sand waves up to a few metres in height, which could potentially cover archaeological material such as shipwrecks.

8.4.10 Other material related to maritime activities, although not constituting actual shipwrecks includes an ammunition dump in an area off Zeebrugge called the 'Paardenmarkt' (the horse market).

Aircraft Crash Sites

8.4.11 There is considerable potential for aircraft crash sites relating to the two World Wars, as indicated by the **Regional Archaeological Overview**. Additionally, aircraft, like wooden shipwrecks, can be difficult to detect on the seabed through geophysical or other survey methods.

8.4.12 The seabed in the Belgian Waters Study Area comprises areas of sand waves up to a few metres in height, which could potentially cover archaeological material such as aircraft crash sites.

8.4.13 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

9 BELGIAN LANDFALL – KNOWN AND POTENTIAL TERRESTRIAL ARCHAEOLOGY

9.1 INTRODUCTION

9.1.1 The Belgian Landfall Study Area comprises an irregular polygon surrounding the cable route landfall variations, and includes an approximately 6 km stretch of beach from Zeebrugge to just beyond Blankenberge and extending inland approximately 1 km from Mean High Water. (**Figure 19**).

9.2 GEOLOGY

9.2.1 The geography of West Flanders comprises a coast that extends along the Southern North Sea, with a flat polder landscape inland. The dune area and adjacent low polders at Wenduine-Uitkerke have been hydrogeologically and hydrogeochemincally investigated (Walraevens *et al.* undated). The dune belt between Wenduine and Blankenberge measures no more than 50 m in width. The polders inland are of two types: those which are located at former creeks where Dunkerque clay was deposited on the sand of the creek, and the lower clay-on-peat sediments also known as 'pool grounds' (*ibid*).

9.2.2 The Tertiary surface of the Polder of Uitkerke was originated by Early Pleistocene erosion (Saalian).

9.2.3 The Quaternary geology developed during the Eemian interglacial stage (130,000 – 114,000 BP), when the Oostende sediments were deposited, comprising gravel sand and shell. Late Pleistocene sediments include the deposit of Uikerke (sand) and the deposit of Wenduine (sand and gravel). The Pleistocene was followed by a period of peat growth that was later eroded during the Flandrian Transgression. Deposits from the Flandrian Transgression include the deposit of Calais, which comprises a sandy deposit of Houtave (base) and a deposit of Zuienkerke (top) which has a sandy character but also contains some clay.

9.2.4 The peat at Nieuwmunster formed behind the dune belt and was progressively removed by the Dunkerque Transgressions, in particular, the Dunkerque II transgression not only removed the peat, but formed creeks at Wenduine and Blankenberge The creek beds remain as 'creek ridges' (clay on sand), where formerly lower level sites are now higher than their surroundings. More recent changes to the local relief occurred from the medieval period through to the late 19th century as a result of peat digging, and clay digging for bricks. A practice which took place up to the middle of the 20th century.

9.2.5 Along the coast, the surface geology largely comprises dune systems which have accreted since the medieval period. Around the River Ijzer, on the west, deposition takes place and the coast builds up slowly, while on the east the coast gradually retreats (Pieters *et al*. 2010).

9.3 KNOWN SITES

9.3.1 The known sites and findspots in the Belgian Landfall Study Area has been compiled using data from the CAI (Central Archaeological Inventory) database from

the VIOE, and is summarised in **Appendix IX** in **Volume II**. In addition, findspots of archaeological material on the beaches have been derived from the 'De Noordzee' chapter in *Relicta 6* (Pieters *et al.* 2010: 177-218) (**Figure 19**).

Prehistoric Period

9.3.2 Flint material has been recovered from the beaches at Wenduine and Blankenberge, although the find from Blankenberge could be natural (Pieters *et al.* 2010: 183). It is not known to what extent beach replenishment could be responsible for the location of finds on the beach, however, if beach replenishment is actively ongoing, some of the discovered finds could derive from the dredged or quarried sand and gravel deposits located elsewhere.

Roman Period

9.3.3 The Belgian Landfall Study Area demonstrates a small but obvious occupation during the Roman Period. The most preponderant example is the remains of the floor of wooden building made of baked tiles (**WA1301**) at Harendjke in the county of Blankenberge. Other evidence of the Roman presence includes finds of fragments of pottery, which have been identified as Terra Sigillata (**WA1325, WA1326**) or contemporary with the Camp Esmeralda (**WA1301**), and a Roman fire place dated approximately from the 2nd century AD (**WA1302**).

9.3.4 Scatters of Roman pottery fragments have been reported from the beaches at Zeebrugge, and the recent find of a young man's jaw bone has been dated to the 4th century (Pieters *et al.* 2010: 193).

9.3.5 The beach of Wenduine is well known for discoveries of Roman artefacts, and these may indicate material from a Roman settlement going back to the Flavian period (Pieters *et al.* 193). It is thought that Wenduine had even developed into an important trade centre, and the finds from this area are notably richer than at other locations on the coast.

Medieval Period

9.3.6 The medieval period is well represented within the extent of the Belgian Landfall Study Area. This period is identified with the presence of several concentrations or isolated instances of pottery of the type Verhaeghe Group A (**WA1303, WA1325, WA1326, WA1327, WA1329**).

9.3.7 There is also evidence for medieval dykes (**WA1311**, **WA1312**, **WA1313**). The first dyke on the beach was constructed around 1200 (Administratie Waterwegen en Zeewezen information plaque). However, it was not strong enough to prevent flooding from the sea. A new dyke was constructed in the 14th century, however, this dyke was in danger of flooding as well. In the 15th century, the inhabitants of Polderland built a new dyke, 'Graaf Jansdijk', running parallel to the previous one. This formed a system of double dykes, consisting of a 'watcher' (the original sea wall) and a 'sleeper' (the new rear dyke). As a result of the construction of these dykes, dunes were established on the foreshore.

9.3.8 A series of sites with moats (**WA1306**, **WA1307**, **WA1308**, **WA1309**, **WA1310, WA1330**), and a flattened mound (**WA1320**) are also located within the Study Area. Additionally, occupation locations encompass sites of former medieval farms such as **WA1305**, **WA1314**, **WA1315**, **WA1331**, **WA1332**, and **WA1333**. The last two examples were still in use up to the post-medieval period.

9.3.9 Late medieval coastal settlements are also indicated by archaeological finds from the beaches and adjacent areas of Wenduine (Pieters *et al.* 2010: 195).

9.3.10 Other medieval structures within the study area consist of a mill (**WA1318**), a waste well (**WA1304**), a tannery craft place (**WA1316**), a footbridge (**WA1317**), a Motte Castrale (**WA1328**), a lock which continued to be used throughout the post-medieval period (**WA1334**), and a fortress associated with farm and a circular moat (**WA1328**). Small finds from the Belgian Landfall Study Area comprise medieval faience pottery (**WA1306**), roof tile (**WA1306**), Verhaeghe Group A pottery (**WA1325**, **WA1326**, **WA1327**, **WA1329**), Badorf type pottery (**WA1326**, **WA1327**).

9.3.11 A reconstruction of the Schelde Estuary around 1300 shows that the former coastline between Blankenberge and Knokke was located further seawards at present, and the 'Vlaakte van de Raan' northwest of Zeebrugge is likely to derive from this situation (Pieters *et al.* 2010: 195).

Post-medieval Period

9.3.12 The post-medieval period at the Belgian Landfall Study Area is sufficiently well represented. Several sites show the remains of occupation such as a homestead (**WA1321**), a 17th century non-walled farm (**WA1323**), and a 16th century farm (**WA1324**). Other structures include a brickyard (**WA1322**), a well (**WA1319**), and a flattened mound (**WA1320**).

9.3.13 Some isolated finds also show evidence of post-medieval activity such as fragment of Raeren Majolica stoneware (**WA1331**) and various fragments of pots, dishes, barrels, and faience (**WA1332**).

Undated

9.3.14 Known sites that do not have dates indicated in their records include a brickyard (**WA1335**), a water place (**WA1336**), and a farmhouse (**WA1337**).

9.3.15 Human bones of unknown date have also been recovered from the beaches of Zeebrugge (Pieters *et al.* 2010: 201)

Walkover Survey

9.3.16 A walkover survey was conducted in October 2010. The walkover survey started from the 20th century Belgian Pier of Blankenberge (**Plate 9**) in the NE direction towards to western side of Zeebrugge port. The walk was conducted on the sea shore first from west to east and then again on top of the dykes (sand dunes) from east to west.

9.3.17 During the course of the walk, apart from the 15th century dykes/dune systems (**Plates 10 - 14**), no other artefacts or monuments of archaeological interest were observed. The only features present are two low elevated stone and concrete longitudinal structures located in the intertidal zone (**Plates 15** & **16**) (approximately 200 to 300 m east of the Belgian Pier of Blankenberge), which have been identified by VIOE staff members as a breakwater from the 1960's, apparently very common all along the Belgian coast.

Potential

9.3.18 There is high potential for the discovery of archaeological sites and material dating from the Palaeolithic to the present, as illustrated in the **Regional Archaeological Overview**. Lithic finds are frequently discovered on Belgian beaches, and the Neolithic to Iron Age discoveries from Raversijde indicate that further finds could be expected (Pieters *et al.* 2010). Roman finds are also regularly discovered on the beaches near Raversijde-Mariakerke and Wenduine, and reports from the first half of the 20th century suggest that peat banks were visible in the intertidal zone or sometimes covered by sand (Pieters *et al.* 2010: 192), indicating the potential not

only for the discovery of material, but also the potential for a high level of preservation.

9.3.19 There is also potential for medieval finds, as indicated by the discovery of medieval material in Middelkerke and Raversijde revealed by coastal erosion. Medieval material associated with the construction of the dykes could also be discovered. The potential for post-medieval and modern material relating to the use of the beaches, maritime trade and military activity to survive must also be considered.

9.3.20 From time to time, there have been discoveries of human remains on Belgian beaches, such as at Zeebrugge, Nieuwport, Middelkerke, Raversijde, and at sites such as Mariekerke, Bredene, and De Haan (Pieters *et al.* 2010:201). These finds suggest the possibility of additional discoveries during construction work.

10 IMPACT ASSESSMENT

10.1 DESCRIPTION OF POTENTIAL IMPACTS

10.1.1 The assessment of impacts has been based on the project overview (PMSS 2010 Version 1). There is potential for impact to the known and potential archaeological receptors from route preparation, construction, operation and decommissioning activities.

10.1.2 The possible impacts on known and potential archaeological receptors comprise damage or destruction to both archaeological material and the disturbance or destruction of relationships between material and the wider surroundings. Archaeological receptors include: known and potential terrestrial sites and findspots, submerged prehistoric archaeological material (including palaeoenvironmental evidence), shipwrecks, aircraft crash sites, associated material, and geophysical anomalies of possible anthropogenic origin.

10.1.3 The types of impacts can be described as direct, indirect, secondary and cumulative. Direct impacts are those that directly impact archaeological receptors on or under the seabed. Indirect effects are those beyond the primary footprint of the development, affecting archaeological sites or deposits that are located some distance away, for example as a result of changes to erosion/sedimentation regimes. Secondary impacts arise from activities that occur as part of the development process but might not be considered to be part of the development as such, for example from anchorages for construction vessels. Cumulative impacts include: impacts occurring over a wider area as a result of various development activities; impacts within the development that affect different environmental topics; and visual impacts / changes to setting.

10.1.4 The optimal cable route has been determined based on an initial feasibility assessment undertaken by Metoc in 2007, followed by an assessment of comparative cost analysis and a review of consenting requirements, and an engineering study. All known wrecks were avoided.

10.1.5 The most likely cable system configuration is the bipole system, where cables are installed in a bundled configuration in the same trench, with no separation between them (PMSS 2010).

Construction

10.1.6 There is potential for direct and secondary impact to archaeological receptors from route preparation activities, including:

- Use of grapnel hook dragged across the seabed to clear out-of-service telecommunications cables that cross the cable route;
- Construction of bridging and separation structures over any pre-existing cables and pipelines that the Nemo cable route crosses. Typically crossing designs involve placement of crushed rock on the seabed above the crossed asset by a specialist vessel that uses a fall pipe to precisely guide the rock to the seabed. Alternatively, 'link-lock' type mattresses could be used. The footprint of cable crossings will be circa 100 m by 30 m;
- Cutting trenches in areas of the seabed where bed rock (such as chalk) is present. It is possible that the trench can be cut during cable laying, alternatively a specialist rock cutting plough will be used. Archaeological receptors in the sediment above bedrock could be impacted;
- Pre-sweeping by dredging to reduce the height of sandwaves because they inhibit burial equipment and, if mobile, decrease the efficacy of burial. The pre-sweeping would normally be carried out by trailing suction hopper dredgers (TSHD) that shave off the crest lines of sandwaves and create a flatter path for a burial machine to move along. Sandwaves are areas of high archaeological potential, possibly covering wreck material. The width of the path would vary, but could be 10 m to 20 m. If adopted, pre-sweeping would be undertaken just a few days in advance of cable laying operations to ensure the dredged path remains open for the installation. The resulting spoil volumes from pre-sweeping are typical of dredging operations for channel or port maintenance and therefore relatively small. It is assumed that spoil will be deposited back on the seabed in the immediate vicinity.

10.1.7 There is also potential for direct and secondary impact to known or potential archaeological receptors during the intertidal and subtidal cable laying:

- Cables will be buried into the seabed either by a plough or trenching machine, with three generic types of equipment possibly to be used: ploughs (towed), jetting machines (towed, free swimming or tracked), and mechanical trenchers. Cable will be buried to a depth of circa 1 – 2 m. Based on current burial technology, it is estimated that the maximum footprint of the burial machine will be 10 m and the footprint of the trench will be between 1 – 5 m.
- Where joints are required between cable sections, the joints will be made on board the cable lay vessel or barge, during which time the vessel is likely to anchor in position.
- There is also potential for impact where the Cable Laying Vessel (CLV) has to anchor for other reasons. Cable laying in deep waters will be undertaken by a Cable Laying Vessel (CLV), likely employing simultaneous lay and burial. These vessels can operate between the 10 m depth contours on either end of the route.
- In shallower waters, there would be additional impact along the cable route, as the main CLV would not be capable of approaching close enough to the beach, so a shallow water spread would be needed. Shallow water spreads are normally based on flat-top pontoon barges that can be fitted with all necessary cable storage and working gear. A four to six point mooring system will be used to manoeuvre the barge during cable work.

10.1.8 At the landfall installation, activities that could impact the known or potential archaeological receptors are dependent on the type of method used for cable laying. The options are:

- Open cut, using mechanical excavators; which is often the most straightforward option;
- Coffer dam which is similar to open cut but with sheet piling used to support the trench walls; or
- HDD where a drill is used to install conduits from dry land to a point further down the foreshore. This would probably also require a cofferdam.
- Sometimes a combination of all three techniques is needed because of the physical conditions, environmental sensitivities or the preferences of regulators or curators. Based on previous work at Richborough by the Thanet Offshore Wind Farm operations, a marine burial cable will likely be possible between 1.5 - 2.0 km from the beach. Inshore of this, the Thanet cables were mostly buried using the land based spider plough, with the last 100-200 m being trenched with tracked excavators.

10.1.9 The construction of converter stations located onshore could also have direct, secondary and cumulative/visual impacts on the known and potential terrestrial archaeological receptors. Although the proposed location in the UK is likely to be the already existing disused Richborough Power Station, which would minimise impact, there would still be impact from the development of a cable route to the converter. In addition, the converter station in Belgium, and associated cable route link, is still being discussed.

Operation

10.1.10 Following installation, routine maintenance work to the cables is not anticipated, however, some work may be required to maintain the burial of the cable (PMSS 2010). Routine survey of the cables is not normally required as the subsea cables will be designed to require minimum maintenance. However, in areas of high seabed mobility, or if post-installation changes in the natural or manmade environment are perceived to have occurred (for example through nearby dredging activity), survey of specific areas of the Nemo cable route may be initiated.

10.1.11 Cable repairs are predicted to be infrequent, and the most common reason for repair will likely be due to damage caused by trawlers and commercial ship's anchors. A repair would typically be carried out by a single vessel. The phases of a repair operation that could impact on archaeological receptors are: cable de-burial, cable recovery, cable re-deployment onto the seabed and reburial.

10.1.12 Additionally, there is the potential for direct and secondary impact from the anchorages of repair vessels during operation.

10.1.13 Potential indirect impacts include changes to the erosion and sedimentation regime in the area. The majority of cable will be buried, so this will not be an issue, however, at cable crossings, the cable could be lifted far enough off the seabed to result in changes to local erosion and sedimentation regimes.

Decommissioning

10.1.14 Should decommissioning be required, the operation will be planned and conducted according to the standard industry protocol at the time (PMSS 2010). The objectives of the decommissioning process will be to minimise both the short and long term effects on the environment while making the sea safe for others to navigate. Based on current regulations and available technology, the following decommissioning is expected:

- Cable system – to be either removed or to be left safely *in situ*, buried to below the natural seabed level;
- Mattresses – to be left *in situ*;
- Scour protection material – to be left *in situ*

10.1.15 Should the cables be decommissioned, the following operations would typically take place. The cable would be exposed using a gripper or cable 'under-roller', and the cable recovery process would essentially be the reverse of the cable laying operation. After decommissioning, it is expected that the survey route would be surveyed to ensure all cable had been removed.

10.1.16 Potential direct/secondary impacts could result from the removal of the cable system and the anchorages of the cable removal vessels.

10.1.17 Onshore decommissioning operations have not yet been determined, however, they would also be planned and conducted according to the standard industry protocol at the time.

10.2 IDENTIFICATION OF EFFECTS

10.2.1 The assessment of effects is based on the methodology set out above. This section provides a detailed discussion of the impacts and effects, and a summary is provided at the end of the section in **Table 12.3**.

10.2.2 As a result of pre-construction, construction, operation and decommissioning impacts, the following effects are possible:

- Potential damage or destruction of known marine or terrestrial archaeological receptors (terrestrial sites and findspots; submerged prehistoric archaeological material; shipwreck; aircraft crash sites; associated material; and geophysical anomalies of possible anthropogenic origin) from direct or secondary impacts;
- Potential damage or destruction of potential marine or terrestrial archaeological receptors from direct or secondary impacts;
- Potential damage or destruction of the relationships between known or potential marine or terrestrial archaeological receptors and their wider surroundings;
- Potential damage or destruction of marine archaeological receptors as a result of indirect impacts, in particular changes to erosion and sedimentation regimes;
- Potential negative effects resulting from the visual impact of the converter stations and impacts on the concept of setting;
- Potential cumulative effects from a combination of seabed developments being undertaken in the area (ie: other cable routes, offshore wind farm developments, port / harbour dredging, etc).

Nature / Magnitude of Impact

10.2.3 The nature or magnitude of the potential impacts has been assessed based on their likelihood, spatial extent, level of change and duration. Sensitivity, recoverability and Importance are dealt with in **Descriptor of Receptor** below.

Likelihood

10.2.4 The Nemo Project Design (PMSS 2010) has indicated that all known wrecks will be avoided. Therefore, the likelihood that known wrecks will be impacted by the cable route construction is unlikely.

10.2.5 However, archaeological interpretation of geophysical and geotechnical data has indicated a number of geological features of potential archaeological interest along the proposed cable route, including the submerged terrestrial/estuarine deposits and palaeochannels identified in the UK and Belgium sectors, and the likelihood of impact is possible to certain. In particular, the archaeologically interesting sedimentary unit identified in **WA VC3** was situated between 0.29 m and 5.6 m below the seabed, and therefore is certain to be impacted by cable installation. The archaeologically interesting material from **WA VC7** was located 4.28 m below seabed and is unlikely to be impacted by the cable route, however, shallower sediments could be impacted.

10.2.6 The likelihood for secondary impacts on the known archaeological receptors from anchorages of construction vessels or other ancillary development activities is possible.

10.2.7 In addition, many areas of the cable route have high potential for the discovery of previously unreported archaeological material, and therefore it is possible that previously unknown archaeological receptors could be affected by direct and secondary impacts.

10.2.8 It is possible that impacts could occur that would damage or destroy relationships between archaeological receptors and their wider surroundings.

10.2.9 Indirect impacts, resulting from changes to the sedimentation and erosion regimes are unlikely to occur, as any changes to the regimes are expected to be within the natural variation of the baseline.

10.2.10 There will be temporary visual impact during the construction phase, however, this is unlikely to be significant as the marine area comprises a busy shipping lane and both terrestrial landfalls are urban in character with modern developments and construction activities. The likelihood of more permanent visual impact at the Landfalls will depend on the location of the converter station. At the Kent Landfall, the reuse of the Richborough Power Station will be unlikely to impact the setting of terrestrial archaeological receptors in the area. However, as the converter station at the Belgian landfall has not yet been identified, it is not possible to comment on the likelihood of impact.

Spatial Extent

10.2.11 The proposed development plan involves the emplacement of a cable the length of a long section of the seabed, and although impact along the route will be extensive, there will be limited impact laterally and vertically.

10.2.12 The overall quantity of seabed impacted by the Nemo cable route is low when examined in a regional context, and the direct or secondary impacts are expected to be within the immediate vicinity.

10.2.13 There is a slight possibility that the construction of bridging and separation structures could result in changes to erosion and sedimentation regimes, but if these occur, they would be expected to be local.

10.2.14 The damage or destruction of the relationships between known or potential archaeological receptors and the wider environment would have a regional spatial extent. Archaeological receptors have relationships not only with material in the immediate vicinity, but also with receptors of a similar date range or site type across a much wider area – with regional, national, and sometimes even international connections.

10.2.15 As the proposed converter station at the Kent Landfall already exists, there would be no additional visual impact. However, as the converter station at the Belgian Landfall has not yet been determined, its impact could have a local spatial extent.

Level of Change

10.2.16 The level of change of known and potential archaeological receptors from direct and secondary impacts would be high, as any change would be considerably more than what is predicted as part of the natural baseline. In addition, as will be discussed below, the recoverability of the archaeological receptors is low, which increases the significance of the high level of change.

10.2.17 The damage or destruction of relationships between known or potential archaeological receptors would be medium to high. Many of the changes may only be noticeable or measurable against the overall archaeological baseline, however, for sites of high interest with strong relationships to other receptors, the change would be high.

10.2.18 Indirect impacts such as increased sedimentation or erosion are expected to be unlikely, however, even localised erosion could expose archaeological material and lead to degradation that would be large compared with the natural variations in the baseline. Increased localised sedimentation, from changes to sedimentation regimes or dredge plumes, could afford temporary additional protection to archaeological receptors

10.2.19 The level of change for the visual impact at the Kent Landfall will be low as a pre-existing building is being used, however, it is not yet possible to determine the level of visual impact at the Belgian Landfall, and depending on the selection of converter station location and building type, it could be anything from low to high.

Duration

10.2.20 The key consideration when examining the nature or magnitude of impact with regard to archaeological receptors is that all damage or destruction to archaeological receptors through direct, secondary or indirect impacts is permanent. The historic environment is a non-renewable resource, and once an archaeological receptor has been damaged or destroyed or its context altered, it is not possible to repair or reinstate the lost value. Hence, the impact from a temporary anchorage is of the same magnitude as the impact from cable installation.

10.2.21 The visual impact of construction activities would be short term, lasting for the length of the construction period. In contrast, the visual impact of the converter stations would endure for at least the length of the Nemo cable operational phase. For the pre-existing Richmond Power Station at the Kent Landfall, the impact has already occurred. However, structures built for the Belgian Landfall would last for the length of the Nemo cable operational phase and may not be removed during deconstruction. Therefore, the duration of impact at the Belgian Landfall would be long term.

Magnitude of Effect

10.2.22 The unmitigated magnitude of direct or secondary impacts on known or potential archaeological receptors during pre-construction or construction activities would be severe, as the level of change would be high and the impact permanent.

10.2.23 The visual impact of the construction activities is expected to be low, as the marine area is already a busy shipping channel and the landfalls are modern urban areas where modern construction activities are not unknown.

10.2.24 The magnitude of the long term visual impact on the terrestrial archaeology at the Kent Landfall will likely be low as the converter will likely be the disused Richborough Power Station. However, the magnitude of visual impact related to the converter at the Belgian landfall cannot yet be determined until further details become available.

10.2.25 The magnitude of the indirect impacts will likely be low to moderate. Any changes in scour or sedimentation will likely be very localised, and changes are probably likely to remain within natural variations. However, if scour or erosion resulted in damage or destruction to archaeological receptors, the effects could be severe. Increases in sedimentation could positively affect the archaeological receptors by providing additional protection.

10.2.26 The magnitude of direct impacts on known or potential archaeological receptors or the relationships between the receptors and the wider surroundings from repairs during operation or from decommissioning activities will likely be low to moderate, as any archaeological receptors within the immediate vicinity of the cable route will likely already have been affected.

10.2.27 However, the secondary impacts of anchorages of vessels during operation, repairs or decommissioning, on known and potential archaeological receptors and relationships between receptors and the wider surroundings has the potential to be severe.

Description of Receptor: Sensitivity and Recoverability

10.2.28 All archaeological receptors have the potential to be damaged or destroyed if they are exposed to direct or secondary impacts during seabed preparation, construction, operation or decommissioning activities associated with the Nemo cable route. As such, all sites and material should be regarded as vulnerable and of high sensitivity.

10.2.29 All damage to archaeological receptors would be permanent, and recovery is limited to stabilisation or re-burial limiting further impact. As such recoverability should be considered low. Additionally, any visual impact from the converters at the landfall would endure for at least the entire period of operation, and as structures could be left standing during decommissioning, the impact could be permanent. As such recoverability should be considered low.

Description of Receptor: Importance

10.2.30 The following section assesses the general importance of the archaeological receptors based on available guidance, as discussed in the methodology section.

Statutory Restrictions

10.2.31 Pegwell Bay is part of the Sandwich Bay to Hacklinge Marshes Natural England Site of Special Scientific Interest (SSSI), and is important not only for its biodiversity but also for its geological interest.

10.2.32 In the Kent Landfall Study Area, there are two Listed Buildings, **WA 1039** and **WA1040**.

10.2.33 There are no sites in the English Waters, French Waters, Belgian Waters or Belgian Landfall Study Areas that are currently subject to statutory protection.

10.2.34 However, there is a known report of a German World War II aircraft in the intertidal zone of Pegwell Bay, a Recorded Loss of a British World War II aircraft (**WA1235**) and considerable potential for the discovery of additional aircraft crash sites in the Study Areas. If the remains of any UK military aircraft were to be discovered, whether in English waters or in international waters, they would automatically be protected under the Protection of Military Remains Act (1986). These archaeological receptors would be of high importance.

10.2.35 British vessels in military service at their time of loss (such as **WA7141, WA7289,** and **WA7294**) could be considered for designation under the Protection of Military Remains Act (1986), whether in British waters or international waters.

Importance of Known or Potential Terrestrial or Submerged Prehistoric Receptors

10.2.36 Until recently in Belgium the integration of archaeological values in spatial planning legislation, guidelines and frameworks has been limited to those protected by legislation, such as protected archaeological zones or monuments (Meylemans *et al.* 2005), and there are no European Union (EU) directives covering cultural heritage or the historic environment with regards to establishing value. In 2006, recommendations were made for the development of consistent approaches and techniques for valuing cultural heritage assets (Jones *et al.* 2006: 46). In the UK, the criteria for scheduling ancient monuments is based on a site's period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential.

10.2.37 Although the majority of known sites at the Landfalls are not designated or scheduled, this does not mean that they lack importance, and they may in fact fulfil many of the criteria. The fact that they are included in the National Monument Record, Historical Environment Record, or Centrale Archeologische Inventaris indicates that they have at least some value as historic and archaeological resources.

10.2.38 Despite the fact that there are no known archaeological sites or material that date to the Palaeolithic, if any remains were to be discovered, they would be of considerable national and international importance, as finds from this period are relatively rare in the British and European records (English Heritage 1998). In Belgian waters, the discovery of palaeozoological remains are considered important, because although they do not demonstrate direct interaction between our human ancestors and animals, they are nevertheless considered part of the archaeological archive (Pieters *et al.* 2010: 182).

10.2.39 Finds from the Mesolithic would also be of importance because of their rarity. A number of palaeochannels of archaeological interest have been identified in the English Waters and Belgian Waters Study Areas. The discovery of peat (**WA VC7**) and evidence for an estuarine environment (**WA VC3**) highlights the potential of these palaeochannels to provide further palaeoenvironmental information, and in addition, they indicate the potential for additional archaeological material in the vicinity.

10.2.40 There are a wide range of known sites from the Neolithic to post-medieval period across the Landfall Study Areas. These sites provide details that enrich the historic environment resource and are locally, regionally, and nationally important. Further discoveries of sites or material from these periods also have the potential to be of local, regional or national importance.

10.2.41 The coast of Kent played a key role in defending Britain against attack during both of the World Wars, and therefore military material is likely to be of heightened importance. There is a wide range of known and recorded military sites at the Kent Landfall from World War I and World War II. English Heritage has produced guidance for evaluating 20th century sites (English Heritage 1998, 2003), based on their national importance or the presence of structures of special interest, as well as the site's survival or completeness, group value, rarity of building types and historic importance.

10.2.42 The coast of Belgium was also greatly impacted by the two World Wars, and military material from these periods and earlier is likely to be of heightened importance. The World War archaeology of Western Flanders is actively promoted by the Association for World War Archaeology in cooperation with VIOE (http://www.a-w-a.be/).

Importance of Known and Potential Shipwrecks

10.2.43 In the UK, criteria have been developed for the identification of the importance of shipwrecks, including the criteria for designating shipwrecks under the Protection of Wrecks Act (1973) (based on period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential), and the criteria outlined in *On the Importance of Shipwrecks* (Wessex Archaeology 2006) (based on the concept of 'ship biography' and covering: build, use, loss, survival and investigation).

10.2.44 Due to the recent development of Belgian legislation for the protection of maritime cultural heritage, there has been only a limited amount of investigation within Belgian territorial waters, and accordingly there is not a specially dedicated list of importance or of protection in place in Belgium. However, the potential for discoveries is substantial, particularly within the area of the sand banks, and all new sites being uncovered should be considered to be of high importance unless proved otherwise.

10.2.45 The French legislation on the protection of maritime cultural heritage specifies that all new discovered sites are of importance, and accordingly would become recognised as of great interest. More specifically, the section of the study area crossing French Waters has been subject to minimal archaeological investigation, and consequently could be of crucial interest, particularly in regards to the importance of the traffic in this region over centuries and millennia. Moreover, the presence of the two vessels within the French study area lost during 'Operation Dynamo' during World War II (**WA7141** and **WA7289**) would be of heightened importance based on their involvement with this operation.

10.2.46 Nine of the known wrecks in the Study Areas were lost due to acts of war (**WA7141, WA7200, WA7275, WA7276, WA7289, WA7293, WA7294, WA7296,** and **WA7301**), and four known wrecks had been in military use at some point in their careers (**WA7270, WA7274, WA7300, WA7302**). The military associations of all of these vessels would indicate high importance.

10.2.47 The *Saint Patrice* (**WA7242**) could also be of medium archaeological importance as a 1920s steam tanker. Although the wreck is considered 'dead' by the UKHO, the

recovery of the ship's bell by divers suggests that more material could remain on the seabed.

10.2.48 The four relatively recent wrecks (**WA7017** (1995)**, WA7287** (1986), **WA7292** (1979), and **WA7303** (marked in 1974)) may be regarded as having low archaeological importance. Other 'wrecks' with low archaeological importance include **WA7271** (abandoned four wheel drive vehicle)**, WA7273** (steel tank), and **WA7286** (abandoned Suzuki jeep).

10.2.49 It is not possible to assess the importance of the seven wrecks with the limited information available (**WA7151, WA7162, WA7259, WA7272, WA7277, WA7295,** and **WA7299)**, or the wreck discovered through the archaeological assessment of geophysical data (**WA7024**). Nor is it possible to assess the importance of the known obstructions or the geophysical anomalies of possible anthropogenic origin. As such, the importance of each site must potentially be regarded as potentially high until further information becomes available.

10.2.50 It is also not possible to assess the importance of potential sites, however, there is general guidance available that indicates the likely importance of these sites, based on their age and rarity (Wessex Archaeology 2008c). So little is known about shipwrecks before the medieval period that any wrecks discovered are likely to be of considerable special interest, in addition, post-medieval shipwrecks are also rare and would be expected to be of special interest. There are more examples of boats and ships from the 19th century, so greater discrimination would be required to determine which ones are of special interest, but ship technology was rapidly changing as were the way vessels were used and any wrecks that make a distinct contribution to understanding and appreciating these changes could be regarded as having special interest. As mentioned above, ships lost during the two World Wars could have increased importance. However, a special case would need to be made for any vessels lost after 1945.

Importance of Potential Aircraft

10.2.51 The majority of aircraft losses in the 20th century have been related to military activity, and, as mentioned above, British aircraft lost while in military service are automatically protected by the Protection of Wrecks Act (1986).

10.2.52 However, aircraft are also important because they provide a tangible reminder of the development of aviation in the UK and on the Continent throughout the 20th century. Because of their recent history, aircraft crash sites also have significance as survivors and living relatives may be found, and they are important for remembrance and commemoration. They also have importance through their cultural value as historic artefacts and for the information they contain about the aircraft itself and its circumstances of loss (English Heritage 2002, Wessex Archaeology 2008b).

Value

10.2.53 There is no cohesive guidance for assessing the value of the archaeological receptors or historic environment resource in the context of developmental effects or in the wider environmental impact assessment process. The assessment in this report recognises that whilst within the known resource there are statutorily designated sites of national significance, there are also examples of well preserved sites and monuments which do not have statutory protection. In addition, there are sites which, while not suitable for statutory protection or particularly significant in isolation, combine to inform the wider understanding of past human activity in the region and have value as a sum of parts. The value of any one of these elements of the resource is entirely dependent on the context in which it is being assessed.

10.2.54 The assessment also considers the fact that archaeological receptors and the historic environment resource is both finite and non-renewable; of high sensitivity and low recoverability. In addition, there is often limited information available about each of the known or potential archaeological receptors, making it difficult to fully assess or analyse a site's individual or collaborative importance. Therefore, in terms of the value of the archaeological receptors, they are generally considered to be of high value unless proven to be otherwise.

Significance of Impacts and Effects Assessment

10.2.55 The significance of impacts and effects has been assessed in relation to the magnitude of effect and the value of the receptor. Although assessed as 'major', 'moderate' and 'minor', in terms of the EIA any 'moderate' significance will be considered 'major'.

10.2.56 Direct or secondary impacts to the late 20th century wrecks (**WA7017, WA7287**, **WA7292**, and **WA7303**) and other 'wrecks' of low archaeological importance (**WA7271, WA7273,** and **WA7286**) would cause effects of moderate negative significance.

10.2.57 Direct and secondary impacts to all other known and potential archaeological receptors (terrestrial sites and findspots, submerged prehistoric archaeological material, shipwrecks, aircraft crash sites, associated material, and geophysical anomalies of possible anthropogenic origin) or the relationships between receptors and the wider surroundings will result in significant negative effects. Although it is difficult to assess the significance of effects caused by the direct and secondary impacts to potential archaeological receptors, the damage or destruction of these sites will be permanent, and therefore the effects have been judged to be of major adverse significance.

10.2.58 As indirect impacts are expected to be minor and localised, the effects are likely to be of moderate to low significance. Localised erosion causing damage or destruction to known or potential archaeological receptors would be of low to moderate negative significance. Localised sedimentation affording additional protection to known or potential archaeological receptors would be of low to moderate positive significance.

10.2.59 The significance of the visual impact of the terrestrial converter stations will depend on their locations. At the Kent Landfall where pre-existing buildings are being re-used, the visual impact will be of low significance, however, at the Belgian Landfall, the significance could range between low and high negative significance depending on the selection of the location and building of the converter station.

11 MITIGATION AND MONITORING

11.1 MITIGATION

11.1.1 With regards to the archaeological resource, international best practice and government policy favours preservation *in situ.* As part of the Nemo cable route design, all known wrecks were avoided. This section identifies further mitigation measures or investigations required to address the additional data gaps identified in this report.

11.1.2 A number of geological features of potential archaeological and palaeoenvironmental interest have been identified along the proposed cable route, namely the terrestrial/estuarine deposits and palaeochannels identified in the UK

and Belgian sectors. With regards to cores **WA VC7** (peat) and **WAVC3** (estuarine environment), a Stage 3 archaeological geotechnical assessment of the samples taken during Stage 2 would provide additional information about the palaeoenvironment and about changes that took place within this landscape. The Stage 3 assessment would comprise an assessment of the pollen, diatoms, foraminifera and ostracods within the sedimentary sequence and scientific dating and recommendations as to whether any further analysis is warranted.

11.1.3 Palaeoenvironmental work and scientific dating are standard archaeological techniques used as mitigation for deeply buried or submerged sedimentary sequences. This is a cost effective method, the alternative being a diver based visual survey and manual sampling/excavation of the identified terrestrial sediments for artefactual and ecofactual remains. These palaeoenvironental and dating techniques have the capacity to elucidate anthropogenic activity. For example, the successive arboreal flora known from Northern Europe has changed by both natural climatic and human activity from prehistoric times to today by activities such as deliberate woodland clearance. The evidence of such activity in the form of relative abundances of microscopic plant remains and charcoal can be found using these methods. Scientific dating is recommended in order to better understand the chronology of the sedimentary sequence and therefore the archaeological periods which they span which are impacted by the development. The scientific dating and palaeoenvironmental work should generate significant archaeological information which can be used to mitigate against the impact of the development.

11.1.4 No additional vibrocores are needed to complete the Stage 3 scientific dating and palaeoenvironmental work. Due to the waterlogged nature of the sediments this work should be undertaken before the environmental remains degrade. Removing the sediments from beneath the seabed begins this process of decay. Dating and palaeoenvironmental work should be undertaken ideally within 6 – 12 months of vibrocore retrieval although this period can be extended with specific storage methods.

11.1.5 If possible, extra care and vigilance should be taken where possible during works in the vicinity of the **WA VC3** core. In this case 'extra care and vigilance' indicates that in the vicinity of this core, any material that is recovered during development (such as during the pre-lay grapnel run) should be reported through the Archaeological Reporting Protocol. Not only has this area demonstrated its potential for the discovery of archaeologically interesting palaeoenvironmental material, the sedimentary unit it is derived from is located very close to the seabed surface, and therefore will definitely be impacted by the development.

11.1.6 However, due to the limited vertical and lateral impact expected to be caused by the emplacement of the cable, and the generally large size of these features as a whole, no further mitigation measures (such as exclusion zones) are deemed necessary. No further coring is expected to be undertaken, however, should future coring programs be undertaken in areas of high palaeo-archaeological potential, further archaeological advice will be sought, and the coring should be undertaken in line with the methodologies outlined in COWRIE 2010 (forthcoming), and access to core samples would be advantageous to further investigate the nature, age and archaeological potential of these features, especially ones of an ambiguous nature (*e.g.* **WA7505**).

11.1.7 To support the avoidance of known wrecks, particularly with regard to secondary impact activities such as the anchorages of vessels, Temporary Archaeological Exclusion Zones have been placed around the eight wrecks and geophysical

anomalies of archaeological interest (A1s) identified during the archaeological assessment of geophysical survey data (**Table 12.1**) (**Figures 16, 17 and 18**). Exclusion zones prohibit development related activities within their extents and have been widely applied in offshore development contexts to sites and anomalies with known or potential archaeological significance.

Table 12.1 – 'A1' wrecks assigned Temporary Archaeological Exclusion Zones

Class	WA_ID	Type	Name	Easting	Northing
A1	7024	Wreck	-	389786	5685532
	7027	Debris		391279	5685143
	7047	Debris		394777	5685245
	7049	Debris		395957	5685445
	7098	Debris		416527	5686440
	7141	Wreck	HMS *Westella*	438175	5686526
	7151	Wreck	-	446702	5685213
	7200	Wreck	*Tringa*	460851	5689298

11.1.8 For the known wreck sites (**WA7141, WA7151,** and **WA7200**) 50 m Temporary Archaeological Exclusion Zones are recommended around the known extents of the wreck sites, as part of impact mitigation strategies during development. This should especially be the case for **WA7141**, as the wreck is completely buried at the present time and its exact location and extent could not be confirmed.

11.1.9 For the previously unrecorded wreck site (**WA7024**), a Temporary Archaeological Exclusion Zone is also recommended and further work to fully ascertain the nature and archaeological potential of the site would be advantageous if it is deemed likely to be impacted.

11.1.10 Sites **WA7027, WA7047, WA7049** and **WA7098** are areas of ferrous debris of unknown origin and could represent the remains of badly degraded wrecks or other structures. Temporary Archaeological Exclusions Zones and further investigation are again recommended for these sites, especially since all but **WA7098** are relatively close to the proposed route.

11.1.11 For the wreck sites of archaeological importance that are recorded in UKHO, SHOM or VIOE data, but that were not identified in the geophysical data, buffers have been suggested (**Table 12.2**) (**Figures 16, 17 and 18**). As the extent of the wrecks is unknown, and as wreck material can be spread over a wide area in the vicinity of the wreck site, the buffers comprise a 100 m radius around the gazetteer points. Buffers do not limit development activities to the same extent as exclusion zones, but can assist in planning, for example, the location of anchorages. As the project progresses, the buffers can evolve, and if impacts to buffered areas cannot be avoided, measures to reduce, remedy or offset disturbance should be agreed.

Table 12.2 - 'A3' wrecks assigned temporary buffers

WA_ID	Type	Name	Easting	Northing
7259	Recorded Wreck	-	506371	5686959
7270	Recorded Wreck	*Harvest Moon*	386196	5685927
7272	Recorded Wreck	-	386928	5685054
7274	Recorded Wreck	*LCP 586*	389454	5685030
7275	Recorded Wreck	-	396314	5685228
7276	Recorded Wreck	*Rydal Force*	396458	5686183
7277	Recorded Wreck	-	404300	5687128
7289	Recorded Wreck	HMS *Blackburn Rover*	437854	5685881
7293	Recorded Wreck	*A-15* (possibly)	483250	5688250
7294	Recorded Wreck	*Empire Path*	488866	5689873
7295	Recorded Wreck	-	488905	5689964
7296	Recorded Wreck	*Gold Shell*	493001	5688721
7299	Recorded Wreck	SS *Kilmare* & *West Hinder* LTV	465186	5689793
7300	Recorded Wreck	*FL5*	476787	5688800
7301	Recorded Wreck	*FL8*	479108	5688790
7302	Recorded Wreck	*Boscobel*	489266	5689685
7303	Recorded Wreck	-	508791	5685728
7306	Recorded Wreck	*St Patrice*	454723	5687712

11.1.12 Buffers are not recommended for the remaining A3 records (representing recorded obstructions or those representing wrecks or wreckage of low archaeological importance), or for the further 254 geophysical anomalies, rated A2 (of possible anthropogenic origin and archaeological interest) that were identified (**Figures 16, 17 and 18**). However, some of the A2 or A3 anomalies could in reality represent features of high archaeological importance and would require further archaeological investigation if they are likely to be impacted by the development activities to confirm or deny their origin or importance. These sites should be assessed on a case by case basis. Once they have been assessed, appropriate action can be taken. If further assessment will not be undertaken prior to installation, these records indicate key areas to be aware of and where some form of monitoring may be appropriate.

11.1.13 Although site **WA7162**, has been described in the UKHO surveying details as a 'probable wreck', a buffer has not been assigned to this point. The site is recorded by the UKHO as an 'unclassified non-sub contact', there is no further record of any survey activities over the site since the initial 1945 survey, the SHOM database does not indicate an obstruction or wreck in this vicinity and the site was not identified during the recent geophysical survey. It is possible that the initial geophysical survey data were unclear or that the positional information was either vague or in error, or, if there is any material in the area, it is completely buried. Although a buffer has not been assigned to this record, the area should be monitored closely during installation activities.

11.1.14 Where preservation *in situ* is not practicable, disturbance of archaeological sites or material should be offset by appropriate and satisfactory measures, such as preservation by record, where the effects of the development can be remedied by carrying out excavation and recording prior to the impact occurring (Wessex Archaeology 2007). The impact of development may also be remedied by restabilising sites that have been destabilised but not destroyed, or by offsetting damage to a site by detailed analysis and safeguarding of otherwise comparable sites elsewhere.

11.1.15 In response to the Scoping Document, English Heritage has recommended the implementation of an Archaeological Written Scheme of Investigation, to be agreed with English Heritage that will support the delivery of any necessary mitigation measures (English Heritage 2010). The Written Scheme of Investigation would address pre-construction and installation activities, such as the grapnel run, and would probably also include a protocol to substitute for a watching brief offshore. A WSI would also be required onshore at the Kent Landfall covering intertidal and terrestrial works.

11.1.16 It is possible that previously unknown archaeological sites or material may be encountered during the course of the cable route trenching or installation, operation or decommissioning. For example, there is a high potential for the discovery of material from Goodwin Sands or the Kwinte Bank areas. Hence, measures should be taken to reduce the development impact in this instance. A formal Archaeological Reporting Protocol should be established and agreed with the appropriate statutory consultees and national heritage bodies to ensure that any finds are promptly reported to the correct authority, archaeological advice is obtained and any recovered material is stabilised, recorded and conserved.

11.1.17 Watching briefs may be appropriate at the landfalls or where seabed material is brought to the surface, for example during pre-lay grapnel runs and during trenching for the cable route.

11.1.18 Archaeological assessment is recommended for any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo, and archaeological advice should be sought in designing the methodologies for these activities (English Heritage 2010). In this regard a new process should be put in place (WSI, Archaeological Reporting Protocol), in order for each discovered feature that the appropriate mitigation could be proposed (the later will depend on the nature, size, importance and location of the feature) and discussed between the client, contractor and curator. The reporting protocol needs to outline not just communications but also actions in regards of the responsibility in the instance of a feature being discovered.

11.1.19 A positive cumulative effect of offshore developments is the accumulation of archaeologically interpreted geophysical and geotechnical data regarding prehistoric land surfaces, palaeo-environmental evidence, wrecks on the seabed, and associated material. However, any positive effects must be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available.

11.1.20 English Heritage has recommended (English Heritage 2010) that the developer ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). To enable deposit of reports with the NMR, the developer must ensure that an English Heritage OASIS (Online AccesS to the Index of Archaeological Investigations) form is completed for the whole consented project, and all copies of completed and agreed archaeological reports are attached as PDF files. All further advice on completing this condition is to be directed to English Heritage's NMR (oasis@english-heritage.org.uk). Notification of the completion of the OASIS form is also to be sent to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER).

11.1.21 Similarly, it should be expected that any archaeological reports will also be agreed with and deposited with the French and Belgian authorities.

11.2 MONITORING

11.2.1 The project design (PMSS 2010) indicates that only limited monitoring will be undertaken during operation, basically determined by perceived changes to the environment in areas of high seabed mobility or as a result of the need for cable repairs, and no monitoring has been recommended post-decommissioning.

11.2.2 Monitoring may provide opportunities to assess the effect of any impact on archaeological receptors that may be due to the effects of cable installation. .

11.2.3 Additionally, once the cable is in operation, the main source of direct or secondary impact will be related to the need for cable repairs, so monitoring undertaken at these times will also benefit the management of the archaeological resource.

11.2.4 Archaeological assessment is recommended for any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo, and archaeological input should inform the methodologies of these activities (English Heritage 2010).

12 RESIDUAL IMPACT

12.1.1 It is expected that the implementation of the above mitigation measures will mean that the residual effects of the development on any archaeological receptors will be minor.

Table 12.3: Impact Assessment

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation	Cable installation	Damage or destruction of submerged prehistoric material below the seabed	100	1	100	100	301 Severe	High	Low	High	High	Significant (negative)	Geotechnical samples from the cable route area have been archaeologically assessed – and Stage 3 assessment could provide further information	100	1	100	100	301 Severe	Shallow sections of the resource will still be impacted by development, however, information about the submerged prehistoric resource will be gained from geotechnical assessment (as explained in section **11.1.3**) – and the area of impact on the feature is comparatively small.	Minor (negative)
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of late 20th century wrecks (**WA7017, WA7287**, **WA7292**, and **WA7303**) and other 'wrecks' of low archaeological importance (**WA7271, WA7273,** and **WA7286**)	1	1	100	100	202 Moderate	High	Low	Low	Low	Minor (negative)	None required, however, to prevent damage to cable laying equipment, wrecks should be avoided.	1	1	100	100	202 Moderate	None	Minor (negative)

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of other known archaeological receptors	100	1	100	100	301 Severe	High	Low	High to Medium	High	Significant (negative)	All known wrecks and terrestrial sites have been avoided in the cable route design. Buffers have been placed around A3 wrecks of archaeological potential, however, A2 geophysical anomalies of potential archaeological interest may still be impacted, and these will either undergo further assessment or will be considered during watching briefs and through the Archaeological Reporting Protocol.	10	1	100	100	211 Severe	Known wrecks, and terrestrial sites will be avoided, and therefore will not be impacted. A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis.	Minor (negative)
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of potential archaeological receptors	10	1	100	100	211 Severe	High	Low	High	High	Significant (negative)	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	10	1	100	100	211 Severe	Potential archaeological sites and material may still be affected by installation activities, however, reporting of discoveries through the Archaeological Reporting Protocol will considerably lessen impact	Minor (negative)

Description of Impact			Nature of Effect					Description of Receptor				Impact Significance	Consideration of Mitigation	After Mitigation					Residual Impact Significance
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value		Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment	10	10	100	100	220 Severe	High	Low	High	High	Significant (negative)	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	10	10	100	100	220 Severe	Mitigation measures will considerably lessen impact	Minor (negative)
Installation	Construction activities	Visual impact or impact on setting of known terrestrial archaeological receptors	100	10	10	1	121 Moderate	Moderate	High	Low to High	Low	Minor (negative)	The visual impact during construction will be temporary. The marine area is a busy shipping channel with consistent impact, and the terrestrial landfalls are urban areas with modern construction activities already taking place.	100	10	10	1	121 Moderate	None expected	Minor (negative)
Installation and Operation	Location of conversion stations	Visual impact or changes to setting on terrestrial archaeological receptors	100	10	100	100	310 Severe	High	Moderate to Low	High	High	Significant (negative)	The re-use of the existing Richborough Power Station will minimise impact – the location of the Belgian Landfall conversion station could also be selected to minimise impact	10	10	10	100	130 Moderate	If Belgian Landfall conversion station is a pre-existing building, impact would be minor, however, construction of new buildings could result in moderate effects.	Minor to Moderate (negative)

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation and Operation	Changes to erosion regimes at bridging structures	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	100	100	202 Moderate	High	Low	High	High	Moderate (negative)	Changes to erosion regimes are expected to be minimal – areas of high sediment movement will be monitored	1	10	100	100	202 Moderate	Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	Minor (negative)
Installation and Operation	Changes to sedimentation regimes at bridging structures	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	100	100	202 Moderate	High	Low	High	High	Moderate (positive)	Changes to sedimentation regimes are expected to be minimal	1	10	10	100	121 Moderate	Changes to sediment regimes are expected to be minimal	Minor (negative)
Operation and Decommissioning	Repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) Removal of infrastructure: cable removal (cable de-burial, cable recovery)	Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors	1	1	1	100	103 Moderate	High	Low	High	Low	Minor (negative)	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	1	1	1	100	103 Moderate	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	Minor (negative)
Operation and Decommissioning	Anchors used to maintain position of repair or decommissioning vessels	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts	10	1	100	100	211 Severe	High	Low	High	High	Significant (negative)	Known sites will be avoided through the maintenance of temporary exclusion zones and buffers, and any material discovered will be dealt with through the Archaeological Reporting Protocol	10	1	100	100	211 Severe	Although sites could still be impacted, the implementation of mitigation measures would greatly lessen impact	Minor (negative)

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Maps, charts and aerial photographs

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NMR RAF/106G/UK/1110 4077 10-JAN-1946

Google Earth imagery date: 2003, 21-APR-2007

Wessex Archaeology

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR
RICHBOROUGH TO WEST-ZEEBRUGGE

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

Volume II: Appendices

(*cf.* Volume I: Report)

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by
Wessex Archaeology
Portway House
Old Sarum Park
Salisbury
SP4 6EB

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APPENDIX I: LEGISLATION AND GUIDANCE

1.1 JURISDICTION

1.1.1 This section presents the legal and policy framework applicable to archaeology in the Study Area, encompassing the territorial waters administered by England and Belgium, within the 12 nautical mile limit, and extending to those areas beyond the 12 nautical mile limit, comprising the Exclusive Economic Zone (EEZ) administered by the United Kingdom, France and Belgium.

1.1.2 It is generally accepted that states have jurisdiction in respect to heritage within their territory, and within their territorial waters to 12 nautical miles. Beyond 12 nautical miles, the situation is more complex. While there are grounds for exercising authority in respect of maritime archaeology in the EEZ, these grounds are limited by international law, such as the UNCLOS Article 149 and 303.

1.2 ENGLAND / UNITED KINGDOM

1.2.1 The NEMO electrical interconnector passes through English Territorial Waters (to the 12 nautical mile limit) and extends beyond the limit to the UK EEZ.

1.2.2 Within the 12 nautical mile limit, the archaeology and historic environment is under the responsibility of English Heritage. In addition, some UK legislation applies to English wrecks whether in English or international waters. In general, newly discovered maritime sites in the UK are not automatically protected under the current legislation until a request for protection is formulated following an identified threat upon the site or an evaluation of its particularity. However, military aircraft are automatically protected.

1.2.3 Legislation in England is currently under review, however the section below represents the situation at time of writing. Although not yet ratified, the draft Heritage Protection Bill, published in 2008, has been designed to unify the terrestrial and marine heritage protection systems, and will replace the provisions of the Planning (Listed Buildings and Conservation Areas) Act (1990), the Ancient Monuments and Archaeological Areas Act (1979) and the Protection of Wrecks Act (1973). However, until it comes into effect, the following legislation remains in place.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Ancient Monuments and Archaeological Areas Act (AMAA) (1979)	Scheduled Monuments and AAIs are afforded statutory protection and the consent of the Department of Culture Media and Sport, advised by English Heritage, is required for any works.
Planning (Listed Buildings and Conservation Areas) Act (1990)	Works affecting Listed Buildings or structures and Conservation Areas are subject to additional planning controls administered by Local Planning Authorities (LPAs).
Protection of Wrecks Act (PWA) (1973)	Under the PWA (1983) Section One, wrecks and wreckage of historical, archaeological or artistic importance can be protected through designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained. Section Two provides protection for wrecks that are designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck (RoW).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Protection of Military Remains Act (PMRA) (1986)	Under the PMRA (1986) all UK aircraft that have crashed while in military service are automatically protected. This part of the Act applies to UK aircraft whether they are located in United Kingdom waters or international waters. The ministry of Defence (MoD) also has powers to protect vessels that were in military service when lost, whether located in United Kingdom waters or international waters.
Merchant Shipping Act (MSA) (1995)	This act sets out the procedures for determining the ownership of underwater finds of 'wreck' material – including flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ship, aircraft, hovercraft, parts of these, their cargo or equipment. If any such finds are brought ashore, the salvor is required to give notice to the RoW. This act covers not only finds of material discovered in English Territorial Waters, but also wreck found or taken into possession outside UK waters but brought into UK waters
Marine and Coastal Access Act (2009)	This involves the regulatory framework affecting development in the coastal area. Through Integrated Coastal Zone Management (ICZM), everyone involved in the management and use of a particular stretch of coast will be brought together within a framework that works to achieve common goals.
Planning Policy Statement 5: Planning for the Historic Environment (PPS 5)	Applies to the marine environment above the mean high water spring tide mark. PPS 5 acknowledges the potentially fragile and finite or irreplaceable nature of the historic environment resource and emphasises the desirability of preserving archaeological remains and their setting within the planning process. It notes that where preservation *in situ* is not justified it is reasonable for planning authorities to require the developer to make appropriate and satisfactory provision for the excavation and recording of remains.
Code of Practice for Seabed Developers Joint Nautical Archaeology Policy Committee 2006 (JNAPC)	This voluntary code provides a framework for seabed developers similar to the principles found in current policy and practice on land. The aim of the Code is to ensure a best practice model for seabed development. The Code offers guidance to developers on issues such as risk management and legislative implications.
England's Coastal Heritage: a statement on the management of coastal archaeology (1996)	This statement sets out a number of principles for managing coastal archaeology. These include the promotion of preservation *in situ*, that finds should be managed in accordance with the principles which apply to terrestrial archaeological remains, that marine and terrestrial remains must be considered seamlessly, that a precautionary approach should be adopted and that PPG16 (now PPS5) should be applied to the treatment of sub-tidal archaeological remains in order to ensure best practice.
Identifying and Protecting Palaeolithic Remains: Archaeolgoical Guidance for Planning Authorities and Developers (English Heritage 1998)	This draws attention to the importance of Palaeolithic remains and states that they must be considered in line with PPG 16 (now PPS 5) when potentially affected by development proposals. Palaeolithic remains are rare and therefore would be of heightened archaeological importance.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Military Aircraft Crash Sites (English Heritage 2002)	This provides archaeological guidance regarding the significance and future management of military aircraft crash sites. It outlines the importance of aircraft crash sites and indicates that they should be considered where they are affected by development proposals.
The Burial Act (1857)	If human remains, including cremated remains, are discovered in the course of site investigations or construction, they must not be exhumed unless a licence has been obtained. The Ministry of Justice is responsible for burials in England and it advises that anyone disturbing buried remains accidentally is advised to leave the remains in place and to contact them immediately.
The Treasure Act (1996)	In England, all finders of 'treasure' are under a legal obligation to report such items to a coroner for the district in which they were found. The Portable Antiquity Scheme defines treasure as: any metallic object that consists of at least 10% precious metal; any group of tow or more metallic objects of prehistoric date; all coins that are at least 300 years old; any objects associated with 'treasure' and any object that would previously have been 'treasure trove'.
Kent and Medway Structure Plan (2003)	The local planning and guidance policy addresses heritage, archaeological sites, buildings or architectural or historic importance and historic landscape within the context of development in the county of Kent.

1.3 FRANCE

1.3.1 The NEMO electrical interconnector passes through French waters beyond the 12 nautical mile limit, but within the Contiguous Zone in the French EEZ. The maritime heritage within both these zones is protected by two pieces of the same legislation which is defined as legal and practical code. The first one is specifically oriented as a legal instrument for the protection of maritime cultural properties, and the second one is defined as a code of practice under the context of rescue archaeology.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Law nº 89-874 relating to Maritime Cultural Properties (1989)	Comprised of Articles L532-1 to L532-14 from Chapitre 2, Titre III, Livre V of the Code to Patrimoine (consolidated version from the 14th of July 2010), and the Articles L544-5 to L544-11, Chapitre 4, Titre IV, Livre V of the Code du Patrimoine. The content of these articles was enacted by the Decret nº 91-1226 in 1991, and has been recently modified as part of a general revision of the Code du Patrimoine by the Ordonnance 2004-178 art 7, 14ºJORF in 2004. This law concerns all maritime cultural property such as deposits, wrecks, remains or generally all property having prehistoric, archaeological, or historical interest and which are located within either the 12 nautical mile limit or the Contiguous Zone (24 nm). It is an offence to carry out any investigative activities, prospective activities or cultural property movement without a granted permission from the French authorities, and that the latter activities have to be effectively undertaken under the direction of the permit holder. If the physical integrity of cultural maritime property is being compromised, it is declared of public interest that a Court of Justice pronounce the transfer of the property's ownership to the French government against some financial compensation. Every find within these waters must be reported by the finder. All failure to comply with the obligation of declaring all discoveries, or the making of a false declaration can lead to a fine of 3750€. Any unauthorised activity on a maritime cultural property can lead to a fine of 7500€. Any person found guilty of acquisition or selling maritime cultural properties from the French maritime public domain can be subject to a sentence of 2 years in jail and a fine of 4500€ or the double of the selling price. Each declaration of discovery to the French authorities can be subject to a reward of which the nature and amount would be determined by the administrative authorities depending on the find's importance and rarity. All maritime cultural property must be claimed by its owner within three years of discovery or ownership will automatically be shifted to the French government.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Law nº 2001-44 relating to Rescue Archaeology (2001)	Articles L521-, L522-1 to L522-8, L523-1 to L523-14, and L524-1 to L524-16 from the Chapitre 1 to 4, Titre II, Livre V of the Code du Patrimoine. These texts are the codification of law nº 2001-44 relating to rescue archaeology which has been modified by law nº 2003-707 from the 1st August 2003. This legislation establishes that rescue archaeology is a public service which is governed by applicable scientific research principles. Its objectives are to ensure on land and underwater an appropriate framework for the detection, conservation, interpretation, dissemination and rescue by scientific study the archaeological heritage affected or potentially affected by private or public development. Operationally, investigative diagnostics are generally undertaken by the governmental rescue archaeology institute INRAP (Institut National de la Recherche en Archeologie Preventive) or local council archaeological services. However, the developer can select a private archaeological operator so long as they hold the agreed accreditation from the French authorities. Financially, these operations are funded by two different sources: the rescue archaeology fee (Redevance d'Archeologie Preventive (RAP)) which funds investigative diagnostics, and the national fund for rescue archaeology (Fond National pour l'Archeologie Preventive) which helps some developers to pay the costs of excavation. This fee is due for all development projects that affect the ground or seabed and is calculated and determined by local planning services (such as the DRAC, SRA, DDE, and so forth). If excavation is required, the price that the developer has to pay to the operator is the counterpart of this excavation service accomplished by this operator.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Inter-prefectoral Decree No. 89/2010 of the Atlantic Maritime Prefet and No. 64/2010 of the Maritime Prefet of the Channel and the North Sea	Article 1: Exploration and research relating to wrecks or maritime cultural heritage situated in the economic zone, the adjacent zone and in the French EEZ offshore from the French coasts of the Atlantic Sea, the Channel and the North Sea are permitted, provided that an information dossier describing the activities planned is submitted (by registered post) to the appropriate maritime Préfet at least 3 months in advance of the commencement of the works. Article 2: Such notification becomes invalid if no activities take place within 30 days of the planned start of the works, or when the works are suspended for a period of 30 days or more. The notification may not used by any other person or organisation other than the original applicant, nor to any other ship than that which is stated in the original submission. Article 3: The information dossier must state the exact nature of the activities planned, must include a list with descriptions of the prospecting and research equipment which is to be used, the precise location (using the WGS 84 geodesic co-ordinates system) of the areas where the operations are to take place, the duration of the operations (with start and end dates), and the use to which the research or items recovered will be put. It must also include a statement setting out the description and function of the wreck or the asset, as well as any historic information which relates to them. The information dossier must include an evaluation of the impacts of the proposed operations on the marine environment. Article 4: Non-observance of the provisions of this Decree will render the operators liable to be required immediately to depart from the marine areas quoted in Article 1 or to return to a French port suitable for the carrying out of an enquiry and to such fines or other penalties which may apply in the circumstances of such non-observance. Article 5: Inter-prefectoral Decree No. 40/2010 of the Atlantic Maritime Prefet and No. 12/2010 of the Maritime Prefet of the Channel and the North Sea dated 21 April 2010 is hereby superseded by the present Decree Article 6: The Admirals commanding the Atlantic and the maritime zone of the Channel-North Sea, the inter-regional director of Rouen Customs, the inter-regional director of N.Atlantic/W.Channel sea areas, the officers and other staff responsible for policy on mines, wrecks, marine cultural heritage, navigation and continental shelf exploration are charged with the execution of the present Decree, each according to their particular areas of responsibility.

1.4 BELGIUM

1.4.1 The NEMO electrical interconnector has a Belgian terrestrial landfall, passes through Belgian Territorial Waters (within 12 nautical miles) and includes an area of the Belgian EEZ. The following legislation applies to archaeology and the historic environment, and has been provided by the VIOE (Vlaams Instituut voor het Onroerend Erfgoed) from data developed by the MACHU project (Culture 2000).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Flemish Parliament Act on the Protection of the Archaeological Patrimony (1993) (Archeologiedecreet, 1993)	This Act is enforced on a regional level on land to low water level. It regulates the protection, preservation, maintenance, restoration and management of the archaeological heritage of Flanders. In addition, it regulates archaeological excavation, prospection (whether through impact to soil or with metal detectors) and unexpected discoveries. This decree may be revised in 2010, and there is political intention to implement the European Valletta Convention and the UNESCO Convention.
Wreck Act on the Finding and Protection of Wrecks (2007) (Wrakkenwet, 2007)	This Act is enforced in federal and territorial waters. It regulates the right of property of wrecks and wreckage in the Belgian territorial sea. In addition, it creates a judicial base for the protection of shipwrecks of archaeological and historical value within the territorial sea. The legislation is based on an agreement between the Federal Ministry of Northsea Affairs and the Flemish Ministry of Spatial Planning and the environment. Although the Act has been agreed on, it has not yet been implemented.
Royal Decree concerning the exploration and exploitation of non-organic resources in the territorial sea and the continental shelf (2004) (Koninklijk Besluit betreffende de exploratie en de exploitatie van niet-levende rijkdommen in de territoriale zee en op het continentaal plat, 2004.	This decree applies to federal and territorial waters as well as the continental shelf. It concerns the conditions, geographic boundaries and procedure of attribution of concessions for the exploration and exploitation of mineral and other non-organic resources. It concerns maritime heritage because it indicates the geographic areas of exploration/exploitation in which the level of threats towards the maritime heritage rise.
Royal Decree creating special zones of protection and nature conservation in the marine area under Belgian jurisdiction (revised) (2005), (Koninklijk Besluit tot instelling van speciale beschermingszones en speciale zones voor natuurbehoud in de zeegebieden onder Belgische rechtsbevoegdheid (bijgewerkt), 2005.)	This decree is enforced in federal waters, territorial waters and on the continental shelf within the Exclusive Economic Zone beyond 12 nautical miles. It marks out the first Marine Protected Areas in the Belgian part of the Northsea: enforcing the European directive of Important Birds (1979) and the European directive of their habitats (1992). It also concerns maritime heritage, because the threats towards maritime heritage in these areas is lower (Articles 2 & 5).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Special law of the Reformation of the institutions (revised) (1980), (Bijzondere wet tot Hervorming der Instellingen, 1980)	This federal legislation divides Belgium into Provinces and Regions while marking out their boundaries. The border of the province of West-Flanders is at 0m LWL.
Act on the protection of the marine environment in sea areas under Belgian jurisdiction (revised) (1999) (Wet ter bescherming van het mariene milieu in de zeegebieden onder Belgische Rechtsbevoegdheid (MMM) (herzien), 1999)	This legislation applies to federal, territorial waters and the continental shelf Exclusive Economic Zone. It summarises the general principles of environmental law, and the purpose of the Act is to preserve the nature, biodiversity and untouched character of the marine environment in Belgian waters. It aims to protect the marine environment and to restore any previous damage to the marine environment. This concerns maritime heritage as it regulates human impact in the marine areas.

1.5 INTERNATIONAL

1.5.1 International heritage policies can apply to all three countries, while other international policies apply beyond each country's territorial waters. Current international law such as UNCLOS Articles 149 and 303, places on signatory states a direct duty of care in regards to wrecks and other submerged historic environment resources. Additionally, some indirect regulation arises from the environmental controls placed on the regulated exploitation of natural resources.

1.5.2 Material discovered on the Continental Shelf / in the EEZ may also be subject to UK legislation, such as the MSA (1995) which covers wreck found or taken into possession outside UK waters but brought into UK waters, and the PMRA (1986) which covers British controlled ships, British citizens and British companies.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
European Landscape Convention (ELC) (also known as the Florence Convention) (2000)	This became binding on the Belgium in 2005, France in 2006 and the UK in 2007. Its principle clauses require the Government to protect and manage landscapes and to integrate landscape into regional and town planning policies including its cultural, environmental, agricultural, social and economic policies. The ELC applies to land, inland water and marine areas, however it is not regarded as applying to sea areas that lie beyond territorial waters (the 12 nautical mile limit).
European Directives (85/337/EEC, 97/11/EC, 2001/42/EC)	Continental shelf activities are subject to Environmental Impact Assessments, and the effects of those activities on the archaeological heritage have to be addressed and mitigation proposed.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
United Nations Convention on the Law of the Sea (UNCLOS) (1982) (Zeerechtenverdrag, 1982)	UNCLOS 1982 has been ratified by the UK, France and Belgium. Article 149 and 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. These articles also provides for coastal states to exert a degree of control over the archaeological heritage within the Exclusive Economic Zone.
European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (the Valletta Convention)	The Valletta Convention has been ratified by France and the UK, and came into force in 1996 in France and in 2001 in the UK. Belgium has signed the Convention, however it has not yet been ratified and therefore has not yet come into force. The convention binds countries to implement protective measures for the archaeological heritage within the jurisdiction of each party, including sea areas. The Convention identifies that archaeological interests should be included in the spatial planning process, and that preservation *in situ* should be considered as the first option. Parties to the convention are obliged to take legal measures for the protection of the archaeological heritage and to warrant the scientific quality of the archaeological research.
UNESCO Convention on the Protection of Underwater Cultural Heritage (UNESCO) (2001)	The UNESCO Convention is a comprehensive attempt to codify international law with respect to underwater archaeological heritage. Although the UK abstained in the vote on the final draft of the Convention, it has stated that it supports most of the articles, particularly the provisions in the Annex governing the conduct of archaeological investigations. Neither France nor Belgium are signatories either, however twenty States have now ratified the Convention, which therefore entered into force on 2 January 2009.
International Council on Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage (1996) (the Sofia Charter)	The Sofia Charter includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all. Belgium, France, and the UK are all members of ICOMOS.
ICOMOS Charter on the Protection and Management of Archaeological Heritage (1990)	The Charter states that archaeological heritage is a fragile and non-renewable cultural resource, and land use must therefore be controlled and developed in order to minimise the destruction of the archaeological heritage. The protection of the archaeological heritage should be integrated into planning policies at international, national, regional and local levels.

APPENDIX II – SUB-BOTTOM PROFILER GAZETTEER

This appendix includes a description of sub-bottom profiling data produced by MMT. Areas of particularly high prehistoric archaeological potential have been illustrated (see **Figure 7** & **16**). However, the remaining images are held in the project archive for future reference.

WA ID	Name / Classification	Archaeological Discrimination	Description	Sources
7500	Palaeochannel	A1	A generally NNE - SSW trending under-filled palaeochannel as identified my multibeam bathymetry. Sub-bottom profiler assessment indicates the presence of channel fill in the base of the feature, and coring has recovered intact terrestrial peat deposits. Cuts through erosion surface 7502. Depth Range: 0.0m - 3.8m BSB.	6511 (sbp)
7501	Palaeochannel	A1	An area of shallow, poorly defined, under-filled palaeochannels as identified in the multibeam bathymetry data. Only one small channel has been identified by the sub-bottom profiler, indicating the rest of the area either has very thin deposits or is filled with more homogenous material. Depth Range: 0.0m - 8.3m BSB.	6510 (sbp)
7502	Erosion Surface	A2	Poorly defined, sporadic, undulating reflector associated with an area of under-filled palaeochannels observed on the multibeam bathymetry data and two observed on the sub-bottom profiler data (7500 and 7501). Could represent the top of the bedrock, or an erosion surface within more recent deposits. Depth Range: 3.4m - 9.4m BSB.	6509 (sbp)
7503	Simple Cut and Fill	A2	Possible poorly defined simple cut and fill located beneath an area of sand waves. Possibly part of an old palaeochannel system. Depth Range: 0.7m - 11.3m BSB.	6507 (sbp)
7504	Simple Cut and Fill	A2	Possible poorly defined simple cut and fill located below erosion surface 7505 and an area of sand waves. Possibly part of an old palaeochannel system. Presence of sand waves probably ensures the feature is mostly beyond the depth of the proposed scheme, though these are likely to be ephemeral features. Depth Range: 2.9m - 15.3m BSB.	6504 (sbp)
7505	Erosion Surface	A2	Strong, sub-parallel, laterally continuous shallow reflector. Possibly represents the boundary between the bedrock and more recent, unconsolidated deposits though could just be the base of the seabed sediments. Cuts through older possible channel feature 7504. Depth Range: 0.0m - 13.7m BSB.	6503 (sbp)
7506	Simple Cut and Fill	A2	Simple cut and fill cut into the bedrock beneath erosion surface 7508. Possibly part of an old palaeochannel system. Probably mostly beyond the depth of the proposed scheme, though is fairly shallow in parts. Depth Range: 3.3m - 11.4m BSB.	6502 (sbp)
7507	Simple Cut and Fill	A1	Shallow simple cut and fill cut into the sediments overlying erosion surface 7508. Most of the internal structure is obscured by shallow gas blanking, though it seems there is a single episode of fill. The gas within the feature indicates the presence of organic material. Depth Range: 0.0m - 5.8m BSB.	6501 (sbp)
7508	Erosion Surface	A1	Strong, sub-parallel, laterally continuous reflector. Possibly represents the boundary between the bedrock and more recent, unconsolidated sediments. Core samples indicate the fill above this boundary are possible estuarine deposits. Cuts through older possible channel feature 7506. Depth Range: 0.0m - 7.0m BSB.	6500 (sbp)

APPENDIX III – GEOARCHAEOLOGICAL ASSESSMENT OF GEOTECHNICAL DATA

Vibrocore logs were provided for 92 core logs, all of which were assessed by Wessex Archaeology. 10 additional vibrocores were physically geoarchaeologically assessed by Wessex Archaeology. All the vibrocore locations were plotted in the GIS (see **Figure 3**). This section provides a list of the vibrocore numbers and their locations.

Location of Vibrocores

VC Number	Easting	Northing
VC-0001	499058.2	5687762
VC-0002	497332.9	5687896
VC-0003	496910.6	5687926
VC-0004	495903.8	5687999
VC-0005	495315.9	5688042
VC-0006	493886.9	5688209
VC-0007	492961.9	5688424
VC-0008	491986.9	5688656
VC-0009	491019.3	5688900
VC-0010	490273.8	5689078
VC-0011	490045.1	5689124
VC-0012	489079.8	5689357
VC-0013	488103.7	5689589
VC-0014	487472.6	5689584
VC-0015	486134.3	5689329
VC-0016	484773.3	5689069
VC-0017	484160.2	5688981
VC-0018	482969.1	5688456
VC-0019	482153.8	5688139
VC-0020	481353	5688174
VC-0021	480212.1	5688214
VC-0022	479043.8	5688281
VC-0023	478325.4	5688333
VC-0024	477337.6	5688399
VC-0025	476337.6	5688461
VC-0026	475441	5688515
VC-0027	474149.4	5688594
VC-0028	471788.1	5688754
VC-0029A	471279.8	5688790
VC-0030	470207.7	5688864
VC-0031	469374.7	5688980
VC-0032B	469021.9	5689140
VC-0033A	468866.4	5689396
VC-0034	468463.5	5689966
VC-0035	467633.7	5690744
VC-0036	466719.4	5690939
VC-0037	466465.3	5690932
VC-0038	465259	5690948
VC-0039	464321	5690532
VC-0040	463798.4	5690291
VC-0041A	462498	5689712
VC-0042A	462176.4	5689565
VC-0043	461654.1	5689610
VC-0044A	460114.9	5689245
VC-0046	457635.4	5688266
VC-0047	457421.9	5688181
VC-0048	455915.6	5687592
VC-0049	454522.1	5687034
VC-0050	453136.5	5686490
VC-0051	452140.6	5686078

VC Number	Easting	Northing
VC-0052	451291.4	5685741
VC-0053	450335.5	5685377
VC-0054	449407.2	5685032
VC-0055A	448045.2	5685200
VC-0057	445716.7	5685678
VC-0058	444796.7	5685869
VC-0059	444005.2	5686038
VC-0060	442943.5	5686261
VC-0061	442805.9	5686289
VC-0062	441916.3	5686393
VC-0063A	441555.6	5686395
VC-0064	440357.6	5686404
VC-0065A	439433	5686413
VC-0066A	438821.7	5686413
VC-0067	438323.2	5686413
VC-0068	437731.7	5686422
VC-0069	436562.2	5686432
VC-0070A	435930	5686434
VC-0071	435033.6	5686445
VC-0072	433832.7	5686454
VC-0073	431812	5686467
VC-0074	431644.9	5686469
VC-0075	429930.3	5686478
VC-0076	428844.6	5686488
VC-0077	428338	5686491
VC-0078	427747.8	5686502
VC-0079	427635.1	5686500
VC-0080	426006.1	5686575
VC-0081	425553.7	5686600
VC-0082	424496.3	5686655
VC-0083	423561.1	5686715
VC-0084	422310.7	5686773
VC-0085	421061.7	5686841
VC-0086	420843.9	5686852
VC-0087	420260.1	5686866
VC-0088	419233.7	5686867
VC-0089	417568.5	5686874
VC-0090	416572.2	5686883
VC-0091	415303.2	5686900
VC-0092	414539.4	5686909
WA_VC1	459043	5688820
WA_VC2	485079	5689134
WA_VC3	496458	5687963
WA_VC4	439728	5686408
WA_VC5	438782	5686421
WA_VC6	432052	5686463
WA_VC7	404296	5686691
WA_VC8	415132	5686851
WA_VC9	414021	5686961
WA_VC10	414185	5686965

Belgium

WA VC1

Depth below seabed(m)	Description
0 – 0.19	2.5Y 5/3 Light olive brown silty sand, medium to fine grain, poorly sorted, soft, with abundant broken molluscs, abundant flint inclusions and pebbles up to 4.4 cm in diameter. Gradual boundary.
0.19 – 0.32	2.5Y 4/2 Dark greyish brown sandy clay, fine grain, moderately well sorted, soft to medium hardness, abundant mollusc and flint inclusions up to 2.2 cm in diameter. This is probably a transition between the above and below sediments. Gradual boundary.
0.32 – 3.5	2.5Y 4/2 Dark greyish brown clay, well sorted, firm. Probably bedrock.

WA VC2

Depth below seabed(m)	Description
0 – 3.54	2.5Y 5/1 Grey silty sand, medium to coarse grain, poorly sorted. Abundant marine mollusc inclusions up to 0.6 cm in diameter, frequent flint sub-angular flint inclusions up to 2 cm in diameter. Gradual boundary over 6 cm.
3.54 – 4.6	2.5Y 4/1 Dark grey clay, firm, very well sorted. Probably bedrock.

WA VC3

Depth below seabed(m)	Description
0 – 0.29	2.5Y 4/1 Dark grey silty clay, very well sorted, soft, occasional shell inclusions up to 0.4 cm in diameter. Sharp boundary. Sample taken at 0.19 m. PMCI Sample taken at 0.2 – 0.3 m.
0.29 – 5.6	2.5Y 5/1 Grey silty clayey sand, fine, very well sorted, firm, very occasional flint and marine mollusc inclusions up to 0.5 cm in diameter, molluscs becoming more frequent with depth. At 0.9 – 0.92 m lenses of brown silty sands with organic material. 2.8 – 3.12m pockets of brown silty sand with abundant organic remains. 3.96 – 4.06 m pockets of brown silty sand with abundant organics. At 4.5m lenses of brown silty sands with organic material. At 4.6m lenses of brown silty sand with organic material. At 5.46 m lenses of brown silty sand with organic material. PMCI Sample taken at 2.8 – 2.9 m and at 4.3 – 4.4 m. Samples taken at 0.91m, 1.77 m, 2.48m, 3.52 m, 4.66 m, 5.12 m and 5.52 m. wood sample taken at 2.99m.

France

WA VC4

Depth below seabed(m)	Description
0 – 1.44	2.5Y 5/2 Greyish brown sand, soft, poorly to moderately sorted, medium to coarse grained, abundant flint and marine mollusc inclusion up to 2cm in diameter. Gradual boundary over 7 cm.
1.44 – 3	2.5Y 4/2 Dark greyish brown silty clay, well sorted, firm. Getting firmer with depth. Probably bedrock.

WA VC5

Depth below seabed(m)	Description
0 – 2.71	2.5Y 6/2 Light brownish grey sand, fine grained, well sorted, loose, frequent broken mollusc inclusions up to 0.2 cm in diameter, moderate flint pebbles getting larger with depth. Between 2.35 – 2.71 pockets of black anaerobic sand occur but still the same layer. Gradual boundary.
2.71 – 3.16	2.5Y 5/2 Greyish brown silty clayey sand, medium to fine grained, well sorted, abundant broken mollusc inclusions up to 0.7cm, and abundant flint inclusion, sub-angular to rounded up to 2.3 cm. Probably the transition between above and below sediments. Gradual boundary.
3.16 – 4.2	2.5Y 4/1 Dark grey silty sandy clay, very well sorted, stiff, moderate rounded flint inclusions up to 1.4 cm.

England

WA VC6

Depth below seabed(m)	Description
0 – 0.96	2.5Y 5/3 Light olive brown sand, medium to coarse grain, well sorted, loose, moderate shell and flint inclusions up to 3 cm. 2 cm boundary.
0.96 – 1.06	2.5Y 4/1 Grey sandy clay, soft, poorly sorted, with flint pebbles up to 5cm in diameter. Probably the transition between above and below sediments. Gradual boundary.
1.06 – 2.5	5Y 4/1 Dark grey clay, well sorted, fine, firm. Probably bedrock.

WA VC7

Depth below seabed(m)	Description
0 – 1.43	2.5Y 4/3 Olive brown sand, medium to coarse grain, moderately well sorted, abundant flint pebble inclusions up to 5 cm in diameter. Sharp boundary.
1.43 – 2.41	2.5Y 4/1 Dark grey sand, coarse to medium grain, poorly sorted, abundant marine mollusc inclusions and flint pebbles up to 2 cm in diameter. Sharp boundary.
2.41 – 4.28	2.5Y 3/1 Very dark grey sandy clay, well sorted, occasional marine mollusc inclusions up to 0.5 cm in diameter. Occasional wood inclusions up to 6 cm long. Sharpe boundary. P,d,f,o samples taken at 2.8m and 4.22m. P,M,C,I sample taken at 1.7 – 1.8m and 2.6 – 2.7m and 4.11 – 4.21m.
4.28 – 5.35	Brown peat, with abundant reed and root remains, and abundant fresh water molluscs. Filled in mollusc burrows on the upper boundary. Gradual horizon. P,d,f,o samples taken at 5.2m and 5.35m.
5.35 – 6	2.5Y 5/1 Grey chalk putty (silty soft clay) with large flint pebble inclusions up to 6 cm in diameter. Probably bedrock eroded by glacial action. P,d,f,o samples taken at 5.5m, 5.6m, 5.7m and 5.85m. P,M,C,I samples taken at 5.35 – 5.45m and 5.45 – 5.5m. snail sample taken at 5.36m. reed sample taken at 5.44m.

WA VC8

Depth below seabed(m)	Description
0 – 2.8	2.5Y 4/3 Olive brown sand, medium grained, loose, well sorted.

WA VC9B

Depth below seabed(m)	Description
0 – 5.6	2.5Y 5/3 Light olive brown sand, very well sorted, loose, very occasional sub-angular flint inclusions up to 0.5cm in diameter. Marine molluscs appear in same sediment later from 1m onwards up to 0.7 cm in diameter. From 5 m onwards the flint inclusions become rounded pebbles up to 0.8 cm in diameter.

WA VC10

Depth below seabed(m)	Description
0 – 5.4	2.5Y 6/6 Olive yellow sand, very well sorted, medium grained, soft, loose, very occasional sub-angular flint inclusions up to 0.5 cm in diameter, very occasional marine mollusc inclusions up to 0.6 cm in diameter. Marine mollusc inclusions disappear from 2 m onwards. The flint inclusions disappear from 4 m onwards.

APPENDIX IV – ENGLISH LANDFALL – TERRESTRIAL SITES GAZETTEER (PRELIMINARY GAZETTEER, AS THESE DATA ARE FURTHER ASSESSED IN ANOTHER REPORT)

This appendix includes a list and description of English terrestrial sites from NMR/HER (see **Figure 5** & **6**)

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1001	Neolithic	Late Neolithic barrow, North of Canterbury Road West.	Late Neolithic / early Bronze Age barrow. Contained burial accompanied by a long necked beaker, a button of jet and a flint knife.	635150	165220	HER MKE7762
1002	Prehistoric	Prehistoric barrows, enclosures etc found north of Bethlehem Farm, Minster, Thanet	Prehistoric barrows. Grave contained skeletal remains. A single sherd of flint-gritted pottery, probably of Iron Age date, was found in the ditch. Finds from three pits have included animal bone, Iron Age pottery and pot-boilers.	634700	164600	HER MKE8103
1003	Bronze Age	Bronze age round barrow, Manston	Bronze Age round barrow.	635020	165390	HER MKE7634
1004	Bronze Age	Barrow, North of Canterbury Road West, Manston	Cropmark indicating the presence of a Bronze Age barrow.	635000	165200	HER MKE7761
1005	Bronze Age	Crouched Inhumation, Cliffs End	Crouched inhumation, accompanied by bell beaker.	634550	164790	HER MKE8083
1006	Bronze Age	Possible Bronze Age features, Cliffsend, Ramsgate	Prehistoric settlement - possibly relating to the Neolithic or the Bronze Age. Artefacts included worked flint and pottery.	634950	164390	HER MKE21097
1007	Bronze Age	Bronze Age enclosure + ring ditch.	Bronze Age enclosure and ring ditch visible as cropmarks.	634810	164680	HER MKE8081
1008	Bronze Age	Bronze Age hoard, Cottington Hill, Minster - Findspot	Bronze age hoard.	633450	163450	HER MKE15874
1009	Bronze Age	Bronze Age founder's hoard, Ebbsfleet Farm, Minster parish	Bronze Age founder's hoard, discovered in 1893 on a farm at Ebbsfleet, near Minster. Consisted of 181 weapons and implements, including socketed axes, spearheads and winged axes. Findspot uncertain.	633270	163080	HER MKE8059
1010	Prehistoric	Prehistoric midden material, Cottington Hill, Minster	Evidence of a prehistoric midden was found in eroded material from the bank of a dyke. Late Bronze / Early Iron Age pottery sherds and associated material.	633850	163620	HER MKE15875

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1011	Bronze Age	Late Bronze Age/early Iron Age postholes & pits, north of Canterbury Road West, Manston	Postholes and pits within a late Neolithic/early Bronze Age barrow.	635150	165220	HER MKE19917
1012	Iron Age	Iron age coins, Cottington Hill, Minster - Findspot	Nine iron age coins, found by metal detectorist. Dated to 100-90BC. Trinovantian type, made of cast bronze.	633630	163900	HER MKE10031
1013	Iron Age	Copper Celtic coin, Cottington Hill, Minster - Findspot	A 'Celtic' coin, found by metal detectorists, dated to 10-20 AD. Trinovantes or Cunobelin type. Made from copper alloy.	633570	163900	HER MKE10032
1014	Iron Age	Gaulish iron age coins, Cottington Hill, Minster - Findspot	Three iron age coins, found by metal detectorist, dated to the mid-1st century BC. Made of copper alloy.	633660	163900	HER MKE10033
1015	Iron Age	Late iron age coin, Cottington Hill, Minster - Findsport	A late iron age coin, found by metal detectorist, Trinovantian type, dated to c. 10BC - 10AD.	633600	163900	HER MKE10034
1016	Iron Age	Late iron age coin, Cottington Hill, Minster - Findspot	A late iron age coin found by a metal detectorist. Cantian type, from the reign of Dubnovellaunus. Dated to c. 23-17BC. The coin is made of silver.	633680	163900	HER MKE10035
1017	Iron Age	Iron age coin, Cottington Hill, Minster - Findspot	A late iron age coin, found by a metal detectorist. Identified as Cantian type, it was dated to c. 100BC. It was made from cast bronze potin.	633730	163900	HER MKE10036
1018	Iron Age	Late iron age coin, Cottington Hill, Minster - Findspot	An iron age coin was found by a metal detectorist. Dated to mid to late 1st century BC. It was made of silver.	633600	163900	HER MKE10037
1019	Iron Age	Iron age burials (found 1959)	Iron Age burials. Skeletal remains dated to 300-200 BC. Some pottery was also found.	634940	164330	HER MKE8072
1020	Romano-British	Romano-British drainage ditches, hearth and two inhumations	Romano-British drainage ditches, hearth and two inhumations.	633894	164001	HER MKE21076
1021	Romano-British	Romano-British pits and associated materials, Cottington Hill, Minster parish	Romano-British pits and associated materials, including late 3rd and 4th century pottery sherds, including coarse wares and Samian wares.	633800	163900	HER MKE8114
1022	Romano-British	Romano-British occupation site, Cliffs End, Minster parish	Romano-British occupation site. Discovery of Samian pottery, other fine wares and building materials suggest a Roman villa site. Belgic remains were also reported.	633800	164100	HER MKE8118
1023	Romano-British	Romano-British ditches, sunken featured building, two cemeteries and pit containing prehistoric pottery	Romano-British ditches, sunken featured building, two cemeteries and a pit containing prehistoric pottery.	633990	164382	HER MKE21075

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1024	Romano-British	Romano-British features at Cliffsend.	The grave of a mature adult was found, finds of a nail and a Belgic sherd, animal bones and shells.	635300	164500	HER MKE15421
1025	Romano-British	Romano-British coins brooch and key	Romano-British coins, a brooch and a key.	635250	164450	HER MKE8038
1026	Romano-British	Samian Cup - Findspot	1st century Samian cup, dredged up in Pegwell Bay in 1902	635500	163500	NMR_469465
1027	Saxon	Saxon landing site, Ebbsfleet, Minster parish	The traditional landing site of the Saxons in AD 449, based on the Anglo-Saxon Chronicle. It is also thought that St Augustine may have landed here in AD 597. Site no longer suitable landing place due to land reclamation.	633600	163100	HER MKE8057
1028	Saxon	St Augustine's Well	St Augustine's Well. This natural spring is the traditional spot where St Augustine camped with his monks on reaching England in AD 597.	634370	163940	HER MKE8058
1029	Medieval	Medieval well shaft	Medieval well shaft.	635750	164380	HER MKE8036
1030	Medieval	Medieval well shaft	Medieval well shaft. The well shaft is only 4m from a small cave entrance leading northward into a complex system of tunnels, reputedly smugglers' caves.	635750	164300	HER MKE8037
1031	Medieval	Possible medieval wall	Possible medieval wall	635800	164000	NMR_469505
1032	Medieval	Early medieval/medieval pit, Cottington Hill, Minster parish	Early medieval/medieval pit. Contained pottery sherds of Tyler Hill and shell tempered pottery from Canterbury and North Kent. Dated to 1050-1100 AD.	633500	163600	HER MKE8115
1033	Medieval	Possible medieval farmstead, Ebbsfleet Farm, Ramsgate	Infilled ditches and pottery sherds - possibly a ditch-enclosed medieval farmstead.	634400	162600	HER MKE15892
1034	Medieval	Possible sunken medieval building near Ebbsfleet Farm	Remains of a possible sunken medieval building. A pit found at the site contained medieval pottery dating to the late 12th to early 13th C. Shellfish remains were also found nearby.	633336	163094	HER MKe17382
1035	Medieval	Probable medieval ditch-enclosed farmstead, near Weatherless Water Treatment Works, Minster parish	Remains of a ditch enclosing a 13th and 14th century farmstead.	633409	162616	HER MKe17355
1036	Medieval	Medieval remains	Medieval remains including fragments of jugs and flagons with dark green glaze. All pottery dated to 13th and 14th century.	635700	164400	HER MKE8027

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1037	Medieval	14th century sea wall, Minster, Ramsgate and Sandwich parishes	A 14th century sea wall. The remains of boarded groin structures extend at least 1.5km and are thought to be the remains of a seawall built in 1365 after an inundation of the sea between Cliffsend and Stonar.	634065	162995	HER MKE8053
1038	Post medieval	Site of Cliffsend Crossing chalk pit	A chalk pit, marked on Ordnance Survey maps.	634550	164750	HER MKE16441
1039	Post medieval	Grade NG listed building. Main construction periods 1737-1737	Grade NG listed building. Main construction period 1737. No. 53 and 5 Foad's Lane.	634592	164257	HER MKE34758 NMR_171743
1040	Modern	St Augustine's Cross	St Augustine's Cross. Carved Celtic cross on a stepped base, erected in 1884 to commemorate the landing of St Augustine in AD 596 at Ebbsfleet in Pegwell Bay.	634030	164160	HER MKE8085 NMR_421310
1041	Modern	Richborough RAF Salvage Yard	Richborough RAF Salvage Yard.	633700	162400	HER MKE42006
1042	Modern	Modern trench, Ebbsfleet, Minster parish	Slit Trench. The cropmarks of a zig-zagged slit trench have been identified in the fields near Ebbsfleet, and were recorded from aerial photographs.	633340	163320	HER MKE8106
1043	WWI	Richborough Train Ferry Dock	Train Ferry dock built during WWI.	633990	162190	HER MKE41999
1044	WWII	PILLBOX	Pillbox	634600	164100	HER MKE39399
1045	WWII	PILLBOX	Pillbox	634000	163800	HER MKE39400
1046	WWII	PILLBOX	Pillbox	635400	164500	HER MKE39669
1047	WWII	PILLBOX	Pillbox	635300	165300	HER MKE39694
1048	WWII	PILLBOX	Pillbox	635500	164900	HER MKE39695
1049	WWII	PILLBOX	Pillbox	635100	164500	HER MKE39696 NMR_1423869
1050	WWII	PILLBOX (TYPE FW3/24)	Standard type 24 pillbox	634000	163200	HER MKE39115

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1051	WWII	PILLBOX	Pillbox	633700	164400	HER MKE39392
1052	WWII	COASTAL BATTERY	Bethlehem Battery - 6in breech loading guns.	634000	164000	HER MKE39272
1053	WWII	GUN EMPLACEMENT	Pair of coastal artillery emplacements.	635682	164405	HER MKE39313
1054	WWII	WWII battery at Little Cliffsend Farm, Ramsgate	A pair of coastal artillery emplacements or battery bunkers.	635700	164490	HER MKE16630
1055	WWII	SLIT TRENCHES	Slit trench	635200	164300	NMR_469492
1056	Multiperiod	Romano British Landscape, inhumation burial and possible WWII anti-aircraft station	Romano-British landscape, inhumation burial and possible WWII anti-aircraft station	633509	163494	HER MKE21077
1057	Multiperiod	Site of former Saltworks, Ebbsfleet, Ramsgate	Earthworks of a salt works - located in a former WWII minefield. A Saltings is marked on Ordnance Survey maps	634100	162300	HER MKE15880
1058	Multiperiod	Prehistoric, Romano-British and Medieval enclosure and boundary ditches and two middens with Bronze Age pottery	Prehistoric, Romano-British and medieval enclosure and boundary ditches and two middens with Bronze Age pottery.	633440	163035	HER MKE21078
1059	Multiperiod	Prehistoric finds and Tudor remains, Cottington Hill, Minster parish	Two sites were found during archaeological excavation. Prehistoric pottery and worked flint. Iron-working artefacts and 16th - 17th century pottery.	633700	163900	HER MKE15864
1060	Multiperiod	Multiperiod occupation, Ebbsfleet farm.	Multiperiod occupation - Bronze Age, Iron Age, Romano-British, medieval and later periods. Settlement material and Late Bronze Age hoard, dated to 9/8 BC.	633200	163000	HER MKE15983
1061	Multiperiod	Multi period remains, Oaklands nursery, Ramsgate	Multiperiod. Ditches containing Iron Age, Romano-British and early medieval pottery. Pits, postholes and evidence of medieval revetment. Possibly the remains of a long-lived domestic settlement.	634470	164500	HER MKE17172
1062	Multiperiod	Bronze Age and Saxon evidence found at Cliffs End Farm in 2004	Bronze Age and Saxon evidence. Site appears to have been used for funerary and ceremonial purposes. Early Bronze Age evidence included four barrows. Late Bronze Age: series of horseshoe enclosures. Saxon: 24 burials.	634794	164266	HER MKE41621

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1063	Multiperiod	Multi period site on on Cottington Hill, Minster parish	Iron Age and Romano-British pottery was found during a rescue excavation. The remains of a Romano-British building was also identified, with a possible late 2nd century date.	633400	163300	HER MKE8113
1064	Multiperiod	Multi period site at Ebbsfleet Farm, near Ramsgate	Multiperiod site. A Bronze Age beaker burial, Iron Age occupation site comprised of pits and ditches (200-50BC) and a Romano-British building (2nd century AD). Romano-British pottery, brick, tile, a coin, rotary quern and buckles were found nearby.	634220	163370	HER MKE9058
1065	Undated	Undated archaeological features, Beech Grove, Ramsgate	Number of features located during watching brief, including possibly late Bronze Age hut circles with a drip trench. Lack of pottery may indicate low occupation.	634370	164160	HER MKE15849
1066	Undated	Undated crouched inhumation burial, Cliffsend, Ramsgate	A crouched inhumation burial was found during a watching brief.	634450	164700	HER MKE15879
1067	Undated	Ring ditch cropmark, Manston	Ring ditch cropmarks, recorded from aerial photographs.	634980	165210	HER MKE7958
1068	Undated	Ring ditch cropmarks, Ramsgate	Ring ditch cropmarks, recorded from aerial photographs.	635550	164600	HER MKE8022
1069	Undated	Area cropmark features, Ramsgate	Large feature cropmark. Identified from aerial photographs.	635560	164500	HER MKE8026

APPENDIX V – ENGLISH WATERS – GAZETTEER OF SITES RECORDED BY UKHO AND GEOPHYSICAL ANOMALIES (FIGURE 8-12)

This appendix includes a list and description of the data for the English waters produced by the UKHO and MMT (see **Figure 8**, **9** & **10**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7000	Magnetic	387232	5686828	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6361 (mag)	-
7001	Magnetic	387641	5686670	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6360 (mag)	-
7002	Magnetic	388058	5686468	A2	-	-	-	87	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6359 (mag)	-
7003	Magnetic	388087	5686618	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6357 (mag)	-
7004	Magnetic	388256	5686219	A2	-	-	-	140	Large well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6355 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7005	Magnetic	388230	5686392	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6354 (mag)	-
7006	Magnetic	388318	5686372	A2	-	-	-	21	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6353 (mag)	-
7007	Magnetic	388536	5686262	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6352 (mag)	-
7008	Magnetic	388528	5686325	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6351 (mag)	-
7009	Magnetic	388558	5686409	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6349 (mag)	-
7010	Debris	388624	5686195	A2	3.1	1.2	0.7	-	Angular dark reflector with shadow but no associated magnetic anomaly. Possibly a piece of non-ferrous debris.	6348 (sss)	-
7011	Dark Reflector	388824	5686071	A2	3.5	0.4	0.5	-	Large dark reflector with large shadow but no associated magnetic anomaly. In an area of variable seabed refelctivity, and could be natural or a piece of non-ferrous debris.	6347 (sss)	-
7012	Magnetic	388969	5686187	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6346 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7013	Magnetic	388873	5686278	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6345 (mag)	-
7014	Magnetic	388963	5685893	A2	-	-	-	49	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6344 (mag)	-
7015	Magnetic	389083	5686027	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6343 (mag)	-
7016	Debris	389174	5685947	A2	4.3	0.8	0.2	-	Short linear dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried non-ferrous debris.	6341 (sss)	-
7017	Recorded Wreck [Live]	389200	5685809	A3	-	-	-	-	Recorded location of the wreck of the *Pisces* (lost 1995), not identified by any of the geophysical equipment. Could be an inaccurate location, or the wreck could be covered by the sand waves currently present at the site.	6340 (db), 2005	15159 (UKHO)
7018	Magnetic	389479	5686018	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6339 (mag)	-
7019	Dark Reflector	389477	5685848	A2	1.4	0.4	0.3	-	Isolated dark reflector with a shadow but no associated magnetic anomaly. Located in ana rea of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6338 (sss)	-
7020	Magnetic	389686	5685873	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6337 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7021	Dark Reflector	389658	5685681	A2	4.6	1.4	0.3	-	Indistinct dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6336(sss)	-
7022	Rope / Chain	389892	5685888	A2	42.8	1.1	0.0	13	long linear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6335 (sss and mag)	-
7023	Magnetic	389953	5685752	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6334 (mag)	-
7024	Wreck	389786	5685532	A1	31.4	4.8	0.8	66	Previously unrecorded wreck identified by all geophysical equipment. Structure is relatively small and appears to be mostly buried, though still retains some structure and height. Medium magnetic anomaly indicates it is at least partly ferrous in nature. The wreck is orientated NNE - SSW, and is situated within a scour approximately 30m x 11m x 0.4m. A large sand wave lies to the north and east, so the structure is probably periodically buried.	6332 (sss and mag)	-
7025	Magnetic	390809	5685336	A2	-	-	-	53	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6331 (mag)	-
7026	Magnetic	390940	5685330	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6330 (mag)	-
7027	Debris	391279	5685143	A1	21.9	17.6	0.0	59	Area of dark reflectors with shadows associated with a medium magnetic anomaly. Located in an area of sand ripples and probably partially buried ferrous debris or the remains of a badly degraded structure.	6329(sss and mag)	-
7028	Magnetic	391380	5685057	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6328 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7029	Debris	391445	5685053	A2	8.1	0.7	0.0	-	Short linear dark refletcor with no shadow or associated magnetic anomaly. Located in an area of sand ripples and could be a piece of linear non-ferrous debris.	6327 (sss)	-
7030	Debris	391390	5685113	A2	0.9	1.8	0.0	-	Two adjacent angular dark reflectors, possibly with shadows but uncertain. No associated magnetic anomaly. Located in an area of sand ripples and could be pieces of partially buried non-ferrous debris.	6326 (sss)	-
7031	Debris	391669	5684906	A2	9.4	0.1	0.2	-	Linear alignment of numerous dark reflectors with large shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6325 (sss)	-
7032	Magnetic	392015	5684828	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6324 (mag)	-
7033	Magnetic	391836	5685008	A2	-	-	-	36	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6323 (mag)	-
7034	Debris	392435	5684935	A2	16.5	2.2	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Located on the edge of a sand wave and possibly an area of partially buried non-ferrous debris.	6322 (sss)	-
7035	Debris	392573	5685151	A2	22.8	1.1	0.5	-	Linear alignment of numerous dark reflectors with large shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6321 (sss)	-
7036	Magnetic	392916	5685167	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6320 (mag)	-
7037	Dark Reflector	392912	5685102	A2	1.7	0.3	0.3	-	Elongate dark reflector with a shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6319 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7038	Debris	393045	5685032	A2	10.7	3.1	0.0	52	Small area of disturbed seabed associated with a medium magnetic anomaly. Possible area of ferrous debris.	6318 (sss and mag)	-
7039	Magnetic	393180	5685073	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6317 (mag)	-
7040	Magnetic	393315	5684950	A2	-	-	-	51	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6316 (mag)	-
7041	Debris	393445	5685057	A2	3.3	0.2	0.6	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Possible piece of linear non-ferrous debris.	6315 (sss)	-
7042	Dark Reflector	393368	5685144	A2	0.9	0.4	0.7	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6314 (sss)	-
7043	Debris	393925	5685063	A2	18.1	2.3	0.0	-	A linear alignment of three closely spaced dark reflectors with shadows but without an associated magnetic anomaly. Possible area of non-ferrous debris.	6312 (sss)	-
7044	Debris	394215	5685254	A2	7.0	0.1	0.1	-	Short linear dark reflector with small shadow but without an associated magnetic anomaly. Possible piece of non-ferrous linear debris.	6311 (sss)	-
7045	Debris	394416	5685134	A2	15.5	4.0	0.0	-	A small area of angular dark and bright reflectors but no associated magnetic anomaly. Possible area of non-ferrous debris.	6310 (sss)	-
7046	Magnetic	394591	5685135	A2	-	-	-	37	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6309 (mag)	-
7047	Debris	394777	5685245	A1	22.2	10.7	0.0	43	Area of angular bright reflectors associated with a medium magnetic anomaly. Probably an area of ferrous debris, or the remains of a highly degraded structure.	6308 (sss and mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7048	Magnetic	395169	5685372	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6307 (mag)	-
7049	Debris [Live Obstruction]	395957	5685445	A1	7.2	6.5	0.9	6	Large, elongate dark reflector (or collection of reflectors) with large shadow and associated with a small magnetometer contact. Identified on multibeam bathymetry data as a depression measuring 22m x 15m x 0.5m, probably representing a scour. Probably an area of debris or the remains of a badly degraded structure. Observed at the location of a known obstruction (foul ground).	6305 (sss and mag), 2017	75358 (UKHO)
7050	Dark Reflector	396102	5685521	A2	1.1	0.4	0.4	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6304 (sss)	-
7051	Debris	396271	5685652	A2	5.3	0.3	0.4	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Possibly a piece of non-ferrous debris.	6303 (sss)	-
7052	Rope / Chain	396359	5685603	A2	150.0	0.5	0.2	-	Very long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Possible length of rope or chain. Dark reflector with shadow at one end is possibly an anchor, indicating it is still probably attached to the sea bed. Length is approximate.	6302 (sss)	-
7053	Rope / Chain	396516	5685581	A2	65.0	0.5	0.3	-	Long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Possible length of rope or chain.	6301 (sss)	-
7054	Rope / Chain	396645	5685518	A2	46.5	0.2	0.2	-	Long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Reflector curves back on itself, and is probably length of rope or chain.	6300 (sss)	-
7055	Dark Reflector	396527	5685687	A2	2.2	0.6	0.5	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6299 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7056	Bright Reflector	396486	5685711	A2	2.4	1.9	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6298 (sss)	-
7057	Debris	396470	5685781	A2	4.5	0.1	0.2	-	Short linear dark reflector with a small shadow but without an associated magnetic anomaly. Possible piece of non-ferrous debris.	6297 (sss)	-
7058	Rope / Chain	396612	5685727	A2	26.0	0.2	0.2	-	Curvilinear dark reflector with a small shadow but no associated magnetic anomaly. Possible length of rope or chain.	6296 (sss)	-
7059	Debris	396655	5685646	A2	31.9	2.0	0.6	-	Linear alignment of a number of dark reflectors with shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6295 (sss)	-
7060	Dark Reflector	396739	5685615	A2	3.1	0.4	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly, one larger than the other. Could be natural or non-ferrous debris.	6294 (sss)	-
7061	Debris	396822	5685599	A2	6.9	4.7	0.0	-	Small area of indistinct dark reflectors with small shadows, possibly attached to a linear dark reflector. No associated magnetic anomaly, but possibly an area of non-magnetic debris.	6293 (sss)	-
7062	Magnetic	396873	5685981	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6292 (mag)	-
7063	Dark Reflector	397255	5685875	A2	3.8	3.8	0.0	-	Poorly defined dark reflector without a shadow or associated magnetic anomaly. Could be natural or a piece of non-ferrous debris. Poor data quality makes definitive identification difficult.	6291 (sss)	-
7064	Dark Reflector	397455	5686059	A2	0.8	0.1	0.6	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6290 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7065	Magnetic	397745	5686029	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6289 (mag)	-
7066	Rope / Chain	399165	5686341	A2	15.7	0.5	0.2	8	Curvilinear dark reflector with a small shadow and possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6285 (sss and mag)	-
7067	Debris	399344	5686534	A2	6.9	0.6	0.3	-	Short, linear alignment of dark reflectors with shadows but no associated magnetic anomaly. Possible piece of partially buried non-ferrous debris.	6284 (sss)	-
7068	Magnetic	400885	5686280	A2	-	-	-	27	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6282 (mag)	-
7069	Magnetic	400723	5686583	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6281 (mag)	-
7070	Bright Reflector	401708	5686249	A2	3.7	2.1	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6280 (sss)	-
7071	Magnetic	404638	5686808	A2	-	-	-	22	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6275 (mag)	-
7072	Magnetic	404373	5686770	A2	-	-	-	43	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6274 (mag)	-
7073	Dark Reflector	406312	5687241	A2	1.4	0.2	0.8	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6269 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7074	Debris	406615	5687129	A2	10.7	9.9	0.6	-	Area of dark reflectors with shadows but no associated magnetic anomaly. Possibly an area of non-ferrous debris.	6268 (sss)	-
7075	Debris	406749	5687159	A2	2.3	0.2	1.3	73	Short linear dark reflector with a large shadow and associated with a medium magnetic anomaly. Probably a piece of ferrous debris.	6267 (sss and mag)	-
7076	Magnetic	406995	5686963	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6266 (mag)	-
7077	Dark Reflector	407402	5687204	A2	0.9	0.5	0.6	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6262 (sss)	-
7078	Magnetic	408188	5687115	A2	-	-	-	24	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6261 (mag)	-
7079	Debris	408332	5687243	A2	1.1	0.6	0.7	8	Dark reflector with shadow and possibly associated with a small magnetic anomaly. Located in an area of sand ripples and could be a partially buried piece of ferrous debris.	6260 (sss and mag)	-
7080	Debris	408730	5686800	A2	24.0	23.0	2.0	-	Large, irregular dark reflector with large shadow but no associated magnetic anomaly. Identified on multibeam bathymetry data as an isolated seabed mound. Possibly an area of non-ferrous debris or small structure, but no recorded wreck or obstruction is known in the vicinity.	6259 (sss)	-
7081	Magnetic	408940	5687020	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6258 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7082	Magnetic	408545	5687020	A2	-	-	-	53	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6257 (mag)	-
7083	Magnetic	408963	5687178	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6256 (mag)	-
7084	Magnetic	408805	5687250	A2	-	-	-	50	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6255 (mag)	-
7085	Dark Reflector	409160	5687350	A2	2.1	1.0	0.8	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6254 (sss)	-
7086	Dark Reflector	409556	5687204	A2	1.4	1.1	1.3	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6252 (sss)	-
7087	Dark Reflector	410579	5686862	A2	3.7	1.0	1.4	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6251 (sss)	-
7088	Debris	410623	5687218	A2	3.5	2.5	1.5	22	Large, irregular dark reflector with large shadow and an associated small magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried ferrous debris.	6250 (sss and mag)	-
7089	Rope / Chain	411082	5686753	A2	64.4	0.2	0.0	-	Long, curvilinear dark reflector without a shadow or an associated magnetic anomaly. Possible length of rope or chain.	6247 (sss)	-
7090	Dark Reflector	411329	5686921	A2	2.7	0.5	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Could be natural or non-ferrous debris.	6246 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7091	Debris	411657	5686985	A2	2.8	0.6	0.8	8	Dark reflector with shadow and possibly associated with a small magnetic anomaly. Located in an area of sand ripples and could be a partially buried piece of ferrous debris.	6244 (sss and mag)	-
7092	Rope / Chain	412342	5686875	A2	218.2	0.3	0.0	11	Long, curvilinear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6243 (sss and mag)	-
7093	Magnetic	412548	5687140	A2	-	-	-	22	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6242 (mag)	-
7094	Magnetic	414243	5686620	A2	-	-	-	80	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6241 (mag)	-
7095	Magnetic	413768	5686708	A2	-	-	-	57	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6240 (mag)	-
7096	Magnetic	413545	5687065	A2	-	-	-	40	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6239 (mag)	-
7097	Magnetic	413853	5687190	A2	-	-	-	28	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6238 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7098	Debris	416527	5686440	A1	9.3	9.4	0.6	16	Two poorly defined, short, parallel linear dark reflectors with shadows possibly associated with a small magnetic anomaly. Possible partially buried ferrous debris.	6237 (sss and mag)	-
7099	Magnetic	417010	5687098	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6236 (mag)	-
7100	Dark Reflector	419566	5686703	A2	4.5	1.4	0.5	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6232 (sss)	-
7101	Magnetic	419615	5686950	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6231 (mag)	-
7102	Debris	419829	5686989	A2	4.2	0.5	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Possible non-ferrous debris.	6230 (sss)	-
7103	Magnetic	420240	5686780	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6229 (mag)	-
7104	Magnetic	420162	5687000	A2	-	-	-	15	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6228 (mag)	-
7105	Magnetic	421212	5686530	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6227 (mag)	-
7106	Magnetic	420832	5686618	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6226 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7107	Magnetic	421335	5686898	A2	-	-	-	41	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6225 (mag)	-
7108	Dark Reflector	421784	5686542	A2	2.4	0.7	0.5	-	Dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6224 (sss)	-
7109	Debris	421877	5686734	A2	7.2	0.2	0.3	-	Small linear dark reflector, or linear alignment of dark reflectors, with shadow but no associated magnetic anomaly. Possible piece of partially buried non-ferrous debris.	6223 (sss)	-
7110	Magnetic	420240	5686780	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6222 (mag)	-
7111	Magnetic	422115	5686878	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6221 (mag)	-
7112	Magnetic	422675	5686565	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6220 (mag)	-
7113	Magnetic	423322	5686700	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6219 (mag)	-
7114	Magnetic	426255	5686465	A2	-	-	-	5	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6218 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7115	Magnetic	425015	5686495	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6217 (mag)	-
7116	Debris	427338	5686310	A2	2.2	0.5	0.3	-	Elongate dark reflector with small shadow but no associated magnetic anomaly. Possible piece of debris.	6216 (sss)	-
7117	Magnetic	427157	5686328	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6215 (mag)	-
7118	Magnetic	427542	5686575	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6214 (mag)	-
7119	Magnetic	427227	5686650	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6213 (mag)	-
7120	Dark Reflector	428537	5686309	A2	2.0	0.7	0.4	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6212 (sss)	-
7121	Magnetic	428312	5686640	A2	-	-	-	5	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6211 (mag)	-
7122	Magnetic	429115	5686330	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6210 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7123	Magnetic	428047	5686323	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6209 (mag)	-
7124	Magnetic	428565	5686575	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6208 (mag)	-
7125	Magnetic	430585	5686625	A2	-	-	-	74	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6206 (mag)	-
7126	Magnetic	429655	5686630	A2	-	-	-	49	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6205 (mag)	-
7127	Dark Reflector	430665	5686454	A2	5.6	0.7	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Located in an area of sand waves and could be natural or partially buried non-ferrous debris.	6204(sss)	-
7128	Magnetic	431548	5686467	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6203 (mag)	-
7270	Recorded Wreck [Live]	386196	5685927	A3					Outside geophysical survey area. Wreck of the *Harvest Moon*.	2001	HER MKE13504
7271	Recorded Wreck [Live]	386609	5685964	A3					Outside geophysical survey area, abandoned four wheel drive vehicle.	2002	70367 (UKHO)
7272	Recorded Wreck [Live]	386928	5685054	A3					Outside geophysical survey area.	2003	13834 (UKHO), NMR 900604

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7273	Recorded Wreck [Live]	388921	5686408	A3					Outside geophysical survey area, steel tank.	2004	13844 (UKHO)
7274	Recorded Wreck [Live]	389454	5685030	A3					Outside geophysical survey area. Wreck of *LCP 586*	2006	13835 (UKHO)
7275	Recorded Wreck [Live]	396314	5685228	A3					Outside geophysical survey area.	2007	NMR 904884
7276	Recorded Wreck [Live]	396458	5686183	A3					Outside geophysical survey area. Wreck of the *Rydal Force*.	2008	13843 (UKHO), NMR 900887
7277	Recorded Wreck [Live]	404300	5687128	A3					Outside geophysical survey area.	2009	13850 (UKHO), NMR 904893
7278	Recorded Obstruction [Live]	386999	5687322	A3					Outside geophysical survey area.	2010	59030 (UKHO)
7279	Recorded Obstruction [Live]	387015	5685955	A3					Outside geophysical survey area.	2011	70374 (UKHO)
7280	Recorded Obstruction [Live]	387205	5686978	A3					Outside geophysical survey area.	2012	59034 (UKHO)
7281	Recorded Obstruction [Live]	387423	5687284	A3					Outside geophysical survey area.	2013	59031 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7282	Recorded Obstruction [Live]	387519	5687243	A3					Outside geophysical survey area.	2014	59032 (UKHO)
7283	Recorded Obstruction [Live]	387685	5686971	A3					Outside geophysical survey area.	2015	59033 (UKHO)
7284	Recorded Obstruction [Live]	389348	5686330	A3					Outside geophysical survey area.	2016	15015 (UKHO)
7285	Recorded Obstruction [Live]	403019	5685997	A3					Outside geophysical survey area.	2018	13842 (UKHO)
7286	Recorded Wreck [Lift]	386798	5686089	A3					Outside geophysical survey area, abandoned Suzuki Jeep.	2019	70366 (UKHO)
7287	Recorded Wreck [Lift]	389816	5686073	A3					Outside geophysical survey area, wreck lost 1986.	2020	58820 (UKHO)
7288	Recorded Obstruction [Dead]	403493	5686941	A3					Outside geophysical survey area.	2021	58893 (UKHO)

APPENDIX VI – ENGLISH WATERS – RECORDED LOSSES

This appendix includes a list and description of the data for Recorded Losses supplied by the NMR. Recorded Losses provide information about the archaeological potential of an area, as they indicate ships that are known to have wrecked in the area, but whose remains have generally not been located on the seabed. When considering Recorded Losses it is important to note that the descriptions regarding the location of a wrecking incident are often vague. Consequently, the positions of recorded losses are often inaccurate, and therefore they have not been illustrated on any of the Figures. In addition to this, the temporal distribution of these Recorded Losses should not be regarded as representative of the density of shipping activity within the given periods. The number of documented losses is dependant on the reporting of the loss and the survival of the record of that loss. Note: There is no equivalent table for Belgian Recorded Losses as the information was not readily available.

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1201		55BC	Wreck of unknown number of Roman transport vessels lost during a sudden storm during Caesar's first invasion of Britain in 55 BC from Gaul, most likely in the vicinity of Kent which has traditionally been regarded as the site of the Roman landings.	387177	5684490	1508031
1202		55BC	Wreck of unknown number of Roman warships wrecked on the strand at the landing site during a sudden storm during Caesar's first invasion of Britain in 55 BC from Gaul.	387177	5684490	1508029
1203	*Nicholas*	1318	Wreck of English cargo vessel (wooden sailing ship) which foundered after being scuttled off Sandwich by Flemish pirates. Her cargo included wine, flour, whalebone, nut oil, vinegar, saffron, and pepper, suggesting that she was homeward-bound to London.	387177	5684490	1445015
1204	*La Seyne Anton*	1359	Wreck of Spanish cargo vessel (wooden sailing ship) which was wrecked near Sandwich, laden with cloth.	387177	5684490	1445835
1205	*La Seinte Marie de Burgh*	1364	Wreck of French cargo vessel (wooden sailing ship) which stranded at Sandwich en route from Sluis to Spain with cloth, silver plate and gold and silver coins.	387177	5684490	1247201
1206		Tudor	Wreck of wooden sailing ship that stranded at Sandwich.	387177	5684490	1444029
1207		1542	Wreck of French cargo vessel which stranded at Sandwich. Constructed of wood, she was a sailing vessel.	387177	5684490	1444027
1208		1653	Wreck of Dutch East Indiaman (wooden sailing ship) which stranded near Sandwich with her general cargo.	387177	5684490	1247841

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1209	*Biscay Merchant*	1682	English wooden sailing ship carrying cargo that was driven out of Margate Roads and stranded near Sandwich Bay. Reported to have broken up.	387177	5684490	1247917
1210		1690	Wreck of a wooden sailing vessel, nationality unknown, which stranded near Sandwich after being "forced out of the Downs" by a gale. The vessel had been captured as a prize by some Ostend privateers.	387177	5684490	1449037
1211	*Falklands Prize*	1705	Wreck of British wooden warship variously described as a Fourth Rate or Fifth Rate ship of the line, which was beached at Sandwich after being driven from her moorings in the Downs. The wreck was later broken up and sold. The vessel may have been the French warship *La Seine* of the 'flute' type captured the previous year.	387177	5684490	1248521
1212	*Race Horse Galley*	1711	Wreck of British "galley" (wooden sailing vessel) which capsized on her maiden voyage from Deptford to the Straits of Gibraltar, thought to be in the vicinity of Sandwich Flats. Possibly a privateer.	387177	5684490	1370384
1213	*Dolphin*	1735	Wooden sailing ship wrecked on Sandwich flats during a storm	387177	5684490	1368560
1214	*Industry*	1735	Wooden sailing ship lost on Sandwich flats after storm	387177	5684490	1368561
1215		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248661
1216		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane"..	387223	5686340	1248643
1217		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248648
1218		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248641
1219		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248646
1220		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248647
1221		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248663
1222		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248601
1223		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248644

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1224		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248621
1225		1768	A brigantine (wooden sailing ship) collier was driven on shore on Sandwich Flats.	387177	5684490	1249021
1226	*Rose Hall*	1771	Wreck of British wooden sailing ship which stranded on Sandwich Flats en route from Jamaica to London.	387177	5684490	1249026
1227	*Kingston*	1809	A British cargo vessel, bound from London to Jamaica was driven on shore on Sandwich Flats during a violent gale.	387177	5684490	1250185
1228		1815	A foreign fir-built galliot laden with timber and deals wrecked near Shellness during a gale. The cargo drifted ashore but the crew were feared lost.	387177	5684490	1344395
1229	*Ann and Elizabeth*	1815	British cargo vessel wrecked at Shell Ness during the same gale as the galliot (**WA 1228**).	387177	5684490	1344393
1230	*Fame*	1815	British cargo vessel wrecked at Shell Ness during the same gale as the galliot (**WA1228**) and the *Ann and Elizabeth* (**WA1229**).	387177	5684490	1344392
1231	*Hussaren*	1828	Cargo vessel from the Cape of Good Hope, stranded on shore on Sandwich Flats full of water, after losing both anchors and cables in the Downs. The wreck went to pieces and the wreck and part of her cargo was strewed along the shore.	387177	5684490	1356671
1232	*Hannah*	1829	British craft, stranded in Sandwich Harbour.	387177	5684490	1250301
1233		1854	Fir-built vessel of about 120 tons, stranded on Sandwich Flats	387177	5684490	1316421
1234	*Fawn*	1911	A British craft sank following a collision with an unnamed 'blow boat'. The vessel was screw driven with a 3 cylinder triple expansion engine and a single boiler.	387177	5684490	1252783
1235	*Spitfire MK IIA P7386*	1940	The *Supermarine Spitfire Mk 11A* was a standard single-seat fighter, one of a batch of 1000 delivered between June 1940 and July 1941 to Contract No. 981687/39. The Spitfire was damaged by Bf 109s near Dover and abandoned over Sandwich Bay on 14 November 1940. The Spitfire had been built by Castle Bromwich Aircraft Factory and was part of Squadron 74.	387177	5684490	1322076

APPENDIX VII – FRENCH WATERS – GAZETTEER OF SITES RECORDED BY SHOM AND GEOPHYSICAL ANOMALIES (FIGURE 13, 14 AND 15)

This appendix includes a list and description of the data for the French waters produced by the SHOM and MMT (see **Figure 13**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7129	Dark Reflector	434211	5686388	A2	2.0	1.1	0.7	-	Dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6200 (sss)	-
7130	Dark Reflector	434319	5686352	A2	2.3	0.5	1.0	-	Dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6199 (sss)	-
7131	Magnetic	434418	5686434	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6197 (mag)	-
7132	Magnetic	434263	5686561	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6196 (mag)	-
7133	Magnetic	434408	5686596	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6195 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7134	Dark Reflector	434625	5686416	A2	3.5	0.4	1.2	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6194 (sss)	-
7135	Magnetic	436124	5686516	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6192 (mag)	-
7136	Magnetic	436427	5686583	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6190 (mag)	-
7137	Magnetic	436850	5686510	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6189 (mag)	-
7138	Magnetic	437339	5686310	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6188 (mag)	-
7139	Magnetic	437032	5686304	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6187 (mag)	-
7140	Magnetic	437330	5686432	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6186 (mag)	-
7141	Wreck [Live]	438175	5686526	A1	-	-	-	149	A large magnetic anomaly observed as the site of the possible wreck of the HMS *Westella*. Not observed by sidescan sonar or multibeam bathymetry, but a large sand wave approximately 5m high has been observed at the site indicating the wreck is probably completely buried.	6183 (mag), 2023	15475 (UKHO) 21612019 (SHOM)

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7142	Magnetic	440106	5686330	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6179 (mag)	-
7143	Debris	441100	5686592	A2	17.7	0.3	0.1	-	Curvilinear dark reflector with a small shadow but no associated magnetic anomaly. Partially buried by a sand ripples, and possibly a piece of non-ferrous debris.	6178 (sss)	-
7144	Magnetic	441185	5686258	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6177 (mag)	-
7145	Magnetic	442050	5686241	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6174 (mag)	-
7146	Magnetic	442845	5686352	A2	-	-	-	54	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6172 (mag)	-
7147	Magnetic	445301	5685840	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6171 (mag)	-
7148	Recorded Obstruction [Live Obstruction]	445705	5685829	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. It could be the location of an ephemeral feature that no longer exists, or be covered by recent sand waves at the site.	6170 (db, 2025	15784 (UKHO) 21612272 (SHOM)
7149	Dark Reflector	445759	5685531	A2	1.1	0.5	0.8	-	Dark reflector with large shadow but without an associated magnetic anomaly. Located in an area of sand waves and could be natural or a piece of partially buried non-ferrous debris.	6168 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7150	Dark Reflector	446214	5685390	A2	5.5	0.8	1.0	-	Large, well-defined dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6167 (sss)	-
7151	Wreck [Live Wreck]	446702	5685213	A1	95.0	31.0	6.0	13	Large seabed mound identified on the multibeam bathymetry data and associated with a small magnetic anomaly. Probably the known wreck UKHO 15469, though was identified approximately 100m NNW of the given position. Located just outside of the area covered by sidescan sonar, so condition unknown. Only partially imaged by multibeam bathymetry, so dimensions are a minimum, though appears to be orientated approx. ESE - WNW with a large NE - SW trending scour measuring 74m x 40m x 2m on the north side.	6165 (sss and mag), 2024	15469 (UKHO) 21612022 (SHOM)
7152	Magnetic	447633	5685434	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6163 (mag)	-
7153	Magnetic	448381	5685284	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6160 (mag)	-
7154	Debris	448669	5684966	A2	3.8	1.0	0.7	-	Elongate dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried non-ferrous debris.	6159 (sss)	-
7155	Dark Reflector	448995	5684915	A2	2.0	0.4	0.8	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of non-ferrous debris.	6157 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7156	Debris	449246	5684879	A2	2.7	0.4	0.4	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of non-ferrous debris. Located close to other possible debris 7157.	6154 (sss)	-
7157	Debris	449258	5684856	A2	2.5	0.3	0.3	-	Angular dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of non-ferrous debris. Located close to other possible debris 7156.	6153 (sss)	-
7158	Magnetic	449249	5685119	A2	-	-	-	36	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6152 (mag)	-
7159	Rope / Chain	449395	5685250	A2	65.2	0.1	0.1	18	A linear alignment of short linear reflectors with small shadows with a possible associated magnetic anomaly. Probably a partially buried length of rope or chain, periodically exposed between sand ripples	6148 (sss and mag)	-
7160	Magnetic	449586	5685021	A2	-	-	-	45	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6147 (mag)	-
7161	Magnetic	449649	5685286	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6146 (mag)	-
7162	Recorded Obstruction/ Probable Wreck [Live]	450638	5685464	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. A large sand wave currently exists at the site, which could be potentially covering the feature. The UKHO record indicates that this has been described as a 'probable wreck'.	6145 (db), 2026	15471 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7289	Recorded Wreck [Live]	437854	5685881	A3					Outside geophysical survey area. Wreck of the HMS *Blackburn-Rovers*.	2022 (mag)	15472 (UKHO)
7290	Recorded Obstruction [Dead]	432654	5687059	A3					Outside geophysical survey area.	2027	69714 (UKHO)
7291	Recorded Obstruction [Dead]	437707	5686934	A3					Outside geophysical survey area.	2028	15477 (UKHO)

APPENDIX VIII – BELGIAN WATERS – GAZETTEER OF SITES RECORDED BY VIOE AND GEOPHYSICAL ANOMALIES (FIGURE 17 AND 18)

This appendix includes a list and description of the data for the Belgian waters produced by the VIOE and MMT (see **Figure 17** & **18**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7163	Debris	452273	5686101	A2	7.4	1.3	0.0	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of partially buried non-ferrous debris.	6144 (sss)	-
7164	Debris	452259	5686177	A2	4.9	0.2	0.4	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of partially buried non-ferrous debris.	6143 (sss)	-
7165	Dark Reflector	452515	5686435	A2	2.7	0.4	0.8	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6139 (sss)	-
7166	Dark Reflector	452707	5686348	A2	4.5	0.6	1.4	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be natural or a piece of partially buried debris.	6138 (sss)	-
7167	Magnetic	453179	5686655	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6137 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7168	Dark Reflector	453618	5686701	A2	2.3	0.9	0.8	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6135 (sss)	-
7169	Dark Reflector	453687	5686888	A2	1.4	0.8	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6134(sss)	-
7170	Dark Reflector	453888	5686986	A2	1.3	0.8	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6133 (sss)	-
7171	Dark Reflector	454084	5686919	A2	1.6	1.0	1.0	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6132 (sss)	-
7172	Dark Reflector	455057	5687493	A2	1.5	1.0	1.0	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6130 (sss)	-
7173	Dark Reflector	455269	5687224	A2	3.6	0.7	0.8	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6128 (sss)	-
7174	Dark Reflector	455749	5687468	A2	2.2	1.0	1.1	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6124 (sss)	-
7175	Dark Reflector	455878	5687467	A2	1.5	0.4	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6123 (sss)	-
7176	Dark Reflector	455835	5687524	A2	1.9	0.5	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6122 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7177	Debris	456017	5687657	A2	3.1	0.7	0.8		Dark reflector with shadow and scour identified in an area of sand ripples, though no associated magnetic anomaly. Surround by an area of possible disturbed seabed, and could be a piece of partially buried non-ferrous debris.	6121 (sss)	-
7178	Dark Reflector	456166	5687790	A2	5.5	0.5	1.3	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6120 (sss)	-
7179	Magnetic	456315	5687665	A2	-	-	-	47	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6119 (mag)	-
7180	Dark Reflector	456393	5687630	A2	3.2	0.4	0.6	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6118 (sss)	-
7181	Dark Reflector	456686	5687803	A2	2.6	2.1	0.9	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6117 (sss)	-
7182	Debris	456654	5687924	A2	3.6	0.3	0.0	-	Short, curvilinear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear, non-ferrous debris.	6116 (sss)	-
7183	Debris	456566	5687968	A2	1.5	0.4	0.7	-	Elongate dark reflector with shadow but no associated magnetic anomaly, located in an area of sand ripples. Could be natural or a piece of non-ferrous debris	6115 (sss)	-
7184	Magnetic	456935	5687833	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6114 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7185	Magnetic	456738	5687753	A2	-	-	-	38	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6113 (mag)	-
7186	Dark Reflector	456893	5687924	A2	1.0	0.5	0.5	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6112 (sss)	-
7187	Magnetic	456980	5687928	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6110 (mag)	-
7188	Debris	457351	5688358	A2	3.5	1.7	0.0	-	A small, tight cluster of dark reflectors with possible small shadows though without an associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of non-ferrous debris.	6109 (sss)	-
7189	Recorded Obstruction [Dead]	457784	5688212	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere. A large sand wave currently exists at the site, which could be potentially covering an older feature.	6108 (db), 2044	15494 (UKHO)
7190	Magnetic	457638	5688438	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6107 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7191	Debris	458053	5688634	A2	13.3	5.1	0.0	-	Area of dark reflectors located on the edge of a sand wave. No associated magnetic anomaly, but could be partially buried non-ferrous debris.	6106 (sss)	-
7192	Magnetic	458173	5688643	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6105 (mag)	-
7193	Dark Reflector	458551	5688577	A2	2.5	1.2	0.6	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6104 (sss)	-
7194	Magnetic	458425	5688745	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6103 (mag)	-
7195	Debris	458626	5688694	A2	4.3	0.7	0.7	17	Two dark reflectors with large shadows, located on the edge of a sand wave. Possibly associated with a magnetic anomaly, but this is uncertain. Possible piece of partially buried ferrous debris..	6101, 6102 (sss and mag)	-
7196	Dark Reflector	459008	5688663	A2	2.2	0.9	1.1	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6100 (sss)	-
7197	Magnetic	459388	5689123	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6099 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7198	Magnetic	460200	5689358	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6098 (mag)	-
7199	Dark Reflector	460457	5689409	A2	3.0	0.5	0.6	-	Elongate dark reflector with shadow but no associated magnetic anomaly, located in an area of sand ripples. Could be natural or a piece of non-ferrous debris. Located next to a similar, smaller contact and could be related (not tagged).	6097 (sss)	-
7200	Wreck [Live]	460851	5689298	A1	90.7	32.1	4.4	64	Location of the known wreck *Tringa*, identified by all of the geophysical equipment. The wreck appears badly broken up, though still exhibits some structure and significant height. Medium magnetic anomaly suggests at least part of the structure is ferrous in nature. No scour or large debris field identified, just one piece of discrete debris some distance from the wreck. Orientated NE - SW.	6095, 6096 (sss, mag and db), 2029	15506 (UKHO) 121/226 (VIOE)
7201	Magnetic	461040	5689458	A2	-	-	-	48	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, possibly from nearby wreck 7200.	6094 (mag)	-
7202	Dark Reflector	461406	5689561	A2	2.3	0.6	0.7	-	Large dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6092 (sss)	-
7203	Dark Reflector	461482	5689613	A2	2.3	0.8	0.9	-	Large dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6091 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7204	Magnetic	463391	5690163	A2	-	-	-	27	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6088 (mag)	-
7205	Magnetic	464335	5690448	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6087	-
7206	Recorded Obstruction [Dead]	465231	5690719	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere.	6086 (db), 2045	15520 (UKHO) (VIOE)
7207	Recorded Obstruction [Dead]	466392	5690773	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere. A large sand wave currently exists at the site, which could be potentially covering an older feature.	6084 (db), 2046	15522 (UKHO)
7208	Magnetic	467863	5690633	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6082 (mag)	-
7209	Magnetic	467558	5690863	A2	-	-	-	31	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6081 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7210	Magnetic	467125	5691028	A2	-	-	-	74	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6080 (mag)	-
7211	Magnetic	467398	5691028	A2	-	-	-	52	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6079 (mag)	-
7212	Magnetic	466225	5690788	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6078 (mag)	-
7213	Magnetic	466545	5690940	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6077 (mag)	-
7214	Magnetic	466373	5690935	A2	-	-	-	47	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6076 (mag)	-
7215	Magnetic	465953	5690870	A2	-	-	-	50	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6075 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7216	Magnetic	471268	5688860	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6074 (mag)	-
7217	Magnetic	469655	5689035	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6073 (mag)	-
7218	Magnetic	470430	5688920	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6072 (mag)	-
7219	Magnetic	470325	5688710	A2	-	-	-	29	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6071 (mag)	-
7220	Magnetic	468740	5689445	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6070 (mag)	-
7221	Magnetic	468543	5689598	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6069 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7222	Magnetic	474883	5688625	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6068 (mag)	-
7223	Magnetic	474233	5688825	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6067 (mag)	-
7224	Magnetic	473320	5688805	A2	-	-	-	48	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6063 (mag)	-
7225	Debris	479141	5688334	A2	4.7	2.8	2.5	-	Large dark reflector with large shadow, located on the edge of a sand wave. Possibly associated with an 80nT magnetic anomaly, though this is more likely to have been created by the large sand waves in the area. Possible piece of debris, or a partially buried structure.	6062 (sss)	-
7226	Magnetic	482608	5688465	A2	-	-	-	109	Large, broad magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. Located along a line of noisy data, so could be noise, but is large so could also indicate a large piece of buried ferrous debris.	6061 (mag)	-
7227	Magnetic	483513	5688693	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6060 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7228	Debris	483705	5688678	A2	3.1	1.3	1.1	-	Large dark reflector with large shadow but no associated magnetic anomaly. Shown by multibeam bathymetry data to be located within a large depression, approx. 25m x 25m x 0.5m. Possibly a piece of non-ferrous debris.	6059 (sss)	-
7229	Magnetic	484086	5689088	A2	-	-	-	93	Large magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Located along a single noisy line, and could be caused by turning a corner in the route during survey, though is a large anomaly and so could also indicate a large piece of buried ferrous debris.	6057 (mag)	-
7230	Rope / Chain	484661	5688954	A2	108.0	0.3	0.2	-	A linear alignment of short linear reflectors with small shadows but no associated magnetic anomaly. Probably a partially buried length of rope or chain, periodically exposed between small sand waves.	6056 (sss)	-
7231	Magnetic	485783	5689115	A2	-	-	-	28	Small magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Located in an area of numerous anomalies and is similar in nature. Could be created by a natural feature, or be indicative of a piece of buried ferrous debris.	6054 (mag)	-
7232	Bright Reflector	485792	5689328	A2	6.4	0.8	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6053 (sss)	-
7233	Magnetic	485946	5689453	A2	-	-	-	63	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6052 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7234	Debris	486591	5689324	A2	2.5	0.3	0.8	45	Well defined dark reflector with shadow and possibly associated with a medium magnetic anomaly. Possible piece of ferrous debris.	6051 (sss and mag)	-
7235	Magnetic	487777	5689755	A2	-	-	-	63	Two medium magnetic anomalies without any associated sidescan sonar or multibeam bathymetry contacts. Located in fairly close proximity, and could be indicative of the same piece of buried ferrous debris.	6049 (mag)	-
7236	Magnetic	488886	5689318	A2	-	-	-	12	Two adjacent, small but well-defined magnetic anomalies without any associated sidescan sonar or multibeam bathymetry contacts. Could be natural or indicative of a piece of buried ferrous debris.	6048 (mag)	-
7237	Debris	488954	5689528	A2	7.9	6.0	0.0	37	Area of seafloor disturbance containing at least one, possibly two, curvilinear dark reflectors. Associated with a medium magnetic anomaly, and probably an area of ferrous debris.	6047 (sss and mag)	-
7238	Magnetic	489976	5688985	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6046 (mag)	-
7239	Magnetic	490396	5688960	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6045 (mag)	-
7240	Magnetic	492101	5688780	A2	-	-	-	64	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris.	6043 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7241	Magnetic	492406	5688573	A2	-	-	-	26	Linear alignment of four small magnetic anomalies without an apparent sidescan sonar or multibeam bathymetry contact, trending NNE - SSW across the proposed cable route. Could be indicative of a buried cable or a piece of long, linear debris.	6041 (mag)	-
7242	Recorded Obstruction [Dead]	494196	5688380	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Located right at the edge of the geophysical survey area, and could be an ephemeral natural feature or located elsewhere.	6040 (db), 2049	69611 (UKHO)
7243	Magnetic	494006	5688088	A2	-	-	-	109	Large magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Located in an area with numerous small anomalies, but is probably indicative of a piece of buried ferrous debris.	6039 (mag)	-
7244	Magnetic	494186	5687993	A2	-	-	-	83	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, but is probably indicative of a piece of buried ferrous debris.	6038 (mag)	-
7245	Magnetic	495223	5687898	A2	-	-	-	43	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6037 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7246	Magnetic	494791	5688000	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6036 (mag)	-
7247	Rope / Chain	498781	5687785	A2	46.6	0.2	0.0	11	Linear dark reflector without a shadow, but possibly associated with a linear alignment of three small magnetic anomalies. Possible length of rope or chain.	6033 (sss and mag)	-
7248	Rope / Chain	499489	5687643	A2	118.1	0.2	0.0	8	Long, curvilinear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6030 (sss and mag)	-
7249	Magnetic	500226	5687710	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6026 (mag)	-
7250	Magnetic	507760	5687153	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6025 (mag)	-
7251	Magnetic	500301	5687820	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6024 (mag)	-
7252	Magnetic	500806	5687655	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6023 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7253	Magnetic	501011	5687443	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6022 (mag)	-
7254	Magnetic	503618	5687320	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6021 (mag)	-
7255	Magnetic	504243	5687528	A2	-	-	-	24	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6020 (mag)	-
7256	Debris	505219	5687483	A2	18.7	5.1	0.0	-	Two indistinct dark reflectors in close proximity without shadows or an associated magnetic anomaly. Possible an area of non-ferrous debris, or two parts of a partly buried structure.	6019 (sss)	-
7257	Seafloor Disturbance	505890	5687131	A2	5.2	2.2	0.0	-	Small area of possible seafloor disturbance, no associated magnetic anomaly. Could be natural or anthropogenic in origin.	6018 (sss)	-
7258	Debris	505947	5687220	A2	3.1	2.9	0.0	-	Strong, angular dark reflector without a shadow or associated magnetic anomaly. Possible piece of non-ferrous debris.	6017 (sss)	-
7259	Recorded Wreck [Live]	506371	5686959	A3	-	-	-	-	Recorded location of the remains of a fishing vessel, not observed by any of the geophysical equipment. Located right at the edge of the geophysical survey area and could actually lie just outside this area.	6016 (db), 2035	27313 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7260	Magnetic	506543	5687043	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6013 (mag)	-
7261	Magnetic	506610	5687190	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6012 (mag)	-
7262	Magnetic	506723	5687295	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6011 (mag)	-
7263	Debris	506807	5687158	A2	4.8	0.1	0.0	-	Short, curvilinear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear, non-ferrous debris.	6010 (sss)	-
7264	Rope / Chain	506972	5686999	A2	37.5	0.2	0.0	33	Curvilinear dark reflector without a shadow but associated with a magnetic anomaly. Probably a length of chain.	6008 (sss and mag)	-
7265	Debris	507341	5687281	A2	7.8	2.7	0.0	-	Small area of dark reflectors with shadows but no associated magnetometer contacts. Possible small debris field.	6007 (sss)	-
7266	Dark Reflector	507408	5687122	A2	2.1	1.1	0.5	-	Dark reflector with shadow but no associated magnetic anomaly. In an area of variable seabed reflectivity, and could be natural or a piece of non-ferrous debris.	6005 (sss)	-
7267	Magnetic	507738	5687015	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6004 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7268	Dark Reflector	508877	5687144	A2	2.1	1.1	0.5	-	Small dark reflector with shadow. No associated magnetic anomaly but possibly with a small area of disturbed seabed. Could be natural or debris.	6002 (sss)	-
7269	Magnetic	510050	5686783	A2	-	-	-	23	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6000 (mag)	-
7292	Recorded Wreck [Live]	464678	5691157	A3					Outside geophysical survey area. Wreck of the *Mariner* (possibly), lost 1979.	2030	15528 (UKHO)
7293	Recorded Wreck [Live]	483250	5688250	A3					Outside geophysical survey area. Wreck of the *A-15* (possibly)	2031	15773 (UKHO) 120/245 (VIOE)
7294	Recorded Wreck [Live]	488866	5689873	A3					Outside geophysical survey area. Wreck of the *Empire Path.*	2032	15514 (UKHO)
7295	Recorded Wreck [Live]	488905	5689964	A3					Outside geophysical survey area.	2033	76861 (UKHO)
7296	Recorded Wreck [Live]	493001	5688721	A3					Outside geophysical survey area. Wreck of the *Gold Shell*.	2034	15502 (UKHO) 121/254 (VIOE)
7297	Recorded Obstruction [Live]	463146	5690550	A3					Outside geophysical survey area.	2036	15842 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7298	Recorded Obstruction [Live]	495110	5688842	A3					Outside geophysical survey area.	2037	15504 (UKHO)
7299	Recorded Wreck [Dead]	465186	5689793	A3					Outside geophysical survey area. Wrecks of the SS *Kilmare* and *West Hinder* LTV.	2038	15510 (UKHO)
7300	Recorded Wreck [Dead]	476787	5688800	A3					Outside geophysical survey area. Wreck of *FL5*	2039	69607 (UKHO)
7301	Recorded Wreck [Dead]	479108	5688790	A3					Outside geophysical survey area. Wreck of *FL8*	2040	69498 (UKHO)
7302	Recorded Wreck [Dead]	489266	5689685	A3					Outside geophysical survey area. Wreck of *Boscobel*.	2041	15512 (UKHO)
7303	Recorded Wreck [Dead]	508791	5685728	A3					Outside geophysical survey area, wreck marked with buoy 1974.	2042	27305 (UKHO)
7304	Recorded Obstruction [Dead]	467411	5689778	A3					Outside geophysical survey area.	2047	15511 (UKHO)
7305	Recorded Obstruction [Dead]	484116	5687969	A3					Outside geophysical survey area.	2048	69710 (UKHO)
7306	Recorded Wreck [Dead]	454723	5687712	A3					Outside geophysical survey area. Wreck of the *St Patrice*.	2043	15489 (UKHO)
7307	Recorded Obstruction [Dead]	492108	5689124	A3					Outside geophysical survey area.	2050	69494 (UKHO)

APPENDIX IX – BELGIAN LANDFALL – TERRESTRIAL SITES GAZETTEER

This appendix includes a list and description of the data for the Belgian terrestrial sites produced by the VIOE (see **Figure 19**)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1301	Roman	Harendjke (UK8)	Dating between the first and third centuries AD. Wooden building floor with baked tiles; as well as Pottery concentration contemporary of Camping Esmeralda	61781	222340	507231	5683653	75182 (De Haan)
1302	Roman	Port 1	Fire place probably from the second century AD	62842	222969	508280	5684301	75183 (Blankenberge)
1303	Medieval	Breeweg (U/171)	Medieval pottery concentration including Verhaeghe Group A.	65405	222882	510843	5684261	71847 (Blankenberge)
1304	Medieval	I molenstraat	Waste well	63591	223425	509020	5684770	76487 (Blankenberge)
1305	Medieval	Vogelghem	Farm	65034	223319	510464	5684691	72324 (Blankenberge)
1306	Medieval	Farm Raas Walle (U/51)	Site with moat of the type A1C (typology Verhaeghe) firstly mentioned in 1209. Medieval Pottery and Faience. Roof tile and metal fragments from undetermined period.	65635	223288	511066	5684671	71858 (Blankenberge)
1307	Late Medieval	Blankenberge Vaart 1	Abandoned site with moat. Yet clearly visible traces of micro-topographic (earthen embankment, surrounded by a wide moat, to 10m wide).	62477	221641	507940	5682967	70052 (Blankenberge)
1308	Late Medieval	Neptune Avenue I	Site with moat.	62089	221684	507551	5683003	70136 (Blankenberge)
1309	Late Medieval	Neptune Avenue (BE28)	Site with moat.	61729	222470	507177	5683781	70138 (De Haan)
1310	Late Medieval	Poseidon Avenue (BE29)	Site with moat.	62147	221923	507605	5683243	70139 (De Haan)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1311	Late Medieval	A vestige B 2	Dyke	64853	222888	510291	5684257	71833 (Blankenberge)
1312	Late Medieval	Uitkerke 2	Dyke	63797	222900	509236	5684249	71834 (Blankenberge)
1313	Late Medieval	Blankenberge Dijk	Dyke	64160	222294	509610	5683650	71835 (Blankenberge)
1314	Late Medieval	Zeebrugge Avenue (U/181)	Farm, no evidence of moat	65190	223015	510626	5684390	71860
1315	Late Medieval	Loge Voorde	Farm	63318	222596	508763	5683937	72279 (Blankenberge)
1316	Late Medieval	Blankenberge Vaart 2	Remains of a tannery craft place composed of 3 round structure with oil substance.	62583	221748	508044	5683076	72282 (Blankenberge)
1317	Late Medieval	Lenebrug	A footbridge with handrails on Zwin Bommel, Just South of the mill Uitkerke.	64089	222321	509538	5683676	72286 (Blankenberge)
1318	Late Medieval	Mill Uitkerke	Mill. The lord of Uitkerke only had the mill right in the Craft Uitkerke. In the early 19th century, Corneille Pollet owner. Because his mill fell, he built a new 200 m east, the later Tytens' mill.	64066	222431	509513	5683786	72319 (Blankenberge)
1319	Post Medieval	Stake Bed	The various entries outline their function well: 1. a repository of the material for the seawall, which consist of stakes, brushwood and stone blocks 2. was an unloading bay for boats, 3. a house for the strandopziener.	65134	224200	510548	5685573	72326 (Blankenberge)
1320	Post Medieval	Stationsstraat/King Albert I-laan/Prinsenlaan	A flattened mound	64103	223394	509533	5684749	72322 (Blankenberge)
1321	Post Medieval	Hofstede Oostpoort	Homestead	64135	223669	509559	5685024	72323 (Blankenberge)
1322	Post Medieval	Telgerie	Brick and tile works (brickyard)	62792	222328	508242	5683659	72280 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1323	Post Medieval	The Sloop	Non-walled farm site mentioned during the 17thy century as a homestead or a manor	63335	222291	508785	5683632	72285 (Blankenberge)
1324	Post Medieval	Ovenkotstuk	Farm land from the 16th century	66319	223558	511744	5684953	72315 (Blankenberge)
1325	Roman, Early Medieval, and Post Medieval	By Haagstraat (U/8)	Roman Pottery (Clip terra sigillata, central Gaul). Early Medieval Pottery (Verhaeghe group A). Post Medieval undetermined occupation showed on the Map of Pourbus (1562-1571).	66707	223633	512131	5685036	71837 (Blankenberge)
1326	Roman and Medieval	Breeweg (U/17, U/95)	Roman pottery concentration over large area including Terra-sigillata. Early Medieval pottery concentration such as Badorf and Gegladde. Late Medieval pottery concentration including Verhaeghe Group A. An also some organic material from undetermined period.	65725	222979	511161	5684364	71845 (Blankenberge)
1327	Roman and Medieval	Meeuwenlaan (U/104)	Roman sherds. Late Medieval pottery concentration including Verhaeghe Group A, and Badorf. Organic and metal material from undetermined period.	65132	222738	510573	5684112	71848 (Blankenberge)
1328	Medieval and Post Medieval	Castle Prince Gog or Castle of Uitkerke	Fortress associated with farm (bailey) and double circular moat. Destroyed by Dutch after an 80 years war (1568-1648), and destroyed again by the locals in 1849. There is also an 18th century Mansion in rococo style in place. And finally a Motte Castrale dating probably at least of 1270.	64547	222431	509994	5683794	71817 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1329	Medieval and Post Medieval	Groendijk (U15, U/16, U/138)	Several type of Early Medieval Pottery (such as Verhaeghe Group A). Other pottery of various type from the Late Medieval period (including Verhaeghe Group A), but without any apparent with the earlier period. Pottery and faience from the possibly from the 16th century. Organic material, bricks and glass fragment from undetermined period.	66247	223357	511676	5684751	71844 (Blankenberge)
1330	Medieval and Post Medieval	Farm Oosthof (U/169)	Residential occupation of a site with moat during the Medieval and Post Medieval period.	66261	223648	511685	5685042	71857 (Blankenberge)
1331	Medieval and Post Medieval	Zeebrugge Avenue (U/9)	Farm occupation from Medieval period. Medieval pottery sherds, and post medieval stoneware including Raeren Majolica. Bone fragments of undetermined period.	65402	223051	510837	5684430	71859 (Blankenberge)
1332	Medieval and Post Medieval	Molenstraat II	Occupation site from the Medieval period to the 18th century with fragments of pots and dishes, barrels, pottery, faience plate, key and shoe clips.	63660	223512	509088	5684858	72234 (Blankenberge)
1333	Medieval and Post Medieval	Tiendehof	Farm and barn demolished and transformed in cropland	64341	222294	509791	5683654	72318 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1334	Medieval and Post Medieval	Oudengemse Sluis	Lock. The lock just west west of oudengem with the arranged drainage of the Church Corner of Reed. The water south of A vestige B flowed through three openings to the Eiesluis. Because the risk of breakthrough from the beachfront for a long time was present, remained until about 1500 with three openings of doors. The three locks, which could shut A vestige were Oudengemse Sluis, Sluis and the Boudin Meitin Koppe Luis.	65028	223015	510464	5684387	72325 (Blankenberge)
1335	Undeterm -ined	Brick Kiln	Brick and tile works (brickyard)	63765	222719	509207	5684068	72278 (Blankenberge)
1336	Undeterm -ined	Spoon Exhibit	Water place	62891	222180	508344	5683513	72281 (Blankenberge)
1337	Undeterm -ined	Bekegem	Occupation site of a Farmhouse	65463	222940	510900	5684320	72314 (Blankenberge)

APPENDIX X – COORDINATES SYSTEM INFORMATION

WGS84 UTM31

Datum:	WGS84
Ellipsoid:	WGS84
Semi Major:	6378137.00
Semi Minor:	6356752.31
Inverse Flattening:	298.2572236
Projection:	Universal Transverse Mercator
Projection Type:	Universal Transverse Mercator
Zone:	UTM-31N
False Easting:	500000.00000000
False Northing:	0.00000000
Latitude of Origin:	0.00000000
Longitude of Central Meridian:	3.00000000
Scale Factor at the CM:	0.99960000
Survey Units:	International metre

British National Grid (OSGB36)

Datum:	OSGB36
Ellipsoid:	Airy 1830
Semi Major:	6377563.40
Semi Minor:	6356256.91
Inverse Flattening:	299.3249646
Projection:	UK and Ireland
Projection Type:	Transverse Mercator (Gauss Kruger)
Zone:	OSGB36
False Easting:	400000.00000000
False Northing:	-100000.00000000
Latitude of Origin:	49.00000000
Longitude of Central Meridian:	-2.00000000
Scale Factor at the CM:	0.99960127
Survey Units:	International metre

Belgium National Grid (Belge Lambert 72 datum)

Datum:	Belge 1972
Ellipsoid:	Int'l 1924
Semi Major:	6378388.00
Semi Minor:	6356911.95
Inverse Flattening:	297.0000000
Projection:	Belgium
Projection Type:	Lambert Conic (2SP Belgium)
Zone:	Belge Lambert 72
False Eastings:	150000.01256000
False Northings:	5400088.43780000
Latitude of the Origin of Projection:	90.00000000
Longitude of the Centre of Projection:	4.35693972
Latitude of Northern Parallel:	51.16666667
Latitude of Southern Parallel:	49.83333333
Survey Units:	International metre

French National Grid (RGF 1993 Lambert 93)

Datum:	RGF93
Ellipsoid:	GRS80
Semi Major:	6378137.00
Semi Minor:	6356752.31
Inverse Flattening:	298.2572221
Projection:	France
Projection Type:	Lambert Conic (2SP)
Zone:	Lambert-93
False Easting:	700000.00000000
False Northing:	6600000.00000000
Latitude of the Origin of Projection:	46.50000000
Longitude of the Centre of Projection:	3.00000000
Latitude of Northern Parallel:	49.00000000
Latitude of Southern Parallel:	44.00000000
Survey Units:	International metre

OSGB36 to WGS84 datum

Conversion carried out using OSTN 2 conversion

Belge Lambert 72 datum to WGS84 datum

Datum:	Belge 1972
Ellipsoid:	Int'l 1924
Semi Major:	6378388.00
Semi Minor:	6356911.95
Inverse Flattening:	297.0000000
Datum Shifts to WGS84:	
Delta X(m):	-99.100
Delta Y(m):	53.300
Delta Z(m):	-112.500
Rotation X(sec):	0.4190
Rotation Y(sec):	-0.8300
Rotation Z(sec):	1.8850
Scale(ppm):	-1.0000000

Appendix 13: French Offshore Non-Technical Summary

Projet Nemo – Câble d'énergie entre le Royaume Uni et la Belgique *Partie française*

Pièce technique : Description du projet

Préparé pour le compte de
Elia Asset NV

Siège Social CREOCEAN
Zone Technocéan / Chef de Baie
Rue Charles Tellier
17000 La Rochelle - France
Tél : 05.46.41.13.13
Fax : 05.46.50.51.02

e-mail : creocean@creocean.fr
web : www.creocean.fr

Rapport 109375-R P2 v2.2

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Abréviations

MN	Mille nautique
PK	Point kilométrique
ZEE	Zone Economique Exclusive
A/C	Alter Course = point tournant de la route du câble
DAM	Drague aspiratrice en marche
CM	Cote marine
OMI	Organisation Maritime Internationale
MCA	Maritime and Coastguard Agency
CROSS	Centre Régional opérationnel de surveillance et de sauvetage
CNIS	Channel Navigation Information Service
RIPAM	Règlement international pour prévenir les abordages en mer
ColReg	Collision Regulation
HSE	Hygiène-Sécurité Environnement
ERCoP	Emergency Response Cooperation Plan
MARPOL	Maritime Pollution
SHOM	Service Hydrographique et Océanographique de la marine
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency / Très Haute Fréquence

1. Situation, consistance et superficie de l'emprise du projet

1.1. Nature du projet

Le projet NEMO, porté par National Grid Nemo Link Ltd et Elia Asset S.A, consiste à mettre en place un **câble d'énergie sous-marin**, traversant la mer du Nord entre la Grande Bretagne et la Belgique ; cette liaison est destinée à connecter leurs réseaux afin d'augmenter la liquidité des marchés et de soutenir la sécurité d'approvisionnement tant en Grande-Bretagne qu'en Belgique.

La capacité de la liaison se situera entre 700 et 1 300 MW. La liaison à courant continu est composée de deux câbles séparés (l'un avec une tension positive, l'autre avec une tension négative), exploités comme un tout unique. L'utilisation de la Haute Tension en Courant Continu (HVDC) est le moyen le plus efficace pour le transport de l'électricité sur cette distance.

La liaison sera constituée de deux grandes parties : une partie sous-marine « offshore » et une partie sur la terre ferme « onshore » ou atterrage (**Figure 1.1.1**). Les deux extrémités sont raccordées à un poste à haute tension, station de conversion, pour la conversion courant continu / courant alternatif (AC / DC) et le raccordement au réseau 380 kV. La conversion est réalisée par des composants semi-conducteurs d'électronique de puissance.

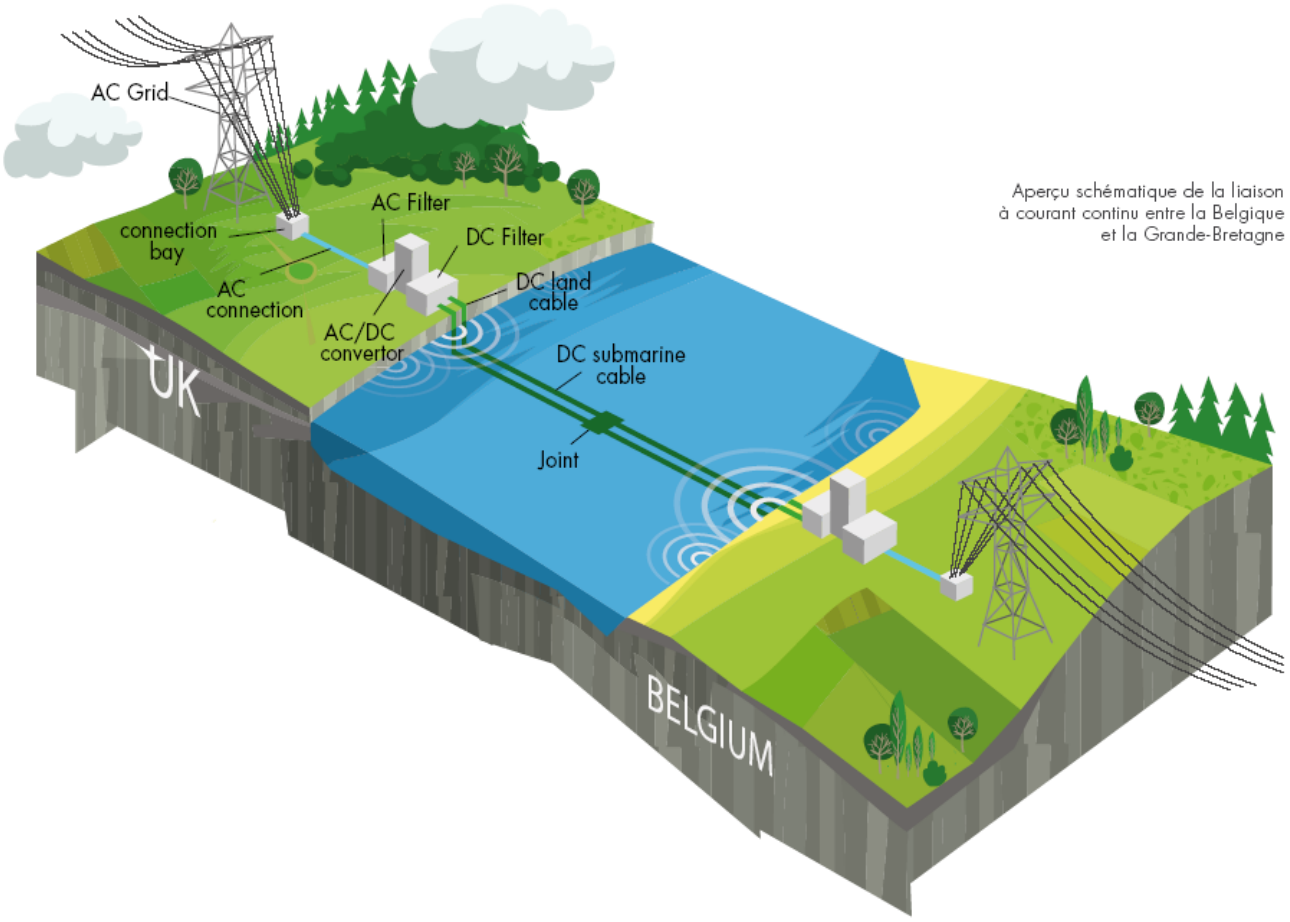


Figure 1.1.1 : Aperçu schématique de la liaison à courant continu entre la Belgique et la Grande-Bretagne

1.2. Route du câble

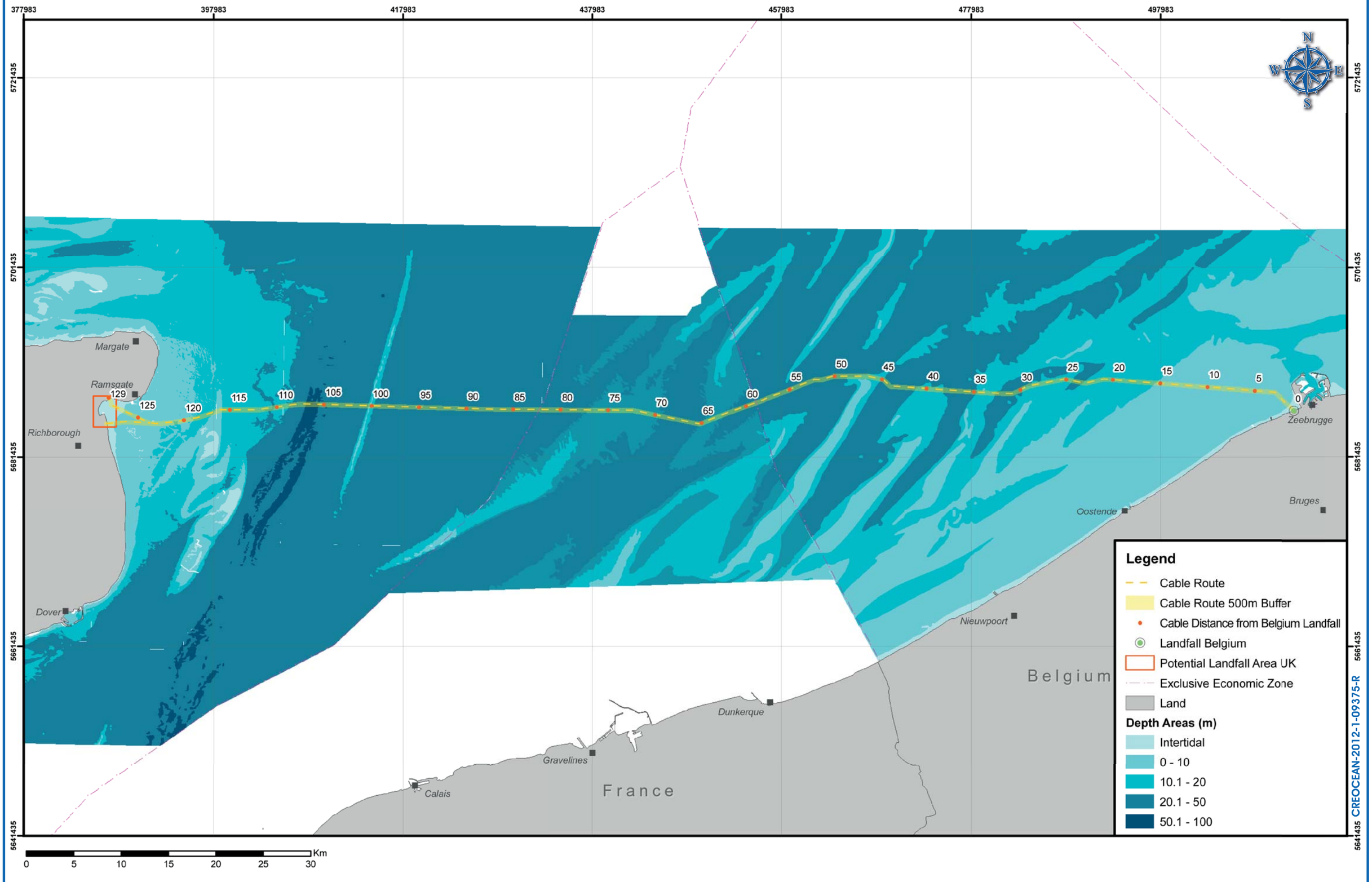
L'ensemble de la route du câble issue du tracé préliminaire et des investigations de terrain est présentée sur la **Figure 1.2.1** et la liste des points du tracé est donnée dans le **Tableau 1.2.1** :

Point tournant	KP	Long WGS 84	Lat WGS 84	Easting UTM31N	Northing UTM31N	Prof. (m CM)	Cap	Raison du changement de direction sur la route
West Zeebrugge	0	3.1670	51.3258	511641	5686073			Atterrage Belgique
ALTERCOURSE	1.6	3.1469	51.3335	510232	5686924	-6.0	273°	
ALTERCOURSE	4.5	3.1060	51.3353	507385	5687119	-8.0	273°	Eviter une épave
ALTERCOURSE	12.1	3.0581	51.3379	504047	5687405	-10.6	272°	Eviter une épave
ALTERCOURSE	17.7	2.9976	51.3416	499833	5687813	-15.2	271°	Eviter zone minée / épaves
ALTERCOURSE	19.5	2.9165	51.3444	494188	5688127	-16.6	278°	Epave répertoriée
ALTERCOURSE	24.3	2.8920	51.3480	492478	5688535	-21.7	278°	Croisement câble C-POWER
ALTERCOURSE	28.1	2.8253	51.3580	487839	5689651	-25.1	263°	Croisement câble Hermes South
ALTERCOURSE	30.1	2.7718	51.3516	484105	5688952	-25.7	255°	
ALTERCOURSE	32.5	2.7449	51.3442	482234	5688135	-21.5	271°	Maintien à 250 m des câbles Pan European Crossing et Hermes 2
ALTERCOURSE	32.8	2.7107	51.3449	479849	5688216	-16.8	274°	
ALTERCOURSE	42.8	2.7064	51.3451	479549	5688248	-32.0	272°	Maintien à 250 m du câble PEC
ALTERCOURSE	43.4	2.5634	51.3505	469593	5688899	-30.7	284°	
ALTERCOURSE	45.1	2.5557	51.3524	469060	5689111	-28.9	312°	Croisement câble Tangerine
ALTERCOURSE	46.0	2.5411	51.3653	468054	5690553	-29.5	286°	
ALTERCOURSE	48.0	2.5364	51.3667	467728	5690702	-33.6	286°	Croisement pipe FRANPIPE et câbles Tangerine et Rioja 2
ALTERCOURSE	48.0	2.4600	51.3570	462402	5689659	-32.1	270°	
ALTERCOURSE	50.0	2.4405	51.3571	461041	5689684	-33.3	256°	
ALTERCOURSE	51.1	2.4367	51.3562	460780	5689583	-35.4	232°	Eviter une épave répertoriée et croisement FRANPIPE
ALTERCOURSE	52.5	2.4322	51.3526	460459	5689193	-35.1	256°	
ALTERCOURSE	52.8	2.2863	51.3152	450262	5685120	-35.4	264°	Maintien à 250 m de Tangerine
ALTERCOURSE	53.3	2.2714	51.3137	449222	5684962	-26.8	277°	Croisement des câbles TAT14 et UK-Belgium 3
ALTERCOURSE	64.2	2.2226	51.3196	445828	5685657	-33.8	277°	
ALTERCOURSE	65.3	2.1721	51.3259	442316	5686390	-37.1	270°	Maintien à 250 m de Tangerine
ALTERCOURSE	68.8	2.0111	51.3253	431094	5686470	-29.8	270°	
ALTERCOURSE	72.4	1.9596	51.3252	427506	5686501	-37.1	271°	Croisement câble UK-Belgium 5
ALTERCOURSE	94.1	1.8600	51.3276	420570	5686870	-40.3	269°	
ALTERCOURSE	96.8	1.8216	51.3272	417893	5686869	-40.3	270°	Croisement câble AC1
ALTERCOURSE	103.5	1.7255	51.3269	411202	5686950	-46.3	273°	
ALTERCOURSE	107.3	1.6712	51.3301	407423	5687369	-36.2	262°	Eviter une crête abrupte
ALTERCOURSE	107.6	1.6665	51.3295	407098	5687306	-29.1	248°	Eviter récif à *Sabelleria*
ALTERCOURSE	108.2	1.6600	51.3268	406634	5687018	-26.4	264°	
ALTERCOURSE	112.3	1.6016	51.3209	402558	5686435	-21.0	269°	
ALTERCOURSE	116.2	1.5453	51.3201	398629	5686430	-8.6	257°	Eviter un banc
ALTERCOURSE	118.7	1.5111	51.3122	396231	5685592	-13.8	263°	
ALTERCOURSE	121.2	1.4766	51.3078	393814	5685152	-12.9	266°	
ALTERCOURSE	123.0	1.4509	51.3059	392021	5684987	-8.8	275°	Eviter une zone endommagée
ALTERCOURSE	123.7	1.4404	51.3064	391290	5685050	-9.5	285°	
ALTERCOURSE	127.3	1.3937	51.3187	388066	5686486	-2.1	283°	
ALTERCOURSE	128.2	1.3814	51.3216	387212	5686831	-0.5	279°	Maintien à 250 m des câbles ferme éolienne Thanet
ALTERCOURSE	129.2	1.3651	51.3248	386089	5687211		297°	
Richborough	129.4	1.3647	51.3249	386059	5687234			Atterrage Royaume Uni

ROUTE PRÉVISIONNELLE RETENUE AVANT SURVEY EN MER

D'après PPMS,2011

Figure 1.2.1



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La partie offshore compte environ 130 km dont **23 km dans les eaux françaises, exclusivement en zone marine,** c'est-à-dire sans atterrage sur le territoire français.

La partie française est située grossièrement entre les PK59 et PK83 (comptés à partir de Zeebrugge, Belgique - **cf. Figure 1.2.2**).

Sur la base des reconnaissances de terrain, la route du câble définie après les reconnaissances de terrain et sur laquelle peuvent être étudiés les impacts, est la suivante :

Tableau 1.2.2 : Route du câble dans les eaux françaises

PK	Latitude N	Longitude E	X	Y	Profondeur (m)
60	2,343°	51,330°	454207	5686696	-38,1
61	2,329°	51,326°	453279	5686325	-36,8
62	2,316°	51,323°	452350	5685954	-35,9
63	2,303°	51,319°	451421	5685583	-35,3
64	2,290°	51,316°	450493	5685212	-29,3
65	2,276°	51,314°	449519	5685007	-34,0
66	2,262°	51,315°	448537	5685103	-35,9
67	2,247°	51,317°	447557	5685303	-36,4
68	2,233°	51,318°	446577	5685503	-37,2
69	2,219°	51,320°	445598	5685705	-36,9
70	2,205°	51,322°	444619	5685909	-34,7
71	2,191°	51,324°	443640	5686114	-31,5
72	2,177°	51,325°	442661	5686318	-30,1
73	2,163°	51,326°	441668	5686395	-30,2
74	2,148°	51,326°	440668	5686402	-31,8
75	2,134°	51,326°	439668	5686409	-35,0
76	2,120°	51,326°	438668	5686416	-33,8
77	2,105°	51,326°	437668	5686423	-28,9
78	2,091°	51,326°	436668	5686430	-39,1
79	2,077°	51,326°	435668	5686437	-38,3
80	2,062°	51,326°	434669	5686444	-37,2
81	2,048°	51,325°	433669	5686451	-38,4
82	2,034°	51,325°	432669	5686459	-39,2
83	2,019°	51,325°	431669	5686466	-31,2

Cette route n'est pas totalement figée : en effet, les porteurs du projet souhaitent maintenir la possibilité de poser le câble dans le couloir de 500 m défini plutôt que sur le tracé central car la morphologie des fonds est susceptible d'évoluer au niveau des zones mobiles comme les vagues de sable, au moment où le câble sera installé.

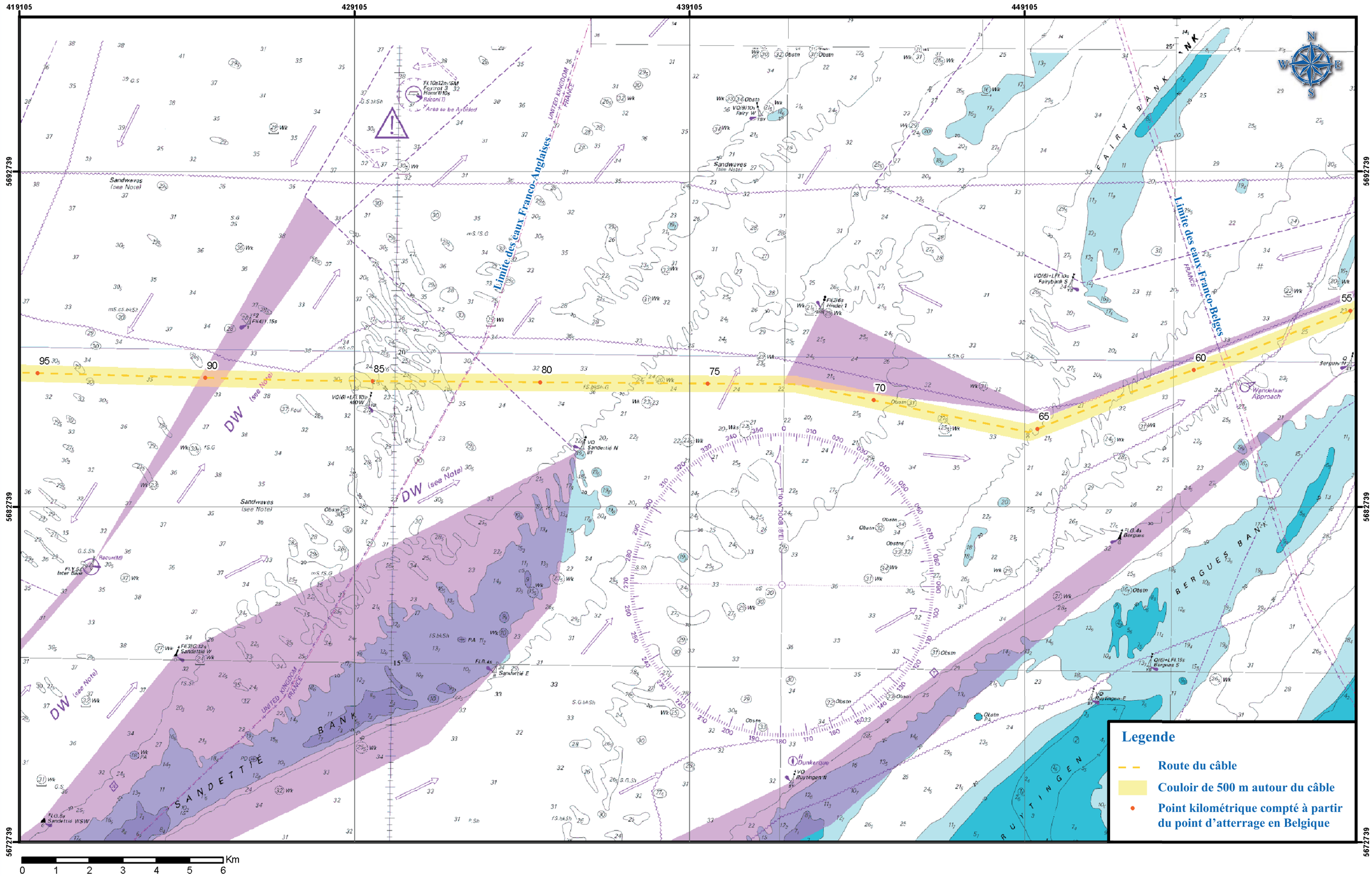
Tableau 1.2.3 : Couloir de 500 m autour de la route du câble dans les eaux françaises

ID	Longitude Est Lon_DD	Latitude Nord Lat_DD	X_UTM31(m)	Y_UTM31(m)
141	2,277669	51,312801	449656	5684850
142	2,276809	51,3125	449596	5684820
143	2,27195	51,3115	449256	5684720
144	2,27091	51,3115	449183	5684720
145	2,24639	51,314498	447478	5685060
146	2,17331	51,323398	442396	5686120
147	2,17158	51,3236	442276	5686140
148	2,06252	51,323398	434676	5686200
149	2,05448	51,323398	434116	5686210
150	2,04501	51,3232	433456	5686200
151	2,044719	51,323398	433436	5686220
152	2,02672	51,3232	432181	5686210
153	2,030649	51,327701	432462	5686710
154	2,172349	51,328098	442335	5686640
155	2,27148	51,316001	449229	5685220
156	2,274189	51,316699	449418	5685300
157	2,29355	51,321399	450772	5685810
158	2,35471	51,337001	455050	5687500
159	2,35553	51,335399	455105	5687320
160	2,35698	51,332599	455203	5687010

TRACÉ DU PROJET DE CÂBLE NEMO DANS LES EAUX FRANÇAISES

Figure 1.2.2

D'après PPMS,2011



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1.3. Superficie de l'emprise du projet dans les eaux françaises

Le projet dans son ensemble comprend plusieurs phases :

- la phase **d'installation** de l'ouvrage (travaux de pose du câble),
- la phase **d'exploitation** et de **maintenance** (surveillance de l'ensouillage du câble, interventions pour réparation…),
- et en fin de vie du câble, l'opération de **démantèlement** et de remise en état du site.

Ces phases avec les techniques utilisées et les moyens mis en œuvre sont décrites dans le paragraphe 3 suivant.

La superficie totale impliquée dans les travaux offshore sur la portion française est de :

Tableau 1.3.1 : Emprise du projet

Phase du projet	Emprise
Préparation de la route du câble	Le couloir à nettoyer des obstructions, afin de faciliter le passage de l'engin d'ensouillage, est de 100 m de part et d'autre du tracé retenu au niveau des zones reconnues au préalable. L'emprise maximale du grappin ou du ROV sur le fond est de 10 m. En surface, l'emprise des navires sur le plan d'eau est de 500 m de rayon.
Pose du câble	Sur le fond marin : • Le câble sera ensouillé à une profondeur de 2 à 3 m. En se basant sur les techniques les plus courantes d'ensouillage, l'emprise maximale de l'engin d'ensouillage est de 10 m et l'emprise de la tranchée est 1 à 5 m. • La largeur de la zone nivelée (pre-sweeping) varie en fonction de la forme et la taille de chaque structure sédimentaire mais peut être généralement considérée de 10 m à 20 m. Sur le plan d'eau (en surface) : • en général, un grand câblier de grande taille (150 m de long) en marche travaille dans un secteur sécurisé de 500 m de rayon ; si l'engin d'ensouillage est tracté par un navire en convoi avec le câblier principal, la zone de sécurité est augmentée de 500 m sur 1000 m, • si le câblier doit travailler en statique avec ancrages, le rayon de la zone de sécurité est porté jusqu'à 2000 m.
Maintenance	La zone de sécurité du navire câblier effectuant une réparation, en station, est de 2000 m.
Démantèlement	Comme pour l'opération de pose, la zone de sécurité autour du navire est de 500 m sur 1000 m.

1.4. Calendrier de réalisation

1.4.1. Echelonnement des travaux

Le calendrier d'installation du câble dépend d'un certain nombre de facteurs tels que la livraison du câble, la disponibilité du câblier et les autres engagements de l'installateur.

Le tracé du projet est relativement simple, avec environ 20 km en petits-fonds (<10 m CM) côté Royaume-Uni, une section d'environ 100 km (traversant les eaux anglaises, françaises et belges) en eau profonde (> 10 m CM) et une section d'environ 10 km en petits-fonds côté belge.

La **Figure 1.4.1** suivante donne une indication du programme d'installation pour les aspects maritimes du projet, avec la séparation des travaux sur les petits et les grands fonds, ainsi que l'échelonnement des travaux dans les eaux anglaises et françaises-belges.

		Mois				
Phase	**Description**	**1**	**2**	**3**	**4**	**5**
C1a installation petits-fonds Royaume Uni	*Nettoyage de la route, pose and post ensouillage du câble*					
C1b installation petits-fonds Belgique	*Nettoyage de la route, pose and post ensouillage du câble*					
C2 installation offshore Royaume Uni	*Préparation des fonds (nivelage des crêtes des vagues de sable et éclaircissement de la route du câble, raccordement du câble, pose et ensouillage simultané du câble*					
C3 installation offshore France et Belgique	**Préparation des fonds (nivelage des crêtes des vagues de sable et éclaircissement de la route du câble, raccordement du câble, pose et ensouillage simultané du câble**					

Figure 1.4.1 : Programme d'installation pour les aspects maritimes du projet

Le programme et la date pour le début des travaux d'installation ne sont pas encore arrêtés mais il est estimé que l'installation pourra commencer en 2016 au plus tôt.
En général, les installations dans les eaux européennes ont lieu pendant la saison estivale (entre Avril et Octobre) : ces opérations sont principalement tributaires des conditions météorologiques et d'agitation du plan d'eau. Le calendrier sera également tributaire de facteurs tels que la mise en œuvre des mesures d'atténuation des impacts sur les compartiments écologiques les plus fragiles, ainsi que de la disponibilité des navires.

Les travaux d'installation dans les zones intertidales au Royaume-Uni et la Belgique devraient prendre moins d'une semaine.

Il est prévu qu'au moins cinq points de raccordement de câbles marins soient nécessaires sur l'ensemble du système et chaque opération de raccordement prend environ cinq jours.

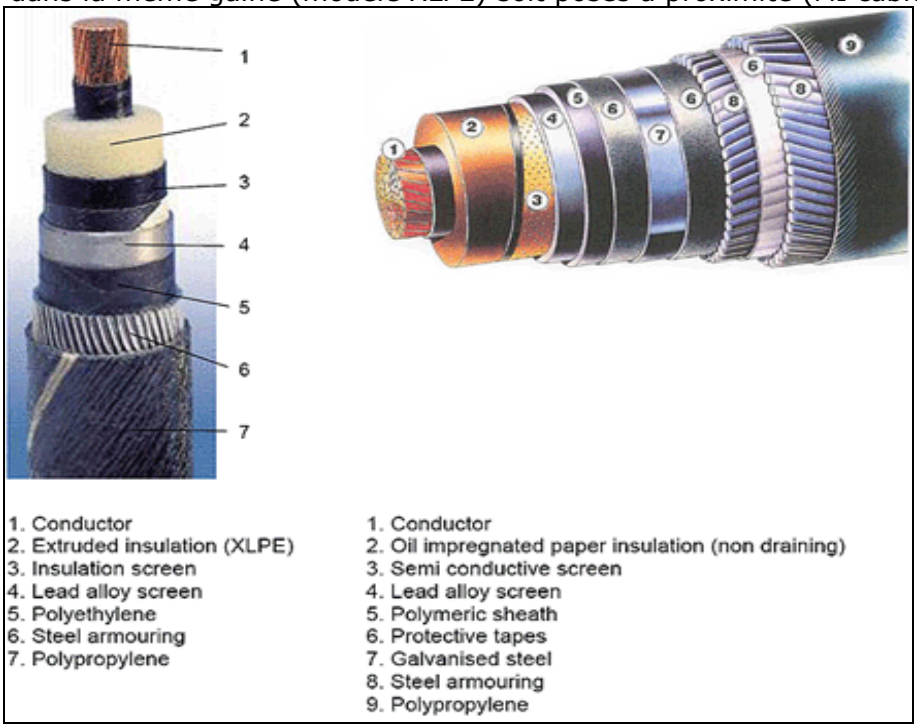
1.4.2. Date de mise en service

Les travaux d'installation sont prévus s'achever en 2018. La date de mise en service n'est pas encore arrêtée.

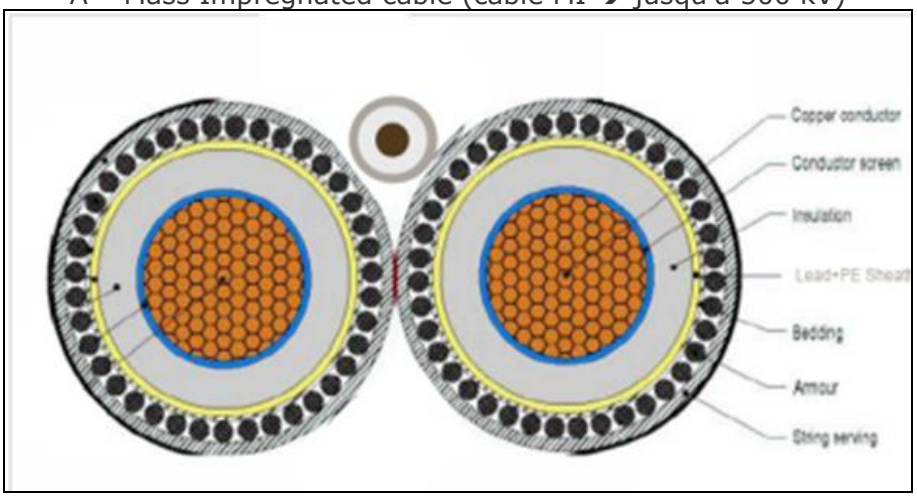
2. Caractéristiques techniques du projet

2.1. Caractéristiques du câble

Le système retenu en priorité est bipolaire haute tension en mode continu (HVDC) avec un voltage de 300 kV ou 500 kV, selon le modèle choisi. La taille d'un câble est d'environ 12 cm.
Pour assurer la liaison bidirectionnelle, deux câbles sont nécessaires (l'un positif, l'autre négatif) : ils seront soit reliés dans la même gaine (modèle XLPE) soit posés à proximité (MI cables).



A – Mass Impregnated cable (câble MI ➔ jusqu'à 500 kV)



B – câble XLPE (jusqu'à 300 kV)

Figure 2.1.1 : Description du câble

- La technologie des **câbles XLPE** est une isolation par Polyéthylène réticulé extrudée sur un conducteur en cuivre ou en aluminium, recouverte d'une gaine étanche de plomb sans soudure et d'une gaine de protection en plastique. Le câble sous-marin destiné au projet Nemo sera doté d'une armure en acier galvanisé, qui lui permettra de mieux résister aux contraintes de l'installation sous-marine : l'armure simple est composée d'une couche de fils enroulés en hélice autour du câble, recouverte d'une gaine de bitume imprégné de polypropylène pour empêcher la corrosion.
  Dans les zones rocheuses ou d'intenses activités humaines, l'armure peut être double.

- Le **câble MI**, dont l'efficacité de cette technologie a été testée sur plusieurs interconnecteurs sous-marins, est constitué d'un faisceau de brins de câble à âme en cuivre, immobilisé et isolé par une couche de papier imprégné d'huile minérale de haute viscosité. Ce type câble n'est ainsi pas pressurisé et il n'y a pas d'huile qui puisse s'écouler en cas de rupture de la gaine du câble. L'armure est composée d'une ou deux couches de fils en acier galvanisé en hélice, sous une couche de fils de jute bitumé et une couche intermédiaire de fils de polypropylène, pour améliorer la maniabilité.

➔Ces deux technologies certifient qu'aucune huile ne puisse être rejetée dans le milieu marin, en cas de rupture du câble.

Pour le projet Nemo d'interconnexion1000 MW, la configuration «de base» du câble la plus probable est **un système bipolaire HVDC, avec deux câbles MI regroupés dans la même tranchée**. Toutefois, en fonction de la technologie d'installation disponible, il y a une faible probabilité que les câbles puissent être installés dans des tranchées distinctes.
Le câble doté d'une armure simple ou double sera ensouillé à une profondeur moyenne de 2 à 3 m sur l'ensemble du trajet, lorsque ce sera possible.

2.2. Installation offshore du câble

Le trajet sur la partie française n'ayant aucun atterrage, seules des techniques offshore adaptées au milieu naturel sont utilisées.

2.2.1. Préparation de la route du câble (Pre-lay)

Trois activités préliminaires à la pose sont nécessaires pour faciliter le passage de l'engin d'ensouillage :

- le nettoyage du tracé du câble des obstructions et des câbles de télécommunications hors service, au moyen d'un grappin,
- la préparation des fonds pour assurer le meilleur ensouillage du câble dans les structures mobiles,
- la préparation des fonds pour le croisement avec les autres ouvrages en service et la mise en place du système de protection.

2.2.1.1. Nettoyage des obstructions (Clearance)

Les débris des fonds marins tels que les filins qui peuvent avoir été largués par les navires sur le fond marin, les câbles de communication abandonnés et d'autres débris peuvent être préjudiciables à la progression et au travail de l'engin d'ensouillage tracté derrière le câblier.

Avant le début des opérations de pose du câble, le parcours du câble doit être nettoyé des obstructions identifiées au cours des précédentes missions de reconnaissance des fonds et au cours de la mission d'essais d'ensouillage (Pre-Lay Grapnel Run ou PLGR).
L'installation du câble peut nécessite plusieurs campagnes, en fonction de la capacité de transport du navire câblier. L'opération PLGR peut être réalisée progressivement afin d'assurer que la route sera bien dégagée des débris récemment rejetés avant chaque campagne de pose.

Les câbles de télécommunications hors service qui croisent le tracé de NEMO sont recherchés et relevés au moyen d'un grapin désensouilleur et coupés sur une longueur de 100 m autour du tracé du projet de câble.

Figure 2.2.1 : grappin de récupération de câble

Le navire tracte le grappin le long du tracé du câble. Le treuil de remorquage est muni d'une jauge de contrainte qui détecte une augmentation de la tension si un objet est accroché. La plupart des câbles anciens et les filins se trouvent normalement en surface sur le fond marin ; le grappin peut pénétrer le fond marin jusqu'à une profondeur d'environ 1 m pour récupérer les câbles hors service ensouillés.

Les débris rencontrés seront ainsi récupérés à bord du navire pour une élimination à terre appropriée. Dans le cas de découverte des munitions non explosées au cours de cette mission, un spécialiste habilité pour l'élimination des munitions et explosifs sera disponible à bord afin d'identifier les éléments suspects et de fournir les conseils sur la marche à suivre.

Les câbles de communication hors service seront coupés sur une distance de 100 m de part et d'autre du tracé du projet. Le tronçon coupé sera remonté à bord et les épissures de deux extrémités coupées du câble seront lestées avant d'être remis à l'eau.

2.2.1.2. Préparation des fonds (nivelage – tranchée)

Après les essais géotechniques, les fonds sont considérés comme meubles sur le tracé français : il ne sera pas nécessaire de préparer une tranchée préalablement à la pose (ensouillage pendant la pose).
Les zones sableuse modelées en vagues de sables représentent des zones instables rendant l'ensouillage du câble difficile et surtout le maintien de la profondeur d'ensouillage au cours du temps. Pour cette raison, il existe une technique dite de Pre-Sweeping qui consiste à niveler les fonds dans le double but de réduire la hauteur des vagues de sables (pour assurer une profondeur

d’ensouillage constante) et d’aplanir la surface pour faciliter le passage de la charrue lors de l’ensouillage du câble. Cette opération est généralement réalisée juste quelques jours avant les opérations de pose du câble au moyen d’une drague aspiratrice en marche, qui rejette les sables à proximité. Cette méthode a été utilisée pour la pose du câble d’énergie BritNed, entre la Grande-Bretagne et les Pays-Bas.

Cette opération peut être réalisée par une Drague Aspiratrice en Marche (DAM). Les volumes dragués sont similaires à ceux des opérations de dragage d'entretien de chenal portuaire et restent donc relativement faibles. Les volumes extraits sont déposés sur le fond marin au voisinage immédiat de l'opération : il n’y a pas d’extraction définitive du milieu marin.

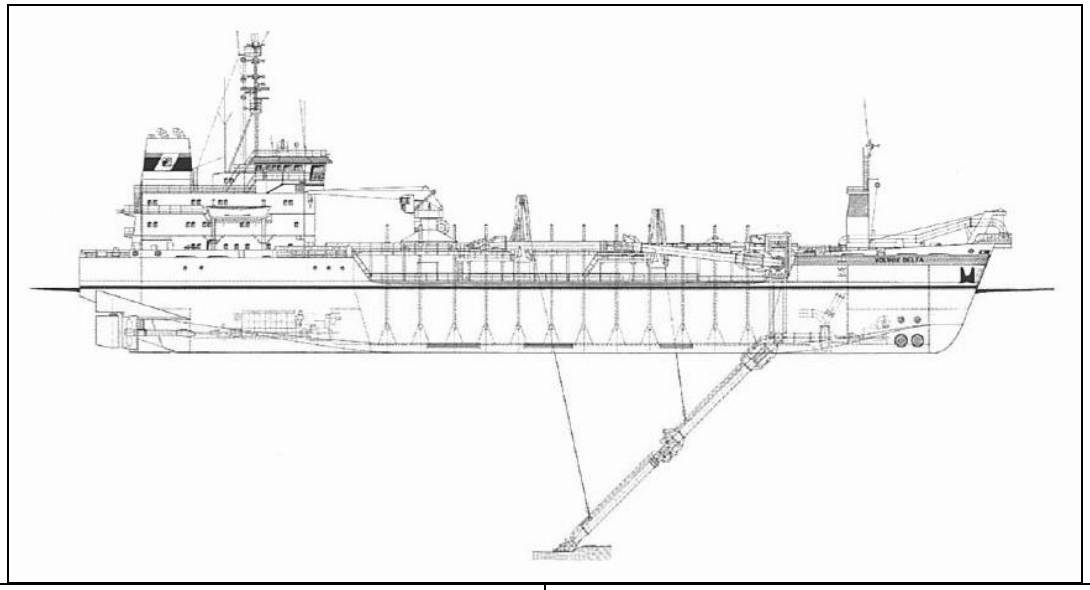


Figure 2.2.2 : Drague aspiratrice en marche (DAM)

La largeur de la tranchée à réaliser à l’élinde dépend de la forme et de la taille de la structure sableuse à traverser : la tranchée la plus large envisagée est de 20 m à la base pour une profondeur de 2 m, avec des pentes latérales de 10 m de largeur de part et d’autre de la tranchée.
Afin de réduire les coûts de transport (par rapport à un site commun de dépôt) et de favoriser la remise en état naturelle du site (sans enlever définitivement les sables) , il est préférable que la drague dépose les sables à environ 1,5 km, en amont des courants et que l’opération n’ait lieu que quelques jours avant la pose du câble (afin d’éviter que la tranchée se referme).

Les secteurs susceptibles d'être ainsi nivelés par dragage (pre-sweeping) ont été identifiés à la suite de la campagne de reconnaissance bathymétrique et un exercice a été réalisé pour calculer les volumes à draguer correspondants. Ceci ne concerne que les crêtes des bancs sableux et des vagues de sables le long de la route du câble.

Sur la partie française, plusieurs secteurs de vagues de sable ont été reconnus (**Figure 2.2.3**). Les pentes mesurées n'ont pas imposé de déviation du tracé du câble mais 4 secteurs convenant aux opérations de pre-sweeping ont été identifiés: ils sont situés à la traversée nord du banc Sandettié et au sud du Banc Fairy.

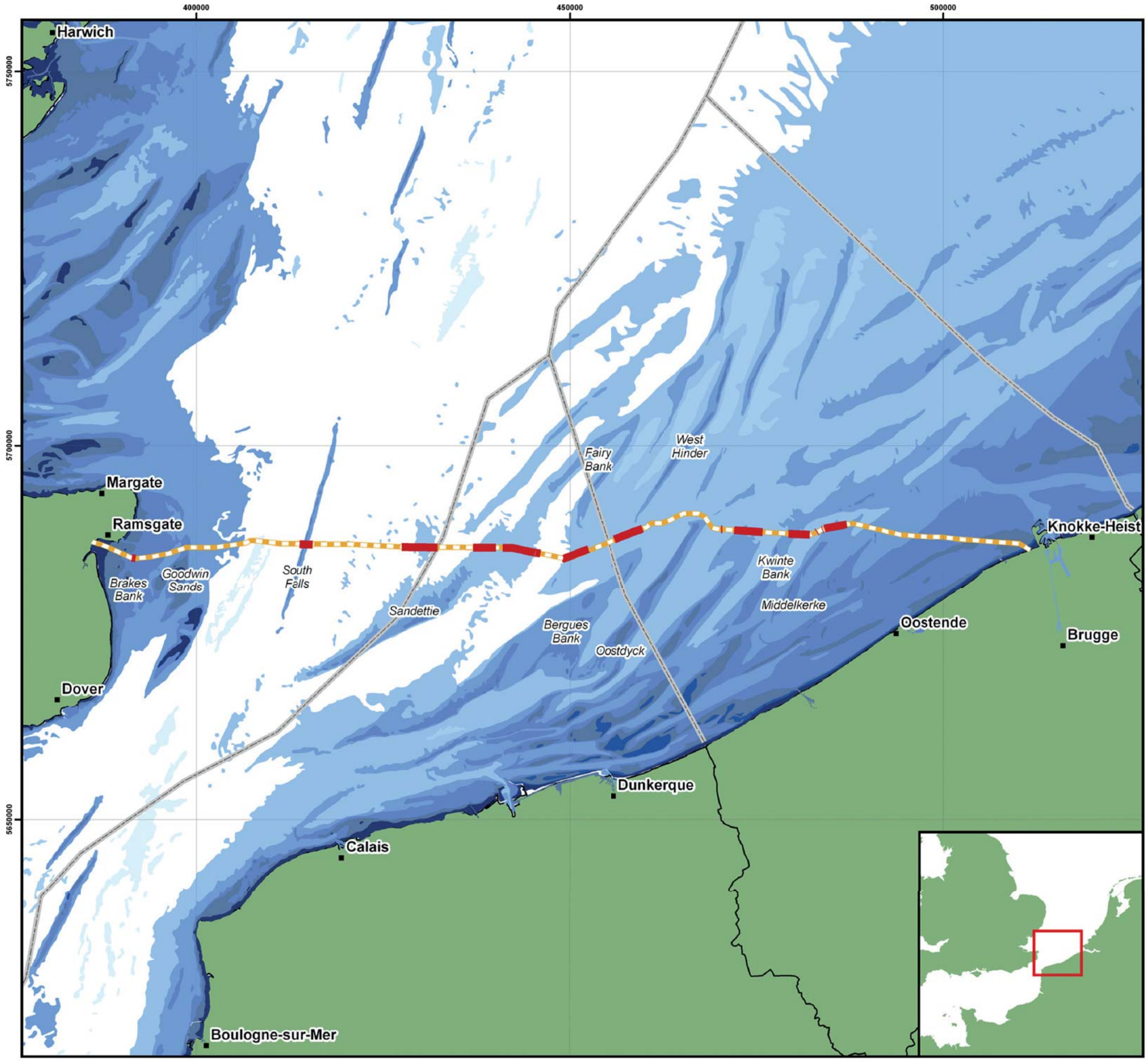
Tableau 2.2.1 : Zones identifiées pour d'éventuelles opérations de pre-sweeping

PK	Latitude N	Longitude E	X	Y	Volume (m^3)	But recherché
63-65.4	51.31693	2.28503	450 174	5 685 316	21 330	Protéger le câble vis-à-vis de la mobilité des vagues de sable
69.2- 73.6	51.32437	2.18433	443 165	5 686 213	60 249	
74.5 – 77.5	51.32572	2.11854	438 583	5 686 417	32 614	
82.3 - 87	51.32529	1.99369	429 883	5 686 480	24 470	

ZONES IDENTIFIÉES POUR D'ÉVENTUELLES OPÉRATIONS DE PRE-SWEEPING

D'après PPMS,2011

Figure 2.2.3



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NEMO

Proposed Dredge Locations

- Zones à draguer
- Frontières maritimes
- Route du câble

Bathymétrie (mCD)

- 0
- 2
- 5
- 10
- 20
- 30
- 40
- 50
- 60

Figure No. DDR4633/13	**Date** 26/05/2011	**Revision** 002
Author dde	**Check** rjsw	**Scale @A3** 1:500,139
Data Source MUMM		**Projection System** UTM Zone 31N
Spheroid WGS84		**Datum** WGS84

0 6 12 18 24 km
0 3 6 9 12 nm

N

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2.2.2. Pose du câble (Laying)

Le navire câblier assure le transport et la pose du câble en le déroulant au fur et à mesure. En fonction de la capacité de transport du câblier et de la longueur totale de l'ouvrage (100 km de câble offshore), plusieurs campagnes successives de pose seront nécessaires. Il est en effet prévu que le tracé du câble nécessite 5 raccordements dont les localisations ne sont pas encore déterminées.

Il existe trois alternatives pour la pose du câble, selon le modèle de câble choisi (deux câbles réunis dans la même gaine ou deux câbles séparés), nécessitant la création d'une ou deux tranchées (cf. **Figure 2.2.4**).

2.2.3. Ensouillage du câble (Burial)

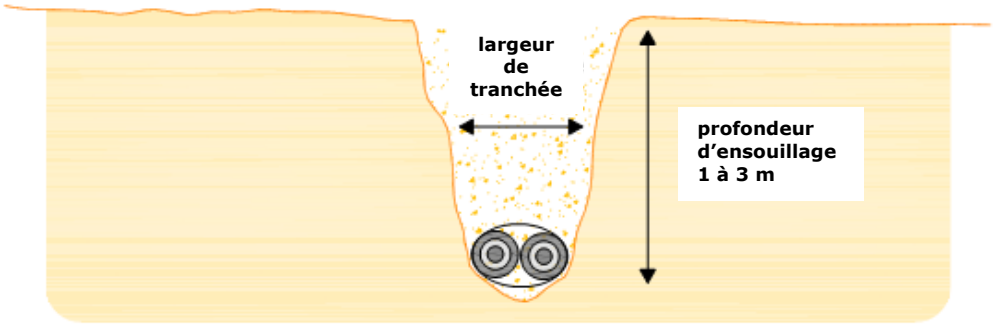
L'ensouillage dans les matériaux sableux peut être réalisé au moyen d'une charrue tractée à partir du navire câblier ou d'une machine à jets tractée ou autonome. Les charrues sont des machines remorquées généralement utilisées pour les opérations simultanées de pose et d'ensouillage, contrôlées à partir du câblier (vitesse, tension et profondeur d'ensouillage).

Dans les matériaux sableux, la charrue ouvre le sillon où le câble est déposé et le sillon se referme par gravité ou nivellement par la charrue, quasi simultanément. Une autre technique d'ensouillage sans déplacement de sédiment est utilisée : la charrue à injection d'eau (jetting), qui injecte de l'eau à haute pression pour déstabiliser la couche sédimentaire et permettre l'ensouillage naturel du câble par gravité, la couche de sédiments se redéposant et se recompactant naturellement ensuite. Cette méthode est efficace dans les bancs sableux car elle requière moins de tension sur le câble qu'une charrue classique pour une même profondeur d'ensouillage. Cependant, le jetting génère plus de turbidité qu'un sillon d'ensouillage et la largeur de la zone déstabilisée dépend de la profondeur d'ensouillage recherchée.

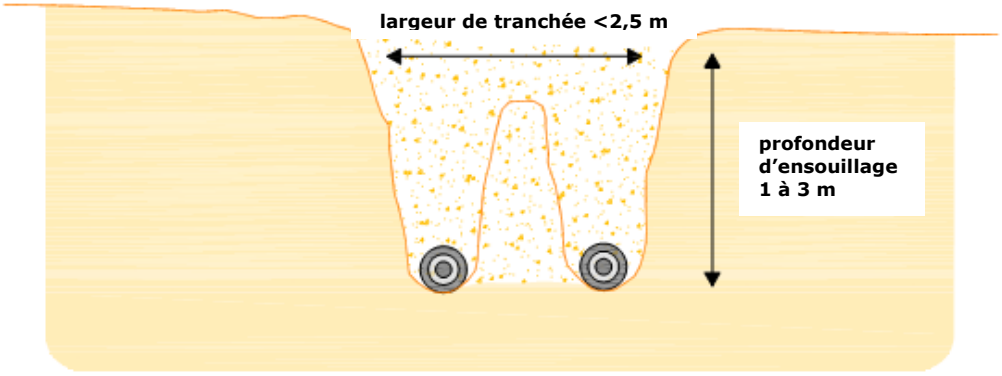
Les photos suivantes illustrent les deux types de charrues utilisables dans le secteur français :

Figure 2.2.5 : Exemples de charrue d'ensouillage : a- charrue à grappin ; b- charrue à jets

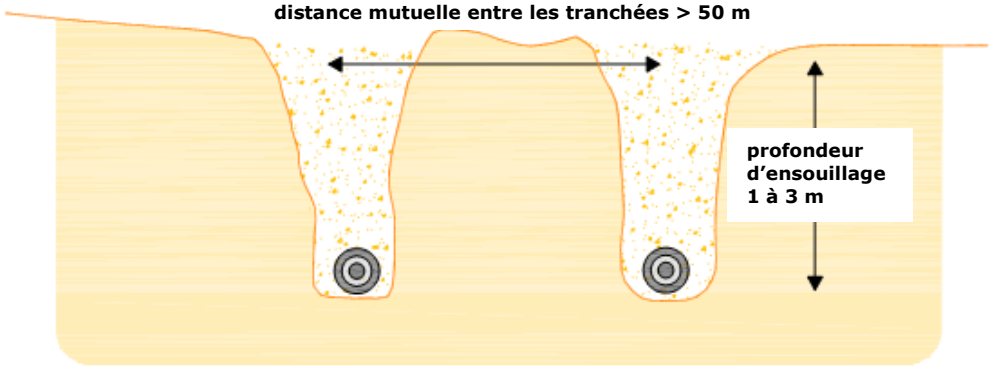
Figure 2.2.4 : Pose du câble (d'après ARCADIS, 2011)



A – Pose du câble double dans une seule tranchée (<1 m de large)



B- Pose des deux câbles dans deux tranchées proches (écart maximal de 2,5 m)



C- Pose des deux câbles dans deux tranchées séparées au maximum de 50 m

2.2.4. Raccordement du câble en offshore

Comme le câblier ne peut transporter l'ensemble du câble en un seul voyage, il est nécessaire de travailler par segments avec raccordement des deux extrémités de câble ; cette opération est effectuée à bord du câblier et peut prendre 1 semaine, le navire étant ancré. Une fois le câble raccordé, la pose peut reprendre normalement.
Il est prévu 5 opérations raccordements pour l'ensemble du câble NEMO sur la partie offshore.

2.2.5. Croisement des câbles

Le croisement avec d'autres ouvrages nécessite l'obtention d'un agrément de croisement avec le propriétaire de l'ouvrage, qui décrit le mode de protection à mettre en place, conformément aux pratiques recommandées par l'International Cable Protection Comitee (ICPC). L'agrément détaillera la protection mise en place et les droits et responsabilités de différentes parties pour assurer l'intégrité des ouvrages et de l'activité.

La figure suivante illustre un exemple de protection au croisement de deux ouvrages. L'emprise du croisement concerne une surface de 100 m (enrochements ou matelas le long de l'ouvrage NEMO) sur 30 m (largeur du pont sur le câble existant).

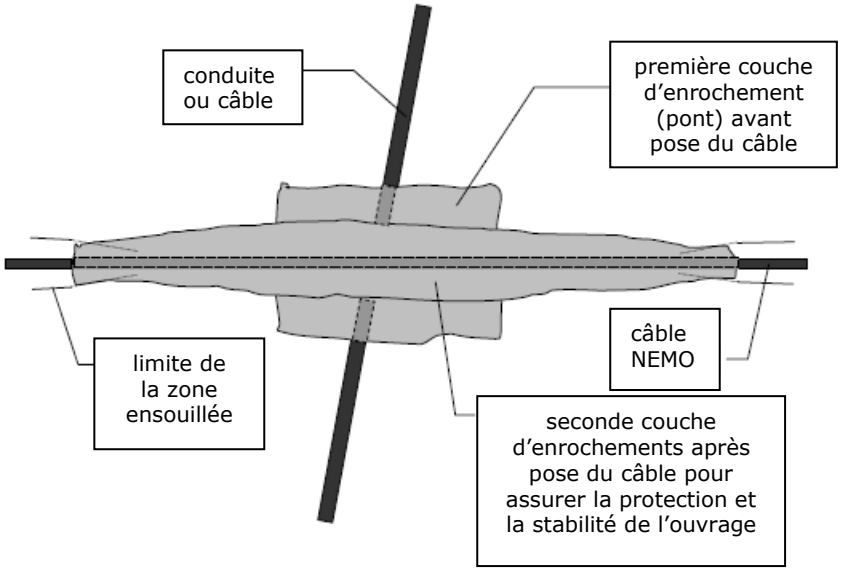
N.B. : si la mise en place d'enrochements s'avère nécessaire pour protéger le câble, un dossier d'autorisation spécifique devra être déposé, comprenant une étude d'impact.

Sur le tracé français, le câble NEMO ne croisera aucun câble ou conduite en service et donc ne nécessitera **pas de** mettre en œuvre la **procédure particulière de croisement d'ouvrage.**

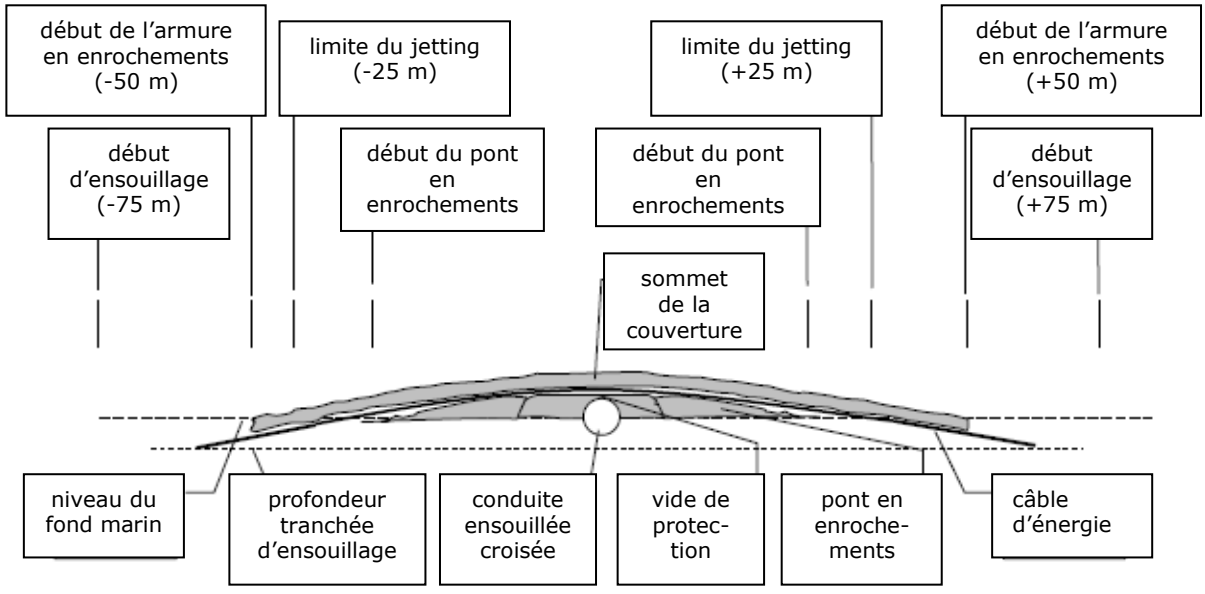
2.2.6. Post ensouillage du câble (Post-burial)

Dans les zones particulières où le câble n'est pas ensouillé au moment de la pose (croisement de câble ou zone de raccordement par exemple), un ensouillage du câble posé ou de la boucle excédentaire de câble peut être nécessaire, dans le prolongement du chantier de pose ou quelques jours après.
Aucun croisement de câble n'est prévu sur le tracé dans les eaux françaises et la position des points de raccordement n'est pas encore connue.

Figure 2.2.6 : Structure de protection de type semi ensouillé / surensouillé pour le croisement de câbles- (PMSS, 2011 d'après METOC, 2004)



Vue en plan



Vue en coupe

2.3. Exploitation du câble

2.3.1. Maintenance

Après l'installation, il n'est pas prévu de travaux d'entretien de routine. Toutefois, certains travaux peuvent être nécessaires pour maintenir l'ensouillage du câble pour le protéger des interactions indésirables avec d'autres usagers de la mer et les processus naturels marins qui pourraient l'endommager. Le câble et son installation sont conçus pour limiter les besoins d'entretien.

2.3.1.1. Surveillance de l'ensouillage du câble

Le câble est ensouillé pour réduire les opérations de maintenance. Cependant, certains secteurs réclament une surveillance régulière telles les zones de croisement des câbles ou ouvrages ainsi que les zones de forte mobilité comme les bordures des bancs sableux de la zone offshore ou les zones d'intenses activités maritimes.
Des campagnes de surveillance au moyen d'un sonar à balayage latéral ou d'un ROV avec caméra vidéo embarquée peuvent être régulièrement programmées pour vérifier d'éventuels secteurs où le câble serait exposé et la tenue des protections dans les zones de croisement d'ouvrages.

2.3.1.2. Intervention sur le câble pour réparation

Bien qu'il soit ensouillé sur la totalité du tracé, des accidents externes (liés aux ancres des navires commerciaux ou aux chaluts) peuvent endommager le câble et nécessiter une réparation.

Le déroulement typique d'une opération de réparation est :

- chargement du segment de secours (à partir du stock de maintenance laissé dans un port à proximité ou provenant du constructeur) ; la longueur de câble nécessaire correspond au minimum à 3 fois la hauteur d'eau où a été détectée la panne (et plus si le câble a été endommagé sur une distance),
- localisation précise possible de la panne,
- désensouillage du câble au moyen d'un grappin
- recouvrement du câble en surface et réparation (jonction avec le segment de câble apporté)
- relargage du câble et réensouillage : la longueur supplémentaire de câble pour la réparation signifie que le câble réparé ne pourra pas être réensouillé et aligné exactement au même endroit ; l'excès de câble forme alors une boucle sur le fond qui sera réensouillée par jetting par exemple.

Selon l'ampleur des dommages, l'opération de réparation du câble peut durer plusieurs semaines voire mois.
Les détails de l'opération (date, cause de la panne, longueur de câble rajoutée, position de la boucle de réparation, navire utilisé…) seront consignés dans le registre de maintenance.

2.3.1.3. Emissions du câble

Il existe un certain nombre d'émissions qui peuvent survenir à des degrés divers lors de l'installation ou de l'exploitation du câble : champs électromagnétiques, chaleur, bruit, courants parasites, élévation du potentiel de terre…

Champs électromagnétiques
Le champ géomagnétique terrestre forme le bruit de fond sur lequel les champs électromagnétiques artificiels interfèrent. Dans l'étude bibliographique réalisée pour l'interconnexion BritNed, on estime que le champ électromagnétique au voisinage du câble sous-marin à environ 48 µT (Swedpower, 2003a), que l'on peut appliquer au câble NEMO.
Le champ géomagnétique joue un rôle dans les déplacements de la faune marine (migrations, chasse) et est également utilisé par l'homme pour naviguer : les compas de marine sont ajustés pour compenser la déclinaison avec le nord magnétique. Des champs électriques sont induits dans l'eau de mer lors de son passage à travers le champ géomagnétique : la force de ces champs dépend de l'intensité du champ géomagnétique et des caractéristiques de l'eau de mer (salinité, viscosité, vitesse d'écoulement et direction par rapport aux lignes de flux magnétique). Les champs électriques naturels pour la mer du Nord ont été mesurées à 35 mV / cm (Pals et al, 1982). En 1974, Kalmijn a estimé que le champ électrique en Manche atteint 25µV/cm deux fois par jour, avec les marées mais il reste essentiellement un champ statique.

Champs magnétiques associés aux câbles sous-marins
Les câbles produisent un champ magnétique statique avec un champ magnétique variable superposé de faible niveau. Le système NEMO produit un champ magnétique statique d'une grandeur sensiblement identique au champ géomagnétique. En théorie, un type de câble appelé Conducteur de Retour Intégré (CRI) créera une forte diminution, voire l'absence, le champ magnétique si les deux conducteurs sont centrées sur le même axe du câble ; ce type de câble, considéré comme idéal pour sa signature magnétique, a été utilisé pour une liaison double HVDC entre l'Ecosse et d'Irlande du Nord. Cependant, il n'est pas actuellement de câble de type CRI capable de transporter le niveau de puissance proposé pour NEMO. Ainsi, le système qui sera mis en œuvre est un système bipolaire avec deux câbles de polarité électrique opposée, en configuration groupée (séparation de 0,2 m). Les champs magnétiques qui en résultent seront très faibles en raison de l'annulation mutuelle des pôles positif et négatif, et la composante variable a été calculée pour être négligeable.

Champs électriques associés aux câbles sous-marins

La haute tension en courant continu (HDVC) du système NEMO produit un champ électrique statique. Le milieu marin est protégé de ce champ électrique par la gaine métallique externe des câbles, qui sont reliés à la terre, ce qui rendra négligeable les champs électriques induits.
Les champs électriques variables produits par induction dans l'eau de mer autour des câbles et les très petits champs électriques variables résultant du « bruit » électrique des câbles ne sont pas considérés comme significatifs.

Le champ électrique produit dans le champ magnétique du câble sera influencé par le champ électrique naturel induit par le champ magnétique terrestre dans l'eau au même endroit. Il n'est pas possible de décrire avec précision l'intensité du champ électrique à un endroit donné sans une réelle compréhension des conditions environnementales locales. Une étude (SwedPower, Décembre 2003) visant à évaluer les champs électriques produits par le système de câbles BritNed (système similaire à NEMO) a été basée sur un débit d'eau maximal parallèle à un câble posé sur le fond marin, qui produit la plus grande induction et ne tient pas compte des interactions avec les champs naturels. La force du champ magnétique sur le fond marin est moins forte pour les câbles ensouillés.
Ainsi, la configuration du système NEMO réduit les champs électromagnétiques vers le milieu marin, comme le montrent les résultats des simulations pour BritiNed (SwedPower, December 2003) :

Configuration	Champ électrique (µV/m)		Champ magnétique (µT)	
	à 1 m du câble	à 5 m du câble	à 1 m du câble	à 5 m du câble
assemblé (0.2 m séparation)	61	1.9	72	2.2
séparés (2 m séparation)	260	18	310	21

Tableau 2.3.1 : Champs électrique et magnétique calculé pour le projet BritNed.
Source: Swepower, December 2003

Remarque: Les valeurs ci-dessus sont calculées pour être le maximum possible des champs électriques et magnétiques qui seront produits par BritNed. Les calculs sont basés sur une vitesse de l'eau de mer actuelle de 0,85 m / s, et un courant câble électrique de 1.320 A.

Ces résultats montrent que les champs électriques et magnétiques sont sensiblement réduits en regroupant les câbles ensemble : l'intensité de champ magnétique diminue à 0,5 µT à 8 m des câbles, ce qui représente seulement 1% de l'intensité du champ magnétique terrestre.
➔ce sera le "scénario de base" du projet NEMO.

2.3.1.4. Chaleur

Pour le transport d'énergie électrique en courant continu, les pertes se produisent en raison de la résistance interne dans le conducteur, proportionnelle à la longueur des câbles et inversement proportionnelle à la surface du conducteur (l'âme en cuivre du câble). L'énergie qui est perdue est convertie principalement en chaleur.
Sur la base des données de résistivité thermique recueillies au cours de la mission géotechnique, le calcul des effets de la présence du câble (2 faisceaux avec un conducteur section transversale de 1440mm², ensouillé à 2,5 m) sur la température des fonds marins (17° C en été et 5° C en hiver) indique que :

- à 30 cm de profondeur, l'élévation de température est de 1,2° C à l'aplomb du câble,
- à 10 cm de profondeur, l'élévation de température est de 0,7° C à l'aplomb du câble.

Ainsi, l'ensouillage à 2,5 m conduit à une augmentation maximum locale de la température des fonds à 18,2° C en été et 6,2° C en hiver dans les 30 premiers centimètres des fonds marins. Cet échauffement ne se produit qu'à proximité immédiate du câble tandis qu'en surface des fonds marins, la température de l'eau de mer n'est pas modifiée.

2.3.1.5. Bruit

Le bruit lors de la période d'installation offshore est lié à la présence des navires, en chantier itinérant (câblier et navire tractant l'engin d'ensouillage). Le convoi se déplace à faible allure (300 m de câble posé à l'heure, sur une base de travail 24/24h) : le bruit occasionné est temporaire. Dans le cas où les navires travaillent en stationnaire, la durée du chantier par zone est de 1 et 2 semaines.

Une étude sur le bruit émis lors de l'installation des câbles d'alimentation pour le parc éolien offshore North Hoyle a été réalisée par Cowrie en 2003, avec des mesures des niveaux de bruit engendrés par les tranchées de câbles dans le fond marin. Les niveaux sonores, enregistrés à une distance de 160 m de la tranchée par un hydrophone situé à 2 m de profondeur, étaient de 123 dB re 1 mPa : le niveau sonore pour les tranchées se situe dans une large bande sonore, intégrant le bruit de fond des machines et des bruits transitoires associés aux bris de roche. L'intensité sonore dépend de la nature des fonds et du type de roche tranché. L'analyse des données indique que si une perte de transmission de 22 log (R) est pris en charge, le bruit résiduel est de

178 dB re 1 mPa /m. La modélisation montre alors que, sur un rayon de 5 km de la source, toutes les mesures sont <70 dBht ➔ les impacts du bruit de la pose de câbles ne sera pas significatif.

Elévation du potentiel de terre
Une élévation de potentiel de terre (EPT) se produit quand un courant électrique de forte intensité s'écoule à la terre. Le potentiel électrique est plus élevé au point où le courant pénètre dans le sol, et diminue avec l'éloignement de ce point. L'EPT est généralement provoquée par des courants de défaut qui peuvent se produire au niveau des postes de distribution électrique, des centrales électriques, ou des lignes à haute tension : un courant de défaut circule à travers la structure des installations jusqu'au point de mise à la terre ; comme la résistance de la terre est finie, le courant injecté au niveau du point de mise à la terre produit une élévation de potentiel par rapport à un point de référence distant.

Lorsque l'isolation autour du conducteur HT fait défaut, pour des raisons externes, la majeure partie du flux de courant engendré retourne au convertisseur de la station terrestre, par le biais de l'armure métallique du câble. Le débit restant circule dans l'eau ou le sol au niveau du défaut sur le câble, où les fonds marins jouent le rôle de masse. Les calculs montrent que l'élévation temporaire du potentiel de la station convertisseur terrestre peut atteindre 800 V (SwedPower, 2003b), ce qui est dangereux pour le public, mais sur les fonds marins, l'ensouillage des câbles évitent cette EPT transitoire. Si la zone de'EPT atteint des infrastructures adjacentes, telles que les pipelines, des tensions jusqu'à 230 V peuvent être transférées à l'infrastructure ; cependant, les potentiels de contact ne s'avèrent pas nocifs si la séparation minimale entre le câble et le pipeline est maintenue à plus de 1,7 m (KEMA, 2003).

2.3.2. Relevage du câble en fin de vie

En fin de vie, le câble ensouillé peut soit être laissé sur place soit retiré selon le protocole industriel en vigueur. Le porteur de projet reconnait l'importance de prendre en compte dès à présent le processus de démantèlement de l'ouvrage ; ainsi, en fin de vie du câble, les différentes options pour le déclassement du câble seront évaluées. Dans certaines situations, l'option la moins dommageable pour l'environnement pourrait être de laisser le câble en place mais cette option soulève la question de la responsabilité de toute réclamation de pêcheurs ou d'autres tiers qui entreraient en contact avec les câbles. Cette question sera abordée dans le stade de la planification du déclassement du câble.

Les objectifs du porteur de projet durant le processus de déclassement sera de minimiser les effets à court et à long terme sur l'environnement tout en rendant le plan d'eau et les fonds sans danger pour les autres usagers de la mer. Sur la base de la réglementation en vigueur et de la technologie disponible, National Grid / Elia propose de retirer le câble lorsque c'est nécessaire ou de le laisser ensouillé, et de laisser en place les protections mises en place (matelas ou enrochements).

En cas de retrait du câble, l'opération de démantèlement correspond à l'inverse d'une opération de pose. Le câble est désensouillé sur toute sa longueur (directement au moyen d'un grappin ou exposé avec d'une machine à jets et repris par un grappin) puis remonté à bord (ré-enroulé dans la cuve du câble ou découpé en tronçons et stocké en containers).
De retour au port, le navire câblier ou de recouvrement du câble dépose les segments ou tronçons à quai pour reprise ultérieure (dont recyclage).
Une campagne de reconnaissance en fin de pose permettra de s'assurer que tout le câble est relevé.

2.4. Moyens nautiques mis en œuvre

2.4.1. Pose

Sur la partie offshore (environ 100 km par des fonds >10 m de profondeur d'eau), le bateau utilisé sera un **câblier** (cable lay vessel) pouvant travailler par des profondeurs d'eau minimale de 10 m, d'une taille de 150 m de longueur. Le câblier travaille à vitesse réduite (1 à 2 nœuds) et déploie des équipements reliés par ombilics : le rayon de sécurité autour de ce navire à capacité de manœuvre restreinte (déroulement du câble et ensouillage) est de 500 m et peut être porté jusqu'à 2 km si le câblier doit ancrer.
La capacité de transport du câblier limite la longueur du câble à poser au cours d'une seule campagne. Plusieurs campagnes sont nécessaires pour poser la totalité du système mais, a priori, la pose dans les eaux françaises se déroulera sur la même journée, s'il n'y a pas de raccordement à faire sur la partie française.
La période de pose préférentielle dans les eaux européennes est l'été mais peut s'étendre d'avril à octobre : cette période assure les meilleures conditions de navigabilité pour poser le câble (état de la mer en particulier).

Dans les zones de fort trafic, les autres navires seront avertis au préalable des opérations de pose par un avis à la navigation (AVURNAV) et message radio VHF. Sur zone, des **navires d'accompagnement** (dits chiens de garde) seront déployés pour protéger le chantier et assurer la liaison linguistique avec les autres bateaux navigant ou opérant à proximité (trafic transmanche, DST du Pas de Calais et pêcheurs français / anglais / belges).

2.4.1.1. Ensouillage

La charrue classique ou à jets est remorquée par le navire câblier (généralement dans la distance de sécurité autour du navire) ou par un autre navire de petite taille suivant le câblier.

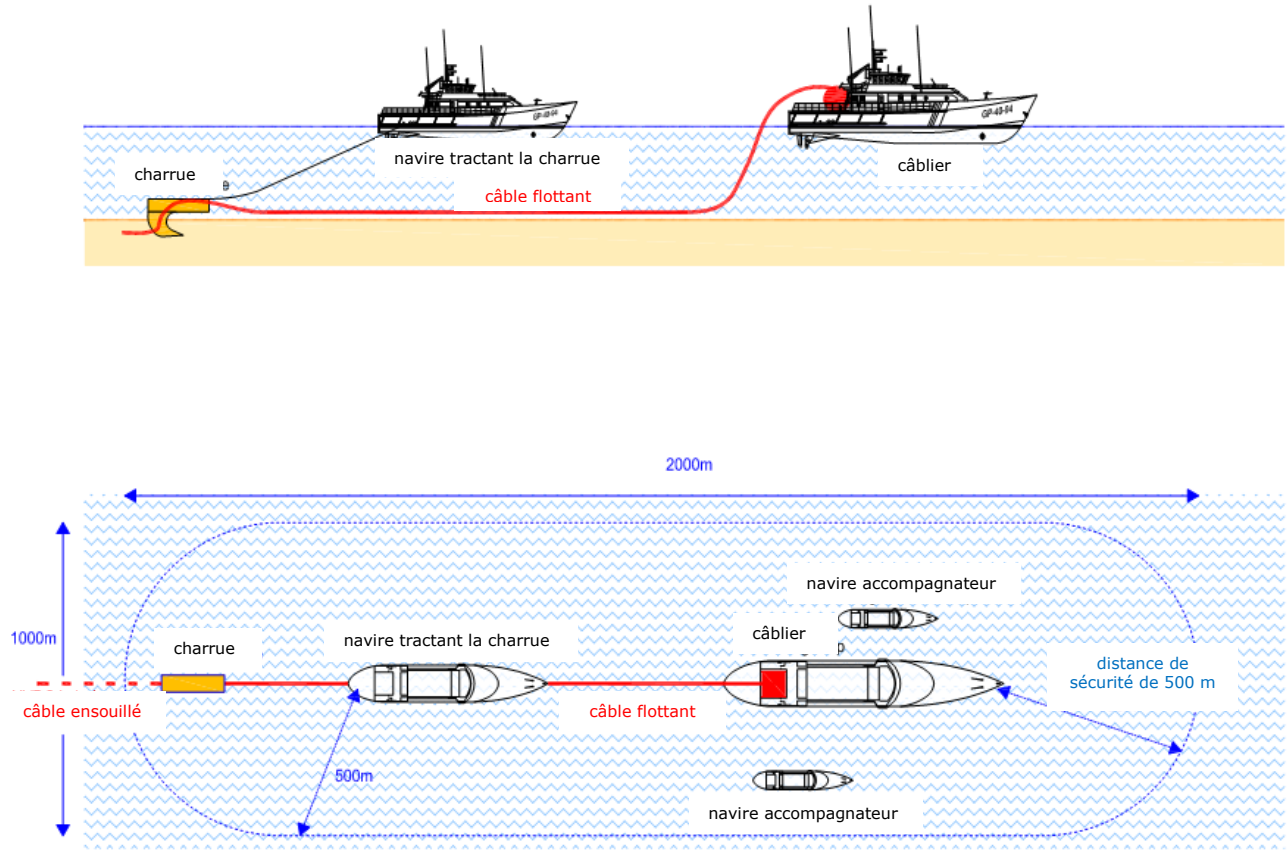


Figure 2.4.1 : Pose et ensouillage assurés par deux navires en convoi (d'après ARCADIS, 2011)

Le rayon de sécurité autour des navires reste de 500 m en latéral de chaque côté du navire mais est porté à 2 km en longitudinal (2 navires en convoi et la charrue). Les navires d'accompagnement évoluent dans le périmètre de sécurité des navires de pose.

2.4.1.2. Raccordement du câble en offshore

Le raccordement de deux segments de câble est réalisé à bord du câblier et peut prendre 1 semaine, le navire étant ancré.
Selon que l'un des 5 raccordements prévus sur l'ensemble du trajet se situe au niveau des 23 km dans les eaux françaises, la durée de l'opération de pose du câble peut être rallongée, le navire étant à l'arrêt (zone de sécurité de 2 km).

2.4.1.3. Post ensouillage

Dans les zones particulières où le câble n'est pas ensouillé au moment de la pose, l'ensouillage après pose est réalisé par un navire de post ensouillage qui peut suivre à une certaine distance le câblier de pose ou intervenir quelques jours après. Ce sont donc deux opérations distinctes dans le temps et l'espace.
A priori, ce ne sera pas nécessaire sur la partie française sauf s'il faut post-ensouiller la boucle excédentaire au niveau d'un raccordement offshore.

2.4.2. Maintenance

Surveillance de l'ensouillage du câble
Les campagnes de suivi de l'ensouillage du câble peuvent être mises en œuvre à partir de petits navires spécialisés ou non, capables de travailler par ces profondeurs d'eau. Il n'est pas nécessaire d'utiliser les moyens lourds mis en œuvre lors des reconnaissances géotechniques et géophysiques.

Intervention sur le câble pour réparation
Une opération de réparation ne nécessite généralement la mise en œuvre que d'un seul navire. Dans les eaux offshores, un câblier ou une barge à positionnement dynamique est mobilisé. Ces navires sont à capacité de manœuvre restreinte car ils doivent travailler à l'arrêt.
Le post-ensouillage du câble en excès et des nouveaux joints de raccordement se fait typiquement au jetting au moyen de machines déployées à partir du navire câblier ou d'un navire spécialisé supplémentaire.

2.4.3. Relevage en fin de vie

Le programme de démantèlement implique la mise en œuvre du même type de navire (câblier relevant et stockant le câble à bord, navire accompagnateur) et le même calendrier que pour une opération de pose (plusieurs campagnes à envisager selon la capacité de transport du câblier). La mise en œuvre du grappin pour récupérer le câble peut se faire directement à partir du câblier.

La campagne de vérification en fin de relevage du câble peut être réalisée par le même type de navire que pour les opérations de surveillance de l'ensouillage de l'ouvrage.

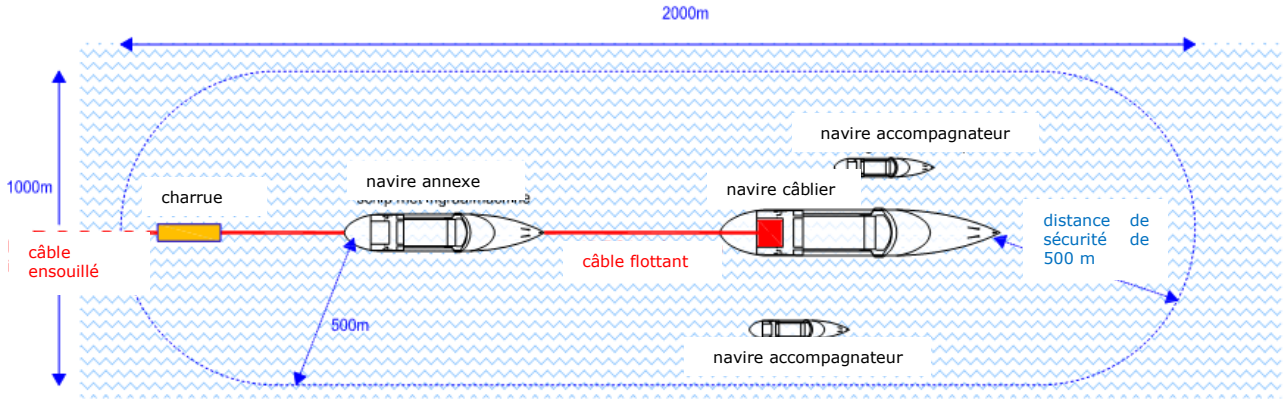
3. Dispositions propres à assurer la sécurité de la navigation maritime et la prévention des accidents maritimes

Des mesures de réduction d'impact ont été définies pour réduire les impacts de l'installation du câble sur la navigation maritime.

3.1. Signalisation et sécurisation du chantier itinérant

3.1.1. Zone de sécurité temporaire mobile

En raison de la vitesse d'évolution et la taille des navires travaillant dans une zone de fort trafic maritime, une zone de sécurité interdite aux autres navires sera établie autour du chantier mobile d'installation du câble.



3.1.2. Navires de garde

La présence de navires accompagnateur (« chiens de garde » sur lequel se trouve un personnel bilingue) permet d'assurer l'information sur le plan d'eau et d'éviter les conflits sur le plan d'eau.
Deux navires de la garde seront assignés au chantier d'installation : un navire en protection rapprochée du câblier et un navire secondaire pour la liaison et la gestion des conflits avec les autres navires.

Ces navires seront choisis en fonction de la vitesse, des équipements maritimes et de la tenue sur la plan d'eau. Ainsi, la protection du chantier peut être assurée par des pêcheurs locaux, qui connaissent bien le secteur et les autres utilisateurs du plan d'eau.

3.1.3. Signalisation

Les navires d'installation de câbles montreront les feux et marques réglementaires, tels que requis par le Règlement international pour prévenir les abordages en mer (RIPAM ou ColReg).

3.2. Coopération avec les services de surveillance du trafic en Manche

L'objectif des services de surveillance du trafic (CNIS - Channel Navigation Information Service ,côté anglais, et CROSS – Centre Régional opérationnel de surveillance et de sauvetage, côté français) est d'assurer la sécurité de la navigation dans le détroit du Pas de Calais, en exhortant les navires à se conformer aux procédures de l'Organisation Maritime Internationale (OMI) pour les bateaux naviguant dans un dispositif de séparation du trafic (TSS) et de fournir les dernières informations à la navigation sur les activités, les conditions et les irrégularités de navigation qui peuvent influer sur la sécurité de la navigation.

La procédure obligatoire d'identification des navires dans le détroit du Pas de Calais (CALDOVREP), et la couverture de la zone radar permettent une réduction des risques non négligeables pendant l'installation du câble. Il est en effet indispensable de communiquer le plan des opérations son opération avec la notification préalable et des rapports quotidiens à destination des services de surveillance du trafic maritime (Station de Dover Coastguard au Royaume-Uni et CROSS Gris-Nez[1] en France). Un plan régulier de communication, indiquant la position des navires et les activités quotidiennes, sera établi avec le CNIS Dover et le CROSS Gris-Nez pour s'assurer des échanges d'informations.

Dans le cas peu probable de navires «voyous» navigant dans le détroit sans communiquer avec le CNIS ou le CROSS en dépit de la réglementation CALDOVREP, les plans d'intervention des navires de garde du chantier maritime incluront une procédure de tractation avec ces navires hors-la-loi.

3.3. Diffusion d'un avis aux navigateurs

Les informations nécessaires à la sécurité pour la navigation seront annoncées conformément aux directives des services de surveillance du trafic maritime, qui diffusent en bade marine VHF un avis aux navigateurs présentant une description de l'opération, l'identification des navires en opération et précisant la zone d'opération. Cet avis est régulièrement mis à jour. Un avis urgent aux navigateurs (AVURNAV) sera émis en cas d'incident ou opération spécifique (raccordement de câble nécessitant un chantier stationnaire…).

Le Service d'information Kingfisher, qui fournit des informations précises sur la position des navires sur le plan d'eau au large des côtes et sur les dangers sous-marins, sera également avisé afin de publier les détails des travaux et le tracé final du câble dans leurs bulletins.

Par ailleurs, le nouvel ouvrage sera indiqué sur les cartes marines et les instructions nautiques diffusées par le SHOM et son équivalent britannique (UKHO).

Une information directe sera donnée aux organisations locales de pêche et de plaisance, via un officier de liaison avec les Pêcheurs (FLO) côté britannique et via les Comités Régionaux de pêche, incluant l'ensemble des flottilles concernées (Basse-Normandie, Haute-Normandie et Nord-Pas de Calais) côté français.

[1] Le CROSS Gris-Nez est un point de contact international SAR (Recherche et Sauvetage maritimes) pour la France, chargé de la surveillance du détroit du Pas de Calais et de la Manche / Mer du Nord, de la frontière belge au Cap d'Antifer, ainsi que des opérations de sauvetage internationales si un navire français est concerné.

3.4. Plan de mesures d'urgence (ERCoP)

Les représentants HSE (Hygiène-Sécurité Environnement) de l'opérateur en offshore fourniront un plan de coordination des mesures d'urgence (Emergency Response Cooperation Plan – ERCoP) couvrant toutes les phases du projet. Ce plan, qui devra être approuvé par le CROSS et le MCA, décrira en détails la coopération avec les services de surveillance du trafic maritime, avec les ressources d'intervention d'urgence, les ports les plus proches et les pilotes.

3.5. Protection du câble

Pour limiter au maximum les risques d'accrochage et de détérioration du câble, notamment en cas de mise à l'ancre d'urgence à proximité du câble, le câble équipé d'une armure métallique est ensouillé à profondeur définie sur la base de pénétration des ancres et des engins de pêche ainsi que sur la jurisprudence dans le détroit du Pas de Calais (à savoir un strict absolu de 0,5 m sur toute la longueur de la route).

3.6. Risque lié à l'exposition du câble

Tout incident entrainant la mise à l'affleurement du câble, devenant sensible aux croches par les navires fréquentant le site (engin de pêche notamment) sera signalé à la surface du plan d'eau par la mise en place de bouée lumineuse et/ou la présence d'un navire de garde (selon la densité du trafic et la zone de l'incident) jusqu'à résolution du problème (réensouillage).

3.7. Interférence géomagnétiques

Les risques liés au champ électromagnétique émis par le câble d'énergie fonctionnel sur la réception des instruments de navigation concernent la navigation dans le DST du détroit du Pas de Calais, notamment en cas de faible visibilité.
L'étude réalisée dans le cadre du projet de câble d'énergie BritNed (2004), dans un configuration similaire à celle du projet de câble NEMO, a montré que la déviation maximale du compas induite par le câble était inférieure à 5 degrés (SwedPower, Octobre 2003), ce qui reste à un niveau acceptable pour les autorités gérant la circulation dans le DST.
L'ensouillage du câble NEMO à des profondeurs similaires rend ces conclusions applicables au projet.

3.8. Découverte de munitions et d'explosifs

Le Maître d'Ouvrage s'engage à signaler, dans les délais réglementaires (48h), aux autorités compétentes (Préfecture Maritime et DDTM) toute découverte d'engin suspect et à respecter ses consignes. Il s'engage également à fournir, en fin de mission de reconnaissance, la liste complète des épaves et obstructions observées dans le couloir d'investigation.

Appendix 14: Belgian Offshore Non-Technical Summary

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Imagine the Result

ENVIRONMENTAL IMPACT REPORT – The NEMO LINK

NON-TECHNICAL SUMMARY

Elia Asset SA

Project n° 11/005405 | 21-12-2012

Client	**Elia Asset SA** Keizerslaan 20 B-1000 Brussel **National Grid Nemo Link Limited** National Grid House – A1 Warwick Technology Park Warwick, CV34 6DA Contact: Tim Schyvens (Elia Asset SA) Tel.: +32 2 546 78 83 Mail: tim.schyvens@elia-engineering.com

Non-technical summary – The Nemo Link

Contractor	ARCADIS Belgium sa **Main Office** Koningsstraat 80 B-1000 Brussels **Post adress** Kortijksesteenweg 302 9000 Gent
Contact	Riet Durinck
Telephone	+32 924 24 424
Telefax	+32 9 24 24 444
E-mail	r.durinck@arcadisbelgium.be
Website	www.arcadisbelgium.be

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NON-TECHNICAL SUMMARY

The Nemo Link

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Responsible for	**Function**	**Name**	**Date**	**Signature**
Content	Project support	Riet Durinck	2012-07-30	
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Approval	Director	Paul Vanhaecke		
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1 PURPOSE AND PROPOSED ACTIVITY

National Grid Nemo Link Limited and Elia Asset SA intend to connect the high voltage grid systems of the United Kingdom and Belgium through an electrical interconnector with an approximate capacity of 1,000 MW, the Nemo Link-project. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. This system provides a rapid response to changes in electrical power production, where the power flows can be adjusted in a short time.

Initiators of the entire Nemo Link-project are National Grid Nemo Link Limited and Elia Asset SA. The applicant for the permits for the section of the route of the HVDC interconnector located in the Belgian part of the North Sea, is Elia Asset SA.

In order for the environmental interests to be taken fully into account in the license granting, an environmental impact report (EIR) has been drafted. This EIR will be used to underpin the consents process and describes the construction, exploitation and dismantling of the HVDC interconnector for the Belgian Part of the North Sea (BPNS). For those parts located in British and French waters, the environmental impacts are described in separate reports. The coastal zone, inland from the MLLWS (mean low low water spring line), is under regional (Flemish) authority, including environmental protection. This has the consequence that the scope of this EIR is limited to the marine areas (i.e. from the mean low low water spring line).

2 PROJECT DESCRIPTION

2.1 General description of the activity

Overall, the activities of the project are defined as follows:

- The study phase (2006 → 2014):
  - Realization of a feasibility study to identify all potentially suitable routes between the United Kingdom and Belgium (2007);
  - Route-engineering study using a desktop study and a marine survey;
  - Engineering of the interconnector;
  - Consult with licensees of crossing cables and pipelines to obtain ‘letters of no objection';
  - Drawing up the EIR and permit applications;
  - Completion and signing of 'crossing agreements’ with licensees of crossing cables and pipelines;

- The construction phase (2014 → 2017):
  - The installation of the cable system is preceded by some preparatory work:
    - Potential local removal of out-of-service telecommunications cables that cross the cable route;
    - Deposit of protective measures, bridging and separation structures at crossings of the interconnector with present cables and pipelines;
    - Local leveling or ‘pre-sweeping' of the route, with local removal of sand waves;
    - Clearance of the seabed, to expose and remove undetected obstacles before the cable is unrolled.

- Offshore installation of the interconnector, consisting of two operations: unrolling & laying the cables and burying the cables. These two operations are performed simultaneously or not;
- Offshore connection between the cable sections;
- Landfall installation.

The start of the work depends on several factors including the delivery of the cables and the availability of ships. In general, installations in European waters are typically undertaken in the summer season, broadly between April and October. This period is determined primarily by the high probability of adverse weather occurring outside of this period. The duration of the offshore construction works of the interconnector in Belgium is estimated at approximately 2 months.

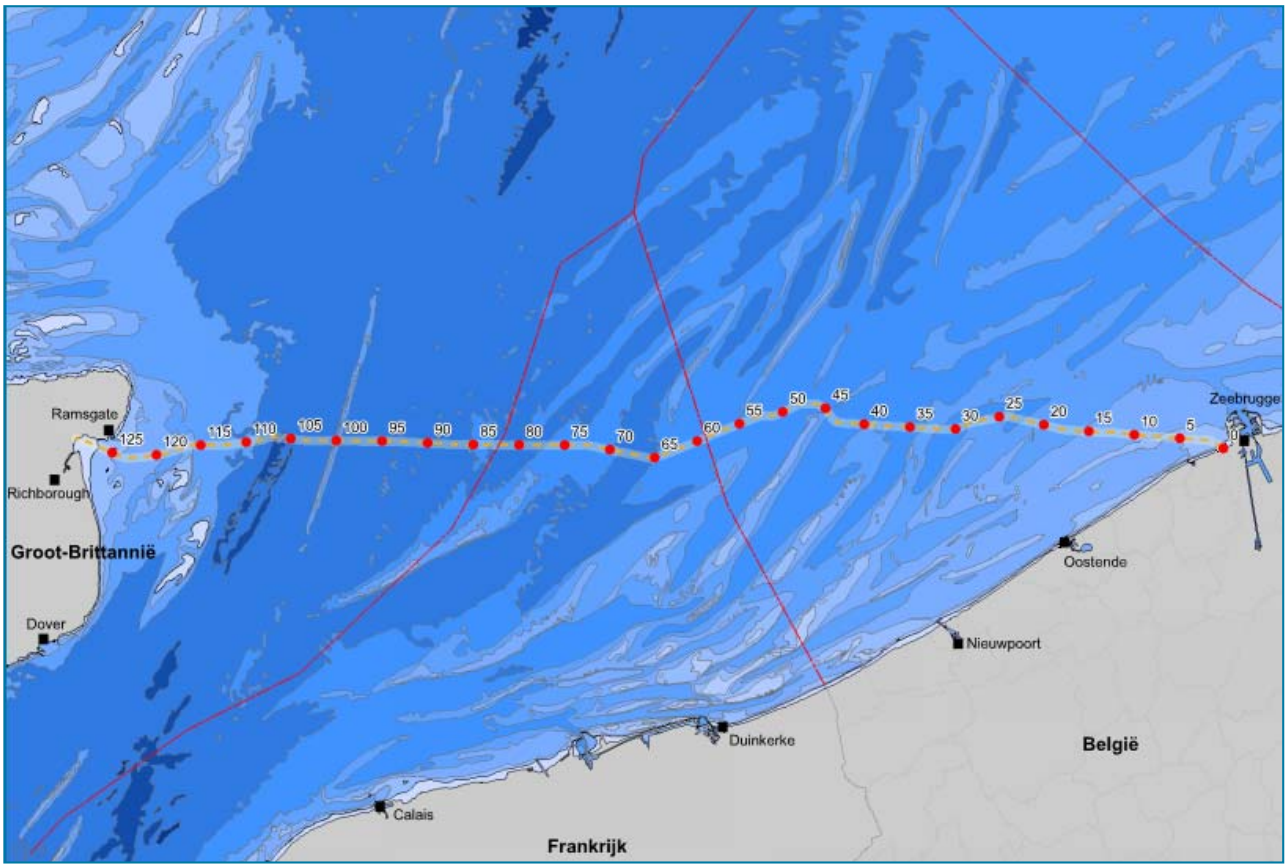
- The operational phase (2017 → 2036):
  - During the operational phase, electrical power flows from the Belgian high voltage grid system to the British high voltage grid system, or vice versa;
  - Regular preventative maintenance and inspection will be performed in order to keep the installation in optimum condition and to avoid interferences;
  - If necessary repair work will be performed;
  - After the operating period, which is set at 20 years, a renewal of the permits will be requested. Otherwise, the cables will be taken out of use (decommissioning phase).

- The decommissioning phase:
  - Currently it is not yet certain whether the interconnector, after it has been taken out of use, will remain in situ or will be removed.

2.2 Location of the cable route

The location of the HVDC interconnector between the United Kingdom and Belgium (shortly: Nemo Link) is shown in the figure below. The cable runs from Richborough (UK) to Zeebrugge. A French section of the North Sea is also being crossed.

The cable route was initially established on the basis of a feasibility study, at which the route between Richborough (Kent) and Zeebrugge West was identified as the most suitable route between the United Kingdom and Belgium, mainly because of availability of land (including for the construction of a new converter station), length of the cable route and licensing and permit issues. Subsequently, a preliminary route engineering study was carried out to identify the most suitable offshore cable route between Richborough and Zeebrugge. The route engineering study consisted of a desktop study, at which existing data and knowledge of the proposed cable route were studied and analyzed, and a marine survey, in which certain aspects on site were verified (mainly geophysical, geotechnical and limited benthic features). Where necessary, adjustments to the route were carried out to mitigate potential impacts or risks in order to minimize both cable and installation costs and disruption of the marine ecosystem and its users. In the present EIR, the cable route resulting from the route engineering study is considered.



2.3 Description of the cable system

2.3.1 System: bipolar direct current connection

For the interconnector between UK and Belgium the HVDC (High Voltage Direct Current) technology will be used. The portion situated in the Belgian Part of the North Sea, is about 59 km long. The base case of the interconnector between UK and Belgium is a bipolar HVDC system, with an approximate capacity of 1,000 MW. Bipolar systems transmit power through two high voltage conductors of opposite polarity (e.g. +500 kV and -500 kV). These cables each have a diameter of approximately 150 mm and a conductive copper or aluminum core surrounded by electrical insulation and protective coating. In the base case of the interconnector between UK and Belgium the two cables are bundled together and installed in the same trench. Other configurations are not excluded (see 'Alternatives').

The cable system is buried up to a depth of 1 to 3 m, depending on local soil properties. Burying too shallow can over time lead to exposure of the cables, while burying too deep can impede heat dissipation. The soil conditions also affect the burial depth in another way: a stable soil (e.g. clay) requires less burial depth than for example a sandy soil to maintain protection of the cable. Moreover, for the determination of the buried depth, the guidelines developed by Maritime Access (Department of Transport and Public Works) and other competent authorities shall also be taken into account. In case suitable burial depth can't be reached, it may be necessary to provide additional protection from anchors and fishing activities.

The subsea cable system is jointed to its corresponding land cable in a joint pit located above mean high water mark. To connect the interconnector, that uses direct current, and the high voltage grid systems of National Grid and Elia, that both use alternating current, HVDC needs to be converted to HVAC in a converter station, both in Belgium and the UK. On the Belgian side, a new converter station will be built in Zeebrugge.

2.3.2 Cable type

Several types of electrical insulation for the cables exist. In the base case of the interconnector between the UK and Belgium the mass-impregnated (MI) cable is used. The MI cable has one copper or aluminum core surrounded by layers of paper that serve as electrical insulation. The paper layers are impregnated with high viscosity mineral oil. The core is contained in a lead sheath to protect the insulation from water ingress and a polyethylene sheath is extruded over this to protect it from corrosion. One, and sometimes two, layers of galvanised steel armour wires are applied in a helix to provide mechanical strength during cable handling and installation and protection from external damage. The armour wires are bedded into a layer of bituminised jute strings and a layer of polypropylene string is applied over them to bind them in and provide abrasion resistance and to improve handling. Such cables have a diameter of approximately 150 mm.

2.3.3 Electromagnetic fields, induction phenomena and heat

Electromagnetic fields, induction phenomena and heat generation are some energetic aspects specific to submarine HVDC connections that will be discussed briefly in following paragraphs. Potential effects due to these specific energetic aspects are discussed in Chapter 4 (‘Description and evaluation of the environmental impact per discipline’) as well as non-specific environmental aspect related to the construction, operation and decommissioning of submarine HVDC connections (increased shipping, increased turbidity, etc.).

2.3.3.1 Electromagnetic fields and induction phenomena

An important characteristic of high voltage cables in operation is the production of electromagnetic fields. When an object is subject to high-voltage, such as a conductor, an electric field around that object will be created. Field strength increases with increasing voltage. A magnetic field is created when current flows through a conductor. The strength of this field is determined by the current.

The electric field of the interconnector is almost completely shielded by the lead sheath and other external metallic components of the cables. Magnetic fields on the other hand are able to pass through most materials.

The magnetic fields around the individual cables can be largely neutralized by installing the two cables of the bipolar system close together. By the opposite flow direction of both individual cables, both magnetic fields will also be opposed so that they cancel each other largely. The smaller the distance between both cables, the smaller the resulting magnetic field.

Burying the cable does not fully mitigate the magnetic field, but it can be assumed that exposure of organisms susceptible to magnetic fields will be greatly reduced by the creation of a physical barrier. Moreover, the field strength rapidly decreases with distance from the cables.

Because seawater flows through the magnetic field of the cable, induced electric fields arise. However these induced electric fields are very small. Especially when magnetic fields are largely neutralized by bundling of the cables and with a buried depth of 1-3 m, the induced voltages in the seawater will be negligible.

2.3.3.2 Heat generation

In transporting electrical energy, losses occur as a consequence of the internal resistance in the conductor. The energy that is lost is converted primarily into heat. The amount of heat that is released is small and is determined by the cable system (DC or AC, mono-or bipolar, bundled or not, insulation type, thickness and material of the conductor, depth at which the cable is laid), the voltage and the characteristics of the environment (thermal conductivity and resistivity) (OSPAR, 2009a).

3 ALTERNATIVES

3.1 To location of the route

The cable route was initially established on the basis of a feasibility study in which a detailed comparison and assessment of the possible routes and landing points was performed, and which showed that the route between Richborough (Kent) and Zeebrugge West offers significant advantages. In a subsequent route-engineering study, the selected route was further optimized, in which the physical and biological aspects and aspects related to human activity were studied in more detail. It was attempted to outline the route so that both cable and installation costs and distortion of the marine ecosystem and it's users are minimized. Given the already very advanced optimization, no alternatives to the location of the route will be studied in the present EIR, and the one remaining route will be considered as the most suitable route.

3.2 To cable type

In the base case of the interconnector between UK and Belgium, the MI (mass-impregnated) cable type is used. Alternatively the XLPE type of cable can be applied. This type is made with extruded and cross linked polyethylene (XLPE) as insulation. XLPE cables are essentially structured similarly to MI cables, but XLPE serves as insulation instead of oil-impregnated paper.

XLPE HVDC cables are more robust compared with MI HVDC cables and can therefore better withstand the stresses of submarine installation. A disadvantage of XLPE cables is that there is no technology available yet for use at very high voltages such as +/- 500 kV DC. XLPE has already been applied up to 200 kV DC. New developments go in the direction of 320 kV DC.

3.3 To cable configuration

The base case consists of two cables that are bound together (bundled). The bundled cables are placed and buried together in one trench. This configuration can be considered as the technically and financially most feasible alternative.

An alternative cable configuration consists of an unbundled system, with a small installation distance of 0.5 to 2 meters between both cables. The cables are laid in one single operation and are buried simultaneously with one excavator in two narrow trenches (i.e. in one large, wide trench in which a partition between both cables is created).

If both cables are installed at more than 2 meters apart, two separate lay and burial operations will be required. The cables are then installed in two separate trenches. According to the safety regulations set out in annex of the Royal Decree of 12 March 2002, the distance between the two cables has to be at least 50 m in this case.

3.4 To offshore installation procedure

Installing the interconnector implies a combination of two operations: the unrolling and laying of the cables on the one hand and burying the cables on the other. Following alternatives to the offshore installation procedure are possible:

Burying the cable	Number of ships to deploy	Alternative
Simultaneously with unrolling and laying → one operation	1 ➔ the cable laying vessel is provided with burial equipment	Alternative 1
	2 ➔ cable laying vessel + separate vessel with burial equipment	Alternative 2
Non-simultaneously with unrolling and laying → two operations	2 ➔ cable laying vessel + separate vessel with burial equipment	Alternative 3

The procedure ultimately used will depend on the contractor that shall carry out the installation of the Nemo Link, and the availability of vessels at this contractor.

3.5 To burial technique

A number of alternative methods are available for cable burial; however, the options are determined by the characteristics of the seabed into which the cables are to be buried. A combination of techniques is also an option. Most generic types of equipment for installing cables into the seabed are ploughs and jetting machines:

- Ploughing: with a plough a large trench is created in the seabed in which the cable can sink
- Jetting: jetting implies fluidization of the seabed to the appropriate burial depth with water jets. In this way, a trench is created in which the cable can sink.

3.6 To landfall technique

The landfall installation of the cable can be carried out with basically two techniques that optionally can be used in combination:

- Open cut trenching, with the use of mechanical excavators. This technique is applicable mostly above the high water line. When combined with a cofferdam, the technique can be used beyond the low water line;
- Horizontal directional drilling (HDD) implies drilling an underground borehole from the dry to a point in the direction of the sea. Then the cables are pulled through the borehole.

4 IMPACT DESCRIPTION AND ASSESSMENT

In this paragraph most important results of the impact assessment are summarized per discipline.

Given the difficulties to quantitatively describe certain effects, a semi-quantitative approach has been chosen. The effects are described as a relation between their size, their range (dimension) and their temporary or permanent character. The described effects are presented as a plus-minus assessment.

The following definitions have been applied:

Symbol	Definition	Description	Assessment environment/ organisms
++	Significant positive effect	Measurable positive effect, large range (BPNS[1]), temporarily or permanent character	Very positive
+	Moderate positive effect	Measurable positive effect, limited range (project area), temporarily or permanent character	Positive
0/+	Small positive effect	Measurable small positive effect, limited range (project area), always temporarily character	Neutral
0	(almost) no effect	Non-measurable effect or not relevant	No
0/-	Small negative effect	Measurable small negative effect, limited range (project area), always temporarily character	Negligible
-	Moderate negative effect	Measurable negative effect, limited range (project area), temporarily or permanent character	Acceptable
--	Significant negative effect	Measurable negative effect, large range (BPNS), temporarily or permanent character	Not acceptable

In the impact assessment distinction has been made between effects during construction, exploitation and potential decommissioning. Knowledge gaps and possible mitigating (effect reducing) measures have also been indicated. Attention has been given to both the negative and possible positive environmental effects.

In Chapter 3 several alternatives are described (for cable type, cable configuration, burial method...). In many cases these alternatives are not distinctive for their effects. Therefore, the various alternatives will only be discussed when a difference is expected in the relevant effects.

4.1 SOIL

4.1.1 Reference situation and autonomous development

The Nemo Link runs from Richborough (UK) to Zeebrugge. A French section of the North Sea is also being crossed. The interconnector enters the Belgian Part of the North Sea southwest of the 'Westhinder' sandbanks. Then the interconnector runs eastward, almost completely parallel to the northern boundary of the 'Vlaamse Banken' (KP[2] 15-58), and passes from west to east the 'Oostdijck', 'Buitenratel', 'Kwintebank',

[1] Belgian Part of the North Sea
[2] KP = kilometer point

'Middelkerkebank' and 'Oostendebank'. The eastern part of the route (KP 0-15) crosses the area of the 'Kustbanken' near the 'Wenduinebank'.

At several locations along the route various sand waves are located, rising up to 6 m above the surrounding seafloor. The sand waves are usually covered with smaller ripples.

The shallow geology (Quaternary and/or partially Tertiary) along the cable route is composed of sand with a thickness of 0 to 6 meters, on top of clay. Occasionally, a thin gravel layer was found on the sea floor (up to 37 cm).

The 'Vlaamse Banken' appear to be quite stable. For the autonomous development in the project area it can be assumed that it would undergo only few changes over the next few decades.

Due to climate change, changes will occur in the flow characteristics and the morphology of the Belgian Part of the North Sea (BPNS). Even within the period of operation changes will already be noticeable. Besides changes in the overall average values of sea level, temperature, etc., an increase in extreme climatic events is expected.

4.1.2 Impact description and assessment

4.1.2.1 Construction phase

Pre-sweeping involves local dredging of (tops) of sand waves and thin layers of sand, followed by the dumping of the dredged sand in the vicinity of the works or at the designated disposal sites for dredged material in the BPNS. It is estimated that an amount of approximately 100,000 m³ of sand shall have to be moved. This will include an increased turbidity and sedimentation in the vicinity of the works. Because of the limited volume of sand to be moved and because of the high mobility and dynamics that sand waves already naturally own, the impact of pre-sweeping on the soil is assessed as small negative (0/-).

At crossings with other cables and pipelines, protective measures and bridges are installed. In the Belgian Part of the North Sea five existing cables and one pipeline need to be crossed. In most cases, these protections are installed by placing special mattresses that are subsequently covered with rock armour to stabilize. The protective measures disturb the original geological structure. However, given the very limited size of the protective measures, this effect is very limited (0).

The thickness of the Quaternary cover along the route of the Nemo Link varies between less than 0.5 m and 17 m, so that the cables will be buried partially in Quaternary and Tertiary sediments. The degree of increase in turbidity and sedimentation here depends on the burial method. The effect of burial of the cables to the overall sediment transport, sedimentology and morphology of the seabed and the original geological structure is assessed as small negative (0/-). The nature and significance of the impact on geology are completely similar (not significant) for the various configuration options and burial techniques.

No effect (0) is expected on soil quality due to accidental discharges from ships and machinery during construction or due to loss of pollutants from the cables or from crossing infrastructures.

4.1.2.2 Operational phase

The HVDC interconnector between the UK and Belgium will be installed in such a way that the coverage of the cables will be guaranteed for the longest possible period. In addition, periodic inspection along the cable route is provided so that insufficient coverage of the interconnector can be noticed in time. The chance that the cables will become exposed is thus quite low. A possible effect due to local erosion at which the cables appear as obstruction on the seabed, is therefore assessed as small negative (0/-).

The scour protection applied at the crossings with other cables and pipelines minimizes the creation of extensive scour holes around the crossing infrastructure. The erosion shall move to the border area between the seabed and scour protection (secondary erosion). The effect of erosion near the crossing infrastructure is assessed as small negative (0/-).

As with the construction phase it is not expected that the operation will lead to contamination of the soil (no effect, 0).

It can be assumed that the increased temperature in the seabed decreases rapidly with the distance from the cables. On the basis of a study in the context of the Nemo Link-project it was calculated that at a cable depth of 3 m the warming-up at the surface would be less than one degree. Using a cable depth of 1 m, this could increase to a heating of the surface by 2 to 3° C. Given the limited volume of the seabed that therefore may be affected by the warming of the cables, the effect is considered negligible (0 / -), irrespective of the type of cable and the configuration alternatives.

4.1.2.3 Decommissioning phase

If the cables are removed, non-significant effects may occur, similar to the effects that will occur during the construction phase (0/-). If the cables are not removed, no effects occur (0). When removing protective measures and associated scour protection at the crossings with other cables and pipelines, the original geological structure and morphodynamics will be restored. In both cases, the impact on the soil is considered as very limited (0).

4.1.3 Mitigating measures

As no significant adverse effects are expected, no mitigating measures are required.

4.2 WATER

4.2.1 Reference situation and autonomous development

The project area, from the landfall in Zeebrugge to about KP 15, is determined by average water depths of 0 to approximately 10 m. At the rest of the route in the BPNS the average water depth is 20 to 30 m. The water level in the project area will vary by the tide (low tide, high tide) and under the influence of wave action and wind.

The currents of the North Sea water in Belgium mainly come from SW to WSW, driven by the tides and prevailing winds.

The turbidity or clarity of the seawater is determined by the amount of suspended (particulate) matter in the water. Satellite images that measure the amount of particulate matter in the upper water column, show a clear spatial variation in concentrations with a decrease from the Belgian coast into the sea. There is always a lower concentration at the sandbanks than near the coast (e.g. Zeebrugge, where the highest concentrations occur) because of the sandy sediment.

The mean water temperature in the BPNS is about 11 °C. Seasonal variations occur with a magnitude of 8 to 9 °C above the mean temperature.

For the project area it can be assumed that the natural concentrations of heavy metals in the water are relatively low. The main organotin compound is tributyltin (TBT). The 'Quality Status Report 2010' by OSPAR demonstrates that concentrations of certain hazardous substances in the seawater have decreased, although problems remain in many coastal areas. With regard to eutrophication, large areas of the North Sea coasts remain problem areas.

Due to climate change, changes will occur in the flow characteristics and chemical properties of the seawater. Even within the operation period changes will already be noticeable. Besides changes in overall mean values of sea level, temperature, etc., an increase in the occurrence of extreme climatic events is expected.

It can further be expected that the anthropogenic impact on water quality in the marine environment will continue to drop. For example, the concentrations of TBT, heavy metals, nutrient supply via rivers, etc., should show a positive downward trend in the future.

4.2.2 Impact description and assessment

4.2.2.1 Construction phase

During the construction phase an impact is possible on water quality resulting from pre-sweeping operations and from burying the cables, by release of heavy metals and organic pollutants from the sediment. As the pre-sweeping involves removal of coarse sediments with a low percentage of fine and organic material and consequently low concentrations of heavy metals, this effect can be regarded as a negligible (0/-). As the burial activities for the present project are very local, temporary and progressive in nature, this effect of burial of the cables is also assessed as negligible (0/-) (OSPAR, 2008).

During the construction phase, a local increase in turbidity will occur, primarily due to pre-sweeping operations and to a lesser extent due to the burying of the cables. Normally all works will be carried out in quiet (low flow) weather conditions, so when the natural turbidity is low. This also means that the sedimentation of the churned sediment will occur relatively quickly and within a small radius around the activities. It is expected that the concentrations of suspended material during construction activities shall occur in the same order of magnitude as the natural levels in stormy weather (Royal Haskoning, 2005; BMM, 2006a; OSPAR, 2008). The preparatory work and actual laying of the Nemo Link will have a local and temporary increase in turbidity with only a small negative effect (0/-), regardless of the burial method and the applied configuration alternative, especially compared to turbidity levels that naturally occur during storms and compared with dredging and commercial sand and gravel extraction operations that are already present in the BPNS (OSPAR, 2008). No long-term effect is expected.

4.2.2.2 Operational phase

No effect on water quality is expected (0) due to accidental discharge during inspection or repair work or due to the release of substances present in or around the cables.

The electric fields generated in the seawater are negligible (0/-), as the strength of the electric field caused by the cables decreases rapidly with distance from the cables and the cables are buried to a depth of 1-3 m, and especially when the magnetic fields are largely neutralized by bundling the cables.

No measurable increase in temperature of the seawater is expected (effect 0) due to heating of the cables.

Only if the cables over time would become exposed at a particular place, a local and temporary increase in turbidity can occur when re-burying the cables. This effect is negligible (0/-).

4.2.2.3 Decommissioning phase

The effects that may occur during the decommissioning phase shall be similar to those in the construction phase (slightly negative, 0/-, to nonexistent, 0).

4.2.3 Mitigating measures

As part of the overall safety system, there will be a clear procedure available which describes how and by whom actions are taken when an emergency should arises that could adversely affect water quality (e.g. oil spill) during the installation, operation or decommissioning.

4.3 CLIMATE & ATMOSPHERE

4.3.1 Reference situation and autonomous development

4.3.1.1 Climatic factors

Belgium generally has a temperate maritime climate. The maritime climate is characterized by relatively high rainfall and wind and small temperature variations between seasons. It has a cool summer and mild winter. The climate characteristics that prevail on land also largely prevail for the climate at sea. At sea however there is generally a more constant wind climate and a higher wind speed. At 10 km from the coast, the wind speed at sea can be 25 % higher than at the coast.

Following future climate changes are expected on a global scale (IPCC, 2007):

- During the next two decades a warming of 0.2 °C per decade is forecasted for many of the scenarios;
- The expectations of the average global warming by 2100 are highly dependent on the emission scenario considered; compared to the period 1980-1999, the expected warming is estimated at 1.8 [1.1 to 2.9] °C to 4.0 [2.4 to 6.4] °C (depending on the scenario);
- The average global warming 'in balance' expected at a doubling of CO_2 concentrations probably lies between 2 and 4.5 °C, with a best estimate of 3 °C. It is highly unlikely that the temperature rise will be below 1.5 ° C. A temperature rise far above 4.5 °C is not excluded.

- A sea level rise between 0.18 and 0.80 m (depending on the scenario) is expected by 2100 relative to the period 1980-1999.

4.3.1.2 Atmosphere

With respect to air quality following parameters are relevant: CO, NO_x, SO_2 and PM_{10} (dust). The air quality near the Belgian coast amply meets the quality objectives for these parameters.

For the autonomous development of the atmosphere it can be stated that the emissions that result from the construction, operation and eventual removal of the cable system will not occur. Therefore, there will be no temporary influence on the local air quality.

4.3.2 Impact description and assessment

4.3.2.1 Climatic factors

During the installation of the Nemo Link the global climate won't encounter relevant impacts (0). During the operation, the local temperature climate in the vicinity of the cable can be influenced by heating of the cables. It can be assumed that the heating of the cables will only cause a limited and very local warming of the sea floor, that is assessed as non-significant (0/-).

During the decommissioning phase, the global climate will encounter no relevant effects, whether the cable is removed or not (0).

4.3.2.2 Atmosphere

The installation of the cable system is associated with only a limited number of vessel movements, spread over a relatively long period. The channel between the UK and the mainland is one of the busiest shipping routes so it is expected that the emissions from vessels used during the construction phase of the Nemo Link only will have a negligible impact on local air quality (0/-).

During the operational phase limited emissions will occur due to inspection and maintenance and potential repair work. It is not expected that these limited emissions will have a noticeable impact on local air quality (0).

The impact on air quality resulting from emissions of vessels that would be used in the potential removal of the interconnector is similar as in the construction phase (negligible, 0/-).

4.3.3 Mitigating measures

Since relevant effects are expected neither the discipline atmosphere, nor for the discipline climatic factors, mitigation measures related to these disciplines are not applicable.

4.4 NOISE

4.4.1 Reference situation and autonomous development

The natural underwater background noise level lies between 90 and 100 dB (re 1 µPa) at frequencies ranging from 100 Hz to a few kHz. The noise of ship engines is one of the major noise sources of human origin. The noise and vibrations from the engine, propeller noise and noise from the currents cause an increase in ambient noise underwater. The channel between the UK and the mainland is in literature considered as a ‘hot spot’ for underwater noise, caused by the high density of shipping. Dredging, seismic investigation of the soil and piling in the construction of wind turbines are also major anthropogenic sources.

Above water, at sea level, the background noise level is estimated to be 35 + 5 dB(A).

Wind and waves dominate the noise level at the beach. According to data found in literature, it seems that near the shore the background noise level lies between 50 and 65 dB(A) at 25 m from the shoreline.

As far as noise is concerned, no significant change is to be expected in the autonomous development of the area from a global point of view. Though an increase of shipping on the route towards the ports of Zeebrugge and Oostende may cause an increase in the underwater and above water noise.

4.4.2 Impact description and assessment

4.4.2.1 Construction phase

The relevant noise sources that will occur during the construction phase, include vessels and machinery with their own characteristics and capabilities depending on the task for which they are used: specialized vessel for the installation of protective measures on existing cables and pipelines, rock dumping vessel, dredger, cable laying ship (equipped with an excavator), support ships.

Effects on the underwater sound

It is not expected that the activities during the construction phase, and the deployed ships and machinery, will produce sounds a high noise level, as is the case with for example seismic investigation or the 'impulsive' noise produced by piling monopile foundations for wind turbines. Noise produced during the construction phase of the Nemo Link will however often be similar to other already existing underwater noise of anthropogenic origin, such as dredging, sand extraction, etc. (OSPAR, 2008). Moreover, the channel between the UK and the mainland is considered as a ‘hot spot’ for underwater noise, caused by the high density of shipping. Therefore it is expected that the limited number of additional shipping movements and the activities for preparation work and installation of the Nemo Link (which are all temporary and progressive in nature), will cause no significant noise disturbance, regardless of the equipment used (small negative impact, 0/-).

Effects on the sound above water

Given the limited number of vessels to be deployed during the construction phase and as the installation works are progressive in nature, the increased noise above water is considered to be generally negligible compared to the normal shipping traffic (0/-), regardless of the equipment or type of cable laying ship used.

4.4.2.2 Operational phase

The presence of the Nemo Link will not result in noise production.

As can be assumed that the inspections and repairs to be carried out during the operational phase will occur rather sporadic and very locally, and as the noise from such works (worst case) will be similar as during the construction phase, the effect of noise disturbance during the operational phase both above and under water is assessed as negligible (0/-).

4.4.3 Mitigating measures

From the aspect of noise, no mitigating measures are considered necessary, as no significant noise disturbance due to the project is expected.

4.5 FAUNA, FLORA & BIODIVERSITY

The discipline Fauna and Flora deals with four different groups of organisms, namely the benthos (macro- and epibenthos), the fish, the birds (avifauna) and the sea mammals.

4.5.1 Reference situation and autonomous development

4.5.1.1 Benthos and fish

Marine organisms that live in or on the seabed, or benthos, are an important part of the food chain (dominant prey for demersal fish) and the ecosystem. They contribute to the biodiversity and the productivity of the sea. In this study we focus exclusively on the epibenthos (> 1 mm; on the seabed) and the macrobenthos (> 1 mm; in the seabed). Due to its limited mobility the presence of macrobenthos is an important indicator for the 'health' of marine systems. As regards the fish we focus only on fish living on or near the seabed (demersal fish) as they are the ones that will probably be affected most by the planned activities.

Four general occurring macrobenthic communities can be distinguished in the subtidal mobile substrates of the Belgian part of the North Sea, named after the most dominant species in the community. In between, another 6 transition-communities are identified. These are characterized by typical species, diversity and density and each are observed within a specific and well-defined environment.

Generally it can be assumed that the coastal zone is characterized by the *Macoma* and *Abra* community (De Backer *et al.*, 2010). The offshore samples are usually only characterized by *Nephtys* and *Ophelia* communities (De Backer *et al*., 2010). In addition, the samples in the coastal zone are generally characterized by a smaller grain size and a higher silt concentration than the offshore samples.

In the epibenthic communities significantly different density and biomass were observed between the coastal and the offshore zone, with significantly higher density and biomass in the coastal zone. With regard to species diversity, there are no significant differences between coastal and offshore.

Analogous to the epibenthos, the coastal zone is clearly richer in demersal fish (in biomass and density) than the more distant areas. Regarding species diversity, there is an overall increase from the coast further offshore, with the highest value at the 'Vlaamse Banken'. The main groups of demersal fish at the BPNS are the Perciformes (e.g. lesser weever, gobies…), the Pleuronectiformes (e.g. dab, plaice, sole…).

As regards the autonomous development it can be said that the benthic communities and the demersal fish fauna would not really change if the HVDC interconnector between the UK and Belgium would not be installed and operated. Other activities such as fishing, aggregate extraction, dumping, etc., can have a certain impact on the benthos and fish communities. Further it can be expected that the benthic and fish communities will undergo changes due to climate change (changes in flow characteristics, chemical properties of the sea water, temperature, storm frequency, etc.). At present there is still much uncertainty about the quantification of the impacts of climate change on the marine environment, especially on the scale of the BPNS. Moreover, the effects induced by climate change cannot always be separated from effects due to other human influences.

4.5.1.2 Birds

At the BPNS the highest densities of seabirds are reached in winter (average density of approximately 11.5 birds/km²) (Vanermen & Stienen, 2009). The species of seabirds occurring at the BPNS, can be divided into species that occur in the coastal zone and species that occur further offshore. Further from the shore the water is clearer, which for some seabirds is a condition to be able to catch prey, such as Common Guillemots, Auks and Northern Gannets. These species besides Red-throated Diver, Little Gull and Black-legged Kittiwakes appreciate the presence of sandbanks, because the concentration of food is apparently high. There are also true offshore species that rarely or never can be observed at the coast; these are Northern Fulmar and Great Skua. As regards the terns, Common Tern and Sandwich Tern forage near the coats mainly during breeding season, and especially around the ports of Zeebrugge, Oostende and Nieuwpoort.

The densities of Common Tern, Sandwich Tern and Little Gull are generally lower at the western part of the cable route than at the eastern part of the route. The highest densities are observed during the breeding season around the ports of Oostende, Zeebrugge and Heist, with highest densities located around the breeding colony of terns in the port of Zeebrugge.

If the Nemo Link is not installed, it can be assumed that the populations occurring on the Belgian part of the North Sea won't be affected in any way and consequently the ornithological value will remain the same.

4.5.1.3 Marine mammals

Until 2003 sea mammals were only sporadically observed during seabird counting in the BPNS. Since spring 2003, sea mammals are however increasingly found in the Belgian and Dutch part of the North Sea, whereby Harbour porpoises and White-beaked dolphins are the main species. This is probably not an actual increase

in numbers, but a shift of the foraging areas of sea mammals from more northerly areas, although other reasons cannot be excluded (Courtens *et al*., 2006; Depestele *et al.*, 2008; Haelters & Camphuysen, 2009).

Due to the mobility of sea mammals, the large area in which populations occur and the unpredictable nature of their occurrence, it is currently very difficult to determine migration corridors or areas that are more or less important for sea mammals (Di Marcantonio *et al.*, 2007; Degraer *et al.*, 2009b).

Four sea mammal species are considered as indigenous in Belgium; the Common seal, Grey seal, Harbour porpoise and Bottlenose dolphin (Haelters, 2009; 2010). As the Harbour porpoise occurs in much larger numbers than the other sea mammal species in the BPNS and as the Harbour porpoise turns out to be very sensitive to disturbance, the focus for the impact assessment is set on the Harbour porpoise.

During migration a large part of the Harbour porpoise population of the North Sea uses the Belgian part of the North Sea. Therefore the Belgian part of the North Sea is considered as seasonal important for the Harbour porpoise within Europe, namely at late winter and early spring (February to late April), with densities between 2000-4000 animals throughout the BPNS (Haelters, 2009; Haelters & Camphuysen, 2009; Degraer *et al.*, 2010b; Haelters *et al*., 2011; Rumes *et al*., 2011).

If the Nemo Link is not installed, it can be assumed that the value of the route of the HVDC interconnector between UK and Belgium will remain the same. Apart from existing (semi)-natural fluctuations in marine mammals stocks (for example by changes in food availability, or by shifts in the wintering areas) there are no indications that significant changes occur in the area. The main threats to marine mammals are overfishing, incidental catch, pollution (including noise and waste), climate change and collision with ships.

4.5.2 Impact description and assessment

4.5.2.1 Benthos and fish

Construction phase

Both during the preparatory work and during the laying of the cables, temporary and local habitat disturbance will occur. Permanent habitat loss doesn't occur during both the construction and operation phase as the cables are laid completely into the soil at a minimum depth of 1 m and the benthic communities mainly occur in the first 20 cm of the soil. As the disturbance may be regarded as limited in size in comparison to the entire surface of the BPNS (i.e. 0.005 % to 0.034 % of the BPNS) and the work is temporary in nature, the effect of habitat disturbance on benthos is assessed as negligible, regardless of the applied burial method or cable configuration. It is assumed that after the work a natural recovery of the benthic community will occur. Moreover fish are mobile organisms, so the effect of habitat disturbance during the construction phase will be even less pronounced.

During some preparation work (leveling or pre-sweeping, clearance of the seabed) and during the laying of the cables increased turbidity and sedimentation will locally occur. As the present life community is well adapted to a sandy surface that is naturally in motion, given the high mobility of fish and given the limited size of the impact zone with increased turbidity and sedimentation (both in time and space), the impact is assessed as negligible, regardless of the applied burial method or cable configuration.

Also on the specific habitat type 'gravel beds' no significant impact is expected, as the 'Hinderbanken', where the most important gravel beds and valuable refugia are situated, are not crossed, since there is not an indication of the occurrence of valuable gravel beds along the route in the BPNS on the basis of the marine survey, and since there will be no removal of sediment in areas where gravel fields may be present. The exact location of the (valuable) gravel beds in the BPNS is nevertheless an important gap in knowledge.

During the installation of the cable, underwater noise disturbance will occur. Because of the temporary nature and the type of work (with no impulsive noise with a high sound level being produced), the effect of noise disturbance on epibenthos and fish fauna is assessed as slightly negative (0/-).

Operational phase

During the operational phase, a magnetic and induced electric field will be generated around the HVDC interconnector. The impact of electromagnetic fields on benthos is expected to be minimal as the electromagnetic fields created by the Nemo Link cable will be within the natural range of the North Sea. There is no doubt that the electromagnetic fields generated by the HVDC interconnector between the UK and Belgium can be detected by some fish. The sensitivity to electromagnetic radiation appears to be species-specific and likely even individual-specific (Gill *et al*., 2010). The occurrence of effects and the significance of these potential impacts at individual and population level is very uncertain, so that more fieldwork is required. All recent literature (Boehlert & Gill, 2010; Gill *et al*., 2009; Tasker *et al*., 2010; Wilhelmsson *et al*., 2010) indicate the impact of electromagnetic radiation on marine organisms as a gap in knowledge. Given the very local nature of the generated electromagnetic fields, as the field strength decreases rapidly with distance from the cables and as the exposure of organisms that are susceptible to electromagnetic fields is greatly reduced by burying the cables (which creates a physical barrier of some thickness), the potential negative effects are assessed as small negative (0/-).

When transmitting electrical energy, the cables itself and the surrounding seabed shall warm up. As most benthic organisms occur in the upper layer of the seabed (about 20 cm from the surface) and the temperature rise in the upper 20 cm is rather low, and as the potential effects will occur very locally, the effect of warming of the seabed on macrobenthos is assessed as small negative (0/-), regardless the chosen cable configuration (bundled or not) or the selected type of cable (XLPE or MI). Based on the fact that the temperature of the seabed at the surface remains unchanged by the rapid removal of heat due to the moving sea water, it can be concluded that there will be no effect (0) on epibenthos and fish.

As part of the operational phase regular inspection of the Nemo Link will take place. If damage is found or parts of the cable are exposed, they will be repaired and/or buried again. This work may cause a potential habitat disturbance and disturbance from sedimentation, but are temporary and limited in size, so the effects on benthos and fish as a result of this work can be regarded as negligible.

Decommissioning phase

If it is chosen to remove the cables, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase (small negative, 0/-). If the cables stay in the seabed, no effects on benthos and fish fauna shall occur (0).

4.5.2.2 Birds

Construction phase

During the preparatory work and actual laying of the Nemo Link, a local increase in water turbidity and an increased sedimentation may occur. Seabirds occurring at the BPNS are however accustomed to foraging in turbid water, and most species feed in the upper meters of the surface. Therefore, the effects of increased turbidity and sedimentation on avifauna are assessed as small negative (0/-).

Furthermore, the increased presence of vessels and machinery can cause a temporary disturbance of avifauna, especially at the landfall. Because of the proximity of the port of Zeebrugge, however, busy shipping is already present in the landfall area of the Nemo Link. This disturbance effect is therefore also assessed as negligible (0/-).

Operational phase

During the operational phase (repair or inspection work), no direct effects is expected on the avifauna present at the BPNS (0).

Decommissioning phase

If a dismantling is chosen at which the cables are re-excavated, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase (small negative, 0/-). If the cables stay in the seabed, no effects on the avifauna shall occur (0).

4.5.2.3 Marine mammals

Construction phase

Installation and preparation work can cause to disturbance of marine mammals by underwater movements, the presence of vessels (busy shipping traffic) and machinery, a change in water turbidity, noise, etc. Given the limited number of additional shipping movements compared to the current number of shipments already present in the BPNS (mainly near the shipping lanes), given the local and non-permanent effect of the installation and given the high mobility of marine mammals, no significant and long-term adverse effects in the form of disturbance (including noise) are expected due the installation of the HVDC interconnector between the UK and Belgium (BERR, 2008; OSPAR, 2008). It is expected that the noise will not affect the echolocation capabilities of marine mammals (DIFRES, 2000). Marine mammals shall probably temporary avoid the area of the construction activities and its surroundings. Given the preceding and very local nature of the cable installation activities, no impact on the migration movements of marine mammals is expected. Disturbance and other potential impacts resulting from construction work is assessed as small negative to negligible (0/- to 0).

Operational phase

The magnetic field generated by the Nemo Link could potentially interfere with the orientation mechanisms of sea mammals (BERR, 2008; OSPAR, 2008; Tasker *et al*., 2010). The strength of the electromagnetic fields

generated decreases rapidly with increasing distance from the cables. As the cables are additionally buried up to a minimum depth of 1 m and as marine mammals do not have the habit to swim close to the seabed surface, it is very unlikely that marine mammals will be exposed to the electromagnetic fields generated by the cables. Therefore it seems unlikely that the electromagnetic fields generated by the Nemo Link cable will affect marine mammals (0).

When transmitting electrical energy, the cables itself and the surrounding seabed shall warm up. The temperature of the sea floor at the surface, however, will remain equal to the temperature of the seawater by the rapid removal of heat due to the moving sea water. Therefore, marine mammals won't be affected by the heating of the cables (0).

Inspections, maintenance or repair during the operational phase can disturb marine mammals. The effect of disturbance is considered as small negative (0/-) given its temporary nature, given the limited area on the Belgian part of the North Sea that will be affected and given the limited additional ship movements compared to the existing traffic in the Belgian part of the North Sea.

Decommissioning phase

If it is chosen to remove the cables when they are out of use, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase: there will be a slight, temporary and local disturbance of marine mammals (small negative impact, 0/-). If the cables are left in situ, there will be no effect at all (0).

4.5.3 Mitigating measures

Uncertainty remains about the exact location of (valuable) gravel beds in the Belgian part of the North Sea. A marine survey conducted in the summer of 2010 in the context of the Nemo Link-project along the proposed route of the Nemo Link, gives however no indication of the presence of valuable gravel beds and their associated fauna. This is in contrast to the British territory where this habitat type was found. Mitigating measures are therefore only proposed in the British part of the North Sea with respect to the gravel beds and their sensitive species (such as herring).

4.6 SEA SCAPE & CULTURAL HERITAGE

4.6.1 Reference situation and autonomous development

The sea and the beach are regarded as positive by the population. In Belgium the coast is an important tourist attraction, for day trippers as well as holiday makers. In contrast to the sea view, the coastal view in the inland direction is characterized by a range of high-rise buildings. Movement in the landscape by freighters, fishing boats, pleasure boats, surfers, etc., are part of the perception of the landscape for people on the dikes. Especially near the seaports there is a continuous coming and going of ships. A development that shall change the seascape in the future is the (further) construction of the currently permitted wind farms.

Along the coast there are many heritage sites, either protected or not. The most important ones are a number of dune areas and polders, piers, lighthouses, the fort of Napoleon, etc. At sea the cultural heritage consists mainly of wrecked ships. Several wrecks are located along the cable route.

4.6.2 Impact description and assessment

4.6.2.1 Construction phase

During the preparation work and the actual installation of the Nemo Link there will be a temporary visual change of the seascape due to passage of several vessels. The landscape at the landfall could also be altered temporarily. The perception of these activities can be assessed as negative (disturbance) or positive (touristic attraction). Because of the very temporary nature of the works the impact of the construction of the HVDC inter connector on the sea sight is assessed as negligible (0/-).

When setting out the cable route for the Nemo Link, avoidance of shipwrecks was used as a basic principle. For this purpose, the existing data of the location of shipwrecks was studied and taken into consideration. Then the position of the known wrecks along the proposed route has been verified using a Side Scan Sonar at the marine survey. With the Side Scan Sonar it was also possible to capture the location of yet unknown wrecks. So as avoidance of shipwrecks is pursued maximally, the effect on the maritime cultural heritage is limited to a minimum (0).

The construction of the HVDC has no direct or indirect impact on the cultural heritage along the coast from Knokke-Oostende (0).

4.6.2.2 Operational phase

Inspections along the cable route and possible cable repairs shall only slightly increase the shipping movements at sea and are of short duration. Therefore, the impact of the activities during the operational phase on the sea sight are assessed as practically nonexistent (0).

The operation of the Nemo Link will have no direct or indirect effects on the (maritime) cultural heritage (0).

4.6.2.3 Decommissioning phase

If the HVDC inter-connector is removed after the period of exploitation, the effects on the sea sight will be similar to those during the installation phase (negligible, 0/-). If it is chosen to leave the interconnector in situ, there are no effects at all on the sea sight (0).

In the preliminary investigation and during the installation of the Nemo Link, the location of all (possibly hitherto unknown) shipwrecks is identified. Therefore, possible removal of the cables will have no impact on the maritime cultural heritage (0). If it is chosen to leave the interconnector in situ after it has been taken out of use, there will also be no effects at all on the maritime cultural heritage (0). The cultural heritage along the coastline is not expected to be affected as well (0).

4.6.3 Mitigating measures

With regard to the sea scape it can be appropriate to inform the general public in advance, for example trough information panels at the dike, especially during the work in the intertidal zone and at the beach. In this way the acceptance of the temporary change in the landscape are strongly encouraged.

A general rule for the cultural heritage when constructing the interconnector is preferable avoidance of shipwrecks. If during the installation of the Nemo Link a wreck should still be 'discovered', the competent authorities must be informed as soon as possible, and avoidance of this wreck should be pursued as far as possible.

4.7 HUMAN ACTIVITY

4.7.1 Reference situation and autonomous development

4.7.1.1 Fishery

Most important species supplied are shrimps and demersale fish species, mainly sole, ray and flounder (Tessens & Velghe, 2010; Dienst Marien Milieu, 2009; Vanderperren & Polet, 2009). The intensity of the fishery (namely trawling) is carried out predominantly in the gullies between the sandbanks. Shrimp fishers on the other hand will look for their catch on the sand banks, mostly nearer the coast. On an international and national scale the fishing sector is faced with socio-economic problems by a steady decline of the existing biomass in the higher trophic levels in the North Atlantic since 1950 and increased fishing intensity during the 1950-1975 period. Researchers have found that the current fish exploitation cannot carry on and that the higher trophic level of fish in the North Atlantic will disappear completely in the next few decennia in view of present trends (Christensen *et al*., 2002). This is also evident from the fact that the stocks of nearly all species are specified as being ‘outside safe biological limits’.

Developments in the European Fisheries policy lead us to believe that further quota restrictions and accompanying measures (such as technical measures and restricting the days at sea) will mean that the trends described above will only grow stronger in the short and medium term.

4.7.1.2 Shipping

The reference situation of the professional shipping is described in the chapter ‘Safety aspects’.

4.7.1.3 Sand and gravel extraction

The exploration and exploitation of sand and gravel now takes place in three ‘control zones’ and one ‘exploration zone’. The Nemo Link runs north of the control zones 2c and 2a, but stays outside of these designated areas. Control zone 2c is located outside ‘Buiten Ratel’ and ‘Oostdyck’ and is open for exploitation throughout the year. Division 2a is located on the ‘Kwintebank’ and is open for exploitation for a period of 3 years alternatingly with sector 2b (rotation system).

4.7.1.4 Military activities

The Nemo Link crosses any of the areas designated for military activities on the BPNS, but passes nearby two military zones:

- A relatively small military zone where war munitions and training mines are detonated. These activities occur ≤ 10 days a year on average.
- A zone in which shooting exercises are performed from the beach of Nieuwpoort - Lombardsijde towards the sea. The number of shooting days in this area is ≤ 9 per year.

4.7.1.5 Cables and pipelines

The HVDC interconnector between the UK and Belgium shall cross a total of six communication cables, one electric power cable and a pipeline in the BPNS. One of the communication cables is yet no longer in use; the Hermes South.

4.7.1.6 Tourism and recreation

Along almost the entire Belgian coast, associated with the dikes and dunes, recreation and tourism plays an important role. The landfall of the Nemo Link is provided west of the western breakwater of the port of Zeebrugge. The beach of Zeebrugge west of the western breakwater is a very wide beach. The dike of Zeebrugge is relatively short (approx. 850 m). The eastern section runs into the dune area 'De Fonteintjes', which is designated as a Special Protection Area. At the most easterly point of the dike, the Animal surf club is located. A swimming area and a (kite)surf zone are situated in front of the surf club.

4.7.1.7 Biodiversity and nature conservation areas

Based on observed biodiversity patterns, different types of protected areas are identified in Belgian marine waters, mainly focusing on the west coast. The cable route of the Nemo Link passes through the special protection area SPA3 'Zeebrugge' and runs in close proximity to the special protection area SPA2 ‘Oostende’. In addition, the cable route crosses the recently approved special area of conservation (SAC) ‘Vlaamse Banken’ (RD 16/10/2012).

4.7.2 Impact description and assessment

In the following sections (socio-economic) impact of the construction and operation of the Nemo Link on relevant aspects is discussed. As a possible removal of the Nemo Link implies similar activities to be carried out and similar machinery to be used as during the construction phase, it is expected that similar effects will occur. The decommissioning phase is therefore not discussed separately.

4.7.2.1 Fishery

The expected impacts during installation of the Nemo Link are assessed as negligible. There is no loss of traditional fishing grounds and disturbance of fish by the work will only be very temporary and limited. During

the installation of the Nemo Link the construction area will nevertheless be temporarily inaccessible to fishing vessels. A security zone of maximum 2 x 1 km will be provided, where fishing is prohibited during the work.

The main potential impacts during the operational phase are the changes in the fish behavior caused by electromagnetic radiation emitted by the Nemo Link. For a discussion of these effects, see the chapter 'Fauna and Flora'.

If the Nemo Link would become exposed during the operational phase, fishing gear could get entangled with the cables. However, the interconnector is installed so that the coverage will be maximally guaranteed for the longest possible period. In addition, periodic inspections along the cable route are provided so that an insufficient coverage of the interconnector can be noticed in time. Therefore, the probability that the interconnector can be entangled in fishing gear is minimal.

4.7.2.2 Shipping

Safety aspects (risk of accidents, oil spills) of the professional shipping is discussed in the chapter 'Safety aspects'.

4.7.2.3 Sand and gravel extraction

The Nemo Link is installed in the vicinity of the control zones 2c and 2a, but stays completely out of these zones, so no conflicts are expected between the construction, operation and potential decommissioning of the interconnector on the one hand and the sand and gravel extraction on the other.

4.7.2.4 Military activities

Given the limited military activities (maximum 10 days per year per zone) at the military zones and the fact that the Nemo Link crosses none of these zones, no significant effects are expected due to the construction, operation and possible decommissioning of the Nemo Link. When approaching these military zones during the construction it remains advisable to maintain proper communication with the competent services of the Ministry of Defense, so they are aware of the activities in the vicinity of the military zones.

4.7.2.5 Cables and pipelines

At crossings with cables and pipelines, structures are made that form a safe bridge or separation between the Nemo Link and the existing cable or pipe. In most cases, these protections are created by placing special mattresses subsequently covered with armour rock to stabilize. In accordance with the provisions of the Royal Decree of 12 March 2002 (Art. 15, 8°), the initiators shall close a 'crossing agreement' with all licensees of the crossed cables or pipes individually, in which specific agreements are recorded with regard to the work to be performed and the manner of crossing with the relevant cable or pipeline. If all contractual agreements are respected, and every precaution is taken to avoid damaging the existing cables and pipelines, it can be assumed that there will be no impact on the existing cables and pipelines due to the construction, operation and possible decommissioning of the Nemo Link. The Nemo Link-project has initiated discussions on crossing agreements for all cables/ pipelines to be crossed.

4.7.2.6 Tourism and recreation

Outside the coastal zone no negative effects are anticipated for tourism and recreation due to the construction of the Nemo Link given the low number of ships to be used. In the shallow coastal zone a temporary disturbance is possible. By recreational boats, windsurfers, kite surfers, swimmers, etc., a safety zone may be used. Since the construction of the Nemo Link however is temporary and the prohibition of entering the safety zone will be monitored, the effect on tourism and recreation is assessed as small negative. Good communication with the Coast Guard during the execution of the work is necessary at this point.

During the operational phase no effects on tourism and recreation are expected at the marine part of the interconnector.

4.7.2.7 Biodiversity and nature conservation areas

Generally it can be stated that the construction will cause a certain disturbance by both the presence of vessels and the movement of the sediment. No significant impact is expected due to the construction work on the special protection areas SPA3 and SPA2 and the recently approved SAC 'Vlaamse Banken' (RD 16/10/2012). Given the temporary and local nature of the installation of the Nemo Link, also no significant adverse effects on the quality of the habitat of porpoises are expected, so the provided conservation objectives are not significantly affected. Exploitation and possible decommissioning of the Nemo Link are also expected to have no significant impact on the protected areas and species.

4.7.2.8 Other activities

Because of the large distance (at least 5 km) from areas where mariculture is allowed to the Nemo Link, no effects are expected on the mariculture activities that may develop in the future.

The entire route of the interconnector has no overlap with the designated area for the construction of wind farms. Consequently, no effects on the existing and planned wind farms are expected due to the construction, operation and possible decommissioning of Nemo Link.

4.7.3 Mitigating measures

Proper communication with the Ministry of Defense and the Coast Guard during the installation of the Nemo Link in the vicinity of the designated military areas is advisable. During the installation of the various crossing infrastructures, all necessary precautions need to be taken to avoid damage to existing cables and pipelines. If several initiatives in which cables are laid, including the future construction of wind farms, are permitted in a limited period of time, it should be attempted to align the different projects (grouped implantation). During the construction of the Nemo Link proper communication with the Coast Guard is required for ensuring the safety of recreational vessels and particularly in the coastal area where windsurfers, kite surfers, swimmers, etc., can be present. Since the work will take place mainly in the summer, this communication is of great importance.

4.8 SAFETY ASPECTS

4.8.1 Reference situation and autonomous development

4.8.1.1 Shipping

A total of approximately 150,000 vessels navigate through the Belgian marine areas, of which about 15 % tankers (oil, chemicals and gas tankers), and nearly half (approx. 50 %) container ships and RoRo's (roll- on roll-off vessels). Loads of oil and other harmful or (environmentally) hazardous substances are mainly transported on board of tankers, container ships and RoRo's. The project area is located near one of the busiest shipping routes in the world (FPS Health, Food Chain Safety and Environment, 2010).

4.8.1.2 Marine pollution

Since the project area is situated in the North Sea, it is covered under the regulations applicable to the MARPOL 'special zones', Appendix I. The discharge of oil containing liquids is thereby prohibited. A loss of oil from ships can have several causes: a collision between two ships, ships that collide with a stationary or floating obstacle, cracks in the hull, sinking, fire on board, severe negligence, intentional (criminal) discharge activity. Should an (accidental) discharge take place, it will spread and a potentially threat the marine ecosystem and coastal areas.

Despite the increase in maritime transport a clear downward trend in the annual number of detected oil pollutions in Belgian waters is being determined. The total volume of discharges also declines. The reason for the overall downward trend can be found in the stricter policy and legislative framework for safety and pollution on the one hand and by the deterrent nature of the current control means (FPS Health, Food Chain Safety and Environment, 2010).

4.8.2 Impact description and assessment

4.8.2.1 Shipping

Construction phase

During the preparatory work and during the actual construction of the cables collision with a cable laying vessel and the accompanying ships may occur. The cable laying vessel navigates at a slower speed than usual traffic (about 300 m per hour), and temporarily comes to a complete standstill when a joint between two interconnector sections is made. To prevent collision with the installation vessels, other vessels need to adjust their course or speed. The risk of collision is greatest near the locations where the cable route crosses the various shipping lanes. Given the very limited number of vessels to be deployed during the construction phase and as all the work is only temporary and local in nature, the chance of a collision is low. Moreover, different measures are provided to keep disturbance to shipping and risk of collision to a minimum. The risk of collision is considered to be negligible (0/-).

Operational phase

During inspections and possible repair work, potential collision with other vessels can occur. Given the very low frequency of these works, their temporary and local character and the very limited number of additional shipping movements in comparison to the total present shipping traffic in the BPNS, no significant increase in the risk for shipping safety is expected in relation the current situation (negligible impact, 0/-).

The magnetic field of the Nemo Link can locally cause compass deviation. The magnetic field around the interconnector is however very small and the field strength decreases rapidly with distance from the cables. The impact of the magnetic field of the HVDC interconnector to shipping and navigation is therefore considered to be negligible (0/-).

Decommissioning phase

If it is decided to remove the cables once they are out of use, the operations to be performed and the vessels to be deployed will be similar to those during the construction phase (negligible impact, 0/-).

4.8.2.2 Marine pollution

Given the very limited number of ships to be deployed during construction, operation and possible decommissioning of the HVDC interconnector between the UK and Belgium and as the work is only of short duration, the probability of the occurrence of oil pollution is small (negligible effect, 0/-).

The effect of loss of oil or other substances from the cables is zero (no effect, 0).

4.8.2.3 Radioactivity

Out of use telecommunication cables that cross the cable route are usually locally removed (cut) near the location where the interconnector crosses this cable. These cables can contain signal amplifiers with radioactive substances. It is therefore advisable to collect in advance all possible information on the signal amplifiers present in the cable that needs to be cut. If the section of the out of use telecommunication cable that should be removed effectively contains a signal amplifier with radioactive substances, the necessary security measures to protect humans and the environment must be provided.

4.8.2.4 Damage to the cables

The main threats to the Nemo Link are bottom fishing, with heavy weights to be pulled across the cable, and anchors of ships. This can cause damage to the cables, possibly resulting in short circuit between the cable core and the sheath. The current is then shortly returned through the sheath and/or the soil. This is recorded in the converter station, and within a few tenths of a second the voltage on the cable is disconnected. As a result damage or injury to infrastructure or persons is prevented.

Given the small risk of occurrence of damage to the cables, and as security mechanisms in the converter station almost immediately would stop the occurrence of possible effects, no safety risks due to the occurrence of damage to the cables are expected (0).

4.8.3 Mitigating measures

During the construction, operation and possible decommissioning work several safety measures should always maximally be used to minimize hindrance and risk of collision.

5 CUMULATIVE EFFECTS

The potential effects arising from the construction, operation and possible decommissioning of the HVDC interconnector between the UK and Belgium (shortly: Nemo Link) can lead to the accumulation of effects when it is combined with the construction, operation and decommissioning of other offshore power cables. The number of electric power cables in the North Sea does indeed increase rapidly (HVDC interconnectors, export cables from wind farms). At the time of the preparation of the present EIR, following planned or already in use electric power cables are known in the Belgian Part of the North Sea:

- The export cables from the C-Power wind farm are two 3-phase 150 kV AC submarine cables of XLPE type. These export cables run from the C-Power wind farm to Oostende and cross the planned route of the HVDC interconnector between the UK and Belgium near kilometer point 20 (KP 20).
  The export cables from the wind farms Belwind and Northwind (formerly Eldepasco) don't traverse the planned route of the Nemo Link, but all land on the beach of Zeebrugge. Only one of the two export cables from the Belwind wind farm is currently installed and in use, the second export cable will be constructed during the second construction phase of this wind farm (planned for launch during 2013). These export cables are all the same type as the export cable of C-Power. Based on the currently known planning of the various projects, there is a chance that the construction of the export cables of Belwind and Northwind will coincide (partially) with the construction of the HVDC interconnector between the UK and Belgium. Given the short duration and the progressive nature of construction work for electricity cables, this chance is however rather small.
- During the preparation of this EIA, a permit was also licensed to the North Sea Power wind farm (MD 01/18/2012). The export cables from the North Sea Power (250 MW to 470 MW) wind farm will be landing at Zeebrugge. These export cables are of the same type as the export cables C-Power, although the North Sea Power wind farm can also opt for a 220 kV AC cable. The export cables will cross the planned route of the Nemo Link near KP1. Again there is a chance that the construction of the North Sea Power wind farm partly overlaps with the construction of Nemo Link.
- For the planned wind farm Rentel was the licensing procedure for the construction and operation recently started. Recently domain concessions have also been granted for the projects Seastar and Mermaid in the designated area for wind farms. The location and characteristics of the export cables of all these future wind farms are not yet known.
- It is important to note that the situation described in previous sections, in which always one or more export cables depart from each separate wind farm to a power station on the coast, the situation is as it was common until now. Currently, however, a concept is developed to build an offshore meshed network

step by step, where the different wind farms are linked to each other at sea, in power stations on platforms that lie close to the various concessions. This network will then be connected to the grid on the mainland through a limited number of cables connected. Currently, this concept has not yet been worked out concretely enough to give an exact estimate of the number of high voltage cables (and their location and characteristics) that finally will be constructed between the designated area for wind farms and the mainland.

- The park cables of the various wind farms (33 kV cables interconnecting the wind turbines and offshore high-voltage stations) will not be considered in this impact assessment, as the occurrence of cumulative effects is ruled out by the large distance of these cables (all located within the designated area for wind farms) to the route of the Nemo Link.

Besides potential cumulative impacts resulting from construction, operation and decommissioning of several power cables, cumulative effects may also result from the construction, operation and decommissioning of the HVDC interconnector between the UK and Belgium in combination with other human activities at sea that (partly) cause similar effects (such as sand and gravel extraction). When relevant, this type of cumulative effects is also discussed.

Only those effects that have at least a small positive or small negative impact on a particular discipline, are discussed, since it is assumed that a certain aspect that has (almost) no effect on the environment for each power cable separately, will also cause no cumulative effect.

5.1 SOIL

Construction phase

The cumulative effect of the construction of several power cables on the soil is considered to be negligible, as the disruption is very limited compared to the size of the Belgian Part of the North Sea.

The route of the HVDC interconnector between the UK and Belgium runs along the northern edge of the sand and gravel extraction areas 2a and 2c. Pre-sweeping and burying the Nemo Link cause similar effects on the seabed as these extraction activities. The differences in scale of both activities are though so large that it can be expected that the construction of the Nemo Link won't reinforce the existing effects, and more likely will blend into the existing high sediment dynamics in this region.

Operational phase

The probability that the various power cables in the BPNS will become exposed simultaneously and for long periods is small given the performance of periodic inspections. Therefore, the cumulative effect on the overall morphodynamics and erosion is considered to be less than the sum of the effects of the individual cables.

The cumulative effect on the seabed of the warming of several cables scattered about the BPNS is negligible given the very limited volume of the seabed that will suffer from warming in comparison with the size of the total BPNS and taking into account the naturally occurring temperature variations.

Two power cables can come close enough together only at the crossings (separated only by crossing infrastructure) so that a further temperature increase of the seafloor (amplified effect) may occur. This effect is highly localized (only a few meters in length) and is therefore considered to be insignificant.

5.2 WATER

Construction phase

Even if multiple cables would be built simultaneously within the landfall zone, it is expected that the effects on the turbidity of the sea water will be completely disappeared after a few tidal cycles. The cumulative effect is at worst equal to the sum of the individual effects, and – compared to the naturally occurring turbidity levels during storms – still acceptable. On the other hand, if there is no overlap of the construction work of several cables, the cumulative effect is smaller than the sum of the effects of the individual cables.

Operational phase

During the operational phase electromagnetic fields occur around power lines. The magnetic fields generated by the Nemo Link are static and districts in this respect from the magnetic fields of export cables from wind farms, operating on alternating and hence changing ('pulsating') magnetic fields. Therefore, the combined magnetic and induced electric field of the HVDC interconnector and an export cable are considered to be complex and almost unpredictable. Interaction between two power cables will however only occur at the point of crossing of two cables, as in both AC and in DC the magnetic field strength decreases rapidly with increasing distance from the cable and because submarine power cables are obliged to be laid at a distance of at least 50 meters apart. In the Belgian Part of the North Sea, the Nemo Link crosses two pair of power lines, namely the export cables from the C-Power wind farm and the North Sea Power wind farm. At this crossing a magnetic and induced electric field in the seawater can thus be generated that is different from the fields generated in the vicinity of the individual cables. It is impossible to predict whether the cumulative effect will be larger (amplified) or smaller (weakened) than the sum of the individual effects. However, it is evident that the cumulative effect takes place to locally to be significant.

5.3 CLIMATE & ATMOSPHERE

During the construction, operation and possible decommissioning of several power cables, the air quality will be affected by emissions from shipping movements. The cumulative effect is negligible.

The impact on the local temperature climate in the seabed by warming of multiple cables in operation is also negligible (see § 5.2).

5.4 NOISE

Even if the construction of multiple cables would simultaneously take place, the cumulative impact on the sound climate (caused by ships, dredging, plowing and/or jetting...) will be negligible.

5.5 FAUNA & FLORA

No relevant cumulative effects on birds and marine mammals are expected.

A possible strengthening of the effects on benthos and (demersal) fish communities during the construction phase will only occur if the construction work of two cables will take place at the same time, and furthermore only in regions where cables will be installed close together, i.e. in the area near the coast to the west of the port of Zeebrugge (landfall area). In this hypothetical case, the cumulative effect equals the sum of the individual effects, and is still acceptable given the small size and duration of the effects. If there is no overlap of the construction work of several cables, the cumulative effect will be smaller than the sum of the effects of the individual cables.

During the operational phase, the electromagnetic fields of two power cables can cause a stronger or weaker combined electromagnetic field at the point of their crossing. Each impact is however localized and therefore no cumulative effect on the benthos community and the fish fauna is expected.

On the other hand, the presence of multiple power cables scattered in the BPNS can exert effects on sensitive species by the frequent and widespread presence of electromagnetic fields, which also differ from each other in orientation, strength and physical appearance (static or pulsing). This can have an impact on fish fauna, with some species using electromagnetic fields for orientation, migration or detection of their prey. Since the impact of the electromagnetic field of one separate power cable on the demersal fish fauna is already a gap in knowledge, the potential impact of multiple electromagnetic fields with different characteristics and scattered on the seabed is not known at all. Further research is therefore appropriate.

No cumulative effect is expected from the heating of the seabed by several cables.

5.6 SEA SCAPE & CULTURAL HERITAGE

No relevant cumulative impact on the sea sight and the (maritime) cultural heritage is expected.

5.7 HUMAN ACTIVITY

The effects on the fishery during the construction works are temporary and local. Given the small chance of simultaneous occurrence of the work of several cables, the cumulative effect is negligible. Potential cumulative effects on fishing during the operation phase are caused by the presence of electromagnetic fields. Currently there great uncertainty concerning the impact of these fields on fish. Further research is therefore appropriate.

Cumulative impacts on tourism and recreation in the coastal zone will only occur when the construction of several power cables in the landfall area will take place simultaneously. Even then, the disturbance is acceptable if a proper communication with the authorities is maintained during execution of the works and if the construction close to the beach takes place outside the tourist season (holidays).

5.8 SAFETY ASPECTS

If no overlap occurs in the construction of the various cables, the cumulative impact on shipping safety will be less than the sum of the individual effects. If there is an overlap of activities, the risk of collision will increase. The cumulative effect is acceptable given the short duration of the works and given the limited number of vessels to be deployed.

6 MONITORING

Given the large sediment dynamics at the BPNS, the cables can become exposed over time. Therefore, periodic inspection of cable burial will take place, including potential erosion around infrastructure at crossings with other cables and pipelines.

Since no significant impact on fauna and flora is expected, no project-specific monitoring is required. The gaps in knowledge are though important to note, where research on the effects of electromagnetic radiation on the marine ecosystem is appropriate. The necessary research on spawning and nursery areas for fish fauna should additionally be noticed.

7 CROSS-BORDER EFFECTS

As in the present EIR no significant negative environmental impacts for the Belgian Part of the North Sea were identified due to the Nemo Link-project, it is evident that there will also be no significant adverse transboundary environmental effects. Significant cumulative effects due to the Nemo Link-project in combination with projects abroad are also excluded because of the short duration and the local nature of most effects.

8 SUMMARY AND CONCLUSIONS

First, it should be noted that the route of the HVDC interconnector between the UK and Belgium has already been mitigated largely at the phase of the design, as various physical, biological and human aspects have already been taken into account maximally during the route engineering study of 2011 to determine the most appropriate offshore cable route between Richborough and Zeebrugge. Where necessary, adjustments to the route were already carried out to mitigate potential impacts or risks in order to minimize both cable and installation costs and disruption of the marine ecosystem and its users.

The impact assessment and discussion of the present EIR show that all effects that can occur during the construction phase are limited in size as all construction activities take place locally and preceding and are always of short duration. The potential impacts during the construction phase are therefore all assessed as small negative (0/-) to nonexistent (0).

For many potential impacts during the operational phase, only a (very) low frequency of occurrence is expected. Moreover, these effects are all temporary and limited in size. Other, more permanent effects (electromagnetic radiation, heating...) are always too limited in size to be significant. All potential impacts during the operational phase are therefore assessed as small negative (0/-) to nonexistent (0).

With regard to the cumulative effects, the probability of simultaneously occurring construction phases of multiple power cables in the BPNS is rather small, given the short duration and the progressive nature of such construction work. The probability of occurrence of cumulative effects during the construction phase is therefore also very small, given the very local and non-permanent nature of the potential impact of the individual cables. Even then, these cumulative effects are still negligible (0/-).

As during the operational phase for the separate power cables only a very low frequency of occurrence for the diverse effects is expected (inspections, repair work) and given the local and temporary nature of these effects, the possibility that the effects of these individual cables will coincide (resulting in potential cumulative effects) is very small. Even then, these cumulative effects are negligible (0/-). Other, more permanent effects during the operational phase (such as warming of the sea floor) take place too locally to cause significant cumulative effects (0/-). The cumulative impact of electromagnetic fields of several power cables in the BPNS on the fish fauna is a gap in knowledge.

Finally it is expected that the construction, operation and decommissioning of the Nemo Link between the UK and Belgium will have no significant impact on the Good Environmental Status and the environmental targets as defined under the Marine Strategy Framework Directive 2008/56/EC.

Offices

www.arcadisbelgium.be

Antwerpen- Berchem
Citylink - Posthofbrug 12
B-2600 Berchem
T +32 3 360 83 00
F +32 3 360 83 01

Hasselt
Eurostraat 1 – bus 1
B-3500 Hasselt
T +32 11 28 88 00
F +32 11 28 88 01

Gent
Kortrijksesteenweg 302
B-9000 Gent
T +32 9 242 44 44
F +32 9 242 44 45

Brussels
Koningsstraat 80
B-1000 Brussel
T +32 2 505 75 00
F +32 2 505 75 01

Liège
26, rue des Guillemins, 2ème étage
B-4000 Liège
T +32 4 349 56 00
F +32 4 349 56 10

Charleroi
119, avenue de Philippeville
B-6001 Charleroi
T +32 71 298 900
F +32 71 298 901

ARCADIS Belgium sa
BTW BE 0426.682.709
RPR BRUSSEL
ING 320-0687053-72
IBAN BE 38 3200 6870 5372
SWIFT BIC BBRUBEBB

Head office
Brussels
Koningsstraat 80
B-1000 Brussel

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Appendix 15: UK Onshore Non-Technical Summary

Nemo Link®

Environmental Statement

Non-Technical Summary

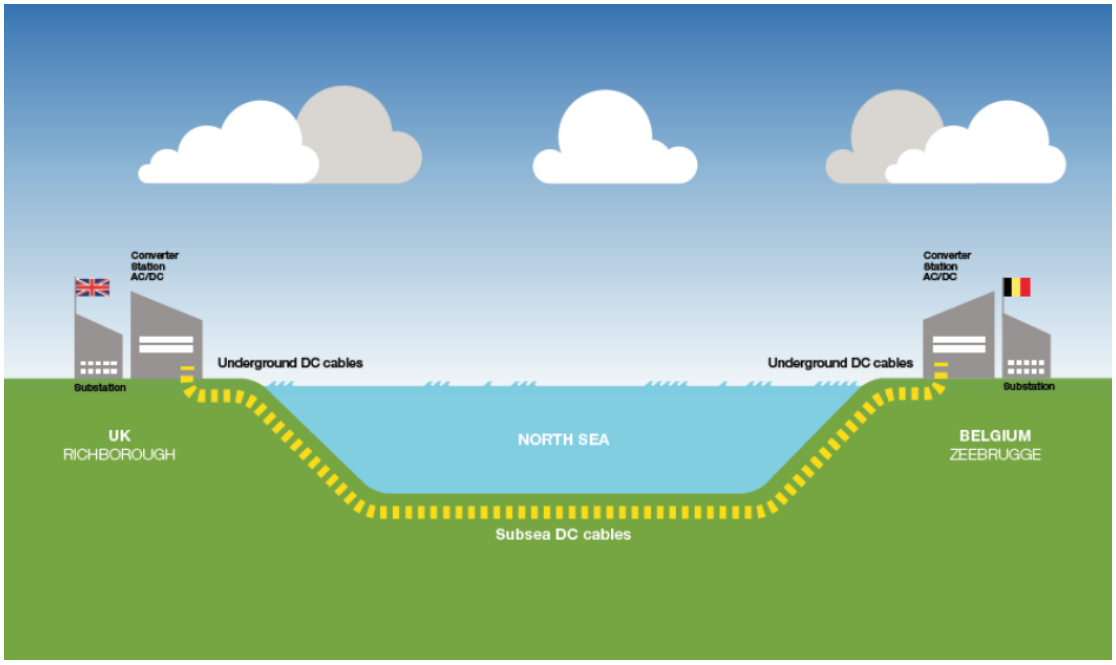
February 2013

Introduction

The Nemo Link (the Project) is a proposed high voltage direct current (HVDC) electrical interconnector with an approximate capacity of 1,000 megawatts (MW) which will allow the transfer of electrical power via subsea cables between the UK and Belgium. The power would be bi-directional, able to flow in either direction at different times, depending on the supply and demand in each country.

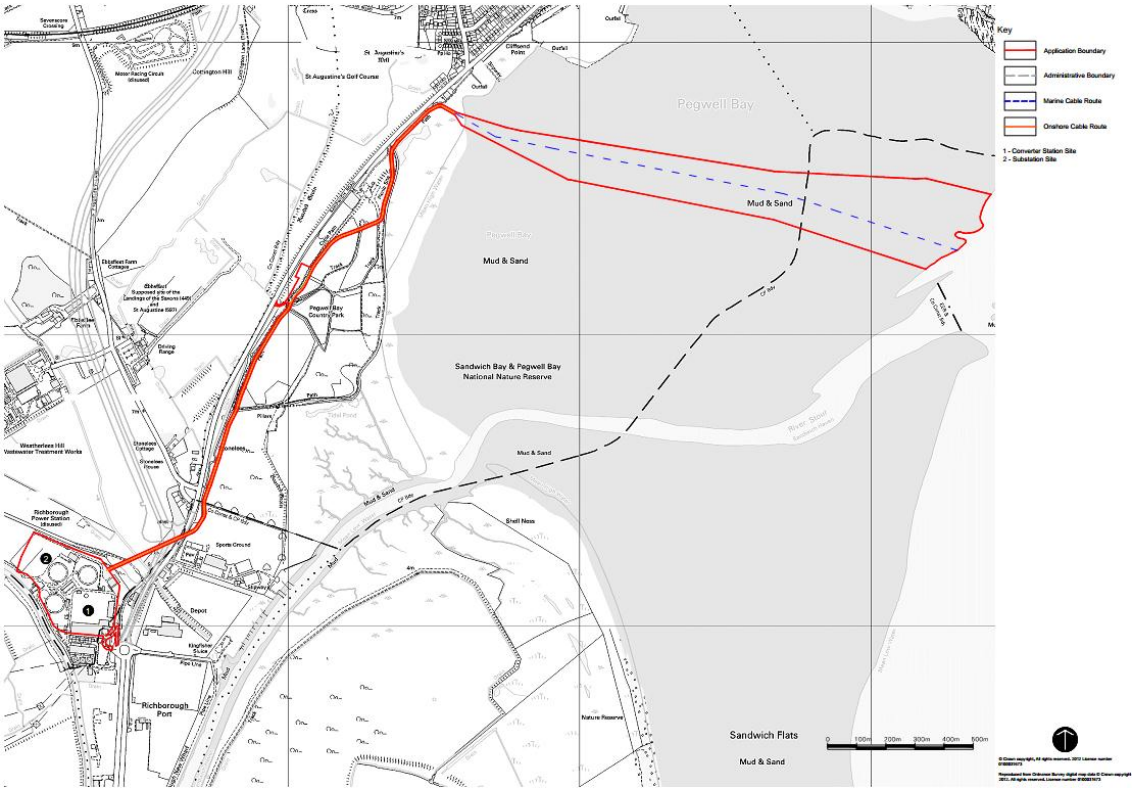
The proposed subsea cables would run from the converter station at the former Richborough power station site to Pegwell Bay at Richborough in Kent to Zeebrugge in Belgium passing through English, French and Belgian waters.

Figure 1 – The Nemo Link Graphical Representation



The UK onshore elements (the Proposed Development) of the Project for which planning permission is being sought (as part of this application) comprise a converter station and substation at the former Richborough power station site, and cables installed below the ground between the converter station and mean low water at Pegwell Bay. These will connect to the other parts of the interconnector (which are outside the planning jurisdiction of the local planning authorities), being the subsea cables from mean low water across the North Sea; onshore underground cables, a converter station and 400kV substation in Belgium. In the UK and Belgium, a connection to the corresponding electricity transmission networks will be required; these will be subject to a separate consenting process and will be promoted separately to this planning application.

Figure 2 – The Proposed Development Application Boundary



The Nemo Link is being developed jointly by National Grid Nemo Link Ltd (NGNLL), part of the National Grid group, and Elia Asset S.A. (Elia) which is part of the national electricity transmission company in Belgium. The proposed substation at Richborough would be owned and operated by National Grid Electricity Transmission (NGET).

This document provides a Non-Technical Summary (NTS) of the predicted effects on the environment of the Proposed Development. It also sets out a summary of the effects, including cumulative effects, of the other parts of the interconnector, together with the effects of the connection to the UK transmission network, which would be promoted by NGET separate to this planning application.

Full details of the effects of the Proposed Development are contained within the Environmental Statement (ES) that has been prepared to support the planning application. Separate Environmental Statements have been prepared to describe the effects of the subsea cables and the onshore elements in Belgium.

Need for the Project

It is European Union (EU) and UK policy to increase the transmission capacity between countries, with the stated wish to see each member state establish an interconnector capacity of around 10% of installed generation capacity. The reasons for this policy is to allow a more efficient energy market within the EU, to facilitate the sustainable development of the electricity sector by increasing opportunities for clean and efficient generation and by making it easier to exploit intermittent renewable electricity resources in the UK and Continental Europe.

There is no existing connection between the UK and Belgian transmission systems. Belgium is particularly suitable for a new interconnector not only because of its geographical proximity to the UK, but also because its electricity transmission system is highly connected to Central Europe. A UK-Belgium interconnector will provide enhanced opportunities for the UK to trade with wider European power markets.

The Planning Process

Electrical interconnectors and the individual components for which consent is being sought are not listed in the Schedules which describe and define Environmental Impact Assessment (EIA) development.

However, NGNLL has decided to prepare and submit a voluntary ES to accompany the planning application to enable the anticipated environmental effects of the proposed works to be assessed and appropriate mitigation measures to be determined and implemented.

Detailed pre-application consultation was undertaken with statutory consultees, including the local Councils, local communities and the general public. Responses received during the formal consultation process have informed the EIA process, throughout which, informal consultation has also been undertaken with a range of stakeholders.

Content of the Environmental Statement

The ES contains the following information:

- A description of the Proposed Development;
- An outline of the alternatives considered;
- A description of the likely significant effects of the Proposed Development on the environment; and
- A description of measures envisaged to prevent, reduce or where possible off-set any significant adverse impacts on the environment.

Project Proposals

<u>Feasibility Studies</u>

Alternative converter station sites, underground cable routes, landfalls and subsea cable routes were considered as part of the development of the Nemo Link. This established that a converter station site at Richborough and an underground cables route to a landfall at Pegwell Bay was the preferred option as this best meets the project objective relating to technically feasibility, economic viability, deliverability and the least disturbance to the environment and people

Following selection of the preferred option, further detailed environmental and technical studies as well as consultation have been used to refine the preferred option and further reduce the potential environmental effects of the Nemo Link project including the substation which the convertor station is required to connect to. This included considering emerging results from environmental

assessments with initial technical designs and results of consultation with stakeholders, land owners and local communities.

Proposed Development

The Proposed Development will comprise a new converter station, substation and onshore underground cable route leading to the sub-sea cable connection.

Converter Station

The converter station will convert between direct current (DC), which is used for sending electrical power through the subsea cables, and alternating current (AC), which is used by each country's national electricity transmission system. The converter station will require a footprint of approximately 4.85 hectares (ha) and it is proposed that the main building will be constructed re-using the steel frame of the former Richborough Power Station's turbine hall.

The converter station will contain the equipment necessary for the conversion between DC and AC, transformers for switching to the correct voltage rating, filter banks and associated switch gear. The converter station requires 'valve halls' and other buildings to enclose the equipment. The main building will comprise 3 main parts and in total will be approximately 149 metres (m) long by 93m wide with a maximum height of approximately 30.3m. The roof and walls of the converter station will be formed by a steel frame clad with metal panels which will graduate in colour from dark green (lower levels) to white (roofline). AC connection gantries of approximately 15m in height will also be required.

The other equipment will be enclosed in two smaller buildings which comprise a service building and a storage building. These buildings will each be approximately 27.4m long, 13.6m wide and 14.5m high, and attached to the main building. The converter station will be designed for a 40 year lifespan.

Substation

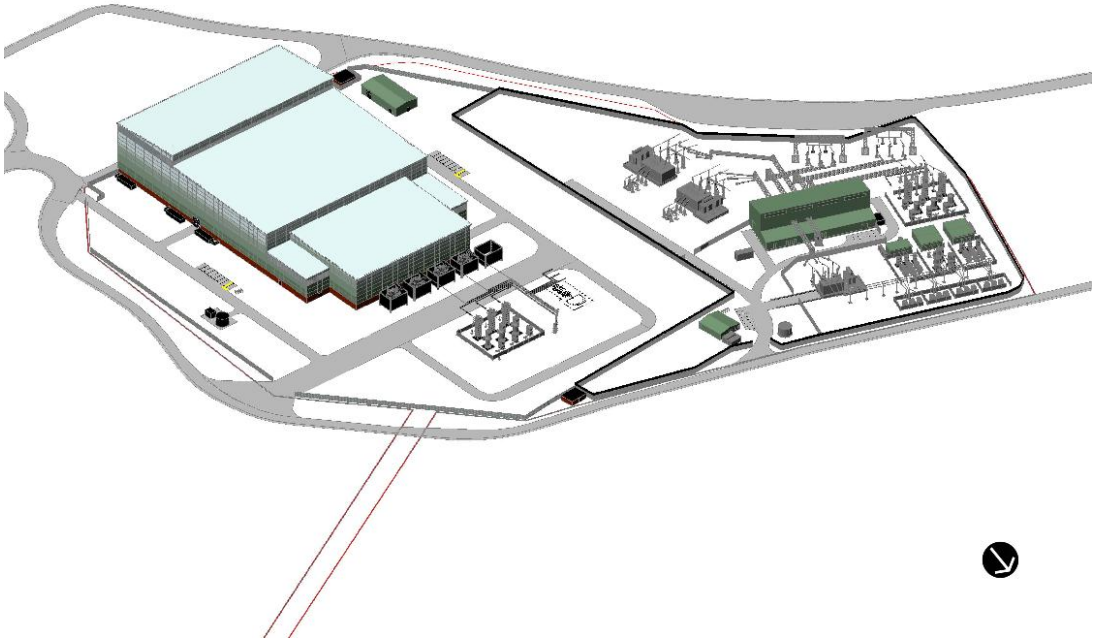
A new 400kV Gas Insulated Switchgear (GIS) substation is needed to connect the interconnector to the national electricity transmission system.

The substation will be within a separately fenced compound adjacent to the proposed converter station to the west. The proposed substation will occupy a footprint of approximately 2.65 ha and will contain a combination of indoor and outdoor electrical equipment.

The substation will include a GIS Hall containing switchgear outdoor gas insulated busbar (GIB), overhead line gantries, two Super Grid Transformers (SGTs), a Mechanically Switched Capacitor (MSC) and a Static Var Compensator (SVC) compound. The MSC and SVC are specific types of equipment used to regulate and stabilise transmission voltages.

The GIS Hall will be approximately 52.2m long, 21.5m wide and 15m high and clad in a similar manner to the converter station. The maximum height of the outdoor electrical equipment will be approximately 12.7m.

Figure 3 – Isometric Drawing of the Proposed Converter Station and Substation



Onshore Underground Cables and Subsea Cables Connection and Landfall

The Proposed Development will include two underground cables (each approximately 15 centimetres (cm) in diameter) which will be installed onshore in a trench approximately 1m wide and 1m deep and sub-sea between the mean low water mark and the landfall in a trench approximately 1-2m wide and 2-3m deep. Fibre optic cables will also be installed for control and communication along the link. An onshore underground cables route has been identified between the subsea cables' landfall at Pegwell Bay and the converter station taking account of the environmental constraints including designated sites of nature conservation, the presence of protected species, the quality of saltmarsh habitat, proximity to residential area, archaeology, highways, planning proposals, watercourses, risk of encountering contamination, utilities and services and land use. The route of the subsea cables to Pegwell Bay has been confirmed by geophysical and geotechnical survey.

The HVDC onshore underground cables will run from the landfall on the coastal side of the existing cycle track which runs parallel to the A256 Sandwich Road, through Pegwell Bay Country Park, then into Stonelees Nature Reserve and the BayPoint sports complex. From the Sports Ground, the cables will be routed by horizontal directional drilling (HDD) beneath the A256, Minster Stream, and a compartment of Hacklinge Marshes SSSI. The cables will terminate at the converter station. The overall length of the onshore cable route and sub-sea cable route from the mean low water mark is approximately 2.1km and 1.8km long respectively.

Upon completion of the cable installation works, land will be restored to its previous condition.

Construction Programme

The construction of the converter station and substation is intended to be undertaken over a period of 36-42 months between mid-2014 and mid-2018. Both the converter station and substation will be commissioned in October 2018.

Main construction activities will include:

- Preliminary works and preconstruction surveys;
- Site clearance and establishment;
- Civil engineering works including earthworks;
- Mechanical and electrical works;
- Commissioning and testing; and
- Site reinstatement and landscape works.

Operation

The converter station and substation will form an integral part of the national grid electricity transmission system. The substation would be an unmanned site and subject to periodic inspections and maintenance visits. The converter station is likely to operate with approximately 6 personnel per day divided between 3 shifts over a 24 hour period.

Summary of Environmental Impacts

The following section summarises the predicted effects of the construction and operation of the Proposed Development on the environment.

Land Use

The cable route and converter station and substation site have been carefully selected to minimise disruption to amenity and the future use of land.

The construction of the converter station and substation will result in the permanent loss of approximately 8 hectares of derelict brownfield land. There is no defined on-going land use; the site and the surrounding land is part of the Richborough Energy Park proposals. The Proposed Development would make a positive contribution as it would result in the re-use of derelict industrial land contributing to national and local sustainability objectives. There would be no adverse effects from the loss of the derelict land to the Proposed Development.

The onshore cables have been routed to avoid areas of existing and proposed developments and the cable route will not result in any permanent land take. Effects on land use during construction will be highly localised and temporary so will be of low significance. Where open space and land which is available for recreation and walking is disturbed, there will be alternative routes available and the absence of any facility will be short term and reversed after the reinstatement of the land.

A permanent 5m cable easement will be required; however this will not affect current land use although there will be some restrictions on planting above the cables route.

Ground Conditions and Contamination

Construction activities such as cables installation, drilling and piling have the potential to disturb areas of contamination and create pathways for the migration of contaminants into watercourses. Prior to construction, targeted investigation works will be undertaken in agreement with an Environmental Health Officer to assess the nature and extent of all known existing areas of contamination and develop appropriate mitigation measures. Cable laying over the surface of the ground within Pegwell Bay Country Park will prevent potential contamination pathways being opened up and the migration of landfill gas and leachate.

There is a risk of ground and water contamination from spillages of fuel, oil and chemicals and from the importation of contaminated materials from off-site; however this can be managed by the implementation of best practice guidelines. A Construction Environmental Management Plan (CEMP) will be prepared to set out the minimum requirements which contractors will be required to undertake in order to prevent adverse impacts.

Appropriate mitigation techniques will ensure that potential adverse effects are prevented both during construction and operation.

Hydrology and Flood Risk

The Proposed Development has the potential to have adverse effects on the water environment through surface water run-off, ground contamination and disturbance to existing flows and the mobilisation of contaminants both during construction and operation. The River Stour is approximately 10m south of and Minster Stream is approximately 100m north east of the former Richborough power station site.

Best practice measures to prevent pollution of the water environment during construction will be implemented through a CEMP which as a minimum will be based on addressing the EA Pollution Prevention Guidance documents. The cables will be installed by HDD beneath the A256 and Minster Stream before connecting to the proposed converter station; this will avoid any disturbance to this watercourse.

The proposed substation and converter station site is within Flood Zone 1 (low probability of flooding). Ground levels will be raised to ensure the proposed substation and converter station compounds will operate safely in an extreme flood event without increasing flood risk elsewhere. Sustainable drainage measures will be integrated into the detailed drainage design to ensure that water quality is not adversely affected and water discharge rates into the River Stour are no higher than the current rate.

Ecology

A number of designated sites are located along the proposed cable route including Thanet Coast and Sandwich Bay Special Protection Area (SPA) and Ramsar site, Sandwich Bay Special Area of Conservation (SAC), Thanet Coast SAC and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI). The cable route crosses the designated areas at three locations along the route, passing through the north of Pegwell Bay, Stonelees Nature Reserve and land north of the Richborough Site. Mitigation measures will be developed in consultation with Kent Wildlife Trust to

minimise impacts on, and reinstate, the habitats within these sites. Further details of the likelihood of effects on these nature conservation areas and mitigation measures are detailed at Appendix 8.9 (information for Habitats Regulations Assessment).

The construction of the converter station and substation will not have a significant impact on nature conservation due to a lack of ecologically sensitive features within the site. The cable has been routed to minimise effects on important species and habitats and site specific mitigation measures will be applied where valuable areas cannot be avoided.

Protected species have been identified along the cable route and mitigation measures identified to ensure no adverse effects will result from the Proposed Development. Any disturbance of the local bird population will be avoided by carrying out construction works at the appropriate time of year in consultation with the statutory authorities.

Impacts affecting protected species will be short-term and mainly associated with site clearance during construction and temporary disturbance or loss of habitat. Habitats affected by the works will be reinstated to prevent long term habitat losses and botanical surveys will be repeated prior to the works to confirm the absence of protected plant species. Where necessary, licences to carry out the works will be obtained from Natural England.

Overall a minor adverse to minor beneficial impact during construction is predicted. No impacts are envisaged during operation.

Archaeology and Cultural Heritage

A desk-based study and walkover survey were undertaken to assess the archaeological potential of the development site.

There are no Scheduled Monuments, UNESCO World Heritage Sites, Registered Parks and Gardens or Registered Battlefields within 1.5km of the development area; a total of 165 designated and non-designated heritage assets were recorded. This included seven designated receptors of high importance (one Grade II* Listed building and six Grade II Listed buildings), and twenty-eight non-designated receptors of medium importance which largely comprise archaeological sites recorded as part of modern development control regimes. The remaining 126 sites are non-designated receptors of low and negligible importance.

No significant impacts on above ground or shallow archaeological deposits are predicted; however, a watching brief is proposed during cables installation to identify the presence of unknown archaeological deposits.

Following the implementation of a programme of mitigation, the archaeological and cultural heritage resource within, and close to, the development site will remain unaffected and the overall impact of the scheme is neutral.

Landscape and Views

The converter station and substation development would be consistent with the existing landscape character of the site and immediate surroundings and would match the scale of existing industrial

built form. The existing landscape character of the underground cable route is generally urban as the route runs close to the A256 and the landscape will be reinstated following construction.

Measures have been incorporated into the development proposals to mitigate effects on landscape and views during construction and on completion of the Proposed Development. Mitigation of the long-term effects on landscape and views would be achieved by using colour graded cladding to the converter station building ranging from a muted green at the building's base to off-white at the roofline, and muted green cladding to the substation building to minimise landscape and visual effects. Native tree and shrub planting is proposed to the western site boundary adjacent the River Stour, to provide filtering and screening of the converter station and substation buildings and associated outdoor equipment particularly in views looking north, east and southwest towards the site from the Saxon Shore Way and River Stour.

The wider proposals for Richborough Energy Park include the implementation of new planting associated with a new estate road. The planting scheme will include tree planting along the eastern and north eastern site boundaries (partly mitigating trees removed to accommodate the new road), new native trees, shrubs and fruit trees near the site entrance, and new native tree planting amongst existing trees and shrubs on the northern site boundary.

The underground cable route would have no effect on landscape character or views 15 years after the reinstatement of land. The above ground cable route through the northern part of Pegwell Country Park will be quickly re-established as chalk grassland resulting in a very limited negative effect on landscape and views after reinstatement. Following 15 years' establishment of the planting proposals surrounding the converter station and substation site it is anticipated that there would be a small negative effect on landscape character as the development would increase the extent of industrial development evident in the locality.

Traffic and Transport

Average Annual Daily Traffic (AADT) flows have been obtained for the key roads to be used during the construction of the Proposed Development including the A229 West Canterbury Road, the A256 Richborough Road, the A256 Dover Road and Sandwich Road. It is predicted that overall the long-term environmental impact of the Proposed Development on traffic and transport during the construction phase would be minor to negligible; a maximum increase of 0.9% in total traffic and 17% increase in HGV traffic is anticipated. A range of mitigation measures including traffic management during construction, appropriate signage in the local area and the preparation of a Transport Management Plan will ensure significant construction effects are avoided.

There are likely to be a number of minor environmental impacts that cannot be fully mitigated during the construction phase. These mainly include impacts relating to pedestrian and cyclist delay and will be addressed by signage and delivery agreements with routes to be agreed for construction and delivery traffic. This is likely to be temporary during the construction period and is not expected to continue during the operation of the proposed converter station and substation.

Once operational, the converter station will generate a small number of vehicular trips as it is anticipated that six members of staff will be based at the site with two people working shifts over a 24 hour period. This would result in approximately 12 two-way trips per day. The substation will be

unmanned; however, it will on average generate approximately four staff trips a week made by car or Light Goods Vehicle (LGV). A small number of trips may be generated during maintenance of both the converter station and substation; however, this is anticipated to occur infrequently. Operation traffic effects are expected to be negligible.

Noise and Vibration

The general noise climate at sensitive receptors in the vicinity of the Proposed Development is primarily affected by road traffic noise, existing industrial noise, noise from agricultural activities and birdsong.

Best practice construction noise methods will be used to minimise noise associated with cables installation and construction of the substation and converter station and detailed in the CEMP. General construction noise is anticipated to be of minor to neutral significance and will be of a temporary nature. Construction noise during HDD will be of moderate significance; however HDD duration will be for a maximum of 2 days and 1 night for each cable (3 cables in total) and effects will be temporary in nature.

Without mitigation, there is potential for the operation of both the converter station and substation to give rise to complaints from neighbouring properties. Mitigation will be incorporated into the design of the converter station and substation to ensure that noise levels no higher than the background noise levels. Mitigation measures could include the use of noise shields, noise enclosures, low noise fans, and silencers or barriers on cooling fans. With mitigation measures included, the significance of operational noise would be minor as noise levels will be below background levels.

Air Quality

The Proposed Development will make no emissions to air during operation and has not been assessed. Potential construction effects on air quality can potentially arise from construction traffic (including the operation of motor vehicles and plant) and dust arising from construction works.

Background concentrations for 3 representative existing sensitive receptor locations have been obtained from the latest 2010 Defra Background Maps which provide an estimate for Particulate Matter (PM_{10}) concentrations of between 15.55 and 16.14µg/m^3 and concentrations of Nitrogen Dioxide (NO_2) of between 12.84 and 14.33µg/m^3. In the absence of monitoring data for dust deposition, it is assumed to be absent from the local environment (this is a very conservative assessment because dust deposition will be occurring naturally in the surrounding environment).

Exceedance of the annual mean objective concentrations for PM_{10} and NO_2 at the 3 representative receptor locations is not predicted to occur as a result of construction traffic. The significance of effects will be negligible.

A number of mitigation measures will be implemented during the construction works and detailed within the CEMP to minimise potential impacts from dust and air quality emissions. Measures include reducing vehicle speed limits, site management, maintenance of equipment, and careful location of storage to avoid wind-blown dust. Following the implementation of these mitigation

measures, effects on air quality resulting from construction traffic and other dust generating activities will be negligible.

Coastal Tourism, Recreation and Socio-Economics

Indirect impacts on tourism and recreational activities would result from temporary disruption caused by construction activities. This would affect coastal recreational activities during the landfall and cable installation works at Pegwell Bay. However the duration of works in this area would be very short and the wider area of the Bay will provide undisturbed opportunities.

Clearly signed temporary diversions will be in place to ensure the Thanet Coastal Trail and the Viking Coastal Trail remain open throughout the duration of the installation works. Access to the Country Park will be possible throughout the duration of the works although there will be some areas with limited access and there will be some temporary disruption to users of BayPoint sports complex.

The works to install the cables are similar to those carried out by any utility company in its day-to-day business and would be of short duration and limited in geographic effect. All land take associated with cables installation will be reinstated following completion of cable laying activities so will not adversely affect future recreational land use.

There would be a large number of construction jobs which would be temporary and short-term. These will be valuable to the local economy and the service industry due to accommodation requirements and the purchase of materials, equipment and other services during the construction phase. This may have a small benefit through the creation of temporary and permanent jobs locally and nationally.

Electric and Magnetic Fields (EMF)

All equipment that generates, distributes or uses electricity produces EMFs. The NEMO Link uses both AC and DC technology therefore producing both static and alternating electric and magnetic fields.

The new converter station and substation will be designed to ensure that they are compliant with the relevant UK Government guidelines on EMF exposure using the Department for Energy and Climate Change (DECC) Code of Practice to assess the compliance.

An assessment has been carried out of the likely impact of the cable route, converter station and substation. The assessment has demonstrated that no mitigation will be required because the EMFs are within UK Government guidance levels and there will not be any significant effects arising from the NEMO link.

Cumulative Impacts

Unrelated Projects

There is the potential for cumulative construction and operation effects to arise from the proposed UK onshore elements of the Nemo Link together with other projects in the surrounding area (unrelated to the Nemo Link) either currently under construction, soon to be subject to a planning application, pending planning decision, or recently granted planning permission. These projects

include: a peaking plant facility at the former Richborough power station site; the Richborough Energy Park estate road; the Pegwell Bay Flood Defence Scheme north of Pegwell Bay Service Station; waste related development on land west of Ramsgate Road; a 5MW solar farm on land west of the River Stour; glasshouses, water storage tanks and pack house at Ebbsfleet Lane; and an anaerobic digestion plant on Ramsgate Road.

An assessment has been undertaken to determine the likely significance of such cumulative effects. There are no predicted long-term cumulative effects resulting from this Proposed Development and other development proposals in the study area. Any potential effects are likely to be localised and temporary during construction and can be mitigated by the use of well-established and industry-standard techniques.

The significance of cumulative effects on landscape character and on views of the proposed converter station and substation in combination with all development proposals (excluding the solar farm) is considered as being no greater than the residual effects (with landscape mitigation and after establishment) recorded in relation to the proposed converter station and substation. Upon completion (with landscape mitigation and after establishment), cumulative effects of the solar farm on landscape will result in a slightly greater adverse effect than reported for the proposed converter station and substation in isolation, but no greater than a minor adverse effect overall.

Other Elements of the Nemo Link Project

Applications for consent for the other elements of the Project (sub-sea cables between the UK and Belgium and onshore cables, converter station and substation in Belgium) are being submitted to the relevant national authorities and each element has been subject to environmental assessment to determine the potential for effects on the physical, biological and human environment. All other elements of the Nemo Link have been assessed as having no significant adverse effects on the environment.

There is the potential for cumulative construction and operation effects to arise from the proposed UK onshore elements of the Nemo Link (to which this application relates) together with other elements of the Project, namely the subsea cables in the UK, France and Belgium and the onshore infrastructure in Belgium. Cumulative effects will be limited to the interaction of the subsea cables close to the UK foreshore and the land cable installation in the foreshore and the surrounding area. There will be no cumulative effects as a result of the UK onshore components and the subsea cable works within French and Belgian waters, and with Belgian onshore components, due to distance between these developments during construction and operation.

No significant cumulative adverse effects resulting from any aspect of the UK onshore elements with any other aspect of the Nemo Link are anticipated to arise during the construction or operation phases as significant adverse effects can be avoided through cable micro-routeing and the adoption of best practice and industry-standard mitigation measures during construction.

Grid Connection

The construction and operation of the grid connection which is required for the operation of the Nemo Link, has the potential to result in direct environmental effects and cumulative effects when considered together with the construction and operation of the UK onshore elements of the Nemo

Link. The development of the grid connection is the responsibility of NGET and the route and technology options for the connection are still in early development. The grid connection does not form part of this planning application; an assessment of the likely effects of the connection is considered within the ES.

For the majority of the environmental topic areas, potential adverse effects will be temporary and localised. Adverse construction effects can also be avoided or reduced through the implementation of best practice industry standard mitigation and prevention measures. Careful route alignment would likely ensure that the potential for significant adverse effects on designated areas could be avoided or minimised as far as possible (subject to detailed routeing at a later date).

Appropriate mitigation measures can be implemented during the construction period to ensure that no significant cumulative effects occur. For construction effects with the potential to be longer lasting and/or permanent (e.g. ground conditions and hydrology), the implementation of best practice industry-standard mitigation and preventative measures will also ensure that significant cumulative effects can be avoided.

Potential cumulative effects during the operation period are largely minimal and localised and are not anticipated to be significant. There is potential for cumulative ecological effects on Thanet Coast and Sandwich Bay, Stodmarsh and The Swale Natura 2000 sites (disturbance to breeding and wintering birds using these sites and moving between them). Such effects could potentially be avoided or minimised through the development of the detailed design of the connection (careful route alignment) and identification of mitigation measures. Environmental assessment work will also be undertaken for the connection option to determine the significance of likely effects and appropriate mitigation. The cumulative operation effects on landscape and views (if an overhead line is proposed) are anticipated to be no greater than moderate adverse due to the presence of existing infrastructure in the surrounding area including three 132kV overhead lines, a wind turbine and two masts.

At a time when the nature and extent of the grid connection is finalised, consent under the relevant legislation will be applied for by NGET separately to this planning application for the UK onshore elements of the Nemo Link. All potential relevant environmental effects and appropriate mitigation of the connection will be assessed and identified separately by NGET to provide sufficient information to the relevant authority to enable consents (if required) to be granted under the relevant legislation.

Summary and Conclusions

The Nemo Link is a proposed HVDC electrical interconnector which will allow the transfer of electrical power between the UK and Belgium. The power would be bi-directional, able to flow in either direction at different times, depending on the supply and demand in each country. The development of the Nemo Link will enable a more efficient energy market within the EU in accordance with EU policy.

NGNLL has decided to prepare and submit a voluntary ES to accompany the planning application to enable the anticipated environmental effects of the Proposed Development to be assessed and appropriate mitigation measures to be determined and implemented.

The construction and operation of the Proposed Development will not give rise to any significant long term effects, either in isolation or when considered in combination with other unrelated projects, other aspects of the Nemo Link and the grid connection. Any impacts identified as part of the assessment are considered to be localised and temporary and appropriate mitigation measures will be implemented to avoid, offset or reduce impacts.

The table below provides a summary of the residual (i.e. with mitigation in place) environmental effects of the proposed UK onshore elements of the Nemo Link to which this application relates.

SUMMARY OF EIA RESULTS		
Topic Area	Residual Effects*	
	Construction	Operation
Land Use	Minor Adverse	No Effect
Ground Conditions and Contamination	No Effect	No Effect
Hydrology and Flood Risk	Minor Adverse	Minor Adverse
Ecology	Minor Adverse-Minor Beneficial	Negligible
Archaeology and Cultural Heritage	Low/Negligible	No Effect
Landscape	Moderate Adverse	Minor Adverse
Views	Moderate/Minor Adverse	Moderate/Minor Adverse
Traffic and Transport	Minor Adverse	Negligible
Noise	Moderate	Minor
Air Quality	Negligible	No Effect
Coastal Tourism, Recreation and Socio-Economics	Minor Adverse-Minor Beneficial	No Effect
Electric and Magnetic Fields	No Effect	No Effect

* Summarises residual effects on the basis of the 'worst' or most significant effect identified.

Appendix 16: Belgian Onshore Non-Technical Summary

Voluntary environmental statement

NON-TECHNICAL SUMMARY

Onshore HVDC cables and converter station at Zeebrugge forming part of the Nemo Interconnector

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	Client	Elia Engineering Prater Building Culliganlaan 1G 1831 Diegem
	Contact **Telephone** **E-mail**	Bart Pelssers +32 2 546 77 93 bart.pelssers@elia-engineering.com
	Contractor	ARCADIS Belgiumnv/sa Posthofbrug 12 2600 Berchem
	Contact **Telephone** **Telefax** **E-mail** **Website**	Hilde De Lembre +32 9 241 77 10 +32 9 242 44 45 h.delembre@arcadisbelgium.be www.arcadisbelgium.be

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1 Project background

The Nemo interconnector (the Project) is being jointly developed by Elia Asset NV and National Grid Nemo Link Limited. The interconnector will be a High Voltage Direct Current (HVDC) transmission cable system with a capacity of 1000 MW that will link the Belgian and UK electricity transmission networks. The Project will enable electricity to flow in either direction at different times depending on the level of supply and demand in each country. The system will allow a quick response to changes in the balance between supply and demand of electricity in Europe and the UK.

Elia Asset NV is the applicant for the permit for the section of the HVDC cables that will lie in the Belgian part of the North Sea.

The Belgian onshore elements of the Project comprise a converter station and underground HVDC cables in Flanders (the Proposed Development). These cables will connect to the subsea cables across the North Sea to a converter station in Richborough in the UK.

Because the distance of the cables inside a special area of conservation is limited, the Proposed Development does not come under annex I or annex II of the Decision of the Flemish government from 10 December 2004, BS 17.02.05. Also, underground high voltage cables are not listed in annex III. Thus, the Proposed Development does not fall under the jurisdiction of the circulation letter, and an environmental impact assessment (EIA) is not required for the Proposed Development. However, Elia is voluntarily supplying this environmental statement. The layout of this document follows the structure of a request for an exemption from the requirement for an EIA.

2 Description of Proposed Development

2.1 Location

The Proposed Development is located in the city of Brugge, west of the harbour of Zeebrugge. The proposed land connection comes ashore at the beach to the north of the nature reserve, De Fonteintjes. After an underground crossing of the nature reserve, the cable will head east south of the GraafJansader to the Baron de Maerelaan. The converter station is proposed inside the triangular area of land bordered by the railroad tracks to the east of the Baron de Maerelaan, the Kustlaan and the Veerbootstraat.

2.2 Detailed description of the Proposed Development

The primary function of the proposed converter station is the conversion of high voltage direct current (HVDC) to alternating current (used in Elia's AC high voltage network) or vice versa, depending on the direction of the energy flows. The new installation will be constructed in the eastern corner of the zone for community and public utilities (indicated according to the RUP 'Optimalisatie van het hoogspanningsnetwerk in Vlaanderen'; according to the old regional planning, this is a military area), along the Baron De Maerelaan in Zeebrugge.

The converter station will be connected to Elia's AC high voltage network at Stevin's substation, located on the other side of the Baron De Maerelaan. The connection between the two stations will be underground.

2.2.1 HVDC cable connection

Elia is proposing an underground HVDC cable connection, consisting of two separate HVDC cables, that connect to the Nemo converter station west of Zeebrugge's harbour.

The HVDC cables will cross the nature reserve 'De Fonteintjes' via horizontal directional drilling (HDD) over an approximate distance of 500 m. Two alternatives exist for the implementation. (see section 3.1).

An underground transition pit will be installed in order to connect the sea cables with the land cables. The transition joints will be installed in an inspection pit in order to allow for any future testing of the cables.

After the HDD, the cables will be installed in open trenches to the proposed Stevin substation west of the Baron de Maerelaan. Because of the route length in the open

trench, the underground HVDC cable will be installed in two sections. The two sections will be connected to each other via a connection joint in the middle of this part of the route east of the Fluxys station.

In order to avoid difficulties in restoring the existing terrain profile, horizontal directional drilling will be used to cross the GraafJansader and the polder grassland ditches. The Baron de Maerelaan will also be crossed in the same manner. Finally, the cables will be connected to the Nemo converter station.

When the cables are in service, they will produce heat. In order to guarantee the continued functioning of the cables, they may not exceed a certain maximum temperature. When placed in open trenches, the underground cables will be installed in a layer of dolomite to avoid this technical problem. Dolomite has a relatively high heat conductivity that quickly dissipates the heat and therefore prevents the cables from over-heating. The dolomite layer will be approximately 60 cm thick.

Before the installation of the cables in the open trench, any water in the trench will be drained to just under the trench depth. This water drainage will be limited to approximately 30 days. The jointing pit will be installed in such a fashion that the drainage time is as short as possible.

2.2.2 Nemo converter station

The Nemo converter station will be located in the public utility zone bordered by the railway tracks to the east of the Baron de Maerelaan, the Kustlaan and the Veerbootstraat.

The most important characteristics of the converter station are:

- Station area: +/- 30,000 m² (only the installation and buildings, not including any green bordering)
- Building area: +/- 7,000 m²;
- Building height: +/- 20 m;
- Access roads and paved area:+/- 9,000 m²;
- Building cellar depth: 0 m (no cellar);
- Foundation depth: +/- -1 m.

The HVDC cables on the converter station site will be open trenched.

An architectural and landscape study is currently being conducted to develop an optimal design to fit with the surrounding landscape.

2.2.3 AC cable connection between Nemo converter station and Stevin substation

The AC cable connection between the Nemo converter station and the Stevin substation will be located under the Baron de Maerelaan, south of the HVDC cables. This connection is likely to be achieved with three pipe jackings with a diameter of 800 mm.

3 Alternatives

3.1 Alternative locations

Multiple alternative locations were investigated during the “plan MER” procedure (see paragraph 4). The current location was selected from 4 alternatives, evaluating each location on the following parameters:

- Environment
- Landscape
- People: farming
- People: housing
- People: Industry

Full details are available in the EIA used for the “plan MER” procedure, ref. 04/006233, version i, 6th April 2011.

3.2 HVDC cable connection alternative work methods

There are two ways of carrying out the horizontal directional drilling. Either the drill rig will commence drilling at sea and drill towards the coast, or the drill rig will be located on land and drill towards the sea or the beach.

With the first option, the cables will hit land south of the nature reserve south of the GraafJansader. With the second option, the drilling machine will be located in the fields to the south of the GraafJansader, so that the cables with come out of the ground in the sea or on the beach. The drilling machine could also be installed on the beach.

In the event of a sea drilling, the installation of the pipe bundle on land must be completed before the sea drilling construction phase begins. If the drilling is from land, the pipe bundle with either float on the surface of the sea or they will lie on the beach. In each case, the pipe bundle will be laid out in the direction of the horizontal directional drilling.

3.3 Nemo converter station alternative work methods

There are no alternative work methods for the implementation of the converter station.

4 Administrative context

4.1 Previous proceedings

The procedure plan-MER (i.e. EIA), '380kV hoogspanning Zomergem-Zeebrugge', was carried out in the period 2008 – 2011 for the spatial implementation plan (RUP) 'Optimalisatie van het Hoogspanningsnetwerk in Vlaanderen'.

The identification of a region for community and public utilities in Zeebrugge, and the identification of a utility zone along a high-voltage cable route from the Nemo converter station to the coast, are part of this RUP.

The plan-MER, including the assessment, was approved by the MER service on 25th May 2011. The approved plan-MER was integrated in the development of the regional spatial implementation plan (GRUP), provisionally adopted by the Flemish government on 22nd July 2011. The public consultation on the provisionally adopted RUP ran from 13th September to 10 November 2011.The RUP was finally adopted on 13th July 2012.

5 Assessment and description of effects

5.1 Soil

5.1.1 Reference situation

In the area of the proposed development there are roughly two soil types: the polders between Brugge and Zeebrugge, and the artificial ground in Zeebrugge's harbour.

OVAM possesses two relevant soil investigation files where soil pollution was documented in the project area. OVAM stands for Openbare Afvalstoffenmaatschappij voor het Vlaams Gewest (Public Waste Agency of Flanders) and is responsible for waste management and soil remediation in Flanders. The contamination is located in the soil of both sites to the west and east of the Baron De Maerelaan. Both sites are currently owned by the Ministry of Defence and will be fully decontaminated before being sold to a new owner. By the time the proposed development is carried out, these sites will be decontaminated.

5.1.2 Impact analysis

5.1.2.1 Warming of the soil

The soils surrounding the underground cables may warm up because of heat dissipation. In order to guarantee the functioning of the cables, a maximum temperature of 90°C is allowed. To avoid this technical problem, a layer of dolomite is used. This is a standard practice used by Elia.

The thickness of the dolomite layer is such that a maximum soil area temperature will amount to 15°C when the cable is operating at maximum power levels. The underground high voltage cables will only cause the soil temperature to be higher than normal during the cold season, and even in times of maximal use, the increase in temperature will be limited to the normal temperature range.

5.1.2.2 Profile disruption and soil compaction

There will be no significant soil profile degradation in the area of the trenches. The clay soils profile is rather homogeneous and the anthropogenic soils are already disturbed. During construction, the top layer of soil will be removed and stored for later re-use. Once the trench is filled in, the top layer will be restored as close as possible to the original layering.

Inside the construction zones, steel planking will be used due to the sensitivity of the clay grounds to soil compaction.

No significant effects are expected at the converter station site. The site is, for the most part, already paved and, according to the soil investigations, the only soils present are of anthropogenic origin.

5.1.2.3 Soil pollution

The re-use of excess soil from the trenches will be recorded in a Technical Report to avoid the risk of spreading any soil that is subsequently identified as being polluted.

Any soils previously identified as being polluted will be decontaminated before the start of the project.

5.2 Water and flood risk

5.2.1 Reference situation

The HVDC cable will be constructed south of the GraafJansader.

According to the salinity map, the freshwater – saltwater border area lies in the area south of the dunes at 2 m below ground level. At the beach north of the dunes, there is a steep salinity gradient to 25 m below ground level at the coastline.

On the water assessment map, the polders are categorized as very sensitive for groundwater flow. In theory, the polders may be flooded from the sea. The zone for the proposed converter station is not located in an area indicated as sensitive to flooding. To the southwest of the proposed Stevin substation is a flood risk zone an area of which was recently flooded.

There is no groundwater extraction or protection zone in the surrounding area.

5.2.2 Impact analysis

5.2.2.1 Modified rain water drainage and infiltration

The site for the proposed converter station is mostly paved. The portion that is paved will be halved by this Proposed Development. Consequently, the Proposed Development will lead to an increase (restored pre-built situation) in infiltration (addition to the groundwater) and/or a decrease (restore pre-built situation) of surface area run-off.

The Proposed Development will meet the urban regulation on rain water wells, infiltration facilities, buffer facilities and separate discharge of sewage and rain water.

5.2.2.2 Disruption of the groundwater level and groundwater flow

5.2.2.2.1 Ground water drainage

Groundwater drainage is necessary while making open trenches and can have an effect on the groundwater level and groundwater flow.

The influence on pools and low-lying grounds is relatively small because of the low permeability. After 30 days of drainage, a reduction of the ground water level of 5 cm is expected at a distance of 100 m from the trench. The expected flow rate of the extracted groundwater for the entire trench is 350 m³/day(trench of 1500 m).

In the polder grounds (= creek deposits) the groundwater level reduction contour of 5 cm is located at a distance of 500 m from the trench. The expected flow rate of the extracted groundwater for the entire trench is 2000 m³/day and is almost six times higher than in the pool grounds, also for a trench length of 1500 m.

The proposed route of the cables lies in a zone with shallow salinized groundwater (0-2 m ground level). The duration and depth of the expected drainage are not of the nature that salinity will increase. A contribution to increased salinity can occur indirectly if freshwater is pulled from under the nature reserve, de Fonteintjes. Poor hydraulic contact between GraafJansader and the dunes to the north of the N34, could cause significant groundwater and surface water reduction in the nature reserve. Considering the natural characteristics of de Fonteintjes, this should be avoided and any necessary measures will be applied. An Appropriate Assessment will define further which measures will have to be taken at what location, in order to minimize effects.

5.2.2.2.2 Dolomite layer

The dolomite layer has a very high permeability, unlike the layers under and above. The dolomite layer could cause a decrease of the groundwater hydrostatic line, causing a draining effect in some connecting grounds and ditches. This draining effect could extend to the nature reserve, de Fonteintjes.

It is also possible that the water table will decrease permanently over the complete length of the trench. The groundwater hydraulic head in certain locations under the polder, clay and peat layers may become 20-30 cm lower than the water table. In the event of an entrenched dolomite bedding, these layers together may cause a hydraulic ‘short circuit’ and make the effect permanent.

Possible mitigation measures

The following mitigating measures are proposed to limit the effects on the groundwater level caused by the Proposed Development:

- Re-pumping of groundwater to the site;
- Limiting duration of groundwater pumping (i.e. by placing sheet piling with underwater concrete);
- Fragmentation of the dolomite bedding by means of ducts;
- The application of clay plugs to limit the hydraulic contact between the dolomite and the water-bearing Pleistocene sands.

The impact radius of the groundwater pumping can be limited, provided that these measures are taken during the installation of the underground HVDC cable. Groundwater fluctuations during the exploitation phase can be avoided by the use of dolomite fragmentation and the application of clay stops.,. Consequently, significant effects to the groundwater level and groundwater flow will be avoided.

Based on the assessment above, an additional groundwater effects study was ordered by Elia to identity the specific mitigation methods.

5.3 Audible noise

5.3.1 Reference situation

The current audible noise quality at the site of the proposed Nemo converter station is determined on the basis of data from a study by Vinçotte Environment. This study shows that during the day and in the evening the VLAREM guide values are exceeded at all points. The night values, however, are met.

5.3.2 Impact analysis

These studies were carried out for the designs of the Stevin and Nemo stations as they were at the time. Modifications to the stations have already been proposed on the basis of those findings. The final design of the Stevin substation will be elaborated in the project EIA for Stevin. The final design of the Nemo converter station will be further elaborated by the supplier of the installations. The final designs will take forward a vision which is currently being developed about the architectural and landscape integration of the stations.

This section therefore provides an assessment of the expected impact based on the current outline designs. The final designs will be determined only in the course of 2013-2014.

5.3.2.1 Nemo converter station

It can be concluded that the audible noise impact of the converter station (including the recommended mitigation measures) on the original ambient audible noise is negligible throughout the daytime and the evening. The calculated increase in ambient audible noise is not perceptible by the human ear.

During the night, an increase in ambient audible noise perceptible by the human ear may occur at one measuring point.

5.4 EM fields

5.4.1 Reference situation

For Belwind's wind turbine concession at Bligh Bank, an onshore underground 150 kV high voltage cable was installed. The cable lands at Londenstraat in Zeebrugge and then continues to Evendijk-West, continuing along it in an easterly direction, crossing the N31 road and railway lines, and eventually connecting to the Blondeellaan substation in the port.

The installation of an onshore 220 kV cable has been proposed by Northwind in the near future (2012/2013) in the framework of their wind farm concession.

Elia will examining the connection of the other offshore wind farm developments to the onshore high-voltage grid. The exact number of cables required, and their precise location, is not yet known. The number is estimated at seven cables, which will land east of the Nemo cable and then run south of the Nemo cable to the Stevin high-voltage station.

Moreover, west of the Baron de Maerelaan the Stevin substation will be built, and there are also plans for a 150 kV overhead line between the existing Blondeellaan substation and the proposed Stevin substation.

5.4.2 Impact analysis

5.4.2.1 HVDC link

The HVDC cables will generate electric and magnetic fields.

The electric field is almost completely screened off by the metal screens on the outside of the insulation around each conductor. Magnetic fields, however, are not blocked by these screens.

The magnetic fields surrounding the separate cables can be largely neutralised by laying the two cables close to one another. Because of the opposite flow direction of the two separate cables, the magnetic fields are also opposite and largely cancel out each other.

In this way, the field strengths remain of the same order of magnitude as the earth's natural magnetic field.

5.4.2.2 Converter station

The HVDC cables will be connected to the Nemo converter station. Inside the station, the direct current is converted to alternating current or alternating current to direct current, depending on the direction of the energy flows.

The main equipment is electrically and magnetically shielded by the converter building.

5.4.2.2.1 DC cables

The static electric and magnetic fields generated by the DC cables at the converter station are comparable with those of the HVDC cable.

5.4.2.2.2 AC cables

Magnetic and electric fields generated by alternating current have a very low frequency. Magnetic and electric fields may occur on the converter station site. However, perimeter fencing will be installed for safety purposes. At the site enclosure, the average magnetic and electric field is already strongly reduced.

5.5 Nature

5.5.1 Reference situation

The area for the Proposed Development is for the most part situated in the ‘Poldercomplex’ special bird protection area, partly in the ‘Duingebieden incl. IJzermonding en Zwin’ special habitat protection area, and partly in ‘de Fonteintjes’ and ‘Oudemaarspolder’ ecological network, of which the recognised ‘Fonteintjes’ nature reserve forms part. The ‘Polders’ special habitat protection area lies in close proximity to the area of the Proposed Development.

5.5.2 Impact analysis

5.5.2.1 Habitat loss

The Proposed Development will cause temporary habitat loss as a result of the temporary storage of the ducts bundle in the polder (for drilling from the sea), creation of the construction area, excavation of the trenches for the HVDC cables, and construction of the underground jointing pits.

When drilling from the land, the ducts bundle would not be temporarily stored onshore, but would prepared at sea or installed on the beach. This would therefore entail a more limited temporary loss of habitat.

The HVDC cable will be installed through directional drilling underneath the beach, the 'Duingebieden incl. IJzermonding en Zwin' (special habitat protection area), the recognised 'Fonteintjes' nature reserve and the 'De Fonteintjes' and 'Oudemaarspolder' ecological network. Directional drilling will therefore not cause a loss of habitat within these protected areas.

Because of the temporary nature of the loss of habitat, and the fact that the vegetation can be restored afterwards, the impact of construction of the trench, the work area and the connecting jointsin the 'Poldercomplex' special protection area, is considered acceptable.

Possible mitigation measures

In order to minimise possible damage to the biologically valuable habitats present in the polder area, it is proposed to install the larger part of the pipe bundle on the less biologically valuable arable plots. Care should be taken that the installation is executed with minimum damage to the vegetation currently under development there (polder meadows, salty lakes/creeks).

Permanent loss of habitat occurs only as a result of the construction of the underground jointing pits and the converter station.

Because of the minimal area of permanent biotope loss, the impact of the construction of the jointing pits is considered negligible. At the converter station, there is only permanent loss of the biologically less-valuable habitats. This is also considered acceptable.

5.5.2.2 Disturbance of birds

Noise emissions may disturb birds in the surrounding ornithologically valuable areas.

Noise generated during the construction phase is not considered significant to bird life because of the following findings:

- the noise during construction is temporary;
- the current ambient audible noise in the area is already quite high because of its position parallel to Kustlaan and the surrounding industry;
- the area is regarded as clearly acoustically disturbed for bird life and is therefore not susceptible to acoustic disturbance of bird life;
- the relatively limited number of (highly) disturbance-sensitive summer birds, water birds and waders;

- a study by Gabriels (1998) has shown that temporary audible noise levels do not have a significant lasting impact on animal life.

The operation of the Nemo converter station will lead to a permanent increase in audible noise level. The audible noise studies have shown that the disturbance contour of more than 45 dB(A) does not reach as far as the polder area. Consequently, no significant audible noise impact is expected in relation to flora and fauna.

5.5.2.3 Drying out

Lowering of the groundwater level during drainage may have a drying-out impact on the local groundwater-dependent vegetation and species habitats. Increased salinity of shallow ground water is also a possible effect to be taken into account. The establishment of a dolomite base may also have a draining, and therefore drying-out, effect. This effect might reach as far as into the De Fonteintjes nature reserve.

Possible mitigation measures that may be used to avert such effects have been mentioned in section 5.2.2.2. On the basis of the possible effects with regards to groundwater, it was decided to conduct additional investigations so that, by the time the application for the planning permit is submitted (which will have to include an Appropriate Assessment for the Natura 2000 areas), it will be clear which mitigation measures will be taken exactly where in order to prevent significant negative effects on the natural characteristics of these areas.

5.5.2.4 Soil heating

As a result of the heat emitted by the underground cables, the soil in the immediate vicinity of the cables may heat up. The warmer soil may speed up the growth of vegetation, but soil heating may also lead to the soil drying out. As the cables will be laid on a dolomite base, there will be a spatial spreading of the heat, reducing soil heating. Soil heating will therefore not give rise to a significant adverse impact on the natural features present.

5.6 Landscape

5.6.1 Reference situation

According to the Landscape Atlas, the area of the Proposed Development is for the most part situated in the valuable landscape areas (“relictzones”) ‘DuinenOostkust’ (north of GraafJansader) and ‘Oudemaarspolder’ and ‘Kreekrugpolder ten westen van het kanaal’ (situated south of GraafJansader). The Proposed Development is also situated in the very valuable landscape areas (“ankerplaatsen”) ‘Strand en DuinenFonteintjes’ and ‘Oudemaarspolder’

In the area covered by the Proposed Development, there are no protected landscapes, village views, demarcated anchorages or heritage landscapes. The project has no visual relationship with the protected area in the beach district northwest of the proposed converter station.

The Central Archaeological Inventory shows that no archaeological finds have so far been reported in the area covered by the Proposed Development. The beach is subject to the effects of tidal movements, and therefore the chance of any archaeological finds in this area will be virtually nil.

5.6.2 Impact analysis

5.6.2.1 Impacts on archaeological potential

For the cables that are laid through directional drilling, the risk of impacts on archaeological heritage is deemed quite limited. Elia will have an archaeological investigation carried out for the part of the HVDC cable that will be installed in an open trench. The archaeological investigation will be conducted in consultation with the *Onroerend Erfgoed* (Heritage) agency.

As a result of the previous activities pursued at the site where the converter station is proposed, it is expected that the soil has already been quite disturbed, which further reduces the likelihood of an impact on archaeological potential. No archaeological investigation is deemed necessary here.

5.6.2.2 Visual disruption

The visual disruption in the construction phase is caused by the presence of temporary site buildings and soil storage. Upon completion of the work, the surface will be restored to its original condition, linking it up with the existing micro-relief. Because of the temporary nature of the impact, this is not considered significant.

The jointing pits are constructed completely underground. However, the inspection pit will be visible. As the size of the pit and the height of the structure above ground level are limited, there will be no significant visual disruption. For landscaping reasons, erecting a high fence around the inspection pits is not deemed desirable.

The former military area has an industrial character, which is further enhanced by the presence of the harbour infrastructure and activities in the surrounding area. It is expected that the erection of a converter station in this area will have little impact on the character of the surrounding landscape. However the architectural and landscaping design of the converter station has been developed to fit the building into the landscape as naturally as possible.

5.7 Human population

5.7.1 Reference situation

The cable route runs across the beach and dunes of Zeebrugge and the polder hinterland. Here, most of the land is used for farming, i.e. as meadows. There are no houses in this area.

The proposed converter station is situated in a highly industrialised environment characterised by harbour and transport activities. The proposed location of the converter station was in military use, but this use has recently been discontinued.

The audible noise study carried out by Vinçotte Environment shows that the ambient audible noise in the area covered by the Proposed Development is already quite high due to the presence of Kustlaan (and transport zone) which constitutes a significant audible noise source.

5.7.2 Impact analysis

5.7.2.1 Consumption of land

The trench itself and the construction area take up land. Moreover, the ducts bundle installed at the drilling exit point also temporarily occupies land (on land in the case of drilling from the sea and at sea or on the beach when drilling from land).

After the trench has been backfilled, farming activities can be resumed, for both grazing and crop cultivation. Farmers who are adversely affected by the land take on farmland will receive appropriate compensation in accordance with the protocol agreed between Elia and the agricultural organisations. Because of the temporary nature of this claim on land, this impact is considered limited.

The only land that is permanently taken up by the HVDC cable is occupied by the inspection pits. This is not regarded as significant because of the limited size of the pits.

The converter station will be built on a site that was formerly used for military purposes. The land permanently occupied by the station is therefore not relevant to functional loss for the human population.

5.7.2.2 Visual disruption

There will be temporary visual disruption during the construction stage of the HVDC cable and the converter station. The work may cause disruption for people spending their leisure time on the beach, cyclists using the coastal cycling route, people living along Evendijk West, and residents of Veerbootstraat. Because of its temporary nature, this impact is considered limited.

After the construction phase, only the inspection pits will be visible along the HVDC link. This is not considered significant because of the limited size of the pits.

The converter station will have a permanent visual effect. The proposed infrastructure may be higher than the existing structures and may also have a more industrial appearance. There will be visual impact for the residents of Veerbootstraat, Venetiëstraat, Kustlaan and Baron De Maerelaan. In order to limit the visual impact, Elia is incorporating an architectural and landscaping design in order to maximise natural integration of the converter station into the surrounding area. Multiple designs are being considered in order to maximise the options.

5.7.2.3 Audible noise

There are residential areas to the east and northwest of the proposed converter station. The noise exposure to humans during the construction phase is considered minor negative because of the following findings:

- the audible noise sources during the construction phase must at all times comply with the standards required by law;
- the noise produced during the construction phase is temporary;
- the current ambient audible noise in the area is already quite high;
- noise reduction measures can be taken.

There will be a permanent increase in audible noise while the Nemo converter station is operational. The audible noise study compiled by Vinçotte Environment shows that the disturbance contour of more than 45 dB(A) is not located within the residential zone. Consequently, it can be argued that the VLAREM guide values for the day, evening and night periods within the adjacent residential areas will be complied with.

5.7.2.4 Impact of electromagnetic fields

5.7.2.4.1 HVDC link

The cables that will be used in the Proposed Development are direct current cables. These generate static electric and static magnetic fields. The electric fields are blocked by the cable covering, which cannot however block magnetic fields.

The maximum magnetic field strength at ground level above the cables will be within the order of magnitude of the earth's magnetic field and be more than 10,000 times lower than the exposure limit to the general public proposed by the ICNIRP. It can therefore be concluded that there will be no impact on human health.

5.7.2.4.2 Converter station

The outdoor installation of the converter station will generate extremely low-frequency electric and magnetic fields (alternating current). However, the site will have a perimeter fence for safety reasons. At the enclosure of the site, the average magnetic field is already greatly reduced.

The houses in Veerbootstraat are located more than 50 m away from the converter station enclosure. At the houses, the magnetic and electric fields will be reduced to such an extent that there can be no impact on humans.

5.7.2.5 Impact as a result of additional surfacing

Since the design will be compliant with regional urban development regulations on rain water wells, infiltration facilities, buffer facilities and separate discharge of sewage and rain water and the decrease of surfacing, no negative impact is expected.

6 Cumulative effects

6.1 Audible noise

The future Stevin substation across the road from Baron de Maerelaan may cause an additional audible noise impact. For this reason, the audible noise impact was also determined for the operation of Nemo together with the Stevin substation.

It can be concluded that during the day and the evening the total audible noise impact of Nemo (including the recommended mitigation measures) and Stevin on the original ambient audible noise is negligible. The calculated increase in ambient audible noise is not perceptible to the human ear.

The final designs of the Stevin and Nemo stations will be elaborated later, including their architectural and landscape integration which is still under development. A new audible noise study will be compiled for the final design in connection with the environmental permit application.

6.2 EM fields

Magnetic and electric fields will also be generated at the proposed Stevin substation. Only AC is applied in this station. The average magnetic field is already greatly reduced at the site enclosure. Accordingly, no impact is expected as a result of the combination of the Nemo converter station and the Stevin substation.

6.3 Landscape

The Stevin substation is being proposed on the former military site west of Baron de Maerelaan. As this site borders the Oudemaarspolder, and the Nemo station is separated from the polder by railway and road infrastructure, it is expected that the Stevin substation will cause a potentially greater visual disruption on the Oudemaarspolder. It is expected that because of the presence of the Stevin substation the additional disturbance to Oudemaarspolder resulting from the construction of the Nemo converter station will be relatively limited.

6.4 Human population

Cumulative effects may result from the proposed Stevin substation which will already be operational when the converter station is built.

The cumulative audible noise impact is described in section 6.1. The disturbance contour of more 45 dB(A) will not be within the residential area. The cumulative effects within the

adjacent residential areas comply with the VLAREM guide values for the day, evening and night periods.

For an analysis of the cumulative impact of the EM fields, see section 6.2. No impact is expected as the result of the combination of the Nemo converter station and Stevin substation.

7 Conclusion

This environmental assessment has been drawn up for the underground HVDC cable system and converter station that Elia intends to build west of the port of Zeebrugge. This report examines which effects could be generated by the Proposed Development in both the construction and operational phase.

For the purposes of the application for the planning and environmental permit, the following investigations to further reduce the impact are still in progress:

- Inquiry into the groundwater system in the vicinity of the cable route.
- Development of an architectural and landscape concept for the station.
- Conducting new audible noise simulations (after the final design has been completed)

The measures taken ensure that the Proposed Development will not have any major negative impacts on the environment.

ARCADIS

Offices www.arcadisbelgium.be

Antwerp - Berchem Posthofbrug 12 B-2600 Berchem T +32 3 360 83 00 F +32 3 360 83 01	**Hasselt** Eurostraat 1 – bus 1 B-3500 Hasselt T +32 11 28 88 00 F +32 11 28 88 01	**Gent** Kortrijksesteenweg 302 B-9000 Gent T +32 9 242 44 44 F +32 9 242 44 45
Brussels Koningsstraat 80 B-1000 Brussel T +32 2 505 75 00 F +32 2 505 75 01	**Liège** 26, rue des Guillemins, 2ème étage B-4000 Liège T +32 4 349 56 00 F +32 4 349 56 10	**Charleroi** 119, avenue de Philippeville B-6001 Charleroi T +32 71 298 900 F +32 71 298 901

ARCADIS Belgium nv/sa
BTW BE 0426.682.709
RPR BRUSSEL
ING 320-0687053-72
IBAN BE 38 3200 6870 5372
SWIFT BIC BBRUBEBB

Head office
Brussels
Koningsstraat 80
B-1000 Brussel

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