

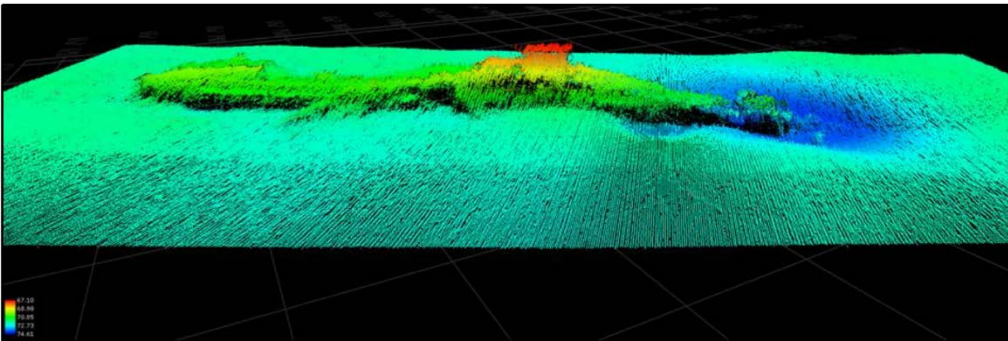
Geophysical Survey and Consenting

Roger Birchall. Geophysical Technical Authority
SSE Renewables – May 2023

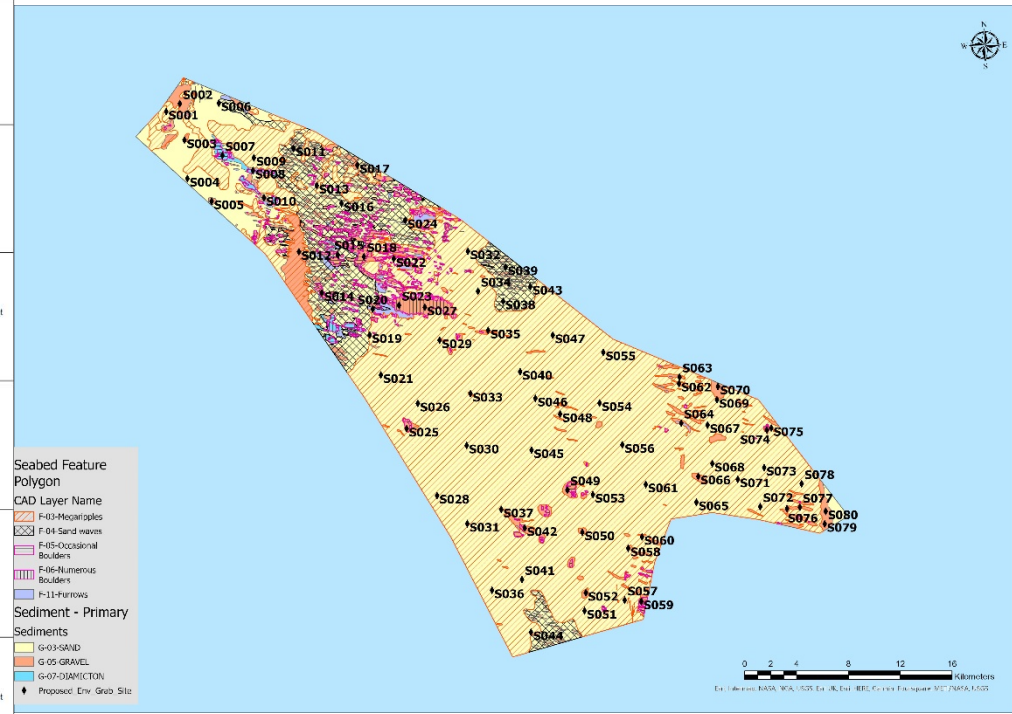


Introduction

- What is the purpose of our Geophysical Surveys
- Timeline And Philosophy
- What are our Consenting and EIA considerations
- Typical Tools and what they are used for
- Examples.



GEOPHYSICAL OVERVIEW (BACKSCATTER)	SAMPLE ID	EASTING	NORTHING	DESCRIPTION	COMMENT
	S049	665531	6277106	Ground-truthing of Coarse Mixed sediments	
	S050	666602	6273840	Ground-truthing of Coarse sediments	
	S051	666856	6267781	Ground-truthing of Sand	Contaminant sampling
	S052	666953	6269165	Ground-truthing of Coarse Mixed sediments	
	S053	667498	6276750	Ground-truthing of Sand	
	S054	668014	6283820	Ground-truthing of Sand	Contaminant sampling



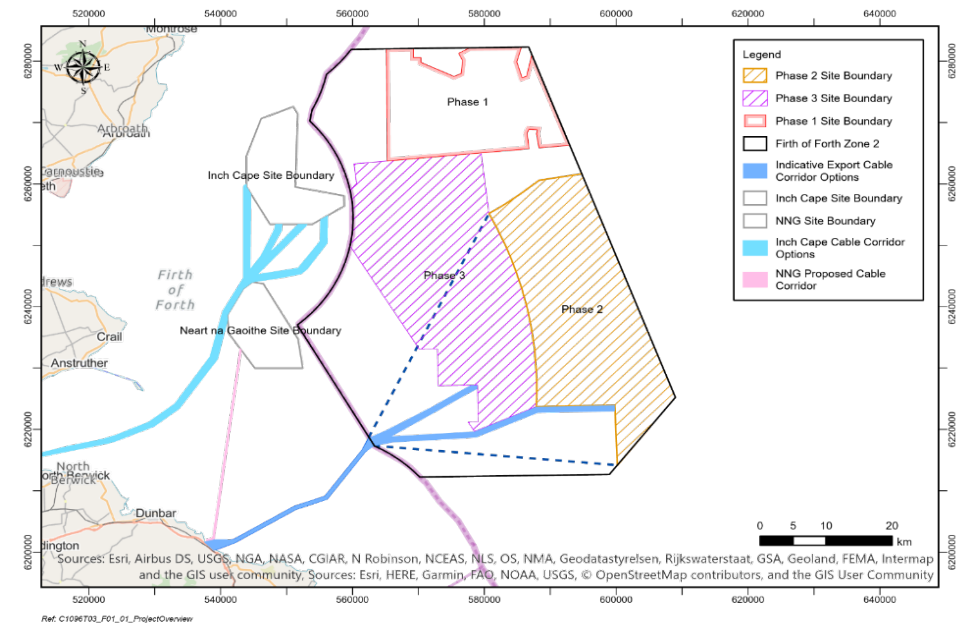
WHAT IS THE PURPOSE OF THE SURVEY?

- Initial scouting survey for ground modelling
- **Consent, WITHOUT IT, NOTHING GETS BUILT**
- Site selection and layout
- Cable layout and installation
- Foundation selection & FEED
- UXO ALARP Certification
- Installation engineering
- Other specialist surveys e.g. DoB confirmation, Archaeological clearance, HDD Duct design and refraction

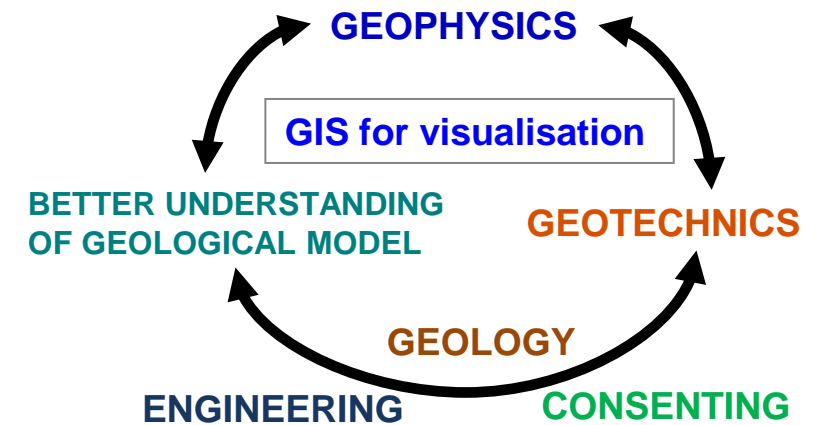
Combinations of the above

TIMELINE:-

- Data acquisition window is Q2 and Q3,
- Need to secure vessel availability for the next shooting season, earlier the better.
- SoW preparation Q3 year before?????
- ITT and contractor selection Q4 year before?????
- QHSE and documentation Q1 year of survey.
- Need to know year of planned installation and work back as need to factor engineering such as UXO/Boulder inspection and clearance + arse factor.



What should we do before we undertake a survey?
Objectives of a geophysical survey investigation?
Defining engineering/consent requirements?
Identifying the tools required to achieve immediate and long-term requirements
What can we use geophysical data for? (and what we can't)



Careful consideration of data acquisition and survey design has to take place so effective integration of the different surveys and datasets can take place, so a greater knowledge of seabed and sub-seabed conditions is gained in order to better understand consent, engineering, planning and design limitations.

GROUND MODEL RISK REGISTER

Four types of geohazard:-

1. Actual geohazards
2. Engineering geohazards (Including UXO and Boulders)
3. Drilling geohazards
4. Environmental geohazards, (Habitats, survey seasons, Archaeological)



So we need to provide insight into issues and limitations in order to understand the approaches and tools required to answer the questions and ensure an appropriately focused survey delivering the data and reporting, relevant for engineers and stakeholders to understand and reduce installation constraints be it engineering or consenting related

Geophysical Survey for Route and Site Investigation

EPS, Marine Licence, Fisheries Liaison and agreements all need to be in place for the duration, and BEFORE survey operations begin

Preliminary Geophysical Surveys
:- feeds into Benthic Habitat assessments (SSS and MBES)
:- Archeologically interest includes wrecks and ancient land surface SSS, MBES, SBP, 2DUHRS and magnetometer

Infrastructure design (FEED) of the Offshore windfarm should avoid sensitive areas and wrecks identified in EIA/ES

Understand physical processes for consideration of mooring and anchoring tech, gives an idea of the potential impact on the seabed

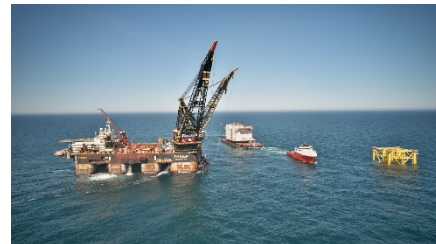
Pre-construction UXO and Engineering Geophysical survey, MBES, SSS, SBP, Magnetometer, (arrays). Higher resolution and specification targeted at where the infrastructure will be placed

pUXO and Archaeological Assessment

pUXO and Archaeological targets inspection and clearance campaign. Boulder Clearance. Pre-Sweeping.



CONSTRUCTION

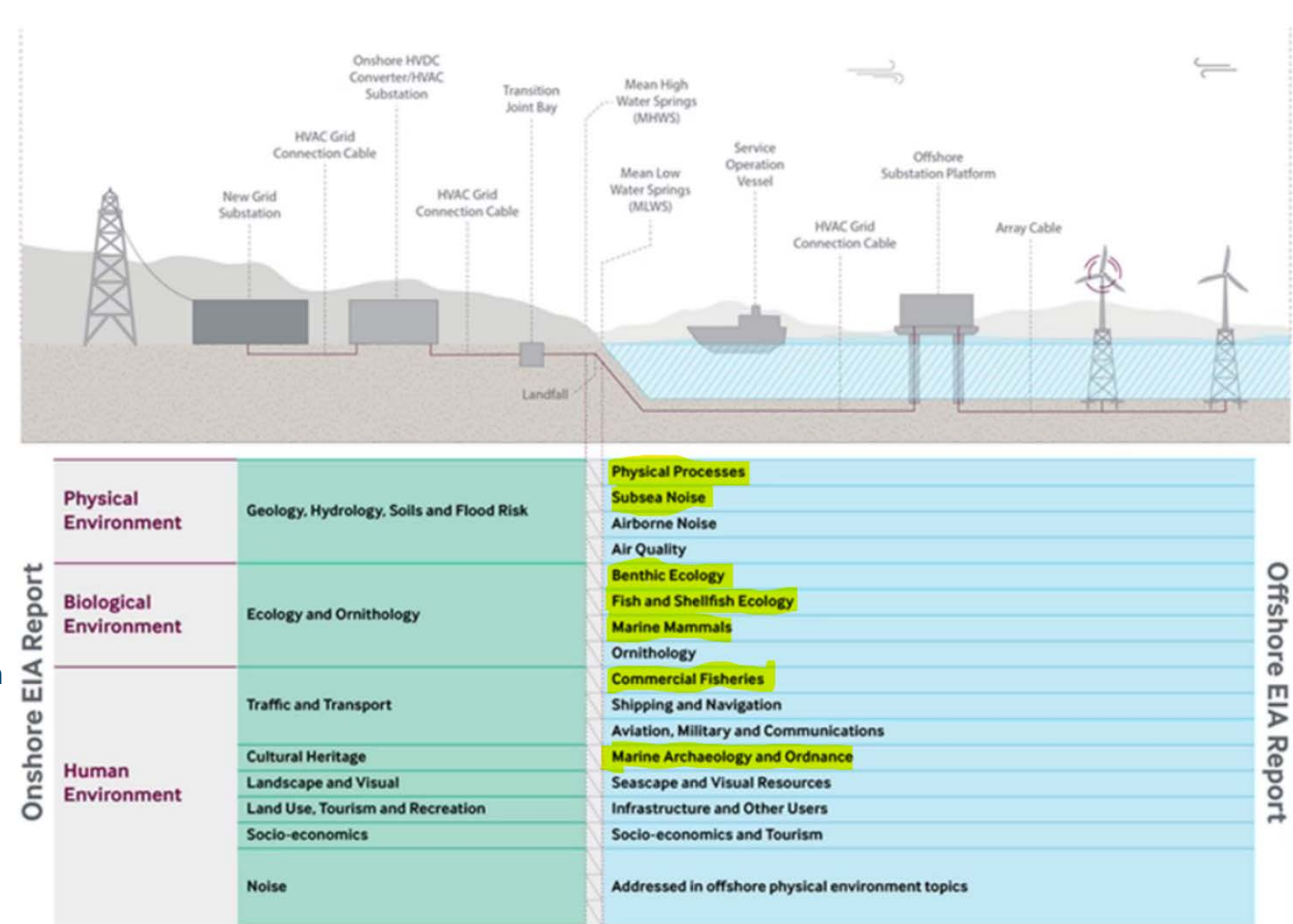


*BC = Before Construction

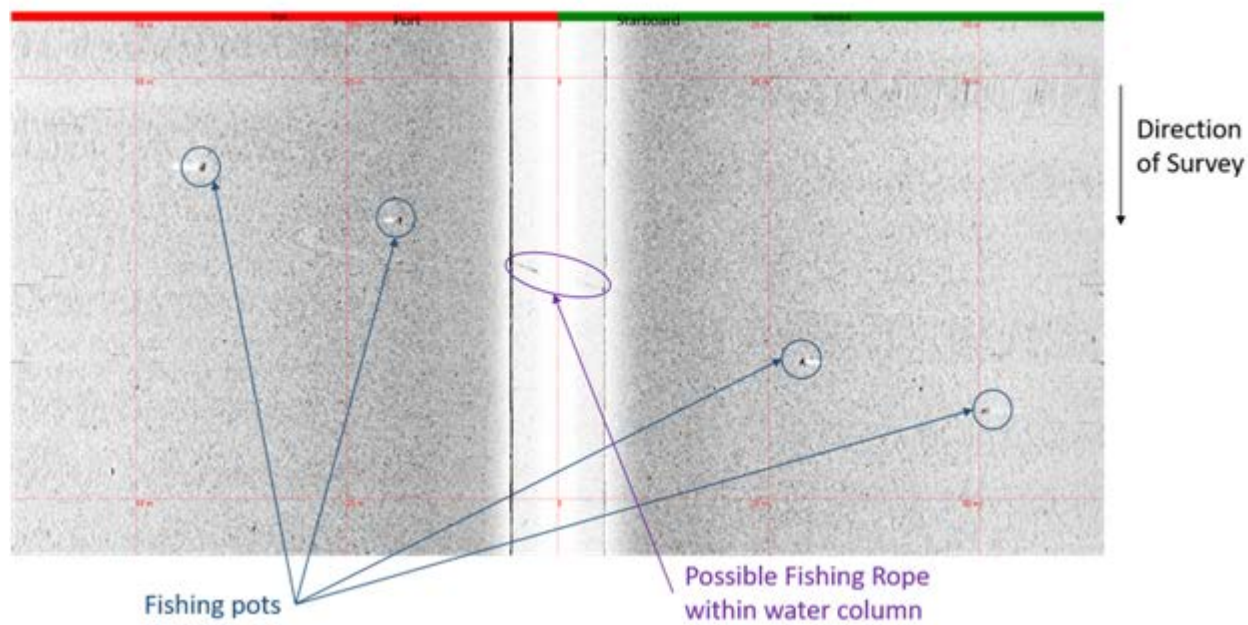


Why is Geophysical Survey relevant to Consents?

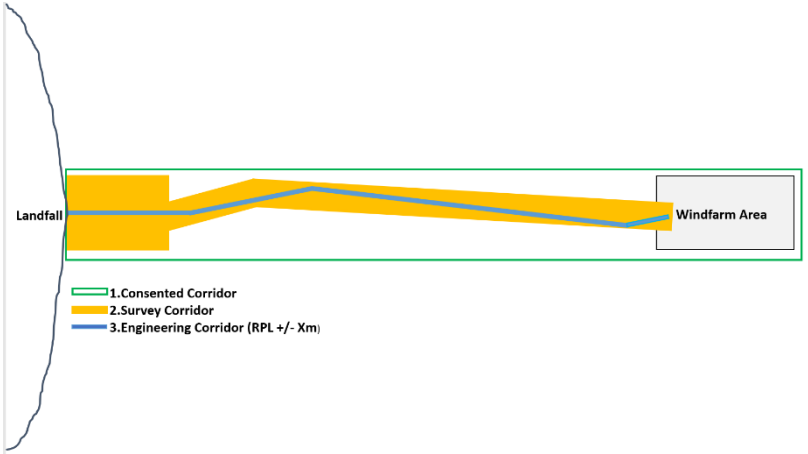
- Commercial Fishing
 - Fisheries Liaison (FLO)
- EPS License requirements
 - Subsea Noise
 - Marine Mammals
 - JNCC Reporting
- EIA requirements
 - Archaeology (Written Scheme of Investigation)
 - UXO
 - Benthic Habitats
 - Fish and shellfish ecology
 - Understanding the species present and their extent can set the sensitivity of the habitat and site selection



- Entanglement of survey equipment particularly on inshore export cable – loss of equipment.
- Close encounters with submerged and unmarked gear
- Close proximity to the route of known and marked gear
- Various types and “quality” of gear!!
- A tactic that has been shown to work well is to have an FLO (Fisheries Liaison Officer) on our survey vessel, supported by a “Scouting vessel” typically an ex- (or local) fishing vessel used for just this kind of work



Point	Date	Time (GMT)	Latitude	Longitude	Type	Description/Notes	Picture
6	19/05/2021	10:12	[Redacted]	[Redacted]	Static Gear Marker	White Buoy with a blue drum with a yellow painted Y	
9	19/05/2021	10:38	[Redacted]	[Redacted]	Static Gear Marker	2 x red flags with white buoy and white drum	
10	19/05/2021	11:17	[Redacted]	[Redacted]	Static Gear Marker	3 x red flags with white buoy and white drum - Red 8 marked	



EPS licence should cover the maximum area ever likely to be surveyed...and then some to prevent delays and offer maximum flexibility if there is a engineering obstacle that requires re-route

- Consultants who see the word “seismic” and think like O&G for EPS Licence details are asking the wrong questions (E.g. Can we have GunDalf readouts for the SBP) or just re-purpose and old document without actually looking up the latest version of a specific tool’s specs. Favourite for this are the ubiquitous Innomar SES 2000 SBP used for profiling shallow soils on cable routes

And in the compressed timelines we are working to, the EPS Licence needs to be ready for the start of Survey Operations

Survey	Example Equipment	Equipment Type	Expected Sound Frequency	Estimated source pressure level	RPS Equivalent
MBES	Kongsberg EM2040 or Reson Seabat 7125	Multibeam echosounder	200kHz - 400kHz	~220dB Peak; 213dB rms	Multibeam echosounder
SSS	EdgeTech FS4200 or 2200	Sidescan Sonar	100kHz / 900kHz	245dB Peak; 242dB rms	Sidescan Sonar
SBP	EdgeTech DW106/512i or similar	Pinger/boomer/sparker/ Chirp	500Hz -12kHz	~248dB Peak	Pinger/Chirp/Boomer
UHRs	Dual Geo-Source 200 or 400 tip	Sparker	200-300Hz to 3500-4000 Hz	<220dB Peak (value is from a more powerful source)	Sparker/Ti Sleeve
Seismic Refraction	Ti Sleeve Gun	Air source and sledge hammer	1-1000Hz	110 dB (instantaneous, measured) at 2 ms, 24 dB	Ti Sleeve gun.

Table 4-3 Summary of results

Auditory group	Threshold		Distance in metres at which threshold is exceeded				
			MBES	SSS	Chirp & Pinger	Boomer	
Low-frequency cetaceans	PTS	NFMS (2018)	219	15	5	Threshold not exceeded	Threshold not exceeded
		Southall et al. (2007)	230	2.6	Threshold not exceeded	Threshold not exceeded	
	TTS	NFMS (2018)	213	40	13	Threshold not exceeded	Threshold not exceeded
		Southall et al. (2007)	224	7	2.6	Threshold not exceeded	Threshold not exceeded
Mid-frequency cetaceans	PTS	NFMS (2018)	230	2.6	Threshold not exceeded	Threshold not exceeded	
		Southall et al. (2007)	224	7	2.6	Threshold not exceeded	Threshold not exceeded
	TTS	NFMS (2018)	230	2.6	Threshold not exceeded	Threshold not exceeded	
		Southall et al. (2007)	224	7	2.6	Threshold not exceeded	Threshold not exceeded
High-frequency cetaceans	PTS	NFMS (2018)	202	110	60	4.6	4.6
		Southall et al. (2007)	230	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS	NFMS (2018)	196	180	110	11	11



We follow the “JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys , August 2017”.

We ask that the survey contractor supplies these services during the ITT so we don’t have to contract them separately, saves a lot of bother.

Outline of the process is:-

- Dedicated and trained MMO and PAM operatives
 - 30 min Pre-shooting search and
 - 20 min “soft-start” in waters up to 200m
 - All sightings are recorded in the required JNCC format and at the end of the job, a dedicated “JNCC Report” is produced for each survey vessel as part of the survey deliverables.

Date	Species	No. of Individuals	Activity/Behaviour	Distance to Source [m]	Source Activity	Mitigation Required
29/04/2021	<i>Halichoerus grypus</i>	3	Frequent surfacing	75	Inactive	None
12/05/2021	<i>Halichoerus grypus</i>	1	Surfaced three times	20	Full power	None
15/05/2021	<i>Balaenoptera acutorostrata</i>	1	Infrequent surfacing	700	Full power	None
15/05/2021	<i>Balaenoptera acutorostrata</i>	1	Infrequent surfacing	2000	Full power	None
15/05/2021	<i>Balaenoptera acutorostrata</i>	1	Infrequent surfacing	300	Full power	None
16/05/2021	<i>Balaenoptera acutorostrata</i>	1	Surfaced once	3000	Full power	None
20/05/2021	<i>Balaenoptera acutorostrata</i>	1	Multiple breaches	2000	Reduced power	None
25/05/2021	Unidentified whale	1	Surfaced once	1500	Reduced power	None
28/05/2021	<i>Halichoerus grypus</i>	1	Bottling whilst sleeping, then dived	750	Full power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Frequent surfacing, following deployed buoy	200	Full power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Frequent surfacing, following deployed buoy	120	Reduced power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Slowly surface swimming	1000	Full power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Intermittent surfacing and slow swimming	1000	Full power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Intermittent surfacing, following deployed buoy	500	Reduced power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Slow surface swimming then dive	1500	Full power	None
29/05/2021	<i>Halichoerus grypus</i>	1	Slow surface swimming then dive	750	Full power	None
30/05/2021	<i>Halichoerus grypus</i>	1	Surfaced next to vessel and dived	50	Full power	None
01/06/2021	<i>Balaenoptera acutorostrata</i>	1	Breached twice	1000	Full power	None
04/06/2021	Unidentified whale	1	Surfaced at irregular intervals	100	Full power	None
06/06/2021	<i>Halichoerus grypus</i>	1	Slow surface swimming then dove	750	Full power	None
06/06/2021	<i>Balaenoptera acutorostrata</i>	1	Surfaced at irregular intervals	150	Reduced power	None
06/06/2021	<i>Halichoerus grypus</i>	1	Bottling at surface	50	Reduced power	None
07/06/2021	<i>Halichoerus grypus</i>	1	Bottling, asleep at surface	10	Full power	None
10/06/2021	<i>Halichoerus grypus</i>	1	Bottling at surface	800	Reduced power	None
11/06/2021	<i>Halichoerus grypus</i>	1	Swimming at surface	150	Reduced power	None
12/06/2021	<i>Halichoerus grypus</i>	1	Bottling at surface	100	Full power	None
13/06/2021	<i>Halichoerus grypus</i>	1	Bottling at surface	100	Full power	None
13/06/2021	<i>Halichoerus grypus</i>	1	Bottling at surface. Awoke when approached	20	Full power	None
18/6/2021	<i>Halichoerus grypus</i>	1	Bottling at surface	600	Inactive	None



Sighting 2, grey Seal



Figure C.2: Sighting 3, minke whale



This is all very well when we are using traditional survey vessels, however with the development and increased use of Unmanned Survey Vessels (USVs) a different approach is required.

- We use the USV’s support/escort vessel (MCA require this when leaving port/harbour areas anyway)
- The MMO goes on the support vessel and the usual protocols are followed.
- Once the equipment is working it remains operational and is not switched off and it is assumed that any marine mammals will be able to detect and avoid the disturbing levels of noise caused by the instruments and work can continue as the support vessel/MMO returns to port.
- There are moves afoot to develop PAMS equipment on the bigger USV’s so even this step may not be required.

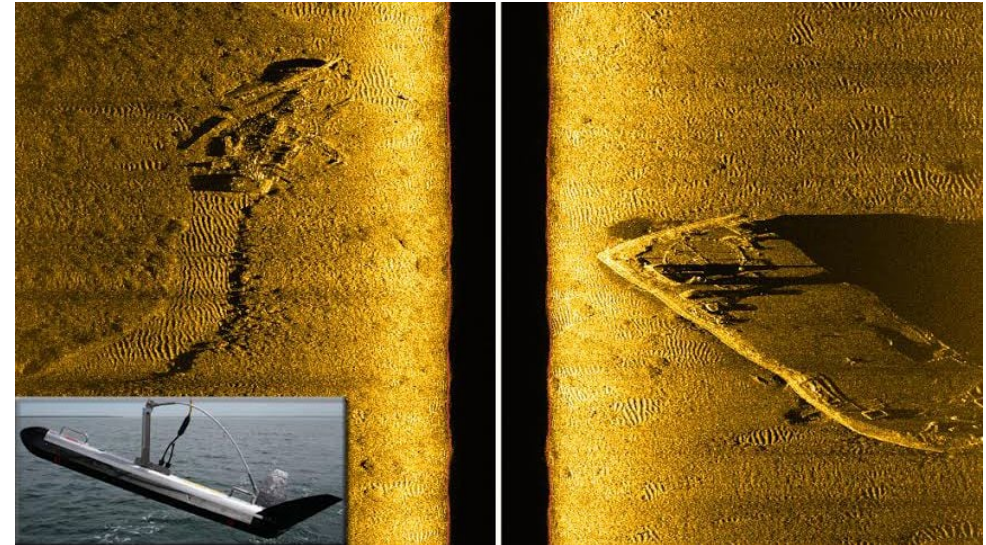
Sidescan sonar:

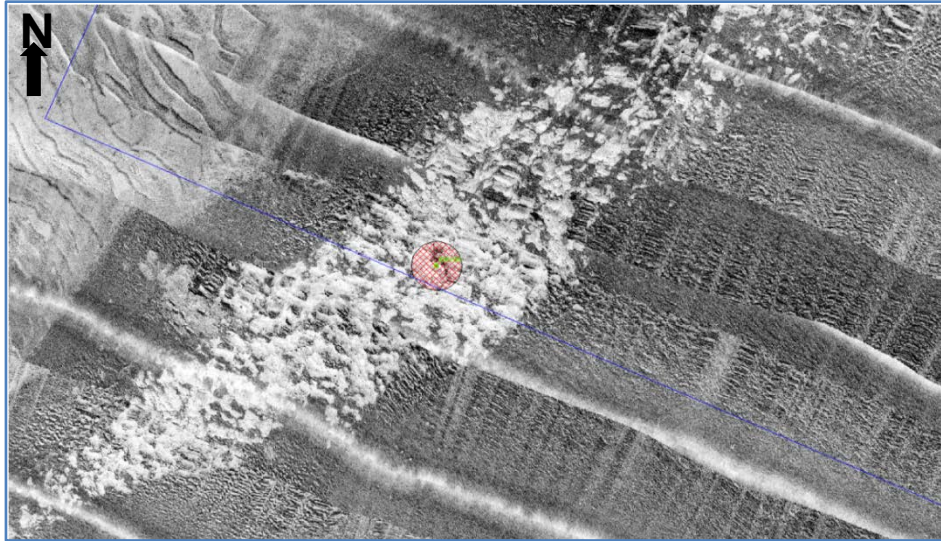
Towfish typically towed 5 – 15m above seabed

- Frequency 100 kHz – 900 kHz
 - Typical frequency 100 kHz; 500 kHz and 900kHz gives better resolution but reduced range
 - 100khz on longer ranges 150m+ for large debris and seabed sediment/habitat classification
 - 500-900khz 30-75m range much higher resolution for UXO and boulder identification
- Interpretation takes some skill particularly with reference to artefacts
- 'Ground truthing' to correlate backscatter with seabed type

USES

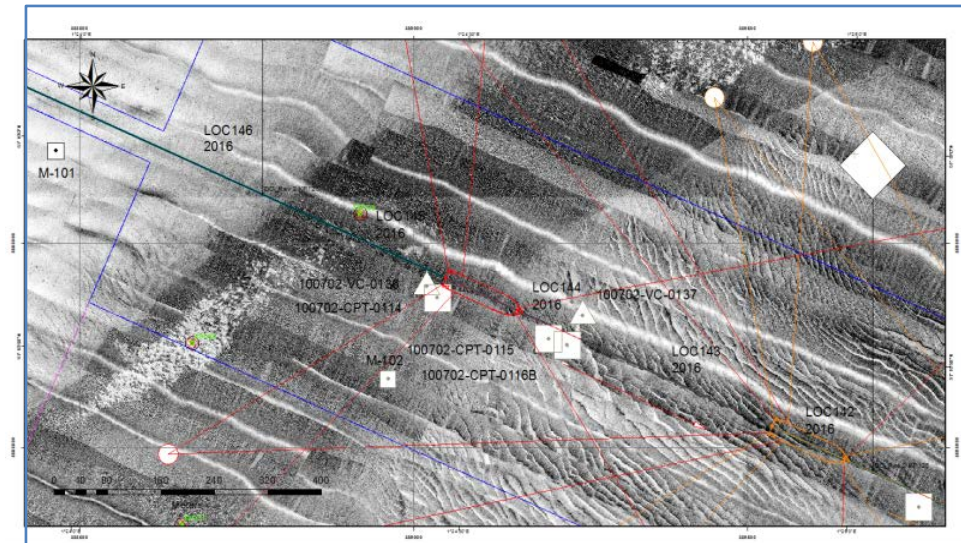
Seabed clearance
Seabed installations, pipelines and cables
Wrecks and obstructions
Seabed soils and bedforms
Seabed stability and slopes
Environmental habitats
Boulders and UXO?





Proposed Environmental Location 30		
Easting (m)	Northing (m)	Water depth
456789	5123456	~12.0m LAT
42m NNE of KP26		
Comments		
Possible mussel beds		

Extract from around the proposed Env 30 location taken from SSS Preliminary Mosaic_tile08



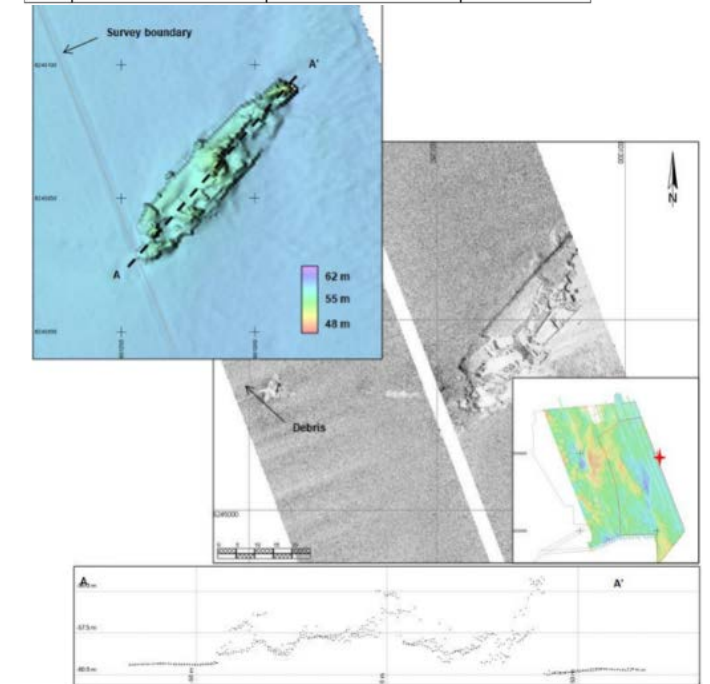
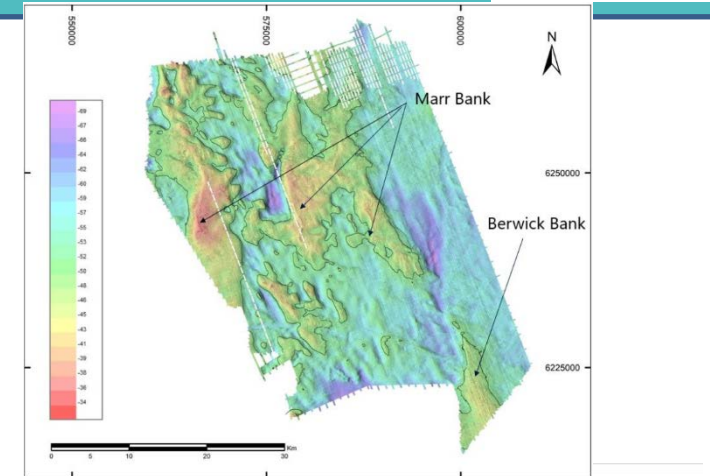
Scale= Circle is 20m in Diameter

Have to avoid Mussel Beds when planning grounding of Maersk Connector and her anchors



Bathymetry delivered as a DTM.

- Site wide water depth generally referenced to LAT
- Shaded Relief to understand seabed morphology and display purposes.
- Develop an understanding of seabed mobility and RSBL
- Derive slope angles for purposes of installation and engineering
- Map large morphological features of interest for engineering and EIA purposes
- Calculate dredge volumes
- Accurate seabed profiles for Cable design
- Wrecks for EIA and Avoidance



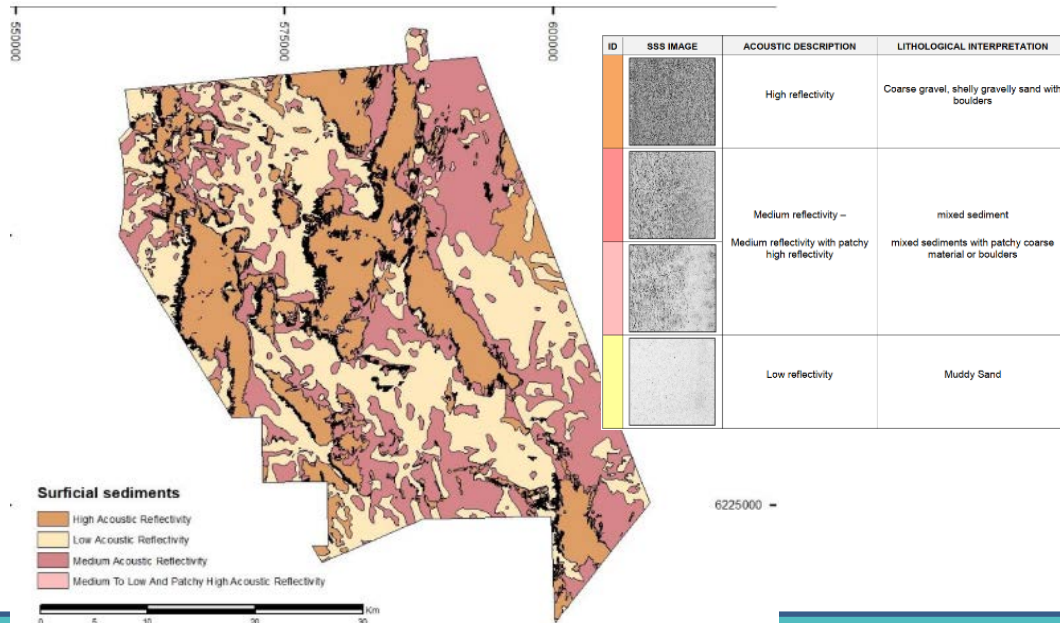
- One product that has been derived from the Bathymetric DTM acquired is the Shaded Relief, not only does it tell us the water depth relative to LAT but we also see Morphological features from the large scale such as the Banks in the area.
- A good shaded relief is a beautiful thing to put up in a slide to Procurement and PM's to see what they got for their money
- Backscatter also recorded, this can be processed once have Benthic sampling results for seabed sediment classification to support EIA and consent. Particularly important with the increasing use of USV's that do not collect SSS data, Backscatter is the same principles as SSS and it can be used to target a Benthic campaign.



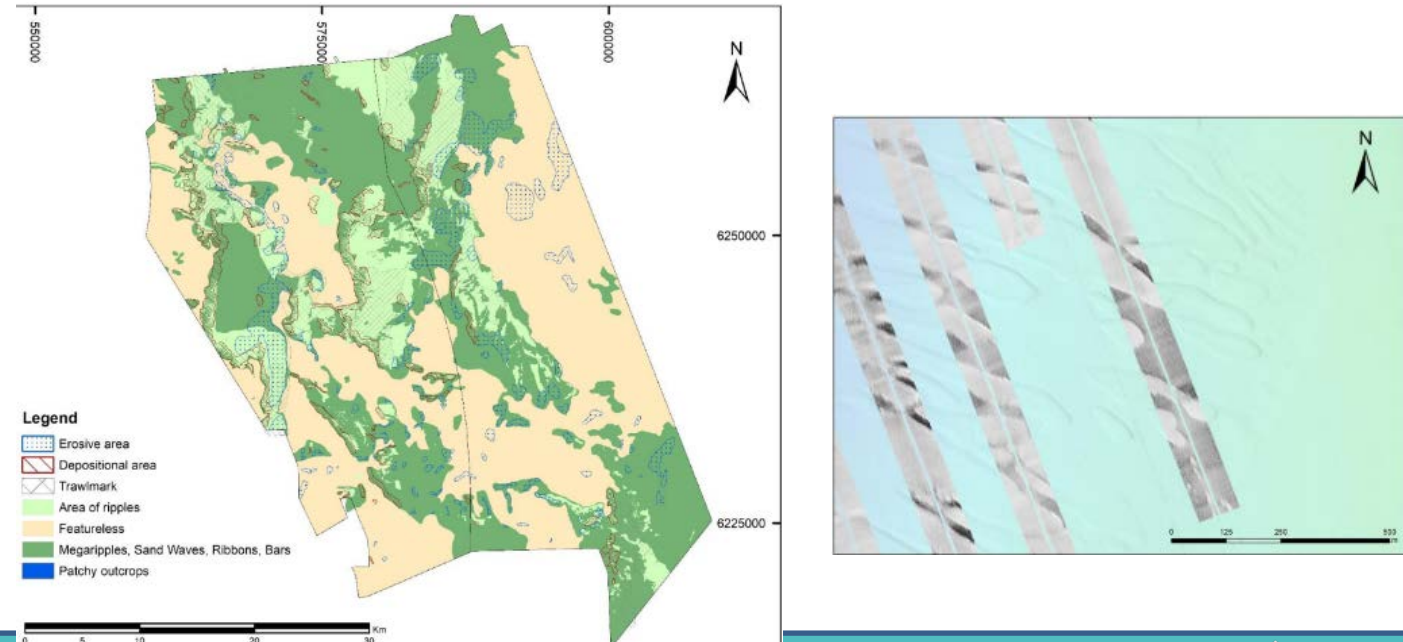
Sidescan Sonar data, mosaics and interpretation

- Seabed sediments distribution
- Seabed morphology and mobility
- Boulder density and distribution (FABM) to inform routing and installation decisions
- Debris avoidance and clearance
- Support habitat mapping for EIA and Consent
- Wrecks for EIA
- Support limited ALARP sign-off for GI campaign

Seabed Sediments

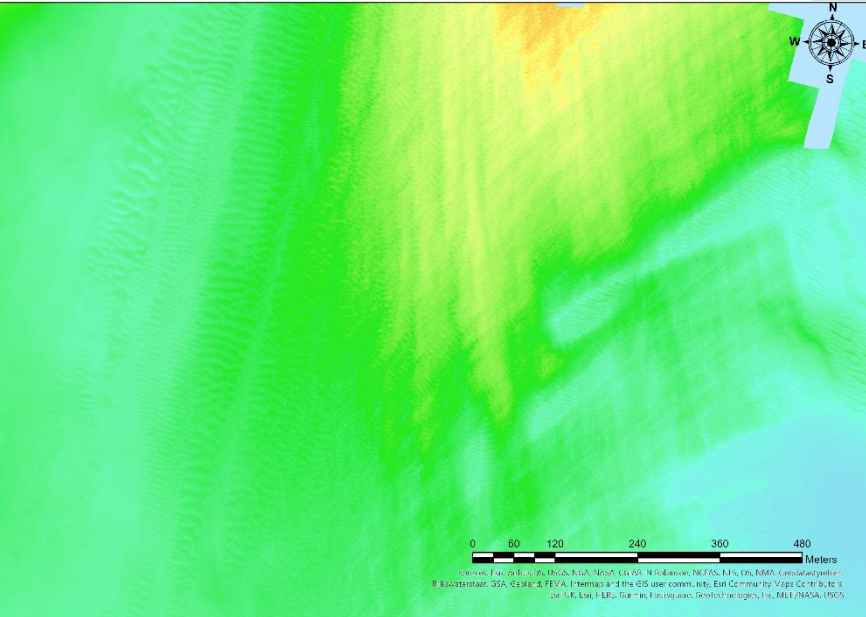


Seabed Features



Bathymetry and MBES Backscatter

MBES Bathymetry - Shaded relief to highlight features



MBES Bathymetry – Derived slope also highlights features



This figure shows a bathymetric map where the derived slope of the seabed is used to highlight features. The slope is color-coded, with steeper slopes appearing in warmer colors (red and orange) and shallower slopes in cooler colors (green and blue). The same diagonal linear feature seen in the first map is clearly visible here as a change in slope. It includes a compass rose and a scale bar from 0 to 480 meters.

MBES Backscatter – Highlight sediment changes



This figure is a backscatter map derived from MBES data, highlighting variations in sediment type. Different sediment textures and compositions are represented by varying shades of gray. The map shows distinct areas of different sediment types, with some areas appearing smoother and others more textured. The same diagonal linear feature is visible. It includes a compass rose and a scale bar from 0 to 480 meters.





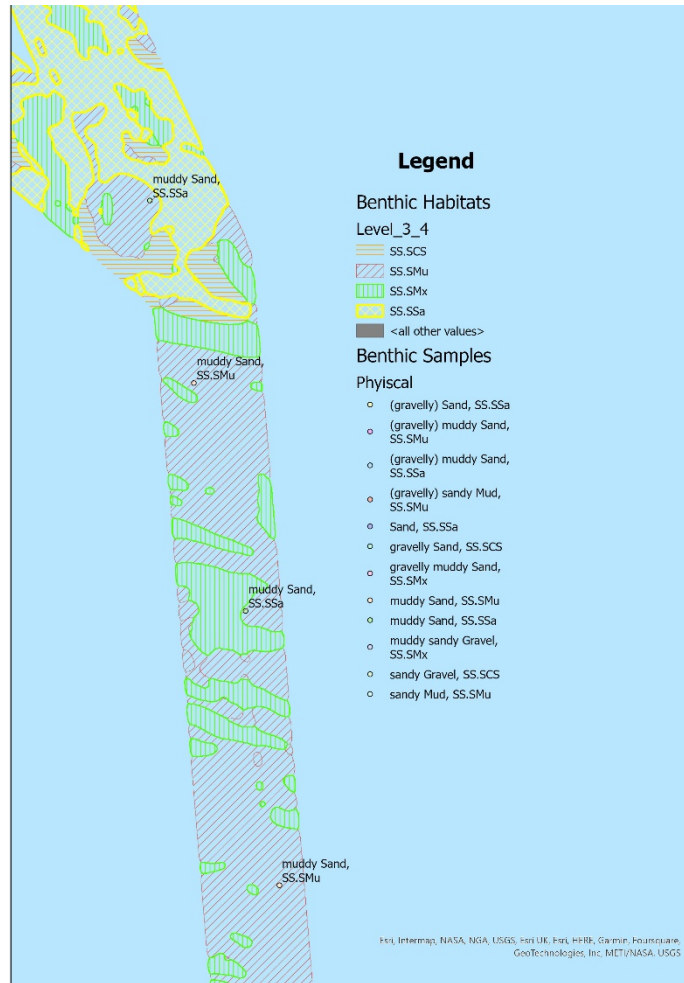
MBES/Backscatter

- Same dataset but a different view

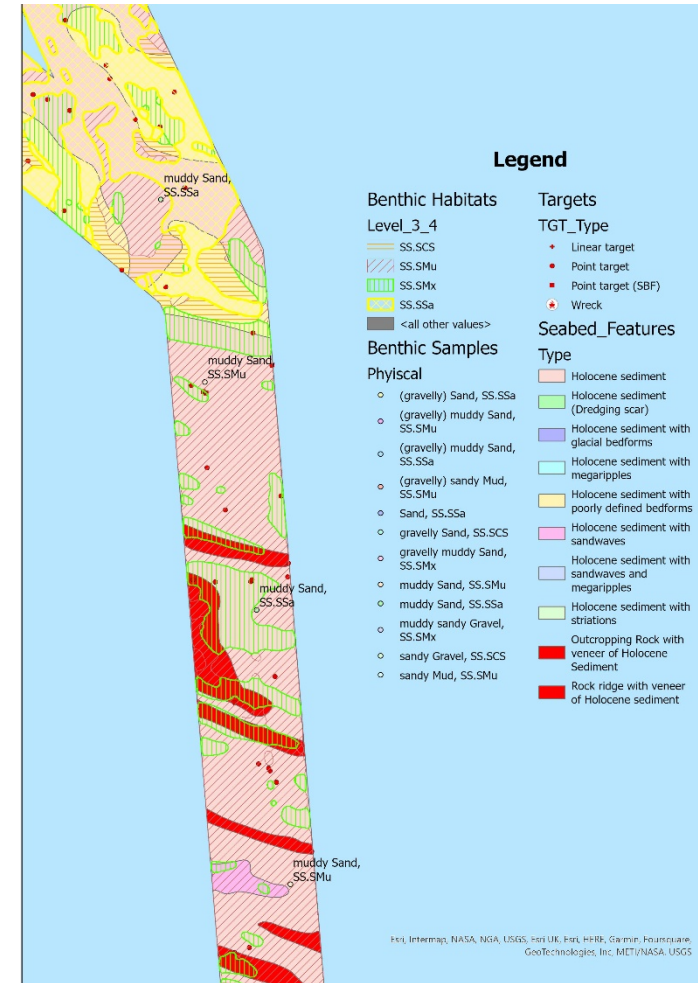
Seabed Features and Sediments - Geophysicist



Habitats - Environmentalist



Habitats - Environmentalist

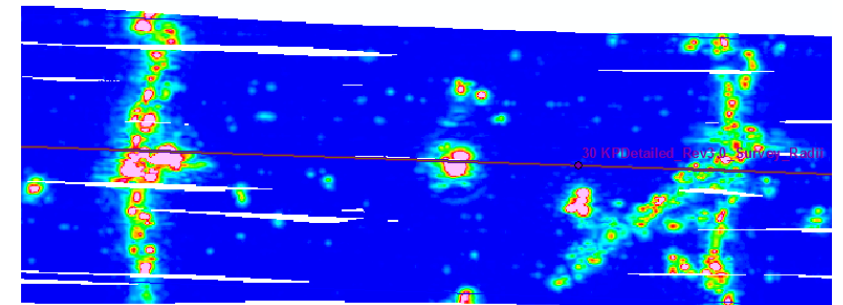


Magnetometer/Gradiometer:

- UXO Survey. Major part of any renewable project as ALARP certification required, also very close support of Archaeological assessment as gives the fine detail often missing from Scouting survey
- Identifying buried metallic debris, uncharted/buried cables, UXO
- EIA and archaeology/wrecks
- ALARP sign off for GI campaign, saving cost of a dedicated UXO survey.
- Other engineering considerations outside of UXO clearance such as abandoned cable/wire/chain identification

Cable route findings Included

- Aircraft Wreckage (potential war grave)
- Cannon (Potential AEZ)
- Confirmed 15th Century wreck (AEZ imposed and had to be routed around)
- Linear magnetic anomalies, found to be variously, steel wire, OOS cables and abandoned chain. All off which had to be cleared from the route or routed around.



Linear magnetic anomalies highlighted as part of UXO survey one was a vintage un-charted OOS cable, the other was a length of chain that took 3 days to excavate and clear

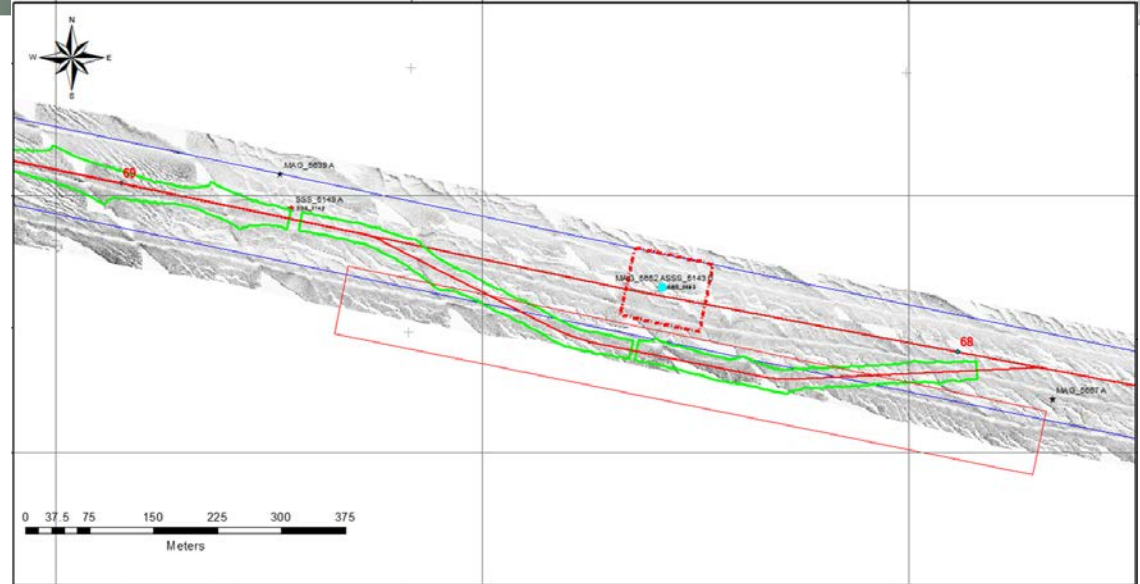
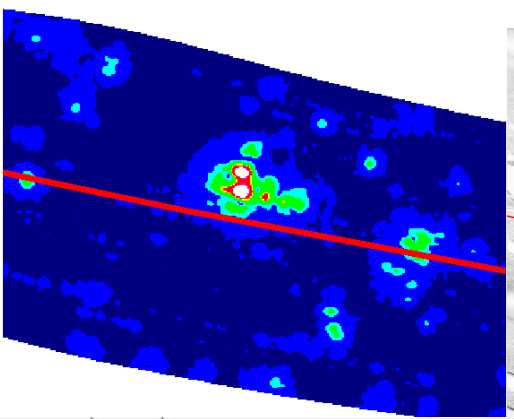
Geophysical Survey – Archaeology: UXO/Debris inspection and clearance

Relocation of the cannon

The Wessex Archaeology team have also helped Nemo Link design a bespoke display case for this interesting discovery to contribute to the cannon's long-term preservation. The cannon is now installed in its custom case, made by conservation experts Armour Systems and showcased in our office at 35 Homer Road, Solihull, UK.



We are excited to showcase this piece of history while continuing to play our part in accelerating to a clean energy future. Perhaps in 300 years a part of Nemo Link, our interconnector will also be proudly on display explaining how it enabled the sharing of renewable energy across Europe?

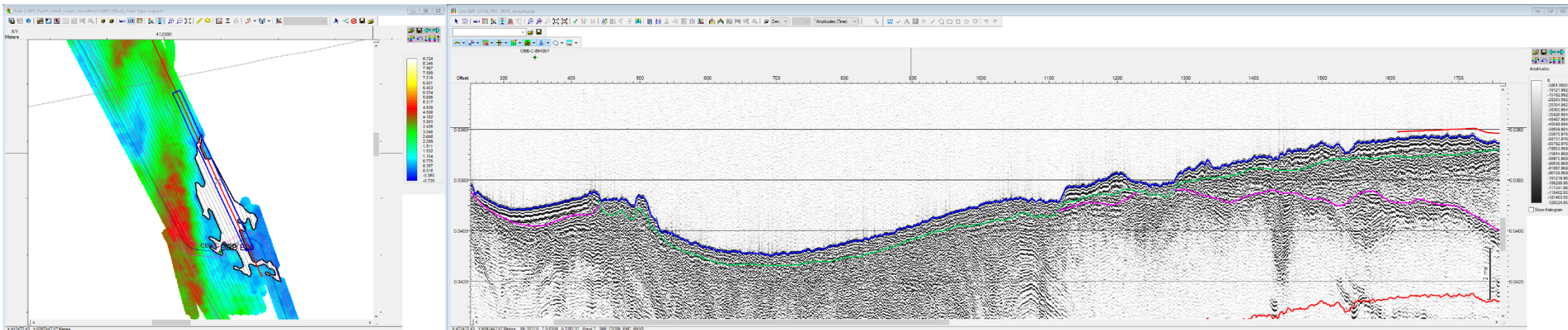


Subsequent investigation by the French Authorities (DRASSM) described "The carbon dating performed during the diagnostic indicates a date somewhere between the end of the Middle Ages and the beginning of the Early Modern Period (1470-1640 AD). This date, which is exceptional for finds in the eastern English Channel area and North Sea, makes this a discovery of major interest



Sub-bottom profiler data and interpretation

- Understanding the shallow soils with particular reference to cable burial conditions, CBRA and ITT for cable lay/installation
- EIA use for archeologically reasons such as ancient land surfaces
- Support of Ground Model for near surface sediments (5m BSB)
- Target locations for shallow CPT/Vibrocore campaign. (used for aging sediments on DB)
- Available for the Windfarm area and also along the proposed export cable route



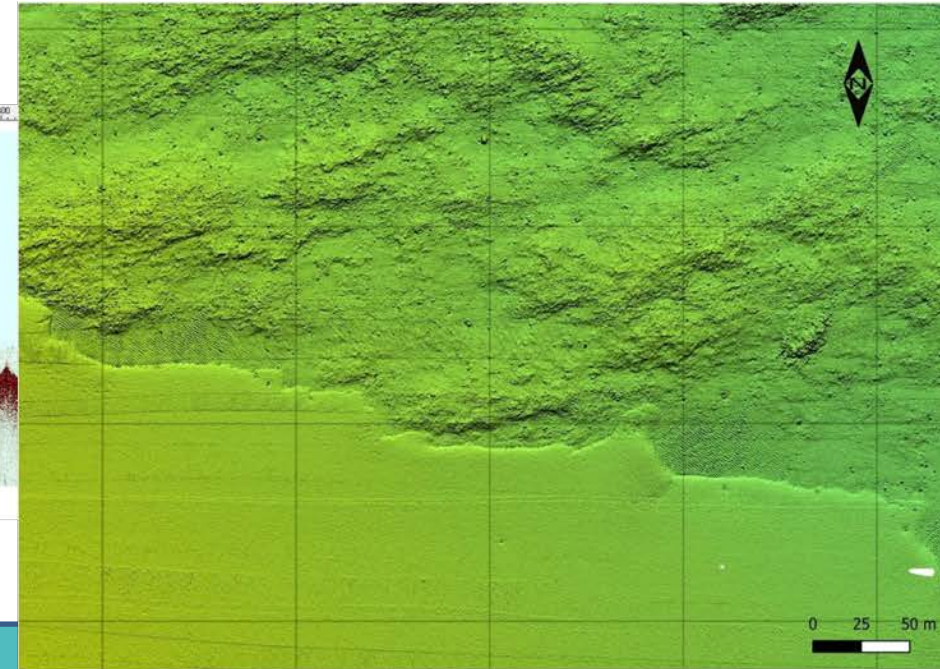
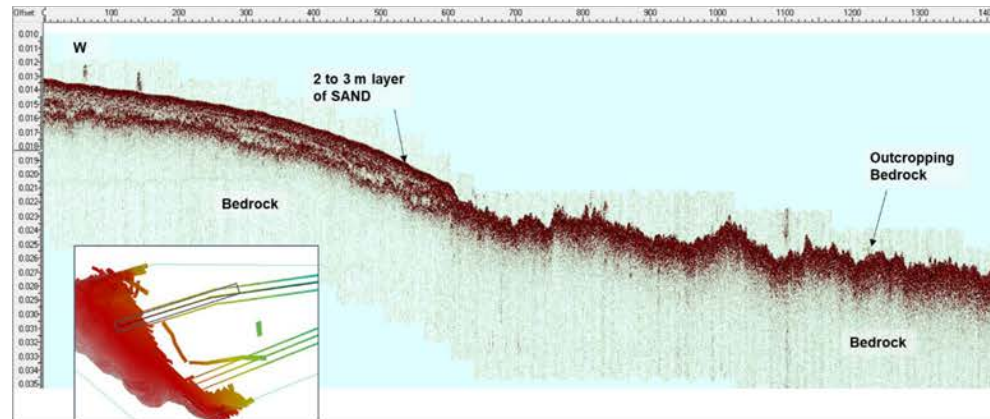
Recorded on a single channel

Typically utilised with pinger and boomer sources

Current industry favourite is Innomar SES2000, good for upto 10m BSB, ie, cables/pipelines, less so for foundations

Sub-bottom profiler data and interpretation

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Archaeological Written Schemes of Investigation for Offshore Windfarm Projects. The Crown Estate, July 2021

The Written Scheme of Investigation forms an umbrella document for all archaeological survey, investigation and assessment required for an- offshore wind farm project.

Historic Environment Guidance for the Offshore Renewable

Sector (Wessex Archaeology and COWRIE 2007), which provides guidance on survey, appraisal and monitoring of the historic environment during the development of OWF projects in the UK.

At the moment data requirements are Bathymetry supported by SSS and Magnetometer

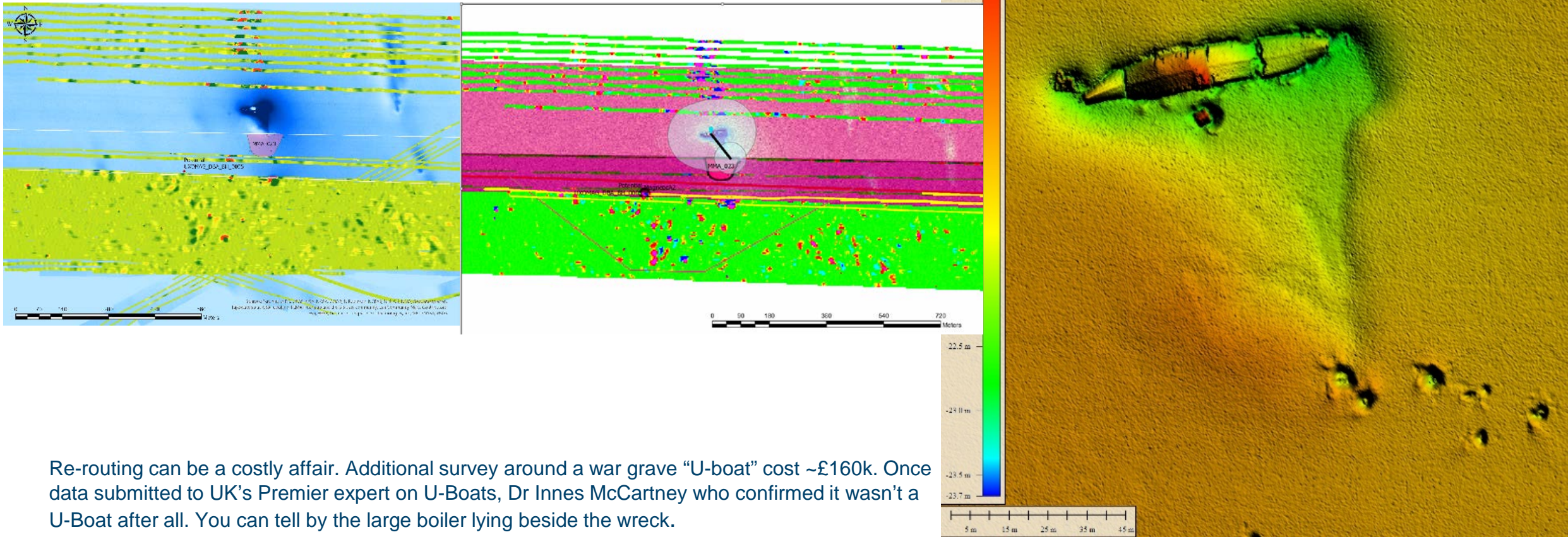
However this needs to be challenged. A cost effective solution to survey, particularly Export cable routes and Habitat surveys is the use of Unmanned survey vessels which until now did not tow gear so the compromise was no Magnetometer or SSS, and the use of MBES backscatter data for Seabed classification

- We therefore need to kick the requirement down the road for SSS and Magnetometer until Pre-construction UXO and engineering survey, Reasons:-
 1. Generally the scouting survey magnetometer is not flown optimally and is there only to pick up large objects (wrecks typically)
 2. SSS is set for habitat mapping and long range so is not capable of detecting small objects.
 3. MBES grids typically now deliver resolution of 1m for the water depths we work in, More than enough to detect a wreck
 4. The smaller and buried items that may be directly affected by our construction activities can be detected during the preconstruction survey with it's targeted cable corridors, WTG and OSP locations,
 5. USV's harness new technologies to deliver a more sustainable option, with a reduced HSE profile at a cost effective price. Availability is also key



Real and material changes so thorough investigation with a view to underlying timelines must be considered

- Additional inspection
- Additional Geophysical Survey (vessel availability is the real question)
- IA Layout changes
- Cable length fix points



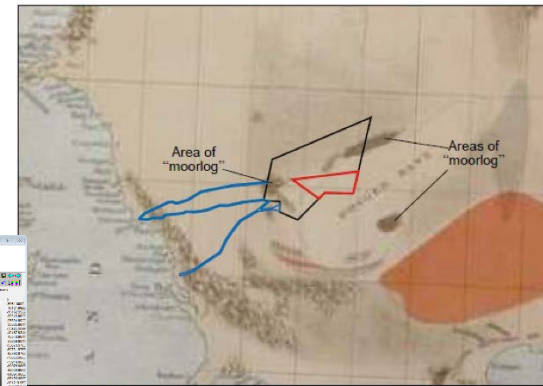
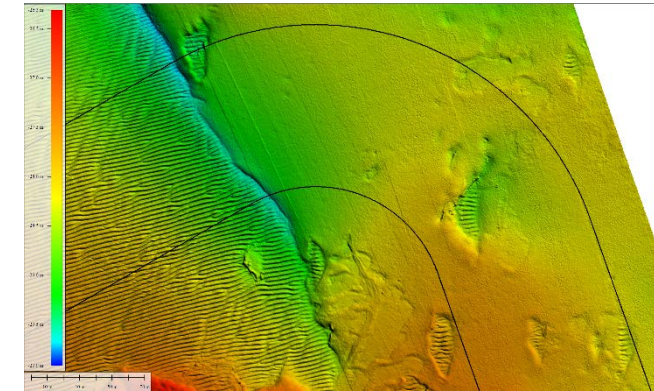
Re-routing can be a costly affair. Additional survey around a war grave “U-boat” cost ~£160k. Once data submitted to UK’s Premier expert on U-Boats, Dr Innes McCartney who confirmed it wasn’t a U-Boat after all. You can tell by the large boiler lying beside the wreck.



Geophysical Survey – Archaeology: Re-routing?

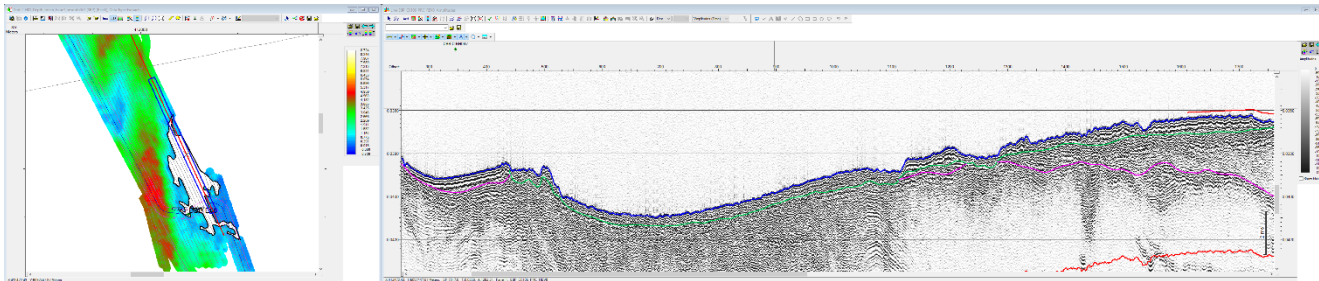
Real and material changes so through investigation with a view to underlying timelines must be considered

- Additional inspection
- Additional Geophysical Survey (vessel availability is the real question)
- IA Layout changes
- Cable length fix points



Olson 1883

An example of potential evidence of a drowned forest on “Doggerland” found right in the critical part of the corridor at the turning point of the IA cable into the J-tube





“In the land of the blind, the one-eyed man is king”
(Erasmus 1466-1536)

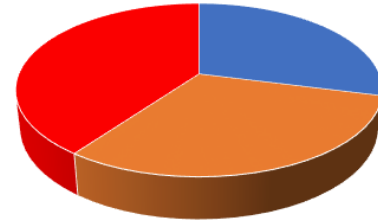
THANK YOU AND ANY QUESTIONS?

Roger.Birchall@sse.com





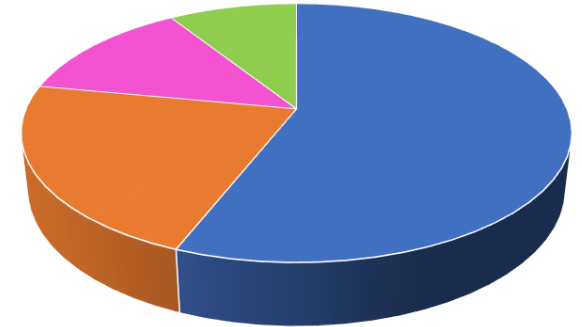
Ingredients



- Beef (29%),
- Pastry:- (Water, Wheat Flour, Salt, MSG)
- Hot Air

Source:- Wikipedia

Popularity



- Steak pies (All Steak, Steak & Kidney and Steak & Ale)
- Chicken and Mushroom
- Minced Beef & Onion
- Others (Meat & Potato; Balti; Cheese, Beer & Veal)

