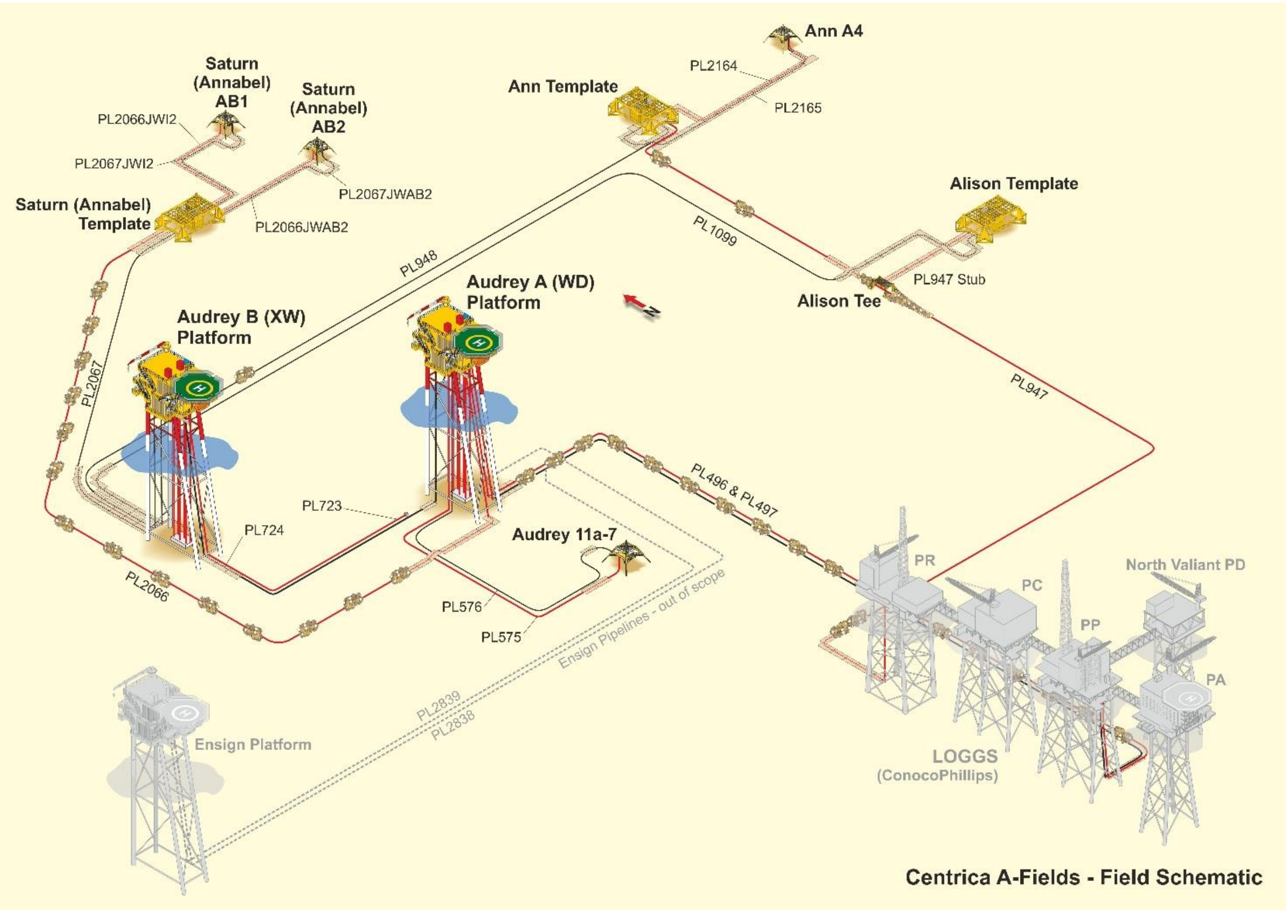
A-Fields Decommissioning
Ann and Alison Fields
Environmental Impact Assessment



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A1	09/08/2016	Early draft
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AMENDMENT RECORD

All amendments to this document shall be recorded on the Amendment Record sheet below. No changes to this document are to be made without approval from the document approver.

DATE	INCORPORATED BY	VERSION	SECTION	DESCRIPTION

DOCUMENT 'HOLD' REGISTER

All 'HOLDS' in this document are recorded here.

HOLD No.	DESCRIPTION	Initial Actionee

INFORMATION SHEET

Project name:	Ann and Alison Fields Decommissioning.
Type of project:	Decommissioning.
Undertaker name:	Centrica North Sea Limited.
Undertaker address:	Millstream, Maidenhead Road, Windsor SL4 5GD.
Centrica doc ref. no:	CEU-DCM-SNS0096-REP-0012
Section of UKCS:	Southern.
Distance from English Coast:	112km due east of Theddlethorpe Gas Terminal (TGT).
Water depth (LAT):	Ann (*c.*27.3-30.2m), Alison (*c.*25.0m).
Licence Blocks:	Ann (49/6a & 48/10a) - first production 1993. Alison (49/11d) - first production 1995.
Licences/owners:	Centrica North Sea Limited is the nominated operator. Centrica North Sea Limited. — 100%
Short description:	Production from the Ann and Alison Fields ceased on the 1st May 2016 and preparations are underway to decommission the subsea infrastructure. The Ann and Alison templates and the Alison tee protection structure will be completely removed. The Ann A4 spool piece (PL2164) and the Ann A4 umbilical jumper (PL2165), both of which are surface laid, will be completely removed. Sections of Ann export pipeline (PL947), the Ann umbilical (PL948) and the Alison umbilical (PL1099), that are not sufficiently buried will be removed including the first *c.*8km section of the Alison umbilical. The majority of the pipelines and umbilicals, including the remaining *c.*7km section of the Alison umbilical, will be decommissioned *in situ* under existing burial cover. Concrete mattresses, bitumen mattresses, grout bags and concrete blocks will be completely removed. Deposited rock and frond mattresses will be decommissioned *in situ*.
Anticipated date for commencement of works:	2017
Significant environmental impacts identified:	Assessment of activities identified no significant environmental effects.
EIA prepared by:	Genesis Oil and Gas Consultants Limited and Centrica.

ACRONYMS

ACRONYM	DESCRIPTION
"	Inch (25.4mm)
%	Percentage parts per hundred
µPa	Micro-Pascal
µg	Microgram
‰	Parts per thousand
AET	Apparent Effect Threshold
Al	Aluminium
ALARP	As low as reasonably practicable
As	Arsenic
Ba	Barium
BAC	Background Assessment Criteria
BAP	Biodiversity Action Plan
BC	Background Concentration
BEIS	Department for Business, Energy and Industrial Strategy
BMS	Business Management System
BRC	Background/Reference Concentrations
BT	British Telecom
c.	circa (when referring to a distance or length)
CA	Comparative Assessment
Cd	Cadmium
Centrica	Centrica North Sea Limited
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CoP	Cessation of Production
CP	(LOGGS) Compression Platform
Cr	Chromium
cSAC	Candidate Special Area of Conservation
CSV	Construction Support Vessel
dB	Decibel
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DOB	Depth of Burial
DP	Decommissioning Programme
DSV	Dive Support Vessel
E&P	Exploration and Production
EC	European Commission
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPR	Environmental Permitting Regulations
EPS	European Protected Species
ERL	Effects Range Low
EU	European Union
FCS	Favourable Conservation Status
FBE	Fusion Bonded Epoxy
Fe	Iron
FOCI	Features of Conservation Importance
GC	Gas Chromatography
GE	Gas export
GJ	Gigajoule
Ha	Hectare
HAB	Harmful Algal Bloom
HMW	High Molecular Weight
HSE	Health & Safety Executive
Hz	Hertz
ICES	International Council for the Exploration of the Sea
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-OES	Inductively Coupled Plasma Optical Emission Spectrometry
IoP	Institute of Petroleum
ISO	International Standardisation Organisation
JNCC	Joint Nature Conservation Committee
Kg	Kilogramme

ACRONYM	DESCRIPTION
kHz	KiloHertz
Km	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
Li	Lithium
LOGGS	Lincolnshire Offshore Gas Gathering System
m	Metre
m/s	Metres per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MBES	Multibeam Echo Sounder
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MEG	Mono Ethylene Glycol
MeOH	Methanol
Mg	Magnesium
mm	Millimetre
MMO	Marine Management Organisation
MP	Minister of Parliament
MPA	Marine Protected Area
MS	Marine Standard
N/A	Not Applicable
N_2O	Nitrous Oxide
NAO	North Atlantic Oscillation
NB	Nominal Bore
NERC	National Environmental Research Council
NFFO	National Federation of Fishermen’s Organisations
Ni	Nickel
NL	Netherlands
NNS	Northern North Sea
Nm	Nautical miles
NMPI	National Marine Plan Interactive
NORM	Naturally Occurring Radioactive Material
NOx	Oxides of Nitrogen

ACRONYM	DESCRIPTION
NPD	Naphthalenes, Phenanthrenes and Dibenzothiophenes
ºC	Degrees Celsius
OCR	Offshore Chemicals Regulations
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPPC	Oil Pollution Prevention Control
OSCAR	Oil Spill Contingency and Response model
OSPAR	OSlo and PARis Convention
OVI	Offshore Vulnerability Index
P&A	Plug and Abandon
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PP	(LOGGS) Production Platform
ppm	parts per million
PR	(LOGGS) Riser Platform
PSA	Particle Size Analysis
QHSE	Quality, Health, Safety, Environment
rms	Root mean square
ROV	Remotely Operated Vehicle
ROVSV	Remotely Operated Vehicle Support Vessel
RSA	Radioactive Substances Act
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SBES	Single Beam Echo Sounder
SCI	Site of Community Importance
Se	Selenium
SEI	Significant Environmental Impact
Sn	Tin
SNS	Southern North Sea
SO_2	Sulphur dioxide
SOPEP	Ship Oil Pollution Emergency Plan
SPA	Special Protection Area

ACRONYM	DESCRIPTION
SPL	Sound Pressure Level
Sr	Strontium
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
SUTU	Subsea Umbilical Termination Unit
TBT	Tributyltin
Te	Tonne
TGT	Theddlethorpe Gas Terminal
THC	Total Hydrocarbon Content
TUTU	Topside Umbilical Termination Unit
UCM	Unresolved Complex Mixture
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
US EPA	United States Environmental Protection Agency
V	Vanadium
VMS	Vessel Monitoring System
VOC	Volatile Organic Compound
WFD	Water Framework Directive
WHPS	Wellhead Protection Structure
WMP	Waste Management Plan
Zn	Zinc

GLOSSARY

TERM	DESCRIPTION
49/6a-A4z	Ann A4 production well.
A-Fields	The collective term for the Audrey, Ann, Alison and Annabel Fields.
Approach	Initial or final stretch of pipeline (or umbilical) as it leaves its point of origin or reaches its destination.
Exposure	A pipeline can be seen on the surface of the seabed but is not free-spanning.
FishSAFE	FishSAFE charts offshore surface and subsea oil and gas structures on the UK Continental Shelf (http://www.fishsafe.eu/en/home.aspx)
Free span	A free span occurs when a pipe segment is not supported by the seabed.
Jack-up	A self-contained combination drilling rig and floating barge, fitted with long support legs that can be raised or lowered independently of each other.
Kingfisher Information Service	Kingfisher work with all the offshore industries, including oil and gas, subsea cable, renewable energy and marine aggregates to provide fishermen with two updates a year of the most accurate and up-to-date positions regarding subsea structures and the seabed.
Metocean	A contraction of the words 'meteorology' and 'oceanology' referring to the wave, wind and current conditions that affect offshore operations.
Pipespool(s)	Short sections of pipe that are typically flanged and bolted together.
SAC	Special Areas of Conservation (SACs) are granted different statuses throughout the designation process. They progress from a pSAC (potential SAC), to a cSAC (candidate SAC), to a Site of Community Importance before finally being designated a full SAC. Throughout this document, where appropriate, the term SAC will be used to describe a site at any stage throughout the designation process.
Spool pieces	Short sections of pipe that are typically flanged and bolted together (aka. Pipespools).
Template	Structure protecting wellheads, Xmas trees and piping manifolds inside.
Umbilical	OGA, in their numbering scheme, has historically applied a PL (‘pipeline’) prefix to umbilicals. Various cables or fluid tubes attached to a subsea Xmas tree to provide hydraulic or electrical control, or to inject chemicals.
Xmas tree	An assembly of valves, spools, pressure gauges and chokes fitted to the wellhead of a completed well to control production.

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1. NON TECHNICAL SUMMARY

This summary outlines the findings of the Environmental Impact Assessment (EIA) conducted by Centrica North Sea Limited (Centrica) for the decommissioning of the Ann and Alison Fields' subsea infrastructure. The assessment concludes that the overall significance of the impacts from decommissioning is **low**.

The purpose of the report is to record and communicate the findings of the EIA, which assessed the potential for environmental impacts as a result of the decommissioning activities. The EIA report has been prepared to support the four Ann and Alison Decommissioning Programmes (which are contained in a single document).

The Comparative Assessment (CA) Reports and the EIA Report are supporting documents to the Decommissioning Programmes and will be submitted to the Department for Business, Energy and Industrial Strategy (BEIS) for consideration under the regulatory approval process. A number of studies and surveys were undertaken to support the decommissioning and have been considered during the EIA, as appropriate.

1.1 Background to the project

'A-Fields' is a collective term used to describe the Ann, Alison, Annabel and Audrey Fields. The A-Fields, situated on the United Kingdom Continental Shelf (UKCS), lie 112km due east of Theddlethorpe Gas Terminal (TGT), in the southern sector of the North Sea.

The A-Fields extend over UKCS quadrants 48 and 49. The nearest jurisdictional boundary to the A-Fields is the United Kingdom (UK)/Netherlands (NL) median line.

Gas was first discovered in 1966 with exploration well 49/06-1 at the Ann Field. Progressive development over the period 1988 (when first production from the Audrey Field was achieved) to 2005 (first production from the Annabel Field) has resulted in the present complex arrangement of subsea tie-backs centred on the infrastructure hub of the Audrey Field platforms. All production from the A-Fields has now ceased. The Ensign Field, which continues to produce over the Audrey A (WD) platform, is not part of the A-Fields development (nor A-Fields decommissioning), and does not form part of this assessment.

A-Fields area infrastructure comprises two platforms, Audrey A (WD) and Audrey B (XW), supporting 14 topsides production wells and four subsea tie-backs, Audrey 11a-7, Ann, Alison and Annabel supporting seven production wells. All production over the entire Field life was by natural depletion and routed to ConocoPhillips' Lincolnshire Offshore Gas Gathering System (LOGGS) platform complex which exported gas, after treatment, to the TGT on the Lincolnshire coast. Cessation of Production (CoP) from the A-Fields was achieved on 1st May 2016.

Three EIA reports have been undertaken to support the decommissioning of the A-Fields: The Ann A4 Installation Decommissioning EIA; the Ann and Alison Fields Decommissioning EIA and the Annabel and Audrey Fields Decommissioning EIA.

This EIA report supports four Decommissioning Programmes:

1. **The Ann Installation Decommissioning Programme covers:**
   - Complete removal of the Ann template;
   - Removal of the top of the Ann template piles; and
   - *In situ* decommissioning of the frond mattresses.
2. **The Ann Pipelines Decommissioning Programme covers:**
   - *In situ* decommissioning of the Ann 12" export pipeline (PL947) except for the following sections that will be completely removed:

- The surface laid Ann 12" spool pieces of PL947 at the Ann template, between the Alison tee and the Alison template and at LOGGS PR;
- The exposed spool pieces of PL947 at the Ann template and at LOGGS PR; and
- The surface laid Alison tee including the including the protection structure and concrete blocks.

- *In situ* decommissioning of the Ann 4" umbilical (PL948) except for the following sections that will be completely removed:
    - The exposed spool pieces of PL948 at the approaches to Audrey B (XW) and the Ann template.
- Complete removal of the surface laid Ann A4 6" pipeline spool piece (PL2164);
- Complete removal of the surface laid Ann A4 4" umbilical jumper (PL2165);
- Compete removal of concrete mattresses; and
- *In situ* decommissioning of deposited rock.

3. **The Alison Installation Decommissioning Programme covers:**
    - Complete removal of the Alison template;
    - Complete removal of the top of the Alison template piles; and
    - *In situ* decommissioning of the frond mattresses.
4. **The Alison Pipeline Decommissioning Programme covers:**
    - Complete removal of:
        - The first *c.*8km of the Alison 4" umbilical (PL1099); and
        - The exposed spool pieces of PL1099 at Audrey B (XW) and the Alison template.
    - *In situ* decommissioning of *c.*7km of the Alison 4" umbilical (PL1099);
    - Complete removal of concrete mattresses and bitumen mattresses; and
    - *In situ* decommissioning of deposited rock.

1.2 Decommissioning activities

In accordance with the Petroleum Act 1998, as operator of the Ann and Alison Fields, Centrica is applying to BEIS to obtain approval for decommissioning the facilities detailed in Section 2 of this document.

The Ann and Alison templates and the Alison tee protection structure will be completely removed and recovered to shore. The Ann A4 spool piece (PL2164) and the Ann A4 umbilical jumper (PL2165), both of which are surface laid, will be completely removed and recovered to shore.

Those sections of the Ann export pipeline (PL947), the Ann umbilical (PL948) and the Alison umbilical (PL1099), that are not sufficiently buried and those that make the transition from full burial to the seabed surface, those that rest on the seabed, and those for which the burial status is not stable will, where not covered in deposited rock, be removed and recovered to shore including the first *c* 8km section of the Alison umbilical.

The majority of the pipelines and umbilicals including the remaining *c.*7km section of the Alison umbilical will be decommissioned *in situ* under sufficient and stable existing burial cover. Concrete mattresses, bitumen mattresses, grout bags and concrete blocks will be completely removed and recovered to shore. Deposited rock and frond mattresses will be decommissioned *in situ*.

Upon their arrival onshore, all installations, sections of pipeline and umbilical, and associated protection and stabilisation features will be considered for reuse in accordance with the waste hierarchy. If reuse is not possible, following disassembly, their component materials will, where possible be recycled. Non-recyclable materials as a last resort, will be disposed of to landfill.

A summary of the methods that will be used to decommission the Ann and Alison Field infrastructure is shown in Table 1-1.

ITEM	METHOD
Ann template and piles; Alison template and piles.	Complete removal of each template. Piles will be cut to 0.6m below the seabed and removed.
Ann export pipeline (PL947) and Alison tee protection structure; Ann umbilical (PL948).	Removal of those sections that are not sufficiently buried, complete removal of the Alison tee protection structure; *in situ* decommissioning of those sections under sufficient and stable existing burial cover.
Alison umbilical (PL1099).	Removal of first *c.*8km section which is not sufficiently buried; *in situ* decommissioning of the final *c.*7km section under sufficient and stable existing burial cover.
Ann A4 spool piece (PL2164); Ann A4 umbilical jumper (PL2165).	Complete removal.
Deposited Rock.	Decommissioned *in situ.*
Concrete mattresses; concrete blocks; bitumen mattresses and grout bags.	Complete removal where both their access and their condition safely allows.
Frond mattresses.	Decommissioned *in situ.*

Table 1-1: Summary of decommissioning methods

1.3 Environmental baseline

The environmental sensitivities along the pipelines at the installations and the surrounding area that may be affected by the proposed decommissioning works are identified. This includes the area along the pipeline routes and the area around the Audrey B (XW) platform and the LOGGS platform complex.

Within the Ann template area water depths range from *c.*27.3m Lowest Astronomical Tide (LAT) to *c.*30.2m LAT. Within the Alison template area water depths ranged from *c.*25.0m to *c.*25.6m LAT. At Audrey B (XW), the natural seabed is almost flat, lying at a depth of approximately 24.5m LAT. Water depths at the LOGGS platform complex ranged from *c.*12.5m LAT in the south-east, to *c.*28.4m LAT in the north-east.

The maximum tidal current speed in the A-Fields area during mean spring tides is between 0.51m/s and 1.02m/s (1-2 knots). Surge and wind–driven currents, caused by changes in atmospheric conditions, can be much stronger and are generally more severe during winter. The annual mean significant wave height is between 1.51m and 1.80m.

The shallow water and active current regime in the southern North Sea (SNS) produces a high energy environment and as a consequence the A-Fields seabed is characterised by sandbanks, sandwaves and megaripples. The majority of sandbanks in the North Norfolk area of the SNS are considered to be large-scale mobile seabed forms. They can have a wavelength between 1 and 10km, and they can achieve a height of several tens of metres.

Sandwaves are a periodic bottom waviness generated by tidal currents in shallow tidal seas. Typical wavelengths range from 100 to 800m and they can be up to between 1 and 5m high. They are not static bedforms and migration speeds can be up to tens of metres per year. Megaripples are large, ripple-like features having wavelengths greater than 1m or a ripple height greater than 10cm.

In general, away from anthropogenic structures, seabed sediments were found to consist predominantly of fine to medium sand, developed into megaripples, with scattered shell fragments and occasional gravel (including pebbles) and cobbles. *Sabellaria spinulosa* tube aggregations were observed at Ann, Alison and Audrey B (XW) but none of these aggregations were found to represent an Annex I reef structure. No Annex I habitats were found in the vicinity of Ann and Alison however the Annex I habitat 'Sandbanks which are slightly covered by sea water all of the time' was found at LOGGS.

The SNS phytoplankton community is dominated by the dinoflagellates *Ceratium fusus*, *Ceratium furca*, and *Ceratium tripos*. The population of diatoms is also significant and includes *Chaetoceros*. In the SNS, the population of zooplankton is mainly composed of small copepods, predominantly *Parapsuedocalanus* sp, with echinoderm larvae being the second most abundant.

The benthic faunal community was generally homogenous across the A-Fields area being dominated by a small number of taxa and showing low diversity. Exceptions were found in areas of deposited rock, for example at the Audrey B (XW) platform. Visible fauna was sparse and included Annelida (Polychaeta), Arthropoda (*Corystes cassivelaunus, Cancer pagurus*), Bryozoa (*Flustra foliacea*), Cnidaria (*Alyconium digitatum*, Hydrozoa), Echinodermata (*Asterias rubens*, *Echinocardium* sp.), Chordata (Ascidiacea, *Gadus morhua*, *Agones cataphractus*, Callionymidae, *Limanda limanda*) and Porifera (Demospongiae).

A number of commercially important fish species are known to spawn and have nursery grounds in the area. These include mackerel, herring, cod, whiting, plaice, lemon sole, sandeel, *Nephrops* and sprat.

Seabird vulnerability to surface pollution in the vicinity of Ann, Alison, Audrey B (XW) and the LOGGS platform complex is variable throughout the year ranging from very high in March and November, to low in June and being moderate to high throughout the rest of the year.

Harbour porpoise and white-beaked dolphin have been sighted in the vicinity of the A-Fields. The mean density of seals expected in the vicinity of the A-Fields is low for both harbour seals (0-1 per 25km^2) and grey seals (5-10 per 25km^2).

All of the Ann and Alison infrastructure except the Ann template and the ends of PL947 and PL948 at Ann lie within the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC) and the SNS candidate SAC (cSAC) for harbour porpoise. The nearest Special Protection Area (SPA) site is the North Norfolk Coast SPA, which is over 90km south-west of the A-Fields. The nearest Marine Conservation Zone (MCZ) to the A-Fields is the Markham's Triangle recommended MCZ which is approximately 38km north-east of the Ann infrastructure.

1.4 Impact assessment

The EIA report process presented in this document considers the impact of the planned activities associated with the decommissioning of the Ann and Alison Fields. The impact was determined by considering the duration/frequency of each of the planned activities and the extent of the environmental risk to determine the overall level of impact as either low, medium or high.

Accidental events (unplanned events) were also considered in terms of the likelihood of such an event occurring and the impact on the environment. This provides a risk of low, medium or high.

1.4.1 Energy use and atmospheric emissions

The principal energy use and generation of emissions to air will arise from fuel combustion for propulsion and power generation by the vessels required for the decommissioning activities. These emissions will include components which have the potential to contribute to global warming, acid rainfall, dry deposition of particulates and photochemical pollution or cause impacts on local air quality. It is expected that impacts will be of low significance as they will be short term.

The energy usage from the decommissioning of the Ann and Alison Facilities is estimated to be 95,337GJ direct (vessel use) and 186,257GJ indirect requirements (manufacture of new materials to replace those decommissioned *in situ*).

Emissions to atmosphere from the decommissioning activities are unlikely to significantly contribute to greenhouse gas emissions or global warming impacts; total direct carbon dioxide (CO_2) emissions generated by the proposed decommissioning are 7,078Te. In relation to the total CO_2 produced from domestic shipping the direct CO_2 emissions from the decommissioning of the Ann and Alison facilities is *c.*0.07%.

Standard mitigation measures to optimise energy usage by vessels will include operational practices and power management systems for engines, generators and any other combustion plant and planned preventative maintenance systems for all equipment for peak operational efficiency.

In summary, due to the localised and relatively short durations of activities and with the identified control and mitigation measures in place, the overall significance of the impact of energy use and associated atmospheric emissions arising from decommissioning the Ann and Alison facilities is considered to be **low**.

1.4.2 Underwater sound

The principal sources of underwater sound associated with the Ann and Alison decommissioning are associated with the use of vessels, surveying equipment and cutting tools.

The vessels programme (comprising a total of approximately 158 individual vessel days spread over a multi-year period) is of relatively short duration and represents only small increment to existing vessel traffic in the area. Cutting tools will only require to be used intermittently over this period and at point locations.

Although there are marine mammals and fish in the area around the Ann and Alison facilities, the level of sound that will be generated is not expected to cause physiological harm or substantive behavioural interference to either fish or mammals known to inhabit the area. The greatest potential disturbance is as a result of vessels using dynamic positioning. However, given that the Ann and Alison facilities are in an area of established oil and gas activity with high shipping activity, marine mammals are likely to be accustomed to similarly sound levels and this reduces the level of impact.

Standard measures that will be applied to control sound include planned maintenance of equipment and optimisation of the work programme to minimise vessel use.

In summary, due to the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall significance of the impact of underwater sound generated during decommissioning of the Ann and Alison facilities is considered to be **low**.

1.4.3 Seabed disturbance

The principal sources of seabed disturbance associated with the Ann and Alison decommissioning concern the over-trawl assessment at the end of decommissioning in addition to the removal of spool end sections of pipeline, mattresses and grout bags and cutting operations around the Ann and Alison Templates and Alison tee. The base case for the over-trawl assessment is that it will be conducted in the 500m safety zones and over a 200m corridor along the pipeline lengths. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment.

Standard measures to control disturbance include operational planning and equipment selection.

The species and habitats observed in the vicinity of Ann and Alison are relatively widespread throughout the SNS and the area anticipated to be impacted represents a very small percentage of the available habitat. Furthermore, the environment in the vicinity of the Ann and Alison Fields is dynamic due to the shallow water depth therefore all disturbed sediments/habitats are expected to recover rapidly and species recruitment would be expected from adjacent undisturbed areas.

In summary, due to the localised and relatively short duration of the decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the impact of seabed disturbance as a result of the decommissioning of the Ann and Alison facilities is considered to be **low**.

1.4.4 Discharges and releases to sea

The principal sources of discharges and releases to sea associated with the Ann and Alison decommissioning are associated with vessels and the breaking of containment/lifting of sections of the pipelines.

The vessel use is of relatively short duration. Operational discharges from vessels during this time are expected to be rapidly diluted and dispersed under prevailing hydrodynamic conditions.

The production fluids will have been removed from the pipeline. The hydraulic fluid that remains within the umbilical and any remaining chemicals are expected to be discharged to the marine environment.

The seabed and the water column are the primary receptors. Control measures include permitting of chemical discharges and strict vessel operating procedures. All of these impacts will be localised and short term given the highly dynamic environment around the Ann and Alison facilities. Overall impact of discharges and releases to sea as a result of decommissioning the Ann and Alison facilities is considered to be **low**.

1.4.5 Large hydrocarbon releases and oil spill response

Whilst there is the potential for a major diesel release during the Ann and Alison decommissioning activities, it is considered unlikely with a rare combination of factors being required for an event to occur. Taking into account the types of sediment and receptors in the area and the mitigations and controls that will be put in place, the overall significance of the impact has been assessed as moderate.

The worst case scenario of an accidental hydrocarbon release would result from a complete loss of fuel inventory from on-site vessels or collision. In the unlikely event of such an incident the vessels will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place. Centrica will minimise the likelihood of such an event occurring by awarding the contract only to vessels that meet Centrica's Marine Standard which ensures that relevant regulatory requirements are implemented. Given that the diesel readily evaporates, would disperse and dilute quickly and is unlikely to impact on any coastline, the environmental risk of such an incident is considered to be **low**.

1.4.6 Waste

All wastes returned to shore will be handled and disposed of in accordance with legislation and the waste hierarchy. All regulatory and company procedures for segregation, transport and disposal, as set out in the project Waste Management Plan (WMP), will be strictly adhered to and only fully permitted facilities will be used for recycling or disposal. The resulting impacts from resource use and waste management are therefore expected to be **low**.

1.4.7 Socio-economic impacts

The primary socio-economic activities that could be impacted are commercial activities, such as oil and gas operations, shipping and fishing.

Access to the area for fishing will be restricted whilst decommissioning is undertaken and this will lead to short term impacts on the fishing industry; however, the impact is considered to be low due to the short duration of operations, the relatively small scale of the activities and the existing 500m safety zones.

A beneficial socio-economic impact is the short-term continuation of jobs in onshore yards and on vessels. It is expected that the overall impact will be low since the local socio-economic system is already altered owing to the presence of the oil industry itself.

A post decommissioning over-trawl assessment will verify that there are no remaining obstructions likely to snag fishing trawls.

Overall, significance of the socio-economic impacts as a result of the Ann and Alison facilities decommissioning is expected to be **low**, with the exception of the fishing sector, where there is potential for a positive impact when 500m safety zones are removed.

1.4.8 Designated conservation sites impacts

The Alison facilities and the majority of the Ann and Alison pipelines lie within the North Norfolk Sandbanks and Saturn Reef SAC and the SNS cSAC for harbour porpoise. The impacts associated with activities that could impact the sites (e.g. cutting, jetting, anchoring) are localised. Sound associated with vessels and the activities could impact the area, however given the existing level of shipping in the area the significance of the impact is assessed as **low**.

The principal sources of seabed disturbance associated with the Ann and Alison decommissioning concern the removal of spool pipeline ends, mattresses and grout bags, cutting operations around the Ann and Alison Templates and Alison tee and the over-trawl assessment which will be conducted in the 500m safety zones and over a 200m corridor along the pipeline lengths. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment. All disturbed sediments are expected to recover rapidly though recruitment from adjacent undisturbed areas therefore the overall significance of the impact of seabed disturbance is considered to be **low**.

A large hydrocarbon release could impact the SAC and cSAC however modelling has shown the risk is relatively low and with control and mitigation measures in place the significance has also been assessed as **low**.

Given that the impacts on North Norfolk Sandbanks and Saturn Reef SAC and SNS cSAC for harbour porpoise have been assessed as **low**, the impact on the Markham's Triangle recommended MCZ which is approximately 38km north-east of the Ann infrastructure has also been assessed as **low**.

1.4.9 Summary of control and mitigation measures

Centrica will follow routine environmental management activities, for example contractor vessel audits and legal requirements to report discharges and emissions, such that the environmental impact of the decommissioning activities will be minimised. Following the EIA process, it can be concluded that activities associated with the decommissioning of the Ann and Alison facilities are unlikely to significantly impact the environment or other sea users, for example shipping traffic and fishing, provided that the proposed mitigation and control measures are put in place.

A summary of proposed control and mitigation measures is shown in Table 1-2.

MITIGATION AND CONTROL MEASURES
General
Lessons learnt from previous decommissioning scopes will be reviewed and implemented.
Energy use and atmospheric emissions
Prior to mobilisation, vessels will be audited to ensure that appropriate planned and preventative maintenance has been carried out and condition of both generators and engine efficiency is in line with manufacturers specifications.
Fuel use for mobilised vessels will be monitored and comply with International Convention for the prevention of Pollution from Ships (MARPOL) requirements, in particular with regard to low sulphur content.
Decommissioning activities will be planned to minimise vessel use (e.g. optimisation of vessel work programmes).
Fuel consumption will be minimised by operational practices and power management systems for engines, generators and any other combustion plant (as required under the contract with the subcontractor).
Planned and preventative maintenance systems will be required for all vessels to ensure that all equipment is maintained at peak operating efficiency for minimum overall fuel usage (as required under the contract with the subcontractor).
Underwater sound
Machinery, tools and equipment will be in good working order and well-maintained (as will be required under the contract with the subcontractor).
The vessels work programme will be carefully planned to optimise use.
The number of required cuts will be minimised consistent with operational (including safety) considerations.
Seabed disturbance
All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised.
The careful planning, selection of equipment, and management and implementation of activities.
A debris survey will be undertaken at the completion of the decommissioning activities. Any debris identified as resulting from decommissioning activities will be recovered from the seabed where possible.
Discharges and releases to sea
Procedures and systems for the minimisation of waste and effluent generation (maintained as required under the contract with the subcontractor).
Procedures and systems for the management of ballast and bilge water (maintained as required

MITIGATION AND CONTROL MEASURES
under the contract with the subcontractor).
Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials.
Vessels will be selected and audited to ensure that effective operational systems and onboard control measures are in place.
Vessels' work programmes will be optimised to minimise use.
Large hydrocarbon releases and oil spill response
Comprehensive management and operational controls plan developed to minimise the likelihood of large hydrocarbon releases and to mitigate their impacts should they occur. These include the Marine Standard and the A-Fields Oil Pollution Emergency Plan (OPEP).
All vessels undertaking decommissioning activities will have an approved SOPEP.
Waste
A WMP will be in place.
If hazardous waste is produced it will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling.
Any Naturally Occurring Radioactive Material (NORM) contaminated equipment will be handled, transported, stored, maintained or disposed of in a controlled manner.
Socio-economic impacts
The timing and location of decommissioning activities, and the location of infrastructure decommissioned *in situ*, will be advertised via the Kingfisher bulletin and via Notices to Mariners.
Decommissioning and post-decommissioning seabed assessments, surveys and monitoring.
The vessels' work programme will be optimised.

Table 1-2: Summary of proposed control and mitigation measures

1.5 Conclusion

Overall, the EIA concludes that the potential for significant impacts as a consequence of decommissioning the Ann and Alison facilities is **low**. Generally, the impacts identified were assessed as localised and short term with low potential for long term or transboundary and cumulative impacts.

2. INTRODUCTION

This Environmental Impact Assessment (EIA) report is a supporting document to the Decommissioning Programmes required by the Department for Business, Energy and Industrial Strategy (BEIS), formerly the Department of Energy and Climate Change (DECC), for the decommissioning of the Ann and Alison Fields. The purpose of the EIA is to assess the environmental impacts and potential impacts (risks) associated with decommissioning and to identify control and mitigation measures to reduce the level of these impacts to 'as low as reasonably practicable'.

This EIA report supports four Decommissioning Programmes (which are contained within a single document) (Centrica, 2017a)

- Decommissioning of the Ann installation;
- Decommissioning of the Ann pipelines;
- Decommissioning of the Alison installation; and
- Decommissioning of the Alison pipeline.

2.1 Project background and purpose

'A-Fields' is a collective term used to describe the Ann, Alison, Annabel and Audrey Fields. The A-Fields, situated on the United Kingdom Continental Shelf (UKCS), lie 112km due east of Theddlethorpe Gas Terminal (TGT), in the southern North Sea (SNS) (Figure 2-1).

The A-Fields extend over UKCS quadrants 48 and 49 with the Audrey B (XW) platform located in block 48/15a, Audrey A (WD) platform located in block 49/11a, the Ann subsea infrastructure located in block 49/6a, the Alison subsea infrastructure located in block 49/11a, and the Annabel subsea infrastructure located in block 48/10a (Figure 2-1). The nearest jurisdictional boundary to the A-Fields is the United Kingdom (UK)/Netherlands (NL) median line with the Audrey, Ann, Alison and Annabel Fields located 66km, 57km, 55km and 67km respectively to the west.

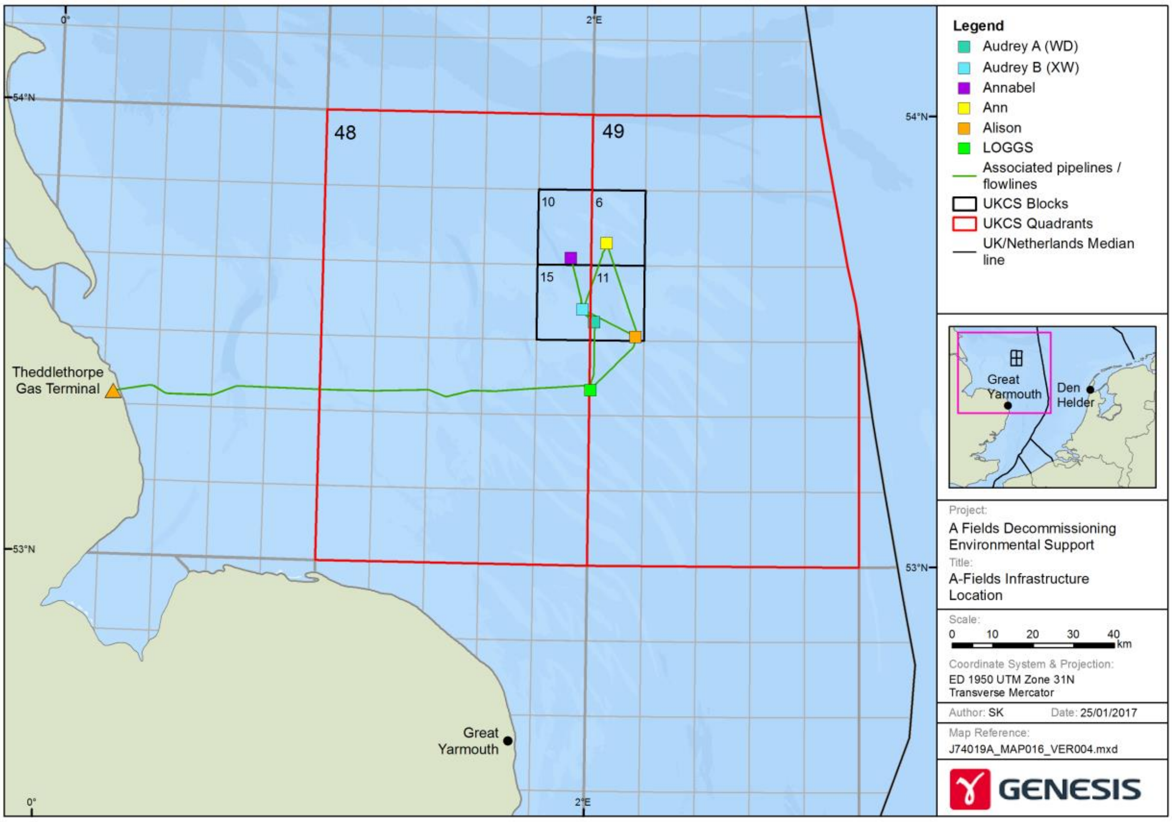

Figure 2-1: Location of the A-Fields in the SNS

Gas was first discovered in 1966 with exploration well 49/06-1 at the Ann Field. Progressive development over the period 1988 (when first production from the Audrey Field was achieved) to 2005 (first production from the Annabel Field) has resulted in the present complex arrangement of subsea tie-backs centred on the infrastructure hub of the Audrey Field platforms. All production from the A-Fields has now ceased. The Ensign Field, which continues to produce over the Audrey A (WD) platform, is not part of the A-Fields development (nor A-Fields decommissioning), and does not form part of this assessment.

A-Fields area infrastructure comprises two platforms, Audrey A (WD) and Audrey B (XW) supporting 14 topsides production wells and four subsea tie-backs, Audrey 11a-7, Ann, Alison and Annabel supporting seven production wells (Figure 2-2). All production over the entire Field life was by natural depletion and routed to ConocoPhillips' Lincolnshire Offshore Gas Gathering System (LOGGS) which exported gas, after treatment, to the TGT on the Lincolnshire coast (Figure 2-1). Cessation of Production (CoP) from the A-Fields was achieved on 1st May 2016.

Three EIAs have been undertaken to support the decommissioning of the A-Fields: The Ann A4 Installation Decommissioning EIA (Centrica, 2016a); the Ann and Alison Fields Decommissioning EIA and the Annabel and Audrey Fields Decommissioning EIA (Centrica 2017c).

The subsea infrastructure included in the Ann and Alison Fields decommissioning scope are discussed in Section 3.

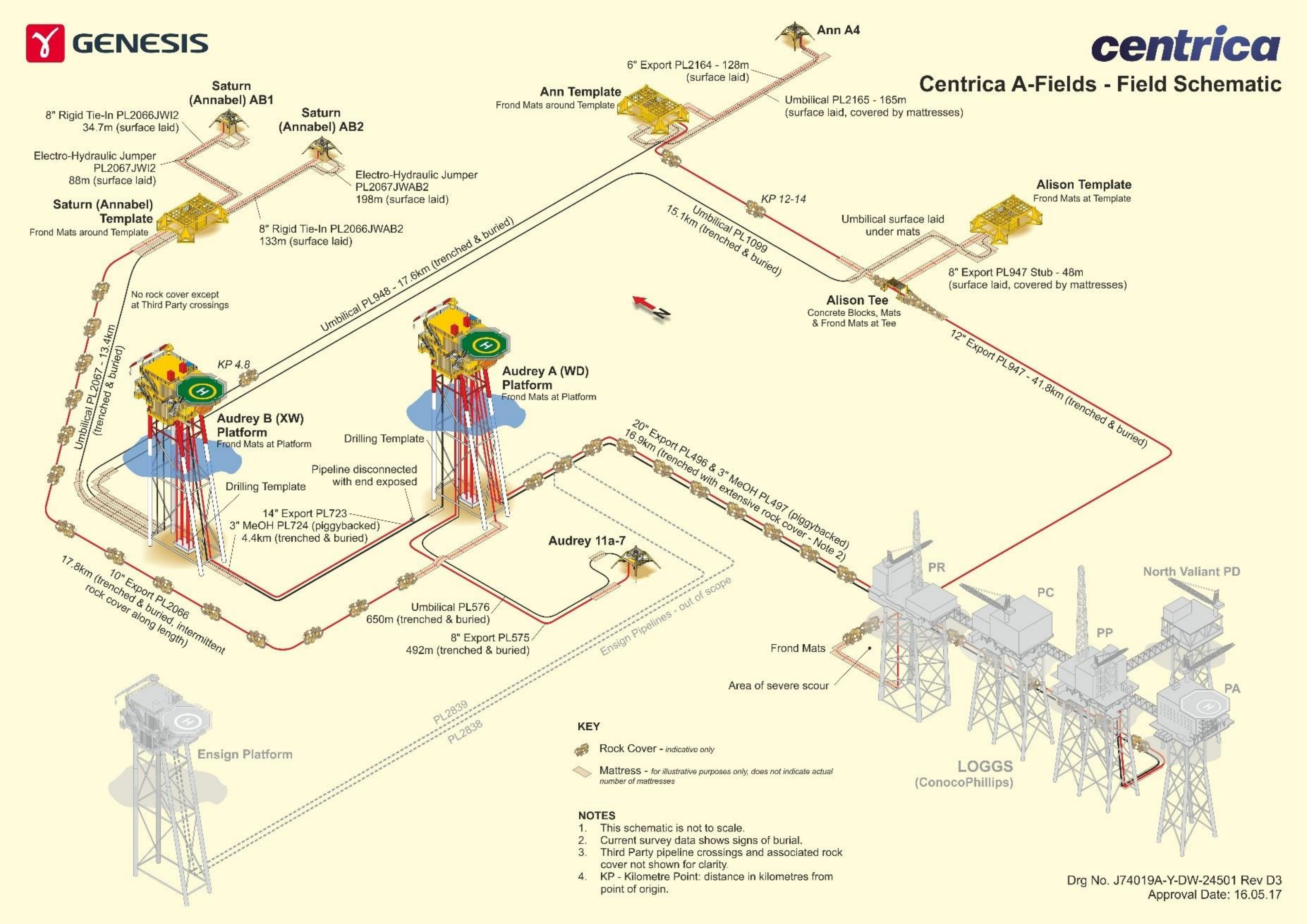

Figure 2-2: A-Fields area infrastructure

2.2 Background to the Decommissioning Programmes

Three wells (two at Ann and one at Alison) will be abandoned in compliance with Health and Safety Executive (HSE) regulations (HSE, 1996) and with Oil and Gas UK guidelines (OGUK, 2015) and preparations made to decommission the associated subsea infrastructure in accordance with the requirements of BEIS Guidance Notes (DECC, 2011) (see Section 3.2). These activities are considered to be preparatory work and do not fall within the scope of the Decommissioning Programmes. Environmental impacts, including chemical use and discharges associated with well abandonment will be assessed within the well abandonment submission. The abandonment of a third Ann well, Ann A4z, is detailed in the Ann A4 Installation Decommissioning Programme (Centrica, 2016a) and supporting EIA (Centrica, 2016b).

2.3 Regulatory context

The relevant UK and international legislation is outlined below.

The UK international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) Convention (OSPAR, 1992). The OSPAR Decision 98/3 (OSPAR, 1998) sets out the UK's international obligations on the decommissioning of offshore installations. However, pipelines and umbilicals are not included within the Decision.

The decommissioning of offshore oil and gas infrastructure (including pipelines) in the UKCS is principally governed by the Petroleum Act 1998 (as amended by the Energy Act 2008) (Petroleum Act, 1998). The Petroleum Act sets out the requirements for a formal Decommissioning Programme, which must be approved by BEIS before the owners of an offshore installation or pipeline may proceed with decommissioning.

The BEIS Guidance Notes (DECC, 2011) on the Decommissioning of Offshore Oil and Gas Installations and Pipelines advise that any Decommissioning Programme must be supported by an EIA. The Guidance goes on to state that the EIA should include an assessment of the following:

- All potential impacts on the marine environment including exposure of biota to contaminants; other biological impacts arising from physical effects; conflicts with the conservation of species and their habitats;
- All potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and impacts on the soil;
- Consumption of natural resources and energy associated with reuse and recycling;
- Interference with other legitimate uses of the sea and consequential impacts on the physical environment; and
- Potential impacts on amenities, the activities of communities and on future uses of the environment.

The Marine and Coastal Access Act 2009 (MCAA) (MCAA, 2009) states that an EIA is required for all licence applications relating to decommissioning activities. The MCAA licence application will be made at the time of decommissioning.

Other relevant legislation includes:

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001;
- The Offshore Chemical Regulations 2002;

- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (requiring an Oil Pollution Emergency Plan (OPEP));
- The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999;
- Environmental Protection Act 1990;
- Special Waste Regulations 1996;
- Hazardous Waste (England and Wales) Regulations 2005;
- Transfrontier Shipment of Waste Regulations 2007; and
- Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008.

As part of the requirements of the International Standardisation Organisation (ISO) 14001 certified Environmental Management System (EMS), Centrica has identified all applicable legal and other requirements associated with the decommissioning activities.

2.4 Stakeholder consultation

Stakeholder consultation is an important part of the decommissioning process. Informal responses received to date from stakeholders that are relevant to the EIA are shown in Table 2-1 and will be addressed as the project progresses.

STAKEHOLDER	COMMENT	RESPONSE
STATUTORY CONSULTATIONS		
National Federation of Fishermen's Organisations (NFFO)	Centrica discussed the decommissioning proposals with NFFO via teleconference 14 March 2017. Centrica also discussed the type of fishing and were advised that the predominant type of fishing in the area is demersal fishing using rock hoppers and beam trawling.	The decommissioning proposals were acceptable. One of the more major concerns is that while 'rock hoppers' can quite easily overcome obstacles such as surface laid concrete mattresses, should these be left in place, these can quite easily be caught up in beam trawlers' and be dragged for several miles without being noticed, removing the protection from infrastructure decommissioned *in situ* and therefore increasing the risk of future snagging.
Joint Nature Conservation Committee (JNCC) and BEIS	Centrica discussed the decommissioning proposals with JNCC and BEIS at a meeting on 3rd May 2017. The following areas were discussed: • Pipelines; • Mattresses; • Rock dumping and anchoring; • Over trawl surveys; • Cumulative impacts; • Stabilisation features; • Habitat assessment; • Noise levels; and • Timelines.	The decommissioning proposals were acceptable. The following items were raised as issues to be taken into consideration within the EIA: • Cumulative effects are of particular interest to JNCC and it was suggested to take into account the marine aggregate industry within the EIA. • JNCC stated that rock dumping is a concern, however none is planned for the Ann and Alison decommissioning. • JNCC welcomed the inclusion of the over-trawl assessment within the seabed disturbance calculation.
ConocoPhillips	Centrica are in constant dialogue with ConcocoPhillips in terms of examining collaboration opportunities in the Alison well abandonments as well as decommissioning operations in the LOGGS complex area.	

Table 2-1: Summary of stakeholder comments

2.4.1 Future consultation

The formal consultation will begin with the submission of the draft Decommissioning Programmes, supported by this EIA report, to BEIS. The consultation process at this stage will include the use of the Centrica internet website to make these documents publicly available.

2.5 Business Management System including environmental management

The management of the decommissioning activities is addressed within the Centrica Exploration & Production (E&P) EMS which is fully certified to the requirements of ISO 14001. The EMS itself is embedded within the Business Management System (BMS) which as a repository for all policies, standards, processes and procedures and supporting documents, is a platform that supports Centrica in managing safety, risk and compliance and in driving operational performance.

2.5.1 Environmental management

Centrica has a commitment to health, safety and security, as outlined below:

- The health, safety and security of our employees, customers and others who may be affected by our activities are a top priority. We believe that all work-related fatalities, injuries and illnesses can be prevented and we are committed to ensuring that all employees work in a safe and healthy way.
- The company's BMS, which describes those controls required to address quality, health, safety, environment (QHSE) risks, is designed to meet business needs and to adopt a consistent approach to QHSE management by satisfying the requirements of the recognised, applicable management systems standards, for environment, ISO 14001 Environmental management systems.

Centrica also has a commitment to the environment and details of this are outlined below:

- We are committed to understanding, managing and reducing the environmental impact of our activities. In particular, we are committed to playing our part in the transition to low carbon energy, while ensuring the security of present and future energy supplies. We aim to achieve this by sourcing and producing energy from cleaner sources, reducing wasted energy and developing and deploying new technology.
- We aim to reduce the carbon intensity of our power generation by developing renewable energy sources. We are also committed to leading the consumer market for low carbon energy products and services, helping customers to reduce their energy usage.
- We recognise that our operations, together with the way we deliver products and services, can have a major impact on the environment. For example, in the way we produce and use energy, manage our local environment and its biodiversity, operate our fleet of vehicles and manage the waste we create. We will work with our employees and suppliers to reduce these impacts through innovation, technology and cultural change. In addition, we will quantify, measure and communicate our environmental performance in a rigorous and clear manner.

2.5.2 Contractor management

Centrica will appoint a project management team to select and manage the operations of competent contractors. The team will ensure the decommissioning is executed safely, in accordance with Centrica Health and Safety principles and safeguard the environment in line with the environmental policy. Any change to the proposed decommissioning activities will be discussed with BEIS.

3. PROJECT DESCRIPTION

This section describes the Ann and Alison infrastructure that will be decommissioned and outlines the method that will be utilised. Please note that where the term 'mattress' has been used this refers to a concrete mattress unless otherwise specified.

3.1 Project scope and boundaries

This EIA report supports four Decommissioning Programmes (which are contained in a single document):

1. **The Ann Installation Decommissioning Programme covers:**
    - Complete removal of the Ann template;
    - Removal of the top of the Ann template piles; and
    - *In situ* decommissioning of the frond mattresses.
2. **The Ann Pipelines Decommissioning Programme covers:**
    - *In situ* decommissioning of the Ann 12" export pipeline (PL947) except for the following sections that will be completely removed:
        - The surface laid Ann 12" spool pieces of PL947 at the Ann template, between the Alison tee and the Alison template and at LOGGS PR;
        - The exposed spool pieces of PL947 at the Ann template and at LOGGS PR; and
        - The surface laid Alison tee including the protection structure and concrete blocks.
    - *In situ* decommissioning of the Ann 4" umbilical (PL948) except for the following sections that will be completely removed:
        - The exposed spool pieces of PL948 at the approaches to Audrey B (XW) and the Ann template.
    - Complete removal of the surface laid Ann A4 6" pipeline spool piece (PL2164);
    - Complete removal of the surface laid Ann A4 4" umbilical jumper (PL2165);
    - Compete removal of concrete mattresses; and
    - *In situ* decommissioning of deposited rock.
3. **The Alison Installation Decommissioning Programme covers:**
    - Complete removal of the Alison template;
    - Complete removal of the top of the Alison template piles; and
    - *In situ* decommissioning of the frond mattresses.
4. **The Alison Pipeline Decommissioning Programme covers:**
    - Complete removal of:
        - The first *c.*8km of the Alison 4" umbilical (PL1099); and
        - The exposed spool pieces of PL1099 at Audrey B (XW) and the Alison template.
    - *In situ* decommissioning of *c.*7km of the Alison 4" umbilical (PL1099);
    - Complete removal of concrete mattresses and bitumen mattresses; and

- *In situ* decommissioning of deposited rock.

The installations and pipelines covered under the four Decommissioning Programmes listed above are shown in Figure 3-1.

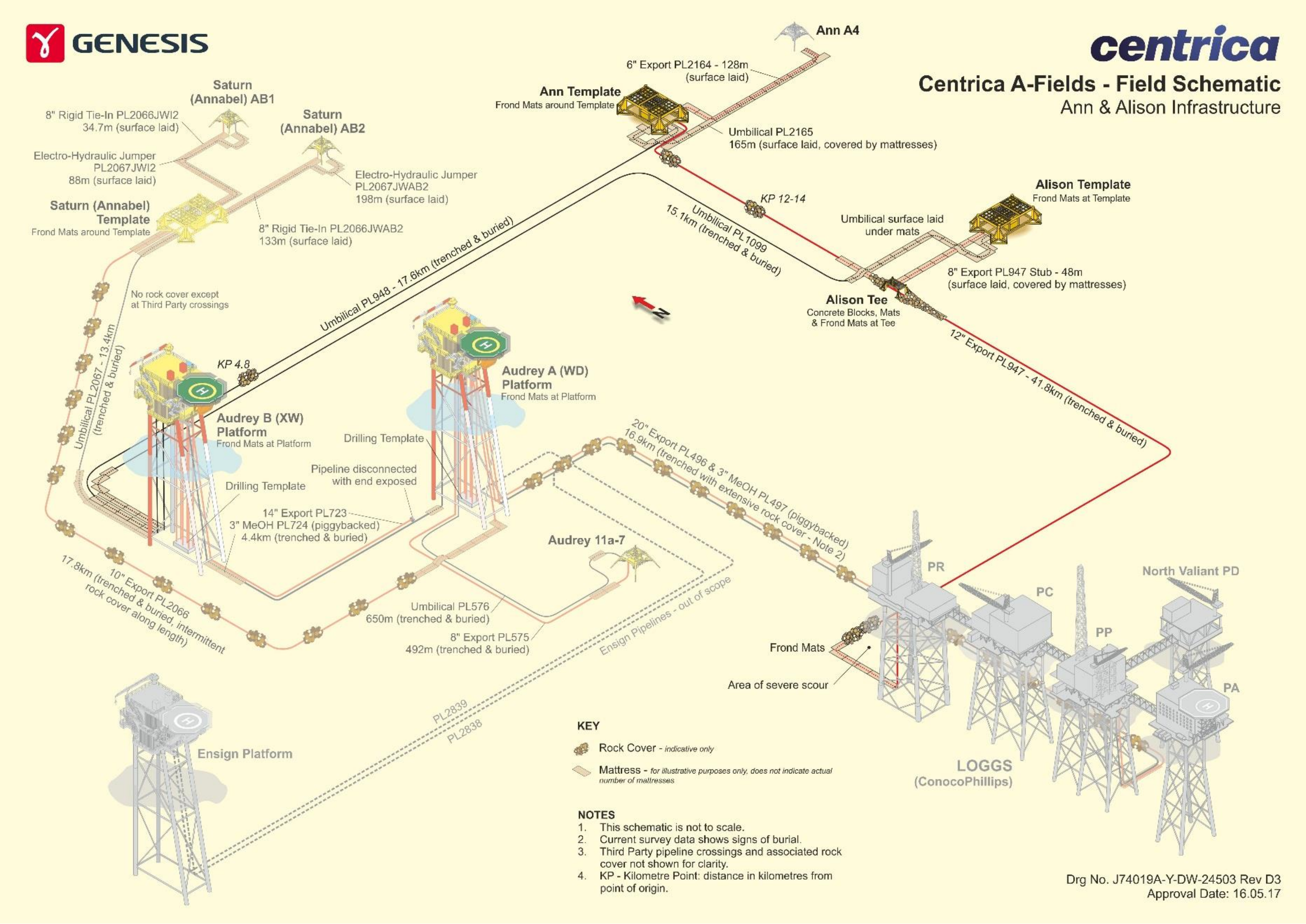

Figure 3-1: Illustration to show all infrastructure and pipelines covered under the Ann and Alison Decommissioning Programmes

3.2 Preparatory works

Although preparatory works are outside the scope of the Decommissioning Programmes, a summary is provided here in order to describe the status of the facilities prior to the commencement of the decommissioning scope.

3.2.1 Well abandonment

As required by Centrica standards, abandonment of the two Ann wells and one Alison well will be undertaken in accordance with Oil and Gas UK (OGUK) Guidelines for the Abandonment of Wells (OGUK, 2015). The abandonment of a third Ann well, Ann A4z, is detailed in the Ann A4 Installation Decommissioning Programme (Centrica, 2016a) and supporting EIA (Centrica, 2016b). The details of the Annabel and Audrey wells are described in the Annabel Decommissioning Programme (Centrica, 2017d), the Audrey Decommissioning Programme (Centrica, 2017e) and the supporting EIA (Centrica, 2017c).

For the A-Fields well abandonment requirements, a drilling rig is anticipated to be required at eight separate locations across the area. The spud cans used to stabilise the drill rig will result in seabed disturbance (see Section 6.3.3).

Chemical use and discharges associated with well abandonment will be assessed on well abandonment permit and licence submissions.

3.2.2 Preparation of pipelines

The Ann export pipeline (PL947) including spool pieces at Alison and the Ann A4 spool piece (PL2164) contain produced fluids which are a mix of predominantly gas with small volumes of condensate and produced water. The pipelines will be prepared for decommissioning by removing the produced fluids. The method for the removal will be agreed with BEIS through the environmental permitting process and associated consultation.

It is likely that the produced fluids will be removed from the pipelines with the use of a combination of gel pigs and flushing. The exact method will be developed during detailed design.

Removal of the produced fluids from the Xmas tree spools will be carried out prior to recovery unless detailed design identifies that it is not technically possible (e.g. where dead legs occur). If this occurs, it will be presented in the environmental permits and discussed during consultation. The flushing fluids, including produced fluids and seawater, will be pushed into the Ann export pipeline (PL947) from where, it is currently anticipated, they will be directed into a dedicated disposal well at the North Valiant platform (see Figure 3-1).

3.2.3 Flushing of umbilicals

The Ann umbilical (PL948) and the Alison umbilical (PL1099) methanol (MeOH) cores will be flushed with treated (filtered) seawater probably from a pumping spread located at Audrey B (XW) unless found not to be technically possible. If this occurs, it will be presented in the environmental permits and discussed during consultation.

3.2.4 Removal of Ann A4 wellhead protection structure

The Ann A4 wellhead protection structure (WHPS) will be removed using a well intervention vessel. This activity has been detailed in a separate Decommissioning Programme (Centrica, 2016a) with a supporting EIA (Centrica, 2016b).

3.3 Decommissioning – Ann

The Ann Field was the second of the A-Fields to be developed, achieving its first production in 1993. Ann is a subsea development comprising three production wells, two of which are contained within the Ann subsea template (Ann A2 and Ann A3z) (Figure 3-2). A third 'infill' well (Ann A4z, first production in 2006) and associated WHPS is located approximately 101m north-north-east of the template (Figure 3-2). The Ann template incorporates a piping manifold that allowed the commingling of gas from Ann A2 and Ann A3z, with that from Ann A4z.

The Ann A4z well exported gas via a 128m long, 6" pipeline (PL2164) to the Ann template, and received power, controls and chemicals via a 165m long, 4" umbilical (PL2165) from the Ann template.

Gas from the Ann template was exported to the LOGGS platform complex via a 41.8km long, 12" pipeline (PL947). Power, controls and chemicals were provided to the template via a 17.6km long, 4" umbilical (PL948) routed from the Audrey B (XW) platform.

Commingled gas from the Alison manifold was exported via a short, 48m long 8" spool piece (PL947 stub) that ties into the Ann gas export pipeline (PL947) at the Alison tee (Figure 3-1 and Figure 3-9). Power, controls and chemicals for the Ann template were supplied via a 15.1km long, 4" umbilical (PL1099) routed from the Audrey B (XW) platform.

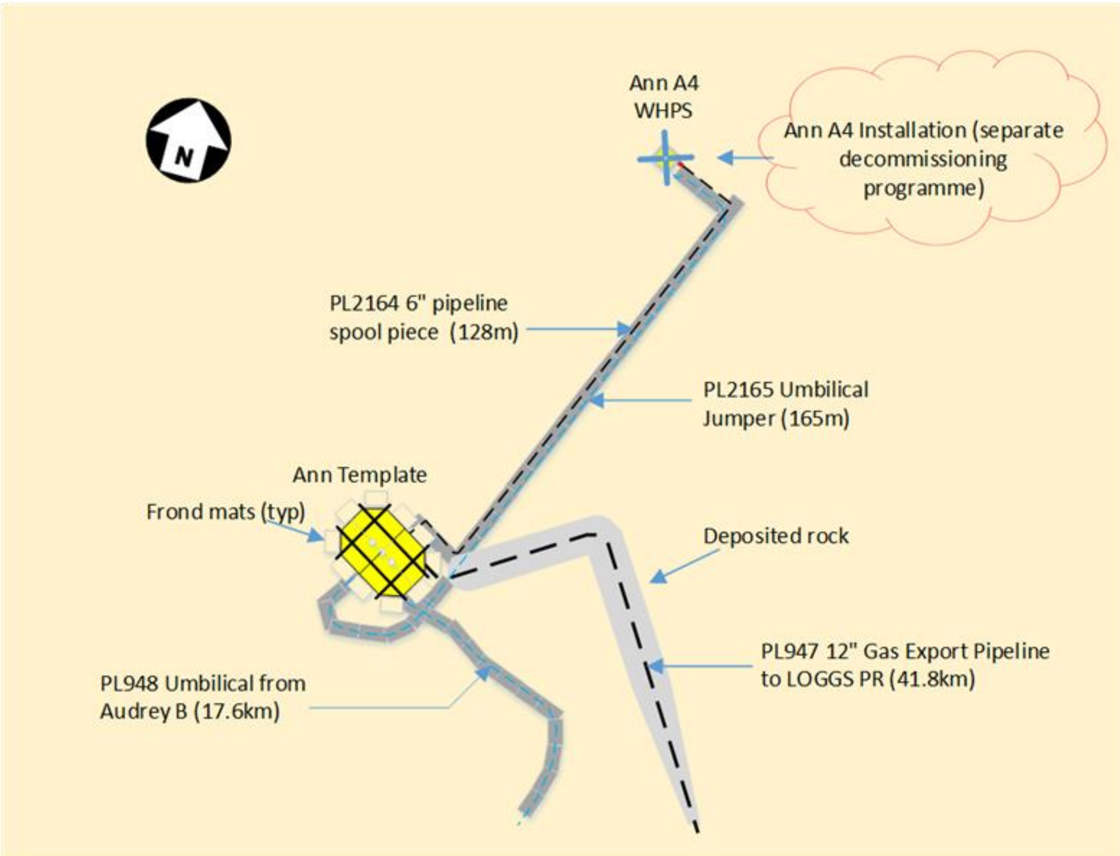

Figure 3-2: Ann Field layout

3.3.1 Ann subsea installation

The Ann installation is summarised in Table 3-1. The Ann template will be completely removed and recovered to shore.

DESCRIPTION	MASS (Te)
Ann template and four template piles.	154.6
TOTAL MASS	**154.6**

Table 3-1: Ann - summary of subsea installation

3.3.2 Ann pipelines and umbilicals

The Ann pipelines and umbilicals are summarised in Table 3-2.

PIPELINE ID	DESCRIPTION	LENGTH (km)
PL947	12" gas export pipeline routed from Ann template to LOGGS and Alison tee.	41.8
PL947 stub	8" gas export spool pieces routed from Alison template to Alison tee.	0.048
PL948	4" umbilical routed from Audrey B (XW) to Ann template.	17.6
PL2164	6" gas export pipeline routed from Ann A4 to Ann template.	0.128
PL2165	4" umbilical jumper routed from Ann template to Ann A4.	0.165

Table 3-2: Ann – summary of pipelines and umbilicals

3.3.2.1 Ann 12" export pipeline (PL947)

The Ann export pipeline is comprised of carbon steel that has been coated with Fusion Bonded Epoxy (FBE) in order to protect it from external corrosion. Its approaches at both the Ann template and the LOGGS PR are protected and stabilised by concrete mattresses and deposited rock. Deposited rock has also been used to protect and stabilise it on each side of the Alison tee. The Alison tee protection structure comprises a tubular steel protection frame, frond mattresses and concrete blocks (see Figure 3-3 and Table 3-5).

The PL947 stub, a 48m long surface laid spool piece section routed from the Alison template to the Alison tee, is protected and stabilised with mattresses over its full length (Figure 3 2).

PL947 was trenched and allowed to naturally backfill along its length during its installation. Historically it is believed that on the LOGGS approach the seabed has experienced significant scour and as such remedial work such as installation of additional concrete mattresses has not always been successful. However, the pipeline is protected and stabilised with deposited rock in this area except for a short length of the pipeline that is exposed for a length of 11m.

Survey data obtained periodically since suggests that the pipeline has remained relatively stable throughout its entire length. However, as can be seen in the burial profile (Figure 3-4) there are two short exposures, 24m and 22m long respectively, at Kilometre Point (KP) 3.4 and KP4.7, and some intermittent exposures for a length of 109m at KP6.1 but these appear stable. Further exposures occur at KP26 (19m and 24m).

There are no data for the pipeline where it passes through a sandbank in relatively shallow water (approximately 11m Lowest Astronomical Tide (LAT)) between approximately KP31 and KP33.5. However, recent (2016) Multibeam Echo Sounder (MBES) data suggest that there are intermittent exposures over a 186m length from KP33.5. In general terms the length of the pipeline with greatest uncertainty is where the pipeline approaches LOGGS PR platform between KP41.3 and KP41.8. Experience would suggest that this is an area of scour, with the profile of the local seabed constantly changing.

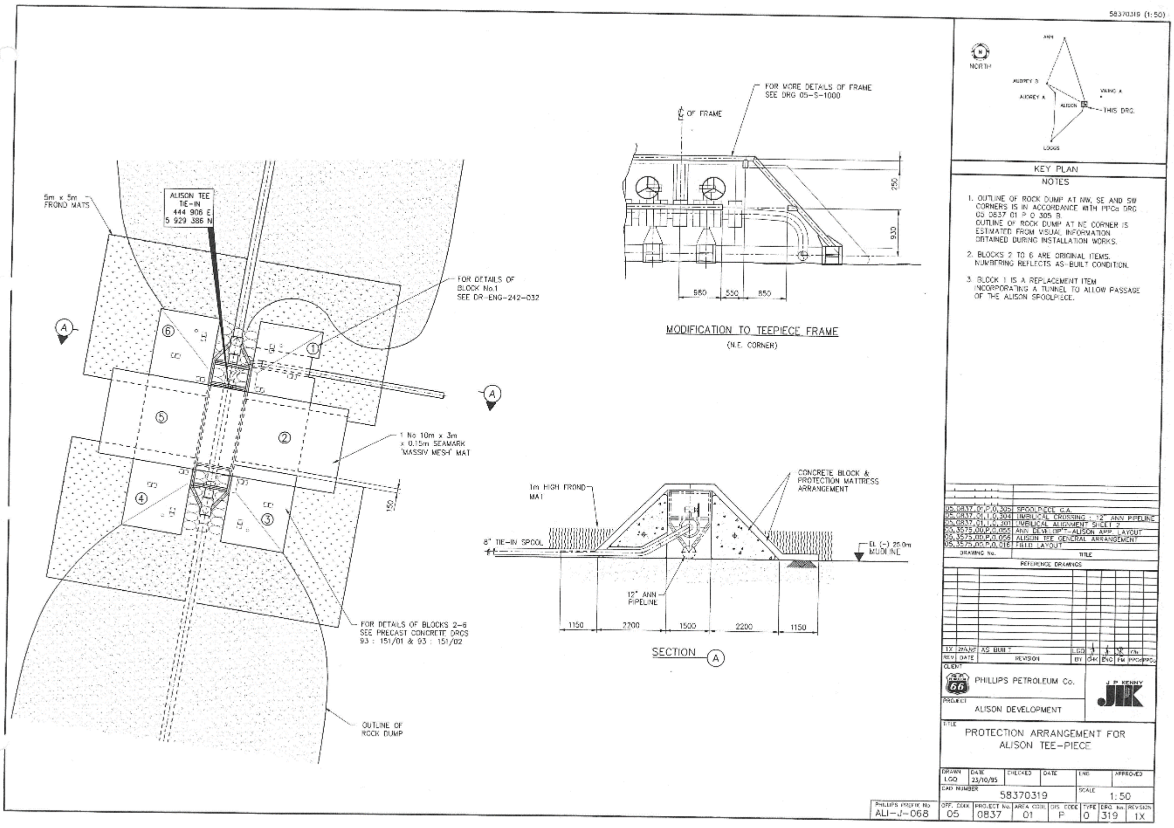

Figure 3-3: Alison tee protection structure

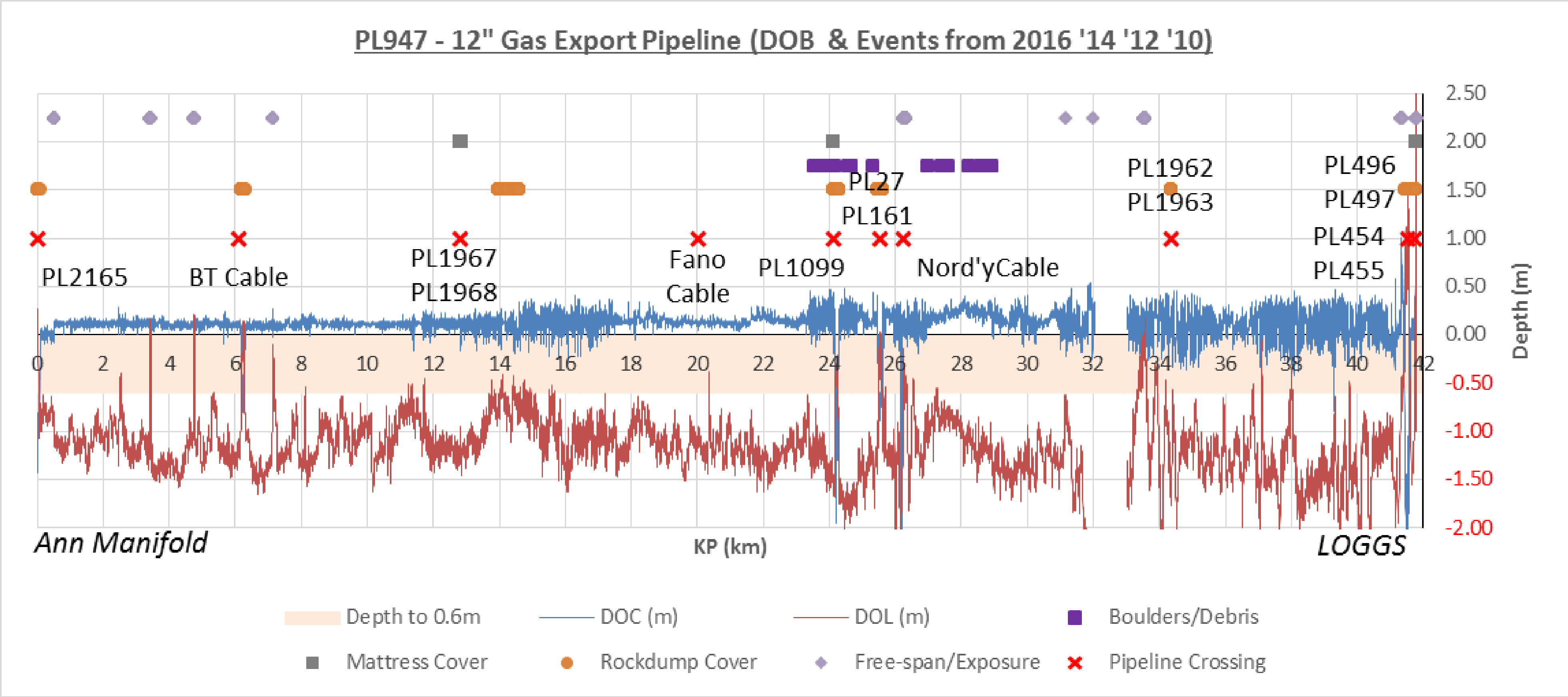

Figure 3-4: Overall burial of PL947 (12" gas export line Ann to LOGGS)

3.3.2.2 Ann 4" umbilical (PL948)

The Ann umbilical (PL948) is comprised of steel wire armour, nine hydraulic hoses, four power cables and plastic fillers. A cross-section of PL948 is shown in Figure 3-5.

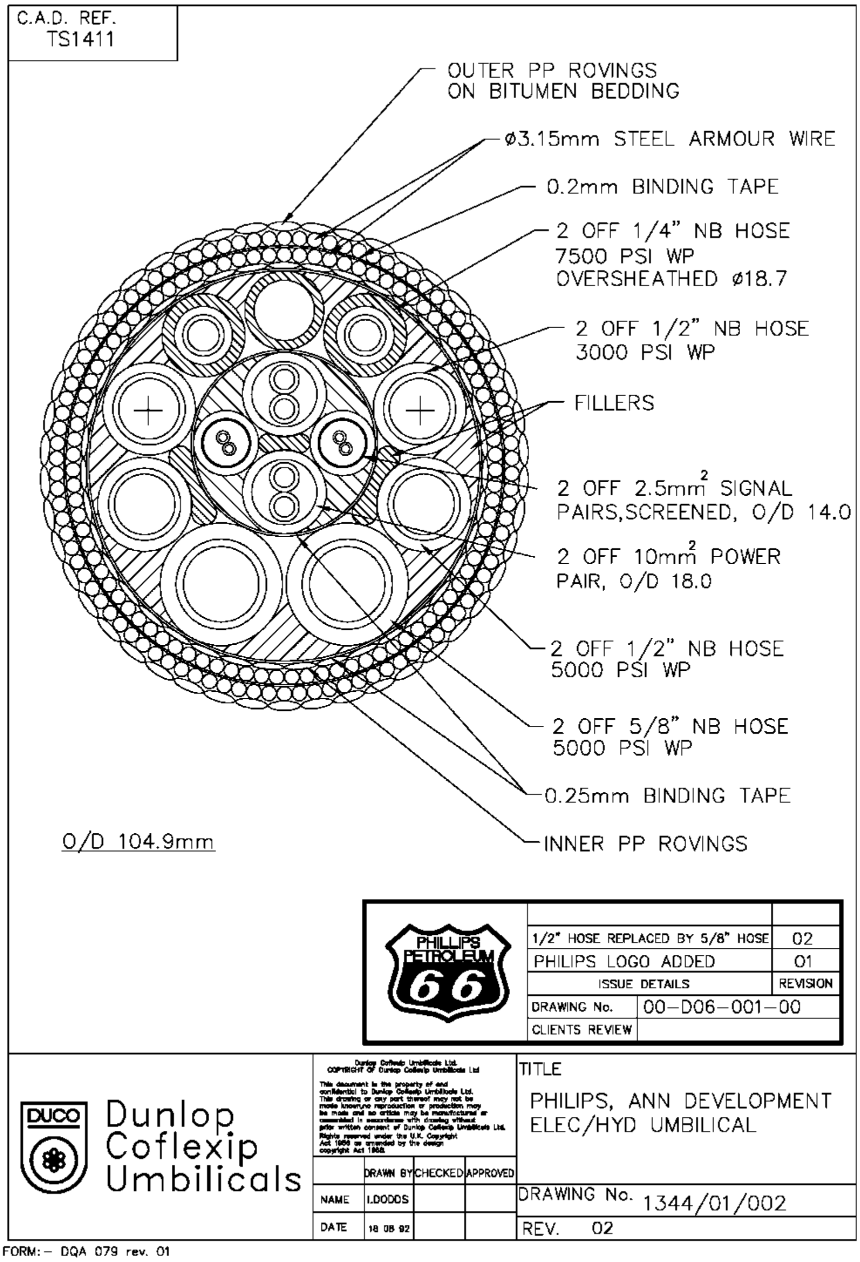

Figure 3-5: Cross-section through the Ann 4" umbilical (PL948)

The Ann umbilical was trenched and allowed to naturally backfill along its length during its installation. Each end of the pipeline is protected and stabilised with concrete mattresses and deposited rock.

As can be seen in Figure 3-6, PL948 has an erratic burial profile between KP0.5 and KP2.8 although few actual exposures have been recorded. This can be attributed to the presence of large sandwaves in the vicinity of Audrey B (XW) (Figure 4-16).

Two exposures were recorded in 2013, one short length adjacent to the Audrey B (XW) platform and at one near KP2.4 about 11m long, although more recent survey data obtained in 2016 suggests that these exposures are no longer present. It is believed that the exposures occurred as a result of the movement of sandwaves in the vicinity of Audrey B (XW) and were not due to insufficient trenching when the umbilical was first installed. On balance, the umbilical remains comparatively stable.

3.3.2.3 Ann A4 6" export pipeline (PL2164)

The Ann A4 spool piece (PL2164) is comprised of carbon steel that has been coated with FBE in order to protect it from external corrosion. It is surface laid and protected and stabilised across its full length by concrete mattresses. The concrete mattresses have also been used to cover PL2165 (Figure 3-2).

3.3.2.4 Ann A4 4" umbilical jumper (PL2165)

The Ann A4 umbilical jumper (PL2165) is comprised of steel wire armour containing eight hydraulic hoses, four power cables and plastic fillers. It is surface laid and protected and stabilised across its full length by the same concrete mattresses used for the Ann A4 spool piece (Figure 3-2).

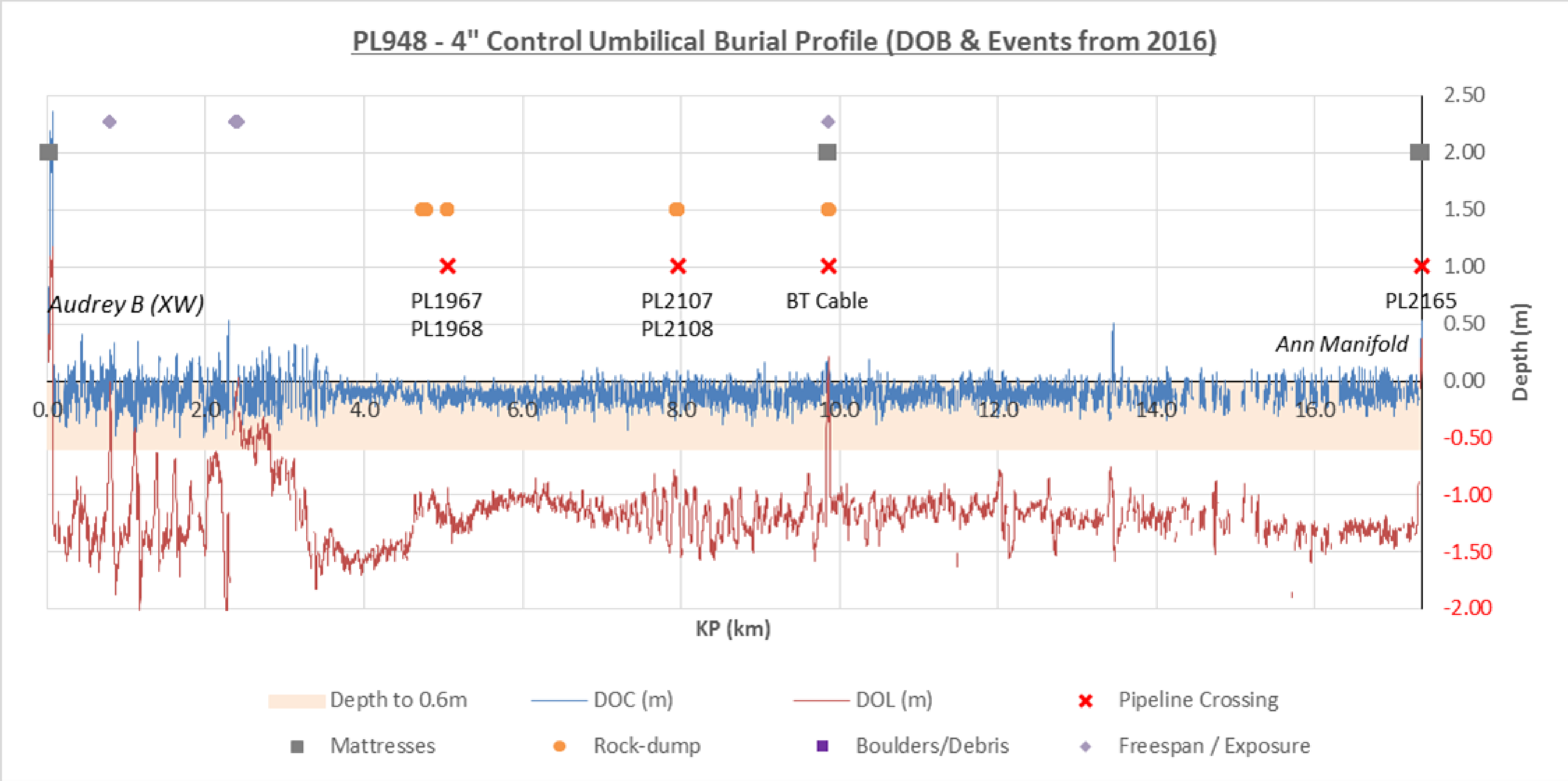

Figure 3-6: Overall burial of PL948 (4" umbilical Audrey B (XW) to Ann)

3.3.2.5 Pipeline crossings

The Ann export pipeline (PL947) and the Ann umbilical (PL948) cross (overlay), or are crossed by (underlay), a number of pipelines (Table 3-3 and Table 3-4).

CROSSING No.	PIPELINE CROSSING ID	CROSSING DESCRIPTION	OPERATOR	KP (km)	OVER/ UNDER
1	PL2165	4" Umbilical from Ann manifold to Ann A4 Umbilical	Centrica	0.01	Under
2	Cable	Telecoms Cable from Weybourne to ACMI MASTER	BT	6.10	Over
3	PL1967 PL1968	20" GE line from Carrack QA to Clipper PR 4" MEG line from Carrack QA to Clipper PR	Shell	12.84	Under
4	Cable	Cable from Weybourne to Fano (Dead)	Unknown	20.04	N/A
5	PL1099	4" Umbilical from Audrey (B) XW to Alison manifold	Centrica	24.13	Under
6	PL27 PL161	28" GE line from Viking AR to Mablethorpe 3" MeOH piggy back line from Viking AR to Mablethorpe	ConocoPhillips	25.55	Over
7	Cable	Cable from Mundersley to Nordeney (Dead)	Unknown	26.25	Over
8	PL1962 PL1963	12" GE line from Viscount VO to Vampire OD 3” MeOH line from Viscount VO to Vampire OD	ConocoPhillips	34.36	Under
9	PL496 PL497	20" GE line from Audrey A (WD) to LOGGS PP 3” MeOH line from LOGGS PP to Audrey A (WD)	Centrica	41.54	Over
10	PL454 PL455	36" GE line from LOGGS to Mablethorpe 4" MeOH line from Mablethorpe to LOGGS	ConocoPhillips	41.72	Over

Table 3-3: Summary of pipeline crossings associated with the Ann export pipeline (PL947). Direction of flow Ann to LOGGS (PR)

CROSSING No.	PIPELINE CROSSING ID	CROSSING DESCRIPTION	OPERATOR	KP (km)	OVER/ UNDER
11	PL1967 PL1968	20" GE line from Carrack South to Clipper 4" MEG Line from Clipper PR to Carrack QA	Shell	5.06	Under
12	PL2107 PL2108	14" line from GE Saturn ND to LOGGS PR 3" MeOH line from LOGGS PR to SATURN ND	ConocoPhillips	7.96	Under
13	Cable	Telecoms Cable from Weybourne to ACMI MASTER	BT	9.87	Over
14	PL2165	4" Umbilical from Ann manifold to Ann A4	Centrica	13.00	Under

Table 3-4: Summary of pipeline crossings associated with the Ann umbilical (PL948). Direction of flow Audrey B (XW) to Ann.

3.3.3 Ann protection and stabilisation features

The Ann installation protection and stabilisation features are summarised in Table 3-5 and the Ann pipeline protection and stabilisation features are summarised in Table 3-6, Table 3-7 and Table 3-8. Concrete mattresses, grout bags and concrete blocks will be completely removed where both their access and safety condition allows and recovered to shore. Deposited rock and frond mattresses will be decommissioned *in situ*.

DESCRIPTION	STABILISATION FEATURES	NO.	DIMENSIONS L x W x H (m)	MASS (Te in air)	TOTAL MASS (Te in air)
Ann template	Anti-scour frond mattresses.	10	5 x 2.5 x 0.5	0.75	7.5
TOTAL MASS			**TOTAL MASS**		**7.5**

Table 3-5: Ann – Summary of Ann installation protection and stabilisation features

PIPELINE ID	DESCRIPTION	KP (Km)	DIMENSIONS L x W x H (m)	MASS (Te)	TOTAL MASS (Te)
PL947	Spot deposited rock on Ann pipeline	Various	N/A	2,690	2,690
PL947	Deposited rock at Ann approach	0.006 to 0.080	75 x 13.5	1,540	1,540
PL947	Deposited rock over BT No. 1 Cable	24.120 to 24.130	160 x 7.5 x 1	2,060	2,060
PL947	Deposited rock on approach to Alison tee from Ann	24.215 to 24.220	80 x 6.675	975	975
PL947	Deposited rock on approach from Alison tee, heading towards LOGGS	24.235 to 24.230	80 x 6.675	975	975
PL947	Deposited rock over 28" Viking Pipeline	25.454 to 25.624	160 x 7.5 x 1	2,010	2,010
PL947	Deposited rock at LOGGS PR approach	41.560 to 41.756	15 x 250	3,602	3,602
PL947	LOGGS approach to LOGGS PR		22 (L)	1,591	1,591
PL947	Deposited rock over 20" and 3" Audrey pipelines	41.480 to 41.539	120 x 9.5 x 1	985	985
PL948	Spot rock deposit on Ann Umbilical	9.875 to 9.825	N/A	720	720
PL948	Deposited rock over BT No 1 Cable	4.781 to 4.729	45 x 2.5 x 1	290	290
TOTAL MASS					**17,438**

Table 3-6: Ann - Summary of deposited rock on the Ann pipelines PL947 and PL948

PIPELINE ID	KP (km)	DESCRIPTION	NO.	DIMENSIONS L x W x H (m)	MASS (Te)	TOTAL MASS (Te)
PL947stub		Concrete mattress protection between Ann template and Alison tee	3 2 1	8.0 x 3.0 x 0.3 6.0 x 3.0 x 0.3 5.0 x 3.0 x 0.3	11.06 8.3 6.9	56.7
PL947*	41.72	Concrete mattresses over 36" and 4" LOGGS pipelines.	4	4 x 2.5 x 0.15	2.3	9.2
PL947*	41.54	Concrete mattresses over 20" and 3" Audrey pipelines	8	4 x 2.5 x 0.15	2.3	18.4
PL947*	6.10	Concrete mattresses over BT No 1 Cable	4	4 x 2.5 x 0.15	2.3	9.2
PL947*	20.04	Concrete mattresses over Weybourne to Fano Cable	1	4 x 2.5 x 0.15	2.3	2.3
PL947*	25.55	Concrete mattresses over 28" Viking Pipeline	6	4 x 2.5 x 0.15	2.3	13.8
PL947		Concrete mattresses at LOGGS	19	6 x 3 x 0.15	4.15	78.85
PL947		Anti-scour frond mattresses at Alison tee	4	5 x 5 x 1.0	0.75	3
PL947		Seamark 'massive mesh mat' at Alison Tee	1	10 x 3 x 0.15	15.3	15.3
PL947		Concrete blocks	2 4	2.2 x 2.2 x 2.8 2.2 x 2.2 x 2.8	12.8 11.3	25.6 45.2
PL947		Anti-scour frond mattresses at LOGGS approach	10	5 x 5 x 1.0	0.75	7.5
PL948		Concrete mattresses at Ann template	19	8.0 x 3 x 0.3	11.06	220.4
PL948		Concrete mattresses at Audrey B (XW)	4	8.0 x 2.5 x 0.15	4.6	18.4
PL948*	9.87	Concrete mattresses over BT No 1 Cable	6	4 x 2.5 x 0.15	2.3	13.8
PL948*	9.87	Concrete mattresses over BT No 1 Cable	6	8 x 2.5 x 0.15	4.6	27.6
PL2164		Concrete mattresses extending the full length from Ann template to Ann A4	23	6.0 x 3.0 x 0.3	8.3	190.9
PL2165		Details as PL2164	9	6.0 x 3.0 x 0.3	8.3	74.7
	TOTAL		136			830.9

*indicates a pipeline crossing OVER another pipeline (see Table 3-3 and Table 3-4).

Table 3-7: Ann - Summary of concrete and frond mattresses on the Ann pipelines

PIPELINE ID	DESCRIPTION	NO.	DIMENSIONS L x W x H (m)	MASS (Kg)	TOTAL MASS (Te)
PL947 stub	Grout bags on Alison spool	60	0.3 x 0.5 x 0.075	25	1.5
PL947	Grout bags over 20" and 3" Audrey Pipelines	67	0.3 x 0.5 x 0.075	25	1.7
PL947	Grout bags over BT No. 1 Cable	4	0.3 x 0.5 x 0.075	25	1
PL947	Grout bags over 36" and 4" LOGGS pipelines	33	0.3 x 0.5 x 0.075	25	0.9
PL947	Grout bags over Weybourne to Fano Cable	8	0.3 x 0.5 x 0.075	25	0.2
PL947	Grout bags over 28" Viking Pipeline	50	0.3 x 0.5 x 0.075	25	1.3
PL947	Grout bags at LOGGS	1,482	0.3 x 0.5 x 0.075	25	37.9
PL947	Grout bags at Alison tee	634	0.3 x 0.5 x 0.075	25	17.6
PL947	Grout gabions at LOGGS	53	1 x 1 x 1	1,000	53
PL948	Grout bags at Audrey B (XW)	33	0.3 x 0.5 x 0.075	25	0.9
PL948	Grout bags at Ann	190	0.3 x 0.5 x 0.075	25	4.9
TOTAL		**2,614**			**121**

Table 3-8: Ann - Summary of grout bags and grout gabions on the Ann pipelines

3.3.3.1 Concrete mattresses

An interrogation of recent survey data (May 2016) would suggest that the concrete mattresses are of the ‘flexible’ concrete mattress type, articulated to flexible along and across pipeline being protected, rather than the ‘log’ type which is only flexible in one direction. These are available from several different manufacturers, including Subsea Protection Systems Ltd (1990s), Pipeshield (1999), etc.

Typically, the concrete blocks are held together with polypropylene rope, and this is also looped around the edges to allow the mats to be lifted and moved into positon.

Older concrete mattresses were manufactured using steel rope, although this material is less durable. If the mattresses have been in location for a long-time its condition usually precludes using the loops for lifting and often results in the concrete mattress disintegrating as attempts at recovery are made.

The intention is to remove all the accessible[1] concrete mattresses. The recoverability of a mattress is heavily influenced by its condition. Mattresses that have become degraded are more difficult and dangerous to recover and have less scope for re-use once recovered. In this case, however, as Centrica have test lifted one of the concrete mattresses at Ann template in January 2016, and as the mattresses are of a similar vintage as those at Alison, Centrica believe that the condition of the concrete mattresses at both Ann and Alison is such that they can be fully recovered. Should any difficulties be encountered during recovery operations, Centrica shall discuss possible solutions with BEIS.

Figure 3-7 shows a Side Scan Sonar (SSS) image of the Alison tee where it is possible to visualise the individual mattresses covering the Alison umbilical (PL1099).

[1] That is, not those buried under rock or under crossings

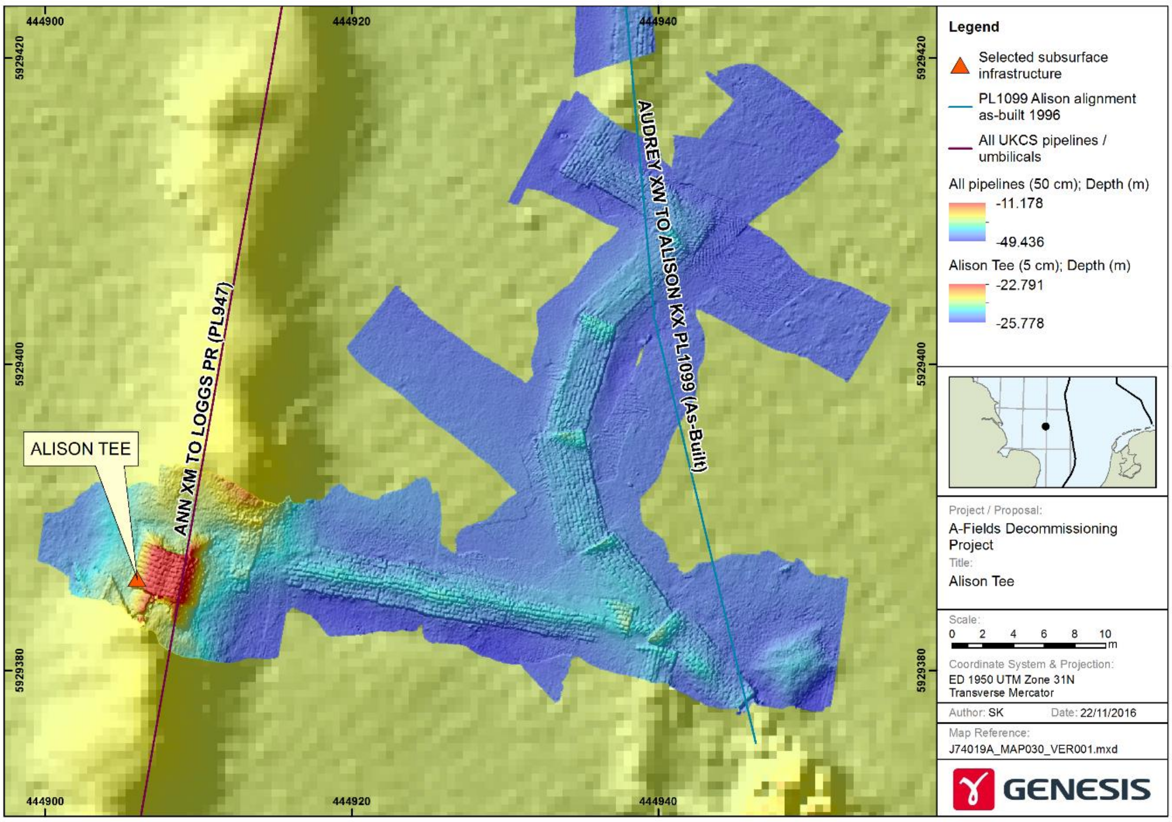

Figure 3-7: SSS image of Alison tee

3.3.3.2 Frond mattresses

When a pipeline or structure is placed into an area with a loose sedimentary material, under certain conditions the flow of water can cause erosion of the seabed, and this is called scour. Scour around a structure or pipeline will undermine its stability, and so is undesirable.

Fronded mattresses are put in place to provide protection against scour, and when they do their job the fronds act like natural seaweed, and silt and sediment that is carried in the water column builds up within the fronds. Eventually they become buried. Given the right conditions they can be very effective.

In general terms, there are two basic types of frond mattresses: the anchor retained type and the gravity-based type, but they both perform the same basic function. The anchor retained type are typically rolled out as a sheet and pegged into the seabed, whereas gravity-based types might use concrete or some other medium to hold them in place while they become buried.

Several frond mattresses were installed to protect the Ann and Alison template structures as well as the Alison tee and PL947 at LOGGS (Table 3-5) although it has not been possible to determine the design details or how they were designed to stay in place with absolute certainty. The indications are that they have performed their function and are now indistinguishable from the surrounding seabed.

An example of a frond mattress is shown in Figure 3-8. Given that they are largely constructed of flexible fronds it is not believed that frond mattresses would present a snagging hazard. All frond mattresses will be decommissioned *in situ*.

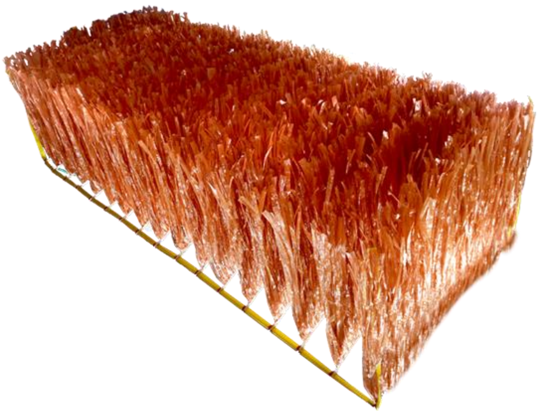

Figure 3-8: Example of a frond mattress

3.3.3.3 Grout Bags

The grout bags will be removed when decommissioning the Ann infrastructure. The integrity of the bags and the feasibility of recovery will depend on the materials used.

All grout bags will be completely removed where both their access, and their condition safely allows. The feasibility of recovery will depend upon the durability of the material from which the bag was constructed.

3.4 Decommissioning – Alison

The Alison Field was the third of the A-Fields to be developed, achieving its first production in 1995. It is a subsea development comprising one production well (49/11a-B3) located within a subsea template that is tied into the Ann to LOGGS export pipeline (PL947) at the Alison tee via a short pipeline stub (PL947 stub). The template contains a second production well (49/11a-KX), owned and operated by ConocoPhillips, that is not part of the decommissioning of the Alison Field.

The Alison template incorporates a piping manifold that allowed the commingling of gas from 49/11a-B3 and 49/11a-KX.

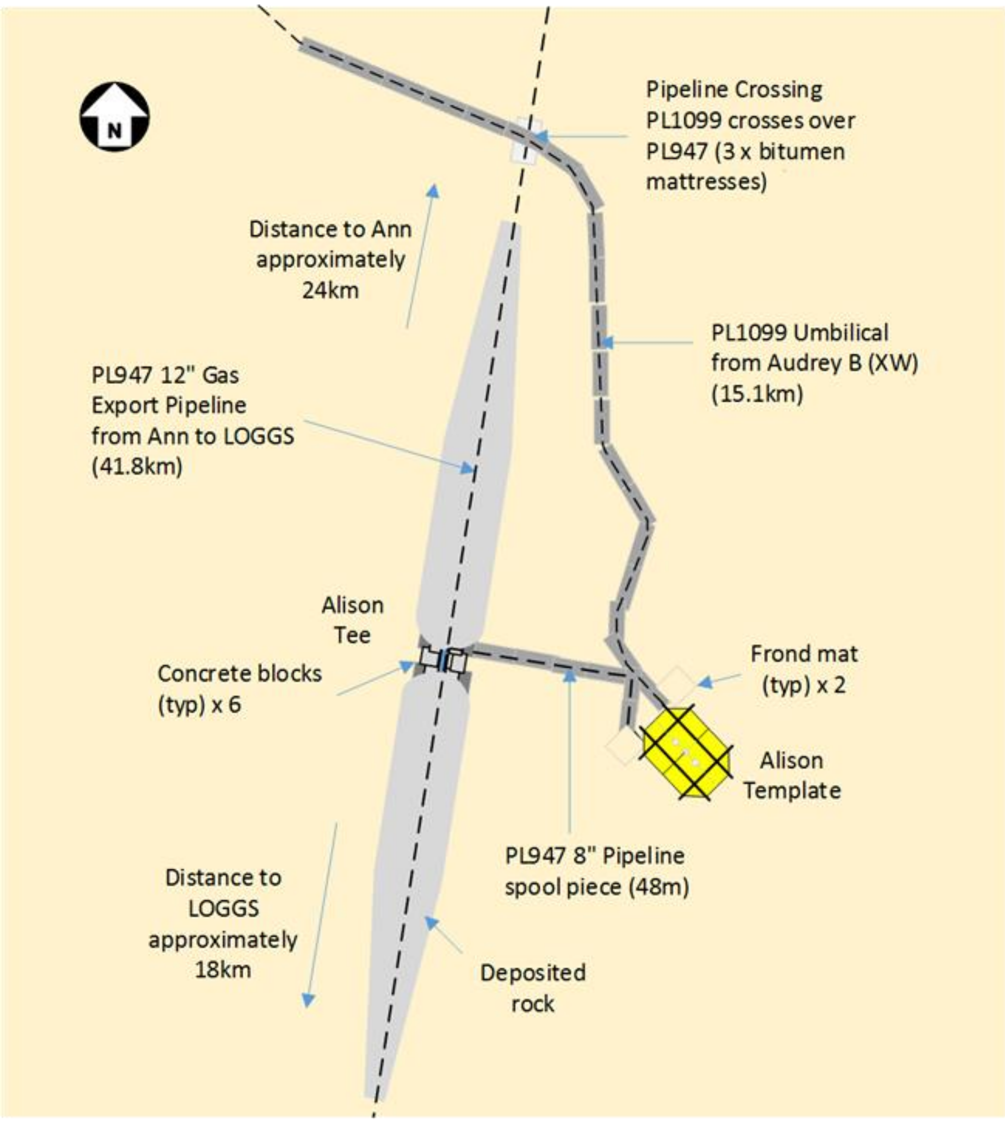

Figure 3-9: Alison Field layout

3.4.1 Alison subsea installation

The Alison installation is summarised in Table 3-9.

DESCRIPTION	MASS (Te)
Alison template and four template piles.	150.1
TOTAL MASS	**150.1**

Table 3-9: Alison – summary of subsea infrastructure

3.4.2 Alison umbilical

The Alison umbilical is summarised in Table 3-10.

PIPELINE ID	DESCRIPTION	LENGTH (km)
PL1099	4" umbilical routed from Audrey B (XW) to Alison template	15.1

Table 3-10: Alison – summary of umbilical

3.4.2.1 Alison 4" umbilical (PL1099)

The Alison umbilical is comprised of steel wire armour, eight hydraulic hoses, four power cables and plastic fillers (Figure 3-10). It was trenched along its full length and allowed to naturally backfill during installation. Its approaches at both the Alison template and Audrey B (XW) are protected and stabilised by concrete mattresses.

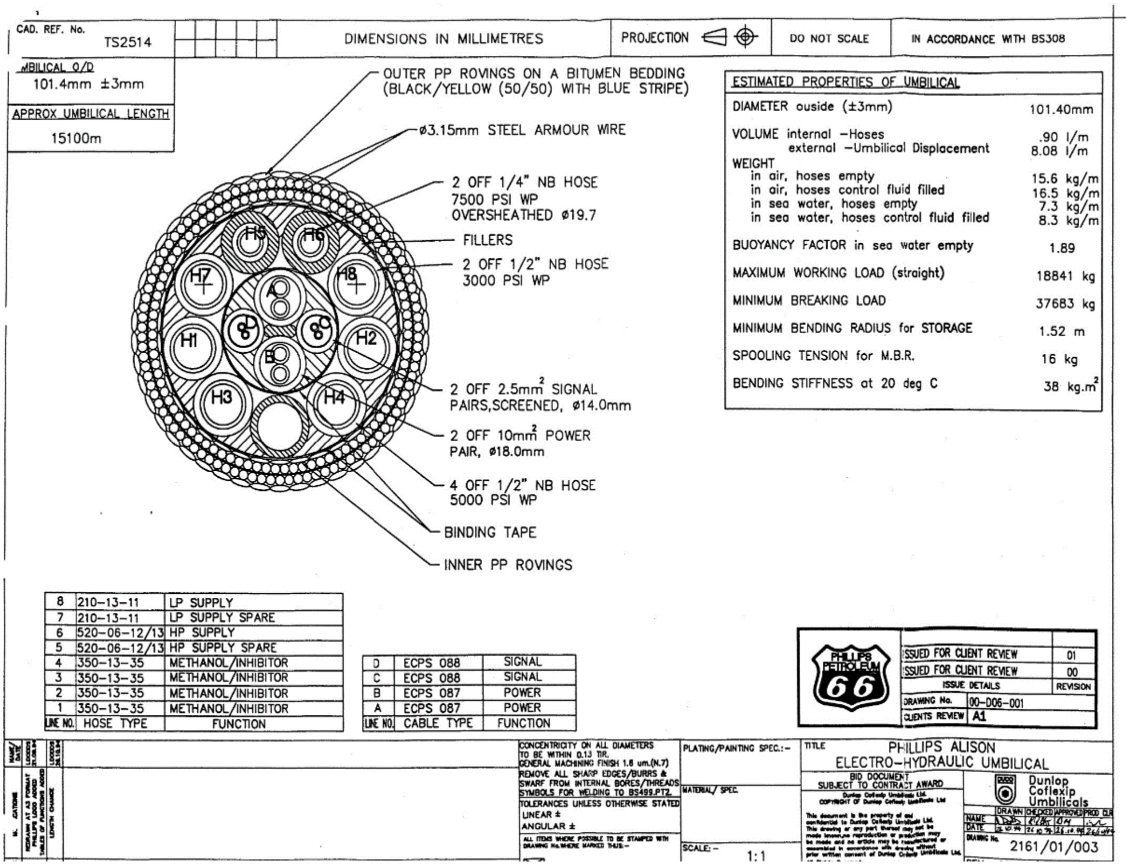

Figure 3-10: Cross-section through the Alison 4" umbilical (PL1099)

The burial profile of the first half of PL1099 between KP0 and *c.*KP8.0 suggests that the umbilical is not stable and prone to increasing length of exposures (Figure 3-11). Although individually these are short in length they appear to be increasing with time. The second half of the umbilical between KP8.0 and KP15.1 has remained buried to depths less than 0.6m below the level of adjacent seabed, however there are fewer sandwaves in the area (Figure 4-15).

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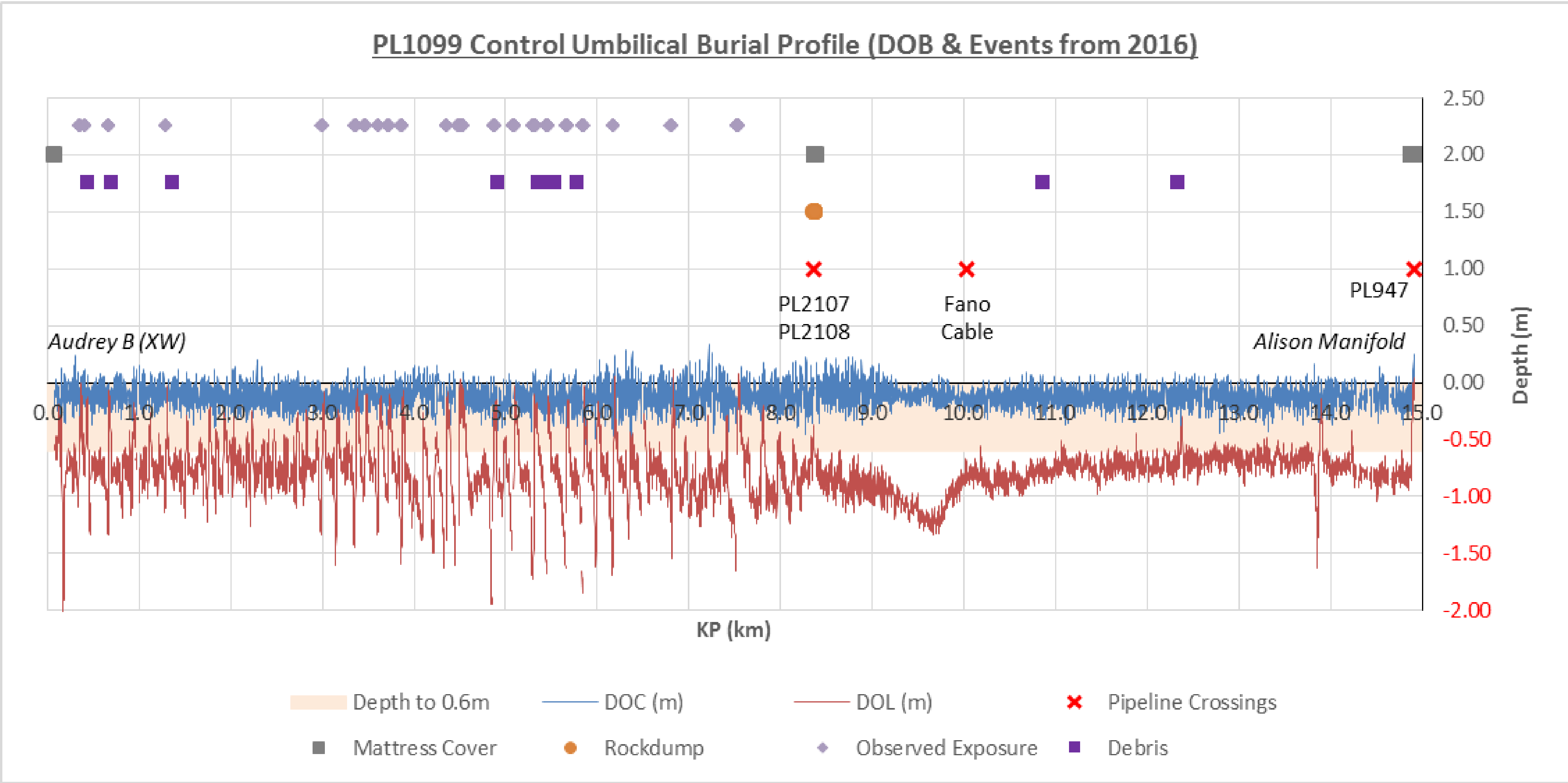


Figure 3-11: Overall burial of PL1099 (4" umbilical Audrey B (XW) to Alison)

3.4.2.2 Pipeline crossings

The Alison umbilical crosses (overlays), or is crossed by (underlays), a number of pipelines (Table 3-11).

CROSSING No.	PIPELINE CROSSING ID	CROSSING DESCRIPTION	OPERATOR	KP (km)	OVER/ UNDER
16	PL2107 PL2108	14" GE line from Saturn ND to LOGGS PR 3" MeOH line from Saturn ND to LOGGS PR	ConocoPhillips	8.38	Under
17	Cable	Weybourne to FANO Cable	Unknown	10.05	Over
5	PL947	Ann 12" GE pipeline	Centrica	14.9	Over

Table 3-11: Summary of pipeline crossings associated with the Alison umbilical (PL1099). Direction of flow Audrey B (XW) to Alison

3.4.3 Alison protection and stabilisation features

The Alison installation protection and stabilisation features are summarised in Table 3-12 and the Alison umbilical protection and stabilisation features are summarised in Table 3-13, Table 3-14 and Table 3-15. Concrete mattresses, bitumen mattresses, grout bags and concrete blocks will be completely removed where both their access and their condition safely allows, and recovered to shore. Deposited rock and frond mattresses and will be decommissioned *in situ*.

DESCRIPTION	STABILISATION FEATURES	NO.	DIMENSIONS L x W x H (m)	MASS (Te)	TOTAL MASS (Te)
Alison template	Anti-scour frond mattresses	2	5.0 x 5.0 x 1.0	0.75	1.5
TOTAL		**2**			**1.5**

Table 3-12: Alison – Summary of Alison installation protection and stabilisation features

PIPELINE ID	DESCRIPTION	NO.	DIMENSIONS L x W x H (m)	MASS (Te)	TOTAL MASS (Te)
PL1099	Concrete mattress protection on approach from Audrey B (XW)	4	8.0 x 3 x 0.15	11.06	44.3
PL1099	Concrete mattress protection at PL947 pipeline crossing	3	8.0 x 3 x 0.15	11.06	33.2
PL1099	Concrete mattress protection on approach to Alison template	18 2	8.0 x 2.5 x 0.3 8.0 x 3.0 x 0.3	9.2 12.3	190.6
TOTAL		**24**			**268.1**

Table 3-13: Alison - Summary of concrete mattresses on the Alison umbilical

PIPELINE ID	DESCRIPTION	NO.	DIMENSIONS L x W x H (m)	MASS (Te)	TOTAL MASS (Te)
PL1099	Bitumen mattresses at PL947 pipeline crossing	3	4 x 2.5 x 0.15	3.75	11.25
TOTAL		**3**			**11.25**

Table 3-14: Alison - Summary of bitumen mattresses on the Alison umbilical

PIPELINE ID	DESCRIPTION	NO.	DIMENSIONS L x W x H (m)	MASS (Kg)	TOTAL MASS (Te)
PL1099	Grout bags on umbilical ramp adjacent to Audrey B (XW)	40	0.25 x 0.45 x 0.125	25	1
PL1099	Grout bags at Alison template	170	0.25 x 0.45 x 0.125	25	4.4
TOTAL		**210**			**5.4**

Table 3-15: Alison - Summary of grout bags on the Alison umbilical

3.4.3.1 Concrete mattresses

The recoverability of a mattress is heavily influenced by its condition. Mattresses that have become degraded are more difficult and dangerous to recover and have less scope for reuse.

The intention is to remove all the accessible[2] concrete mattresses. All concrete mattresses will be completely removed where both their access and their condition, safely allows.

3.4.3.2 Frond mattresses

There are a number of frond mattresses protecting the Alison template (see Table 3-12) although it has not been possible to determine the design details or how they were designed to stay in place. The indications are that they have performed their function and are now quite indistinguishable from the surrounding seabed.

The majority of their thickness is manufactured from flexible material design to accumulate seabed sediment (see Figure 3-8) and as such it is not believed that they would present a snagging hazard. Therefore, it is proposed to decommission the frond mattresses by leaving them *in situ*.

3.4.3.3 Bitumen mattresses

Bitumen mattresses provide protection and stabilisation to pipelines in the same way as concrete mattresses, although they are used in circumstances where concrete is considered too abrasive. They support and protect pipelines and cables with a cushioned interface to reduce the threat of damage from sharp edges. They are manufactured from a blend of mastic and concrete. Three bitumen mattresses measuring approximately 4m x 2.5m x 0.2m thick (Table 3-14) are used to protect PL1099 at the PL947 pipeline crossing (Table 3-11) north-west of the Alison tee (Figure 3-12).

The recoverability of a mattress is heavily influenced by its condition. Mattresses that have become degraded are more difficult and dangerous to recover and have less scope for

[2] That is, not those buried under rock or under crossings

reuse once recovered. At the time of writing it has not been possible to establish whether the bitumen mattresses could be physically recovered without incident, more will be known in the future assuming that the overlying concrete mattresses that protect PL1099 can be removed. Any removal method will need to take account of the proximity of the underlying rock and pipeline, and PL947. Any decommissioning proposals of the bitumen mattresses would involve leaving any rock associated with the PL947 pipeline crossing undisturbed.

Depending upon the identification of a suitable technology, all bitumen mattresses will be completely removed where both their access, and their condition safely allows.

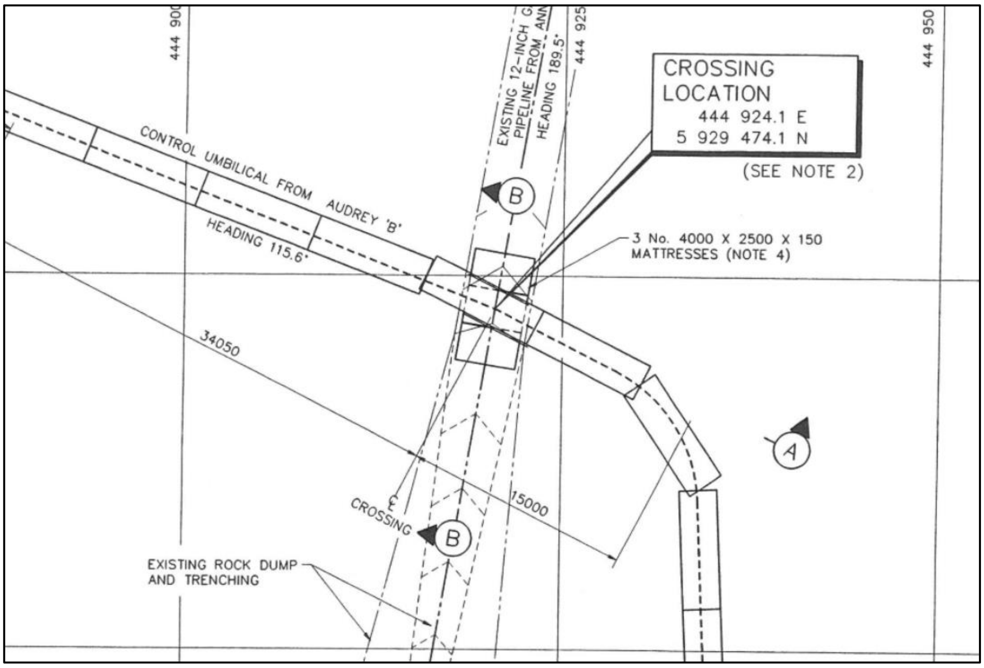


Figure 3-12: Bitumen mattresses at PL1099 over PL947 crossing

3.4.3.4 Grout bags

The grout bags will be removed when decommissioning the Alison infrastructure. The integrity of the bags and the feasibility of recovery will depend on the materials used.

All grout bags will be completely removed where both their access, and their condition safely allows. The feasibility of recovery will depend upon the durability of the material from which the bag was constructed.

3.5 Comparative Assessment

A Comparative Assessment (CA) (Centrica, 2017b) of the pipeline decommissioning options is a key supporting document of the Decommissioning Programmes submitted to the BEIS. The options were assessed using the BEIS Decommissioning Guidance Notes (DECC, 2011) and Centrica Comparative Assessment guidelines (Centrica, 2014). During the assessment process, evaluations were made principally on a qualitative basis using Centrica's established corporate risk assessment tables but also combined with deterministic values from the cost which were normalised to provide a consistent measure against all CA evaluation criteria of:

- Safety;
- Environmental;
- Technical;
- Societal; and
- Cost.

The CA was undertaken with a focus on the decommissioning options Ann and Alison pipelines as summarised in Table 3-2 and Table 3-10. The CA also considered the protection and stabilisation features as discussed in Sections 3.3.3 and 3.4.3.

3.5.1 Decommissioning options

The options detailed in this section are those that have been included in the CA process. The pipelines are separate and are therefore considered individually. Therefore, the options for decommissioning these pipelines are independent.

There is an implicit assumption that options for reuse of the pipelines have been exhausted by Centrica prior to the facilities moving into the decommissioning phase and associated CA; therefore, this option has been excluded.

In general terms three options are considered for decommissioning the pipelines, although depending on the pipeline being assessed the number of options may reduce to two, because there is little to differentiate at least two of the three options:

- **Complete removal** – This involves the complete removal of the pipelines by whatever means would be most practicable and acceptable from a technical perspective. In the event a pipeline is crossed over by a third-party pipeline, the pipeline would be cut either side of the third-party crossing;
- **Partial removal** – This will either involve removing poorly buried or potentially unstable sections of pipelines or doing what other remedial work Centrica believe would be necessary to make the pipeline safe for leaving the remainder *in situ*; or
- **Leave *in situ*** – This involves leaving the pipeline *in situ* with no remedial works but possibly verifying the stability of the pipeline via future surveys.

By implication, all options would involve removing short ends exposed on the sea bed as well as the pipelines in the trench transition areas not covered with rock, so these elements are not considered as differentiators in this CA process. All options include removal of features such as spool pieces, mattresses and grout bags in accordance with mandatory requirements unless explicitly stated otherwise.

The short ends associated with the pipeline approaches and exposed on the seabed are illustrated in Figure 3-13.

Details of the pipeline decommissioning options for PL947, PL948 and PL1099 are shown in Table 3-16, Table 3-17 and Table 3-18 respectively. The activities detailed in Table 3-16, Table 3-17 and Table 3-18 are expected to be undertaken using different vessel types. Vessel types might include a construction support vessel (CSV), a dive support vessel (DSV), or a pipelay vessel or a mixture of all three, depending on the activities being undertaken.

ID[34]	ITEM	OPTION 1 COMPLETE REMOVAL	OPTION 2 PARTIAL REMOVAL	OPTION 3 LEAVE *IN SITU*
1	12" pipe spools exiting Ann manifold, 13.7m long	Remove. *Cut pipe on approach into rock using remotely operated cutting equipment and lift pipe to CSV. Return pipe to shore for processing*	Remove. *As option 1*	Remove. *As option 1*
2	12" pipeline	Remove. *Uncover the buried pipeline ahead of removal operations using mass flow excavator; recover pipelines by spooling onto to a suitable vessel such as a pipelay vessel. The vessel used would be dependent on cost, but essentially recovery works would be supported by ROVSV. A typical vessel might be able hold 15km of pipe at one go so would need three trips to port to offload to pipeline. Return pipe to shore for cutting into transportable lengths and processing*	Remove poorly buried or potentially unstable sections at KP3.4 (24m), KP4.7 (22m), KP6.1 (109m), crown exposures KP26.2 (9m), KP26.3 (24m), and intermittent exposures from KP33.5 (186m) and leave acceptably buried or acceptable stable sections *in situ*. Leave potentially poorly buried 12" pipeline in sandbank area in vicinity of between KP31.0 to KP33.0 *in situ* *Method for individual lengths of pipe would be to locally excavate, cut and lift*	Leave entire pipeline *in situ* with no remedial works to rectify any exposed sections of pipeline
3	8" pipeline spool pieces between Alison manifold and Alison tee, 46m long	Remove. *Pipespools disconnected or cut and recovered to CSV. Return pipe to shore for processing*	Remove. *As option 1*	Remove. *As option 1*
4	Alison Tee including protection frame, concrete blocks, concrete mattresses, 12" pipeline and valves inside Alison Tee, approx. 14m long	Remove. *Cut pipeline either side of Alison Tee where it enters the rock cover and recover to DSV. Return pipe to shore for processing* Remove. *Protection frame, concrete blocks and concrete mattresses and grout bags all completely removed, Existing rock cover left in situ but re-profiled. Recover frond mattresses if possible*	Remove. *As option 1*	Remove. *As option 1*
5	12" pipeline approaches at LOGGS, 43.6m	Remove. *Cut pipe and recover pipe between end of rock and LOGGS RP to CSV. Return pipe to shore for processing*	Remove exposed pipeline at LOGGS. *At LOGGS this would involve removing the final lengths of pipe between the rock and the LOGGS RP riser.* *Return pipe to shore for processing*	Leave exposed pipeline at LOGGS. *At LOGGS this would involve removing the final lengths of pipe between the rock and the LOGGS RP riser. Return pipe to shore for processing*

Table 3-16: Options for decommissioning PL947

[4] Items 1 and 5 are included for completeness, although the approach will be the same for all decommissioning options being considered

ID[5]	ITEM	OPTION 1 COMPLETE REMOVAL	OPTION 2 PARTIAL REMOVAL OR REMEDIAL WORK	OPTION 3 LEAVE *IT SITU*
1	Umbilical end adjacent to Audrey B (XW) to transition depth, 32m long on seabed	Remove. *Remove concrete mattresses and grout bags to expose umbilical. Disconnect from TUTU on platform topsides and connect rigging to subsea end excavated at transition depth. This may also involve local excavation. Pull section out from bottom of J-tube to deck of Dive or Construction Support Vessel using winch[6]. Cut into manageable lengths using remotely operated cutting equipment supported by CSV. Return to shore for processing*	*Complete removal, as option 1*	*Complete removal, as option 1*
2	Buried umbilical from transition depth at Audrey B (XW) to start of transition on approach to Ann manifold	Remove. *Pull umbilical out through covered trench and onto a reel mounted on a vessel, probably a DSV or CSV. Return to shore for cutting into manageable lengths and processing*	Leave *in situ*. As option 3	Leave *in situ*. No work
3	Exposure at KP0.8, approx. 8m long, and intermittent exposure at KP2.4, 39m long	Removed as part of overall umbilical removal activity	Remove. *Locate poorly buried sections, expose end extremities by local water jetting, cut using remotely operated cutting equipment, and connect to winch for recovering to deck of vessel. Recover to deck of DSV and return to shore for processing*	Leave *in situ*. No work
4	SUTU and umbilical end at Ann manifold, 114m long	Continue to remove as part of overall umbilical removal activity	*Remove concrete mattresses and grout bags to expose the surface laid umbilical and excavate to transition depth. This may involve local excavation. Cut into manageable lengths using remotely operated cutting equipment. Return to shore for processing*	*Complete removal, as option 1*

Table 3-17: Options for decommissioning PL948

[5] Items 1 and 4 are included for completeness, although the approach will be the same for all decommissioning options being considered

[6] An alternative approach would be to cut the umbilical at the bottom of the J-tube and recover to topsides; best method to be determined during detailed design

ID[7]	ITEM	OPTION 1 COMPLETE REMOVAL	OPTION 2 PARTIAL REMOVAL OR REMEDIAL WORK	OPTION 3 LEAVE *IT SITU*
1	Umbilical end at Audrey B (XW), 138m long on seabed	Remove. *Disconnect from TUTU on topsides, connect rigging to subsea end excavated at transition depth and pull section out from bottom of J-tube to deck of DSV using winch. Cut into manageable lengths using remotely operated cutting equipment. Return to shore for processing*	Remove. *As option 1*	Remove. *As option 1*
2	Buried umbilical (first half); Start to KP8.0	Remove. *Pull umbilical out through covered trench and onto a reel mounted on a vessel, probably a DSV. Return to shore for cutting into transportable lengths or weights and processing*	Remove several individually exposed sections[8]	Leave *in situ.* No work
3	Buried umbilical (second half); KP8.0 to end at Alison manifold	Remove. *Continue recovery operations from first half of umbilical*	Leave *in situ*, as option 3. No work.	Leave *in situ.* No work
4	SUTU and umbilical end at Alison manifold, 160m long; this includes the section of umbilical that crosses over PL947	Remove. *Remove concrete mattresses to expose the surface laid umbilical and excavate to transition depth. Cut into umbilical pipeline manageable lengths using remotely operated cutting equipment and recover to DSV. Return to shore for processing*	Remove. *As option 1*	Remove. *As option 1*

Table 3-18: Options for decommissioning PL1099

[7] Items 1 and 4 are included for completeness, although the approach will be the same for all decommissioning options being considered

[8] Up to 30 individual exposures totalling 149m in length (Alison Pre-Decommissioning Report, Gardline Geosurvey Ltd, 2016b) section 2.4.1 refers to 30 exposures totalling 157m with the longest being 130m; the apparent discrepancy is due to different interpretations of the available data) have been identified within the first 8km of umbilical. Should sections of exposed umbilical be cut and removed it's possible that the ends would present a greater long-term threat to interactions with fishing activities in the area. Furthermore, the cover of the exposures and any cut ends could present an increased risk to the mariners. However, we are not aware of any physical snagging having occurred, and no exposed lengths of umbilical have warranted reporting to FishSAFE

3.5.2 Conclusion of PL947 CA

Pipeline PL947 is trenched and buried and the evidence would suggest that although there are exposures along the length of the pipeline these are relatively small (Figure 3-4) and there has been no requirement to report the exposures to the Kingfisher Information Service.

Three decommissioning options were compared for this pipeline – complete removal, partial removal and leave *in situ*. Partial removal would involve removing at least five individual and exposed lengths of pipeline and an intermittent length of exposed pipeline 186m long, giving a total of approximately 384m of pipeline being removed. The leave *in situ* solution could involve leaving the pipeline 'as is' and monitor its burial over the foreseeable future.

Removal of the pipeline and associated stability features at the Alison tee would be challenging but Centrica believe that it is feasible. Any rock used to stabilise the Alison tee would be disturbed to enable access to the concrete blocks, concrete mattress and grout bags, but would be left on site and profiled to ensure no residual hazards remain after decommissioning operations have been completed.

Complete removal would involve exposing the pipeline using a mass flow excavator and then re-reeling the pipeline back onto a suitable vessel or cutting into manageable sections and lifting. Depending on the capacity of the pipeline reel, recovery of the pipeline may involve a few trips back to shore to offload the recovered pipe. Once onshore, approximately 41.8km of pipe would need to be retrieved from the pipe reel, cut into manageable lengths and recycled.

The complete removal option would incur higher cost, unplanned risk and greater short-term impacts on the environment. Offshore there would be an increased risk to safety of personnel and planned environmental impacts associated with transferring and disposing of any recovered material onshore.

By completely removing the pipeline, the risk of snagging is removed in perpetuity and therefore the complete removal option results in lower residual risks to mariners and other users of the sea. However, residual snagging hazards for the partial removal and leave *in situ* options can also be considered low on the basis that the pipelines are buried and the Alison tee and exposed ends - including the 48m long surface laid stub (PL947 stub) from Alison, will be removed.

Although the pipeline has exposed sections of pipe along its length, the assessment found that these was little to differentiate the partial removal and leave *in situ* options, but both were found to be preferable to complete removal. Both options were found to be materially better for safety, environment, technical and cost considerations.

Residual snagging risks associated with the partial removal and leave *in situ* options are likely to remain low, but legacy surveys will be required in order to verify this.

In conclusion, based on the comparative assessment 'leave *in situ*' is the recommended option for decommissioning the pipeline. On this basis the majority of the pipeline will be left *in situ* underneath existing burial cover, but future inspections will be planned over the foreseeable future to ensure that that pipeline does not pose a risk to other users of the sea.

3.5.3 Conclusion of PL948 CA

PL948 is approximately 17.6km long and trenched and buried. The most recent survey data indicate that the umbilical is only exposed for a short length of *c.*11m at a single location (Figure 3-6). This exposure is small when taking account of the length of the umbilical and to date there has been no requirement to report any exposures to the Kingfisher Information Service.

Otherwise the assessment found the risks and impacts associated with the decommissioning options to be broadly acceptable for most impacts and risks except that in the complete removal option the short-term impact of decommissioning operations on the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC) (see Section 4.5.1.1) rises to 'tolerable' and non-preferred compared to other options.

Small differences are found between the safety assessment with more work required offshore and onshore for the complete removal than leave *in situ* and consequently higher safety risk. Conversely there would be lower safety risks to mariners arising from complete removal than for either partial removal or leave *in situ* because the pipeline would no longer be present as a potential snag hazard. However, the CA concluded that even with the umbilical remaining *in situ* the snagging risk posed to fishermen and other users of the sea would remain low on the basis that the umbilical would remain buried.

In conclusion, based on the comparative assessment 'leave *in situ*' is the recommended option for decommissioning the umbilical. On this basis, the majority of the umbilical will be left *in situ* underneath existing burial cover, but future inspections will be planned ensure that that umbilical does not pose a risk to other users of the sea.

3.5.4 Conclusion of PL1099 CA

PL1099 is approximately 15.1km long and was assessed as two parts, Start to KP8.0 and KP8.0 to end. For the first half of the umbilical up to KP8.0 the decommissioning options considered were: complete removal, partial removal and leave *in situ*. For the second half of the umbilical between KP8.0 and the end there was nothing to distinguish between 'partial removal' and 'leave *in situ*' so the partial removal option was discounted.

The CA concludes that the most efficient approach that removes uncertainty concerning the burial status and stability of the umbilical would be that the first *c*.8km of pipeline should be removed. The second half of the umbilical should be left *in situ* as it appears buried and stable (Figure 3-11).

Complete removal of the first *c*.8km is the best option over the longer-term in that it removes future uncertainty of the burial status and stability of the umbilical. In the short-term the objectives of the North Norfolk Sandbanks and Saturn Reef SAC (see Section 4.5.1.1) would be compromised but evidence suggests that over the longer term the seabed and surrounding area affected by removal operations will fully recover. For the second half of the umbilical the proposed solution would be to leave this section of umbilical *in situ* and monitor its burial, at least over the foreseeable future.

Partial removal of the first half of the umbilical was considered to be the best option. Primarily this was because of the effort that would be involved in finding and excavating the ends of the exposed umbilical and the ensuing uncertainty of what might happen to the severed parts of the umbilical that would be left and the increased snagging risk they might impose on commercial users. The assessment concluded that it could be better to leave the umbilical intact *in situ*, but better still remove the first half entirely. This would remove the associated snagging risks in perpetuity.

3.5.5 Conclusion of PL2164 CA

PL2164 is a short pipeline 128m long routed from Ann A4 to the Ann manifold located inside the Ann template. It comprises a number of surface laid pipe spools. The pipeline is protected and stabilised using concrete mattresses. As it is surface laid, Centrica propose to fully remove this pipeline and associated stabilisation features.

3.5.6 Conclusion of PL2165 CA

PL2165 is a short umbilical jumper 165m long routed from the Ann manifold to Ann A4 wellhead. The pipeline is protected and stabilised using the same concrete mattresses used for PL2165. As it is surface laid, Centrica propose to fully remove this pipeline and associated stabilisation features.

3.6 Summary of the Ann and Alison infrastructure to be removed

A summary of the Ann and Alison infrastructure to be removed from the seabed is detailed in Table 3-19 and illustrated in Figure 3-13. The short ends associated with the pipeline approaches and exposed on the seabed in Figure 3-13 are as follows:

PL947: Items 6, 11, 16

PL948: Items 17, 18

PL1099: Items 13, 14, 19, 20

ITEM	METHOD
Ann template and piles; Alison template and piles.	Complete removal of each template. Piles will be cut to 0.6m below the seabed and removed.
Ann export pipeline (PL947) and Alison tee protection structure; Ann umbilical (PL948).	Removal of those sections that are not sufficiently buried, complete removal of the Alison tee protection structure; *in situ* decommissioning of those sections under sufficient and stable existing burial cover.
Alison umbilical (PL1099).	Removal of first *c.*8km section which is not sufficiently buried; *in situ* decommissioning of the final *c.*7km section under sufficient and stable existing burial cover.
Ann A4 spool piece (PL2164); Ann A4 umbilical jumper (PL2165).	Complete removal.
Deposited Rock.	Decommissioned *in situ.*
Concrete mattresses; concrete blocks; bitumen mattresses and grout bags.	Complete removal where both their access and their safety condition allows.
Frond mattresses.	Decommissioned *in situ.*

Table 3-19: Summary of Ann and Alison decommissioning activities

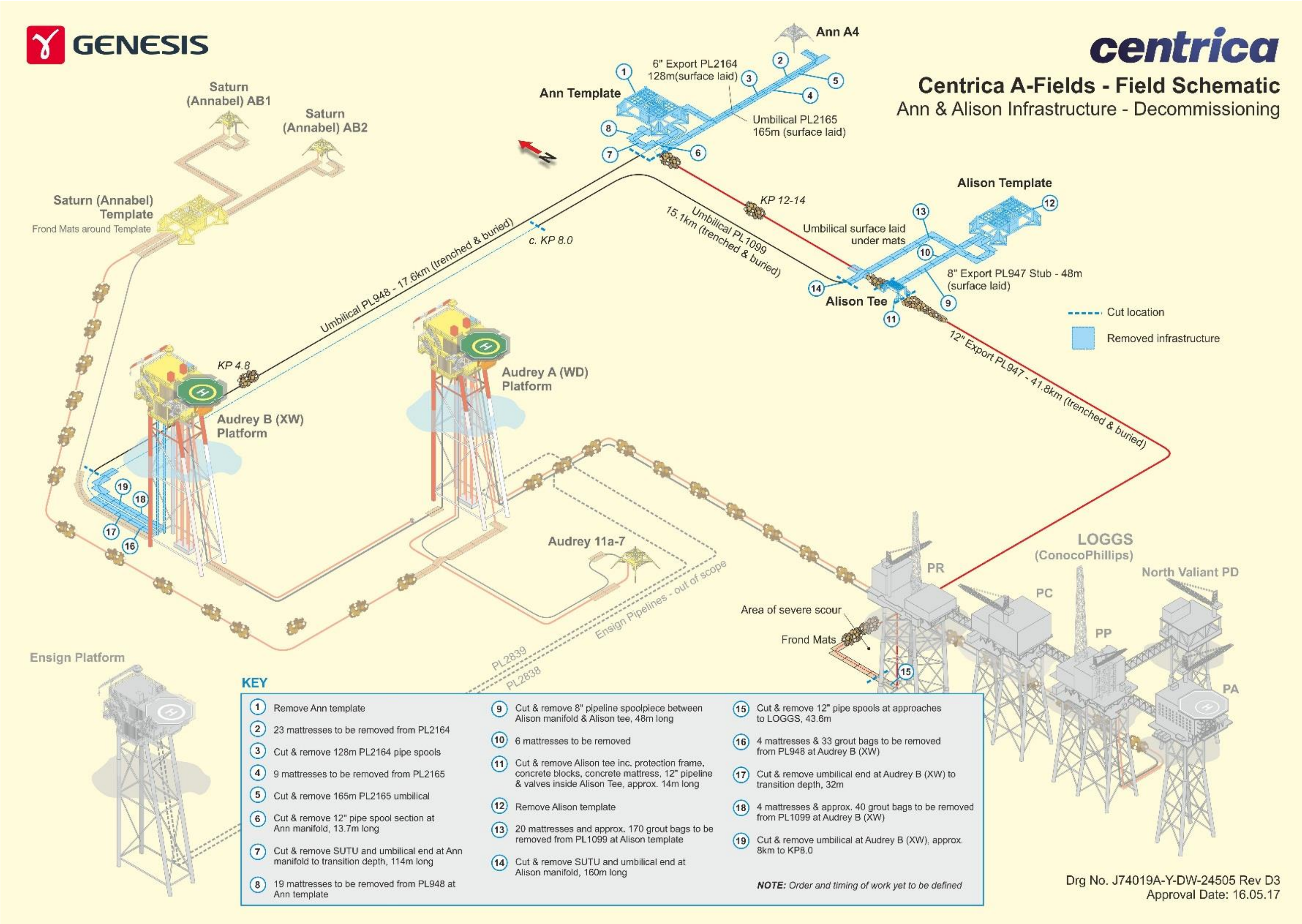


Figure 3-13: Summary of Ann and Alison infrastructure to be removed from the seabed

3.7 Summary of principal planned decommissioning activities

Excavation, removal of marine growth, cutting, temporary seabed placement, lifting (removal), vessel use, processing and disposal (to landfill) are the principal activities that are considered in the EIA.

3.7.1 Offshore

The following specific decommissioning activities are currently anticipated. Each, in conjunction with the chosen offshore contractor, will be confirmed during the projects detailed design and execution process.

3.7.1.1 General (in support of all removal activities)

- Use of vessels for the deployment of specialist subsea tools; the lifting (removal) from seabed, and transport (recovery) to shore, of materials; and
- Miscellaneous duties.

3.7.1.2 Complete removal and recovery of subsea installations (including their foundation piles)

The subsea installations (e.g. templates) will be completely removed from the seabed using specialist tools and lifting apparatus deployed from a surface vessel, and recovered to shore. The template will, following reconditioning, preferentially be re-used, in accordance with the waste hierarchy. Installation foundation piles will be removed to a depth of 0.6m below the seabed and recovered to shore, and in not being suitable for re-use, will have their component material (steel) recycled. If re-use of the installation is not possible, following onshore disassembly, its component materials (predominantly steel) will, where possible, be recycled. Non-recyclable materials will, as a last resort, be disposed of to landfill.

In summary:

- Preparatory mechanical disconnection (using an unbolting or cutting tool) of the pipeline spool piece or umbilical from the subsea installation;
- Mechanical cutting of the installation's piles[9] (and pile sleeves) to disconnect them from the seabed;
- Lifting of the installation, either whole or in parts, by and to, a surface vessel; and
- Local (as required) excavation of sediment, and clearance of marine growth[10] to permit access to the installation's surfaces for the attachment of lifting loops or slings, or to its existing lifting loops, bolt heads etc.

3.7.1.3 Complete removal and recovery of protection and stabilisation features

Where their access and their condition safely allows, installation, and pipeline and umbilical protection and stabilisation features including concrete mattresses, bitumen mattresses, concrete blocks and grout bags, but excluding deposited rock and frond mattresses, will be completely removed from the seabed using specialist tools and lifting apparatus deployed

[9] Cutting of piles will preferentially be undertaken using an internally deployed tool. If external tool deployment is required, sediment will need to be excavated around the base of the pile.

[10] Excavation of sediment and clearance of marine growth will be accomplished using a high pressure/low volume or low pressure/high volume water-jetting tool, or a suction tool.

from a surface vessel, and recovered to shore for preferential re-use in accordance with the waste hierarchy. If re-use is not possible, following onshore disassembly, their component materials (concrete, steel, plastic etc.) will, where possible, be recycled. Non-recyclable materials, as a last resort, will be disposed of to landfill.

Deposited rock and frond mattresses will be decommissioned *in situ* on or within the seabed.

In summary:

- Lifting of features by, and to, a surface vessel either individually and directly, or in batches following their temporary seabed placement within a basket; and
- Local (as required) excavation of sediment, and clearance of marine growth[11] for general de-burying of features, and to permit access to the feature's surfaces for the attachment of lifting loops or slings, or to its existing lifting loops etc.

3.7.1.4 Partial removal and recovery of pipelines (including spool pieces)

All spool pieces are surface laid. They will be completely removed from the seabed using specialist tools and lifting apparatus deployed from a surface vessel. Spool pieces will be mechanically disconnected into manageable sections either by unbolting at existing flange connections, or by cutting at required locations, and recovered to shore.

The sections of pipeline and spool pieces that are not sufficiently buried are those that make the transition from full burial to the seabed surface, those that rest on the seabed, and those for which the burial status is 'not stable'. These sections, where not covered by deposited rock, will be cut into manageable sections using a specialist tool, and removed from on or within the seabed using specialist lifting apparatus (each deployed from a vessel) and recovered to shore.

Following onshore disassembly, the component materials of all spool pieces and pipelines (steel, concrete, plastic etc.) will, where possible, be recycled in accordance with the waste hierarchy. Non-recyclable materials, as a last resort, will be disposed of to landfill.

Access to spool piece flange connections (for unbolting) or to the spool piece or pipeline circumference (for external cutting) may require the deployment of water jetting or suction tools to locally excavate (displace) sediment, or to locally remove marine growth[8]. The excavations containing the cut ends of the pipeline sections that will be subject to *in situ* decommissioning will be left to naturally back fill with sediment.

In summary:

- Local (as required) excavation of sediment at required cut locations to permit access to the pipeline or spool piece circumference for the unbolting or cutting tool;
- Local (as required) excavation of sediment along sections of pipeline in preparation for lifting (de-burial);
- Mechanical disconnection (using an unbolting or cutting tool); and
- Lifting of cut sections of pipeline or spool piece from on, or within, the seabed by, and to a surface vessel either individually and directly, or in batches following their temporary seabed placement within a basket.

[11] Excavation of sediment and clearance of marine growth will be accomplished using a high pressure/low volume or low pressure/high volume water-jetting tool, or a suction tool.

3.7.1.5 Partial removal and recovery of umbilicals (including umbilical jumpers)

The umbilical jumper is surface laid and will be completely removed from the seabed using specialist tools and lifting apparatus deployed from a vessel. The umbilical jumper will be mechanically disconnected into manageable sections, either by unbolting at existing connections, or by cutting at required locations, and recovered to shore. Following onshore disassembly, the jumper's component materials (predominantly steel and plastic) will, where possible, be recycled in accordance with the waste hierarchy. Non-recyclable materials, as a last resort, will be disposed of to landfill.

The sections of umbilical that are not sufficiently buried are those that make the transition from full burial to the seabed surface, those that rest on the seabed, and those for which the burial status is 'not stable'. These sections, where not covered in deposited rock, will be removed and recovered to shore using a vessel. The sections will either be lifted using the continuous 'reverse-reeling' method, or, lifted with specialist apparatus after being cut into manageable sub-sections using a specialist tool deployed from the vessel.

Following onshore disassembly, the umbilical's component materials (predominantly steel and plastic) will, where possible, be recycled in accordance with the waste hierarchy. Non-recyclable materials, as a last resort, will be disposed of to landfill.

Access to the circumference of the umbilicals and umbilical jumper for disconnection may require the deployment of water jetting or suction tools from the vessel to locally excavate (displace) sediment, or to locally remove marine growth[12]. The excavations containing the cut ends of the umbilical sections that will be subject to *in situ* decommissioning will be left to naturally back fill with sediment.

In summary:

- Local (as required) excavation of sediment at required cut locations to permit access to the umbilical and umbilical jumper circumference for the unbolting or cutting tool;
- Local (as required) excavation of sediment along the umbilical in preparation for lifting (de-burial);
- Mechanical disconnection (using an unbolting or cutting tool);
- Lifting of cut sections of pipeline from on, or within, the seabed by, and to a vessel either individually and directly, or in batches following their temporary seabed placement within a basket; and
- Removal of umbilical sections from on, or within, the seabed using 'reverse-reel', or 'cut and lift' (of individual sections), methods.

3.7.1.6 Execution of the decommissioning and post-decommissioning survey and monitoring programme

- Use of vessels to deploy acoustic and environmental survey equipment, and bottom trawl apparatus.

[12] Excavation of sediment and clearance of marine growth will be accomplished using a high pressure/low volume or low pressure/high volume water-jetting tool, or a suction tool.

3.7.2 Onshore

3.7.2.1 Processing and management of recovered materials

- The light processing (cleaning, cutting, crushing etc. but excluding recycling) of recovered materials at a shore base by a variety of plant and equipment in preparation for their preferential reuse or recycling, else disposal to landfill.

3.8 Vessel use

Offshore decommissioning activities will take place in four principle geographical areas, and under two principal operational modes, namely:

- At, and in the vicinity of, the Ann template, Alison template and Alison tee, the Audrey B (XW) platform and the LOGGS platform complex, vessel supported subsea operations predominantly for the removal and recovery activities; and
- Along the length of the Ann gas export line (PL947), the Ann umbilical (PL948) and the Alison umbilical (PL1099), predominantly for surveying and monitoring and the removal of the first *c.*8km of the Alison umbilical.

A range of vessel types (e.g. DSV, survey vessel) will be required at various times, and for various durations, to undertake particular component activities of the offshore decommissioning programme. The fuel consumption rate of the generic vessel types required are understood which, in conjunction with the anticipated vessel schedule, has allowed fuel consumption to be calculated (Table 3-20).

Estimates of fuel use are based on Institute of Petroleum Guidelines (IoP, 2000). The durations given allow for transit to and from the site as well as the operations. The vessel durations given are worst case estimates.

VESSEL				FUEL USAGE (Te)		
TYPE	DURATION (Days)					
	Ann	Alison	Total	Ann	Alison	Total
DSV, CSV	67	49	116	938	686	1,624
Burial Survey Vessel	8	4	12	172	86	258
Environmental Survey Vessel	6	6	12	129	129	258
Fishing Vessel	11	7	18	44	28	72
TOTAL			**158**			**2,212**

Table 3-20: Vessel requirements for the Ann and Alison decommissioning scope (including legacy surveys)

3.8.1 Decommissioning and post-decommissioning survey and monitoring programme

A seabed debris survey, a pipeline and umbilical ‘as left’ trenching and burial status survey, and a seabed over-trawl assessment will be undertaken at the end of decommissioning activities.

Post-decommissioning assessments of the trenching and burial status of the pipeline and umbilicals that were decommissioned *in situ*, and of the environmental status of the seabed will be undertaken. While the exact timing and extent of required 'legacy' monitoring will be agreed with the BEIS for the purpose of this assessment, at least two such rounds will be undertaken. The estimates of survey vessel days used in Table 3-20 are based upon this minimum requirement and allow for both vessel mobilisation and demobilisation. It should be noted however that legacy monitoring of decommissioned Ann and Alison Field infrastructure will be undertaken in combination with other Centrica surveying requirements at the time in the SNS and that actual required vessel days are likely to be lower.

3.9 Management of waste and recovered materials

Recovered materials will be returned to a pre-determined shore base for initial laydown.

All sites and waste carriers will have appropriate environmental and other operating licences in order to carry out this work and will be closely managed within contractor assurance processes.

Non-hazardous material includes scrap metals (steel, aluminium and copper), concrete and plastics that are not cross-contaminated with hazardous material. Hazardous materials will include oil contaminated materials and chemicals. There is no asbestos expected from the Ann and Alison facilities.

Many types of hazardous waste generated during decommissioning are also routinely generated during production and maintenance of offshore installations. However, the decommissioning process may generate significantly greater quantities of both non-hazardous and hazardous waste when compared to routine operations and as such requires appropriate management.

Approximately 571 zinc anodes were installed on the infrastructure and pipelines; however, it is anticipated that a large amount of zinc in each anode will have been oxidised since installation and therefore it is expected that the anodes will be greatly reduced in weight.

Pipework that has been exposed to produced fluids may be contaminated by Naturally Occurring Radioactive Material (NORM).

Centrica holds a permit issued by the Environment Agency allowing it to accumulate and dispose of radioactive waste containing NORM in the form of solid waste arising from the production of oil and gas at its Ann and Alison Fields. The permit limits the amount of solid radioactive waste that can be held on site at any one time, and requires solid wastes to be disposed of within certain time limits by transfer to operators who are themselves permitted to receive and dispose of these wastes.

3.10 Decommissioning schedule

The proposed schedule for the Ann and Alison Fields decommissioning is shown in Table 3-21. The proposed schedule for the other A-Fields decommissioning (Annabel and Audrey Fields) which are not considered within this EIA are shown in Table 3-22 for reference and in order to consider cumulative environmental impacts of the decommissioning of the Ann and Alison Fields.

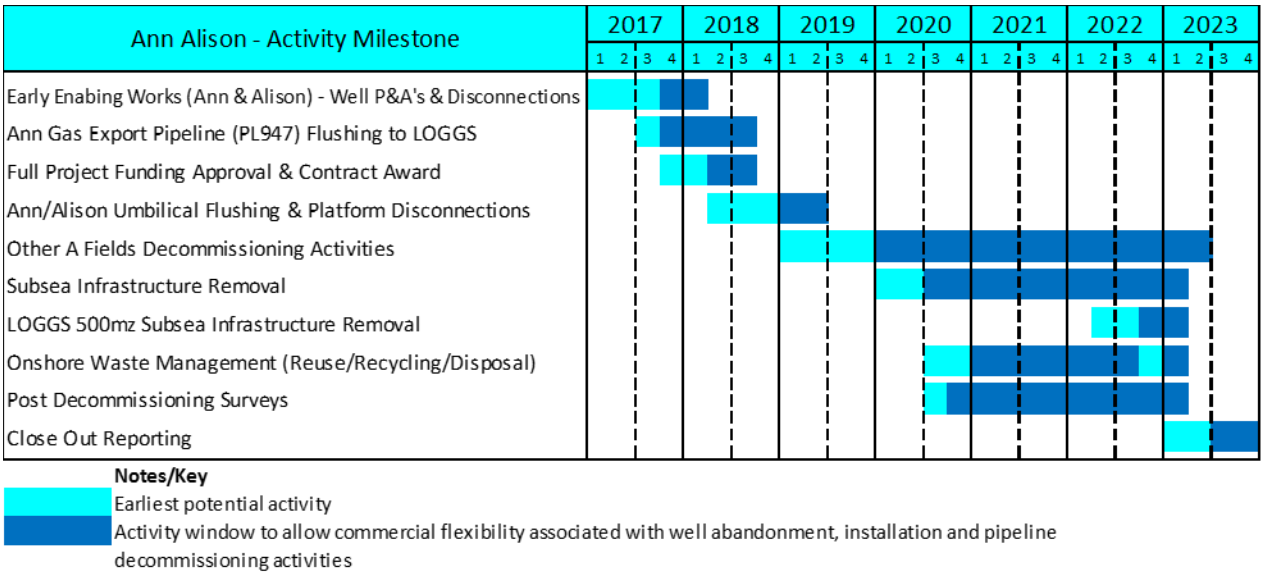


Table 3-21: Proposed Ann and Alison Fields decommissioning schedule

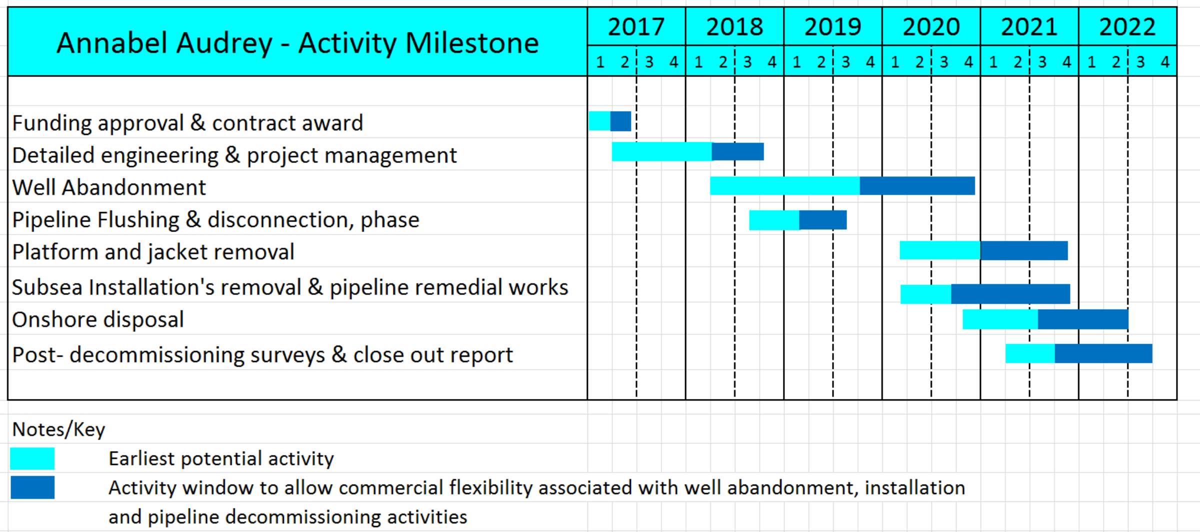


Table 3-22: Proposed Annabel and Audrey Fields decommissioning schedule

4. ENVIRONMENTAL BASELINE

This section provides an overview of the key environmental features in the vicinity of the Ann and Alison subsea infrastructure. The sensitivities in the location and the surrounding area that may be affected by the proposed decommissioning works are identified which the includes the area along the pipeline routes and the area around the Audrey B (XW) platform and the LOGGS platform complex. The information will be used to assess the level of impact that the aspects (activities with the potential to impact the environment) have on the environment.

4.1 Environmental surveys

A number of surveys have been undertaken in the vicinity of the Ann and Alison infrastructure and the wider A-Fields area prior to decommissioning. These surveys, which are detailed in Table 4-1, inform the environmental baseline and the impact assessment.

Geophysical data were acquired across the Audrey A (WD), Audrey B (XW), Annabel and LOGGS survey areas utilising Side Scan Sonar (SSS), Single Beam Echo Sounder (SBES) and Multibeam Echo Sounder (MBES) to accurately confirm water depths and seabed material, and to locate and identify any environmental habitats, seabed features or debris.

Seabed sampling was conducted with a double van Veen grab (2 x 0.1m^2). Four samples were acquired from two deployments at each station; one sample was retained for physico-chemical sub-sampling and three samples retained and screened through a 0.5mm mesh size sieve to provide benthic macrofaunal samples.

Figure 4-1 shows the extent of the pre-decommissioning survey coverage within the A-Fields area. The results and the location of sampling locations are discussed in more detail in the relevant sections.

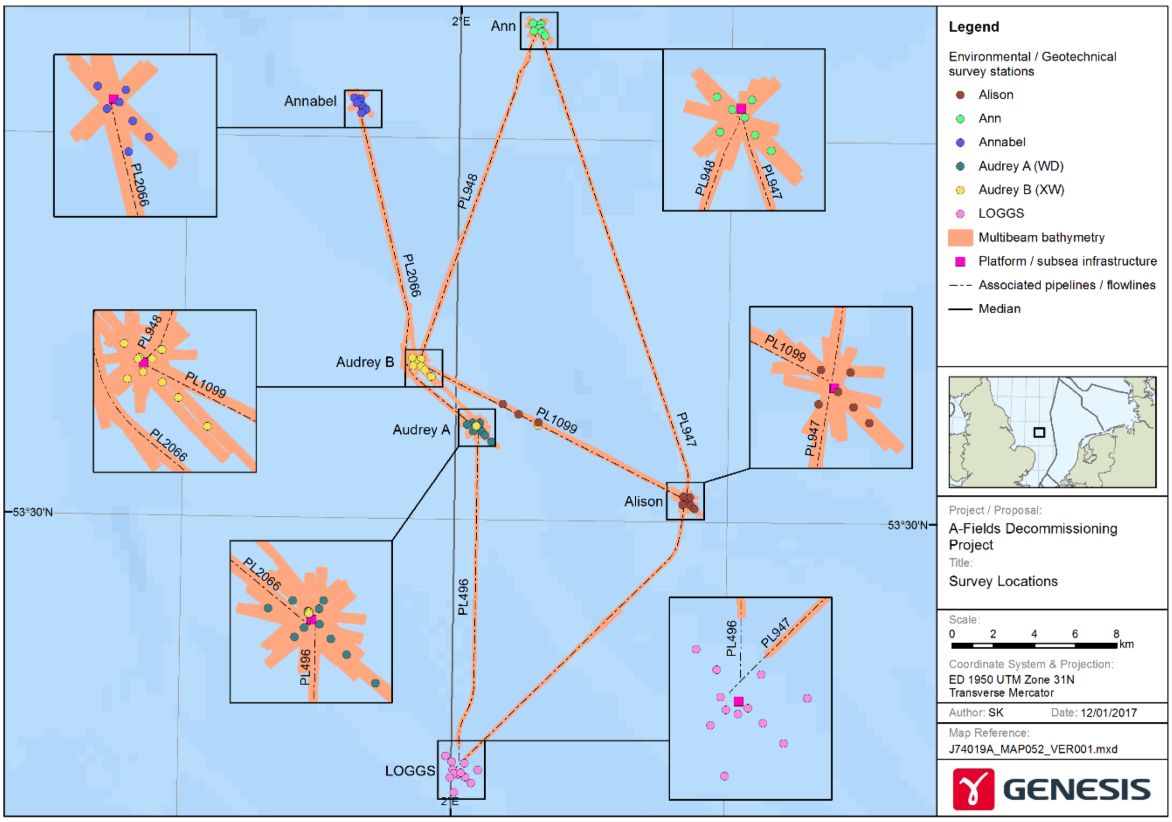


Figure 4-1: Pre-decommissioning survey coverage of the A-Fields

TITLE	SURVEY COMPONENTS	REFERENCE
Ann Pre-Decommissioning Survey	Geophysical seabed survey at Ann and pipeline/umbilical status and seabed surveys along PL947, PL948, PL2164 and PL2165 including mattressing status assessments (with remotely operated vehicle (ROV) visuals). Habitat assessment and environmental baseline site survey at Ann.	Gardline Geosurvey Ltd, (2016a)
Alison Pre-Decommissioning Survey	Geophysical seabed survey at Alison and pipeline/umbilical status and seabed surveys along PL1099 and the tie in line to tee including mattressing status assessments (with ROV visuals). Habitat assessment and environmental baseline site survey at Alison and along PL1099 (KP4.3 – KP6.8).	Gardline Geosurvey Ltd, (2016b)
Audrey A (WD) to Audrey B (XW) Pre-decommissioning Survey	Geophysical seabed survey at Audrey A (WD) and Audrey B (XW) and pipeline/umbilical status and seabed surveys along PL496, PL497, PL575, PL576, PL723 and PL724 including mattressing status assessments (with ROV visuals). Habitat assessment and environmental baseline at Audrey A (WD) and Audrey B (XW). Drill cuttings pile survey.	Gardline Geosurvey Ltd, (2016c)
Annabel Pre-Decommissioning Survey	Geophysical seabed survey at Annabel and pipeline/umbilical status and seabed surveys along PL2066 and PL2067 including mattressing status assessments (with ROV visuals). Habitat assessment, environmental baseline and herring spawning ground assessment at Annabel.	Gardline Geosurvey Ltd, (2016d)
SNS Decommissioning Survey LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD and Europa EZ Habitat Assessment Report	Geophysical data were acquired across all five areas (LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD and Europa EZ platforms) utilising SSS and (MBES to accurately confirm water depths and seabed material and to locate and identify any environmental habitats, seabed features or debris.	Gardline Environmental Limited, (2015a)
SNS Decommissioning Survey LOGGS Gas Fields (LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD and Europa EZ) Pre-decommissioning Survey Report	The objective was to obtain baseline physico-chemical and faunal data around the LOGGS Hub, Mimas MN and Ganymede ZD installations, prior to decommissioning. No environmental sampling or imagery work was undertaken in the South Valiant TD or Europa EZ survey areas. Geophysical data were acquired across all five areas utilising SSS, single bean echo sounder (SBES) and MBES to accurately confirm water depth and seabed material, and to locate and identify any environmental habitats, seabed features or debris.	Gardline Environmental Limited, (2015b)

Table 4-1: Pre-decommissioning surveys in the vicinity of the A-Fields

Ann

Seven environmental stations (ENV1 to ENV7) were pre-selected by Centrica with Station ENV1 situated on a suspected drill cuttings pile (Figure 4-2). After review of the geophysical data, seabed camera photography and video at Station ENV1, the suspected drill cuttings pile was confirmed to be an anthropogenic deposited rock, and seabed sampling was cancelled at this location (Gardline Geosurvey Ltd, 2016a).

Alison

Six environmental stations ENV8 to ENV13 were pre-selected by Centrica offset at various distances from the Alison template and Alison tee (Figure 4-3) (Gardline Geosurvey Ltd, 2016b).

Audrey B (XW)

Eleven environmental stations ENV33 to ENV43 were pre-selected by Centrica with ENV33, ENV34 and ENV35 situated on a suspected drill cuttings pile (Figure 4-4). These station locations were amended after review of geophysical survey data notably with the replacement of Station ENV35 which was selected too close to the Audrey B (XW) platform (59m north-north-west) and was cancelled in the field, and another Station ENV47 was selected slightly further afield (73m north-west of Audrey B (XW)) (Figure 4-4) (Gardline Geosurvey Ltd, 2016c).

The LOGGS platform complex

Geophysical data were acquired utilising SBES and SSS. These data covered an area of 2km x 2km at each installation surveyed (Gardline Environmental Limited, 2015a). A total of 11 environmental stations were sampled around the LOGGS platform complex (Figure 4-5:).

4.2 Metocean conditions

In order to design, operate and decommission offshore installations in a safe and efficient manner, it is essential to have a good understanding of the metocean (meteorological and oceanographic) conditions to which the installation may be exposed. Sediment type, currents, tides and circulation patterns all influence the type and distribution of marine life in an area. Metocean conditions also influence the behaviour of emissions and discharges (including spills) from offshore facilities. For example, the speed and direction of water currents have a direct effect on the transport, dispersion and ultimate fate of any discharges from an installation while sediment type can influence the levels of contaminants that may be retained in an area.

4.2.1 Bathymetry

Ann

The natural seabed within the area of the Ann Template shows low relief and is gently undulating and largely covered with megaripples. Within 75m of the Ann Template and Ann A4 WHPS, water depths vary from 27.9 to 29.7m LAT (Figure 4-2).

Natural water depths across the area deepen very slightly from 28.4m in the north-west to 29.3m in the south-east. Current induced seabed scouring is evident around the seabed infrastructure and rock deposits and has caused artificial bathymetric highs and lows. Broad current induced scoured depressions, approximately 0.8m deep, occur to the south-west and north-east of both the Ann template and the Ann A4 WHPS (Figure 4-2). A further current induced scoured depression occurs around the pipeline PL948 to the south of the Template which is 70m long, 35m wide and up to 1m deep.

A maximum water depth of 30.2m has been identified alongside the mattressing at PL948, whilst a minimum depth of 27.3m has been identified on the crest of the deposited rock to the east of the Ann Template. The megaripples, which extend across the surveyed area, have a south-west, north-east orientation and show typical heights of 0.2m and average wavelengths of about 10m (Gardline Geosurvey Ltd, 2016a).

Alison

The natural seabed within the survey area at Alison is almost flat, demonstrating very low relief. Within 75m of the Alison manifold, water depths range from 25.2m LAT in the south-south-east to 25.6m in the east-south-east. Beyond the immediate vicinity of the Alison manifold, very similar flat seabed conditions continue whilst the seabed very gently shoals to less than 25m LAT towards the south (Gardline Geosurvey Ltd, 2016b) (Figure 4-3).

Audrey B (XW) platform

The Audrey B (XW) platform lies at the end of the Swarte Bank (Figure 4-33) one of the sandbanks in the North Norfolk Sandbanks and Saturn Reef SAC (Section 4.5.1.1). At Audrey B (XW), the natural seabed is almost flat, lying at a depth of approximately 24.5m LAT. The platform lies in a trough, midway between two large south-west, north-east trending sandwaves with south-east facing lee slopes (Figure 4-4). The sand wave crests lie at water depths of 21-22m, standing 1.5-2m above the local seabed level. Between the major sandwaves, the seabed shows numerous megaripples. These are less than 0.5m high and are particularly insignificant in the immediate area of Audrey B (XW) (Gardline Geosurvey Ltd, 2016c).

The LOGGS platform complex

The LOGGS platform complex lies at the end of Broken Bank (Figure 4-33) another of the sandbanks in the North Norfolk Sandbanks and Saturn Reef SAC (Section 4.5.1.1). Depths at the LOGGS platform complex surveyed in 2015 ranged from *c*.12.5m LAT in the south-east, to *c.*28.4m LAT in the north-east (Figure 4-5). In the central and western regions of the surveyed area, the seabed was characterised by north-east to south-west orientated sandwaves with a maximum height of 7.6m and an average wavelength of *c*.175m (Gardline Environmental, 2015a).

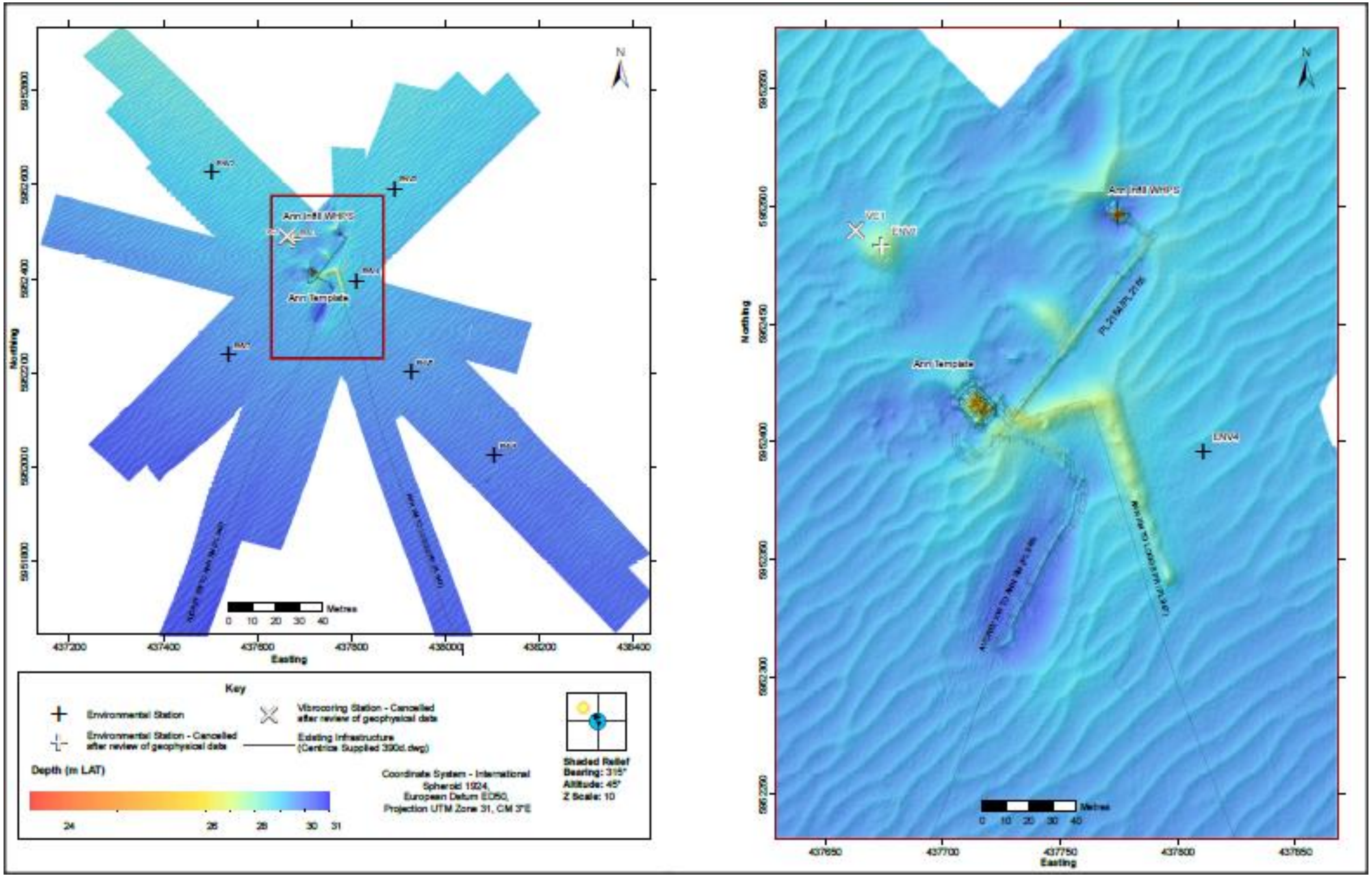


Figure 4-2: Colour shaded relief of bathymetry around the Ann template and Ann A4. The location of the environmental sampling stations is also shown (Gardline Geosurvey Ltd, 2016a).

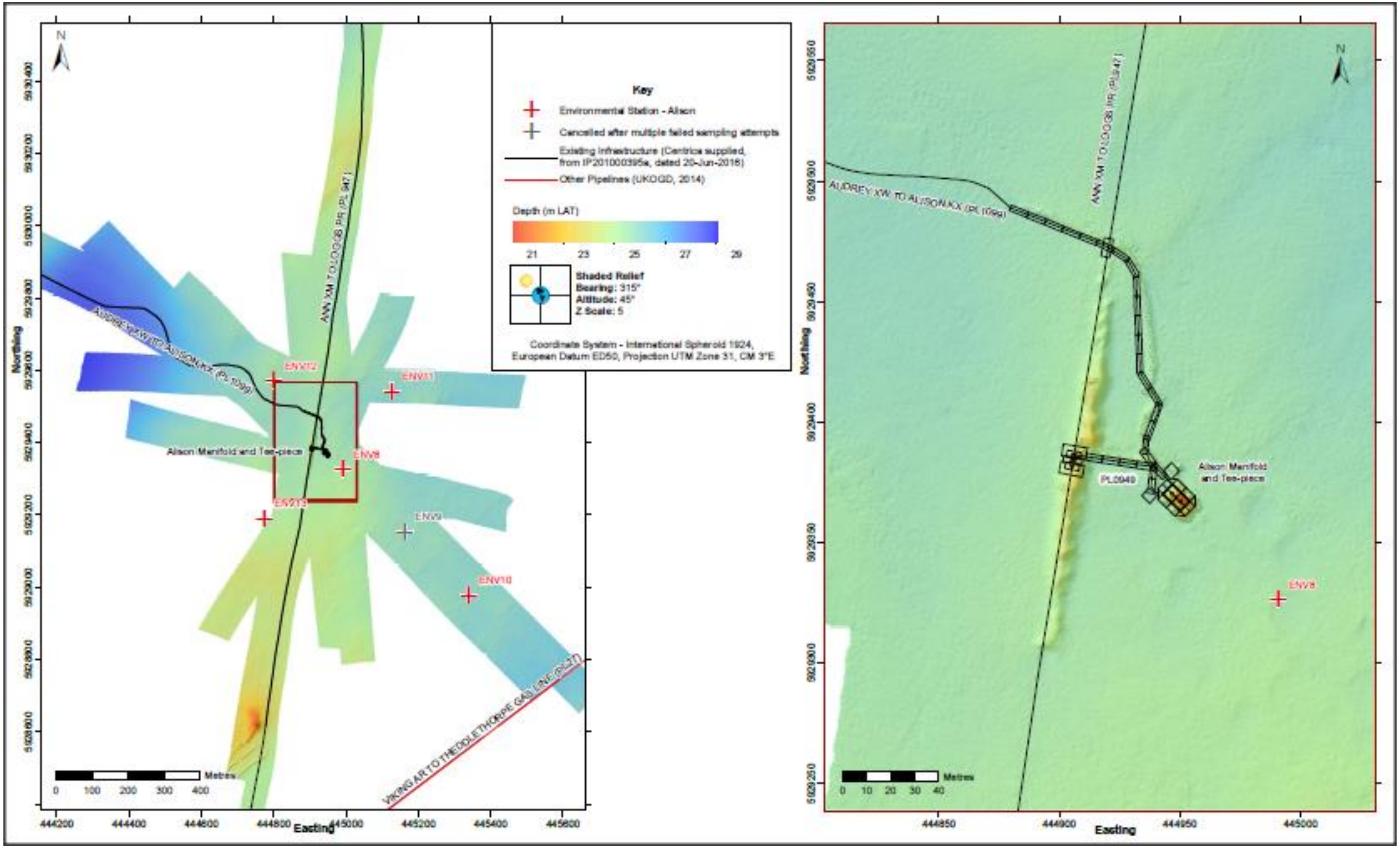


Figure 4-3: Colour shaded relief of bathymetry at the Alison tee. The location of the environmental sampling locations is also shown (Gardline Geosurvey Ltd, 2016b).

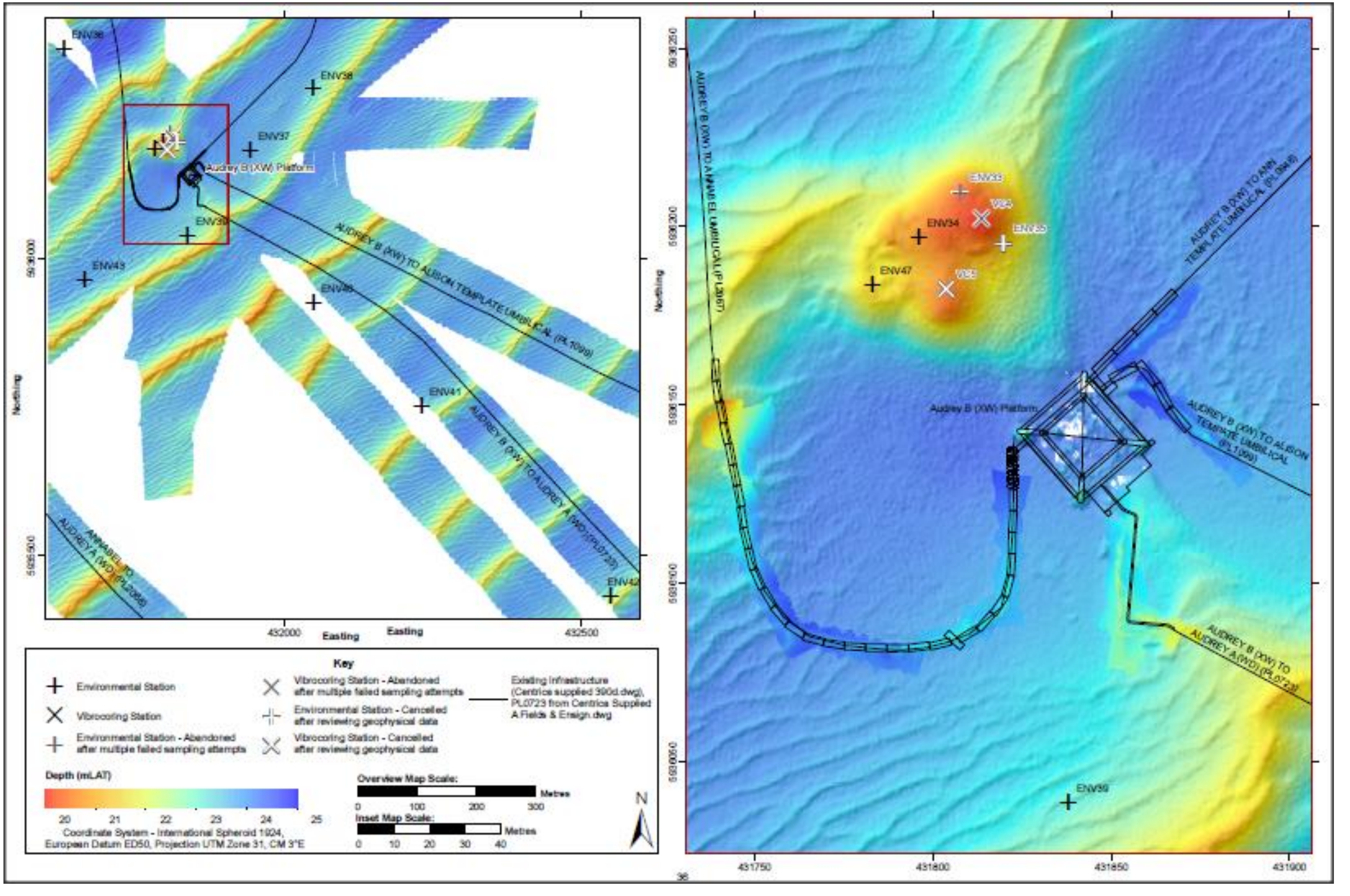


Figure 4-4: Colour shaded relief of bathymetry at the Audrey B (XW) platform. The location of the environmental sampling locations is also shown.

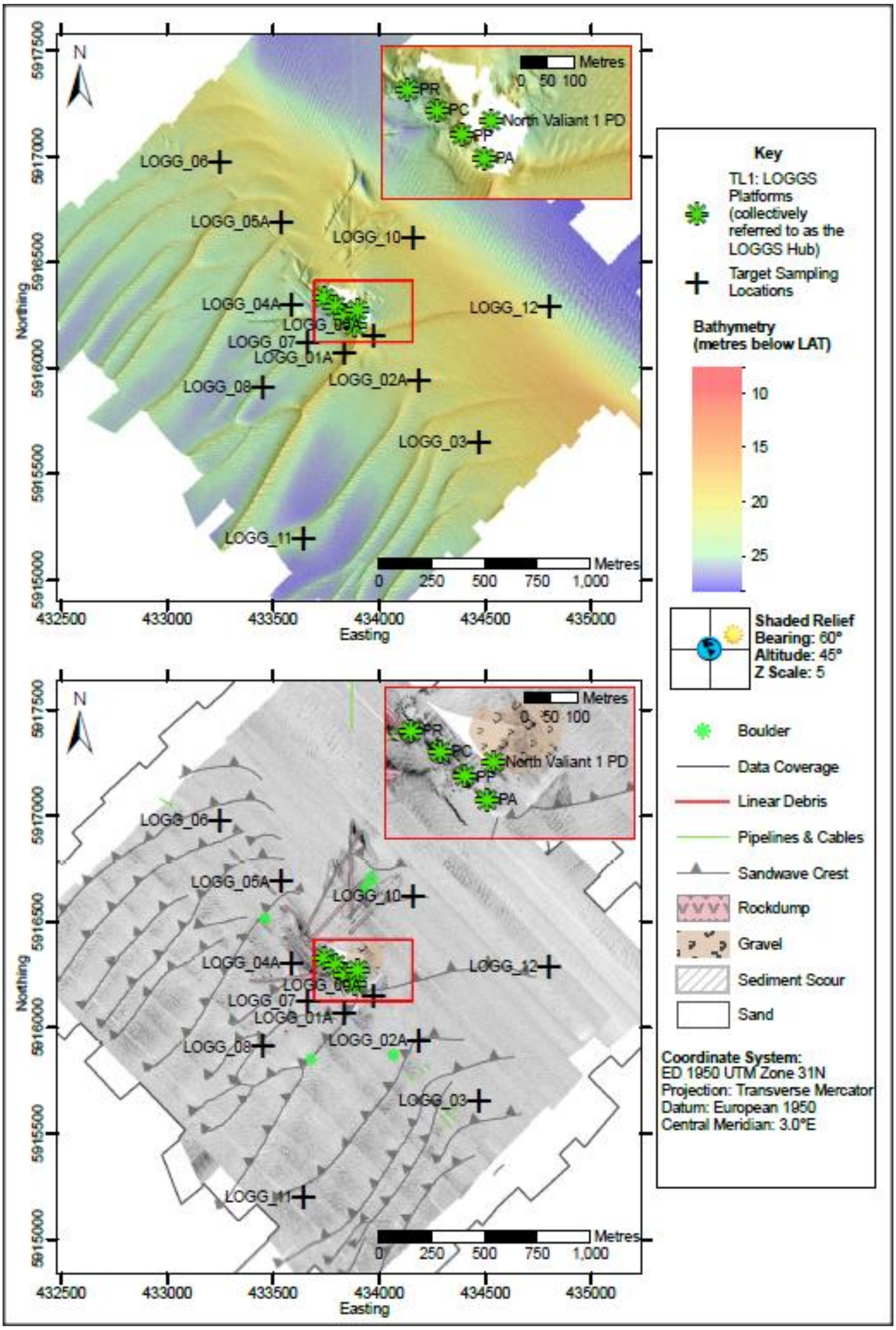


Figure 4-5: Colour shaded relief of bathymetry and seabed features at the LOGGS gathering station. The location of the environmental sampling locations is also shown. (Gardline, 2015)

4.2.2 Hydrology

Water circulation in the North Sea is anticlockwise, with the main inflow occurring along the western slopes of the Norwegian Trench. Minor inflows from the English Channel and the Baltic Sea supplement this flow, as shown in Figure 4-6. Frontal zones, marking boundaries between water masses including tidally mixed and stratified (layered) water are numerous in the North Sea. The water column of the SNS remains mixed throughout the year while to the north it becomes layered (stratified) in summer (DTI, 2002).

The maximum tidal current speed in the A-Fields area during mean spring tides is between 0.51m/s and 1.02m/s (1-2 knots) (BODC, 1998). Surge and wind–driven currents, caused by changes in atmospheric conditions, can be much stronger and are generally more severe during winter. The annual mean significant wave height is between 1.51m and 1.80m (Scottish Government National Marine Plan Interactive (NMPI), 2016).

During storms, the re-suspension and vertical dispersion of bottom sediments due to waves and currents affects most of the North Sea. The storm surge elevation in the A-Fields area is *c.*1.75-2m with a return period of 50 years (BODC, 1998).

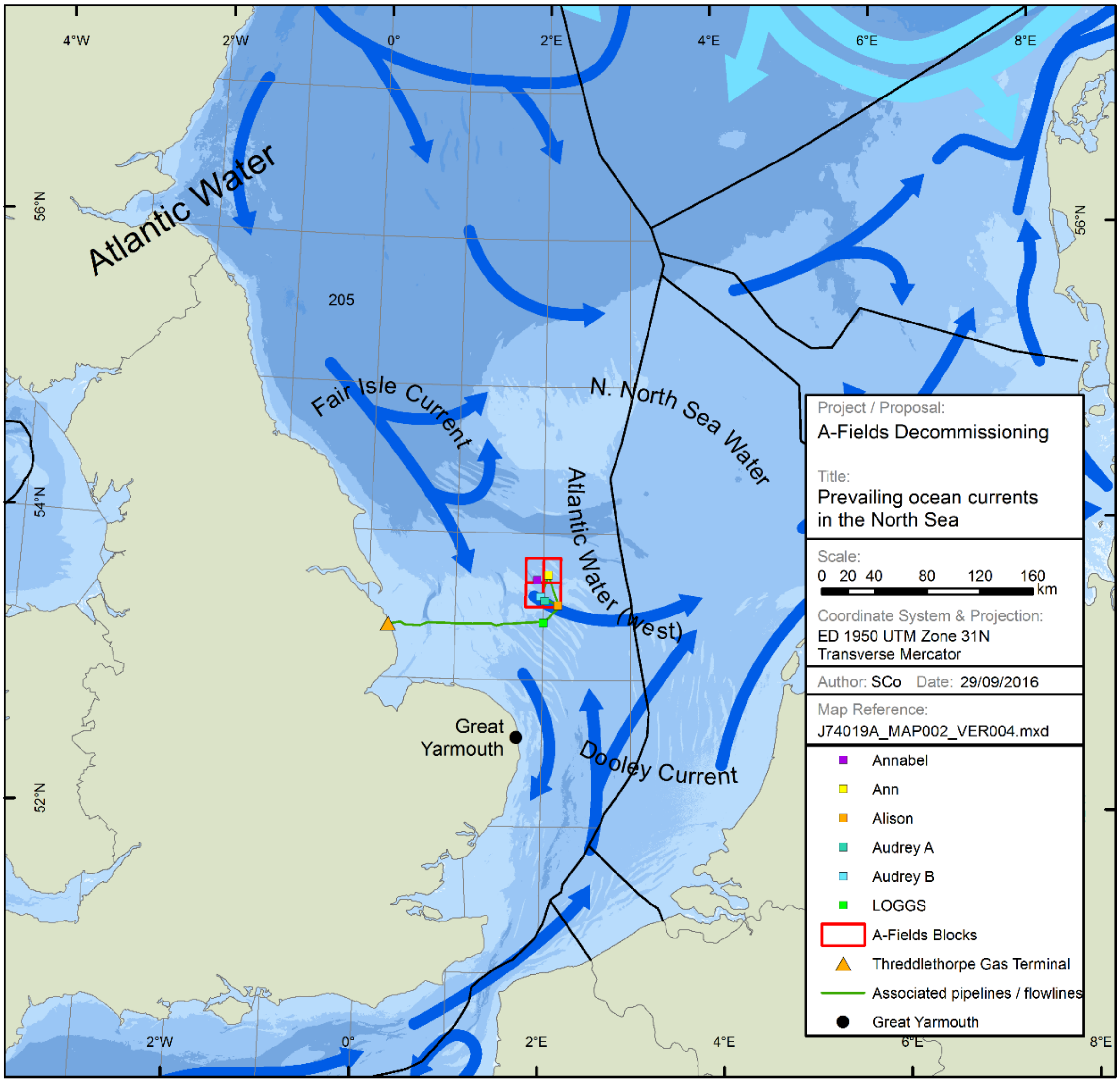


Figure 4-6: General water circulation of the SNS

4.2.3 Meteorology

Wind speed and direction directly influence the transport and dispersion of atmospheric emissions from an installation. These factors are also important for the dispersion of water borne emissions, including oil, by affecting the movement, direction and break up of substances on the sea surface.

Winds in the SNS can occur from all directions, with speeds generally representing moderate to strong breezes (6-13m/s) (DTI, 2001).

4.2.4 Temperature and salinity

There is little difference between water temperatures on the sea surface and sea bottom in this shallow water area. Annual mean temperatures are between 10-11°C for both surface and seabed temperatures (NMPI, 2016).

Fluctuations in salinity are largely caused by the addition or removal of freshwater to/from seawater through natural processes such as rainfall and evaporation. The salinity of seawater around an installation has a direct influence on the initial dilution of aqueous effluents such that the solubility of effluents increases as the salinity decreases. Salinity in the area shows little seasonal variation, with water salinities reported as *c.*34.5‰ throughout the year (NMPI, 2016).

4.3 The seabed

The nature of seabed sediments is an important factor in providing information to help assess the potential for re-suspension and transport of sediments. It is also a determining factor in the flora and fauna present and for their suitability as spawning and nursery grounds.

Sediment erosion and transport in the SNS is driven by the strength and direction of tides and currents, and is influenced by the susceptibility of the source rock type to erosion (BGS, 2002). The shallow water and active current regime in the SNS produces a high energy environment which results in a relatively thin sediment layer. Sands and gravelly sands are the principal component in nearshore areas, with finer sediments becoming dominant as the water deepens further offshore (Wallingford, 2002).

The A-Fields partly lie within the North Norfolk Sandbanks and Saturn Reef, details of which can be found in Section 4.5. The formation of the different sedimentary features depends on current strength and sand availability (Belderson *et al*., 1982). With increasing currents, the following series of bedforms is observed: megaripples, sandwaves, sand banks, sand ribbons and finally sand streams. If the sand supply decreases, sand banks will be cannibalised to form sand ribbons and sand streams, sand patches replace fields of megaripples and the other types of bedforms will appear less frequently (Figure 4-7).

Below is a definition of sand banks, sandwaves and megaripples which are a feature of the A-Fields area.

4.3.1 Sandbanks

The majority of sandbanks in the North Norfolk area of the SNS are considered to be large-scale mobile seabed forms in dynamic equilibrium with the environment. They can have a wavelength between 1 and 10km, and they can achieve a height of several tens of metres (van der Veen and Hulscher, 2009). Sandbanks are found widely on shallow continental shelves where there is an abundance of sand and where currents exceed a certain speed (Kenyon and Cooper, 2005) (Figure 4-7). This speed is much more than is needed to move seabed sediment and sand banks arise from an inherent instability of a seabed subject to tidal flow and mass transport. They can go from being active to a dying state, stranded in weak currents as the sea level rises.

4.3.2 Sandwaves

Sandwaves are a periodic bottom waviness generated by tidal currents in shallow tidal seas. Typical wavelengths range from 100 to 800m and they can be up to between 1 and 5m high (Figure 4-7). The crests are almost orthogonal to the direction of tide propagation. They are not static bedforms and migration speeds can be up to tens of metres per year.

When local tidal flows interact with a bottom waviness it generates a steady streaming in the form of recirculating cells. When the steady velocity drags the sediment from the troughs towards the crests of the waviness, sandwaves tend to appear. They can be complex to model, and subtle changes to the environment can change the dynamics of the local interaction between the tidal flows and the seabed.

4.3.3 Megaripples

Large, sandwaves or ripple-like features having wavelengths greater than 1m or a ripple height greater than 10cm; Megaripples are formed in a subaqueous environment, and they are also known as subaqueous dunes. They may be superimposed with smaller bedforms (Bates and Jackson, 1984).

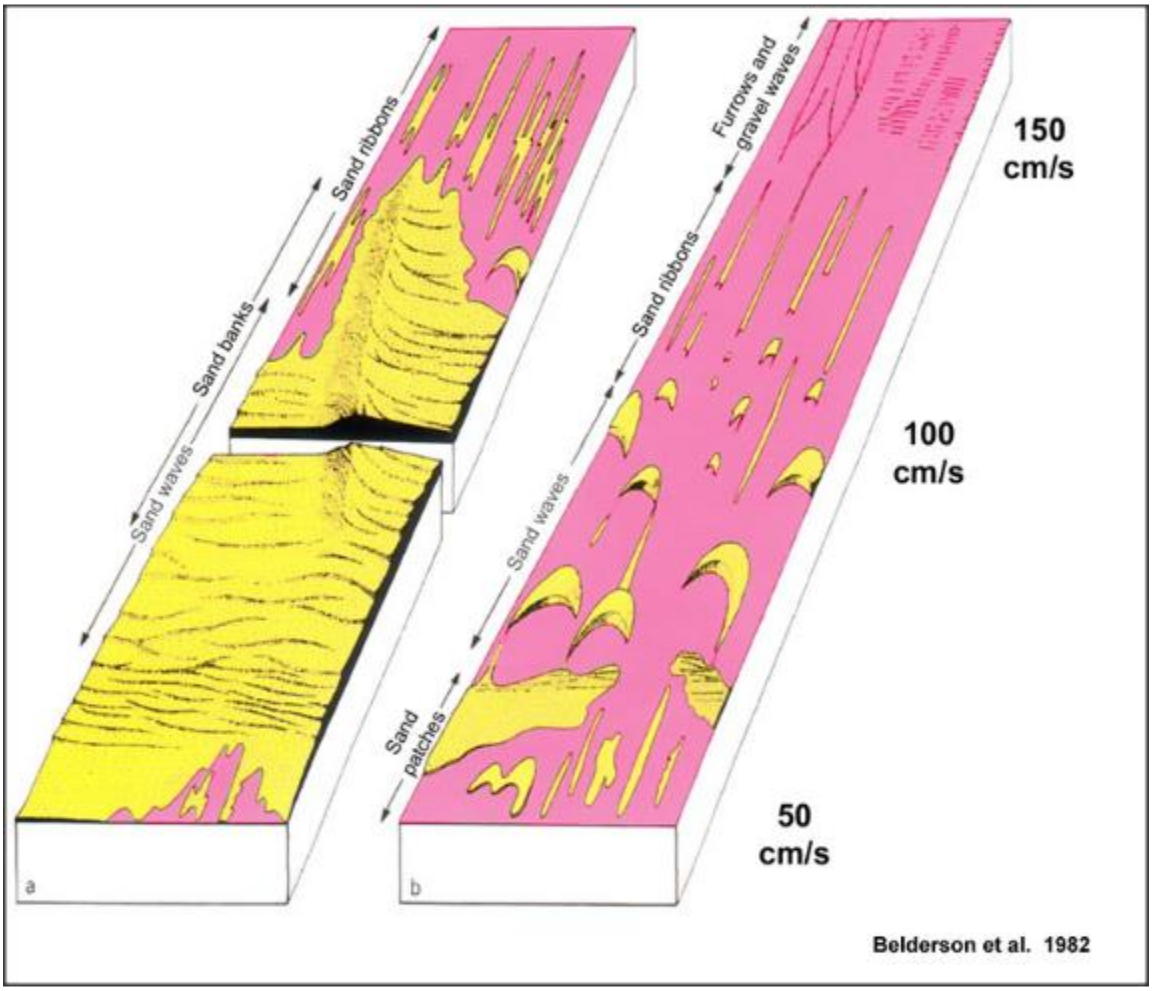


Figure 4-7: Sandwaves and sandbanks

4.3.4 Sediment characteristics

Ann

All stations within the Ann Template and Ann A4 WHPS area were classified as fine to medium sand under the Wentworth (1922) classification of mean grain size. Additionally, all stations were moderately sorted to moderately well sorted, displaying a unimodal distribution of size classes and as such the mode was also fine to medium sand under the Wentworth classification.

The mean particle diameter of sediments at all stations also showed homogeneity, varying between 220µm at Station ENV5 and 280µm at Station ENV6. The proportion of fine material (<63µm, silts and clays) varied between 3.8% at Stations ENV3 and ENV6 and 6.1% at Station ENV5, while percentages of gravel (≥2mm) were negligible throughout (≤0.2% at all stations). These homogeneous results throughout the area, with little fine material and negligible coarser particles, resulted in all stations within the Ann area described as Sand under the modified Folk (1954) classification (Gardline Geosurvey Limited, 2016a).

Alison

Sediments were defined as very poorly sorted, with a bimodal distribution. Stations ENV8 and ENV12 were dominated by pebbles according to the Wentworth (1922) classification of mode, with a secondary mode of medium sand, while Stations ENV10, ENV11 and ENV13 were dominated by medium sand, with a secondary mode of pebbles.

The mean particle diameter at all stations varied between 1,319µm at Station ENV12 and 6,676µm at Station ENV8. Percentages of fine material (<63µm, silts and clays) were below 5%, with the exception of Station ENV12 with 8.5% fines. The proportion of gravel-sized material (≥2mm) was between 43.2% and 45.6%, with the exception of Station ENV8 where coarse material represented 70.2% of the sample.

The relatively high proportion of gravel-sized material at all stations and generally low proportions of fine material resulted in the sediment being classified as sandy gravel under the modified Folk (1954) classification, with the exception of Station ENV12 where the sediment was classified as muddy sandy gravel (Gardline Geosurvey Limited, 2016b).

Audrey B (XW) platform

Sediments were generally homogeneous across the Audrey B (XW) survey area, where fines were mostly absent or in negligible (<1%) proportions, while gravel varied between 0.2% at Station ENV42 and 17% at Station ENV37. All stations, were therefore classified as sand, slightly gravelly sand or gravelly sand under the modified Folk (1954) classification (Gardline Geosurvey Limited, 2016c).

Seabed imagery supported the geophysical data interpretation, confirming the seabed sediments at Audrey B (XW) as sand with shell fragments and occasional gravel, pebbles and cobbles. Areas of abundant cobbles and boulders were visible at the transect Station ENV33 (covering Stations ENV33, ENV34 and ENV35) (Figure 4-4), which could correspond to a low resemblance stony reef, as listed under Annex I of the Habitats Directive as implemented by the Offshore Marine Conservation (Natural Habitats, &c.) Regulations (Gardline Geosurvey Limited, 2016c).

The LOGGS platform complex

Particle Size Analysis (PSA) generally supported the observations made at the time of sampling. Sediments across the LOGGS hub survey area were largely uniform with the mean particle diameter varying from 250µm at Station LOGG_06 to 362µm at Station LOGG_08.

All stations were dominated by sand (≥63µm to <2mm), which accounted for ≥98.9% at all stations. There was no fine material (<63µm) at any of the sampled LOGGS stations, and the proportions of gravel (≥2mm) were negligible, reaching a maximum recorded value of 1.1% at LOGG_07. For this reason, all stations were characterised as sand under the modified Folk classification, with the exception of Station LOGG_07, classified as slightly gravelly sand due to a proportion of gravel >1% (Gardline Environmental Limited, 2015b).

4.3.5 Seabed chemistry

4.3.5.1 Hydrocarbon concentrations

It has been previously shown that benthic macrofauna suffer adverse effects when Total Hydrocarbon Content (THC) is in excess of 50µg g^{-1} (UKOOA, 2002; Kjeilen-Eilertsen *et al*., 2004; UKOOA, 2005) and as such this value represents the threshold above which hydrocarbons are expected to have a 'significant environmental impact' (SEI). Following a review of studies on the effect of macrobenthos from hydrocarbon contamination, Gerrard *et al.,* (1999) identified a range of threshold values for ecological effects in the North Sea noting a change in community composition to be possible at THC concentrations from anywhere between 0.8µg g^{-1} and 10µg g^{-1}, reduced faunal diversity from anywhere between 3µg g^{-1} and 109µg g^{-1} and that a prevalence of opportunistic species would not be expected until anywhere between 31µg g^{-1} and 291µg g^{-1}. To put these values in to a wider regional context, UKOOA (2001) reported a mean THC of 4.3µg g^{-1} (measured by Gas Chromatography (GC)) for stations over 5km from existing infrastructure in the SNS between 1975 and 1995.

Ann

Concentrations of THC across the survey area were very low with ≤1.6µg g^{-1} at all stations and an average of 0.9µg g^{-1} across the area (Table 4-2), which is typical of sandy sediments. Concentrations were all below the UKOOA (2001) reported mean THC concentration of 4.3µg g^{-1} for stations over 5km from existing infrastructure in the SNS between 1975 and 1995. Additionally, concentrations were all below the SEI threshold of 50µg g^{-1}, reported as the concentration at which a macrofaunal community may suffer adverse effects (Kingston, 1992; UKOOA, 2002; Kjeilen-Eilertsen *et al*., 2004; UKOOA, 2005), below the minimum reported threshold value of 10µg g^{-1} considered to potentially influence faunal community composition through the loss of specific sensitive species (Kingston, 1992) and well below the reported threshold value of 291.4µg g^{-1} at which any opportunistic species would be expected to be prevalent (Mair *et al*., 1987).

GC across all stations revealed a low-level, high molecular weight (HMW) unresolved complex mixture (UCM), with a predominance of odd over even-numbered n-alkanes. This pattern suggested that the majority of sediment hydrocarbons in the Ann area were a low level mixture of biogenic material from terrestrial plant sources and highly weathered petrogenic material, typical of areas of historical oil and gas exploration such as the North Sea. Chromatograms also presented n-alkane resolved peaks within the nC_{16} to nC_{20} carbon range, with slightly higher concentrations of the nC_{17} n-alkane, which was thought to correspond to the presence of microbial degradation of phytoplankton in the area (McDougall, 2000).

Total polycyclic aromatic hydrocarbons (PAHs) concentrations were all below the 'Effects Range Low' (ERL) threshold (Long *et al*., 1995), indicating that these concentrations were unlikely to be associated with toxicity in the sediments. Overall, PAH distribution at all stations indicated a mixed input of petrogenic compounds likely derived from anthropogenic activities such as shipping and oil and gas exploration, and pyrogenic hydrocarbons from inputs such as atmospheric fallout and river discharges. At each station, the United States Environmental Protection Agency (US EPA) PAH concentrations were below their respective 'apparent effect thresholds' (AETs; Buchman, 2008), indicating that these concentrations would not have an ecotoxicological effect on the fauna.

Alison

THC concentrations were low and ranged from 0.8µg g^{-1} at Station ENV11 to 2.8µg g^{-1} at Stations ENV8 and ENV13. The average THC concentration across the survey area was 1.7µg g^{-1} comparable to the average of 1.4µg g^{-1} recorded in the LOGGS area (Gardline Environmental Limited, 2015b) (Table 4-2).

GC traces across all stations revealed a low-level HMW UCM, with predominance of odd over even-numbered n-alkanes. This pattern suggested that the majority of sediment hydrocarbons in the Alison Template and Alison tee and PL1099 (KP4.3 to 6.8) survey areas were a low level mixture of biogenic material from terrestrial plant sources and highly weathered petrogenic material, typical of areas of historical oil and gas exploration such as the North Sea. At several stations within the Alison survey area, pronounced n-alkane peaks across the chromatogram also suggested evidence of less weathered chronic low level petrogenic contamination from a non-drilling source such as shipping.

Total PAHs concentrations were below the ERL threshold at all stations, with the exception of Station ENV13 within the Alison Template and Alison tee area. This indicated that most concentrations across both areas were unlikely to be associated with toxicity in the sediments. Overall, PAH distribution at all stations indicated a mixed input of petrogenic compounds likely derived from anthropogenic activities such as shipping and oil and gas exploration, and pyrogenic hydrocarbons from inputs such as atmospheric fallout and river discharges. At each station, the US EPA PAH concentrations were below their respective AETs (Buchman, 2008), indicating that these concentrations would not have an ecotoxicological effect on the fauna.

Audrey B (XW) platform

With the exception of Station ENV47, THC concentrations across the survey area were ≤6.3µg g^{-1} with an average THC of 5.0µg g^{-1} (Table 4-2) and were below the threshold value of 4.3µg g^{-1} for stations over 5km from infrastructure in the SNS. Station ENV47, which was located on the area interpreted as deposited rock presented a THC concentration of 17.9µg g^{-1}. The highest THC concentrations were recorded at the stations closest to the Audrey B (XW) Platform, ≤*c.*100m south-east and north-west, and therefore could reflect low level dispersion of contamination in the vicinity of the platform and particularly on the deposited rock. All THC concentrations were below the SEI threshold and below the minimum threshold value considered for any opportunistic species to be prevalent. Therefore, whilst the THC concentration at Station ENV47 could not be considered as representative of background conditions in the SNS, this concentration was not expected to impact the faunal community.

GC at all stations showed a low-level, HMW UCM with a pattern of odd over even-numbered n-alkanes. This pattern suggested that the majority of sediment hydrocarbons were a low level mixture of biogenic material from terrestrial plant sources and highly weathered petrogenic material, typical of areas of historical oil and gas exploration such as the North Sea.

Total PAHs and NPD PAH concentrations were below their respective AETs at all stations indicating these concentrations were not thought to present a potential ecotoxicological impact on the macrofauna. The concentration of NPD PAH at Station ENV40 was, however, above its ERL, indicating that it could potentially be associated with toxicity in the sediments. Overall, PAH distribution at most stations presented <50% of petrogenic NPD compounds likely derived from anthropogenic activities such as shipping and oil and gas exploration, and were dominated by pyrogenic HMW compounds from inputs such as atmospheric fallout and river discharges.

The LOGGS platform complex

THC concentrations were low and ranged from 0.5µg g^{-1} to 2.6µg g^{-1} with an average THC of 1.4µg g^{-1} (Table 4-2). This range of concentrations is well below the SEI threshold and well below the UKOOA (2001) regional background level.

The UCM accounted for 83% to 100% of the THC at all stations within the LOGGS platform complex indicating that the majority of hydrocarbons were well weathered at all stations (Gardline Environmental Limited, 2015b).

SURVEY	THC	UCM	nC_{10-20}	nC_{21-37}	nC_{10-37}	CPI[1]	Pristane (Pr)	Phytane (Ph)	Pr/Ph Ratio	NPD[2]	Total PAH	NPD[3]/ 4-6 Ring
Ann[3]	0.9	0.8	0.036	0.062	0.098	2.6	0.008	NC	3.2	0.010	0.022	1.0
Alison manifold[4]	1.7	1.4	0.115	0.204	0.319	1.5	0.035	0.011	3.2	0.078	0.145	1.2
Audrey A (WD)[5]	1,342	1,330.4	7.231	1.110	8.341	1.8	3.757	0.076	12.4	0.592	0.708	2.5
Audrey B (XW)[5]	5.0	4.8	0.075	0.086	0.161	1.8	0.020	NC	NC	NC	0.040	NC
Annabel[6]	5.0	4.5	0.173	0.318	0.491	1.6	0.035	0.008	4.9	0.074	0.127	0.9
LOGGS[7]	1.4	1.3	0.053	0.069	0.122	1.5	0.017	0.004	3.0	NC	NC	NC

Unless indicated, concentrations expressed as mean µg g^{-1} dry sediment

NC - Not calculated due to one or more values below the LOD.

[1] Calculated using $2(nC_{27} + nC_{29})/nC_{26} + 2(nC_{28}) + nC_{30}$.

[2] Naphthalenes, phenanthrenes and dibenzothiophenes (total).

[3] Gardline Geosurvey Limited (2016a)

[4] Gardline Geosuvey Limited (2016b)

[5] Gardline Geosuvey Limited (2016c)

[6] Gardline Geosurvey Limited (2016d)

[7] Gardline Environmental Limited, (2015b)

Table 4-2: Summary of sediment hydrocarbon analyses across the A-Fields. Average values are presented

4.3.5.2 Metal concentrations

Concentrations of arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni), lead (Pb), selenium (Se), tin (Sn), vanadium (V) and zinc (Zn) were all determined by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) following 50% nitric acid extraction. Concentrations of aluminium (Al), barium (Ba), iron (Fe), lithium (Li), magnesium (Mg) and strontium (Sr) were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) following the same extraction technique.

Where available, metals data were compared to OSPAR (2005) background concentrations (BC) and background assessment criteria (BACs, and where these were not available, to OSPAR background/reference concentrations (BRCs) (OSPAR, 1997). Concentrations of all metals were normalised to 5% Al for comparison to these values.

Ann

Ba can be an important element in the detection of localised anthropogenic sediment pollution. It is often used in the form of barite (barium sulphate; $BaSO_4$) as a weighting agent in drilling fluids and hence Ba can occur in high concentrations in sediments surrounding drilling activity, particularly when drill cuttings have been deposited on the seabed. Barite is predominantly insoluble in oxic seawater, although it may be mobilised under anoxic conditions and therefore can provide a useful indication of drilling mud dispersion since discharge. All stations across the Ann survey area presented low and homogeneous Ba concentrations <30µg g^{-1} with an average Ba concentration of 18.8µg g^{-1} across the Ann survey area (Table 4-3). There were no correlations between Ba and sediment characteristics, hydrocarbon concentrations or other metals. Ba concentrations could therefore not be linked to anthropogenic activities across the survey area, but were likely related to the homogeneous sediments characteristics.

All detectable concentrations of As, Cr, Cu, Ni, Pb and Zn were above their respective BCs, with all averages of these metals also above their respective BACs. All detectable concentrations of Fe, Li and V were above the upper limit of their respective BRC ranges (Table 4-3).

These patterns indicated that most metals within the survey area presented concentrations above background, and above concentrations expected in areas where certain activities such as oil and gas exploration would not be present. This was an expected outcome of this comparison as the area has been shown to be heavily industrialised, notably due to oil and gas exploration.

Alison

The average Ba concentration of 80.5µg g^{-1} across the Alison Template and Alison tee survey area was found higher and more variable than those of the previous LOGGS surveys of 13.7µg g^{-1} (Table 4-3). Further, Ba significantly positively correlated with mean particle size; Station ENV8 also recorded a comparatively higher mean particle size of 6,676µm. Although this correlation suggests the higher concentrations observed in the current survey may be possibly linked to the larger sediment diameter, this is contrary to the typical relationship of contaminant retention within the chemically active fine and organic sediment fraction of sediment (<63µm, silt, clay) coupled with the combined overall larger surface area.

Station ENV8, was located 58m south-east of the Alison Template, situated adjacent to spudcan foot print depressions observed on the MBES data (Figure 4-3) and together also recorded the highest concentrations of Cr, Pb, Sn, Sr and Zn. These metals are also known constituents of drilling muds (Neff, 2005) and therefore it should also be considered the source at Station ENV8, maybe associated with the presence of residual drilling discharges derived from historical activity at Alison.

Overall, concentrations of As, Cd, Hg, Se and Sn were comparable to the LOGGS survey, while concentrations of Cr, Cu, Fe, Li, Mn, Ni, Sr and Zn in the current survey were found higher than those recorded in the LOGGS surveys, with Pb and Zn higher than those of the LOGGS survey (Gardline Environmental Limited, 2015b).

All detectable concentrations of As, Cd, Cr, Cu, Ni, Pb and Zn were above their respective BCs, with averages of all these metals except Cd, also above their respective BACs (Table 4-3). All detectable concentrations of Li and V were also above the upper limit of their respective BRC ranges.

These patterns indicated that most metals within the survey area presented concentrations above background, and above concentrations expected in areas where certain activities such as oil and gas exploration would not be present. This was an expected outcome of this comparison, as the area has been shown to be heavily industrialised, notably due to oil and gas exploration.

Audrey B (XW) platform

Concentrations of Ba across the Audrey B (XW) platform survey area were ≤56.3µg g^{-1}. The average Ba concentration of 25.8µg g^{-1} was lower than results at Audrey A (WD) and the Alison manifold, however, were generally higher and more variable than those of the LOGGS and Ann surveys (Table 4-3). Ba concentrations were positively correlated with the percentages of gravel across the survey area, and also correlated to the distance to the closest existing well from each station. These correlations showed that although Ba was linked to natural variations of sediment size, concentrations were also linked to the existing infrastructure and drill cuttings pile in the area.

A subtle halo effect was apparent around Audrey B (XW), with highest concentrations of metals focussed on the drill cuttings pile (ENV34 and ENV47) or nearby perpendicular to the main current (ENV37) and then at a distance of *c.*300m or 1,000m south-east of the platform (ENV40 or ENV42). This may be related to the anthropogenic changes to the current regime immediately around the platform influencing the transport and settlement of some metals. This distribution of metals also reflects the less sandy and more variable sediments evident in the seabed video imagery, camera stills photography, grab samples or PSA results at most of these stations.

All detectable concentrations of As, Cd (one detectable concentration), Cr, Cu, Hg, Ni, Pb and Zn were above their respective BCs, with averages of all these metals bar Cd and Hg, also above their respective BACs (Table 4-3). All detectable concentrations of Li (two stations) and V were also above the upper limit of their respective BRC ranges. These patterns indicated that most metals within the survey area presented concentrations above background, and above concentrations expected in areas where certain activities such as oil and gas exploration would not be present. This was an expected outcome of this comparison as the area has been shown to be heavily industrialised, notably due to oil and gas exploration.

The LOGGS platform complex

Concentrations of Ba within the LOGGS platform complex varied between 8.7µg g^{-1} and 33.4µg g^{-1} with most stations <20µg g^{-1} (Table 4-3). Concentrations of Ba were correlated to the depth across the survey area indication a distribution of Ba in sediments consistent with natural variation (Gardline Environmental Limited, 2015b).

All concentrations of As, Cr, Cu, Ni, Pb and Zn were above their respective BCs, with all averages also above their respective BACs. All concentrations of Fe and V were also above the upper limit of their respective BRC ranges.

These patterns indicated that most metals within the survey area presented concentrations above background, and above concentrations expected in areas where certain activities such as oil and gas exploration are not present. This was an expected outcome of this comparison, given the area has been shown to be heavily industrialised, notably due to gas exploration (Gardline Environmental Limited, 2015b).

SURVEY	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Li	Mn	Ni	Pb	Se	Sn	Sr	V	Zn
Ann[1]	1,056	5.8	18.8	NC	6.9	1.8	4,775	NC	NC	121.3	3.7	4.1	NC	NC	13.0	14.4	11.3
Alison manifold[2]	5,040	10.4	80.5	NC	14.9	8.0	16,604	NC	10.4	365.8	17.5	7.3	NC	NC	80.1	28.8	32.5
Audrey A (WD)[3]	1,464	9.6	1,095	NC	7.4	4.7	10,032	NC	NC	218	6.6	4.9	NC	NC	41.4	14.9	17.8
Audrey B (XW)[3]	1,103	14.4	25.8	NC	11.5	2.7	6,692	NC	NC	356	5.3	3.8	NC	NC	42.3	57.0	12.1
Annabel[4]	3,403	28.9	80.5	NC	13.2	6.1	17,182	NC	5.6	753	14.9	8.5	NC	NC	65.4	39.6	29.6
LOGGS[5]	741	8.5	13.7	NC	6.6	3.2	6,118	NC	NC	65.4	4.2	3.0	NC	NC	23.7	14.5	8.1

Concentrations expressed as mean $\mu g\ g^{-1}$ dry weight sediment.
Unless specified, concentrations determined following 50% nitric acid sediment digestion.
NC - Not calculated due to one or more values below the LOD.
[1] Gardline Geosurvey Limited (2016a)
[2] Gardline Geosuvey Limited (2016b)
[3] Gardline Geosurvey Limited (2016c)
[4] Gardline Geosurvey Limited (2016d)
[5] Gardline Environmental Limited (2015a)

Table 4-3: Summary of average sediment metal concentrations

4.3.6 Seabed characteristics

Ann

Interpretation of the sonar data, environmental samples and photographs in the vicinity of the Ann template and Ann A4 WHPS shows the seabed sediments to consist predominantly of fine to medium sand developed in to megaripples (Figure 4-8).

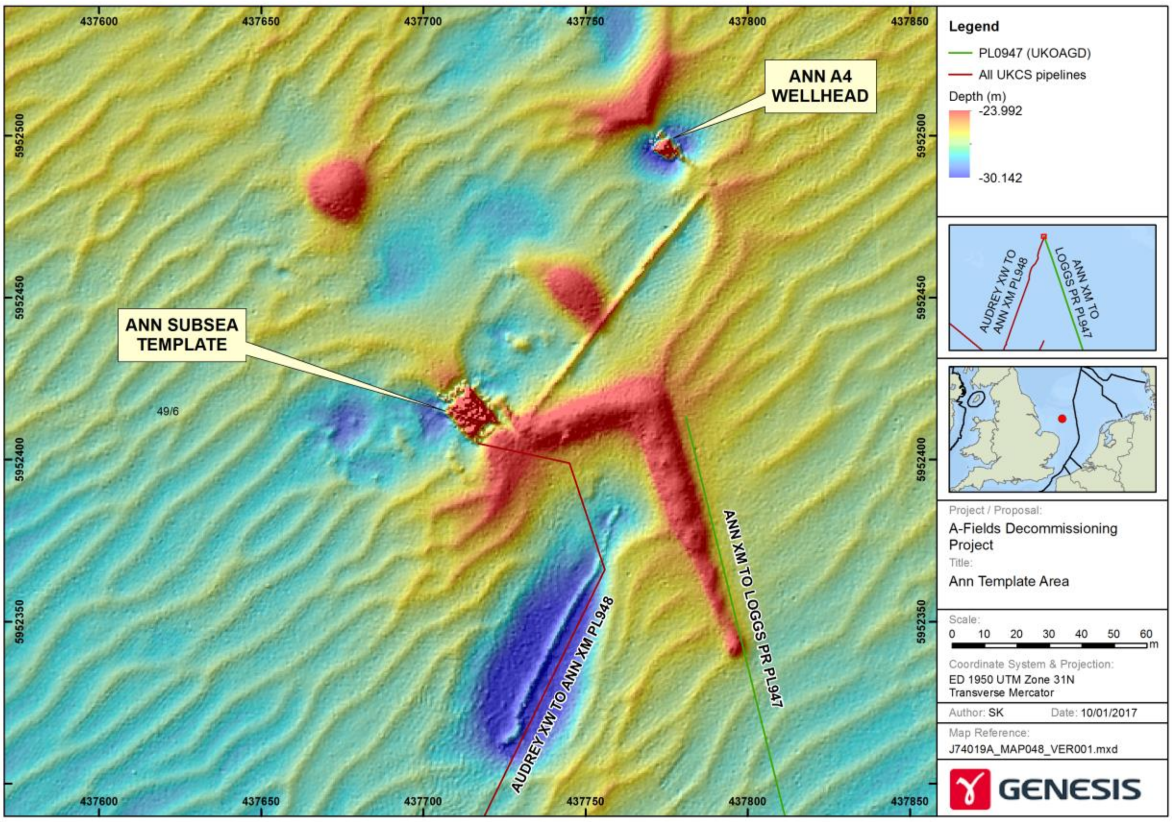


Figure 4-8: Ann Template area

An area of high reflectivity is visible on the sonar data 80m north-north-west of the Ann Template (Figure 4-8). This feature with an area of 375m^2 forms a discrete mound, up to 1.5m high above the surrounding seabed. The area, which was originally considered to represent a drill cuttings pile, following examination of sonar data and seabed imagery, has been subsequently interpreted as deposited rock (Figure 4-9).

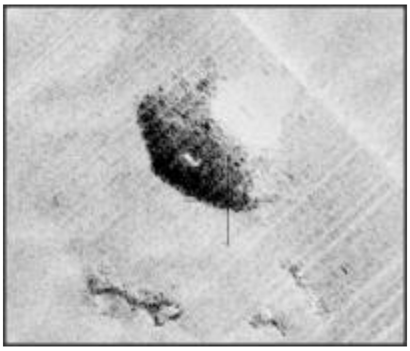


Figure 4-9: Deposited rock 80m north-north-west of the Ann Template

Seabed video imagery at Station ENV1 situated on this deposited rock clearly revealed cobbles and boulders. The reasons for the deposited rock are unknown, but it may originate from the time when rock was placed on Ann to LOGGS pipeline PL947 on the approaches to the Ann Template.

Two areas of disturbed seabed have been identified about 30m west of the Ann Template. The largest of these measures 164m^2 while the smaller feature measures 19m^2. Eight areas of grout and/or grout with rope/material debris occur around the Ann Template, ranging in size from 13m^2 to 116m^2. Five of these “grout” areas are located within 35m of the Ann Template and the remaining three located up to 80m north-west. The areas of grout appear as low mounds occasionally with sharply defined stepped margins and frequently with encrusting fauna attached to their surface (see Figure 4-10).

Figure 4-10: Example of grout with encrusting fauna attached

PL947

PL947 12" gas export pipeline from Ann to LOGGS is predominantly buried along its entire length. It is initially exposed for *c.*6m after leaving the Ann Template as it descends to the seafloor and before it becomes buried by sand and buried by deposited rock 15m from the centre of the Ann Template.

Along the entire length of the pipeline, the seabed consists of sand locally swept up into low megaripples or rare sandwaves (e.g. Figure 4-11). Occasionally, the original pipe trench is visible as a very shallow linear depression typically 5-10cm deep. In areas of intermittent pipeline exposure between LOGGS and Alison the pipe trench depression is about 40cm lower than the surrounding seabed (KP33.5) whilst the top of the pipe is just visible between low sandwaves at about KP26.250 and KP26.315 (Figure 4-12). Between KP29.49 and KP30.54 the pipeline route crosses a seabed showing scattered small mounds (a few tens of centimetres high and 2m-3m in length) representing a *Sabellaria spinulosa* reef zone. The zone is isolated and unique within survey coverage on PL947.

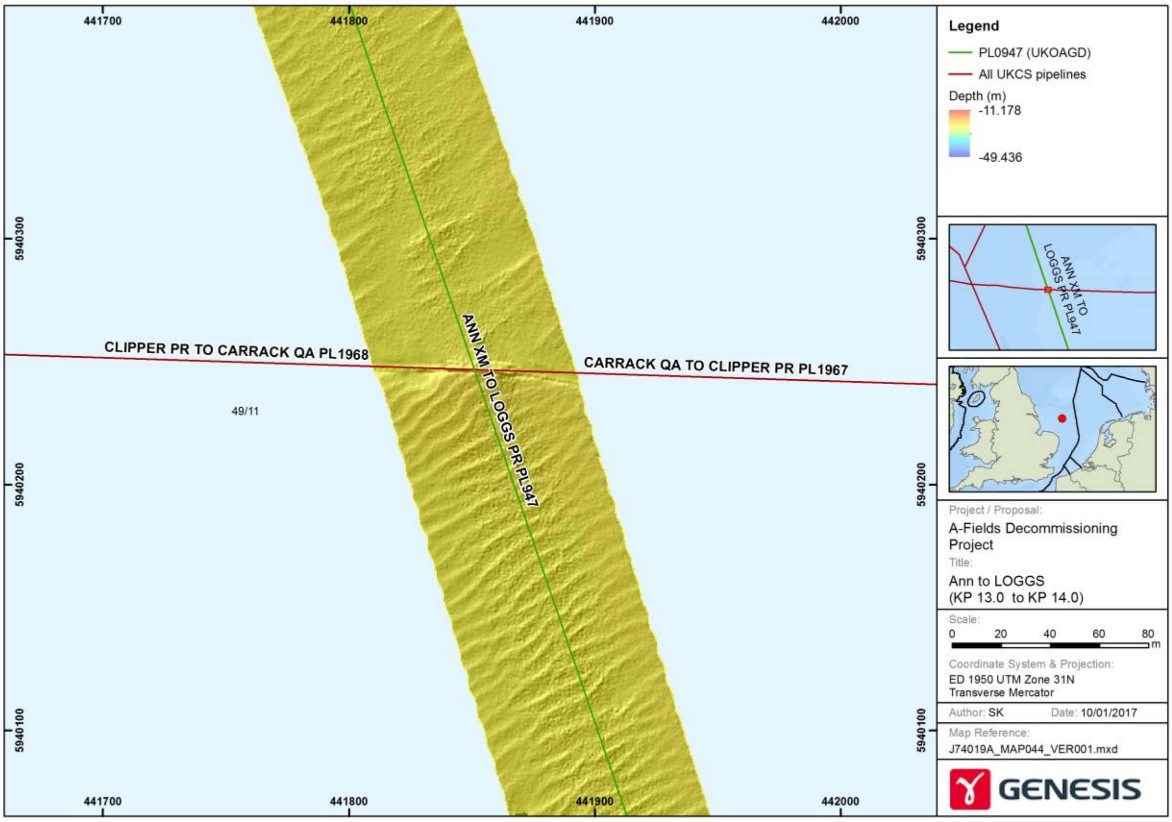


Figure 4-11: PL947 - KP13.0 to 14.0. PL1968 (20" Gas Carrack South to Clipper PM) crossing over PL947

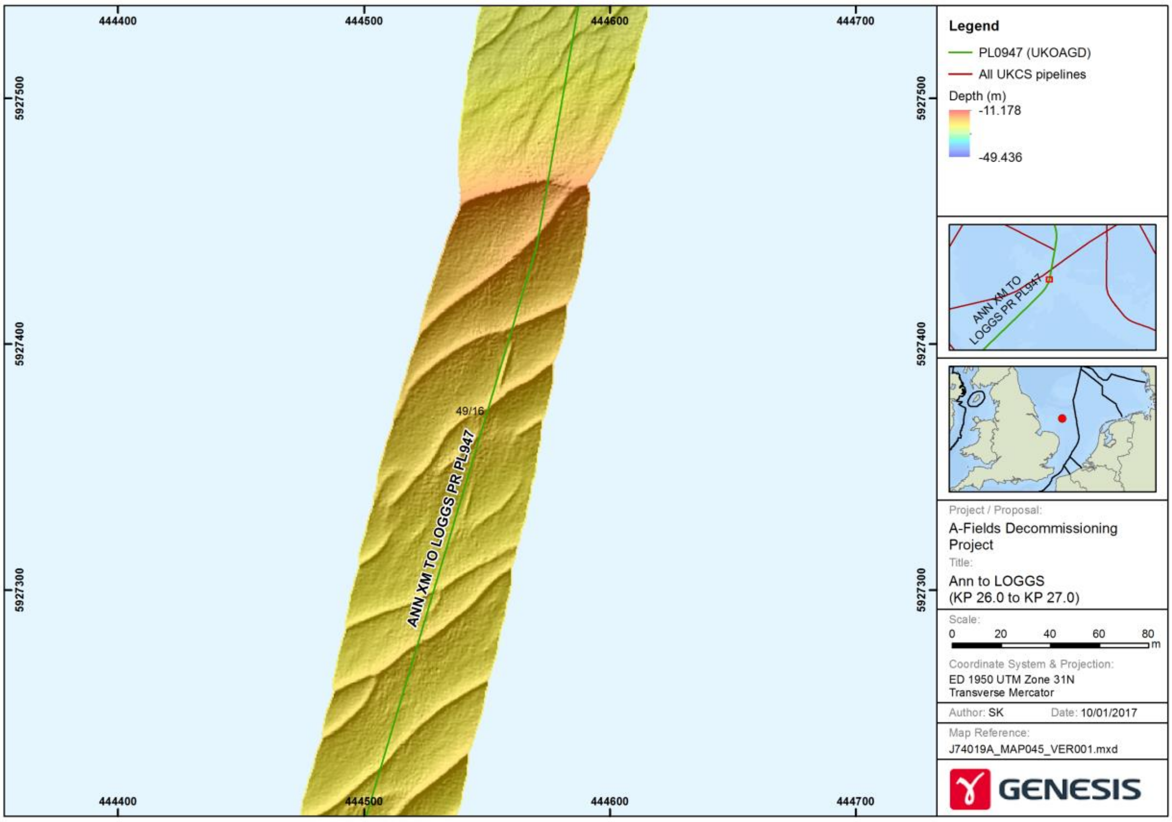


Figure 4-12: PL947 - KP26.0 to KP27.0

PL948

The PL948 umbilical from Audrey B (XW) to the Ann Template is predominantly buried. Where it is not buried it is protected by either mattressing or deposited rock. An area of deposited rock is present between KP4.747 and KP4.787. A further area of deposited rock is present at the Weybourne to ACMI BT Telecom cable crossing (KP9.866 and KP9.886).

PL948 is crossed by the PL1968 14" Gas Carrack South to Clipper PM at KP5.058 and by the PL2107 and PL2108 Saturn 14" Gas and 3" Methanol lines at KP7.959. As with PL947, the PL948 umbilical route crosses alternating areas of relatively smooth sandy seabed and more irregular areas of megarippled seabed.

In the vicinity of Audrey B (XW), sandwaves (up to 3.5m high) are present (Figure 4-16) whilst 2m-4m high examples occur between KP12.0 and KP15.5. In the vicinity of the Ann Template, PL948 mattresses are laid over the pipeline from approximately 100m south of the template, with this section lying within a scour induced depression, up to 1m deep and 35m wide (Figure 4-8).

Alison

Interpretation of the SSS data, environmental grab samples and seabed photographs in the vicinity of the Alison Template and Alison tee show the seabed sediments to predominantly consist of gravelly, shelly sand, with scattered cobbles and occasional boulders. Towards the south and east the gravelly sands are in part overlain by thin mobile sand patches. The sediments are more variable in this part of the survey area with scattered boulders also being present.

Three spudcan depressions are located to the south-south-east of the Alison Template. The depressions are about 20m in diameter but show minimal relief (Figure 4-13).

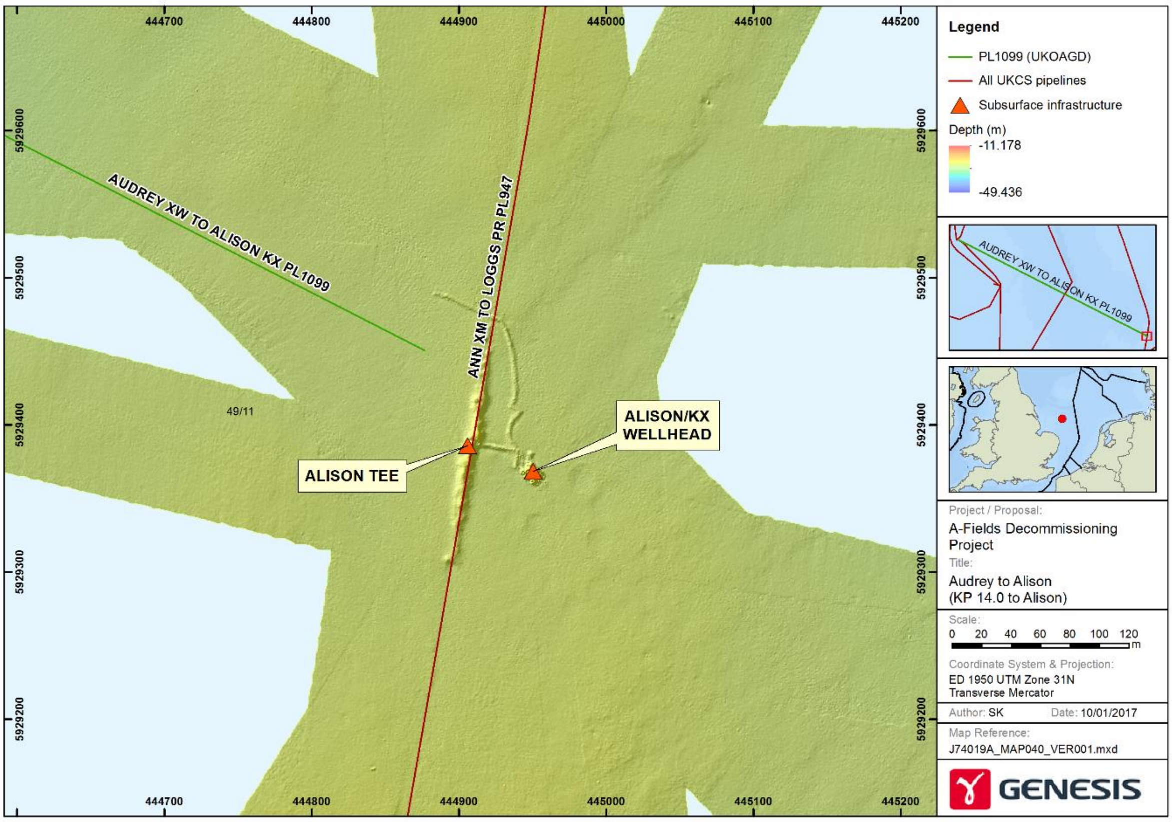


Figure 4-13: Alison manifold and Alison tee

PL1099

PL1099 is predominantly buried along its entire length and is fully buried between KP7.813 and Alison. From KP0.138 to KP8.5 the seabed along the umbilical comprises an area of megaripples and sandwaves up to 3.5m high (e.g. Figure 4-14 and Figure 4-16).

Between Audrey B (XW) and KP7.813 there are 30 exposures totalling 157m, with the longest being 13m. Despite the mobile nature of the seabed in this area, lengths of exposed umbilical are short and rare, averaging about 5m long, but with an increased frequency between KP3.0 and KP5.5. Two short sections (<5m length) of freespan umbilical were observed starting at KP3.882 and KP4.107. Other than in the exposed areas, there are virtually no traces of the original umbilical trench.

In the immediate vicinity of Audrey B (XW), PL1099 crosses an area of smooth sandy seabed and is covered by mattressing to KP0.079. From KP0.138 to KP8.5 the seabed along the umbilical comprises an area of megaripples and sandwaves up to 3.5m high.

Megaripples replace sandwaves as the largest bedform from KP8.5 to KP10.0 (Figure 4-15). From KP8.5 to KP 10.7, PL1099 crosses a major depression (16m deep) reaching a maximum depth of 48.0m LAT at KP9.619 (Figure 4-15). From KP10.0 to KP11.446 the umbilical crosses a particularly smooth seabed with occasional megaripples developing between KP11.446 and KP11.883. From KP11.883, other than encountering a lone sand wave at KP13.854 the umbilical crosses smooth gravelly sand, which continues to the proximity of the Alison Template (Figure 4-15).

Mattresses are located on PL1099 on its approaches to the Alison Template and crosses the PL947 12" Ann to LOGGS pipeline at KP14.925 (Figure 4-13). The umbilical itself is not exposed from KP7.813 until the Alison Template. At the Alison Template the umbilical is briefly exposed as it emerges from the mattressing and enters the structure.

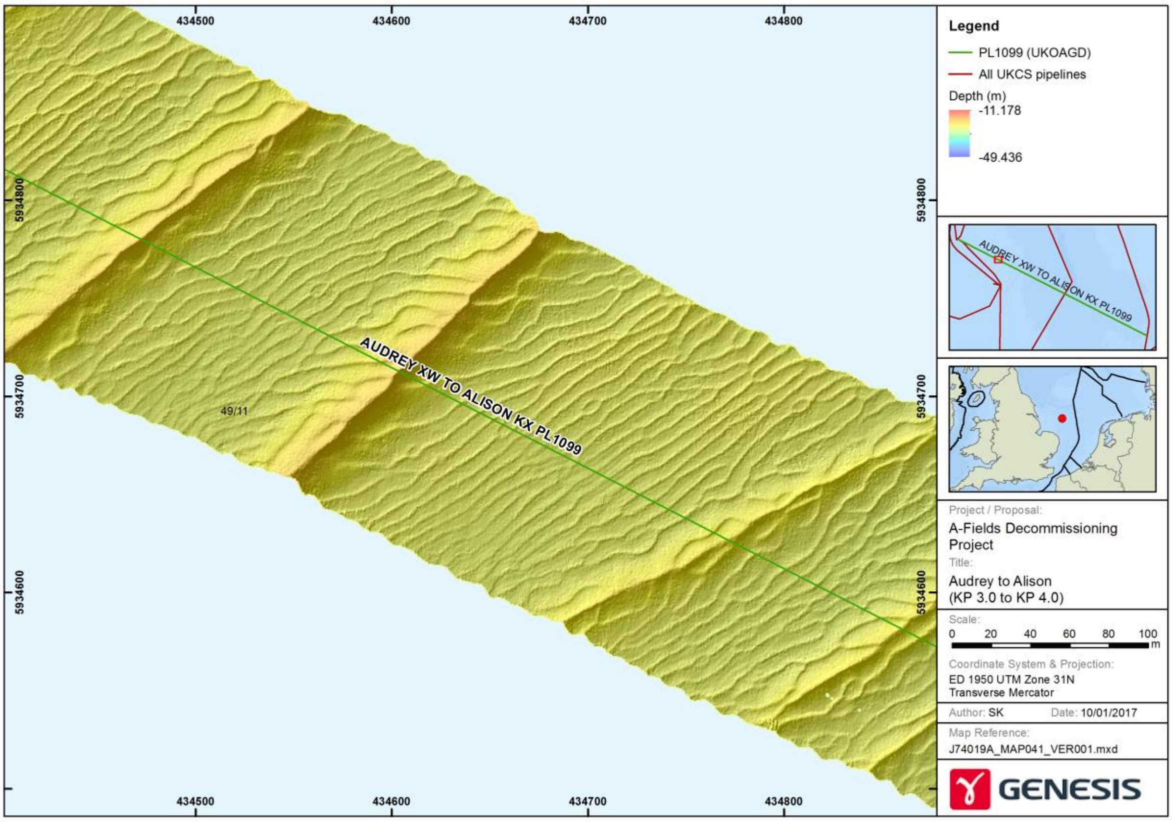


Figure 4-14: PL1099 – KP3.0 to KP4.0

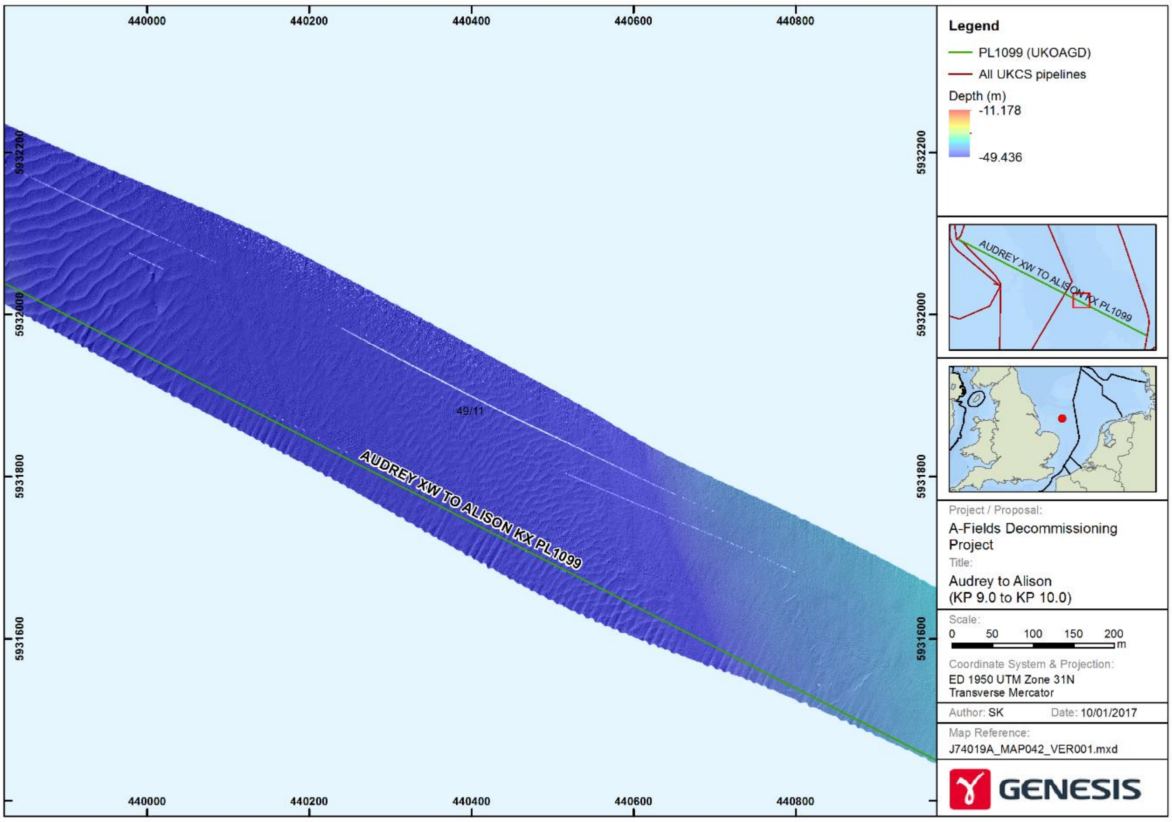


Figure 4-15: PL1099 – KP9.0 to KP10.0

Audrey B (XW) platform

The Audrey B (XW) platform lies in the trough, midway between (i.e. about 80m from), two large south-west, north-east trending sandwaves with a further sand wave lying another 80m to the north (Figure 4-16). The sand wave crests lie at water depths of 21-22m LAT, standing 1.5-2m above the local seabed level, with south-east facing lee slopes indicating a net south-easterly sediment transport direction.

The seabed at Audrey B (XW) is dominated by a deposited rock mound approximately 60m in diameter with its centre lying approximately 70m north-west of Audrey B (XW) (Figure 4-4 and Figure 4-16). The mound presents a minimum depth of 19.8m LAT, a maximum height of about 3.5m above the local seabed level and a volume of about 4,800m³ (Figure 4-4 and Figure 4-16) (Gardline Geosurvey Ltd, 2016c).

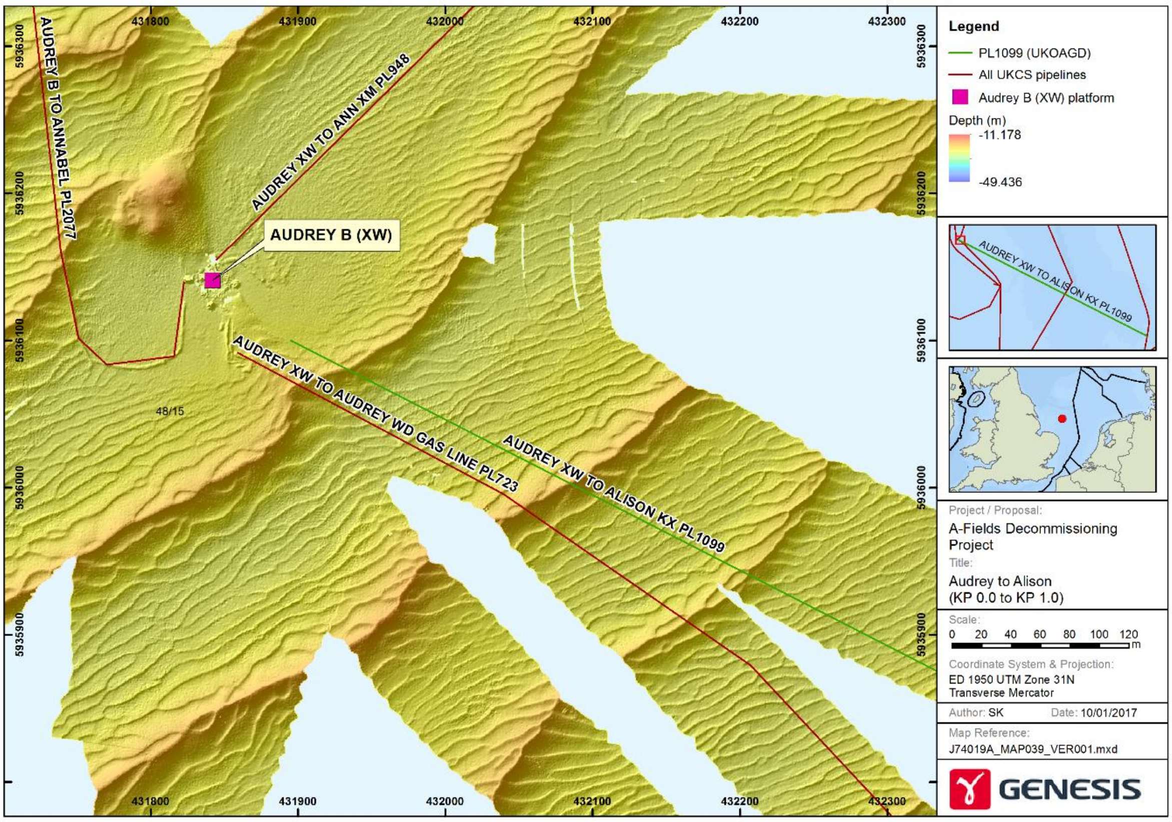


Figure 4-16: Audrey B (XW)

The LOGGS platform complex

In the central and western regions of the LOGGS platform complex survey area, the seabed was characterised by north-east to south-west orientated sandwaves with a maximum height of 7.6m and an average wavelength of *c.*175m (Figure 4-5). A north-west to south-east orientated bathymetric ridge was observed trending through the central region of the survey area, corresponding to Broken Bank. There was a significant area of seabed scour to the north and south of the Saturn ND to LOGGS PR 14" Gas Line PL2107 (Figure 4-5). The scour was situated 550m to the north of the LOGGS PR platform and was approximately 7m deep.

Interpretation of the SSS data identified occasional isolated boulders/debris contacts up to 1.7m high across the survey areas at the LOGGS platform complex. It is possible that the majority of these contacts represent accumulations of isolated deposited rock. Environmental camera imagery revealed the seabed predominantly comprised sand with shells and shell fragments. Ripples were observed on the cameral imagery supporting the evidence of a mobile sandy seabed (Figure 4-17) (Gardline Environmental Limited, 2015a).

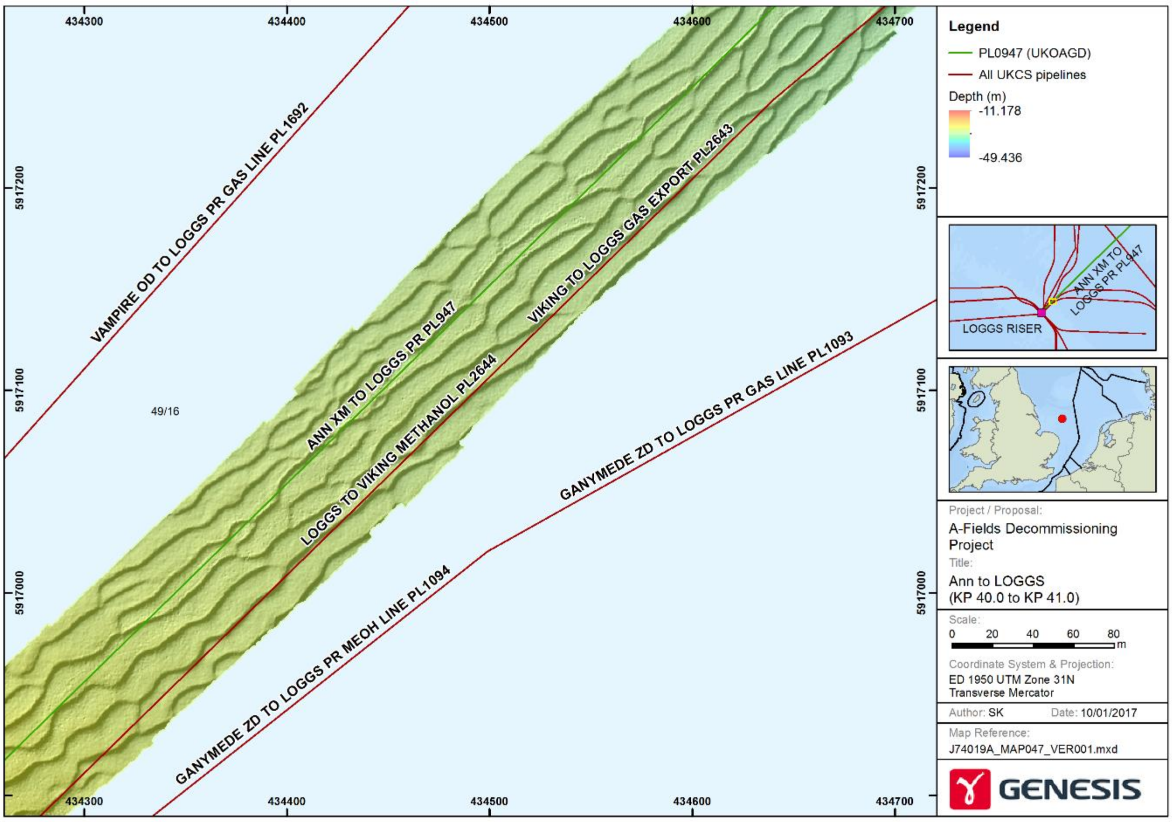


Figure 4-17: PL947 KP40.0 to KP 41.0 approaching the LOGGS platform complex

4.3.7 Seabed habitats

Ann

The extent and elevation above seabed together with the abundance of cobbles, boulders and epifauna at the interpreted deposited rock 80m north-north-west of the Ann Template, suggested medium resemblance to a 'stony reef' according to criteria by Irving (2009). The deposited rock faunal community was largely characterised by encrusting colonies of *Sabellaria spinulosa* (with a range of tube heights) as well as Bryozoa (*Flustra foliacea*), Echinodermata (*Asterias rubens*), Cnidaria (*Alcyonium digitatum*) and Porifera.

The distinction between what is, or is not a *Sabellaria spinulosa* '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 characteristics of reef features.

- Physical characteristics: elevation, sediment consolidation, spatial extent, patchiness;
- Biological characteristics: *Sabellaria sp.* density, biodiversity, biotope and community structure; and
- Temporal characteristics: longevity and stability.

Upon acquisition of seabed imagery, and should *Sabellaria sp.* be identified, the Hendrick and Foster-Smith (2006) scoring system can be applied in an attempt to define the 'reefiness' of the areas or colonies identified within the surveyed area. The scoring criteria that can be used are:

- Spatial Extent – Area (from the geophysical data) of interpreted extent of colonies;

- Patchiness – Percentage cover (from video/stills footage); and
- Elevation – Average height of tubes within colony(ies) (from video/stills footage) as well as elevation of overall reef-like features relative to surrounding seabed (from MBES data).

Whilst mainly subjective, the results can allow a basic understanding of the *Sabellaria sp*. colony composition of each area to be made, and a measure of its 'reefiness' to be arrived at.

Photograph analysis revealed *Sabellaria sp*. to be present across the deposited rock, investigated at Station ENV1. The highest score applicable to each photograph, regardless of the percentage coverage, is presented in Figure 4-19. Taking into account the patchiness of the *Sabellaria sp.* aggregations observed and their variable elevation, these aggregations of *Sabellaria sp.* exhibited low 'Reefiness' as described by Gubbay (2007). This interpretation is expected to apply to the other deposited rock areas around the Ann Template and Ann A4 WHPS.

Interpretation of the SSS data, together with seabed video imagery, camera photography and sampling observations shows the surrounding seabed sediments in the vicinity of the Ann Template and Ann A4 WHPS, away from anthropogenic structures, to consist predominantly of fine to medium sand, developed into megaripples, with scattered shell fragments and occasional gravel (including pebbles) and cobbles (Figure: 4-18). Away from the harder substrate of the deposited rock, visible fauna was sparse and included Annelida (Polychaeta), Arthropoda (*Corystes cassivelaunus*), Bryozoa (*F. foliacea*), Cnidaria (*A. digitatum*, Hydrozoa), Echinodermata (*A. rubens*, *Echinocardium* sp.), and Osteichthyes (Callionymidae, Pleuronectiformes).

Results of the seabed video imagery, camera photography observations and PSA across the Ann survey area were consistent with the adjacent habitat 'sandbanks slightly covered by seawater all the time', which is listed under Annex I of the Habitats Directive (1992), and is a priority habitat in England, listed under Section 41 of the NERC Act (2006) that is deemed to require action in the UK Biodiversity Action Plan and continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework (Joint Nature Conservation Committee (JNCC) and Department for Environment, Food and Rural Affairs (DEFRA), 2012). However, the Ann Template is situated outside of the North Norfolk Sandbanks and Saturn Reef SAC (Figure 4-32).

The Ann survey area did not present any species or habitats classified as Features of Conservation Importance (FOCI), or broadscale habitats, defined in relation to the MCZ network (Natural England and Joint Nature Conservation Committee, 2010) as required under the MCAA (2009). An individual *Gadus morhua* (Atlantic cod) was observed within the Ann survey area, which is listed on the OSPAR (2016) list of threatened and/or declining species and habitats. In the IUCN red list of threatened species (IUCN, 2016) *G. morhua* has been categorised as Vulnerable (see Section 4.5).

Fix: 1088 **E**: 437675 **N**: 5952468 **Depth**: 24

Fix: 1100 **E**: 437674 **N**: 5952483 **Depth**: 25

Station: ENV1
Sediment Description:
Fix1088: Sand with rare shell fragments. Faunal burrows present.

Fix1100: Silty sand with cobbles and *Sabellaria* sp.aggregations.

Fauna Description:
Fix1088: Echinodermata (*Asterias rubens*).

Fix1100: Annelida (*Sabellaria* sp.), Bryozoa (*Flustra foliacea*), Echinodermata (*Asterias rubens*, Ophiuroidea sp.) and Porifera (orange encrusting sp.).

Fix: 1134 **E**: 437664 **N**: 5952488 **Depth**: 25

Fix: 1138 **E**: 437667 **N**: 5952480 **Depth**: 25

Station: ENV1
Sediment Description:
Fix1134: Silty sand with *Sabellaria* sp. aggregations and scattered cobbles.

Fix1138: Cobbles and boulders interspersed with silty sand.

Fauna Description:
Fix1134: Arthropoda (*Cancer pagurus*), Bryozoa (*Flustra foliacea*) and Cnidaria (Hydrozoa). Aggregations of *Sabellaria* sp. tubes present.

Fix1138: Echinodermata (*Asterias rubens*), Cnidaria (Hexacoralia sp.2, Hydrozoa) and Porifera (pink encrusting sp.). Aggregations of *Sabellaria* sp. tubes present.

Figure: 4-18: Seabed photograph from station ENV1 at Ann (location shown in Figure 4-2)

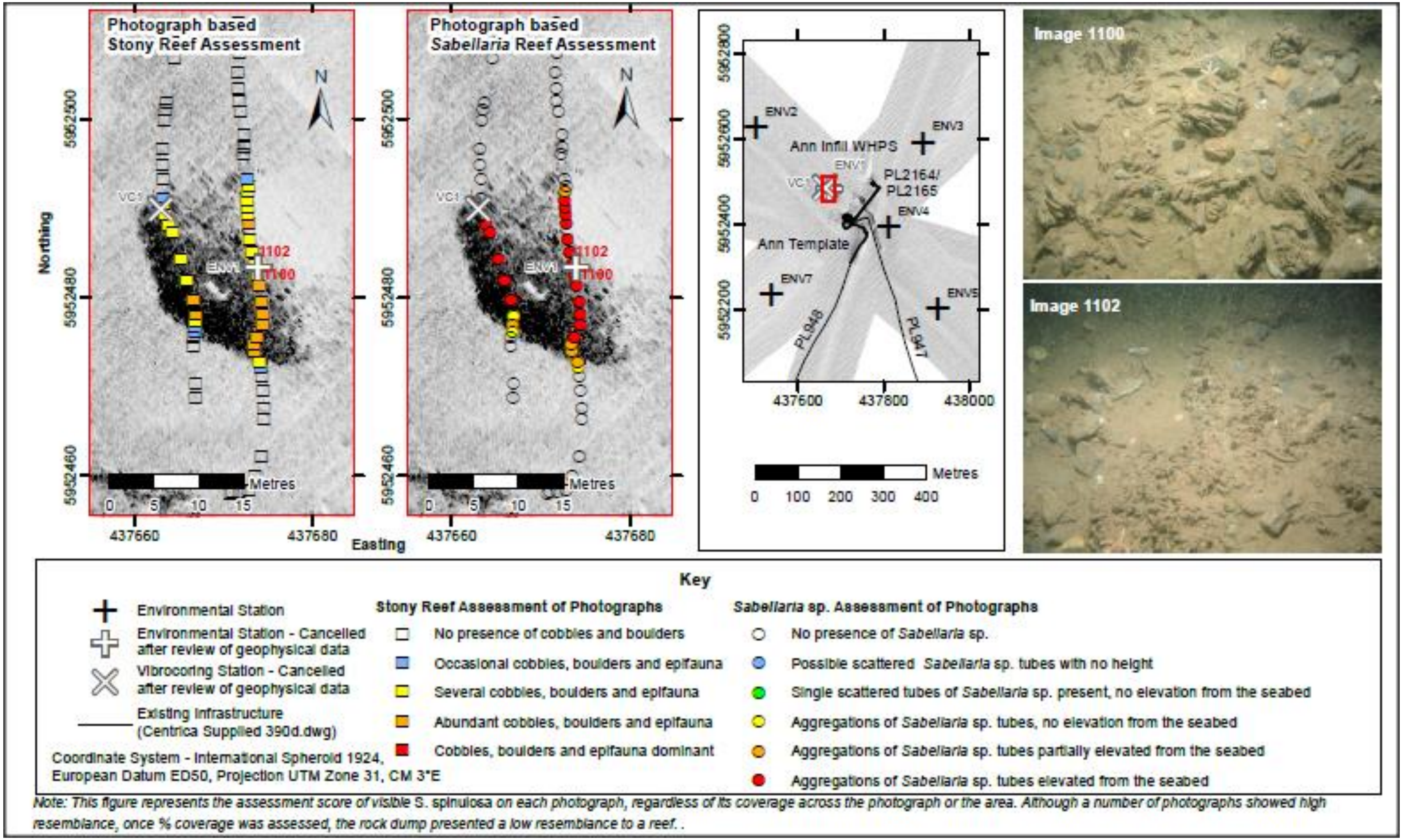


Figure 4-19: Stony reef and *Sabellaria spinulosa* assessment from photographs at Station ENV1

Alison

Seabed imagery and sampling observations were in accordance with the geophysical survey interpretation of the seabed sediments. These confirmed sand with varying amounts of shell fragments, gravel, (including pebbles) and cobbles across the Alison Template and Alison tee survey area; while they comprised mainly sand along PL1099 (KP4.3 to KP6.8) (Figure 4-20).

The faunal community across the Alison Template and Alison tee survey area was generally characterised by Bryozoa (*Alcyonidium diaphanum, Flustra foliacea*), Cnidaria (*A. digitatum* Hydrozoa) and Echinodermata (*A. rubens*) as well as occasional Porifera. Other fauna occurring at the stations included Arthropoda (*Cancer pagurus*, Paguridae, *Pagurus bernhardus*), Cnidaria (Hexacorallia), Echinodermata (Ophiuroidea), Mollusca (Nudibranchia), Osteichthyes (Callionymidae, Gobiidae) and Chordata (Ascidiacea).

Sabellaria spinulosa tubes occurred in a number of photographs at Station ENV13 (Figure 4-21). The Hendrick and Foster-Smith (2006) scoring system was applied in an attempt to define the 'reefiness' of the area or colonies identified within the survey area (Gubbay, 2007).

Of the 13 photographs taken at ENV13, one displayed aggregations of *Sabellaria sp.* with no height, which covered 24% of the image (Fix 279, presented in Figure 4-22) and five displayed up to 10% coverage of single scattered tubes with no height. Given that there were no observed raised aggregations of *Sabellaria sp*. visible in the photos and the patchiness of coverage, the seabed type at Station ENV13 does not represent a reef, relative to the Gubbay (2007) criteria. Furthermore, given the findings from all nine stations, the natural seabed overall across the Alison template and tee survey area and along PL1099 (KP4.3 to KP6.8) does not contain *Sabellaria reef*. Additionally, no potential reef features were interpreted from the acoustic (SSS and MBES) data.

Seabed imagery at Stations ENV8 (Figure 4-20) and ENV9 (Alison Template and Alison tee) exhibited areas of abundant cobbles and boulders and increased epifauna at these stations suggested there may be a degree of resemblance to a 'stony reef'. Stony reefs are listed under Annex I of the Habitats Directive (1992), as implemented by the Offshore Marine Conservation (Natural Habitats, &c.) Regulations (2007 (as amended)). However, after further assessment based on the criteria by Irving (2009), the composition of these two stations was found not to resemble a stony reef.

The faunal community in the sandy sediment along PL1099 (KP4.3 to KP6.8) was sparse, consistent with a mobile substrate, and was mainly characterised by occasional Annelida (Polychaeta), Echinodermata (Ophiuroidea) and Cnidaria (Hydrozoa). Other fauna occurring at the stations included Cnidaria (*A. digitatum*), Echinodermata (Echinidae) and Chordata (Scorpaeniformes, Pleuronectiformes).

Results of the seabed imagery observations and PSA across the PL1099 (KP4.3 to KP6.8) survey area showed some similarities to the adjacent habitat 'sandbanks slightly covered by seawater all the time'. Results showed that the Alison Template and Alison tee survey area was not consistent with this habitat. In addition, the Alison Template and Alison tee and PL1099 (KP4.3 to KP6.8) survey area did not present any species or habitats classified as FOCI, or broadscale habitats, defined in relation to the MCZ network (Natural England and JNCC, 2010) as required under the MCAA (2009).

Fix: 283 E: 444987 N: 5929320 Depth: 33

Fix: 301 E: 444991 N: 5929327 Depth: 33

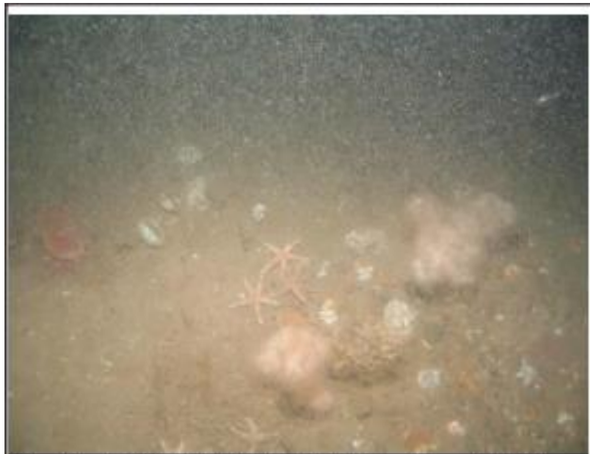
Station: ENV8
Sediment Description:
Fix283: Gravelly sand with cobbles and scattered shell fragments.

Fix301: Gravelly sand with occasional cobbles and shell fragments.

Fauna Description:
Fix283: Arthropoda (*Pagurus bernhardus*), Bryozoa (*Alcyonidium diaphanum, Flustra foliacea*), Cnidaria (*Alcyonium digitatum*, Hydrozoa), Echinodermata (*Asterias rubens*), Osteichthyes (Callionymidae sp.) and Porifera (grey spherical sponge).

Fix301: Annelida (Polychaete), Arthropoda (Paguridae), Bryozoa (*Flustra foliacea*), Cnidaria (Hydrozoa, *Alcyonium digitatum*) and Echinodermata (*Asterias rubens*, Ophiuroidea sp.). Scattered *Sabellaria* sp. tubes.

Figure 4-20 Seabed photograph from station ENV8 at Alison (location shown in Figure 4-3)



Fix: 280 E: 444779 N: 5929192 Depth: 25m Laser Scale: 10cm

Fix: 282 E: 444779 N: 5929187 Depth: 25m Laser Scale: 10cm

Station: ENV13
Sediment Description:
Fix280: Sand with gravel and cobbles patches and shell fragments.

Fix282: Sand with gravel patches and shell fragments.

Fauna Description:
Fix280: Annelida (Polychaeta worm tubes), Arthropoda (*Cancer pagurus*), Bryozoa (*Flustra foliacea*), Cnidaria (*Alcyonium digitatum*, Hydrozoa) and Echinodermata (*Asterias rubens*). Scattered single *Sabellaria* sp. tubes (no reef structure visible).

Fix282: Cnidaria (Hyrozoa). Scattered single *Sabellaria* sp. tubes (no reef structure visible).

Figure 4-21 Seabed photograph from station ENV13 at Alison (location shown in Figure 4-3)

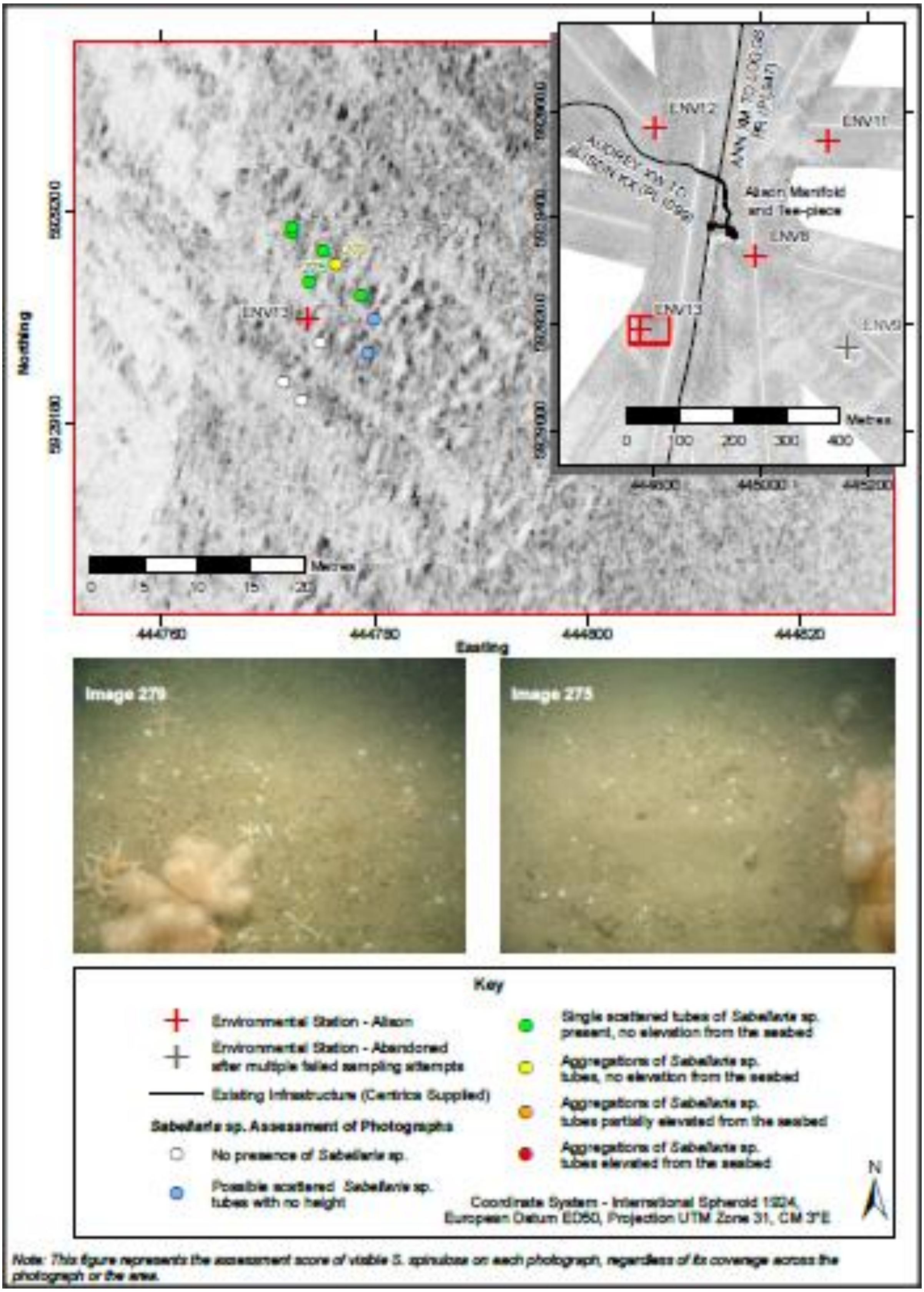


Figure 4-22 *Sabellaria spinulosa* assessment at station ENV13 – Alison template and Alison tee

Audrey B (XW) platform

All 11 stations selected for investigation were successfully ground-truthed with the digital camera system. Geophysical data showed generally lower sonar reflectivity interpreted as predominantly sand. Seabed imagery supported the geophysical data interpretation, confirming the seabed sediments as sand with shell fragments and occasional gravel, pebbles and cobbles (Figure: 4-23, Figure: 4-24 and Figure: 4-25). Areas of abundant cobbles and boulders were visible at the transect Station ENV33 (covering Stations ENV33, ENV34 and ENV35) (Figure: 4-23), which could correspond to a low resemblance stony reef, as listed under Annex I of the Habitats Directive (1992), as implemented by the Offshore Marine Conservation (Natural Habitats, &c.) Regulations (2007 (as amended)).

Overall, the composition of Stations ENV33, ENV34 and ENV35 was indicative of having no resemblance to a 'stony reef' as defined by Irving (2009) although it should be noted that some images at these stations were classified as low resemblance 'stony reef'. Additionally, no potential 'stony reef' features were interpreted from the acoustic (SSS and MBES) data.

Sabellaria spinulosa tubes were observed in a number of photographs at the transect Station ENV33. The Hendrick and Foster-Smith (2006) scoring system was applied in an attempt to define the 'reefiness' of the area or colonies identified within the survey area (Gubbay, 2007). Aggregations were observed in greatest abundance and height where the seabed presented occasional to abundant cobbles and boulders. No *Sabellaria sp.* aggregations were observed where sediments did not comprise coarse material (cobbles and boulders). *Sabellaria sp.* reefs are listed under Annex I of the Habitats Directive (1992), as implemented by the Offshore Marine Conservation (Natural Habitats, &c.) Regulations (2007 (as amended)).

Sabellaria sp. individuals only occurred at the transect across Station ENV33 (covering ENV33, ENV34 and ENV35 locations) in the Audrey B (XW) survey area (Figure 4-4). At the transect across Station ENV33, most of the *Sabellaria sp.* occurred as partially raised aggregations, visible in 25% of images, and covering on average 5.4% of the photographs. *Sabellaria sp.* also occurred as aggregations rising off the seabed, most similar to a reef, however these structures were only seen in 8.8% of photographs, with an average photograph coverage of 3%.

Taking into account the patchiness of the *Sabellaria sp.* aggregations observed and their variable elevation, these aggregations of *Sabellaria sp.* exhibited low 'reefiness' as described by Gubbay (2007) and this station cannot be considered as a *Sabellaria sp.* reef.

Other fauna observed across the stations included Annelida (Echiura, Polychaeta including *Lanice conchilega*, *Sabellaria sp.*, Serpulidae), Arthropoda (Brachyura, *Cancer pagurus*, Cirripedia, *Necora puber*, Paguridae), Bryozoa (*A. diaphanum*, *F. foliacea*), Cnidaria (*A. digitatum*, Actiniaria including *M. senile*, Hexacorallia, Hydrozoa including Hydractinia echinata and *T.indivisa*), Echinodermata (*A. rubens*, Ophiuroidea), Chordata (Ascidiacea, *Agones cataphractus*, Callionymidae, *Limanda limanda*), Porifera (Demospongiae) and Sipuncula. Similar to the Audrey A (WD) area, benthic fauna was generally sparse with higher densities associated with the occasional presence of gravel, pebbles and cobbles.

Fix: 4164 **E:** 431821 **N:** 5936238 **Depth:** 21.25

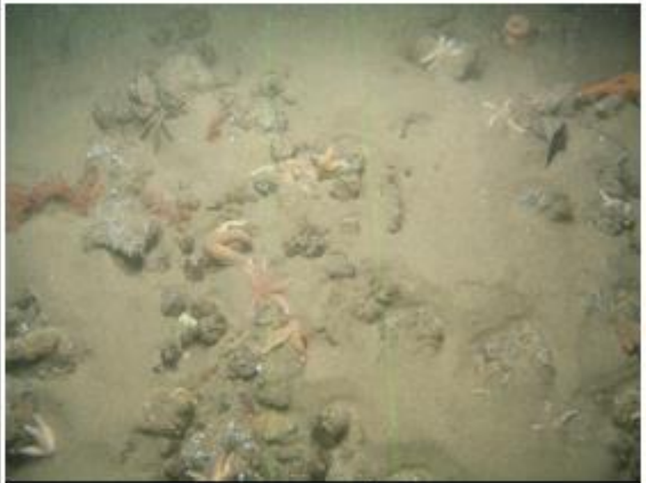
Fix: 4175 **E:** 431806 **N:** 5936209 **Depth:** 20.62

Station: CAM33, CAM34 & CAM35
Sediment Description:
Fix4164: Sand ripples with shell fragments and gravel.

Fix4175: Cobbles with sand.

Fauna Description:
Fix4164: No Visible Fauna

Fix4175: Cnidaria (Actinaria, *Alcyonium digitatum*, hydrozoa, *Tubularia indivisa*), Arthropoda (*Cancer pagurus*), Echinodermata (Asteroidea), Porifera (Demospongiae), Bryozoa (*Flustra foliacea*)



Fix: 4184 **E:** 431798 **N:** 5936202 **Depth:** 19.93

Fix: 4189 **E:** 431796 **N:** 5936199 **Depth:** 20.59

Station: CAM33, CAM34 & CAM35
Sediment Description:
Fix4184: Sand ripples with cobbles and pebbles.

Fix4189: Sand ripples with shell and gravel.

Fauna Description:
Fix4184: Annelida (Serpulidae),Arthropoda (*Necora puber*, Paguridae), Echinodermata (*Asterias rubens*), Porifera (Demospongale) , Cnidaria (Hydrozoa including *Tubularia indivisa*)

Fix4189: Annelida (*S. spinulosa*) Cnidaria (Actinaria, Hydrozoa) Echinodermata (Asteroidea), Porifera (Demospongiae)

Figure: 4-23: Seabed photograph from station ENV33, 34 and 35 at Audrey B (XW) (location shown in Figure 4-4)

Figure: 4-24: Seabed photograph from station ENV42 at Audrey B (XW) (location shown in Figure 4-4)

Figure: 4-25: Seabed photograph from station ENV43 at Audrey B (XW) (location shown in Figure 4-4)

The LOGGS platform complex

The LOGGS survey area was found to be relatively homogeneous consisting of fine to coarse sand with shell fragments (Figure: 4-26 and Figure: 4-27).

The LOGGS survey area showed similarity to the Annex I habitat 'Sandbanks which are slightly covered by sea water all of the time'. A north-west to south-east orientated bathymetric ridge was observed trending through the central region of the survey area which corresponds to Broken Bank (Figure 4-33), over the top of which water depths were generally less than 20m. This bathymetric feature, the sandy nature of the sediments and the EUNIS classification of the infralittoral fine sand are all consistent with the Annex I habitat 'Sandbanks which are slightly covered by sea water all of the time' (Gardline Environmental Limited, 2015b).

Visible fauna included: Arthropoda (Paguroidea), Chordata (Pleuronectiformes), Echinodermata (*Asterius rubens*, *Astropecten irregularis*, Ophiuroidea), Cnidaria (possible *Alcyonium digitatum*).

There was no indication of species or habitats on the OSPAR (2008) list of threatened and/or declining species and habitats or any species on the IUCN Global Red List of threatened species (IUCN, 2016).

Figure: 4-26: Seabed photograph from station ENV06 at LOGGS (location shown in Figure 4-5)

Figure: 4-27: Seabed photograph from station ENV08 at LOGGS (location shown in Figure 4-5)

4.4 Marine flora and fauna

Typical of a shallow region in a temperate climatic zone, the North Sea is a complex and productive ecosystem which supports important fish, seabird and marine mammal populations. Pelagic and benthic communities are interlinked in tightly coupled food webs which, together with the abiotic environment, make up marine ecosystems. The flora and fauna that interact to make up the North Sea ecosystem are discussed below.

4.4.1 Plankton

Within the North Sea, planktonic assemblages are influenced mainly by vertical mixing and the availability of light and nutrients for growth (Striebel *et al*., 2010). During the winter months the rate of phytoplankton production decreases and increased concentrations of key nutrients i.e. phosphorus, ammonia, nitrogen and silicate, can be recorded as these are no longer used up during the production of phytoplankton. However, during the spring months, the rate of primary production increases significantly, coupled with a reduction in the available nutrients, which is subsequently followed in August by a smaller peak in abundance of phytoplankton (Johns and Reid, 2001). These large phytoplankton blooms which occur in the North Sea during the spring and autumn support the majority of marine food chains in the area.

The SNS is characterised by shallow, well-mixed waters, which undergo large seasonal temperature variations (JNCC, 2004). The region is largely enclosed by land and, as a result, the environment here is dynamic with considerable tidal mixing and nutrient-rich run-offs from the land (eutrophication). Under these conditions, there is relatively little stratification throughout the year and constant replenishment of nutrients, so opportunistic organisms such as diatoms are particularly successful (Margalef 1973, cited in Leterme *et al.*, 2006); diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates from November to May, when mixing is at its greatest (McQuatters-Gollop *et al.,* 2007). The phytoplankton community is dominated by the dinoflagellate genus *Ceratium* (*C. fusus*, *C. furca*, *C. lineatum*), along with higher numbers of the diatom, *Chaetoceros* than are typically found in the Northern North Sea (NNS). Harmful algal blooms (HABs) caused by *Noctiluca* sp. are often observed in the region.

The zooplankton community comprises *Calanus helgolandicus* and *C. finmarchicus* as well as *Paracalanus* sp., *Pseudocalanus* sp., *Acartia* sp., *Temora* sp. and cladocerans such as *Evadne* sp. There has been a marked decrease in copepod abundance in the SNS in recent years (Edwards *et al*. 2013), possibly linked to the North Atlantic Oscillation (NAO) index, which has a significant impact in the SNS, where the interface between the atmosphere and the sea is most pronounced (Harris *et al*. 2013)

4.4.2 Benthos

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Species living on top of the sea floor may be sessile (e.g. seaweeds) or freely moving (e.g. starfish) and collectively are referred to as epibenthic organisms. Animals living within the sediment (e.g. clams, tubeworms and burrowing crabs) are termed infaunal species. Semi-infaunal animals, including sea pens and some bivalves, lie partially buried in the seabed.

The structure and distribution of North Sea benthic communities can be explained by the environmental parameters including temperature, salinity, tidal/wave-induced seabed stress, stratification, depth, and sediment type. Their relative importance varies spatially, and many are inter-correlated (Rees *et al*., 2007).

Ann

The benthic faunal community was generally homogeneous across the survey area, typical of sandy sediments of the SNS and dominated by the crustacean *Bathyporeia* sp., the bivalve *Mactra stultorum* and the polychaete *Sipophanes bombyx* accounting for 46% of the 1,161 individuals recorded at the six stations. In terms of taxonomic groups, the Polychaeta, Crustacea and Mollusca groups dominated the macrofaunal community both in terms of individuals and species, while there was no clear dominance pattern from one of these groups over the others across the samples. Respectively, these three groups represented between approximately 28.8%, 36.6% and 32.2% of all individuals and 31.0%, 33.8% and 26.8% of all taxa in the full data set. Conversely Echinodermata represented only 2.3% of all individuals and 7.0% of taxa, while Other accounted for 0.1% of all individuals and 1.4% of all taxa in the full data set (Table 4-4). Approximately 6% of individuals and 11% of taxa were juvenile and these were generally evenly distributed between the five main taxonomical groups and across the survey area. Univariate statistics indicated slight variation in community structures across the samples.

Overall, the results of the macrofaunal analyses did not indicate any impact related to anthropogenic activities around the Ann Template.

Alison

Within the Alison Template and Alison tee survey area, the macrofaunal community was generally homogeneous and dominated by the polychaete *Syllis* (Type 1). More generally, the area was dominated by the phylum Polychaeta in terms of taxa which represented 48.5% of all taxa (adult data set), however there was no firm dominance structure across the survey area in terms of the abundance of individuals, with Polychaeta, Crustacea and Mollusca representing 34.3%, 24.2% and 28.9% of all individuals (adult data set) (Table 4-4).

Approximately 8% of individuals and taxa were juvenile, and these were generally unevenly distributed across the stations. Univariate statistics indicated slightly heterogeneous community structures across the samples, with Samples ENV8 and ENV11 less diverse and evenly distributed and slightly dominated by the crustacean *Stenothoe marina* and the mollusc *Kurtiella bidentata*. The remainder of the samples presented somewhat more even and less dominated communities, with higher diversity. Within the PL1099 (KP4.3 to KP6.8) survey area, the macrofaunal community was generally homogeneous and was dominated by the arthropod *Bathyporeia elegans*. More generally, the phyla Crustacea and Polychaeta dominated the fauna in terms of individuals and taxa, together representing 97% of individuals and 81% of taxa. Approximately 11% of individuals and 15% of taxa were juvenile, and these were generally evenly distributed across the stations.

Audrey B (XW) platform

The benthic faunal community was slightly heterogeneous across the survey area, generally typical of the sandy sediments of the SNS, dominated by the polychaetes *Ophelia borealis* most notably at stations *c.*100m from the Audrey B (XW) platform (Stations ENV37 and ENV39), *Spiophanes bombyx* and the crustacean *Bathyporeia elegans* particularly at stations *c.*300m north-west and south-east to 550m south-east of the platform (Stations ENV36, ENV40 and ENV41) and *Spio goniocephala* most notably at 1,000m south-east (Station ENV42) or perpendicular to the dominant current at *c.*250m north-east (Station ENV38). These three taxa together accounted for 42% of the 2,148 individuals across the 18 samples obtained in the survey area (Table 4-4).

In terms of taxonomic groups, the macrofaunal community was dominated by Polychaeta both in terms of individuals and taxa, which was found representative of the wider area of the SNS. Approximately 11% of individuals and 14% of taxa were juvenile, and these were also predominantly polychaetes, therefore having an insignificant influence on the overall faunal community structure.

Univariate statistics indicated some heterogeneity in the community structures across the samples. Interestingly, the samples from the deposited rock/drill cuttings pile presented the greatest species richness and diversity values. This shift in community structure, including the tube dwelling amphipod *Jassa* and the Polychaeta *Phyllodoce maculata*, which were unique to these two stations is consistent with the relatively stable substrate at this location. The remaining stations were more sparsely populated and less diverse, as would be expected for the mobile sandy conditions across the rest of the survey area.

Multivariate analyses confirmed the clear dissimilarities in the macrofaunal composition based on distance from the Audrey B (XW) Platform, described above, with the samples from the deposited rock/drill cuttings pile (ENV34 and ENV47) identified as the most dissimilar to the remaining samples. This pattern was compared to the physico-chemical data set, which resulted in an 82% correlation between the faunal pattern and concentrations of TOC, THC, As and Pb. It was therefore concluded that the macrofaunal community in the Audrey B (XW) Platform survey area was influenced by variations in sediment characteristics and concentrations of contaminants that can all be related to the presence of drill cuttings and coarse sediments.

The LOGGS platform complex

At the LOGGS platform complex 12 faunal samples were collected from 12 sampling stations. A total of 1,339 individuals representing 83 taxa were recorded across the 12 stations. Juveniles accounted for 420 individuals from 26 taxa representing 31% of total individuals and of the total taxa (Table 4-4).

Amphipoda represented 87% of all juvenile Crustacea with 95% of those distributed across the genera *Urothoe* and *Bathyporeia*. Adult Crustacea, were dominated by Cumacea, which represented 49% of all adult Crustacea, 86% of which belonged to a single species, *Monopseudocuma gilsoni*.

Polychaeta was the second most abundant major taxonomic group in both full and adult data sets, representing 25% of all individuals and 29% of adults, which corresponded to 36% of all taxa and 39% of adult taxa. The taxonomic groups Mollusca, Echinodermata and “Others” each represented ≤5% of all individuals and a lower proportion of adults (≤2%). Mollusca, Echinodermata and “Others” comprised 8%, 6% and 6% of all taxa, respectively and 7%, 4% and 7% of adult taxa, respectively. Only two Echinodermata individuals were adults, all other 63 individuals (97%) were juveniles, dominated by Ophiuroidea and Spatangoida juveniles (73% and 22% of all Echinodermata juveniles, respectively).

GROUP	ANN		ALISON		AUDREY B (XW) PLATFORM		THE LOGGS PLATFORM COMPLEX	
	PROPORTION CONTRIBUTION (%)		PROPORTION CONTRIBUTION (%)		PROPORTION CONTRIBUTION (%)		PROPORTION CONTRIBUTION (%)	
	INDIVIDUALS (n=1,161)	TAXA (n=71)	INDIVIDUALS (n=1,518)	TAXA (n=142)	INDIVIDUALS (n=2,148)	TAXA (n=103)	INDIVIDUALS (n=1,339)	TAXA (n=83)
Polychaeta	28.8	31.0	39.4	50.0	68.4	42.7	24.8	36.1
Crustacea	36.6	33.8	22.3	25.4	21.1	31.1	67.7	43.4
Mollusca	32.2	26.8	26.7	12.0	2.9	15.5	1.7	8.4
Echinodermata	2.3	7.0	3.7	4.2	0.4	4.9	4.9	6.0
Others	0.1	1.4	7.9	8.5	7.2	5.8	1.0	6.0

Table 4-4: Contribution of taxonomic groups to the macrofaunal community (full data set)

4.4.3 Fish populations

Fish occupying areas in close proximity to offshore oil and gas activities could be exposed to aqueous discharges and may accumulate hydrocarbons and other contaminating chemicals in their body tissues.

Fish communities comprise species that have complex interactions with one another and the natural environment. They consume a wide range of benthic invertebrates and/or act as predators at higher trophic levels, while themselves being a source of prey for larger animals.

At present, more than 330 fish species are thought to inhabit the shelf seas of the UKCS (Pinnegar *et al*, 2010). Finfish species can broadly be divided into pelagic and demersal species. Pelagic species e.g. herring, mackerel, blue whiting and sprat are found in mid-water and typically make extensive seasonal movements or migrations. Demersal species e.g. cod, haddock, sandeels, sole and whiting live on or near the seabed and, similar to pelagic species, many are known to passively move (e.g. drifting eggs and larvae) and/or actively migrate (e.g. juveniles and adults) between areas during their lifecycle.

The most vulnerable stages of the life cycle of fish to general disturbances, such as disruption to sediments and oil pollution, are the egg and larval stages. Hence, recognition of spawning and nursery grounds within a project area is important. Table 4-5 shows approximate spawning times of some of the commercial fish species occurring in the region of the A-Fields and identifies some species known to use the area as a nursery ground (Coull *et al*., 1998; Ellis *et al*., 2012).

SPECIES	J	F	M	A	M	J	J	A	S	O	N	D	NURSERY
Mackerel													
Herring													
Cod													
Whiting													
Plaice													
Lemon Sole													
Sandeel													
Nephrops													
Sprat													
KEY	SPAWNING PERIODS							NURSERY GROUNDS PRESENT					

Table 4-5: Spawning periods and nursery grounds in the vicinity of the A-Fields

Spawning and nursery areas cannot be defined with absolute accuracy and are found to shift over time. Recognised spawning and nursery grounds of some commercially important species occurring within the area are shown in Figure 4-28 (Coull *et al*, 1998; Ellis *et al*., 2012).

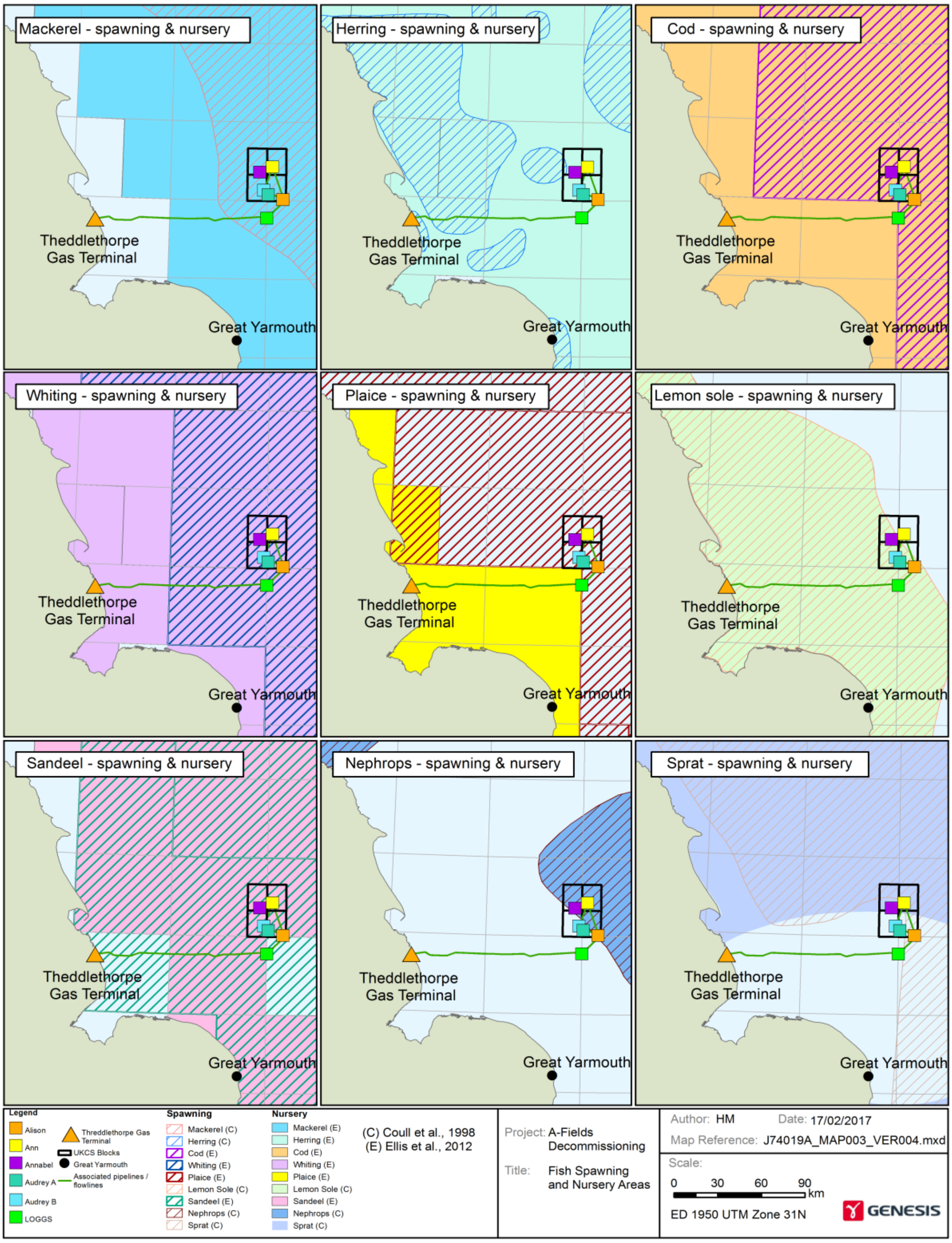


Figure 4-28: Spawning and nursery grounds in the vicinity of the A-Fields

4.4.4 Marine mammals

Marine mammals include cetaceans (whales, dolphins and porpoises), pinnipeds (seals) and mustelids (otters), all of which are susceptible to anthropogenic stresses.

4.4.4.1 Cetaceans

Sightings of numerous species of cetacean have been recorded on the European continental shelf. However, in many instances within the North Sea, recorded sightings are associated with single individuals (Reid *et al*, 2003). All cetacean species occurring in UK waters are afforded European Protected Species (EPS) status (Section 4.5.5).

As with most species, an optimal survey design for monitoring population sizes of cetaceans would involve surveying the species across its entire distribution at any one time. The impracticality of such a task, combined with difficulties of species identification, has made it difficult to confidently assess cetacean population sizes. The JNCC has compiled an atlas of cetacean distribution in north-west European waters (Reid *et al*., 2003) which gives an indication of the types of cetaceans and times of the year that they are likely to frequent areas of the North Sea.

Harbour porpoise, and white-beaked dolphin have been sighted in the vicinity of the A-Fields as shown in Table 4-6 and Figure 4-29 (Reid *et al*, 2003).

SPECIES	J	F	M	A	M	J	J	A	S	O	N	D
Harbour Porpoise												
White-beaked dolphin												
	Species sighted						Species not sighted					

Table 4-6: Cetaceans sighted in the vicinity of the A-Fields (Reid *et al*, 2003)

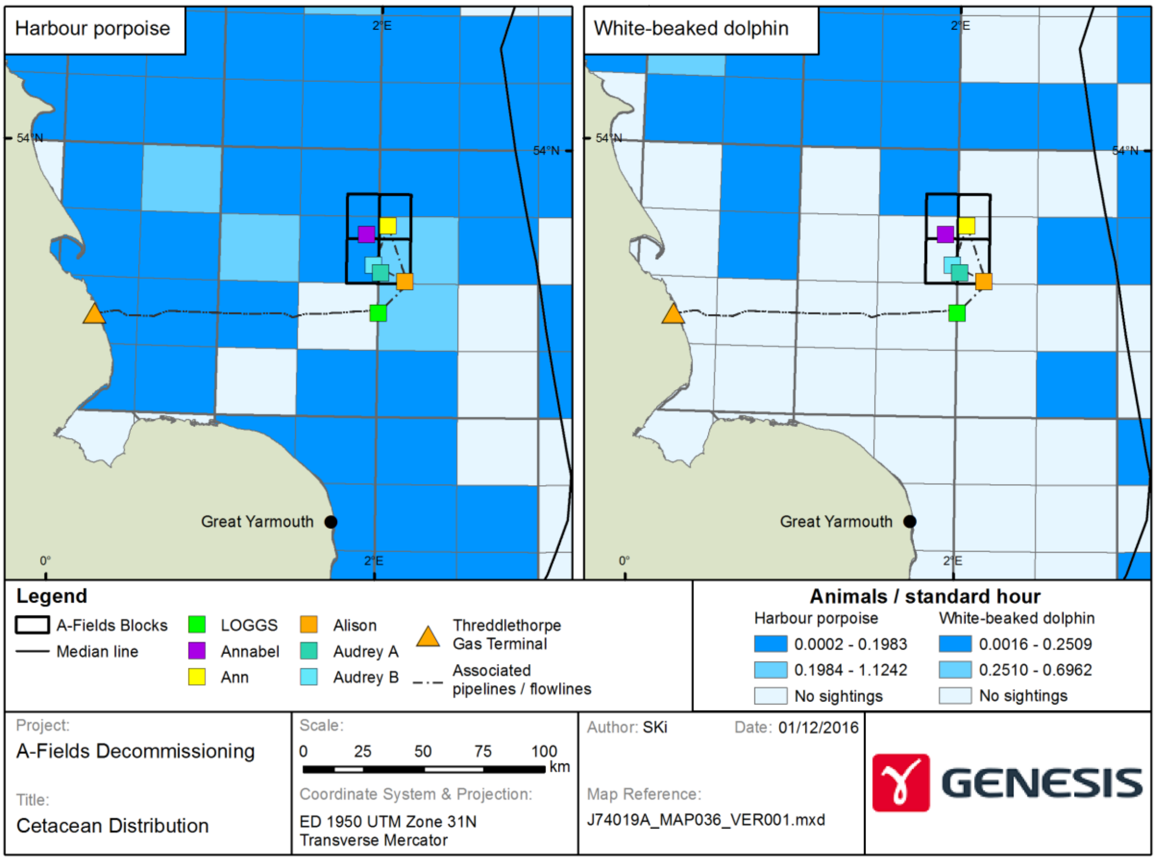


Figure 4-29: Sightings of harbour porpoise and white-beaked dolphins in the vicinity of the A-Fields (Reid *et al*., 2003)

The Habitats Directive lists those habitats and species (Annex I and II respectively) whose conservation requires the designation of special areas of interest. Harbour porpoise are listed under Annex II of the Habitats Directive (see Section 4.5.5). cSACs have been identified for harbour porpoise in UKCS waters and are currently under public consultation (JNCC, 2016a). The A-Fields are located in one of these identified areas and is discussed further in Section 4.5.

4.4.4.2 Pinnipeds

Two species of seal reside in UK coastal waters; the grey seal (*Halichoerus grypus*) and the common seal (*Phoca vitulina*).

Both species will feed in both inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping (October and November for grey seals and June and July for common seals) and moulting (generally January to April for grey seals and August and September for the common seal) seasons. Seal tracking studies from the Moray Firth have indicated that the foraging movements of common seals are generally restricted to within a 40 to 50km range of their haul-out sites (Special Committee on Seals (SCOS), 2012).

The movements of grey seals can involve larger distances than those of the common seal, and trips of several hundred kilometres from one haul-out to another have been recorded (Jones *et al.*, 2013). Figure 4-30 shows that the mean density of seals expected in the vicinity of the A-Fields is low for both harbour seals (0-1 per 25km^2) and grey seals (5-10 per 25km^2) (Jones *et al.*, 2013). As such it is possible that seals may pass through the area around the A-Fields, but they are unlikely to spend significant periods there, particularly during the pupping and moulting seasons when they will spend more time ashore.

It should be noted that grey seals and harbour seals are both listed under Annex II of the Habitats Directive (Section 4.5.5).

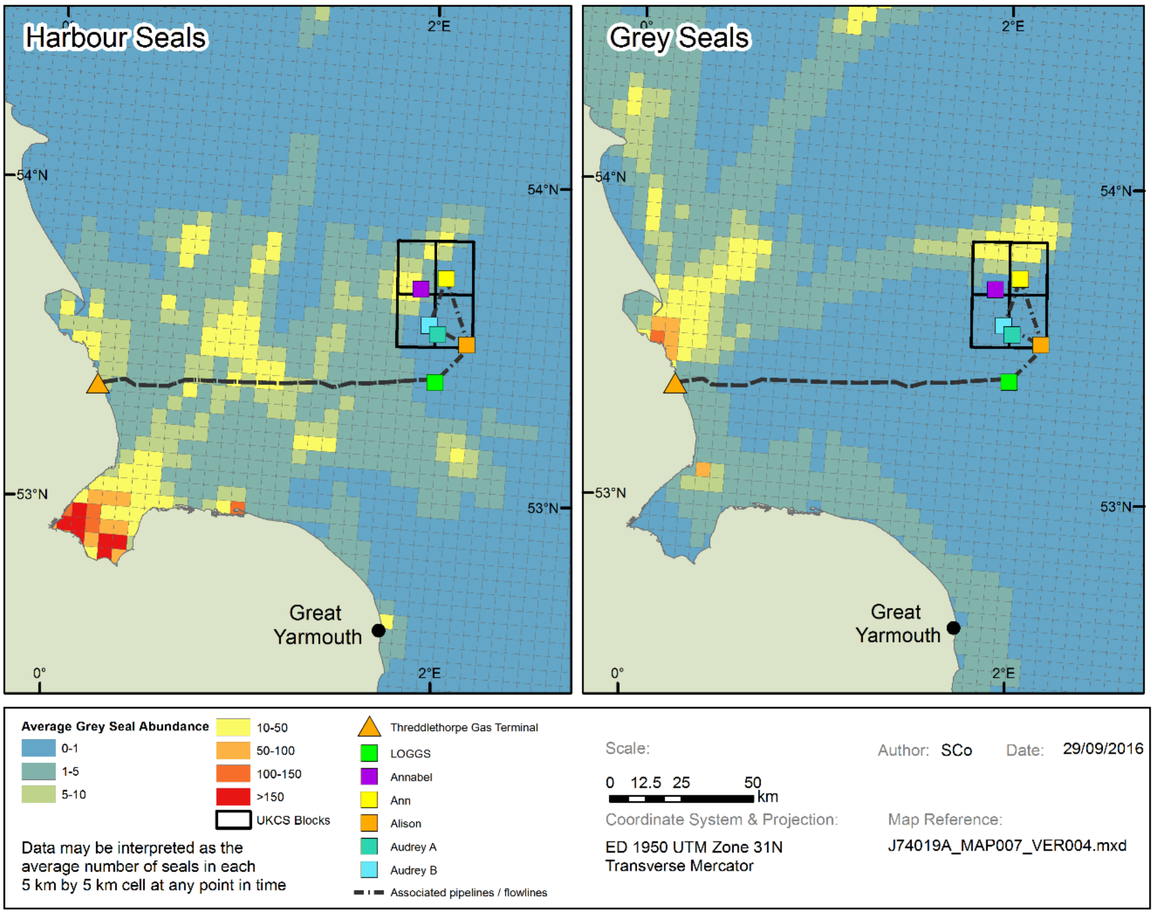


Figure 4-30: Average seal abundance in the vicinity of the A-Fields

4.4.5 Seabirds

Seabirds are generally not at risk from routine offshore operations. However, they may be vulnerable to pollution from less regular activities, for example from accidental hydrocarbon releases.

JNCC has produced an Offshore Vulnerability Index (OVI) for seabirds encountered within each offshore licence block within the North Sea and the Irish Sea. For each block, an index of vulnerability for all species is given which considers the following four factors:

- The amount of time spent on the water;
- The total biogeographical population;
- The reliance on the marine environment; and
- The potential rate of population recovery.

Each of these factors is weighted according to its biological importance and the OVI is then derived (Williams *et al*, 1994). The OVI of seabirds within each offshore licence block changes throughout the year. This is due to seasonal fluctuations in the species and number of birds present in the area.

The combined seabird data and species sensitivity index values are subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. This is presented as a series of fine scale density maps for each month that show the median, minimum and maximum seabird sensitivity to oil pollution, and an indication of data confidence. The index is independent of where oil pollution is most likely to occur; rather, it indicates where the highest seabird sensitivities might lie if there were to be a pollution incident. The mean sensitivity SOSI data for the area surrounding the A-Fields is shown in Figure 4-31. Where data is available, sensitivity is seen to be extremely high, except in August when sensitivity is considered to be medium. Data is not available for the A-Fields blocks in January, March, April, May, June, October and December.

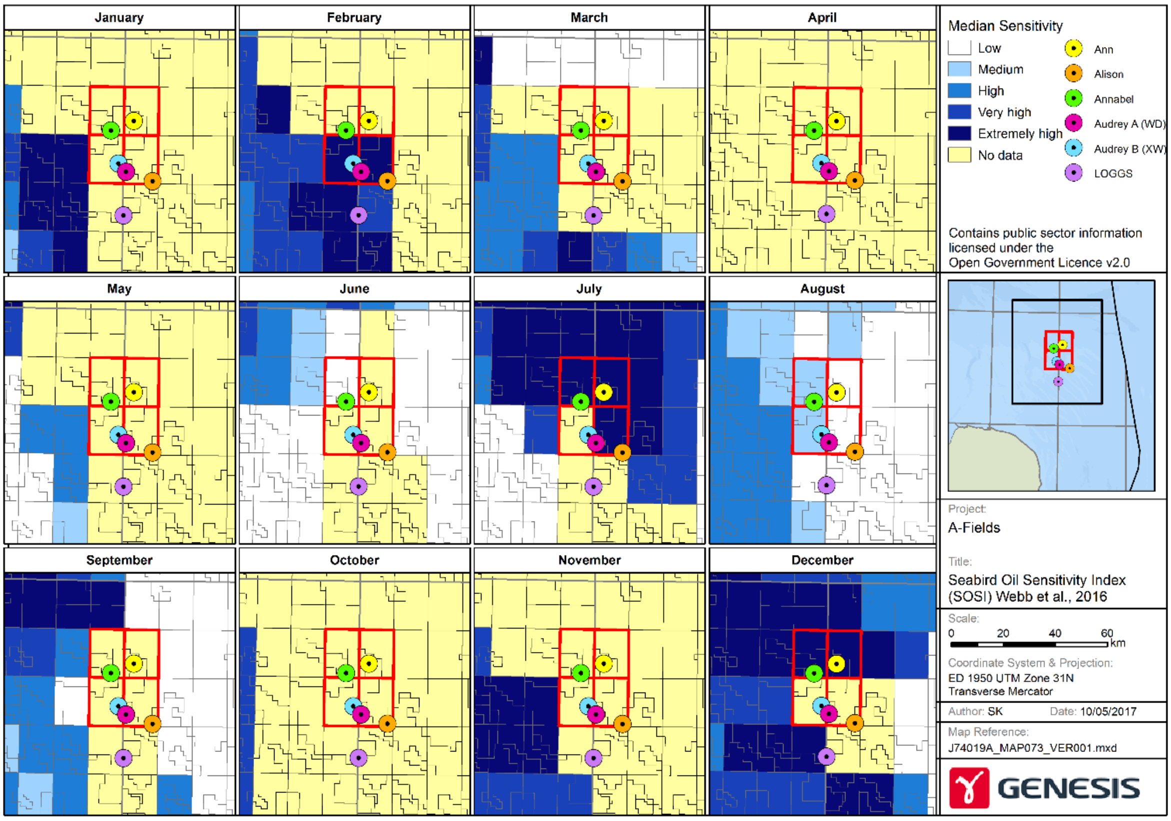


Figure 4-31 Median seabird oil sensitivity index in the vicinity of the A-Fields (Webb *et al.*, 2016)

In order to reduce the extent of the coverage gaps in Figure 4-31, guidance from JNCC (JNCC, 2017) has been followed. By following the JNCC guidance, the data gaps are reduced. The revised SOSI for the A-Fields area is shown in Table 4-7. Using the JNCC guidance the areas with no data have been reduced. In general, sensitivity is extremely high from November to February in the A-Fields blocks. From March to October, sensitivity is generally high to low with the exception of July where sensitivity is extremely high.

Block	J	F	M	A	M	J	J	A	S	O	N	D
48/4	*	*		*	*					*	*	
48/5	*	*		*	*					*	*	
49/1	*	*		*						*	*	
49/2	*	*		*	*					*	*	
48/9	*	**	**		*					*	*	
48/10 (Annabel)	*	**			*				*		*	
49/6 (Ann)	*	**							*		*	
49/7	*	**			*					*	*	
48/14				*		*				*		
48/15 (Audrey B)	*		*		**	**	*		*		**	**
49/11 (Audrey A, Alison)	*		*			*			*			**
49/12		**			*					*		
48/19				*						*		
48/20 (LOGGS)	*		*		**	**	*		*		*	
49/16 (LOGGS)	*		*				*		*			**
49/17		**	**			*				*		**
48/24	*			*			*			*		
48/25	*			*	**	**	*		*	*		
49/21	*			*			*		*	**	*	
49/22	*	*		*			*			*	*	
KEY	Extremely High		Very High		High		Medium		Low		No data	

** data gap filled using data from the same block in adjacent months (JNCC, 2017)*

*** data gap filled using data from adjacent blocks (JNCC, 2017)*

Table 4-7: Revised median seabird oil sensitivity index using JNCC guidelines to fill on data gaps (JNCC, 2017)

4.5 Habitats and species of conservation concern

The EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC) are the main driving forces for safeguarding biodiversity in Europe.

Through the establishment of a network of protected sites these directives provide for the protection of animal and plant species of European importance and the habitats that support them.

The EU Habitats Directive 92/43/EEC and the EU Birds Directive 79/409/EEC have been enacted in the UK by the following legislation:

- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) transpose the Habitats and Birds Directives into UK law. They apply to land and to territorial waters out to 12nm from the coast and have been subsequently amended several times;
- The Conservation of Habitats and Species Regulations 2010: The Conservation of Habitats and Species Regulations 2010 consolidate all the various amendments made to the Conservation (Natural Habitats, &c.) Regulations 1994 in respect of England and Wales. In Scotland, the Habitats and Birds Directives are transposed through a combination of the Habitats Regulations 2010 (in relation to reserved matters) and the 1994 Regulations;
- The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended 2009 and 2010): These regulations are the principal means by which the Birds and Habitats Directives are transposed in the UK offshore marine area (i.e.

outside the 12nm territorial limit) and in English and Welsh territorial waters; and

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended 2007): These regulations apply the Habitats Directive and the Wild Birds Directive in relation to oil and gas plans or projects wholly or partly on the United Kingdom Continental Shelf and adjacent waters outside territorial waters (i.e. outside the 12nm territorial zone).

The Habitats Directive lists those habitats and species (Annex I and II respectively) whose conservation requires the designation of special areas of interest. These habitats and species are to be protected by the creation of a series of Special Areas of Conservation (SACs), and by various other safeguard measures such as Sites of Community Importance (SCIs) for particular species. SACs are sites that have been adopted by the European Commission (EC) and formally designated by the government of the country where the site lies and SCIs are sites that have been adopted by the EC but not yet formally designated by the government of the relevant country.

The Birds Directive requires member states to nominate sites as Special Protection Areas (SPAs). Together with adopted SACs, the SPA network form the 'Natura 2000' network of protected areas in the European Union. Figure 4-32 shows the location of Ann and Alison in relation to protected areas.

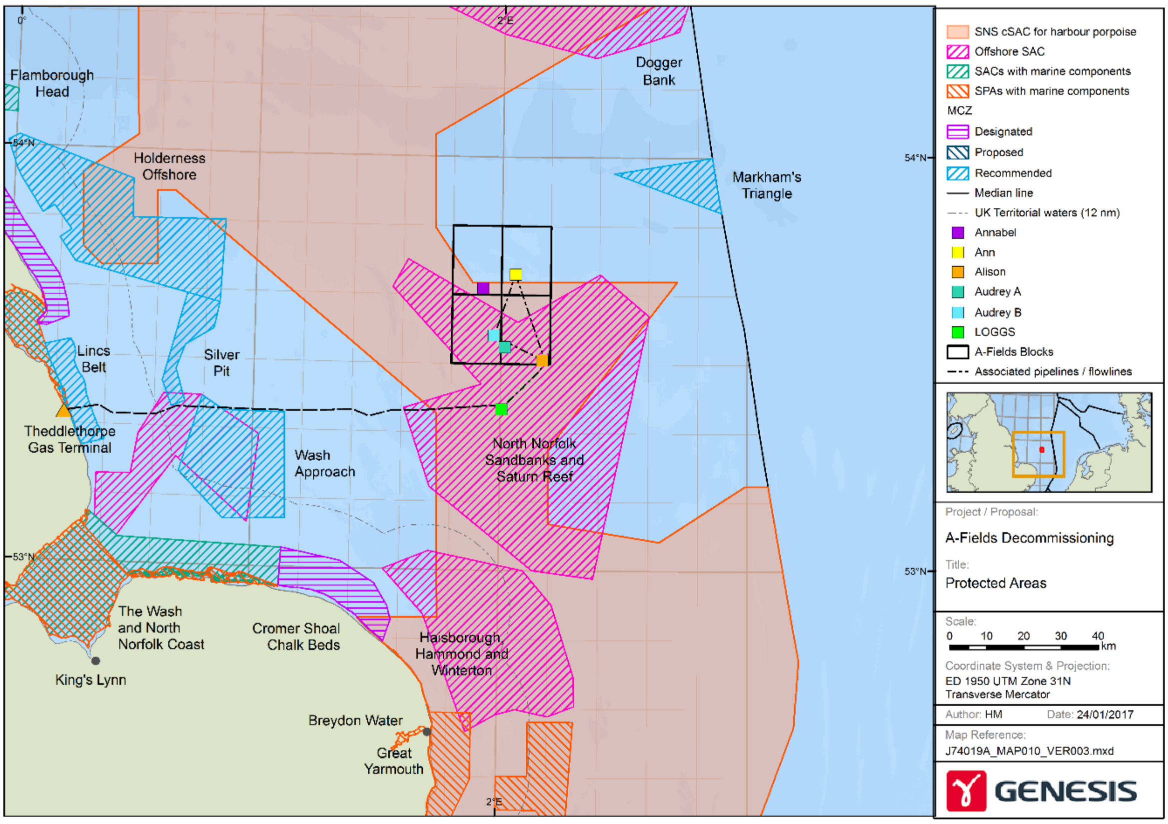


Figure 4-32: SACs/SCIs, cSACs, SPAs and MCZ sites in the region of Ann and Alison

4.5.1 Special areas of conservation / sites of community importance

There are currently 99 SACs with marine components, covering 7.6% of the UK marine area. Of these, 83 SACs are found within inshore waters, 16 are located in offshore waters and there are four sites which are within both inshore and offshore waters. In addition, five candidate SACs (cSACs) for the Annex II species harbour porpoise (*Phocoena phocoena*) centrica

have been identified, including one in the SNS which coincides with the majority of the A-Fields area.

4.5.1.1 North Norfolk Sandbanks and Saturn Reef SAC

The Audrey platforms lie within the North Norfolk Sandbanks and Saturn Reef SAC (Figure 4-33) which covers an area of 3,603km^2 (Figure 4-33). This comprises a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes (see Section 4.3.7) and areas of *Sabellaria* sp. biogenic reef.

The Conservation Objectives for North Norfolk Sandbanks and Saturn Reef SAC sandbanks which are slightly covered by seawater all the time, and reef, are:

Subject to natural change, restore the sandbanks which are slightly covered by seawater all the time and reefs to favourable condition, such that the:

- *The natural environmental quality, natural environmental processes and extent are maintained; and*
- *The physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time and reefs in the Southern North Sea are restored* (JNCC, 2012)*.*

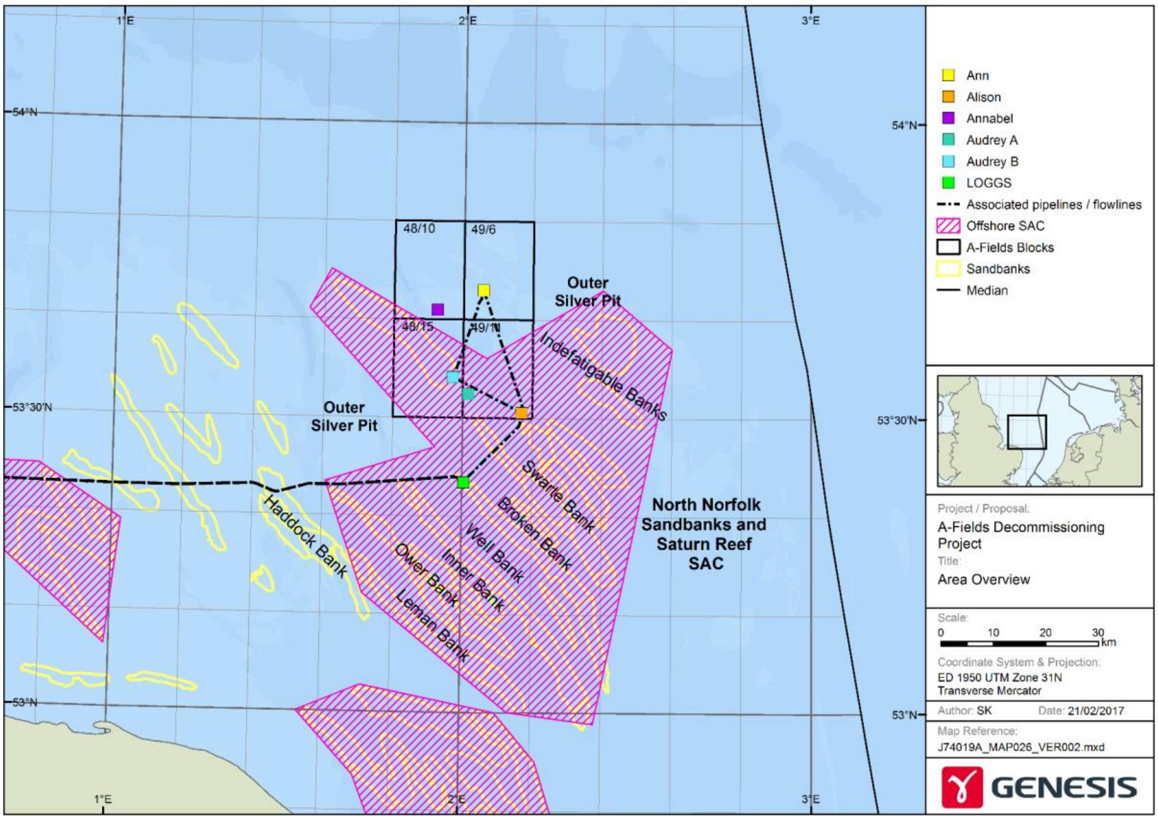


Figure 4-33: North Norfolk Sandbanks and Saturn Reef SAC

Sandbanks

The North Norfolk Sandbanks extend from about 40km off the north-east coast of Norfolk out to *c.*110km. The banks are the most extensive example of offshore linear ridge sandbank types in UK waters and the outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters (Graham *et al*., 2001).

The sand banks are subject to a range of current strengths which are strongest on the banks closest to shore and which reduce offshore (Collins *et al*., 1995). The outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters. Sand waves are present, being best developed on the inner banks; the outer banks having small or no sandwaves associated with them (Collins *et al*., 1995).

The sand banks have a north-west to south-east orientation and are thought to be progressively, though very slowly, elongating in a north-easterly direction (perpendicular to their long axes) (Cooper *et al*., 2008). The summits of the banks are in water shallower than 20m below Chart Datum, and the flanks of the banks extend into waters up to 40m deep.

A sandbank by definition lies under no more than 20m of water however, the extent of the Annex I sandbank habitat in the North Norfolk Sandbanks and Saturn Reef area was determined including flanks and troughs of these banks which are also part of the sandbank feature but extend into deeper waters (JNCC, 2010b).

Sabellaria spinulosa reefs

The Saturn *Sabellaria* sp. reef consists of thousands of fragile sand-tubes made by polychaetes which have consolidated together to create a solid structure rising above the seabed. Reef habitats such as those formed by *Sabellaria* sp. are listed within Annex I of the Habitats Directive. Although *Sabellaria* sp. is found widely distributed in UK waters, significant elevated reef structures are rare (JNCC, 2010b). *Sabellaria* sp. reef structures can be temporary and unstable but it is generally accepted that broad areas which support reef production typically remain so until hydrographical conditions change (Jones *et al*., 2000).

Stony reef

Reefs are one of the habitats of conservation significance listed under Annex I of the Habitats Directive for protection within SACs. Rocky reefs (bedrock and stony reefs) can be extremely variable, both in structure and in the communities they support. A wide range of topographical reef forms meet the European definition of this habitat type, including vertical rock walls, horizontal ledges, sloping or flat bed rock, broken rock, boulder fields, and aggregations of cobbles (McLeod *et al.*, 2005). In terms of its intended composition, deposited rock would meet these criteria, hence why an assessment against the stony reef criteria is appropriate.

Stony reefs can comprise areas of boulders or cobbles that stand proud from the seafloor and can provide a suitable substratum for the attachment of benthic communities of algae and marine fauna. Boulders and cobbles are generally considered to be greater than 64mm in diameter; and a feature of a stony reef must be that it is topographically distinct from the surrounding seafloor. A multi-criteria scoring system is used to assess the characteristics of a potential stony reef. Each characteristic can be scored as low, medium or high, with spatial extent (m^2), substrate composition (% cover) and elevation as the primary characteristics, as defined by Irving (2009).

Table 4-8 summaries the presence of Annex I habitat in the vicinity of the Ann and Alison decommissioning activities.

AREA	ANNEX I HABITAT		
	'Sandbanks which are slightly covered by seawater all of the time'	*Sabellaria* reef'	Rocky reefs (bedrock and stony reefs)
Ann	✗	✗	✗
Alison	✓	✗	✗
Audrey B (XW) platform	✓	✗	✗
The LOGGS platform complex	✓	✗	✗
Alison and Audrey B (XW) are both situated within the North Norfolk Sandbanks and Saturn Reef SAC. Despite the pre-decommissioning surveys not classifying the habitat as Annex I (Section 4.3.7 and Gardline Geosurvey Ltd, 2016c) it is classified as Annex 1 habitat in this table.			

Table 4-8: Presence of Annex I habitat within the vicinity of Ann, Alison, Audrey B (XW) and the LOGGS platform complex

4.5.1.2 Harbour porpoise cSAC

The Alison subsea infrastructure and the Audrey platforms lie within one of a number of cSACs which have been identified for harbour porpoise in UKCS waters, which are currently under public consultation (JNCC, 2016a).

The cSAC is a single feature site, proposed to be designated solely for the purpose of aiding the management of harbour porpoise populations throughout UK waters, in accordance with EU legislation. The Conservation Objectives for the site are:

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise. The aim is to achieve this by ensuring that:

- *The species is a viable component of the site (e.g. they are able to survive and live successfully within the site);*
- *There is no significant disturbance of the species; and*
- *The supporting habitats and processes relevant to harbour porpoises and their prey are maintained* (JNCC, 2016a).

As harbour porpoise are highly mobile species, the areas proposed are large. The SNS cSAC covers 36,958km^2, extending down the North Sea from the River Tyne south to the Thames and includes habitats such as sandbanks and gravel beds (Figure 4-34). The water depths within the site range between 10 and 75m.

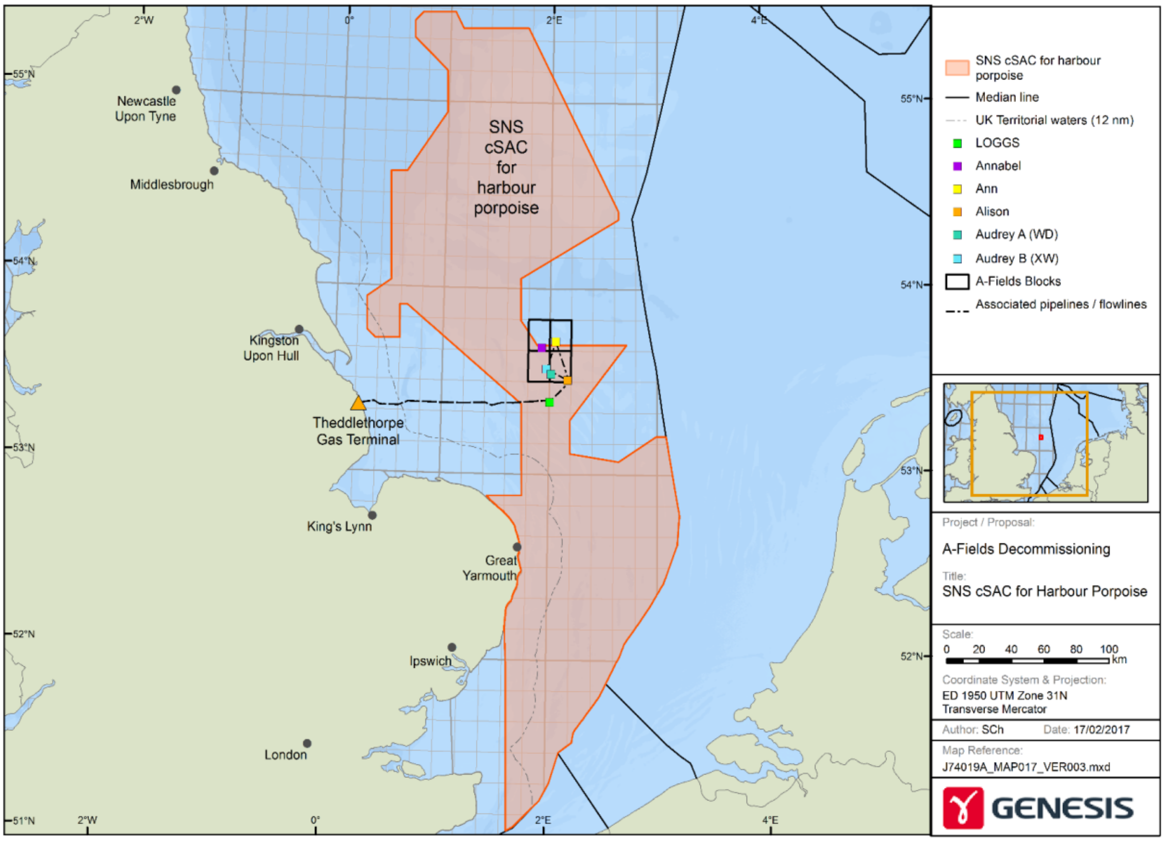


Figure 4-34: SNS cSAC for harbour porpoise

Tagging studies undertaken in Denmark indicate that harbour porpoises range widely in the North Sea, with individuals tagged in the Skagerrak occurring off the east coasts of Scotland and England (Sveegaard *et al.*, 2011). Harbour porpoise densities vary seasonally and across the SNS cSAC. In the central and northern area of the cSAC, the highest densities occur during the summer period with modelled harbour porpoise densities greater than 3.0/km^2 occurring widely across the SNS (Figure 4-35). During the winter period the distribution of harbour porpoise in the SNS changes with reduced densities over the central and northern area but an increase in densities in nearshore waters and the southern part of the cSAC (Figure 4-35) (Heinänen and Skov, 2015).

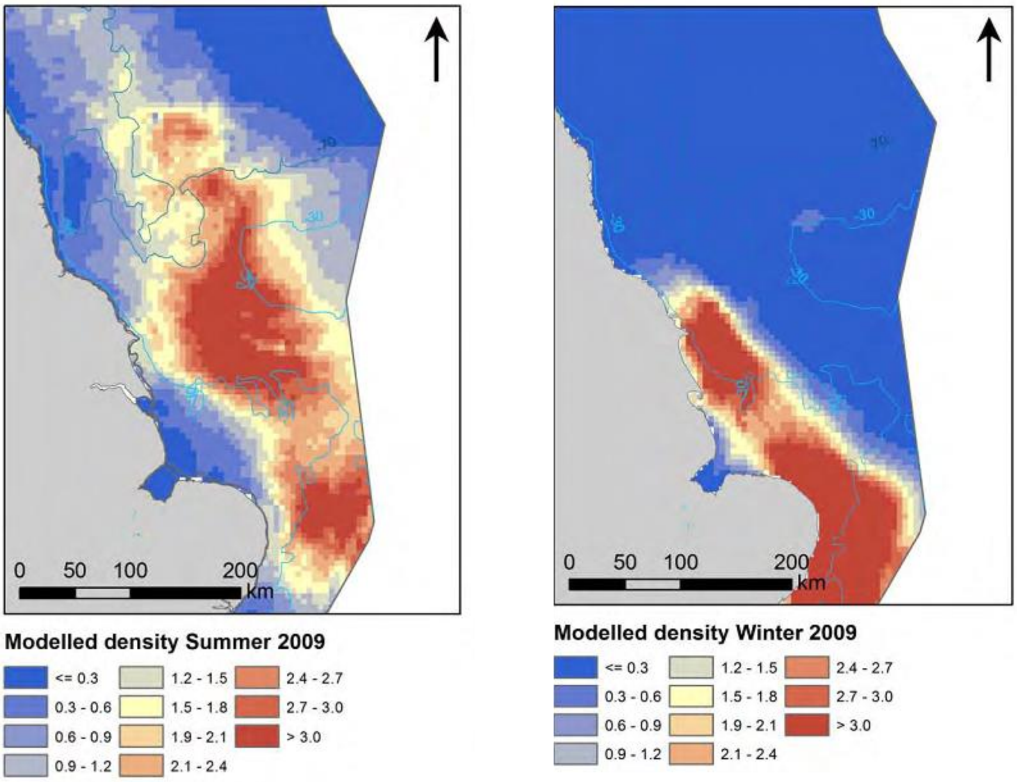


Figure 4-35: Estimated densities (no/km^2) of harbour porpoise in the SNS

4.5.2 Special Protection Areas

SPAs are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species. There are a total of 270 SPAs designated in the UK. The nearest protected site is the North Norfolk Coast SPA, which is over 90km southwest of the blocks (Figure 4-32).

4.5.3 Marine Conservation Zones

Under the MCAA (2009) the NCZ project (led by the JNCC and Natural England) was set up in 2008 to identify MCZs in English, Welsh and Northern Irish offshore waters. MCZs aim to protect a range of nationally important marine wildlife, habitats, geology and geomorphology. In November 2013, 27 MCZs were designated. In January 2016, a further 23 sites were designated following the Tranche Two consultation. It is expected that there will be a third tranche of designations in the future (candidate MCZs).

The nearest MCZ to the A-Fields is the Markham’s Triangle recommended MCZ (Figure 4-32) which is approximately 38km north-east of the Ann infrastructure and designated for broad scale habitat features such as subtidal sand and subtidal coarse sediments. The next closest MCZ is the Wash Approach recommended MCZ which is approximately 70km from the Alison infrastructure (Figure 4-32).

4.5.4 East Inshore and East Offshore Marine Plan

The East Inshore and East Offshore Marine Plans are the first plans produced for English seas, and entered into force in April 2014 (Figure 4-36).

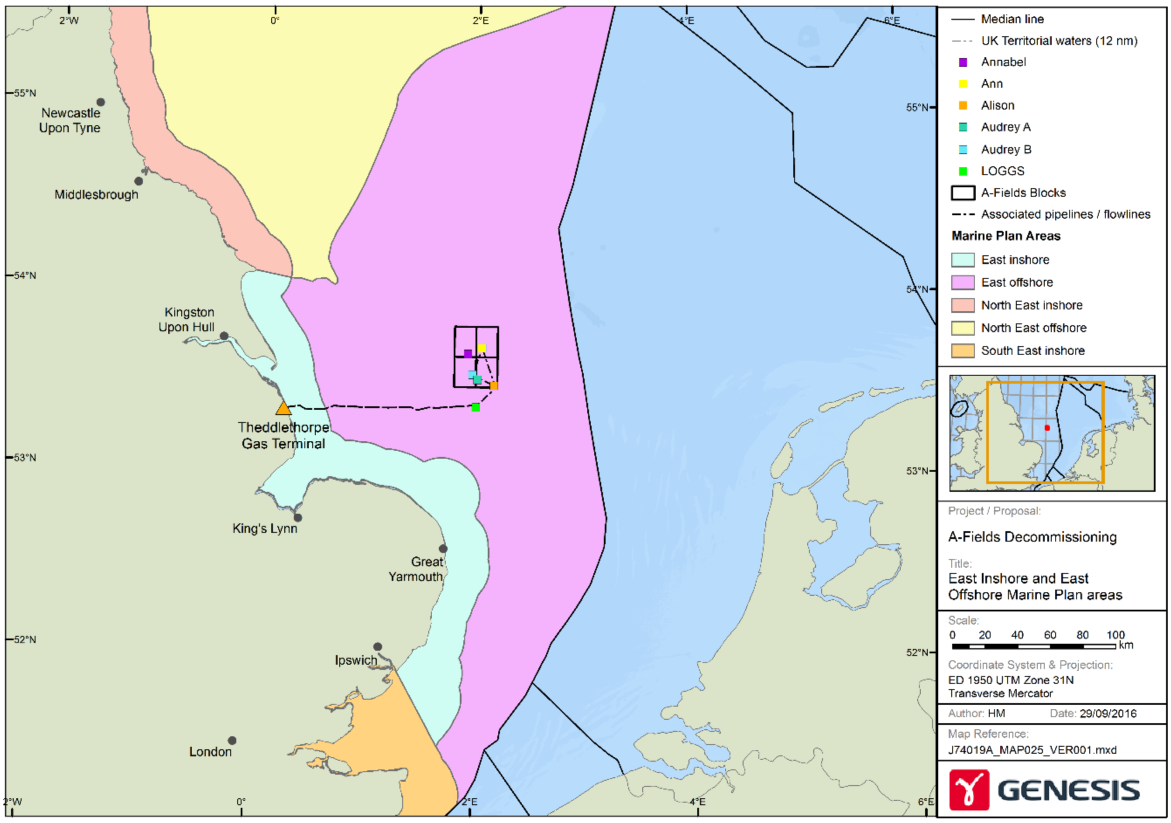


Figure 4-36: East Inshore and East Offshore Marine Plan areas and bordering nations

The aim of marine plans is to help ensure the sustainable development of the marine area through informing and guiding regulation, management, use and protection of the marine plan areas. The Plan sets out 11 objectives (listed in Table 4-9) that need to be met in order to deliver the vision for East Marine Plan Areas in 2034. The objectives are supported by cross-sectorial and sector specific policies. The purpose of the policies is to provide direction or guidance on how decisions should be made to ensure the plan objectives are met. The Plan's policies in general apply to new, rather than existing, developments, uses and management measures. However, they may also apply in the review of existing activities or measures (MMO, 2014).

OBJECTIVE	DETAILS
1	To promote the sustainable development of economically productive activities, taking account of spatial requirements of other activities of importance to the East marine plan areas.
2	To support activities that create employment at all skill levels, taking account of the spatial and other requirements of activities in the East marine plan areas.
3	To realise sustainably the potential of renewable energy, particularly offshore wind farms, which is likely to be the most significant transformational economic activity over the next 20 years in the East marine plan areas, helping to achieve the United Kingdom's energy security and carbon reduction objectives.
4	To reduce deprivation and support vibrant, sustainable communities through improving health and social well-being.
5	To conserve heritage assets, nationally protected landscapes and ensure that decisions consider the seascape of the local area.
6	To have a healthy, resilient and adaptable marine ecosystem in the East marine plan areas.
7	To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas.
8	To support the objectives of Marine Protected Areas (and other designated sites around the coast that overlap, or are adjacent to the East marine plan areas), individually and as part of an ecologically coherent network.
9	To facilitate action on climate change adaptation and mitigation in the East marine plan areas.
10	To ensure integration with other plans, and in the regulation and management of key activities and issues, in the East marine plans, and adjacent areas.
11	To continue to develop the marine evidence base to support implementation, monitoring and review of the East marine plans

Table 4-9: Objectives for the East Inshore and East Offshore Marine Plans (MMO, 2014)

The proposed operations have been assessed against the marine plan objectives and cross-sectorial and sectorial policies. In summary, the proposed activity does not contradict any of the marine plan objectives and policies.

4.5.5 Species of conservation concern

The designation of fish species requiring special protection in UK waters is receiving increasing attention with particular consideration being paid to large slow growing species such as sharks and rays. A number of international laws, conventions and regulations as well as national legislative Acts have been implemented which provide for the protection of these species. They include:

- The UK Biodiversity Action Plan (BAP) priority fish species (JNCC, 2016b);
- The OSPAR List of Threatened and/or Declining Species & Habitats (OSPAR, 2016);
- The IUCN (International Union for Conservation of Nature) Red List of Threatened Species (IUCN, 2016);
- The Wildlife and Countryside Act 1981 (which consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the Birds Directive in Great Britain) (JNCC, 2016c). The Wildlife and Countryside Act makes it an offence to intentionally kill, injure, possess or trade any animal listed in Schedule 5 and to

interfere with places used by such animals for shelter or protection; and

- The EC Habitats Directive (transposed into UK law through the Conservation of Habitats and Species Regulations 2010 in England and Wales and also the 1994 Regulations in Scotland).

Those species of fish that could potentially occur in the vicinity of the A-Fields (FishBase, 2016) and are listed under the protection measures discussed above are shown in Table 4-10. It should be noted however that only Atlantic cod (*G. morhua*) were observed in the vicinity of the A-Fields during the pre-decommissioning surveys undertaken in 2016.

SPECIES	UK BAP	OSPAR	IUCN	BERN CONVENTION	HABITATS REGULATIONS
Allis shad *(A. alosa)*	✓	✓	Least Concern	✓	✗
Twaite shad (*A. fallax*)	✓	✗	Least Concern	✓	✗
Angel shark *(S. squatina)*	✓	✓	Critically Endangered	✓[1]	✗
Atlantic salmon (*S. salar*)	✓	✓	Least Concern	✓[2]	✗
Atlantic cod *(G. morhua)*	✗	✓	Vulnerable	✗	✗
Common skate (*D. batis*)	✓	✓	Critically Endangered	✗	✗
Basking shark (*C. maximus*)	✓	✗	Vulnerable	✓	✗
Porbeagle shark (*L. nasus*)	✓	✓	Vulnerable	✓	✗

[1] = Applies in the Mediterranean only.
[2] = Does not apply in sea waters.

Table 4-10: Designation of fish species occurring in the vicinity of the proposed project

In addition, four marine mammal species listed under Annex II of the Habitats Directive occur in relatively large numbers in UK offshore waters:

- Grey seal (*Halichorerus grypus*);
- Harbour seal (*Phoca vitulina*);
- Bottlenose dolphin (*Tursiops truncatus*); and
- Harbour porpoise (*Phocoena phocoena*).

The bottlenose dolphin and harbour porpoise, like all the cetacean species found in UK waters, also have EPS status, along with several other marine mammals found in UK waters. Developers must therefore consider the requirement to apply for the necessary licences if there is a risk of causing any potential disturbance / injury to EPS.

4.6 Socio-economic

As part of the assessment it is necessary to consider the impact of decommissioning operations and endpoints on other users of the environment.

4.6.1 Fishing activity

The International Council for the Exploration of the Sea (ICES) is the primary source of scientific advice to the governments and international regulatory bodies that manage the North Atlantic Ocean and adjacent seas. For management purposes ICES collates fisheries information for area units termed ICES rectangles measuring 30nm by 30nm. Each ICES rectangle covers approximately one half of one quadrant i.e. 15 licence blocks. The importance of an area to the fishing industry is assessed by measuring the fishing effort which may be defined as the number of days (time) x fleet capacity (tonnage and engine power). Due to the requirement by UK fishermen to report catch information such as total landings (includes species type and tonnage of each), and location of hauls and catch method (type of gear/duration of fishing), it is possible to get an indication of the value of an area (ICES rectangle) to the UK fishing industry. It should be noted, however, that fishing activity may not be uniformly distributed over the whole area of the ICES rectangle. The A-Fields infrastructure is located in ICES rectangle 36F2.

4.6.2 Fishing effort

The UK fishing effort within 36F2 varies throughout the year and averages 109 days per annum (2012–2015) (Scottish Government, 2016). Approximately 0.07% of total UK landings between 2012 and 2015 were taken from the area (Table 4-11).

Year	Total Fishing Effort by UK Fishing Fleet (days)		
	UK Total	36F2	36F2 as % UK Total
2012	185,200	76	0.04
2013	183,400	147	0.08
2014	129,850	108	0.08
2015	124,850	107	0.09
Average over 2011 - 2015		109	0.07
Note these data are based on reported landings from ICES rectangles within which more than five UK vessels measuring over 10m were active. In those ICES rectangles where < 5 vessels were active the information is considered disclosive and is therefore not available.			

Table 4-11: Fishing effort by UK fishing fleet in ICES rectangle 36F2 and UK total (Scottish Government, 2016)

4.6.3 Fish landings

The quantity of landings by UK vessels in ICES rectangle 36F2 is shown Table 4-12. The data suggest that ICES rectangle 36F2 is of relatively low value to the UK fishing industry.

Year	Total Landings by UK Fishing Fleet (Te)		
	UK Total	36F2	36F2 as % UK Total
2012	678,980	962	0.14
2013	640,930	448	0.07
2014	604,180	235	0.04
2015	547,070	292	0.05
Note these data are based on reported landings from ICES rectangles within which more than five UK vessels measuring over 10m were active. In those ICES rectangles where < 5 vessels were active the information is considered disclosive and is therefore not available.			

Table 4-12: Total landings by UK fishing fleet in ICES rectangle 36F2 and UK total (Scottish Government, 2016)

The mass of fish landings from the area by species type is shown in Figure 4-37. The area is targeted primarily for demersal species.

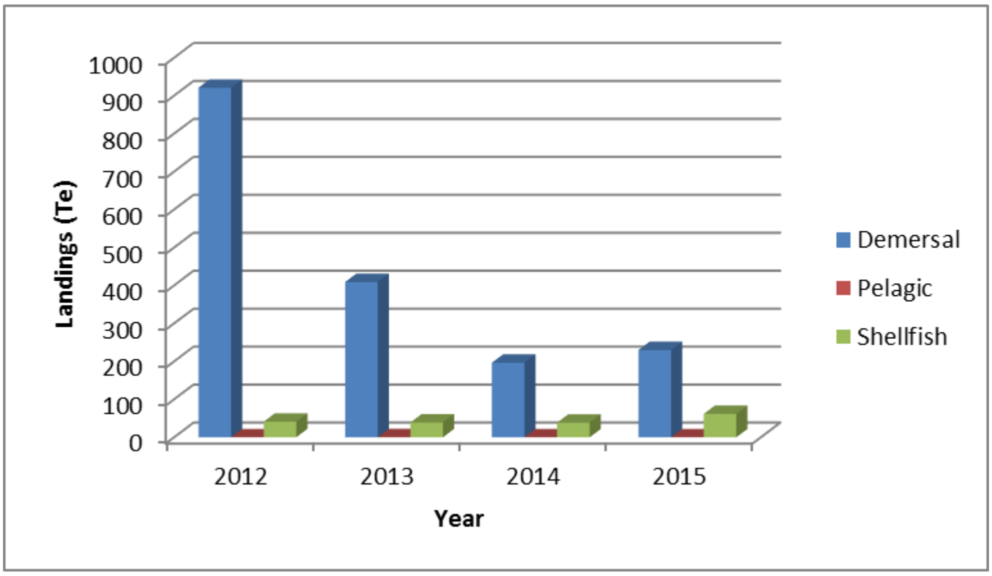


Figure 4-37: Live catches within ICES rectangle 36F2 by species type

The value of landings of different fish types (demersal, pelagic or shellfish) from ICES rectangle 36F2 in 2015 is shown in Table 4-13. The total value of landings from ICES rectangle in 2015 was £562,101 with the majority of this (£417,493) comprising demersal species. These landings equate to approximately 0.20% of the total reported landings of demersal species types at UK ports in 2015, suggesting the area is of relatively low importance to the UK demersal fishing industry.

ICES Rectangle 36F2	Demersal	Pelagic	Shellfish	Total
Value of landings (£)	417,493	1	144,607	562,101
UK Annual Total (£)	205,126,339	173,299,527	195,493,099	573,918,965
% UK Total	0.20	0.00	0.07	0.10

Table 4-13: Relative value of landings from ICES Block 36F2 to total UK catches in 2015

UK vessels ≥15m in length have Vessel Monitoring Systems (VMS) on board that allow environmental and fisheries regulatory organisations to monitor the position, time at a position, course and speed of fishing vessels. VMS data for all UK registered commercial fishing vessels ≥15m length for the period 2007-2013 have been combined with landings information to develop GIS layers describing the spatial patterns of landings of the UK offshore fleet from within the UK Fishing limits (200nm) (Kafas *et al*., 2012). Figure 4-38 shows the fishing intensity by the monitored fishing vessels. The data shows that fishing intensity is low in the A-Fields area.

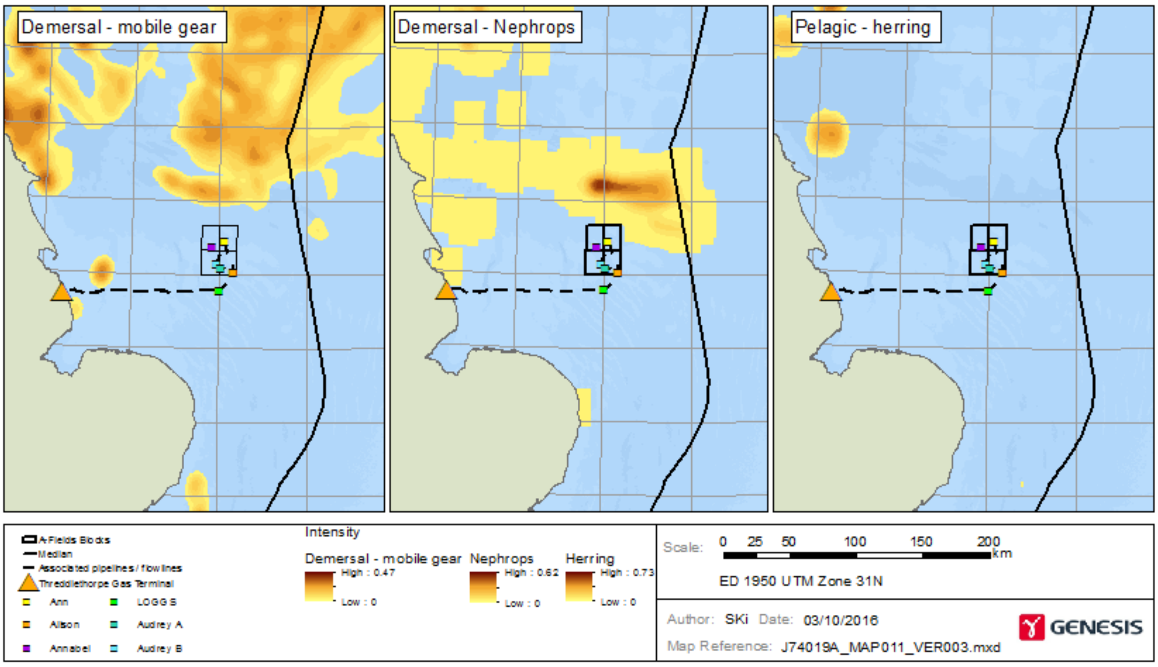


Figure 4-38: VMS data combined from 2009 – 2013 showing the fishing intensity by fishing vessels >15m in length in the North Sea using demersal mobile gears, *Nephrops* mobile gears and pelagic herring gears (Kafas *et al*., 2012)

4.6.4 Shipping

The density of shipping traffic within the SNS is high, due to the presence of a number of large international ports within the region. There are 33 shipping routes utilised by an estimated 3,426 ships per year passing within 10nm of the Audrey platforms. This corresponds to an average of 9-10 vessels per day (Anatec, 2015).

Shipping activities in the North Sea are categorised by the Oil and Gas Authority (OGA, 2016) to have either: very low; low; moderate; high; or very high shipping density. Figure 4-39 provides an assessment of the level of shipping activity within the area of the A-Fields. Shipping in block 49/6 and block 49/11 which contain Ann and Alison infrastructure respectively is considered high.

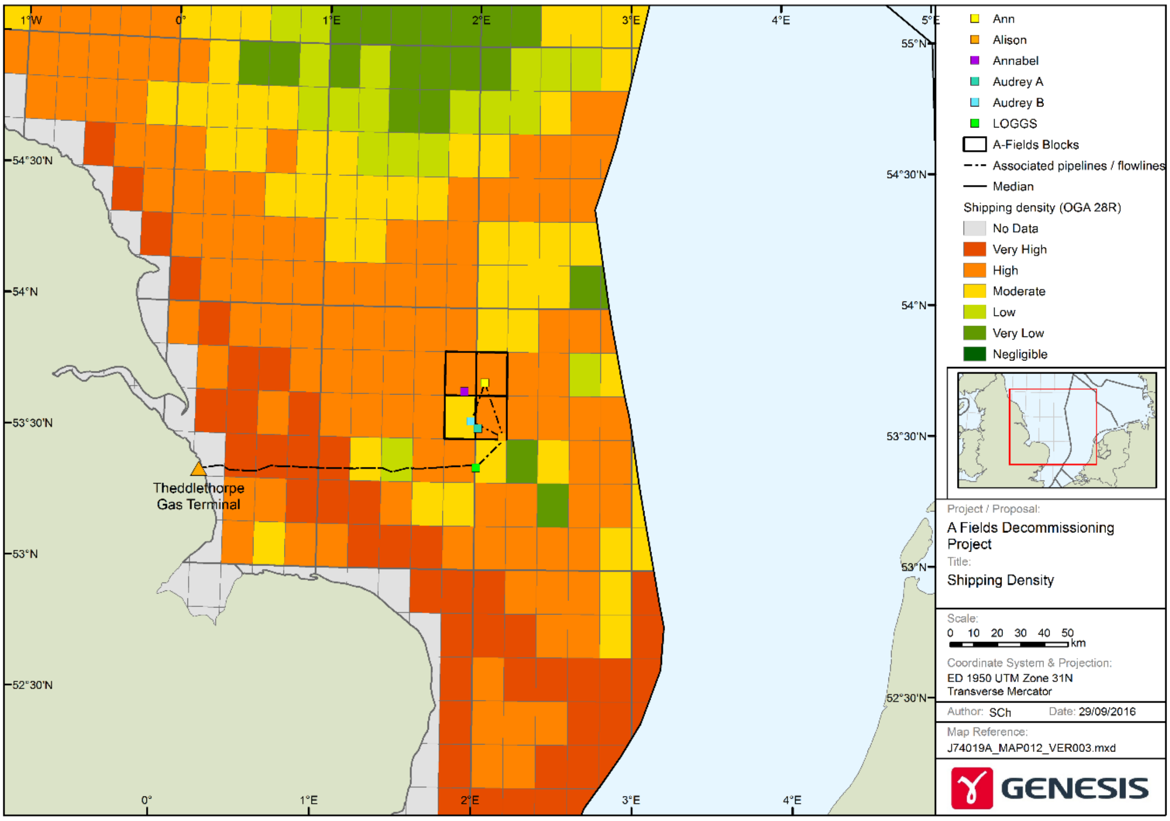


Figure 4-39: Shipping density in the vicinity of the A-Fields as categorised by the OGA (2016)

4.6.5 Existing oil and gas activity

The SNS gas basin in which the A-Fields are located is a region well developed by the oil and gas industry. Figure 4-40 shows surface oil and gas installations in the vicinity of the A-Fields (note it also shows the Ann, Alison and Annabel subsurface installations). There are 140 surface installations in the region of the A-Fields. Of the 140 surface installations, Leman BH (Shell) and ST-1 (Centrica) currently have decommissioning plans submitted to BEIS. The decommissioning plans for the Thames Complex (Perenco), Horne & Wren (Tullow) and Viking (ConocoPhillips) have been approved (Figure 4-40) (BEIS, 2017a).

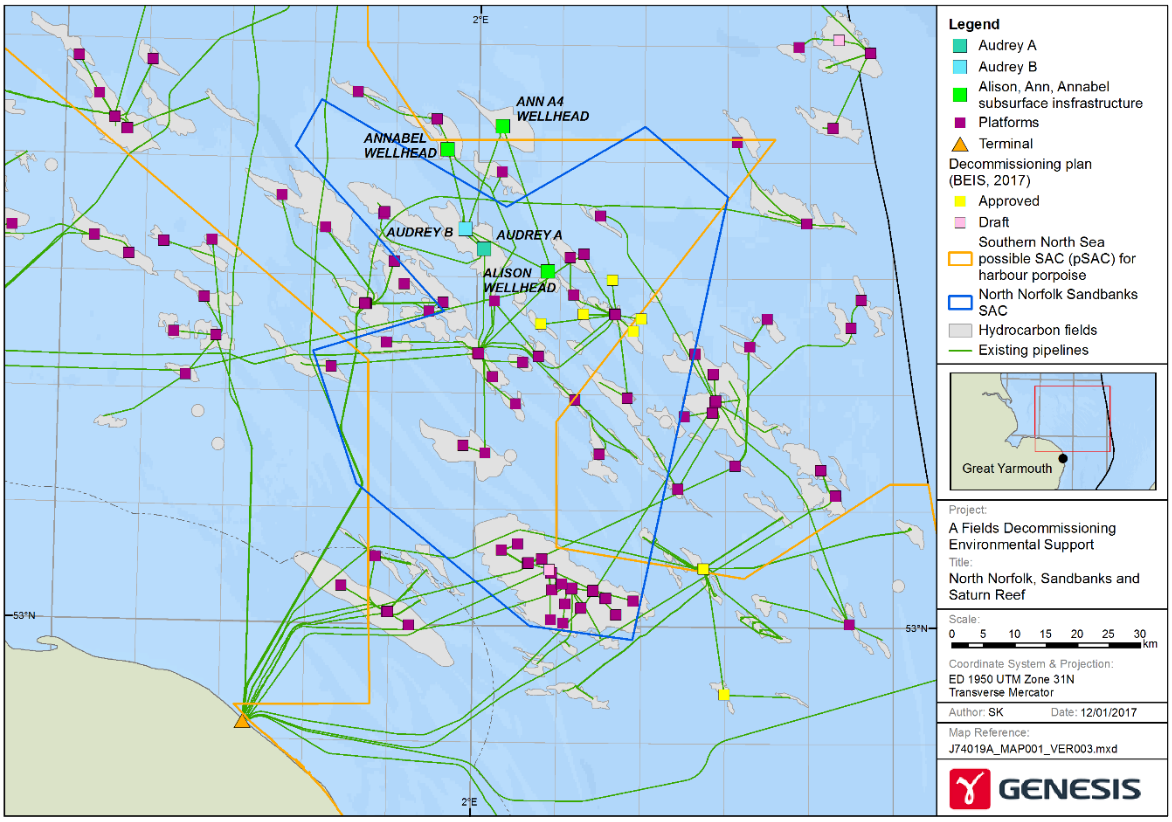


Figure 4-40: Oil and gas surface infrastructure within the vicinity of the A-Fields

4.6.6 Offshore renewable energy activity

There are a number of wind farm areas at different stages of the consenting process within the vicinity of the A-Fields (Figure 4-41). The closest operational wind farm to Ann and Alison infrastructure is Sheringham Shoal, 76km to the south-west of Ann and Alison. The nearest wind farm under construction is Dudgeon, 54km to the south-west. The Heron West, Njord and Heron East consented blocks are being developed by Dong Energy as the Hornsea Project One at a distance of approximately 12km north of Ann at the closest point. Onshore construction of the project commenced in 2016 with offshore construction due to begin in 2018. The proposed cable route for the Dong Energy Hornsea Project Three (area Z4 Project Three in Figure 4-41) passes through the A-Fields area. Construction for this project is currently expected to occur between 2022 and 2025.

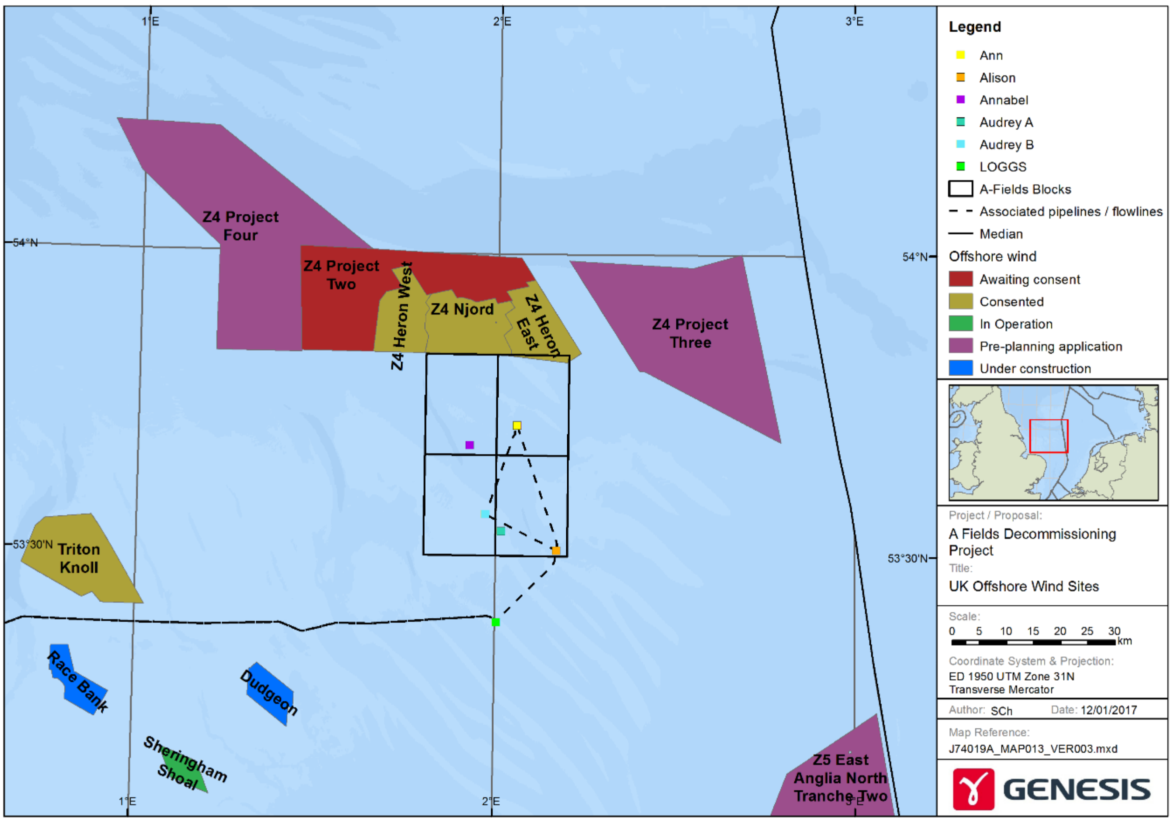


Figure 4-41: Location of wind farm projects in the vicinity of the A-Fields (NMPI, 2016)

4.6.7 Military exercises

There are no military exercise areas within the proximity of the A-Fields.

4.6.8 Other offshore activity

There are two disused telecommunications cables within the vicinity of the A-Fields (Figure 4-42). Approximately 2.8km to the north of Ann is an area available as an aggregates option and an aggregates application in place in the same area (Figure 4-43). Tender rounds offer interested parties the opportunity to bid for rights to prospect the seabed in some or all regions under Crown Estate mineral management and to obtain an option for a production agreement to extract marine aggregate (subject to the terms of a marine licence) (Crown Estate, 2016).

Tender applications are assessed on a number of factors and successful bidders are granted a prospecting licence to undertake further investigations, in conjunction with a time-limited option to obtain a marine licence from the regulator.

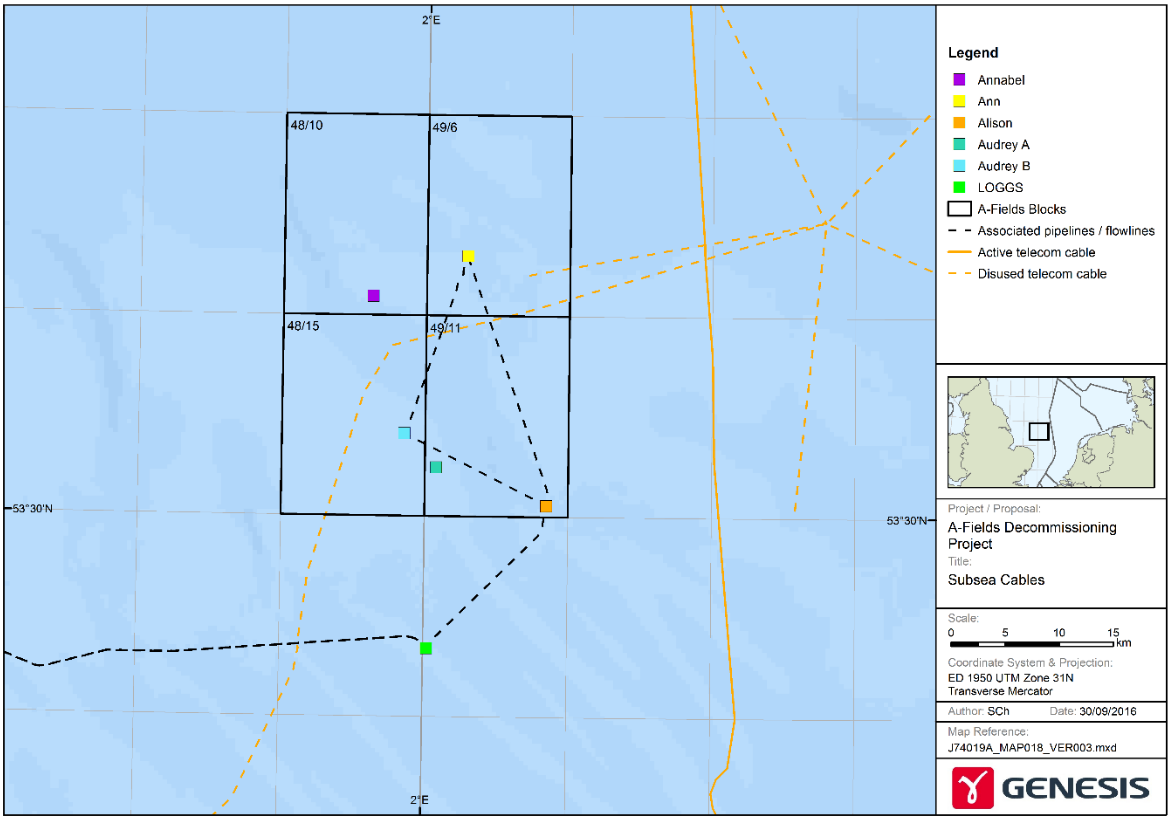


Figure 4-42: Subsea telecommunication cables within the area (NMPI, 2016)

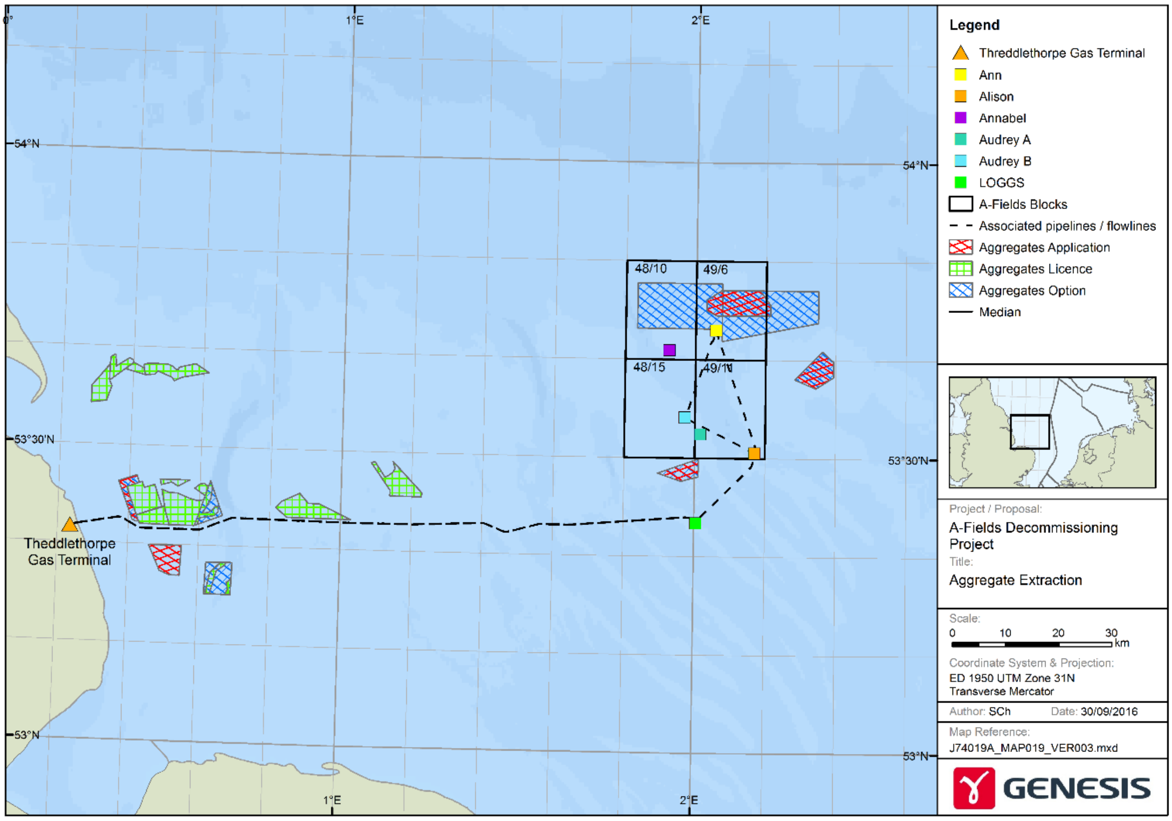


Figure 4-43: Aggregate extraction within the area (Crown Estate, 2016)

5. ENVIRONMENTAL IMPACT ASSESSMENT METHOD

This section applies the EIA process to each of the decommissioning activities in order to determine the significance of the environmental and social impacts.

5.1 Overview

The EIA process identifies the potential environmental and social impacts of a project from both planned and unplanned activities, and aims to prevent, reduce and offset any adverse impacts identified. Planned activities and unplanned events (aspects) likely to affect the environment or other users of the area are first identified, then assessed to define the level of potential impact they may cause. Where necessary, project specific control and/or mitigation measures in addition to the industry standard, legislative and prescriptive controls and mitigation measures are identified in order to reduce any impacts to ‘as low as reasonably practicable’ in line with the philosophy of the Centrica Environmental Policy.

The environmental impact of planned and unplanned activities were assessed separately using specific matrices for each. The approach is described in detail in the following sections.

5.2 Definitions

The most important consideration in any assessment is whether the impacts have been identified, are understood and that suitable controls and mitigation measures have been documented and will be implemented such that the impacts will be managed to as low as reasonably practicable in line with the philosophy of the Centrica Group Environmental Policy (Centrica Energy, 2015a).

Definitions of the key terms used in the EIA method are shown in Table 5-1.

Aspect (ISO 14001:2004)	Element of an organisations activities, products or services that can interact with the environment.
Impact (ISO 14001:2004)	Any change to the environment wholly or partially resulting from an organisations environmental aspects.
Inherent Control and Mitigation Measures	• Standard controls for the activity within the region; • Administrative or Procedural Controls; and • Engineering or Physical Controls.
Additional or supplementary Control and Mitigation Measures	• Project Specific; and • Centrica E&P Best Practice.
In combination effect	Effects on the environment which are caused by the combined results of past, current and future activities.

Table 5-1: Definition of key terms

5.3 Planned activities

5.3.1 Significance of planned event impacts

The matrices shown in Table 5-2 and Table 5-3 are used for assessment of the significance of impacts from planned events by combining the extent of the aspect to the different receptor types and the duration the different receptor types will take to recover. It is considered that a receptor has recovered when approximately 80% of the damage has been rectified.

When combined these are plotted onto the matrix, the position on the matrix indicates the level of significance of the impact. It also allows for the identification of beneficial effects. The level is presented in two ways, numerically and graphically with colours. The higher the number the greater the level of significance. Likewise, the colours are graduated from pale blue to dark blue, with dark blue representing a higher level of significance, the level of significance is graduated from the bottom left corner up to the top right.

All practicable mitigation and control measures should be applied to drive the level of significance to the bottom left corner. The level of significance which is acceptable should be decided on an impact by impact basis, dependent on project factors such as alternatives, receiving environment and in combination effects, nevertheless all potential impacts should be “as low as reasonably practicable”.

Extent	Land and air		Benefit	Duration of harmful effect (habitat or species *c*.80% of damage rectified): within 1 month	within 1 year	≤3 years	>3 years or >2 growing seasons for agricultural land	>20 years
Habitats / Species	**Air and Soil or sediment**		+1	1	2	3	4	5
• >50% of site area, associated linear feature or population of designated land/water sites (nationally important) • >25% of site area, associated linear feature or population of a designated land/water sites (internationally important) • >100ha or >50% of land of other designated land • >20ha or >50% of habitat of scarce habitat • Widespread habitat - non-designated land - contamination of >100ha of land, preventing growing of crops, grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively, contamination of 10ha or more of vacant land. • Widespread habitat - non-designated water - contamination of aquatic habitat which prevents fishing or aquaculture or renders is inaccessible to the public.Loss of >10% of animal or >50% of plant ground cover of a particular species (Note - these criteria apply nationally) • Marine >20ha littoral or sub-littoral zone, >100ha of open sea benthic community, >1,000 dead sea birds (>5,000 gulls), >50 dead/significantly impaired sea mammals	**Air** – increase in contaminants to the atmosphere such that the relevant thresholds (e.g. Air Quality Limits) are exceeded. **Soil or sediment (**i.e. as receptor rather than purely a pathway) - contamination of >100ha of land, as per widespread habitat; contamination rendering the soil immediately hazardous to humans (e.g. skin contact) or the living environment, but remediation available (but difficult).	5	-	5	10	15	20	25
• >0.5ha or 10-50% of site area, associated linear feature or population of designated land/water sites (nationally important) • >0.5ha or 5-25% of site area or 5-25% of associated linear feature or population of designated land/water sites (internationally important) • 10-100ha or 10-50% of land of other designated Land • 2-20ha or 10-50% of scarce habitat • Widespread habitat - non-designated land - contamination of 10-100ha of land, preventing growing of crops, grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively, contamination of 10ha or more of vacant land. • Widespread habitat - non-designated water - contamination of aquatic habitat which prevents fishing or aquaculture or renders is inaccessible to the public. • Particular species (note - these criteria apply nationally) - Loss of 1-10% of animal or 5-50% of plant ground cover. • Marine - 2-20ha littoral or sublittoral zone, 100-1000ha of open sea benthic community, 100-1000 dead sea birds (500-5000 gulls), 5-50 dead/significantly impaired sea mammals	**Air** – increase in contaminants to the atmosphere such that the relevant thresholds (e.g. Air Quality Limits) are exceeded. **Soil or sediment** (i.e. as receptor rather than purely a pathway) - contamination not leading to environmental damage (as per Environmental Liability Directive), or not significantly affecting overlying water quality or exceeding contaminated land thresholds.	4	-	4	8	12	16	20
• <0.5ha or <10% of designated land/water sites (nationally important) • <0.5ha or <5% (<5% linear feature/population) of designated land/water sites (internationally important) • <10ha or <10% of other designated land • <2ha or <10% of scarce habitat • <10ha of widespread habitat - non-designated Land • Widespread habitat - non-designated water - contamination of aquatic habitat such that fishing or aquaculture is not inaccessible to the public. • Particular species - Loss of <1% of animal or <5% of plant ground cover in a habitat. • Marine- <2ha littoral or sublittoral zone, <100ha of open sea benthic community, <100 dead sea birds (<500 gulls), <5 dead/significantly impaired sea mammals	**Air** – increase in contaminants to the atmosphere such that they are above background, but below thresholds. **Soil or sediment** (i.e. as receptor rather than purely a pathway) - contamination of 10-100ha of land etc.as per widespread habitat; contamination sufficient to be deemed environmental damage (Environmental Liability Directive) or in alignment with contaminated land legislation.	3	-	3	6	9	12	15
Environment - Change is within scope of existing variability but potentially detectable or all within the site boundary / 500m zone (78.5 ha).		2	-	2	4	6	8	10
Environment - Effects are unlikely to be noticed or detectable.		1	-	1	2	3	4	5

Table 5-2: Environmental Impact Matrix – Habitats / Species, Air and Soil or Sediment

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			Benefit	Duration of harmful effect				
Surface water (any harm of drinking water source or ground water would be cat 4 or above)				Immediate	within 1 month	≤1 years	>1 year	>10 years
Reinstatement of Built Environment - Can be repaired…				…immediately	…in <1 year	…in <3 years	… in >3 years	Cannot be rebuilt
Recovery for Societal - Decrease in the availability or quality of a resource **Extent**				Access immediately after operations have been completed	Short term decrease	Medium term decrease Short or medium term loss	Medium to long term decrease & Medium term substantial or long term minor loss	Long term decrease Substantial loss (e.g. long term loss of fishing grounds).
Water	**Built Environment and Societal**		+1	1	2	3	4	5
• Source of public or private drinking water (groundwater or surface water) >1 x 107 person-hours interruption of drinking water (a town of ~100,000 people losing supply for month) or 10-100ha for groundwater protection zones (e.g. SPZ) drinking water standards breached • >100ha groundwater body (non- drinking water source) • Fresh and estuarine water habitats - The effect causes the water quality to exceed a water quality guideline or water quality objectives, or for the WFD chemical or ecological status lowered by one class for >10km of watercourse or >20ha or >50% area of estuaries or ponds or present an increased risk to ground water (as above). • Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.	**Built Environment -** Complete destruction of an area of built importance or nationally registered building **Societal -** A large population with high dependence on the impacted resource affected. Substantial loss of private users or public finance. e.g. highly productive fishing grounds	5	-	5	10	15	20	25
• Source of public or private drinking Water (groundwater or surface water) interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] > 1,000) or 1-10ha of ground water protection zones where drinking water standards are breached • Groundwater body (non- drinking water source) - 1-100ha of groundwater body where the WFD status has been lowered or the water quality has exceed a water quality guideline • Fresh and estuarine water habitats – The effect causes the water quality to exceed a water quality guideline or a water quality objective, or for the WFD chemical or ecological status lowered by one class for 2-10km of watercourse or 2-20ha or 10-50% area of estuaries or, ponds or present an increased risk to ground water (as above). • Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.	**Built Environment -** Damage to an area of built importance or nationally registered building such that there would be a loss of integrity, leading to de-registering / categorisation with a requirement for remedial / restorative work to be undertaken. **Societal -** A moderate population with high dependence on the impacted resource affected. Moderate loss of private users or public finance (e.g. medium term loss of fishing grounds).	4	-	4	8	12	16	20
• Interruption of drinking water supply <1000 person-hours or <1ha of ground water protection zones, e.g. SPZ, for public or private drinking water (groundwater or surface water) • <1ha of groundwater body (non- drinking water source) • Groundwater not a pathway to another receptor. • Fresh and estuarine water habitats – The effect does not cause the water quality to exceed a water quality guideline or a water quality objective, or for the Water Framework Directive (WFD) chemical or ecological status to be lowered for more than 2km of watercourse or 2ha or 10-% area of estuaries or ponds or, present an increased risk to groundwater (as above).	**Built Environment -** Damage to an area of built importance or nationally registered building with a requirement for remedial / restorative work to be undertaken. **Societal -** A small population with some dependence on the impacted resource affected. Minor loss to private users or public finances (e.g. short term loss of fishing grounds).	3	-	3	6	9	12	15
Change is within scope of existing variability but potentially detectable or all within the site boundary / 500m zone.	**Built Environment -** Damage to an area of built importance or nationally registered building with a requirement for remedial / restorative work to be undertaken. **Societal -** A small population with some dependence on the impacted resource affected. Negligible loss to private users or public finances.	2	-	2	4	6	8	10
Effects are unlikely to be noticed or detectable.	**Built Environment -** Damage to an area of built importance or nationally registered building with no requirement for remedial / restorative work to be undertaken. **Societal -** Short term decrease in the availability or quality of a resource affecting a few individual with low dependency on the impacted resource.	1	-	1	2	3	4	5

Table 5-3: Environmental Impact Matrix – Water, Built Environment and Societal

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5.4 Unplanned events

The Centrica risk assessment matrix for assessing the risk and severity of impact from unplanned events considers the likelihood of an event occurring (rather than its duration and frequency as is the case for a planned event) and its consequence to determine the risk.

5.4.1 Risk of impact from unplanned events

The significance of the impact translates across onto the severity when assessing the level of risk, where the level of risk is the combination of the probability (or likelihood) of an event happening which could have a certain significance of impact or severity (Centrica Energy, 2011). The translation for the impact matrix to the severity is as shown below in Table 5-4.

SIGNIFICANCE OF IMPACT (FROM THE IMPACT MATRIX)	SEVERITY SCALE (FROM THE RISK MATRIX)	ENVIRONMENTAL DESCRIPTION (FROM THE RISK MATRIX)
20-25	Catastrophic	Catastrophic effect on the regional environment resulting in > 10yrs remediation and monitoring over an extensive area
15-16	Major	Major effect on the regional environment resulting in > 5yrs remediation and monitoring over a wide area
10-12	Severe	Severe effect on the local environment resulting in a requirement for some remediation and monitoring
5-9	Moderate	Limited effect on the local environment requiring some monitoring but no remediation
1-4	Minor	Insignificant effect on local environment with no remediation or monitoring required

Table 5-4: Significance of impact translated into risk severity scale

centrica

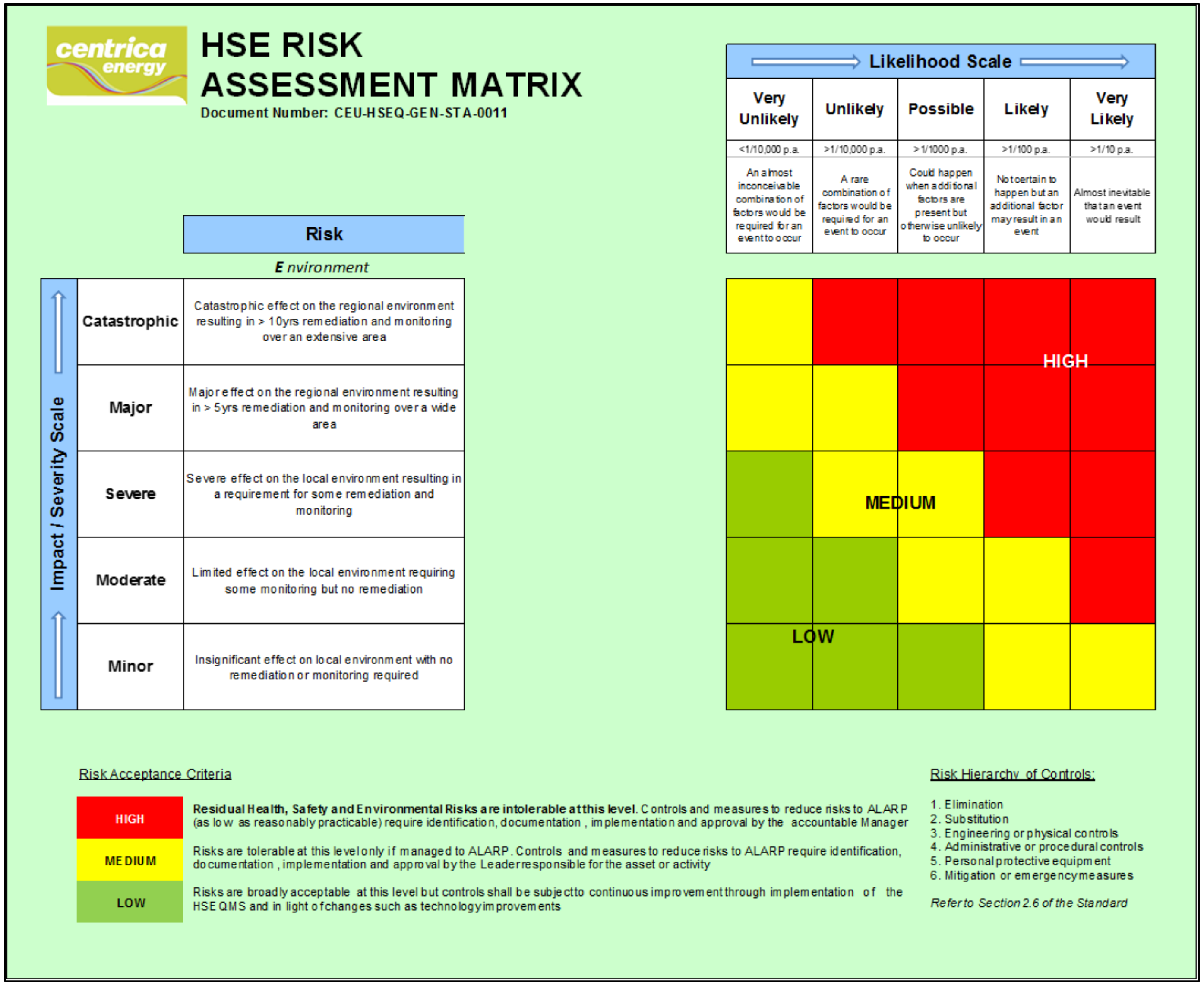


Figure 5-1: Centrica Health, Safety and Environment risk assessment matrix (Centrica Energy, 2011)

5.5 Assessment of potential impacts and control measures

Using the information provided in Sections 3 and 4 and the criteria set out in Section 5, an Environmental Assessment and Management Workshop was held to identify the environmental aspects and assess their potential environmental impact and risk. The output table from this process is shown in Appendix A.

The environmental aspects which were either: subject to regulatory control, or were found to pose a moderate or high risk to the environment, or were recognised during the consultation phase as areas of public concern, were further assessed and are described in Section 6.

6. ENVIRONMENTAL IMPACT ASSESSMENT

In this section, the environmental impacts, and potential environmental impacts (risks), have been identified and the control and mitigation measures designed to minimise these impacts to as low as reasonably practicable have been detailed.

An Environmental Assessment and Management Workshop was held on the 21st June 2016 which identified the aspects and assessed the environmental impact and risk associated with the following:

- Energy use and atmospheric emissions;
- Underwater sound;
- Seabed disturbance;
- Discharges and releases to sea;
- Large hydrocarbon releases and oil spill response;
- Waste; and
- Socio-economic impacts.

This section applies the EIA process to each of the decommissioning activities in order to determine the significance of the environmental and social impacts.

6.1 Energy use and atmospheric emissions

This section identifies the various offshore and onshore based energy requirements connected with the decommissioning activities. The quantity of the associated atmospheric emissions is estimated and the impact assessed.

Following adoption of appropriate control and mitigation measures, residual effects and impacts are assessed in the context of the sensitivity of, and the dispersive capacity of, the receiving environment.

6.1.1 Sources

The principal planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the use of vessels has been identified as the only offshore activity that will have a substantive direct energy requirement, and therefore the only activity to warrant additional assessment.

The light processing (e.g. cleaning and cutting, but excluding recycling) of recovered materials, (primarily steel) will require the use of a variety of vehicles, plant and equipment at a shore base. Onshore transportation of recovered materials for reuse, processing, recycling or disposal to landfill is unlikely to be conducted on a scale that would lead to substantive additional emissions when considered in the wider context of general onshore transportation activities and is therefore excluded from this assessment.

The Institute of Petroleum (IoP, now the Energy Institute) Emissions Estimate Guidelines for decommissioning have been used to inform this assessment (IoP, 2000). They advise that:

- A materials inventory for each structure to be decommissioned must be created;
- All decommissioning activities associated with the decommissioning programmes should be identified; and,
- A calculation of direct and indirect energy use and the associated atmospheric emissions from the activities should be undertaken using suitable conversion factors.

The decommissioning activities' direct and indirect energy requirements will result in the emission of a range of gaseous combustion products, primarily carbon dioxide (CO_2) but including nitrogen oxides (NO_x), nitrous oxide (N_2O), sulphur dioxide (SO_2), carbon monoxide (CO), methane (CH_4) and volatile organic compounds (VOC).

Under the IoP guidance, the significant indirect energy use associated with the following end points has been accounted for:

- Offshore *in situ* decommissioning: the replacement energy that would be indirectly used in the manufacture of 'lost' materials; and
- Onshore recycling: the energy that would be indirectly used in recycling recovered materials.

6.1.1.1 Offshore

Vessel use

The energy use (combustion of fuel) by vessels to provide propulsion, dynamic positioning and ancillary services will result in direct atmospheric emissions (as exhaust gasses).

While contracts securing the services of named vessels have not yet been established, the performance characteristics (including the fuel consumption) of the required generic vessel types are well understood. This has allowed, in conjunction with a consideration of the vessels' work programme, estimates of atmospheric emissions to be made (Table 6-1).

SOURCE	FUEL USE (Te)	ENERGY USE (GJ)	EMISSIONS FROM FUEL USE (Te)						
			CO_2	NO_x	N_2O	SO_2	CO	CH_4	VOC
Total vessel emissions	2,212	95,337	7,078	131	0.5	4	35	0.4	4
UK shipping emissions 2014 (CCC, 2016)			9,900,000						
Total vessel emissions as % of 2014 UK shipping emissions			0.07						

Table 6-1: Energy use and atmospheric emissions associated with vessel use

6.1.1.2 Onshore

Recycling

An estimate of the indirect energy that would be required to recycle the recovered steel from installations, pipelines and umbilicals has been undertaken (Table 6-2). It should be noted that the atmospheric emissions resulting from this energy use would occur at a location (or locations) remote from the Ann and Alison facilities. It is anticipated that reuse or recycling of recovered metals other than steel will not be undertaken on a scale that will lead to significant additional emissions, so they are not considered further. For example, recovered concrete (from mattresses) may be crushed for reuse, an activity considered to have a relatively low energy demand.

Replacement energy of 'lost' material

An estimate of the indirect, replacement energy that would be required to manufacture a quantity of steel equivalent to that contained within the pipeline and umbilical sections that will be decommissioned *in situ* has been undertaken (Table 6-2). Note that the masses presented in Table 6-2 only represent the steel portion of the infrastructure to be decommissioned and therefore do not necessarily match the total inventory masses presented in Section 3.

INFRASTRUCTURE	STEEL (Te)	ENERGY USE (GJ)	CO_2 (Te)
Emissions associated with recycling of recovered steel			
Ann installation	100	904	96
Ann pipelines	58	524	56
Alison installations	96	864	92
Alison pipeline	99	888	95
Steel recycling total	**353**	**3,180**	**339**
Emissions associated with replacement of steel left *in situ*			
Ann installation	26	652	49
Ann pipelines	7,189	179,722	13,580
Alison installations	26	652	49
Alison pipeline	82	2,051	155
Steel replacement total	**7,303**	**183,077**	**13,833**
Overall steel total	**7,676**	**186,257**	**14,172**

Table 6-2: Energy use and emissions associated with recycling and replacement of steel

A summary of direct and indirect energy use and associated atmospheric emissions is shown in Table 6-3.

SOURCE	ENERGY USE (GJ)	ENERGY USE (%)	CO_2 (Te)	CO_2 (%)
End points	186,257	66	14,172	67
Vessel use	95,337	34	7,078	33
Total	**281,594**	**100**	**21,250**	**100**

Table 6-3: Summary of energy use and atmospheric emissions

6.1.2 Impacts and receptors

6.1.2.1 Offshore

This direct energy used by vessels accounts for approximately 34% of the total energy use and 33% of the associated atmospheric emissions resulting from, or attributable to, the decommissioning activities.

The impact of NO_x, SO_2 and VOC in the atmosphere is the formation of photochemical pollution in the presence of sunlight, comprising mainly low level ozone, but by-products may include nitric acid, sulphuric acid and nitrate-based particulate. The formation of acid and particulate may lead to a contribution to acid rainfall and the dry deposition of particulate.

If such deposition occurs at sea, it is possible that the substances will dissolve in sea water. The ultimate fate of emitted pollutants can often be difficult to predict owing to the dependence on metocean conditions (especially wind), which may be highly variable and lead to wide variations in pollutant fate over short timescales.

The activities will be of localised extent, of relatively short duration, and take place a significant distance (*c*.85km) from the nearest coastline. In general, prevailing metocean conditions would be expected to lead to the rapid dispersion and dilution of the associated atmospheric emissions resulting in localised and short term impacts only to air and water quality. The significance of these impacts has therefore been assessed as **low**.

The facilities are located in an area known to support fish spawning and nursery grounds; there is also the potential for marine mammals and seabirds to be present throughout the year (Section 4). Given the low impact on air and water quality assessed above, the significance of the impact of atmospheric emissions on biological receptors has also been assessed as **low**.

CO_2, as a greenhouse gas, contributes to global warming. The total direct estimated CO_2 emissions produced as a result of the decommissioning activities in relation to the total CO_2 produced annually by shipping vessels in the UK is 0.07%. On this basis, the significance of the impact of CO_2 emissions has been assessed as **low**.

6.1.2.2 Onshore

The indirect energy required for replacement of ‘lost’ steel and for recycling of recovered steel has been estimated as approximately 68% of total energy use for the decommissioning activities. This energy use equates to the emission of 14,172Te of CO_2 which is 0.11% of the total emission of CO_2 equivalent (CO_2e) from industry in the UK in 2015 (BEIS, 2017b). On this basis, the significance of the impact of CO_2 emissions has been assessed as **low**.

Power or heat generation for primary or secondary smelting, and the associated emissions, is permitted under the Environmental Permitting regime (England) and the Pollution Prevention and Control regime (Scotland). The impact of emissions will have had to have been assessed as ‘acceptable’ for these permits to have been approved.

6.1.3 Transboundary and cumulative impacts

The Ann and Alison facilities are located approximately 55km west of the UK/NL median line. The transboundary impact of the direct atmospheric emissions arising from the decommissioning activities has been assessed to be of **low** significance owing to the distance from the median line and the anticipated rapid dispersion and dilution of emissions that will occur under prevailing metocean conditions.

In comparison with current levels of shipping traffic present in the vicinity of the A-Fields (approximately 9.4 vessels per day within 10nm (Anatec, 2015)) direct atmospheric emissions only represent a very small increment. The significance of cumulative impacts on receptors from atmospheric emissions resulting from the decommissioning activities has therefore been assessed as **low**.

6.1.4 Control and mitigation measures

In accordance with Centrica’s standard environmental management of vessels, the following measures will be adopted to optimise energy use and reduce the impacts from atmospheric emissions to ‘as low as reasonably practicable’:

- Prior to mobilisation, vessels will be audited to ensure that their management system appropriately addresses maintenance of both generator and engine efficiency in line with manufacturer's specifications;

- Fuel use for mobilised vessels will be monitored and comply with MARPOL (MARPOL, 1973) requirements, in particular with regard to low sulphur content;
- Decommissioning activities will be planned to minimise vessel use (e.g. optimisation of vessel work programmes);
- Fuel consumption will be minimised by operational practices and power management systems for engines, generators and any other combustion plant (as required under the contract with the subcontractor); and
- Planned and preventative maintenance systems will be required for all vessels to ensure that all equipment is maintained at peak operating efficiency for minimum overall fuel usage (as required under the contract with the subcontractor).

6.1.5 Conclusion

The principal direct energy requirement and source of atmospheric emissions associated with Ann and Alison facilities decommissioning activities concerns the fuel combusted by vessels for power generation. The indirect energy requirements and atmospheric emissions attributable to materials replacement and materials recycling have also been considered.

The direct atmospheric emissions associated with decommissioning activities have the potential to impact upon both local and regional air quality, and to contribute to global warming. The prevailing metocean conditions are however expected to rapidly disperse and dilute airborne contaminants.

Direct CO_2 emissions represent approximately 0.07% only of the total CO_2 produced annually by shipping on the UKCS.

Standard mitigation measures to optimise energy usage by vessels will include operational practices and power management systems for engines, generators and any other combustion plant and planned preventative maintenance systems for all equipment for achieving peak operational efficiency.

In summary, due to the localised and relatively short duration of activities, and with the identified control and mitigation measures in place, the overall significance of the impact of energy use and associated atmospheric emissions arising from the decommissioning of the Ann and Alison Fields is considered to be **low**.

6.2 Underwater sound

This section identifies and assesses the impact of sound generated from activities at the surface and subsea.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed with regard to the sensitivity and abundance of known receptors.

6.2.1 Sources

The principal planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the use of vessels, the use of excavation and cutting tools, and the use of acoustic surveying equipment have been identified as having the potential to generate sound at levels warranting additional assessment.

Ambient sound in the ocean is generated by natural (e.g. wind, waves, tectonic activity, rain and marine organisms) and human (e.g. background shipping traffic and offshore construction) sources (e.g. Hildebrand, 2009; Richardson *et al*., 1995). Shipping is a key contributor to ambient sound in the frequency range 10Hz to 1kHz (Wenz, 1962).

The characteristics of the sound produced, in terms of strength or intensity and range of frequencies, vary with the type of activity and vessel type. Sound levels in the marine environment diminish exponentially with distance from the source. Details of the specific sound sources identified are discussed in this section.

6.2.1.1 Vessels

The primary sources of sound from vessels are propellers, propulsion and other machinery (Ross, 1976 and Wales *et al*., 2002). In general, vessel sound is continuous and comprises narrowband tonal sounds at specific frequencies and broadband sounds.

Acoustic broadband source levels typically increase with increasing vessel size, with smaller vessels (< 50m in length) having a source root mean square (rms) sound pressure level (SPL) of 160-175dB re 1µPa at 1m, medium size vessels (50-100m) 165-180dB re 1µPa at 1m, and large vessels (> 100m) 180-190dB re 1µPa at 1m (Richardson *et al*., 1995). However, sound levels depend on the operating status of the vessel and can vary considerably in time. Acoustic energy is strongest at frequencies below 1kHz.

Some of the vessels used for the proposed activities will use dynamic positioning systems to maintain and adjust their position when working. Sound levels can be louder during use of dynamic positioning, which requires the operation of thrusters to control a vessel’s location.

6.2.1.2 Excavation and cutting tools

Any localised excavation will involve the use of tools such as water-jetting and suction equipment. Cutting of underwater structures will be achieved through mechanical methods. Mechanical methods, such as hydraulic shears, use hard cutting tools that produce a sawing or machining action.

There is very little information available on underwater sound generated by tools used for underwater cutting operations. Anthony *et al*., (2009) present a review of published underwater sound measurements for various types of diver-operated tools. Several of these are underwater cutting tools, including a high-pressure water jet lance, chainsaw, grinder and oxy-arc cutter. Reported source sound pressure levels were 148-170.5dB re 1µPa (it was not indicated whether these are rms or zero-peak). It is possible that larger, ROV operated cutting tools could generate higher intensity sound levels but no published data are available.

6.2.1.3 Acoustic surveying

Seabed surveys carried out as part of decommissioning will typically employ low energy, high frequency acoustic surveying equipment such as SSS and echo sounders to generate images of the seabed.

6.2.2 Impacts and receptors

6.2.2.1 Fish

Fish species (as described in Section 4) differ in their hearing capabilities depending on the presence of a swimbladder, which acts as a pressure receiver, and whether the swimbladder is connected to the otolith hearing system, which further increases hearing sensitivity (McCauley, 1994; Popper *et al*., 2014). Most fish can hear within the range 100Hz to 1kHz, with some able to detect lower frequencies. Fish with a connection between the swimbladder and otolith system have more sensitive hearing and may detect frequencies of several thousand Hz. Elasmobranchs do not have a swim bladder and therefore have less sensitive hearing (Popper *et al*., 2006).

Fish are mobile animals that would be expected to be able to move away from a sound source that had the potential to cause them harm. If fish are disturbed by a sound, evidence suggests they will return to an area once it has ceased (Slabbekoorn *et al*., 2010).

Fish exhibit avoidance reactions to vessels and it is likely that radiated underwater sound is the cue. For example, sound from research vessels has the potential to bias fish abundance surveys by causing fish to move away (de Robertis, 2013; Mitson, 2003). Reactions include diving, horizontal movement and changes in tilt angle (de Robertis, 2013).

There is no published information on the response of fish to sound generated by underwater cutting. However, reported source levels are relatively low compared with those generated by vessels and cutting operations are expected to be of short duration.

Very little information is available on the potential effects of SSS and echo sounders on fish (Popper, 2009; ICES, 2005). Experiments exposing caged fish of various species to mid-frequency (2.8-3.5kHz) sonar at a received SPL of 210dB re 1µPa rms found evidence of temporary hearing damage in fish with hearing sensitivity in the frequency range generated by the source but not those with lower frequency hearing. Hearing damage recovered within 24 hours and no evidence of pathology or mortality was found (Halvorsen *et al.,* 2012).

Unpublished work by the Norwegian Defence Research Establishment (Jorgensen *et al.,* 2005; presented in Kvadsheim *et al.,* 2005) exposed larval and juvenile fish to simulated sonar signals at 1.5kHz, 4kHz and 6.5kHz to investigate potential effects on survival, development and behaviour. The fish species used were herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), saithe (*Pollachius virens*) and spotted wolfish (*Anarhichas minor*). Received sound levels ranged from 150 to 189dB re 1µPa. The only effects on fish behaviour were some startle or panic movements by herring for sounds at 1.5kHz. There were no long-term effects on behaviour, growth or survival. There was no damage to internal organs and no mortality apart from in two groups of herring (out of over 40 tests) at received sound levels of 189dB, for which there was a post-exposure mortality of 20 to 30%. Herring can detect higher frequencies than are detected by the other species in the study.

The level of sound generated by the decommissioning activities is considered highly unlikely to result in physiological damage to fish. Given the relatively high shipping activity in the vicinity of the A-Fields, fish behaviour would be expected to be habituated to general vessel sound. Sound generated by vessel thrusters when starting is still likely however to elicit a startle response in fish in the immediate vicinity.

Given the above, and the localised extent and short duration or intermittent nature of the activities, the significance of the behavioural impact of vessel sound upon fish has been assessed as **low**.

6.2.2.2 Marine mammals

Sound is important for marine mammals for navigation, communication and prey detection (e.g. Southall *et al*., 2007; Richardson *et al*., 1995). The introduction of anthropogenic underwater sound, therefore, has the potential to impact on marine mammals if it interferes with the ability of an animal to use and receive sound (e.g. OSPAR, 2009). The potential impact of sound on an animal depends on many factors including the level and characteristics of the sound, hearing sensitivity of the species and behaviour of the species.

Vessel sound can mask communication calls between cetaceans, reducing their communication range (Jensen *et al*., 2009). Exposure to low frequency ship sound may be associated with chronic stress in whales. Rolland *et al*., (2012) reported a decrease in baseline levels of stress-related faecal hormones concurrent with a 6dB reduction in underwater sound along the shipping lane in the Bay of Fundy, Canada in 2001.

The facilities are located in an area that marine mammals (harbour porpoise, white-beaked dolphin, grey seals and harbour seals) are known to inhabit (see Section 4.4.4).

The peak sound levels and frequency spectra generated by the various sources of underwater sound are not deemed capable of causing any physical injury to acoustically sensitive species, such as marine mammals. It is possible however that some sound induced disturbance to marine species may occur. For example, underwater sound levels may cause marine mammals to move away from the local area during the period of activity such as vessel use or use of cutting tools.

There is no published information in the response of marine mammals to sound generated by underwater cutting. However, reported source levels are relatively low compared with those generated by vessels and cutting operations are expected to be of short duration.

The impact from underwater sound of acoustic survey equipment sound on marine mammals depends on frequency, pulse characteristics (e.g. duration, repetition rate and intermittency), source and received levels, directivity, beam width and receptor species. A review of the impact of acoustic surveying techniques on marine fauna in the Antarctic concluded that acoustic instruments such as SSS and many echo sounders are of sufficiently low power and high frequency as to pose only a minor risk to the environment. This concurs with a review by Richardson *et al*. (1995), which found most evidence for a behavioural response to sonar operating at frequencies around 3kHz to 13kHz and no obvious response to pingers, echo sounders and other pulsed sound at higher frequencies unless the received levels were very high. Behavioural responses included avoidance and changes in swimming behaviour and vocalisation.

For echo sounders operating in shallow water depths such as at Ann (*c.*29m) and Alison (*c.*27m), the high-end of frequencies outside the hearing range of marine species are used, which attenuate rapidly, also operating power is lower than in deeper water (JNCC, 2010a). Under these conditions JNCC considers that injury or disturbance would be unlikely. Similarly, JNCC consider the risk of injury or disturbance from SSS to be negligible because of the high frequencies that are outside the hearing range of marine mammals and attenuate rapidly and the short duration of this type of survey.

Given the above, and the localised extent and short duration or intermittent nature of the activities, the significance of the impact to marine mammals has been assessed as **low**.

SNS cSAC for harbour porpoise

Harbour porpoise are one of the most common species of cetaceans in the SNS and as described in Section 4.4.4, the decommissioning activities will be undertaken within the SNS cSAC for harbour porpoise (Figure 4-34). The conservation objectives for the harbour porpoise cSAC aim to maintain or restore in the long term the attributes listed in Section 4.5.1.2 (JNCC, 2016a).

Decommissioning activities must minimise any impact which could threaten these objectives. There should be no significant disturbance to, and no deterioration of, the qualifying species or the habitats upon which they rely. The Draft Conservation Objectives and Advice on Activities document assessed the current level of impact risk (based on sensitivity and exposure to certain activities) identifies anthropogenic sound as having a medium level of risk meaning that there is some scope for harbour porpoise to be impacted by sound.

There is no published information on the response of marine mammals to sound generated by underwater cutting. However, reported source levels are relatively low compared with those generated by vessels. The equipment used during acoustic surveys (echo sounders and SSS) emit high frequencies which attenuate rapidly (JNCC, 2010a). Under these conditions JNCC considers that injury or disturbance would be unlikely.

The area of the cSAC for harbour porpoise that is anticipated to be impacted by the sound associated with vessels, acoustic surveying equipment, and by sound associated with excavation and cutting tool use, is anticipated to be very small. The A-Fields are located within an extensive, mature hydrocarbon basin with emissions from routine production, maintenance and support operations (including vessel use) all contributing to a broad and active 'soundscape'; high levels of general shipping activity are additionally present (Section 4.6.4). It is considered likely therefore that marine mammals, including harbour porpoise, in the area will already have been exposed to similar types and levels of sound that will be generated by the decommissioning activities. The reported response of animals to received sound has been found to wane with repeated exposure in some studies (Southall *et al*., 2007) and it is anticipated that any harbour porpoise or other marine mammals will avoid areas in close proximity to vessel activities (Verboom and Kastelein, 2005).

Given the above, and that only a very small proportion of the cSAC will be affected by activities, the significance of the impact to it from underwater sound has also been assessed as **low** with no detrimental impact to the conservation objectives of the site being anticipated.

6.2.3 Transboundary and cumulative impacts

The A-Fields are located approximately 55km west of the UK/NL median line. The transboundary impact from underwater sound arising from the decommissioning activities has been assessed to be of **low** significance given this distance and the attenuation of sound that will occur.

The A-Fields are part of the highly developed SNS hydrocarbon basin which currently has 140 surface installations, 10 of which have either submitted decommissioning plans or had them approved (BEIS, 2017a) (Section 4.6.5). The nearest platform to Ann infrastructure is the Tethys platform (7.3km) and the nearest platform to Alison infrastructure is the Viking KD platform (4.1km).

The SNS cSAC for harbour porpoise covers an area of 36,958km^2. The impact of sound generated by the decommissioning activities has been assessed as of low significance with no detrimental impact to the conservation objectives of the site being anticipated.

The underwater sound generated from vessels and the use of excavation and cutting tools are expected to be localised and of relatively short duration. Hence, no substantive cumulative impacts are anticipated.

6.2.4 Control and mitigation measures

The following measures will be adopted to ensure that sound levels, and their effects upon potential receptors, are minimised to 'as low as reasonably practicable':

- Machinery, tools and equipment will be in good working order and well-maintained (as required under the contract with the subcontractor);
- The vessels' work programme will be carefully planned to optimise use; and
- The number of required pipeline cuts will be minimised consistent with operational (including safety) considerations.

6.2.5 Conclusion

The principal sources of underwater sound associated with Ann and Alison facilities decommissioning activities are concerned with the use of vessels, the use of excavation and cutting tools and the use of acoustic surveying equipment.

The vessels' work programme comprises a total of approximately 158 individual vessel days spread over a multi-year period. This is of relatively short duration and represents only a small increment to existing vessel traffic in the area. Excavation and cutting tools will only require to be used intermittently over this period and at point locations.

The level of sound that will be generated is not expected to cause physiological harm or substantive behavioural interference to either fish or marine mammals known to inhabit the area.

Standard measures that will be applied to control and mitigate sound include planned maintenance of equipment and optimisation of the work programme to minimise vessel use.

In summary, due to the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall significance of the impact of underwater sound generated during decommissioning of the Ann and Alison Fields is considered to be **low**.

6.3 Seabed disturbance

This section identifies and assesses the impact of the various sources of planned seabed disturbance that will result from the decommissioning activities. It also considers potential sources of unplanned (accidental) seabed disturbance.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed in the context of the sensitivity, and the attenuating capacity, of the receiving environment.

6.3.1 Sources

The principal planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the excavation of sediments, the lifting (removal) of materials, the temporary placement of objects on the seabed, the over-trawl assessment and the use of vessels have been identified as warranting further assessment in terms of their potential to disturb the seabed.

6.3.1.1 Temporary impact sources

Temporary disturbance of the seabed from decommissioning activities can result in direct physico-injury to benthic species and also re-suspension of sediment, resulting in increases in suspended solid concentrations in the water column and on the seabed with the potential to change the physical chemical characteristics of the seabed.

Excavation

The degree of seabed disturbance will be related to the required number of pipeline and umbilical disconnections - and the extent to which each location is initially buried with sediment; and, the length of pipeline and umbilical sections being removed - and the extent to which they are initially buried with sediment. Sediment may also require to be excavated in order to install or locate the lifting points of the installations being removed. Marine growth may also be required to be cleared at disconnection and lifting points. The anticipated low volumes of material are considered not to warrant further assessment.

Lifting (removal) of infrastructure

The degree of seabed disturbance will be related to the length and diameter of the pipeline or umbilical section being removed, the size (‘footprint’) of the protection and stabilisation features being removed, the size (‘footprint’) of the installations being removed and the extent to which they are buried by sediment prior to lifting.

Temporary seabed placement

Baskets may be temporarily placed on the seabed to facilitate the batch lifting of materials. The degree of seabed disturbance caused will be related to number of baskets deployed and their size (‘footprint’).

Debris survey and over-trawl assessment

Upon completion of each decommissioning operation, appropriate surveys will be taken to identify and recover any debris located on the seabed which has arisen from the decommissioning operation or from past development and production activity.

The area to be covered includes a radius of 500m from the location of an installation and up to 100m either side of a decommissioned pipeline over its whole length. An over-trawl assessment to confirm that the area of decommissioned pipelines and installations is clear of debris will then be carried out.

In the SNS, the verification of a clean seabed might typically involve using ‘rock hopper’ fishing gear with scraper chains to determine if there remain any snagging hazards. Assuming the area is free of snagging hazards, a Clean Seabed Certificate is issued. These over-trawl assessments are carried out to make sure the seabed is safe for normal fishing.

Vessels

The wash from vessel propulsion and dynamic positioning systems may disturb the seabed depending upon vessel draught, vessel operating mode and the water depth. However, given the prevailing currents in the vicinity of the A-Fields and the dynamic nature of the seabed, it is anticipated that certain sediment sizes would routinely be mobilised and it can therefore be expected that the local fauna would be habituated to this environment and would not be affected to any significant degree and would recover quickly. As such, the impact of vessels on seabed disturbance is not considered further.

Unplanned activities and events

During all lifting activities there is the potential for materials and equipment to be accidentally dropped as a consequence of procedural, or mechanical failure. The degree of disturbance will be related to the size of the dropped object’s ‘footprint’.

Summary

The main sources of temporary seabed disturbance, with corresponding estimates of a total impact, are itemised in Table 6-4 where the total estimated area of seabed disturbance is calculated to be 15.3924km^2 which is dominated by the over-trawl assessment. To put this into context, a UKCS licence block covers approximately 200km^2, and the North Norfolk Sandbanks and Saturn Reef SAC occupies 3,603km^2. The area impacted is therefore considered very small.

The estimate of seabed disturbance given in Table 6-4 does not include an allowance for the excavation of sediment, or the temporary placement of baskets on the seabed. The area will be small and within the area already impacted by the removal activities. The impact from the latter will be the subject of a Marine Licence application prior to project execution.

SOURCE OF DISTURBANCE	ASSUMPTIONS MADE	AREA IMPACTED (KM^2)
Pipeline ends of PL947, umbilical ends of PL948, *c*.8km of PL1099, all of PL2164 and Pl2165, the spool pieces and the Alison tee	Total length of pipelines, umbilicals and spool pieces ends to be recovered is approximately 8.93km. The area of seabed disturbance was assumed to be a corridor width of 10m, allowing for sediment to be moved from its current location over the partially buried infrastructure to either side.	0.0914
Ann template **Alison template**	Additional 1m added on all sides to allow for disturbance beyond exact dimension of each structure. Total area of structures = $0.0004km^2$. Total footprint of disturbance = $0.0007km^2$.	0.0007
Removal of concrete mattresses*	To calculate the area of disturbance associated with the removal of the 143 concrete mattresses, an additional impacted area of 1m was assumed on either side of the mattresses. The mattresses are of varying size.	0.0060
Removal of bitumen mattresses	To calculate the area of disturbance associated with the removal of the 3 bitumen mattresses an additional impacted area of 1m was assumed on either side of the mattresses (4m x 2.5m)	0.0001
Removal of concrete blocks (at Alison tee)	Removal of approximately 6 concrete blocks, each is assumed to impact on an area of 2.2m x 2.2m. An additional impacted area of 1m was assumed on either side of the blocks.	0.0001
Removal of grout bags	Recovery of approximately 2,824 grout bags, each is assumed to impact on an area of 0.25m x 0.45m.	0.0156
Over-trawl assessment	A conservative assumption has been made for the assessment to cover a 200m corridor along all pipeline lengths and the two HSE 500m safety zones.	15.2788
Total area impacted		**15.3924**
* The concrete mattresses and concrete blocks are positioned over the pipeline and umbilical and, by considering them separately, the areas calculated above include some double countin. Likewise, grout bags may have been placed on top of each other.		

Table 6-4: Estimate of temporarily impacted seabed area

6.3.1.2 Permanent impact sources

The *in situ* decommissioning of pipelines and umbilicals, including any associated protection or stabilisation features, can be considered to cause long term disturbance to the seabed. The degree of disturbance will be related to the length and diameter of the pipeline or umbilical section being decommissioned and the burial status.

Estimate of permanently impacted seabed

An estimate of the seabed area potentially affected by long-term impacts is presented in Table 6-5. It shows that the estimated total area impacted is $0.0165km^2$. To put this into context, a licence block is approximately $200km^2$ and the North Norfolk Sandbanks and

Saturn Reef SAC is 3,603km^2. The area impacted by the decommissioning activities is therefore considered small.

INFRASTRUCTURE	ASSUMPTIONS MADE	AREA IMPACTED (KM^2)
Existing deposited rock	Based on data in Table 3-6.	0.0096
Pipelines decommissioned *in situ*	PL947, PL948 and part of PL1099.	0.0151
Protection / stabilisation features decommissioned *in situ*	16 frond mattresses (5.0m x 5.0m)	0.0004
Total area impacted		**0.0252**
* It should be noted that there will be some double counting in the above calculation where rock is deposited over a pipeline and therefore the calculation can be considered conservative. The pipelines and frond mattresses to be decommissioned ***in situ*** are buried to a sufficient depth that that would not be expected to have an impact on the seabed and are included here to present a conservative estimate.		

Table 6-5: Estimate of long-term impacted seabed area

6.3.2 Impacts and receptors

6.3.2.1 Temporary impacts

A total of 15.3924km^2 of seabed has been calculated to be temporarily impacted as a result of removal activities. Impacts from removal activities may result in the direct physical injury of benthic species. Disturbance of seabed sediment will also lead to increases in suspended solid concentrations in the surrounding waters. However, suspended materials will be rapidly dispersed and diluted by prevailing hydrodynamic conditions before settling back to the seabed and the disturbance will therefore be short term. Whilst some redistribution of material is to be expected, the impact of this will depend on the sediment characteristics in the area.

Suspended Material

The Ann survey showed homogeneous results, with all stations within the survey area being classified as sand under the modified Folk classification. The sediments across the Alison survey area were generally homogeneous with all but one station being classified as sandy Gravel under the modified Folk classification. Therefore, although the two sites presented slightly different sediment characteristics, the seabed composition in the small areas that will be impacted is largely uniform. Concentrations of contaminants across the A-Fields survey area were generally low for THC and PAH (see Section 4.3.5). Further, the mobile nature of the seabed within the North Norfolk Sandbanks and Saturn Reef SAC is likely to result in turbidity, reducing the impact of sediment re-suspension from the decommissioning activities. Long term impacts are therefore not anticipated and the risk of habitat modification (due to the homogenous nature of the sediment) is considered to be **low**.

Localised disturbance of the ecosystem at the seabed may occur, leading to some degree of community change. It is known that some bottom-dwelling marine organisms are particularly vulnerable to natural or man-made activities which cause disturbances of the seabed, such as deposition of sedimentary material. The majority of offshore benthic species are recruited from the plankton, and usually recover rapidly once disturbance from the decommissioning activities cease. The seabed disturbance is therefore likely to be spatially limited rather than across the area as a whole due to the homogeneity of sediments at each site.

It is also possible that bottom-dwelling organisms may be smothered by settlement of suspended solids, however rapid dispersion and dilution by prevailing hydrodynamic conditions before the material settles back to the seabed will prevent the development of substantial accumulations of re-settled materials far from the disturbance. The risk of smothering is therefore considered to be in line with the normal re-distribution of seabed sediment which occurs as a result of natural hydrodynamic conditions and is an inherent component of the ecosystem.

There may be the potential for sub-lethal impacts on benthic and epibenthic fauna as a consequence of physical abrasion from excavation works. The *c.*8km section of the Alison umbilical (PL1099) which is being removed may be reverse reeled, minimising the potential of direct injury. Complete removal of this section was identified as the best option over the longer-term through the CA process in that it removes future uncertainty of the burial status and stability of the umbilical.

Figure 6-1 shows the position of the umbilical PL948 which was trenched and left naturally to backfill in 1993 and the current seabed bathymetry. There is no visible impact from the trenching operations and the seabed appears to have fully recovered. In the short-term the objectives of the North Norfolk Sandbanks and Saturn Reef SAC (see Section 4.5.1.1) would be negatively impacted but evidence suggests that over the longer term the seabed and surrounding area affected by removal operations will fully recover.

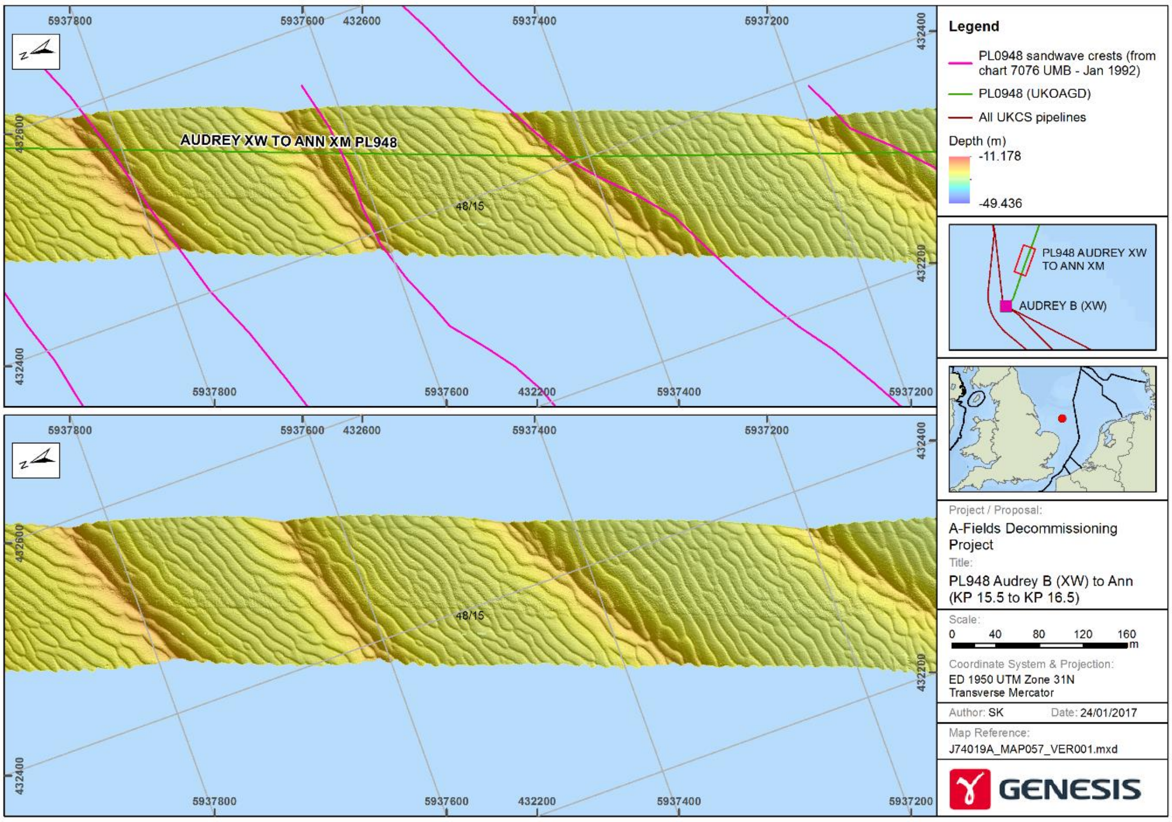


Figure 6-1: Current seabed bathymetry overlaid with position of sandwaves from 1992 survey and position of PL948

Careful management and planning of activities to minimise affected areas will reduce the potential for physical abrasion but it is impossible to eliminate the risk entirely and some impacts on populations may occur. Since the disturbance will be short term and given the strong currents in the SNS, it is expected that any impacts on the populations and the wider ecosystem will be minimal and that rapid and complete recovery of the localised seabed community will occur once activities cease.

Direct physical impacts

Lifting of materials is likely to damage/destroy any sensitive surface species settled on the sediment. It is unlikely however to affect mobile species, either on, or under the surface of the sediment, which are likely to move away from the disturbance.

The intentional or unintentional temporary placement of objects on the seabed will result in the effected substrate being no longer available for colonisation by either surface dwelling or burrowing species.

Reef habitats such as those formed by *Sabellaria* sp. are listed within Annex I of the Habitats Directive. *Sabellaria* sp. tube aggregations were observed at Stations ENV1 (Ann) and ENV13 (Alison). The Hendrick and Foster-Smith (2006) scoring system was applied in an attempt to define the 'Reefiness' of the area or colonies identified within the Ann and Alison survey area. The patchiness and low elevation of the clusters of *Sabellaria* sp. observed at Stations ENV1 and ENV13 did not represent a *Sabellaria* sp. reef structure at either of these stations.

Given that the area of seabed/infrastructure that will be affected by excavation, lifting of materials, or temporary placement of objects represents a very small proportion only of biotopes available in the SNS, that the *Sabellaria* sp. present do not represent Annex I habitat and that recolonization of affected substrate is expected to occur rapidly via recruitment of individuals from adjacent undisturbed areas, the significance of these impacts has been assessed as **low**.

Fish spawning and nursery grounds

As discussed previously a number of species of fish are known to spawn within block 49/6 and 49/11, with others using it as a nursery area in the period immediately following spawning. Smothering of these areas, particularly during spawning is likely to affect the spawning success which could have wider impacts to the population as a whole.

Ideally, the decommissioning activities would be undertaken outside of the spawning period to ensure there is no impact. However, the overlap of spawning periods throughout the year would make this impossible. Given the above, longer term habitat modification is not anticipated and the significance of the impact has been assessed as **low**.

6.3.2.2 Permanent impacts

The *in situ* decommissioning of infrastructure can lead to long term impacts to the seabed and its habitat, especially modifications to seabed dynamics (and morphology) and changes to the benthic fauna.

There is no additional deposited rock required for the decommissioning of the Ann and Alison infrastructure. As such, there is no additional permanent loss of habitat expected and this is not considered further.

Seabed Dynamics

The in situ decommissioning of *c*.70km of pipeline and 1,585Te of deposited rock in the area of the North Norfolk Sandbanks could potentially change the seabed dynamics. The total area of pipelines and stabilisation materials is 0.0252km^2 which represents 0.0007% of the total area of the North Norfolk Sandbanks and Saturn Reef SAC.

An assessment was undertaken to determine the impact of the Scroby Sands offshore windfarm (located 2.3km offshore of Great Yarmouth) on sandbank morphology (Cefas, 2006). The study found no evidence of any changes to sandbank morphology as a result of the 30, 4.2m diameter monopile foundations driven up to 30m into the seabed. This suggests that the decommissioning of the Ann and Alison pipelines and deposited rock *in situ* is unlikely to have an impact on the sandbank morphology and dynamics and is supported by Figure 6-1 which demonstrates that the sandwaves appear intact and in the same orientation after over 20 years of the umbilical PL948 being trenched and buried.

Change to Fauna

Under the Ann and Alison Decommissioning Programme, a total of *c.*70km of trenched and buried pipeline are proposed to be decommissioned *in situ*. These pipelines will be cleaned prior to decommissioning, however, there is a possibility that a small amount of residual deposits will remain on the inside of the pipeline including small amounts of hydraulic fluid inside the umbilical. The pipeline will corrode and degrade over time and as such there is a possibility that any residual deposits on the inside of the pipeline will be released to the water column. This could impact benthic species if the residual deposits become bioavailable. Any such release would be very gradual and any impact would be highly localised (OGUK, 2013).

6.3.3 Transboundary and cumulative impacts

The A-Fields are located approximately 55km west of the UK/NL median line. Given this distance and the localised nature of the impacts resulting from the seabed disturbances, no substantive transboundary impacts are anticipated.

The cumulative area of seabed disturbed due to currently planned decommissioning activities within the North Norfolk Sandbanks and Saturn Reef SAC is shown in Table 6-6. The table includes A-Fields well abandonment activities which are considered preparatory works hence they have not been included as a source in Section 6.3.1.

LOCATION	AREA IMPACTED (KM^2)		
	SHORT-TERM	LONG-TERM	
	Total	Total	Deposited Rock
A-Fields well abandonment	0.0029	0	0
Ann and Alison	15.3924	0.0252	0.0111
Annabel and Audrey	11.6754	0.0810	0.0627
Viking and LOGGS	0.0144	0.6208	0.0754
Leman BH	0.4058	0	0
Dong Energy Hornsea Project Three	10.38[1]	-	-
Total	**37.8709**	**0.7270**	**0.1492**
[1] Note that not all of this area of seabed disturbance occurs within the North Norfolk Sandbanks and Saturn Reef SAC.			

Table 6-6: Cumulative Impacts within North Norfolk Sandbanks and Saturn Reef SAC

The total cumulative area of seabed identified which may experience short-term impacts is 37.8709km^2 which comprises 1.05% of the North Norfolk Sandbanks and Saturn Reef SAC. The timing of these impacts are not expected to overlap to a great extent and they will not occur in close proximity. Due to the short duration and localised nature of the activities from short-term seabed disturbance, significant cumulative impacts are not anticipated.

The area of infrastructure and protection and stabilisation features, including deposited rock, decommissioned *in situ* from the A-Fields and other projects in the surrounding area are shown in Table 6-6. The total area equates to 0.020% of the area of the North Norfolk Sandbanks and Saturn Reef SAC. As discussed in Section 6.3.2, there is currently no evidence from survey analysis to suggest that changes to the sandbank morphology and dynamics are likely to occur.

6.3.4 Control and mitigation measures

The following measures will be adopted to ensure that seabed disturbance and its impacts are minimised to 'as low as reasonably practicable':

- All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised;
- The careful planning, selection of equipment, and management and implementation of activities; and
- A debris survey will be undertaken at the completion of the decommissioning activities. Any debris identified as resulting from decommissioning activities will be recovered from the seabed where possible.
- Optimise the area that requires an over-trawl assessment through discussion with the NFFO and the regulators.

6.3.5 Conclusion

The principal sources of seabed disturbance associated with the Ann and Alison facilities decommissioning activities concern the over-trawl assessment and the lifting of materials from the seabed during their recovery. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment.

Excavation and lifting operations will be undertaken at the pipeline and umbilical ends and the piles at the Ann and Alison subsea templates.

Standard measures to control disturbance include operational planning and equipment selection.

The species and habitats known to inhabit the vicinity of Ann and Alison facilities are relatively widespread throughout the SNS and the area anticipated to be impacted represents a very small percentage of the available habitat. Furthermore, the environment in the vicinity of the Ann and Alison Fields is dynamic due to the shallow water depth therefore all disturbed sediments/habitats are expected to recover rapidly and species recruitment would be expected from adjacent undisturbed areas.

Based on as laid bathymetry data for the A-Fields infrastructure there is no evidence of long-term detrimental impact to the North Norfolk Sandbanks and Saturn Reef SAC feature due to the presence of pipelines, umbilicals and stabilisation features. As such, the significance of the impacts of decommissioning pipelines and deposited rock *in situ* is considered to be **low**.

In summary, due to the localised and relatively short duration of the decommissioning activities, and with the identified control and mitigation measures in place, the significance of the impact of seabed disturbance as a result of the decommissioning of the Ann and Alison facilities is considered to be **low**.

6.4 Discharges and releases to sea

This section identifies the various sources, and assesses the impact, of planned discharges to the marine environment that will result from the decommissioning activities. It also considers (with the exception of large hydrocarbon releases which are addressed in Section 6.5) the potential for, and the effects of, unplanned (accidental) releases ('spills') to the marine environment.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts (and the risk of such) are assessed in the context of the sensitivity of, and the assimilative capacity of, the receiving environment.

6.4.1 Sources

The principal planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the use of vessels and cutting and removal activities have been identified as warranting further assessment in terms of the potential impact of their discharges and releases.

6.4.1.1 Surface discharges and releases

Vessels

- Planned (operational) discharges (ballast water, bilge water, general shipboard drainage, treated sewage and grey water from accommodation and amenities); and
- Unplanned releases of small volumes of hydrocarbons or chemicals.

6.4.1.2 Seabed and water column discharges

Cutting and removal

- Planned discharge (post-cleaning), upon breaking containment of spool pieces/umbilicals/pipelines, of remaining concentrations of flushing and conditioning chemicals, and hydrocarbons and solids at the seabed, and through the water column during recovery.

6.4.2 Impacts and receptors

The discharges and releases have the potential to impact the marine environment (plankton, benthos and fish etc.) in the immediate vicinity of the discharge point. Bioaccumulation in the food chain may also occur.

6.4.2.1 Operational discharges and releases from vessels

Planned operational discharges to sea from vessels will be subject to on-board control measures designed to secure compliance with the requirements of MARPOL (1973).

Decommissioning activities will comprise approximately 158 vessel days spread over a multi-year period (Table 3-21). During this time discharges will be controlled and minimised using operating procedures and systems for optimum performance, including planned preventative maintenance systems for peak operating efficiency of on-board systems for the management of drainage, effluent, ballast water and bilge water.

It is possible that technical problems may lead to unplanned small volume releases of diesel or other hydrocarbons (e.g. through the drainage system). The likelihood of such releases is considered very low.

Although water quality will be reduced at the immediate time and location of discharge, the effects of routine vessel discharges and any small volume unplanned releases will be minimised due to the expected rapid dispersal and dilution of contaminants under ambient metocean conditions. It is considered unlikely that impacts beyond those associated with normal shipping activities will occur. The significance of the impacts from these discharges and releases has therefore been assessed as **low**.

6.4.2.2 Remaining chemicals

The entire length of all pipelines (including spool pieces) and umbilical cores containing methanol will be flushed with, and left containing, filtered seawater prior to decommissioning. Pipeline sections will additionally be pigged (Section 3.2.2). The pipeline contents may contain very low concentrations of remaining chemicals that were not able to be cleaned.

Upon cutting of sections of pipeline and umbilical, their contents (including any remaining chemicals), will begin to be discharged at the seabed. Upon lifting of the cut sections, further and complete discharge of the contents is expected to occur through the water column *en route* to surface.

The contents of the sections of the pipeline and umbilical being decommissioned *in situ* will eventually be lost to the surrounding sediment and water column over time, as the materials from which the pipelines and umbilicals are constructed gradually deteriorate, and the containment provided fails.

The prevailing metocean conditions at the seabed and through the water column are likely to lead to rapid dispersion and dilution. The discharge of remaining chemicals in this manner is not expected to result in detectable impacts upon water quality. The significance of the impact has therefore been assessed as **low**.

6.4.2.3 Residual hydrocarbons

The pipeline will be pigged. The pig train will be pushed along the pipeline using filtered seawater which will remain in the pipeline until decommissioning. The seawater may contain low concentrations of residual hydrocarbons left following cleaning.

Upon cutting of sections of pipeline their contents (including any residual hydrocarbons) will begin to be discharged at the seabed. Upon lifting of the cut sections, further and complete discharge of the contents is expected to occur through the water column *en route* to surface.

Hydrocarbon discharges will be permitted under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended) (OPPC).

The prevailing metocean conditions at the seabed and through the water column are likely to lead to rapid dispersion and dilution. Any impacts would therefore be expected to be localised and short term. The significance of the impact of residual concentrations of hydrocarbons being discharged in this manner has therefore been assessed as **low**.

6.4.2.4 Hydraulic fluid

The umbilical cores containing hydraulic fluid will not be flushed prior to decommissioning. Their content will eventually be lost to the surrounding sediment and water column over time, as the materials from which they are constructed gradually deteriorate, and the containment provided fails.

Hydraulic fluids selected are water-soluble chemicals with low environmental toxicity and are permitted for use and discharge under the Offshore Chemicals Regulations 2002 (OCR).

A detailed, specific chemical assessment of the impact of the discharge will be included in the environmental permits submitted prior to the execution of the work under the OCR.

The significance of the impact of hydraulic fluid being discharged in this manner has been assessed as **low**.

6.4.3 Transboundary and cumulative impacts

The A-Fields are located approximately 55km west of the UK/NL median line. Given this distance, and the localised and short duration of the discharges and potential releases to the marine environment associated with the decommissioning activities, no substantive transboundary impacts are anticipated.

Cumulative impacts resulting from discharges to sea are considered unlikely as the impacts are expected to be short-term with rapid dispersion, dilution and degradation.

6.4.4 Control and mitigation measures

All operational activities will be undertaken in compliance with regulations (particularly Radioactive Substances Act, Environmental Permitting Regulations, OPPC, OCR and MARPOL and all its annexes).

The following measures will be adopted to ensure that discharges to sea and their impacts are minimised 'to as low as reasonably practicable':

- Pigging and/ or flushing procedures will be followed to minimise residual contaminants within pipelines and umbilicals;
- Procedures and systems for the minimisation of waste and effluent generation (maintained as required under the contract with the subcontractor);
- Procedures and systems for the management of ballast and bilge water (maintained as required under the contract with the subcontractor);
- Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials;
- Vessels will be selected and audited to ensure that effective operational systems and onboard control measures are in place;
- Vessels' work programmes will be optimised to minimise use; and
- Lessons learnt from previous decommissioning scopes will be reviewed and implemented with regards to discharges to sea.

6.4.5 Conclusion

The principal sources of discharges and releases to sea associated with Ann and Alison decommissioning activities concern vessels and the breaking containment/lifting of sections of pipeline and umbilical.

The vessels' work programme is of relatively short duration, comprising of a total of approximately 158 individual vessel days spread over a multi-year period. Operational discharges from vessels during this time are expected to be rapidly dispersed and diluted under prevailing hydrodynamic conditions.

With the exception of hydraulic fluid, residual traces of chemical and hydrocarbons only are expected to be discharged to the marine environment during recovery of the end sections of the pipeline and umbilical.

The hydraulic fluid has previously been permitted for use and discharge during production operations at this location. The volume will be small and being water soluble, the discharge is expected to undergo rapid dispersion and dilution under the prevailing hydrodynamic conditions.

Standard measures to manage vessel discharges include operating procedures and management systems, and planning to optimise vessel utilisation.

In summary, given the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall impact of discharges and releases to sea as a result of decommissioning the Ann and Alison Fields is considered to be **low**.

6.5 Large hydrocarbon releases and oil spill response

This section identifies the potential sources of, and assesses the impact of, large unplanned (accidental) releases ('spills') to the marine environment in connection with the decommissioning activities.

Following the adoption of appropriate prevention and response measures, the overall risk of impact presented by identified release scenarios is assessed in terms of probability of occurrence, and the consequences given the sensitivity of, and the assimilative capacity of, the receiving environment.

6.5.1 Potential sources

The principle planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the use of vessels and the associated potential for an unplanned large volume release of diesel to sea has been identified as warranting further assessment in terms of the potential impact on the environment.

6.5.1.1 Unplanned releases to the sea

Vessels

Unplanned large volume releases of diesel to sea from vessels could occur as a result of:

- Loss of structural integrity of storage tanks following a collision with another vessel or fixed facility; and
- Loss of structural integrity of storage tanks following corrosion or mechanical failure.

The worst case in terms of volume and rate of release would be the immediate total loss of diesel inventory to sea as a consequence of collision or mechanical failure. This eventuality is considered to be highly unlikely owing to procedural (vessels' management systems) and operational controls that will be applied.

Oil spill fate and trajectory modelling

Oil Spill Contingency and Response model (OSCAR) modelling was carried out to support the OPEP (Centrica Energy, 2015b). This included modelling an instantaneous release of 3,550m^3 of diesel from the location of the A-Fields (specifically at the Annabel wellhead). This is inherently conservative in terms of impact assessment since the expected maximum diesel release from the types of vessel required for the Ann and Alison decommissioning work is less than 1,400m^3 and accident scenarios involving multiple vessels are considered to be highly improbable.

Stochastic modelling (taking into account prevailing weather conditions to determine a probability of surface oiling) was undertaken using:

- Representative wind data from the European Centre for Medium-Range Weather Forecasts (2008 – 2014); and
- Representative current data (2008 to 2014).

For the selected worst case scenarios, in excess of 100 simulations were undertaken using a wind-time series which started on a randomly generated date within the seasonal period covered. This approach allows a sufficient number of simulations to adequately model the variability in the wind speed and direction in the area identified within the simulation.

Running multiple release simulations during a single season should provide a reliable prediction of the oil pathways and oiling probabilities for a release starting during that season and extending into subsequent seasons.

6.5.2 Impacts and Receptors

The probability of surface oiling is modelled to be 40-50% in the direct vicinity of the discharge point (Figure 6-2). The area of water with a high probability (>40%) of surface oiling is relatively small (0.49km^2). The majority of diesel released is likely to rapidly evaporate and a significant proportion will biodegrade.

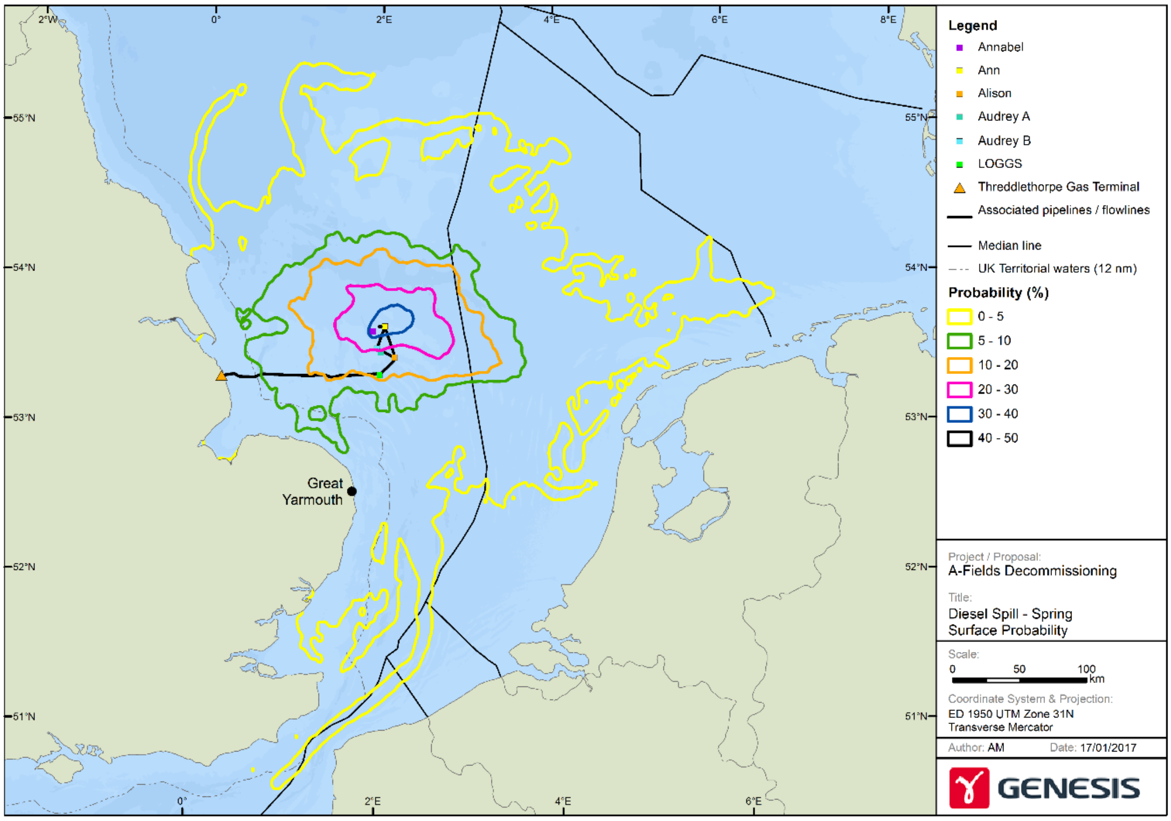


Figure 6-2: Probability of surface oiling due to a large diesel release

The maximum probability for shoreline oiling up to 20 days after release is modelled to be 10-20% in the area of Yorkshire and the Humber between March and May. The maximum mass of accumulated onshore oil from the 100+ simulations modelled was 1,392m^3. The majority of the locations and seasons modelled show either no shoreline oiling or a maximum probability of shoreline oiling of 5%.

Diesel has very high levels of light hydrocarbons and therefore evaporates quickly on release. The low asphaltene content prevents emulsification reducing its persistence in the environment. The Transocean Winner semi-submersible rig ran aground near the Isle of Lewis, Scotland on 8th August 2016 resulting in the discharge of up to 53m^3 of diesel near the coast. Investigation of the environmental impact is ongoing but an interim report by Marine Scotland has been published (Marine Scotland, 2016). Initial sampling in the days following the incident showed no discernible increase in petrogenic contamination in mussels or salmon with respect to typical farmed concentrations from a clean site. Additionally, a survey undertaken by the Royal Society for the Protection of Birds (RSPB) found no evidence of oiled birds.

The loss of the entire diesel inventory is considered highly unlikely (a rare combination of factors would be required for an event to occur) as no such incident has occurred in the UK oil and gas industry.

6.5.2.1 Plankton

The planktonic community is composed of a range of microscopic plants (phytoplankton) and animals (zooplankton) that drift with the oceanic currents. As oil can float on the water's surface and disperse within the ocean as it weathers, plankton are exposed to both floating oil slicks and to small dissolved droplets of oil in the water column (Cormack, 1999; Almeda *et al*., 2013).

Changes in the patterns of distribution and abundance of phytoplankton can have a significant impact on the entire ecosystem (Ozhan *et al*., 2014). Both oil and oil biodegradation can cause problems for phytoplankton in the immediate vicinity of a spill. Oil slicks can inhibit air-sea gas exchange and reduce sunlight penetration into the water, both essential to photosynthesis and phytoplankton growth (González *et al*., 2009). The PAHs in the oil also affect phytoplankton growth, with responses ranging from stimulation at low concentrations of oil (1mg/l i.e. 1,000ppb) to inhibition at higher concentrations (100mg/l i.e. 100,000ppb; Harrison *et al*., 1986).

Zooplankton at the air-sea interface are thought to be particularly sensitive to oil spills due to their proximity to high concentrations of dissolved oil and to the additional toxicity of photo-degraded hydrocarbon products at this boundary (Bellas *et al*., 2013). Following an oil spill zooplankton may suffer from loss of food in addition to the direct exposure of oil toxicity resulting in death from direct oiling as well as impaired feeding, growth, development, and reproduction (Blackburn *et al*., 2014 and references therein).

The limited swimming ability of the free-floating early life stages (meroplankton, i.e. eggs and larvae) of invertebrates such as sea urchins, molluscs and crustaceans renders them unable to escape oil-polluted waters. These early life stages are more sensitive to pollutants than adults and their survival is critical to the long-term health of the adult populations (Blackburn *et al*., 2014 and references therein).

Given the abundance and widespread distribution of plankton populations, and the high rates of evaporation that would be expected under the prevailing metocean conditions, the significance of the impact, given its very unlikely probability of occurrence, from a complete loss of diesel inventory has been assessed as moderate. The significance of the risk of this impact has been assessed as **low**.

6.5.2.2 Benthos

Oil that becomes emulsified or dissolves in the water column can attach to suspended particles and sink to the bottom thus becoming more bioavailable to benthic species (Meador, 2003). As stated, the low asphaltene content of diesel prevents emulsification reducing its persistence in the environment and therefore the proportion entering the water column is anticipated to be low.

In response to oil exposure, benthic animals can either move, tolerate the pollutant (with associated impacts on the overall health and fitness), or die (Gray *et al*., 1988; Lee and Page, 1997). The response to oil by benthic species differs depending on their life history and feeding behaviour as well as the ability to metabolise toxins, especially PAH compounds.

There is little documented evidence on the impact of a diesel spill of the scale which could potentially occur at the Ann and Alison. However, significant negative impacts from larger scale oil spills have been observed on amphipods such as population suppression (Jewett and Dean, 1997; Dauvin, 1982). Amphipods are possibly especially sensitive to the effects of local pollution because of their low dispersal rate, limited mobility and lack of a planktonic larval stage. Marine amphipods e.g. *Bathyporeia* sp, *Nototrophis* sp. *Liljeborgia* sp. and *Urothoe* sp. were identified during the surveys carried out at the in the vicinity of the A-Fields (see Section 4.4.2).

A diesel spill in the region could impact on molluscs found in the area for example the bivalves *Spisula elliptica*, *Phaxas pellucidus*, *Mactra stultorum*, *Gari* sp., and *Abra* sp. (see Section 4.4.2). Filter feeders tend to have a limited capacity to metabolize hydrocarbons such that toxic PAH compounds have been shown to accumulate in filter feeders (Blackburn *et al*., 2014 and references therein; Menon and Menon, 1999).

Polychaetes were the most abundant taxonomic group amongst the benthic species sampled in the vicinity of the A-Fields (see Section 4.4.2). The responses of polychaete populations to oil spills are complex and varied and are thought to differ depending on their different feeding strategies and trophic relationships in benthic environments. Some species decrease in abundance after an oil spill whilst others may be the first colonisers in the aftermath of oil spill die-offs (Blackburn *et al*., 2014 and references therein). Some polychaetes contribute to biodegradation of oil in sediments whilst some have different abilities to metabolize contaminants (Bauer *et al*., 1988; Driscoll and McElroy, 1997).

The different response of polychaetes to oil pollution is likely a consequence of their different feeding strategies and trophic relationships in benthic environments. *Capitella capitata* has been found to be amongst the first colonisers in the aftermath of a spill. This species thrives in the absence of competition and is a non-selective deposit feeder consuming detritus and algae and benefitting from organic pollution.

Given the low persistence of diesel in the marine environment and the low volumes of diesel entering the water column, the significance of the impact to benthos from a complete loss of diesel inventory has been assessed as moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low**.

6.5.2.3 Fish

Exposure of fish to contaminants can occur either through uptake of dissolved fractions across the gills or skin or direct digestion of the pollutant. Fish spending the majority of their life-cycle in the water column are likely to receive the highest exposure to contaminants that remain in solution though some will also accumulate sediment bound contaminants indirectly through their diet (i.e. digestion of animals that have accumulated the contaminants in their tissues). Fish associated with the seabed (e.g. flatfish) are more exposed to particle bound contaminants with the main exposure route being either directly through ingestion of contaminated sediments or through their diet. Seabed dwelling organisms can also absorb contaminants through the surface membranes as a result of contact with interstitial water. Once the oil disappears from the water column fish generally lose their oil content very quickly. This rapid loss of oil from fish tissue is linked to the fact that fish will metabolise accumulated hydrocarbons very rapidly (Krahn *et al*. 1993).

Given the anticipated rapid rate of evaporation, the wide distribution of fish in the SNS and the evidence for rapid recovery of fish following hydrocarbon releases, the significance of the impact from a complete loss of diesel inventory has been assessed to be moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low**.

6.5.2.4 Marine Mammals

Marine mammals may be exposed to oil either internally (swallowing contaminated water, consuming prey containing oil based chemicals, or inhaling of volatile oil related compounds) or externally (swimming in oil or oil on skin and body).

The effects of oil on marine mammals are dependent upon species but may include:

- Hypothermia due to conductance changes in skin;
- Toxic effects and secondary organ dysfunction due to ingestion of oil, congested lungs;
- Damaged airways;
- Interstitial emphysema due to inhalation of oil droplets and vapour;
- Gastrointestinal ulceration and haemorrhaging due to ingestion of oil during grooming and feeding;
- Eye and skin lesions from continuous exposure to oil;
- Decreased body mass due to restricted diet; and
- Stress due to oil exposure and behavioural changes.

Cetaceans known to inhabit the Ann and Alison area are harbour porpoise and white-beaked dolphins (see Section 4.4.4). Harbour porpoise have been observed during May to September in relatively low abundance (0.0002 – 1.12 animals per hour). White-beaked dolphins have been observed in January and December in relatively low abundance (0.0012 – 0.25 animals per hour).

Pinnipeds known to inhabit the Ann and Alison area are grey seals and common seals. Figure 4-30 shows that the mean density of seals expected in the vicinity of the A-Fields is low for both harbour seals (0-1 per 25km^2) and grey seals (5-10 per 25km^2).

There is little documented evidence of cetaceans being affected by oil spills. Smultea and Wursig (1995) found that bottlenose dolphins apparently did not detect sheen oil and that although they detected slick oil, they did not avoid traveling through it. Evans (1982) observed that gray whales *Eschrichtius robustus* typically swam through oil seeps off California. Lack of an olfactory system likely contributes to the difficulty cetaceans have in detecting oil. Waves and darkness can reduce their visual ability at the surface and it is possible that individuals could resurface within a fresh slick and find it difficult to locate oil-free water (Matkin *et al*., 2008).

Cetaceans can be susceptible to inhaling oil and oil vapour. This is most likely to occur when they surface to breathe. Inhaling oil and oil vapour may lead to damaging of the airways, lung ailments, mucous membrane damage or even death. A stressed or panicking dolphin tends to move faster, breathe more rapidly and therefore surface more frequently into oil and increase exposure.

Cetaceans have mostly smooth skins with limited areas of pelage (hair covered skin) or rough surfaces. Oil tends to adhere to rough surfaces, hair or calluses of animals, so contact with oil by cetaceans may cause only minor oil adherence.

Figure 6-3 and Figure 6-4 show the surface oiling probability and the abundance of harbour and grey seals respectively. Seals are very vulnerable to oil pollution because they spend much of their time near the surface and regularly haul out on beaches. Seals have been seen swimming in oil slicks during a number of documented spills (Geraci and St Aubins, 1990). Most pinnipeds scratch themselves vigorously with their flippers but do not lick or groom themselves so are less likely to ingest oil from skin surfaces. However, a pinniped mother trying to clean an oiled pup may ingest oil. The risk of oiling increases for pinniped pups. They spend much of their time in rocky shore areas and tidal pools where spilt oil can accumulate. Recent evidence suggests that pinniped pups are very vulnerable during oil spills because the mother/pup bond is affected by the odour and pinnipeds use smells to identify their young. If the mother cannot identify its pup by smell in the large colony, it may not feed it and this leads to abandonment and starvation.

Given the relatively small area of water of 0.49km^2 with a high probability (>40%) of surface oiling and the rapid evaporation expected, the significance of the environmental impact of a diesel inventory loss on marine mammals has been assessed to be moderate. The significance of the risk of this impact has been assessed as **low**.

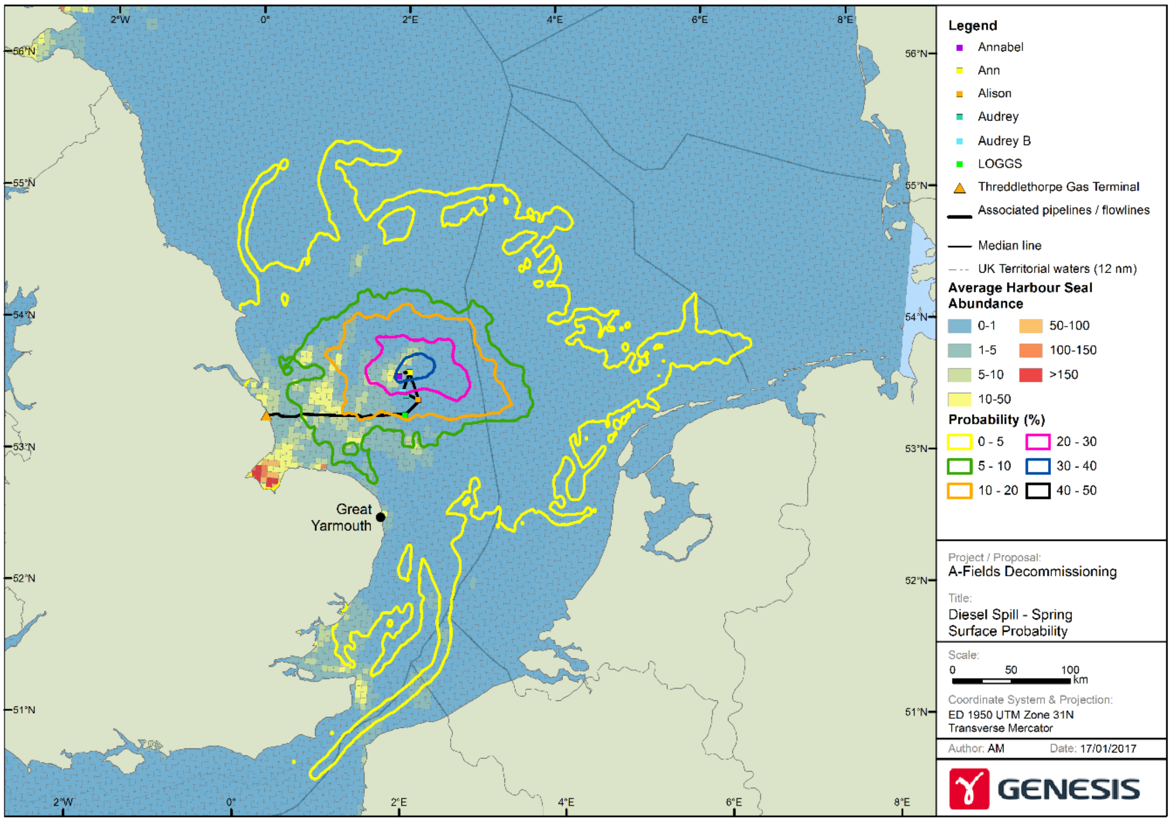


Figure 6-3: Probability of surface oiling and harbour seal abundance

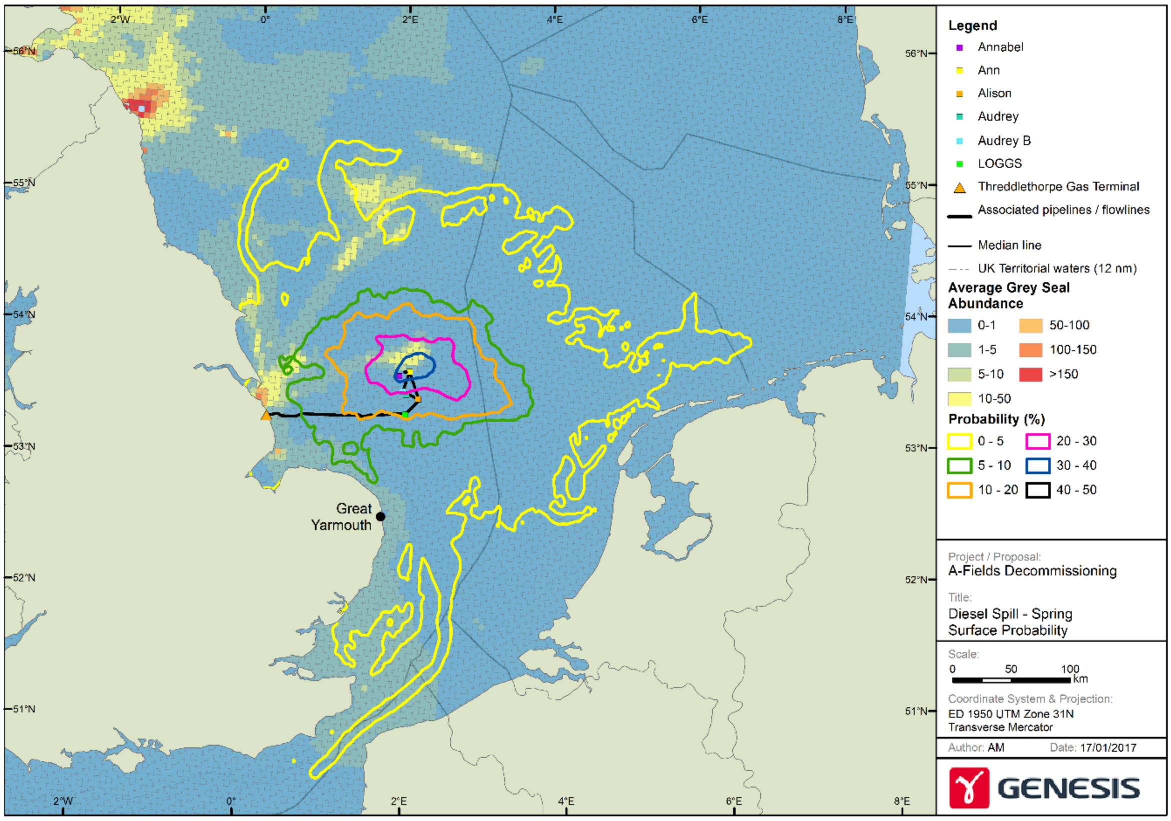


Figure 6-4: Probability of surface oiling and grey seal abundance

6.5.2.5 Seabirds

Overall annual vulnerability is considered moderate in blocks 48/15, 48/20, 49/11 and 49/16 and high in Block 49/6. The probability of surface oiling from the modelled diesel inventory release and annual OVI are shown in Figure 6-5.

Birds are vulnerable to oiling from surface oil pollution, which can cause direct toxicity through ingestion and hypothermia as a result of a bird's inability to waterproof their feathers. Oil pollution can also impact birds indirectly through contamination of their prey. Seabird species vary greatly in their responses and vulnerability to surface pollution, therefore in assessing their vulnerability it is important to consider species-specific aspects of their feeding, breeding and population ecology (White *et al*, 2001).

Species that spend a greater proportion of their time on the sea surface are considered to be more at risk from the effects of surface pollution; for example, puffins are more likely to be affected than the highly aerial petrels. Species that are wholly dependent on the marine environment for feeding and resting are considered more vulnerable to the effects of surface pollution than species that use offshore areas only seasonally or move offshore only to rest or roost. Additionally, the potential reproductive rate of a species will influence the time taken for a population to recover following a decline. Other factors such as mortality and migration rates, species abundance and conservation status (e.g. globally threatened) also determine the effects of an oil spill on seabird populations.

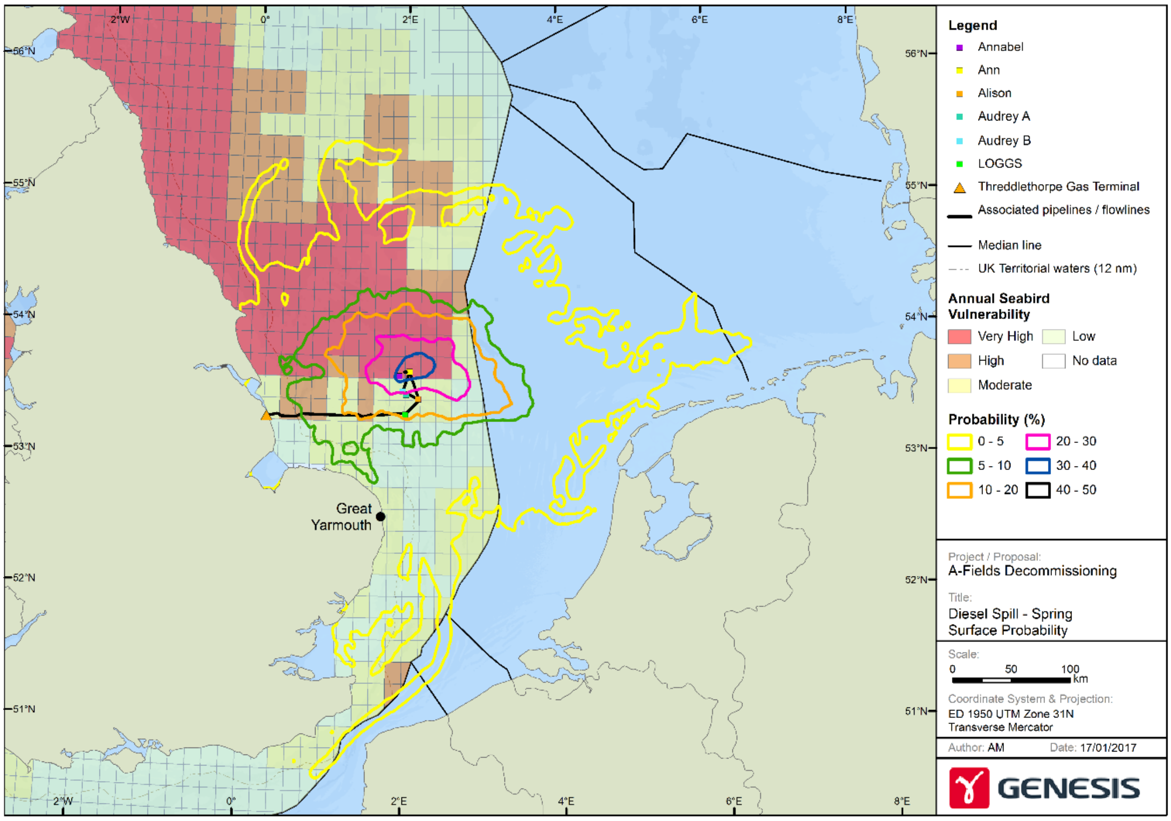


Figure 6-5: Probability of surface oil and annual seabird vulnerability

Figure 6-5 shows that the area of water with a high probability (>40%) of surface oiling is relatively small (0.49km^2). A full release of diesel inventory (1,400m^3) is considered highly unlikely however, if it did occur, rapid evaporation of diesel expected.

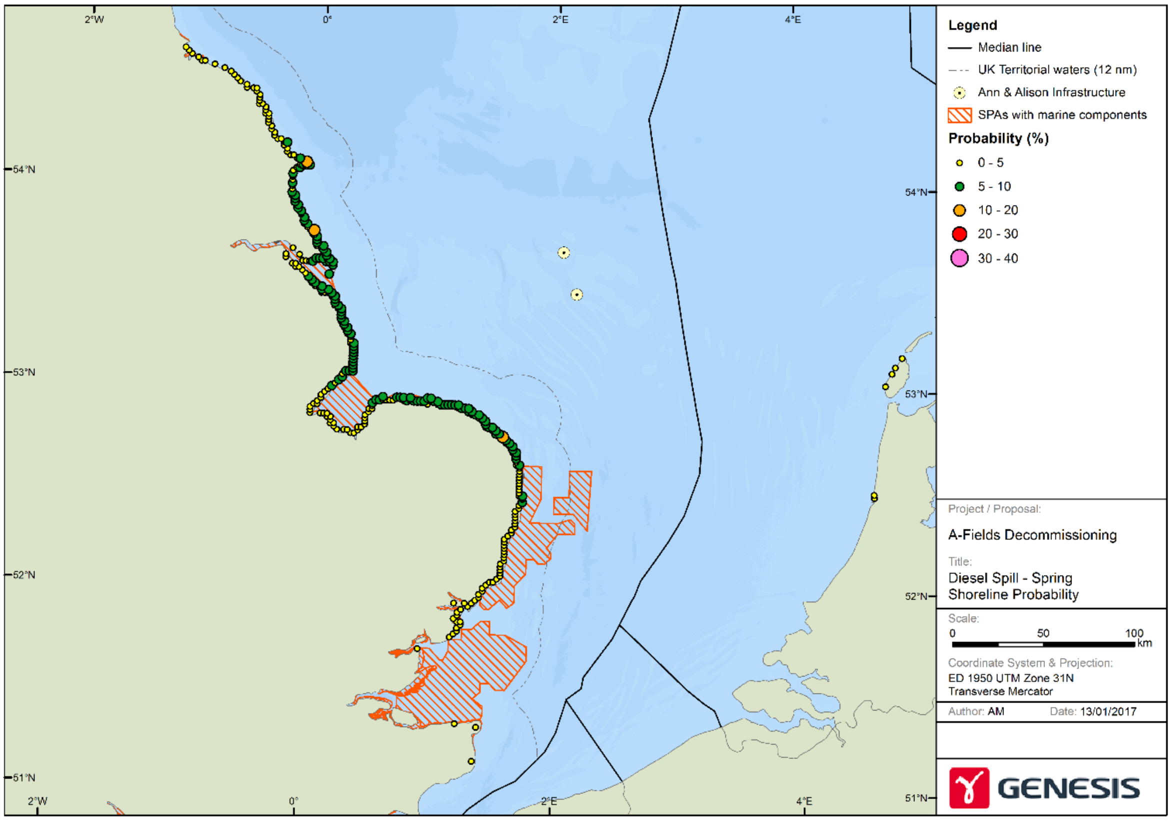
Given that the area of a potential spill coincides with very high seabird vulnerability, the significance of the environmental impact of a diesel inventory loss on seabirds has been assessed as severe. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **medium**.

6.5.2.6 Coastal Protected Areas

As discussed in Section 4.5 there are a number of protected areas along the UK coast. A number of these could be impacted following a large unplanned release of diesel.

The probability of diesel beaching close to SPAs with marine components is shown in Figure 6-6. The graphic highlights that the probability of diesel beaching around the Humber Estuary, The Wash, Deben Estuary, Foulness, The Swale and the Outer Thames Estuary SPAs is less than 10% with the model predicting that the probability is actually likely to be less than 5%.

Given the low probability of shoreline beaching, the significance of the impact of a diesel inventory loss on coastal protected areas has been assessed to be moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low**.



<u>Figure 6-6: Probability of surface oiling and interaction with SPAs with marine components</u>

6.5.2.7 Offshore Protected Areas

A number of offshore protected areas could potentially be affected by large, unplanned releases of diesel in the vicinity of the A-Fields. The nearest offshore SACs are:

- North Norfolk Sandbanks and Saturn Reef SAC – 11km from Ann; Alison is within SAC;
    - Designated for the protection of sandbanks slightly covered by seawater all the time and reefs.
- SNS cSAC for harbour porpoise – 2km from Ann; Alison is within cSAC; and
    - Designated for the protection of harbour porpoise.
- Markham's Triangle MCZ - 38km from Ann; 53km from Alison.
    - Designated for the protection of sandbanks slightly covered by seawater all the time.

Figure 6-7 shows the probability of surface oiling and the interaction with offshore protected areas. As discussed, diesel has very high levels of light hydrocarbons and therefore evaporates quickly on release and the low asphaltene content prevents emulsification reducing its persistence in the environment although some portion of the diesel will enter the water column. The impact of a diesel inventory loss on the sandbanks and reefs is therefore expected to be moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low.**

As previously discussed, cetaceans such as harbour porpoise can be susceptible to inhaling oil and oil vapour, principally when they surface to breathe. Inhaling oil and oil vapour may lead to damaging of the airways, lung ailments, mucous membrane damage or even death.

The modelled area of overlap of surface oiling with the SNS cSAC for harbour porpoise with a high probability (>40%) is very small with respect to the total cSAC area of 36,958km^2. The significance of the environmental impact of a diesel inventory loss on offshore protected areas has therefore been assessed to be moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low**.

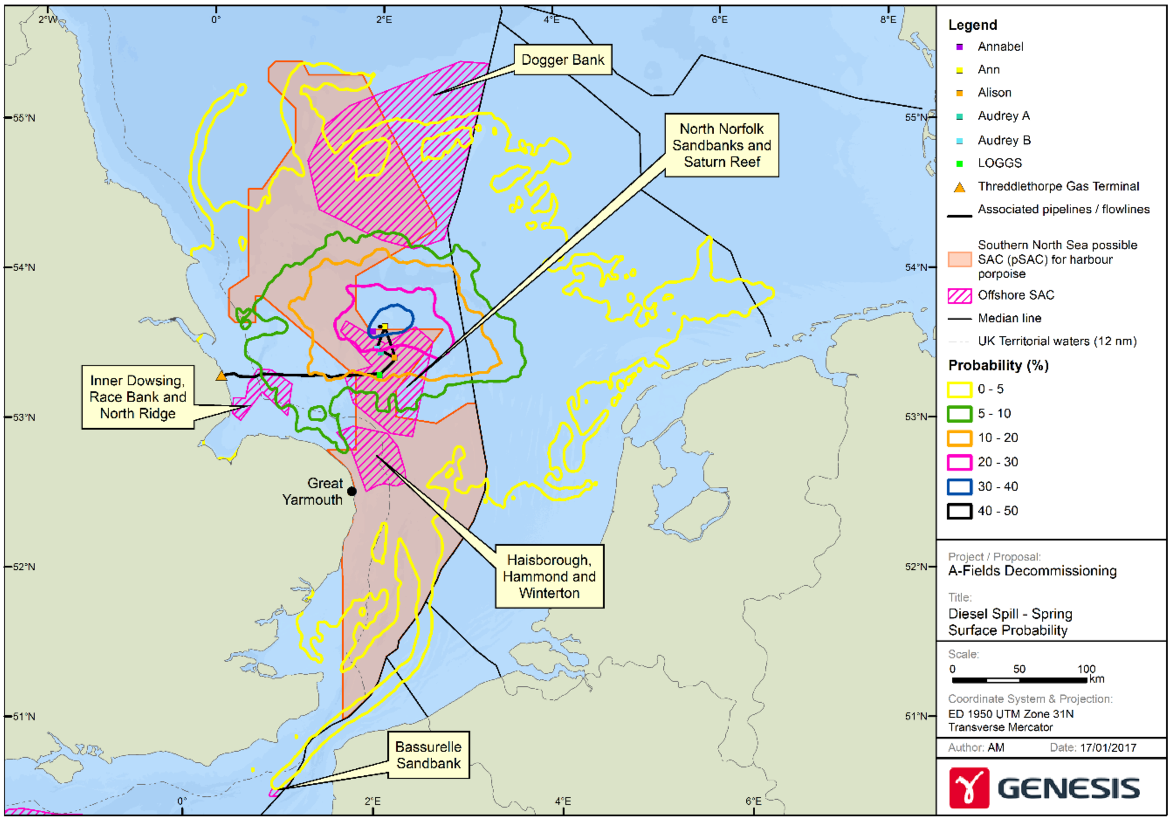


Figure 6-7: Probability of surface oiling and interaction with offshore protected areas

6.5.3 Transboundary and cumulative impacts

The A-Fields are located approximately 55km west of the UK/NL median line. The modelling shows that there is a low probability (0-5%) of surface oiling occurring in Dutch and German waters. Less than 20% of the model runs predict surface oiling beyond the UK/NL median line. The significance of transboundary impacts are therefore assessed to be moderate. The significance of the risk of this impact, given its very unlikely probability of occurrence, has been assessed as **low**.

6.5.4 Control and mitigation measures

Centrica has developed comprehensive procedural (vessels' management systems) and operational controls to minimise the likelihood of large hydrocarbon releases and to mitigate their impacts should they occur. These include the Marine Standard and the A-Fields OPEP (Centrica Energy, 2015b). In addition, all vessels undertaking decommissioning activities will have an approved SOPEP developed within the requirements of Regulation 37 of MARPOL Annex 1 (MARPOL, 1973).

These control measures are considered to be effective in reducing and minimising the risk of release during the decommissioning activities to 'as low as reasonably practicable'.

6.5.5 Conclusion

The sole source of a potential unplanned large volume release of diesel to sea is associated with loss of containment from a vessel. The worst case in terms of volume and rate of release would be the immediate total loss of diesel inventory to sea as a consequence of collision or mechanical failure. This eventuality is considered to be very unlikely owing to the procedural (vessels' management systems) and operational controls that will be applied.

Diesel has very high levels of light hydrocarbons and therefore evaporates quickly on release. The low asphaltene content prevents emulsification reducing its persistence in the environment.

The modelling of diesel surface oiling probability has shown that the area of high probability (>40%) is low with respect to sensitive species and habitats.

Given the low likelihood of such a release and the rapid evaporation rate of diesel, low environmental persistence, and with the identified control and mitigation measures in place, the significance of the risk of impact from a large unplanned release of diesel to sea as a result of decommissioning the Ann and Alison Fields is considered to be **low**.

6.6 Waste

This section identifies and assesses the impact of disposal of waste likely to be generated as a result of the decommissioning activities.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed with regard to the sensitivity of known receptors in the receiving environment. The volume of waste produced and disposed to landfill will be minimised.

6.6.1 Regulatory requirements

The Revised Waste Framework Directive (Council Directive 2008/98/EC) was adopted in December 2008 with European Union (EU) Member States being required to implement revisions by December 2010. The overriding aim is to ensure that waste management is carried out without endangering human health and without harming the environment. Article 4 also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

The Waste (England and Wales) (Amendment) Regulations 2012 outlines the requirement for collection, transport, recovery and disposal of waste. It sets out the principles of the waste hierarchy which should be considered when treating and handling waste. In addition, the DECC Guidance Notes (DECC, 2011) under the Petroleum Act 1998 require all decommissioning decisions to be made in line with the waste hierarchy.

Whether a material or substance is determined as a 'waste' is determined under EU law. The EU Waste Framework Directive defines waste as:

"*any substance or object which the holder discards or intends or is required to discard*".

Materials disposed of onshore must comply with the relevant health and safety, pollution prevention, waste requirements and relevant sections of the Environmental Protection Act 1990. The waste management assessment should be based on the worst case and follow the hierarchy shown in Figure 6-8, in line with relevant legislation, permits and consents.

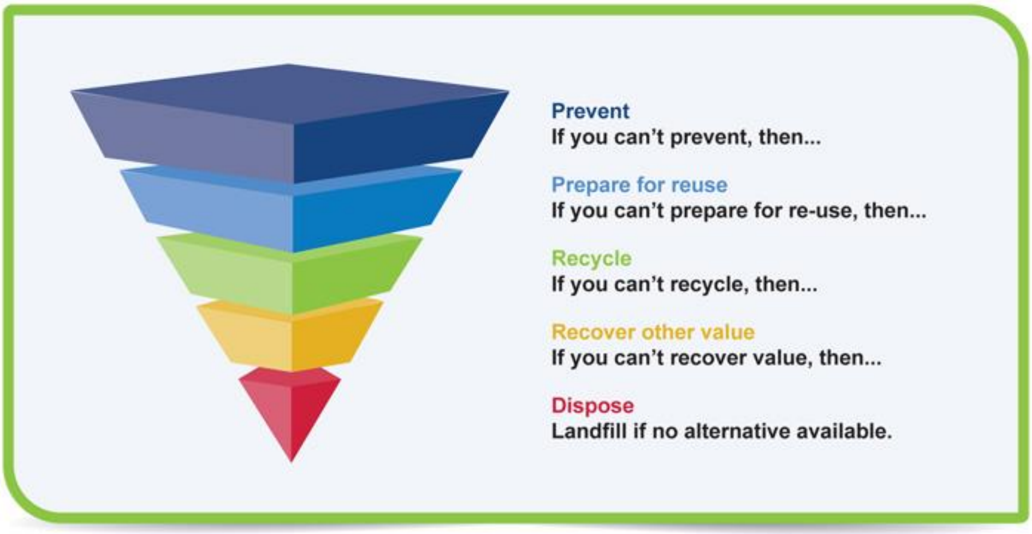


Figure 6-8: Waste hierarchy

Management of radioactive materials is governed under:

- Radioactive Substances Act 1993; and
- Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008.

The handling and disposal of radioactive waste requires additional authorisation.

Onward transportation of waste or recycled materials must also be in compliance with applicable legislation, such as the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, a highly prescriptive regulation governing the carriage of dangerous goods by road.

6.6.2 Sources

The decommissioning will generate hazardous and non-hazardous waste that will need to be managed to ensure appropriate disposal and minimise waste to landfill.

Non-hazardous materials, which include metals (steel, aluminium), plastics and concrete will be kept separately from any potentially hazardous substances (mainly chemicals).

Infrastructure and materials recovered to shore will be transferred to a designated waste management facility, which will have all necessary approvals and licences in place and possess the capability to reuse or recycle the majority of recovered material.

The minimisation of waste arising from the decommissioning will be of particular significance at the planning stage, where opportunities for reuse will be considered initially prior to any other disposal route selection.

The inventory of Ann and Alison materials and the reuse, recycling and disposal aspirations of material recovered to shore are presented in Table 6-7 and Table 6-8 and include mattresses and grout bags.

INVENTORY (EXCLUDES ROCK)	TOTAL INVENTORY (Te)	PLANNED TO SHORE (Te)	PLANNED TO BE DECOMMISSIONED *IN SITU* (Te)
Installations	313.7	261.5	52.2
Pipelines	8,932.3	1,3	7,513.0
Total	9,246.0	1,680.8	7,565,2

Table 6-7: Inventory disposition

INVENTORY	RECYCLE	DISPOSAL
Installations	237.9	23.6
Pipelines	1,358.5	60.8

Table 6-8: Anticipated recycling and disposal for material recovered to shore

The planned materials recovered to shore include templates (and their piles), pipeline spool pieces, sections of pipeline and umbilical, mattresses, and grout bags.

6.6.2.1 Naturally Occurring Radioactive Material

Centrica holds a permit issued by the Environment Agency allowing it to accumulate and dispose of radioactive waste containing NORM in the form of solid waste arising from the production of oil and gas at its Ann and Alison Fields. The permit limits the amount of solid radioactive waste that can be held offshore at any one time, and requires solid wastes to be disposed of within certain time limits by transfer to onshore operators who are themselves permitted to receive and dispose of these wastes.

Suitably maintained and calibrated contamination monitors are required to be used offshore to identify the presence of NORM on recovered materials which are known to have been exposed to well fluids during production and are therefore known to be susceptible to NORM contamination. Samples of material demonstrating activity will be sent to an onshore laboratory for radiochemical analysis to determine whether the material is 'radioactive' or 'exempt'. No materials will be cleaned offshore. Confirmed NORM contaminated material will be handled, transported to shore and processed in strict accordance with the approved procedures of Centrica's subsea decommissioning contractors.

6.6.3 Impacts and Receptors

The potential impacts from waste disposal are principally associated with the onshore environment and landfills. The impacts typically include:

- Use of sometimes scarce landfill space (resource use);
- Degradation of local/regional air quality as a result of emissions from onshore transport;
- Potential degradation of the water environment if any leachate is produced by the landfill site and reaches surface water and/or groundwater; and
- Nuisance to the local community from traffic, odour and visual impacts.

Where possible, materials brought to shore which cannot be reused will be recycled. The impacts associated with recycling will occur at existing processing plants:

- Degradation of local/regional air quality as a result of emissions from transport;
- Degradation of local/regional air quality as a result of plant emissions;

- Degradation of the water environment (surface water and groundwater) associated with any discharges from processing plant; and
- Nuisance to the local community from traffic and visual impacts.

Only existing permitted facilities (under the Environmental Permitting regime (England) or the Pollution Prevention and Control regime (Scotland)) will be used and for those permits to have been approved, the impacts to air, land, water and to the local community, will have already been assessed as acceptable. Therefore, the use of existing permitted facilities for recycling or disposal is not considered to result in a substantive environmental impact.

Marine growth will be dealt with by the selected shore base in line with accepted practices. This normally involves landfilling or composting. The major sources of odour following removal of structures can be associated with degradation of marine growth. Significant marine growth is not expected and therefore odour is unlikely to be an issue. In addition, much of the marine growth will be lost during the cutting and lifting process and during transportation.

6.6.4 Transboundary and cumulative impacts

Only UK shore bases are being considered for receiving the waste recovered to shore from the A-Fields decommissioning activities, hence there will be no transboundary impacts.

The SNS is a well developed area of oil and gas infrastructure with many mature assets and as such the cumulative impacts of decommissioning should be considered. The timing of the A-Fields decommissioning activities are unlikely to overlap with the other decommissioning projects in the vicinity and therefore the potential significance of the cumulative impact from onshore waste handling has been assessed as **low**.

6.6.5 Control and mitigation measures

Centrica will have a Waste Management Plan (WMP) in place which will be used to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. Segregating materials at source and maintaining the separation between hazardous and non-hazardous streams will reduce the amount of material requiring onshore treatment.

If hazardous waste is produced it will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling. Under the Landfill Directive, pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to landfill sites. Other non-hazardous wastes that cannot be reused or recycled will be disposed of to landfill.

Any NORM contaminated equipment must be handled, transported, stored, maintained or disposed of in a controlled manner. Protocols are required to ensure that equipment is not released or handled without controls to protect the worker and prevent contamination of the environment.

6.6.6 Conclusion

In summary, with the identified control and mitigation measures in place ensuring that the majority of the materials recovered to shore will be recycled, the overall significance of the impact of waste as a result of decommissioning the Ann and Alison facilities is considered to be **low**.

6.7 Socio-economic impacts

This section examines the various offshore and onshore sources (or types) of socio-economic impact (beneficial as well as detrimental) that will (or may) result from the decommissioning activities.

Following the adoption of appropriate control and mitigation measures, detrimental residual effects and impacts are assessed in terms of the sensitivity of known receptors.

6.7.1 Sources

The principal planned decommissioning activities, including their location and estimated duration, are described in Section 3. Of these, the use of vessels, and the onshore processing of recovered materials have been identified as the activities warranting further assessment in terms of their potential socio-economic impact.

In addition, the *in situ* decommissioning of subsea infrastructure will inherently and permanently present a small, residual risk of interaction to third party users of the seabed.

6.7.1.1 Physical presence of vessels and onshore processing of recovered materials

Denial of access and interference with navigation

The physical presence of vessels engaged in decommissioning activities may temporarily deny commercial fishing vessels access to fishing grounds, or oblige shipping to alter their course.

Contribution to the economy

Vessels will require the use of a range of port facilities and will likely also need to purchase a variety of local goods and services. The light processing (cleaning, cutting etc.but not recycling) of recovered materials will be undertaken at a local shore base resulting in a short-term continuation of jobs in onshore yards.

6.7.1.2 Physical presence of decommissioned infrastructure

Decommissioned *in situ*

The physical presence of the majority of the pipeline and umbilical following its *in situ* decommissioning could present a permanent snagging risk to fishing vessels deploying bottom-trawled gear should sufficiency of trench or burial cover fail to be maintained for any reason.

Recovered to shore

The majority of subsea infrastructure will be recovered to shore. As such there is potential for a positive impact due to removal of the current 500m safety zones, opening up the area to the fishing industry.

6.7.2 Impacts and receptors

6.7.2.1 Physical presence of vessels and onshore processing of recovered materials

As explained in Section 3, a range of vessel types will be required at various times, and for various durations, to undertake particular decommissioning activities. Operations will be associated with infrastructure removal or recovery and with surveying or monitoring.

The impact (loss of opportunity) associated with any denial of access to, or navigation through, an area of sea is a function of the requirement of third parties to access or transit that area, and the time over which their free access or navigation will be denied.

Third party vessels are already prevented from entering the 500m safety zone that has been established around the Ann wellhead and Alison wellhead.

In combination, the various components of the decommissioning and post-decommissioning surveying/monitoring programme are estimated to take 158 days spread over a multi-year period. Furthermore, the area to which access is denied on these days is limited.

Given the localised, short-term or infrequent nature of the activities, the significance of the impact with regard to denial of access or free navigation has been assessed as **low**.

Specialist vessel management services (including shore base and waste management services) will be required to support the decommissioning activities. Such services will likely be sourced from ports and harbours local to the A-Fields and in so doing will support offshore and onshore employment. The onshore processing of recovered materials will be undertaken at a local shore base resulting in a short-term continuation of jobs in onshore yards.

Given the relatively small scale and duration of decommissioning operations, the significance of this beneficial impact has been assessed as **low**.

6.7.2.2 Physical presence of infrastructure

The impact associated with sections of the pipelines/umbilical that have been decommissioned *in situ* will be a function of the snagging risk associated with insufficiently trenched and buried pipeline, and the requirement of third parties (predominantly commercial fishing vessels) to deploy equipment that may interact with this hazard. There are no indications that this will occur and bottom-trawled gear is not used in the area.

A pipeline and umbilical 'as-left' trench/burial status survey and a seabed over-trawl assessment will be undertaken upon conclusion of the decommissioning activities. Additional post-decommissioning trench/burial status monitoring will also be undertaken. This and any requirement for trench/burial remediation would be agreed with BEIS.

Removal of the Ann template protection structure, Alison template, Alison tee with piles cut below the seabed, spool pieces and their protection represents a beneficial impact as this will permanently remove the risk of snagging presented to third parties by this infrastructure and provide them full access to this area of seabed.

Given that the majority of subsea infrastructure and approximately 8km of PL1099 will be removed, and Centrica's commitment to the ongoing trench/burial status monitoring of that which will remain *in situ*, the significance of the impact of physical presence of infrastructure has been assessed as **low**.

6.7.3 Transboundary and cumulative impacts

The A-Fields are located approximately 55km west of the UK/NL median line. Given this distance, and the short duration, relatively small scale and localised nature of the decommissioning activities, no substantive transboundary socio-economic impacts are anticipated.

The following socio-economic activities, if they occur at the same time, and in the same area as the decommissioning activities, could result in an 'in-combination' effect:

- Oil and gas production (including inspection, maintenance, supply);
- Oil and gas development (surveys, drilling, installation of infrastructure);
- Oil and gas decommissioning (installation or pipelines removal and recovery); and
- Wind farm development and operation.

The third party oil and gas infrastructure in the vicinity of the Ann and Alison Fields is mature. There is no known planned installation of oil and gas infrastructure that would lead to construction activity taking place at the same time as the decommissioning of the A-

Fields.

The closest operational wind farm to Ann and Alison infrastructure is Sheringham Shoal at a distance of over 76km and the nearest wind farm under construction is Dudgeon at a distance of over 54km. The Heron West, Njord and Heron East consented blocks are being developed by Dong Energy as the Hornsea Project One at a distance of approximately 12km north of Ann at the closest point.

The impacts associated with Ann and Alison decommissioning activities have been assessed to be localised and therefore no substantive in-combination effects are anticipated with respect to neighbouring oil and gas surface installations (the closest of which is the Viking KD platform at approximately 4km from Alison).

Should other pipelines (or sections of pipelines) in the area be decommissioned *in situ* there could be a cumulative socio-economic impact. The total area potentially affected is considered relatively small. The potential significance of the cumulative impact has therefore been assessed as **low**.

6.7.4 Control and mitigation measures

The following measures will be adopted to ensure that detrimental socio-economic impacts are minimised to ‘as low as reasonably practicable’:

- The timing and location of decommissioning activities, and the location of infrastructure decommissioned *in situ*, will be advertised via the Kingfisher Bulletin and via Notices to Mariners;
- Necessary seabed debris surveys, seabed over-trawl assessment, depth of burial surveys and environmental surveys will be conducted; and
- The vessels’ work programme will be optimised.

6.7.5 Conclusion

The principal source of socio-economic impact associated with the Ann and Alison Fields decommissioning activities concerns the use of vessels.

The physical presence of vessels engaged in decommissioning activities will deny commercial fishing access in the vicinity of the Ann and Alison Fields. The approximately 158 individual vessel days is however of relatively short duration and spread over a multi-year period. Furthermore, the area to which access is denied on these days is limited.

The *in situ* decommissioning of subsea infrastructure will present a very small but permanent potential for interaction with commercial fishing activities. This residual risk however will be mitigated by a commitment to ongoing trench/burial status monitoring.

Beneficial impacts will arise through short-term job creation for specialist vessel management services and onshore processing of recovered materials. The removal of 500m safety zones will open these areas up to fishing industry.

In summary, due to the localised and short duration of decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the socio-economic impact from the decommissioning of the Ann and Alison Fields is considered to be **low**.

7. CONCLUSIONS

The Ann and Alison facilities are to be decommissioned by Centrica during 2021 to 2024. A CA has been carried out in order to identify the recommended decommissioning option. The selected option was to decommission PL947 and PL948 *in situ*, the complete removal of *c.*8km of PL1099, with the remaining section decommissioned *in situ* and the complete removal of PL2164 and PL2165. Included in the decommissioning activities is the complete removal of the Ann and Alison templates, the top section of the template piles, the ends of the pipelines and umbilicals that are insufficiently buried including the Alison tee protection structure, and complete removal of concrete mattresses, bitumen mattresses and grout bags. Deposited rock and frond mattresses will be decommissioned *in situ*.

The EIA process presented in this document considers the impact of the planned activities associated with the decommissioning of the Ann and Alison facilities. The impact was determined by considering the duration/frequency of each of the planned activities and environment to determine the overall significance of impact as either low, medium or high. The significance of the impact of all planned activities was considered to be **low**.

The impacts of all activities were assessed at a workshop, with the following areas being considered in more detail: energy use and atmospheric emissions, underwater sound, seabed disturbance, discharges and releases to sea, large hydrocarbon releases and oil spill response, waste and socio-economic impacts,

Accidental events were also considered in terms of the likelihood of such an event occurring and the significance on people, the environment, the asset, Centrica's reputation and the stakeholder. This provides a risk of low, medium or high. Accidental events identified to potentially have a medium environmental risk were all associated with vessel collisions prior to mitigation measures being identified. Measures to mitigate this risk include only contracting vessels which meet Centrica's Marine Standard.

Centrica will follow routine environmental management activities for example contractor vessel audits and legal requirements to report discharges and emissions, such that the environmental impact of the decommissioning activities will be minimised. Following the EIA process, it can be concluded that activities associated with the decommissioning of the Ann and Alison facilities are unlikely to significantly impact the environment or other sea users, for example shipping traffic and fishing, provided that the proposed mitigation and control measures are put in place. The key points from the EIA are summarised below.

7.1 Energy use and atmospheric emissions

The principal energy use and generation of emissions to air will arise from fuel combustion for propulsion and power generation by the vessels required for the decommissioning activities. These emissions will include components which have the potential to contribute to global warming, acid rainfall, dry deposition of particulates and photochemical pollution or cause impacts on local air quality. It is expected that impacts will be of low significance as they will be short term.

The energy usage from the decommissioning of the Ann and Alison Facilities is estimated to be 95,337GJ direct (vessel use) and 186,257GJ indirect requirements (manufacture of new materials to replace those decommissioned *in situ*).

Emissions to atmosphere from the decommissioning activities are unlikely to significantly contribute to greenhouse gas emissions or global warming impacts; total direct CO_2 emissions generated by the proposed decommissioning are 7,078Te. In relation to the total CO_2 produced from domestic shipping the direct CO_2 emissions from the decommissioning of the Ann and Alison facilities is *c.*0.07%.

Standard mitigation measures to optimise energy usage by vessels will include operational practices and power management systems for engines, generators and any other combustion plant and planned preventative maintenance systems for all equipment for peak operational efficiency.

In summary, due to the localised and relatively short durations of activities and with the identified control and mitigation measures in place, the overall significance of the impact of energy use and associated atmospheric emissions arising from decommissioning the Ann and Alison facilities is considered to be **low**.

7.2 Underwater sound

The principal sources of underwater sound associated with the Ann and Alison decommissioning are associated with the use of vessels, surveying equipment and cutting tools.

The vessels programme (comprising a total of approximately 158 individual vessel days spread over a multi-year period) is of relatively short duration and represents only small increment to existing vessel traffic in the area. Cutting tools will only require to be used intermittently over this period and at point locations.

Although there are marine mammals and fish in the area around the Ann and Alison facilities, the level of sound that will be generated is not expected to cause physiological harm or substantive behavioural interference to either fish or mammals known to inhabit the area. The greatest potential disturbance is as a result of vessels. However, given that the Ann and Alison facilities are in an area of established oil and gas activity with high shipping activity, marine mammals are likely to be accustomed to similarly sound levels and this reduces the level of impact.

Standard measures that will be applied to control sound include planned maintenance of equipment and optimisation of the work programme to minimise vessel use.

In summary, due to the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall significance of the impact of underwater sound generated during decommissioning of the Ann and Alison facilities is considered to be **low**.

7.3 Seabed disturbance

The principal sources of seabed disturbance associated with the Ann and Alison decommissioning concern the over-trawl assessment at the end of decommissioning and removal of spools, mattresses and sand bags and cutting operations around the Ann and Alison templates and Alison tee. The over-trawl assessment will be conducted in the 500m safety zones and over a 200m corridor along the pipeline lengths. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment.

Standard measures to control disturbance include operational planning and equipment selection.

The species and habitats observed in the vicinity of Ann and Alison are relatively widespread throughout the SNS and the area anticipated to be impacted represents a very small percentage of the available habitat. Furthermore, the environment in the vicinity of the Ann and Alison Fields is dynamic due to the shallow water depth therefore all disturbed sediments/habitats are expected to recover rapidly and species recruitment would be expected from adjacent undisturbed areas.

In summary, due to the localised and relatively short duration of the decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the impact of seabed disturbance as a result of the decommissioning of the

Ann and Alison facilities is considered to be **low**.

7.4 Discharges and releases to sea

The principal sources of discharges and releases to sea associated with the Ann and Alison decommissioning are associated with vessels and the breaking of containment/lifting of sections of the pipelines.

The vessel use is of relatively short duration. Operational discharges from vessels during this time are expected to be rapidly diluted and dispersed under prevailing hydrodynamic conditions.

The production fluids will have been removed from the pipeline. The hydraulic fluid that remains within the umbilical and any remaining chemicals are expected to be discharged to the marine environment.

The seabed and the water column are the primary receptors. Control measures include permitting of chemical discharges and strict vessel operating procedures. All of these impacts will be localised and short term given the highly dynamic environment around the Ann and Alison facilities. Overall impact of discharges and releases to sea as a result of decommissioning the Ann and Alison facilities is considered to be **low**.

7.5 Large hydrocarbon releases and oil spill response

Whilst there is the potential for a major diesel release during the Ann and Alison decommissioning activities, it is considered unlikely and that a rare combination of factors would be required for an event to occur. Taking into account the types of sediment and receptors in the area and the mitigations and controls that will be put in place, the overall significance of the impact has been assessed as moderate.

The worst case scenario of an accidental hydrocarbon release would result from a complete loss of fuel inventory from on-site vessels or collision. In the unlikely event of such an incident the vessels will have a SOPEP in place in order to reduce the impact. Centrica will minimise the likelihood of such an event occurring by awarding the contract only to vessels that meet Centrica's Marine Standard. Given that the diesel would disperse and dilute quickly and is unlikely to impact on any coastline, the environmental risk of such an incident is considered to be **low**.

7.6 Waste

All wastes returned to shore will be handled and disposed of in accordance with legislation and the waste hierarchy. All regulatory and company procedures for segregation, transport and disposal, as set out in the project WMP, will be strictly adhered to and only fully permitted facilities will be used for recycling or disposal. The overall significance of the impact of waste as a result of decommissioning the Ann and Alison facilities is considered to be **low**.

7.7 Socio-economic impacts

The primary socio-economic activities that could be impacted are commercial activities, such as oil and gas operations, shipping and fishing.

Access to the area for fishing will be restricted whilst decommissioning is undertaken and this will lead to short term impacts on the fishing industry; however, the impact is considered to be low due to the short duration of operations, the relatively small scale of the activities and the existing 500m safety zones.

A beneficial socio-economic impact is the short-term continuation of jobs in onshore yards and on vessels. It is expected that the overall impact will be low since the local socio-economic system is already altered owing to the presence of the oil industry itself.

A post-decommissioning over-trawl assessment will verify that there are no remaining obstructions likely to snag fishing trawls.

Overall, significance of the socio-economic impacts as a result of the Ann and Alison facilities decommissioning is expected to be **low**, with the exception of the fishing sector, where there is potential for a beneficial impact when 500m safety zones are removed.

7.8 Designated conservation sites impacts

The Alison facilities and the majority of the Ann and Alison pipelines lie within the North Norfolk Sandbanks and Saturn Reef SAC and the SNS cSAC for harbour porpoise. The impacts associated with activities that could impact the sites (e.g. cutting, jetting, anchoring) are localised. Sound associated with vessels and the activities could impact the area, however given the existing level of shipping in the area the significance of the impact is assessed as **low**.

The principal sources of seabed disturbance associated with the Ann and Alison decommissioning concern the removal of spool pipeline ends, mattresses and grout bags, cutting operations around the Ann and Alison Templates and Alison tee and the over-trawl assessment which will be conducted in the 500m safety zones and over a 200m corridor along the pipeline lengths. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment. All disturbed sediments are expected to recover rapidly though recruitment from adjacent undisturbed areas therefore the overall significance of the impact of seabed disturbance is considered to be **low**.

A large hydrocarbon release could impact the SAC and cSAC however modelling has shown the risk is relatively low and with control and mitigation measures in place the significance has also been assessed as **low**.

Given that the impacts on North Norfolk Sandbanks and Saturn Reef SAC and SNS cSAC for harbour porpoise have been assessed as **low**, the impact on the Markham's Triangle recommended MCZ which is approximately 38km north-east of the Ann infrastructure has also been assessed as **low**.

7.9 Summary of control and mitigation measures

Centrica will follow routine environmental management activities for example contractor vessel audits and legal requirements to report discharges and emissions, such that the environmental impact of the decommissioning activities will be minimised. Following the EIA process, it can be concluded that activities associated with the decommissioning of the Ann and Alison facilities are unlikely to significantly impact the environment or other sea users, for example shipping traffic and fishing, provided that the proposed mitigation and control measures are put in place.

A summary of proposed control and mitigation measures is shown in Table 7-1.

MITIGATION AND CONTROL MEASURES
General
Lessons learnt from previous decommissioning scopes will be reviewed and implemented.
Energy use and atmospheric emissions
Prior to mobilisation, vessels will be audited to ensure that their management system appropriately plans maintenance of both generator and engine efficiency in line with manufacturers specifications.
Fuel use for mobilised vessels will be monitored and comply MARPOL requirements, in particular with regard to low sulphur content.
Decommissioning activities will be planned to minimise vessel use (e.g. optimisation of vessel work programmes).
Fuel consumption will be minimised by operational practices and power management systems for engines, generators and any other combustion plant (as required under the contract with the subcontractor).
Planned and preventative maintenance systems will be required for all vessels to ensure that all equipment is maintained at peak operating efficiency for minimum overall fuel usage (as required under the contract with the subcontractor).
Underwater sound
Machinery, tools and equipment will be in good working order and well-maintained (as will be required under the contract with the subcontractor).
The vessels work programme will be carefully planned to optimise use.
The number of required cuts will be minimised consistent with operational (including safety) considerations.
Seabed disturbance
All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised.
The careful planning, selection of equipment, and management and implementation of activities.
A debris survey will be undertaken at the completion of the decommissioning activities. Any debris identified as resulting from decommissioning activities will be recovered from the seabed where possible.
Discharges and releases to sea
Procedures and systems for the minimisation of waste and effluent generation (maintained as required under the contract with the subcontractor).
Procedures and systems for the management of ballast and bilge water (maintained as required under the contract with the subcontractor).
Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials.
Vessels will be selected and audited to ensure that effective operational systems and onboard control measures are in place.
Vessels' work programmes will be optimised to minimise use.
Large hydrocarbon releases and oil spill response
Comprehensive management and operational controls plan developed to minimise the likelihood of large hydrocarbon releases and to mitigate their impacts should they occur. These include the Marine Standard and the A-Fields OPEP.
All vessels undertaking decommissioning activities will have an approved SOPEP.

MITIGATION AND CONTROL MEASURES
Waste
A WMP will be in place.
If hazardous waste is produced it will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling.
Any NORM contaminated equipment will be handled, transported, stored, maintained or disposed of in a controlled manner.
Socio-economic impacts
The timing and location of decommissioning activities, and the location of infrastructure decommissioned *in situ*, will be advertised via the Kingfisher bulletin and via Notices to Mariners.
Decommissioning and post-decommissioning seabed assessments, surveys and monitoring.
The vessels' work programme will be optimised.

Table 7-1: Summary of proposed control and mitigation measures

7.10 Transboundary and cumulative impacts

Given the location of the location of the Ann and Alison facilities, there will be minimal impact on the Dutch sector. All impacts including transboundary following the application of suitable mitigation measures, have been assessed as of **low** significance.

The cumulative impact of the Ann and Alison decommissioning activities has been assessed as **low** based on the relatively short duration of the activities, the associated low significance of the impacts combined with Ann and Alison being located in an area developed for oil and gas activities with existing shipping activity in the area.

7.11 Overall

The initial environmental workshop and the subsequent EIA has concluded that all impacts and risks identified were within the low category and reduced to 'as low as reasonably practicable'. Overall, the significance of impacts as a consequence of decommissioning of the Ann and Alison facilities is **low** and most effects will be short term, localised and with low potential for long term wider Field impacts.

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APPENDIX A – ENVIRONMENTAL ASSESSMENT AND MANAGEMENT WORKSHOP