PremierOil

BALMORAL DECOMMISSIONING ENVIRONMENTAL APPRAISAL

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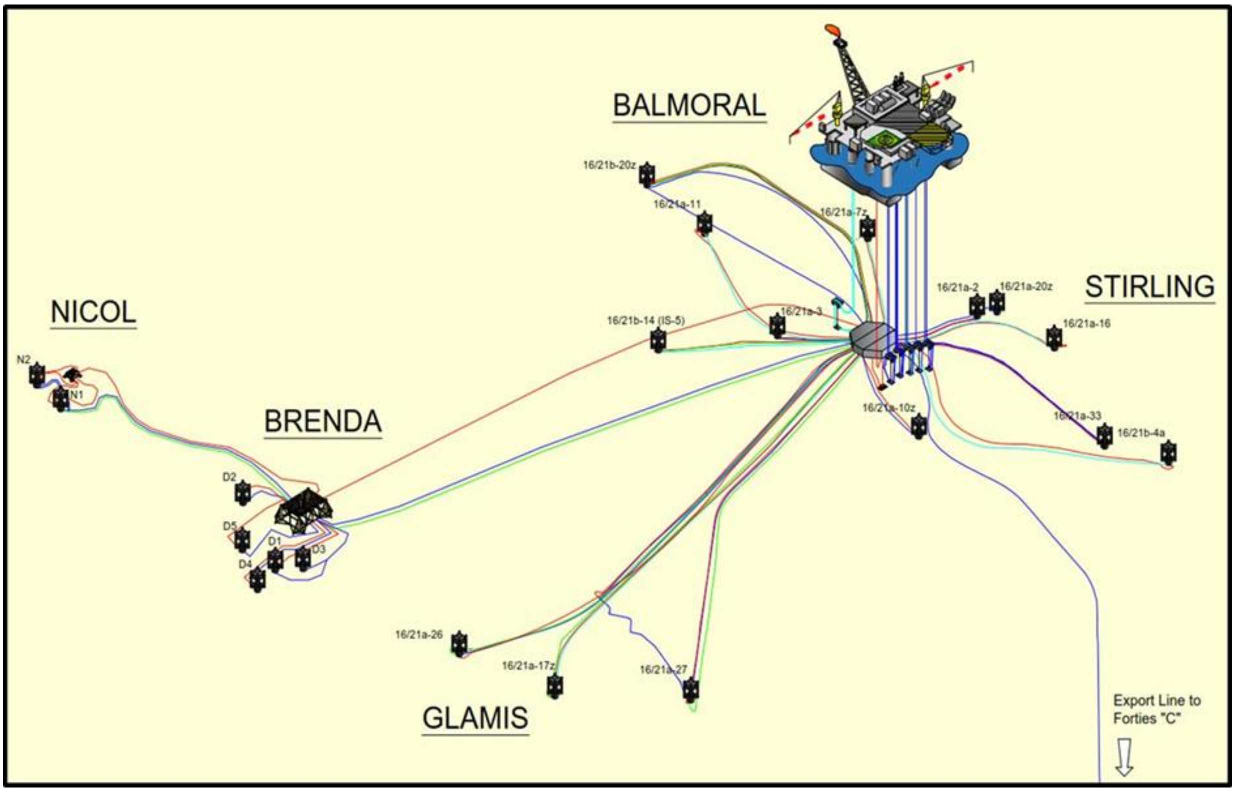

Greater Balmoral Area Decommissioning

Environmental Appraisal

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Distribution List

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Contents

Terms and Abbreviations

Abbreviation	Text in Full
µg/g	Micrograms per gram
µg/kg	Micrograms per kilogram
AIS	Automatic Identification System
AHV	Anchor Handling Vessel
ALARP	As Low As Reasonably Practicable
AWMP	Active Waste Management Plan
BEIS	Business, Energy and Industrial Strategy
BGS	British Geological Survey
BLLP	Balmoral Late Life Project
BP	British Petroleum PLC.
CA	Comparative Assessment
CFE	Controlled Flow Excavation
CIEEM	Chartered Institute of Ecology and Environmental Management
CNRI	Canadian Natural Resources International
CNS	Central North Sea
CoP	Cessation of Production
CSV	Construction Support Vessel
DECC	Department of Energy and Climate Change
DFPV	Drained, Flushed, Purged and Vented
DoB	Depth of Burial
DP	Decommissioning Programme
DREAM	Dose-related Risk and Effect Assessment Model
DSV	Diving Support Vessel
DTI	Department for Transport and Industry
EA	Environmental Appraisal
ECMWF	European Centre for Medium range Weather Forecasting Model
EIF	Environmental Impact Factor
EMS	Environmental Management System
EMT	Environmental Management Team
ENE	East-Northeast
EPS	European Protected Species
ESE	East-Southeast

Abbreviation	Text in Full
EU	European Union
EUNIS	European Nature Information System
FFS	Fishing Friendly Structure
FPSO	Floating Production Storage and Offloading
FPV	Floating Production Vessel
FSU	Floating Storage Unit
HLV	Heavy Lift Vessel
HSE	Health & Safety Executive
HSES	Health, Safety, Environment and Security
HYCOM	Hybrid Coordinate Ocean Model
ICES	International Council for the Exploration of the Seas
IEMA	Institute of Environmental Management and Assessment
in	Inch(es)
IRPCS	International Regulations for the Prevention of Collision at Sea
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kg	Kilogrammes
km	Kilometre
KPI	Key Performance Indicator
LAT	Lowest Astronomical Tide
m	Metre
MAIB	Marine Accident Investigation Branch
MARPOL	International Convention for the Prevention of Pollution from Ships
MCDA	Multi Criteria Decision Analysis
MCZ	Marine Conservation Zone
MDAC	Methane Derived Authigenic Carbonate
mg/l	Milligrams per litre
mm	Millimetre
MMO	Marine Management Organisation
MPA	Marine Protected Area
MWA	Mid-Water Arches
N	North
N/A	Not Applicable

Abbreviation	Text in Full
NCMPA	Nature Conservation Marine Protected Area
NE	Northeast
NMP	National Marine Plan
NMPI	National Marine Plan Interactive
NORM	Naturally Occurring Radioactive Material
NW	Northwest
OGA	Oil & Gas Authority
OGUK	Oil & Gas UK
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
OSPAR	Oslo Paris Convention – Convention for the Protection of the Marine Environment of the North East Atlantic
P&A	Plugging and abandonment (Wells)
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PEC	Predicted Environmental Concentration
PL	Pipeline
PLET	Pipeline End Termination
PMF	Priority Marine Features
PNEC	Predicted No Effect Concentration
ppm	Parts per million
Premier	Premier Oil E&P UK Limited
Repsol Sinopec	Repsol Sinopec North Sea Limited
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SACFOR	Superabundant Abundant Common Frequent Occasional Rare Less than rare indicated by extrapolation
SAHFOS	Sir Alistair Hardy Foundation for Ocean Science
SE	Southeast
SEPA	Scottish Environmental Protection Agency
SFF	Scottish Fishermens Federation
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOPEP	Shipboard Oil Pollution Emergency Plan

Abbreviation	Text in Full
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Areas
SSS	Side Scan Sonar
Te	Tonne
TFSW	Trans-Frontier Shipment of Waste
THC	Total Hydrocarbon Concentration
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
Umb	Umbilical
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USO	Unidentified Seabed Objects
UTA	Umbilical Termination Assemblies
VMS	Vessel Monitoring System
WHPS	Wellhead Protection Structure

EXECUTIVE SUMMARY

1 Introduction and Background

This section provides a non-technical summary of the findings from the Environmental Appraisal (EA) conducted by Premier Oil UK Limited (Premier) for the proposed decommissioning of the Greater Balmoral Area (commonly known as B-Block). The Greater Balmoral Area comprises the Balmoral, Glamis, Stirling, Brenda and Nicol Fields, all of which produce via the Balmoral FPV (Floating Production Vessel). These five associated fields sit within Oil and Gas Authority (OGA) Blocks 15/25 and 16/21 in the Central North Sea (CNS), approximately 187 km east-northeast of Peterhead, Scotland and 30 km west-southwest of the UK/Norway median line (Figure 1-1).

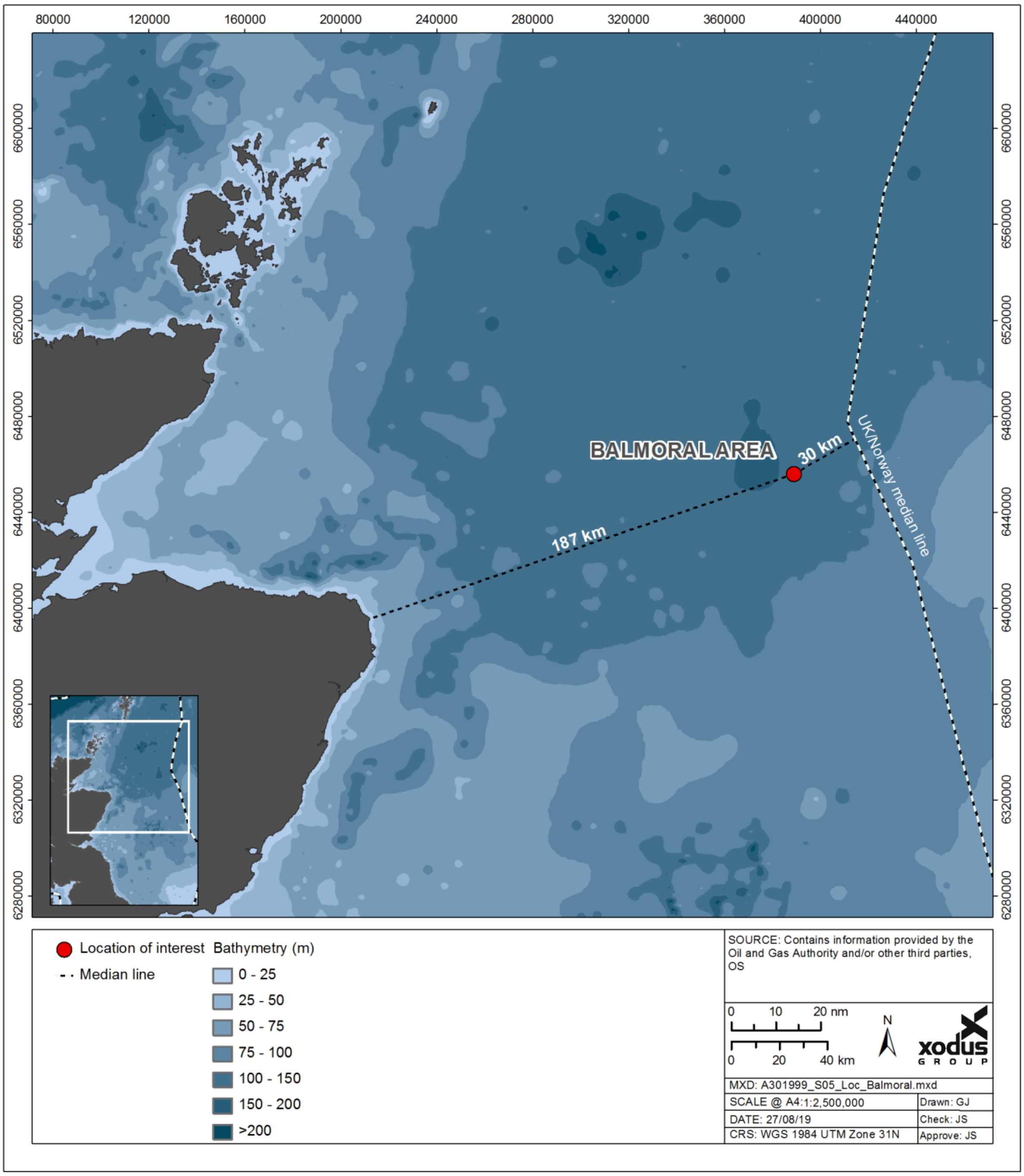

Figure 1-1 Location of the Greater Balmoral Area

2 Decommissioning Overview

As part of the planning for decommissioning and to obtain regulatory approval for the proposed activities, a Decommissioning Programme (DP) will be prepared for each of the fields to be decommissioned (i.e. Balmoral (includes the FPV and subsea installations and pipelines), Glamis, Stirling, Brenda, and Nicol), which is supported by a single EA report covering the environmental impacts for all five fields. The EA report will cover the following:

- The Balmoral FPV;
- The Balmoral Template; and
- Flowlines and subsea installations associated with the Balmoral, Brenda, Nicol, Glamis, and Stirling Fields.

The DPs for the decommissioning of the infrastructure provided above (Premier, 2020a-e) and this supporting EA do not cover well plugging and abandonment (P&A), or the flushing and cleaning operations that will be undertaken prior to the commencement of the decommissioning activities. The Xmas trees with Fishing Friendly Structures (FFS) in the Brenda and Nicol fields and the Wellhead Protection Structures (WHPS) in the Glamis Fields are included as part of the subsea infrastructure for consideration in the respective DPs for these fields; however, these installations will be removed as part of the P&A operations within the well abandonment campaign and will be covered by that permitting regime. Assessment of impacts from onshore energy use and atmospheric emissions for P&A activities will be included in license applications for appropriate onshore disposal facilities. As the environmental assessment of the removal of these subsea installations will be captured within the relevant permits, they are considered outwith the boundaries of this EA. This activity will be carried out as part of the preparatory work preceding decommissioning, under existing field operational permits. Further detail about the infrastructure to be decommissioned is provided in Section 2.

3 Proposed Schedule

The precise timing of the decommissioning activities is not yet confirmed and will be subject to market availability of cost-effective removal services and contractual agreements. The high-level Gantt chart featured in Figure 1-2 provides the overall schedule for the Greater Balmoral programme of decommissioning activities for the following Fields operated by Premier Oil: Brenda, Nicol, Glamis, Stirling, and Balmoral.

Prior to the removal of the FPV, Premier Oil will flush the subsea pipelines associated with the Burghley and Beauly fields operated by Repsol Sinopec North Sea Ltd (hereon 'Repsol Sinopec').

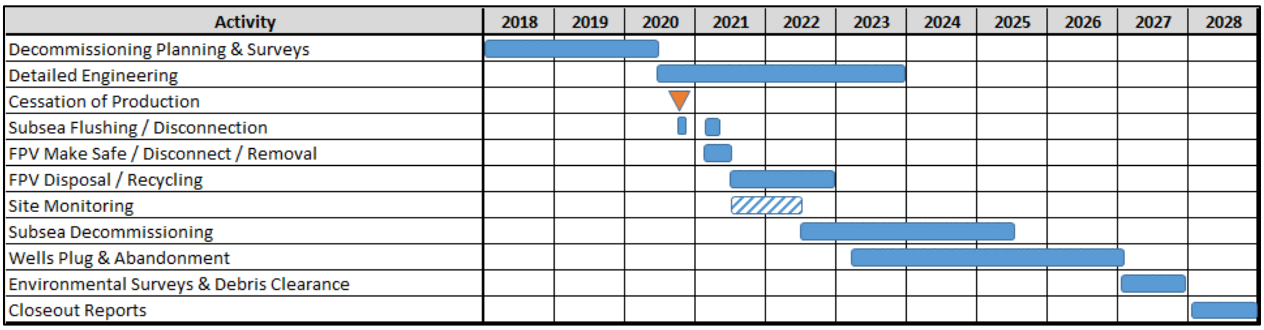

Figure 1-2 Gantt Chart of the Greater Balmoral Area Decommissioning Project Plan

4 Options for Decommissioning

All of the Balmoral subsea infrastructure was assessed against the BEIS (2018) *Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines*. The recommended Comparative Assessment (CA) process was applied. Equipment was initially organised into groups of items with similar characteristics, this allows for greater efficiency in dealing with the large inventory. The guidance identifies certain equipment which must be fully removed and some categories of pipelines which may be left decommissioned *in situ,* subject to completing the recommended CA process.

Once the equipment groups designated for full removal were identified the remaining groups were assessed further. All possible decommissioning options for the remaining groups were coarsely screened. This involves consideration of each option against the primary criteria as specified within the Guidance: Safety; Environment; Technical; Societal and Economic. The options were scored against each criterion as either green, amber, or red, pertaining to attractive, acceptable, or unattractive, respectively. This process eliminated the least favourable options from each equipment group in preparation for detailed evaluation of the remaining options. Those remaining options were then investigated in detail to develop quantitative and qualitative data for each option pertaining to the primary criteria and sub-criteria (e.g. safety data, environmental impact data, technical considerations, societal impacts and costs). Once this data was prepared in the form of published studies, a detailed evaluation was conducted to determine the final recommended decommissioning option for each item of equipment. This was facilitated by comparing the data for each sub-criterion across the options using a pair-wise analysis to produce a relative score for each sub-criterion that would be summed to produce an overall relative score for each option and thereby identify the emerging recommendation for the group.

The decision-making process underpinning the proposed DP is described in Section 2 and the selected decommissioning options, including those carried forward to CA, are summarised in Table 1-1 below. Table 1-2 depicts the decommissioning options reviewed in the CA Process, with the selected options in bold. Section 2 additionally contains further details about the process and outcomes of the CA.

Table 1-1 Decommissioning Activities for Greater Balmoral Area Infrastructure

Decommissioning Option	Subsea and surface installations / infrastructure
Full Removal	• Balmoral FPV • Flexible Jumpers, including those at Balmoral Template • Rigid Spoolpieces, including those at Balmoral Template • Control & Chemical Jumpers, including those at Balmoral Template • Small subsea installations • Large installations - Balmoral Template • Mattresses [Note 1] • Flexible risers
Carried forward to CA	• Surface Laid Flowlines & Umbilicals • Trenched & Buried Rigid Flowlines • Trenched & Buried Flexible Flowlines & Umbilicals • Mattresses – Other (incl. grout bags) • Mooring System incl. anchor piles

Notes:

1. The base position is the full removal of all stabilisation materials. However, there may be older mattresses located within the B-Block Fields which are potentially difficult to remove due to their initial design and/or how they have aged in the marine environment. For this reason, older mattresses have been considered in the CA process to determine the best possible means of decommissioning, should difficulties with their removal be encountered.

Table 1-2 CA Decommissioning Options Considered

CA Group No.	Subsea Infrastructure Description	Decommissioning Options Considered (selected option in bold)
1	Surface Laid Flowlines & Umbilicals	• Disconnect ends and trench entire length to adequate depth to remove snag hazards • **Full removal by reverse reel**
3	Trenched & Buried Rigid Flowlines	• Disconnect and remove ends with local rock placement at ends • **Disconnect and remove ends and exposures with local rock placement at ends and exposures** • Re-trench entire lines • Disconnect ends and fully rock cover lines • Full removal by de-burial and cut and lift
4	Trenched & Buried Flexible Flowlines & Umbilicals	• Disconnect and remove ends with local rock placement at ends • Disconnect and remove ends and exposures with local rock placement at ends and exposures • Re-trench entire lines • Disconnect ends and fully rock cover lines • **Full removal by de-burial and reverse reel** • Full removal by de-burial and cut and lift
14	Mattresses – Other (incl. grout bags)	• Leave as is and rock cover • Leave as is and bury • **Fully remove using remote mechanical means** [Note 1]
15	Mooring System incl. Anchor Piles	• Leave *in-situ* (minimal intervention) – leave as is • **Leave *in-situ* (minor intervention) – remove mooring chain at seabed and leave piles and buried chain *in situ*** • Leave *in-situ* (major intervention) – bury or rock dump chain • Leave *in-situ* (re-use) – leave piles/chains *in situ* for use in any potential new developments • Full removal

Notes:

1. The base position is to remove all mattresses if safe to do so, including the potentially difficult to remove mattresses (i.e. the older mattresses which are known to potentially have reduced integrity). Should difficulties be encountered which would make it disproportionately problematic to remove any particular mattress, Premier will open a dialogue with Offshore Petroleum Regulator for Environment & Decommissioning (OPRED) to agree an alternative decommissioning approach.

5 Environmental and Societal Baseline

The key environmental and societal sensitivities in the Greater Balmoral Area have been summarised in Table 1-3.

Table 1-3 Key Environmental and Societal Receptors and Sensitivities for the Greater Balmoral Area

Environmental Receptor	Description
Physical Environment	
Weather and sea conditions	Water depth within the Greater Balmoral Area is approximately 151 m. The mean residual current surrounding the Greater Balmoral Area is approximately 0.1 m/s (Wolf *et al.*, 2016). Wave energy at the seabed ranges between 'low' (< 0.21 N/m^2) and 'high' (> 1.2 N/m^2) in the CNS region (McBreen *et al.*, 2011). The wave height within the area of proposed operations ranges from 2.1-2.4 m and the annual mean wave power is 24.1–30 kW/m, which is typical of the wider area (NMPI, 2019).
Key Conservation interests	
Oslo Paris Convention (OSPAR) (2008) List of Threatened and/or Declining Habitats and Species	
Ocean quahog (*Arctica islandica*)	Few juveniles were observed during habitat surveys, though in numbers too low and at too early a life history stage to be considered an 'aggregation'. Ocean quahog larvae are known to settle within the proximal Fladen Ground (Witbaard *et al.*, 2003) and aggregations are protected at designated sites within the CNS; including: the Norwegian Boundary Sediment Plain Marine Protected Area (MPA) (32 km) and East of Gannet and Montrose Fields MPA (77 km). However, the Greater Balmoral Area is not expected to protect any aggregations of this protected species.
Seapens and burrowing megafauna communities	During the Fugro (2017a) habitat assessment survey observations at the Greater Balmoral Area revealed the presence of seapens and burrowing megafauna communities.
Conservation sites	
Special Area of Conservation (SAC)	The nearest SAC to the Balmoral decommissioning project is the Scanner Pockmark SAC, which is situated 9 km from the project area. This site is designated for the presence of submarine structures formed by leaking gases, which are found within seabed depressions referred to as "pockmarks" and support reef-like communities distinct from the surrounding soft sediments (Premier Oil, 2018). The SAC is a singular large depression which contains Methane Derived Authigenic Carbonate (MDAC) blocks made by leaking gases, which support a fauna typical of rocky reefs, including anemones (*Urticina feline* and *Metridium senile)* and squat lobsters (JNCC, 2018a). Pockmarks have been observed in the Greater Balmoral Area; however, these have been suggested to be formed by leaking fluids as opposed to gases; therefore, there are no Primary Marine Features (PMFs) present in the Balmoral survey area (UTEC, 2008; SNH, 2014).

Environmental Receptor	Description
Nature Conservation Marine Protected Area (NCMPA)	The nearest NCMPA to the Greater Balmoral Area is the Norwegian Boundary Sediment Plain MPA located 29 km from the project area. The site is designated for the conservation of ocean quahog aggregation, including sands and gravels as their supporting habitat (JNCC, 2014). Central Fladen MPA is located 88 km to the north west of the project area. The site is designated for features such as burrowed mud (seapens and burrowing megafauna and tall seapen components), and sub-glacial tunnel valley representative of the Fladen Deeps Key Geodiversity area (JNCC, 2018b). East Gannet and Montrose Fields located 77 km to the south of the project area. The site is designated for the conservation of ocean quahog aggregation.
Special Protection Area (SPA)	There are no SPAs in the vicinity of the project area. The closest SPA is the Buchan Ness to Collieston Coast SPA located approximately 188 km to the south west of the project area. The site is of importance as a nesting area for a number of seabird species (gulls and auks). These birds feed outside the SPA in the nearby waters as well as more distantly.
Annex I Habitats	The Greater Balmoral Area is an area with characteristics similar to those supporting Annex I submarine structures which generate MDAC. However, no Annex I Habitats were identified in any of the site-specific surveys.
Conservation Species	
Coastal and Offshore Annex II species most likely to be present in the project area	
Pinnipeds – Harbour and Grey Seals	Pinnipeds are not expected in significant numbers across the project area, with densities estimated at approximately 0-1 individuals per 25 km^2 for both harbour and grey seals (NMPI, 2019). This is due to the site being approximately 187 km offshore and even farther from important seal haul outs.
European Protected Species most likely to be present in the project area	
Harbour porpoise	The harbour porpoise (*Phocoena phocoena*) is a small, highly mobile species of cetacean that is the most commonly occurring cetacean in UK waters. As such, harbour porpoise can also be found in the waters of the proposed decommissioning area. Particularly large numbers occur in near the project area during the summer months, with a peak in numbers in July and August (Reid *et al.,* 2003; Hammond *et al.,* 2017). The density of harbour porpoise is roughly estimated at 0.6-0.7 animals/km^2 across the project area (Hammond *et al.,* 2017).
White-sided dolphin	The Atlantic White-sided dolphin (*Lagenorhynchus acutus*) species lives mainly in cool waters (7-12°C), particularly seaward or along the edges of the continental shelf in depths of 100-500 m (Reid *et al.,* 2003). However, the species can also be numerous in much deeper, oceanic waters. The species comes onto continental shelfs such as those of the north western North Sea (Reid *et al.,* 2003). *L. acutus* are found in deep waters around the north of Scotland throughout the year but enter the North Sea mainly in the summer (Reid *et al.*, 2003). The relative density of white-sided dolphin is estimated at 0.021 animals/km^2 in the project area (Hammond *et al.,* 2017).

Environmental Receptor	Description
Minke whale	Minke whales (*Balaenoptera acutorostrata*) are usually sighted in pairs or in solitude, though groups of up to 15 individuals can be sighted feeding within their seasonal feeding grounds. The relative density of minke whales is estimated at 0.037 animals/km^2 in the project area (Hammond *et al.,* 2017).
White-beaked dolphin	White-beaked dolphins (*Lagenorhynchus albirostris*) are usually found in water depths of between 50 and 100 m in groups of around 10 individuals, though groups of up to 500 animals have been seen. They are present in the UK waters throughout the year, however more sightings have been made between June and October. The relative density of white-beaked dolphin is estimated at 0.032 animals/km^2 in the project area (Hammond *et al.,* 2017).
Biological environment	
Seabed type	Side Scan Sonar (SSS) data from a survey by UTEC (2008) showed a seabed of uniform with moderate reflectivity. Published British Geological Survey (BGS) data described the seabed sediment in this area as sandy mud. The presence of coherent sediments at the seabed is confirmed by the presence and preservation of numerous trawl scars. Given the consistency of the sonar reflectivity characteristic, it is expected that this sediment type will occur across the Balmoral survey area. These results are comparable to the Gardline rig site and habitat survey (Gardline, 2008) at the Balmoral A33 well locations 4 km South East of Balmoral Template location). The seabed is a veneer of very fine silty sand underlain throughout the site by acoustically well-layered sediments of the Witch Ground Formation (reported by BGS to consist predominantly of very soft to soft clays and silts). A pre-decommissioning environmental baseline survey was undertaken for the Greater Balmoral Area by Fugro (2017b). During this survey, 100 grab samples were taken. The sediment type was classified as poorly sorted coarse to medium silt with moderate carbonate and low organic content. Hydrocarbon level showed similar distribution levels across the project site area and was typical of low level weathered petroleum residues commonly found in CNS sediments. The majority of the Balmoral survey area was identified as the EUNIS biotype, 'Circalittoral fine mud' (A5.35) (Fugro, 2017b). The Scottish PMF 'burrowed mud' and its component habitat, 'Seapens and burrowing megafauna in circalittoral fine mud', were prevalent throughout the area (Fugro, 2017b).
Benthic Fauna	The Fugro (2017b) pre-decommissioning survey found the most dominate species were the polychaetes (*Paramphinome jeffreysii* and *Levinsenia gracilis),* with communities being typical for that of the CNS. A total of 67 stations were sampled for macrofaunal content using a 0.1m^2 dual van Veen grab. Of the 181 taxa reported in those samples, 91 (50.3%) were annelids, 36 (19.9%) were arthropods, 37 (20.4) were molluscs, six (3.3%) were echinoderms and 11 (6.1%) were other phyla.

Environmental Receptor	Description
Plankton	
Plankton	In both the northern and central regions of the North Sea, the phytoplankton community is dominated by dinoflagellates of the genus *Ceratium (fusus, furca, lineatum)* and diatoms such as *Thalassiosira spp*. and *Chaetoceros spp.* In recent years the dinoflagellate (*Alexandrium tamarense)* and the diatoms *Pseudo-nitzschia* (known to cause amnesic shellfish poisoning) have been observed in the area (DECC, 2016). Zooplankton communities in this area are dominated in terms of biomass and productivity by copepods, particularly *Calanus* species such as *C. finmarchicus* and *C. helgolandicus*. Other important taxa include *Acartia*, *Temora*, and *Oithona spp*. Larger zooplankton species such as *euphausiids* and decapod larvae are also important to the zooplankton community in this region (DECC, 2016). *Calanus finmarchicus* has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Analysis of Continuous Plankton Reader (CPR) surveys in the 10-year period between 1997 and 2007 shows that the biomass of *C. finmarchicus* in the CNS attains higher levels than in the Southern North Sea (SNS) but lower than in the NNS. The trend indicates a small increase in abundance between April and May within the CNS which corresponds to an increase in phytoplankton in April. Overall abundance of *C. finmarchicus* has declined dramatically over the last 60 years, which has been attributed to changes in seawater temperature and salinity (Beare *et al.,* 2002; FRS, 2004).
Fish – spawning and nursery grounds	
Spawning grounds	The Greater Balmoral Area is located within the spawning grounds of cod (*Gadus morhua)*, mackerel (*Scomber scombrus)*, *Nephrops* (*Nephrops norvegicus)* and Norway pout (*Trisopterus esmarkii)* (Coull *et al.*, 1998; Ellis *et al.*, 2012).
Nursery grounds	The following species have nursery grounds in the vicinity of the project: anglerfish (*Lophius piscatorius)*, blue whiting (*Micromesistius poutassou)*, cod, European hake (*Merluccius merluccius)*, haddock (*Melanogrammus aeglefinus)*, herring (*Clupea harengus)*, ling (*Molva molva)*, mackerel (*Scomber scombrus)*, *Nephrops*, Norway pout, sandeel (*Ammodytidae spp.)*, spotted ray (*Raja montagui)*, spurdog (*Squalus acanthias)*, and whiting (Coull *et al.*, 1998; Ellis *et al.*, 2012). However, fisheries sensitivity maps indicate that the probability of significant aggregations of juveniles of these species in the offshore project area is low (Ellis *et al.*, 2012).
Probability of 0 age group fish aggregation	Aires *et al.* (2014) provides modelled spatial representations of the predicted distribution of 0 age group fish. The modelling indicates the presence of juvenile fish (less than one year old) for multiple species: anglerfish, blue whiting, European hake, haddock, herring, mackerel, horse mackerel, Norway pout, plaice, sprat, and whiting. Across the Greater Balmoral Area, the probability of juvenile fish aggregations occurring is very low; <0.2 for all species.

Environmental Receptor	Description
Seabirds	

According to the density maps provided in Kober *et al.* (2010), the following species could be found within the Greater Balmoral Area: northern fulmar (*Fulmarus glacialis)*, Manx shearwater (*Puffinus puffinus)*, European storm-petrel (*Hydrobates pelagicus),* northern gannet (*Morus bassanus)*, Arctic skua (*Stercorarius parasiticus)*, great skua (*Stercorarius skua)*, black-legged kittiwake (*Rissa tridactyla)*, great black-backed gull (*Larus marinus)*, common gull (*Larus canus)*, lesser black-backed gull (*Larus fuscus)*, herring gull (*Larus argentatus)*, Arctic tern (*Sterna paradisaea)*, common guillemot (*Uria aalge)*, razorbill (*Alca torda)*, little auk (*Alle alle)*, Atlantic puffin (*Fratercula arctica)* and pomarine skua *(Stercorarius pomarinus)*. Seabird Oil Sensitivity Index (SOSI) identifies areas at sea where seabirds are likely to be most sensitive to surface pollution (Webb *et al.*, 2016). Seabird vulnerability in Blocks 15/25 and 16/21 is low throughout the year with no data for November and December. Block 15/25 experiences a Medium SOSI value only in the month of June (Webb *et al.*, 2016). The risk of an oil spill from the proposed operations at Balmoral is considered remote and therefore the overall risk to birds is considered negligible.

Seabird Oil Sensitivity Index

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
15/19	5*	5	5*	5*	5	5	5	5	5	5*	N	N
15/20	5*	5	5*	5*	5	4	5	5	5	5*	N	N
15/24	5*	5	5*	5*	5	4	5	5	4	4*	N	N
15/25	**5***	**5**	**5***	**5***	**5**	**4**	**5**	**5**	**5**	**5***	**N**	**N**
15/29	2*	5	5*	5*	5	5	5	5	4	4*	N	N
15/30	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/16	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/17	5*	5	5	4*	4	5	5	5	5	5*	N	N
16/21	**5***	**5**	**5***	**5***	**5**	**5**	**5**	**5**	**5**	**5***	**N**	**N**
16/22	5*	5	5	5*	5	5	5	5	5	5*	N	N
16/26	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/27	5*	5	5	4*	4	5	5	5	5	5*	N	N

Key						
Key	1 = Extremely high	2 = Very high	3 = High	4 = Medium	5 = Low	N = No data
	* in light of coverage gaps, an indirect assessment of SOSI has been made					

Societal Receptor	Description
Commercial fishing	

The Greater Balmoral Area is in International Council for the Exploration of the Seas (ICES) Rectangles 45F1 and 45F0 (Scottish Government, 2019).

Vessel Monitoring System (VMS) data from 2009-2013 for demersal, shellfish and pelagic species (Kafas *et al.,* 2013) indicates that fishing intensity within ICES rectangles 45F1 and 45F0 is low to medium for pelagic species (namely herring) and low for demersal species, but high for shellfish species (namely *Nephrops*) when compared to the wider area (Kafas *et al.,* 2013).

In 2018 fishing effort in ICES rectangle 45F1 were highest for September and October, together accounting for 56% of the total number of days fished, with February, April, May, July, August, and November contributing for the remaining 44% of fishing effort with the rest of the months being disclosive (Scottish Government, 2019).

In 2018 fishing effort in ICES rectangle 45F0 were highest for May and October, accounting for 51% of the total number of days fished, with all other months contributing for the remaining 49% of fishing effort (Scottish Government, 2019).

Trawls were the most utilised gear in rectangle 45F1 and 45F0. In total, trawls contributed to more than 99% of total fishing effort in the ICES rectangle 45F1 and 45F0 with <1% made up from seine nets (Scottish Government, 2019).

Fishery Landings in ICES Rectangle 45F0

Species type	2018		2017		2016		2015		2014	
	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)
Demersal	551	1,015,488	1,126	2,159,207	523	946,707	230	304,201	606	850,199
Pelagic	125	77,839	3,146	1,477,408	3,450	1,876,544	2,208	785,146	2,894	839,768
Shellfish	146	539,525	630	2,561,223	181	819,300	88	350,360	704	2,747,700
Total	**822**	**1,632,852**	**4,902**	**6,197,838**	**4,154**	**3,642,551**	**2,526**	**1,439,707**	**4,204**	**4,437,667**

Fishery Landings in ICES Rectangle 45F1

Species type	2018		2017		2016		2015		2014	
	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)
Demersal	365	643,789	536	1,007,325	627	1,034,037	482	620,334	388	543,272
Pelagic	1	674	0	5	421	189,494	1,892	676,413	352	119,962
Shellfish	293	988,946	323	1,236,543	218	1,045,948	241	1,012,362	421	1,832,176
Total	**659**	**1,633,409**	**859**	**2,243,873**	**1,266**	**2,269,479**	**2,615**	**2,309,109**	**1,161**	**2,495,410**

Other sea users	
Shipping activity	The Greater Balmoral Area is in an area that experiences very low shipping intensity (OGA, 2016).

<table>
<tr><th>Societal Receptor</th><th>Description</th></tr>
<tr><td>Oil and Gas</td><td>The Greater Balmoral Area is located in the CNS in an area of extensive oil development with several fields located in the surrounding waters. Oil and Gas surface infrastructure within 40 km of the project area is described below[Note 1]:
<table>
<tr><th>Installation</th><th>Installation Type</th><th>Operator</th><th>Distance & direction</th></tr>
<tr><td>Alba North</td><td>Platform</td><td>Ithaca Energy Limited</td><td>19 km SW</td></tr>
<tr><td>FPSO Global Producer III</td><td>FPSO</td><td>Total</td><td>20 km NW</td></tr>
<tr><td>Britannia</td><td>Platform</td><td>Chysaor</td><td>20 km SE</td></tr>
<tr><td>Alba FSU</td><td>FSU</td><td>Ithaca Energy Limited</td><td>21 km SW</td></tr>
<tr><td>Andrew</td><td>Platform</td><td>BP</td><td>27 km SE</td></tr>
<tr><td>Hummingbird FPSO</td><td>FPSO</td><td>Teekay</td><td>29 km SE</td></tr>
<tr><td>Tiffany</td><td>Platform</td><td>CNRI</td><td>29 km NE</td></tr>
</table></td></tr>
<tr><td>Telecommuni-cation</td><td>The closest submarine cable to the Greater Balmoral Area is the TAMPNET 3 cable, which is located 40 km to the east (KIS-ORCA, 2019).</td></tr>
<tr><td>Military activities</td><td>There are no military restrictions on Blocks 16/21 or 15/25 (OGA, 2018) and there are no known military activities within the area (NMPI, 2019).</td></tr>
<tr><td>Renewables</td><td>There is no renewable energy activity in the vicinity of the Greater Balmoral Area (NMPI, 2019).</td></tr>
<tr><td>Wrecks</td><td>There are two unknown wrecks in the vicinity of the project area, approximately 5km south east and 4 km north west of the project area, and there is one named wreck (Elhanan T) located approximately 8 km from the project area. This wreck is classified as a non-dangerous wreck (NMPI, 2019).
There are no protected wrecks in the vicinity of the project area (NMPI, 2019).</td></tr>
</table>

Notes:

1. FPSO = Floating Production Storage and Offloading; FSU = Floating Storage Platform; BP= British Petroleum; CNRI = Canadian National Resources International

6 Impact Assessment Process

This EA Report has been prepared in line with the OPRED Decommissioning Guidelines and with Decom North Sea's EA Guidelines for Offshore Oil and Gas Decommissioning. The OPRED Decommissioning Guidance states that an EA in support of a DP should be focused on the key issues related to the specific activities proposed; and that the impact assessment write-up should be proportionate to the scale of the project and to the environmental sensitivities of the project area.

The environmental impact assessment has been informed by several different processes, including the identification of potential environmental issues through project engineer and marine environmental specialist review in a screening workshop, and consultation with key stakeholders (see Section 4.1).

The impact assessment screening workshop discussed the proposed decommissioning activities and any potential impacts these may pose. This discussion identified eleven potential impact areas based on the proposed removal and decommissioning *in situ* activities. Three of the eleven potential impacts were screened in for further assessment based on the potential severity and/or likelihood of their respective environmental impact. The eleven potential impacts are detailed in Table 1-4 below, together with justification statements for the screening decisions.

Table 1-4 Environmental Impact Screening Summary for the Greater Balmoral Area Decommissioning Project

Potential impact	Further assessment?	Rationale
Emissions to air	No	Emissions during decommissioning activities, (largely comprising fuel combustion gases) will occur in the context of the CoP. As such, emissions generated by infrastructure, equipment and vessels associated with operation of the Greater Balmoral Area assets will be replaced by those from vessels and equipment required for decommissioning activities, as well as the recycling of decommissioned materials. Assessment of impacts from onshore energy use and atmospheric emissions for P&A activities will be included in license applications for appropriate onshore disposal facilities. Reviewing historical EU Emissions Trading Scheme data and comparison with the likely emissions from the proposed workscope suggests that emissions relating to decommissioning will be minor relative to those generated during production. Review of available decommissioning EAs shows conclusively that atmospheric emissions in highly dispersive offshore environments do not present significant impacts and are extremely small in the context of UKCS and global emissions. Most submissions also note that emissions from short-term decommissioning activities are trivial compared to those previously arising from the asset over its operational life. The majority of atmospheric emissions for the Greater Balmoral Area decommissioning relate to vessel time or are associated with the recycling of material returned to shore. The estimated total CO_2 emissions to be generated by the selected decommissioning option activities is 83,380 Te, of which 50,757 Te is related to vessel emissions. This equates to 0.65% of the total annual UKCS vessel emissions (excluding fishing vessels) when considering 2017 data (7,800,000 Te; BEIS, 2019). The remaining 32,623 Te CO_2 will be generated through the life cycle of the project materials; those recovered and not reused or left *in situ*. The CO_2 emissions total has been calculated assuming an anticipated maximum of 614 days of operational vessel activity for the duration of the project. This is split across multiple vessel types (including, but not limited to: a DSV/CSV, trenching vessel, rockdumper, reel vessel, AHV, ROVSV, pipehaul vessel, supply vessel, trawler and survey vessel). This is a worst-case estimate of vessel days based on ample overtrawling, which is not expected to be required. Atmospheric emissions in highly dispersive offshore environments do not present significant impacts and are extremely small in the context of UKCS and global emissions. Furthermore, emissions from short-term decommissioning activities are small compared to those previously arising from the asset over its operational life.

Potential impact	Further assessment?	Rationale
		Considering the above, atmospheric emissions do not warrant further assessment.
Seabed disturbance	Yes	There is potential for decommissioning and legacy activities to generate disturbance to the seabed; these include activities associated with the removal of Greater Balmoral Area subsea installations and the vessel anchoring system and the removal of pipelines and umbilicals, as well as any associated remediation post-decommissioning, including overtrawling. Seabed impacts may range in duration from short-term impacts, such as temporary sediment suspension or smothering, to permanent impacts, such as the introduction of new substrate or any consequential habitat or community level changes which may transpire. Additionally, seabed disturbance from the removal of infrastructure has the potential to modify the habitat in a way which might impact upon other sea users which utilise the seabed. The reverse reeling of trenched and buried flexible flowlines has the potential to generate clay berms in the muddy benthic habitat which defines the Greater Balmoral Area. Clay berms may pose a potential snagging hazard to commercial fishing gears which make contact with the seabed. Post-decommissioning, the clear seabed will be validated by an independent verification survey over the installation sites and pipeline corridors. The methods used will be discussed and finalised with OPRED. Non-intrusive verification techniques will be considered in the first instance, but where these are deemed inconclusive by the SFF, seabed clearance is likely to require conventional overtrawl survey methods. Field debris items are anticipated to be located on the surface of the seafloor, or partially buried by surface sediments, and will be recovered with minimal intervention (e.g. using an ROV). The area of potential impact will be superficial, temporary, and largely limited to the dimensions of the debris item being retrieved, which will be determined during the Seabed Clearance Verification survey. As such, seabed disturbance associated with field debris items is considered negligible and has thus been screened out of further assessment. Impacts to the seabed from project activities have been assessed further in Section 6.2, whilst impacts to commercial fisheries generated by seabed disturbance are assessed in Section 6.3 below.
Physical presence of vessels in	No	The presence of a small number of vessels for decommissioning activities will be short-term in the context of the life of the Greater Balmoral Area and assets. Activity will occur using similar vessels to those currently deployed for oil and gas installation, operation,

Potential impact	Further assessment?	Rationale
relation to other sea users		and decommissioning activities. The vessels required will also generally be within the existing 500 m safety zones. The decommissioning of the Balmoral FPV will reduce the number of vessels occupying the area long-term and will increase access to commercial fishing grounds by removing the existing exclusion zone. The decommissioning of the Greater Balmoral Area is estimated to require various vessels, as listed in Emission to Air, depending on the selected method of removal; however, these would not all be on location at the same time. In general, vessel use will be split between the two phases of decommissioning: moving the FPV off-station (Phase 1); and subsea infrastructure decommissioning (Phase 2). For Phase 1, vessel use will comprise the intermittent employment of a DSV / ROVSV, CSV, four anchor handling vessels (13 days combined), the on-station FPV (16.8 days), Tug (3 days), and supply vessels for the limited period the FPV remains on-station (assumed two visits per week). During Phase 2, vessel use will comprise a combination of DSV / ROVSV (184.6 days total for both phases), CSV (104.5 days total for both phases), HLV (9 days), Reel Vessel (71.2 days), Barge (43.4 days), survey vessel (128.3 days) and trawler (40 days). In between the two phases, a guard vessel will be on site, generating a total of 613.8 days of vessel activity associated with the decommissioning activities. Other sea users will be notified in advance of planned activities through the appropriate mechanisms, meaning those stakeholders will have time to make any necessary alternative arrangements during the finite period of operations. Although the decommissioning of the Greater Balmoral Area is estimated to require various vessels depending on the selected method of removal, these would not all be on location at the same time. In consideration of the duration and location of vessel presence in conjunction with employment of standard practices, as well as the long-term decrease in vessel presence post-decommissioning, the short-term presence of vessels does not require further assessment.
Physical presence of infrastructure decommissioned *in situ* in relation to other sea users	Yes	All subsea installations and surface-laid pipelines will be fully removed, and the Balmoral FPV will be taken offsite for decommissioning. Trenched and/or buried flexible flowlines will be de-buried (as necessary) and reverse-reeled for removal and the seabed will be subsequently remediated. All jumpers, spoolpieces and risers will be fully removed. The only infrastructure to be decommissioned *in situ* are the trenched and buried rigid flowlines, potentially unrecoverable mattresses identified during mattress removal, and mooring

Potential impact	Further assessment?	Rationale
		systems. Trenched and buried rigid flowlines will have the ends cut and lifted, with remediation. Depth of Burial (DoB) surveys have confirmed the integrity of these flowlines and they are not expected to pose any risk of interaction with other sea users (see Appendix C). However, long-term degradation may compromise the integrity of the buried flowlines and introduce free spans which pose a potential snagging hazard to commercial fisheries which utilise the seabed. Future monitoring work will ensure the integrity of the DoB of these structures, but further consideration of the proposed activities is necessary. Mooring chains will be cut at the mudline from the buried anchor piles, which are located 6 m below the seabed and will be decommissioned *in situ*. BEIS Guidance (2018) on moorings dictates that, "any concrete anchor-base associated with a floating installation which does not, and is not likely to, result in interference with other legitimate uses of the sea...(is) not included in the definition of a disused steel or concrete installation in Decision 98/3 and as such may be left in place". Older mattresses which may be difficult to remove due to reduced integrity have been managed during the operational life of the Greater Balmoral Area to pose minimal snagging risk. These difficult to remove mattresses may be decommissioned *in situ*, in agreement with OPRED. In such circumstances, additional rock placement or intervention will be used to further reduce snagging risk. These activities will be covered by the requisite permitting. Post-decommissioning, the clear seabed will be validated by an independent verification survey over the installation sites and pipeline corridors. The methods used will be discussed and finalised with OPRED. Non-intrusive verification techniques will be considered in the first instance, but where these are deemed inconclusive by the SFF, seabed clearance is likely to require conventional overtrawl survey methods. Further assessment related to potential snagging risks associated with the decommissioning of infrastructure *in situ* is provided in Section 6.3 below.
Water quality	Yes	All the decommissioning activities in the Greater Balmoral Area will take place after the cleaning and flushing of its relevant infrastructure. The Balmoral subsea installations will be Drained, Flushed, Purged and Vented (DFPV) using Premier's DFPV management strategies prior to the commencement of any decommissioning activities. The wells are outwith the scope of this EA and will be P&A, covered by their own permitting regime. Vessel discharges are managed through existing, International Convention for the Prevention of Pollution from Ships (MARPOL) compliant controls, including bilge

Potential impact	Further assessment?	Rationale
		management procedures and good operating practices. Post-flushing and/or water jetting, residual liquids present during the decommissioning of pipelines and subsea installations will be treated before being discharged to sea, such that the discharge will comprise treated water. Any residual remaining material will be in trace levels/volumes following the DFPV regime and will not pose any significant risk to water quality. All residual solids will be shipped to shore for disposal. Cuttings deposits which remain within the Balmoral Template will require removal prior to the cutting and lifting of this substructure. This activity comprises controlled flow excavation (CFE). This tool enables both horizontal and vertical mass flow excavation of materials. Vertical means the jets will be directed towards the seabed and horizontal means the jet will be directed parallel to the seabed. Whilst the majority of cuttings will be discharged to the seabed immediately, some of the cuttings will remain within a plume within the water column, generating a temporary change in water quality. Whilst water quality in the vicinity of the cuttings will be reduced, the effects are anticipated to be minimised by rapid dilution in the dynamic receiving water column. Water quality impacts from the CFE of the cuttings deposits located within the Balmoral Template have been assessed in Section 6.1.
Underwater noise emissions	No	Vessel presence will be limited in scale (i.e. the size and number of vessels) and duration and, therefore, does not constitute a significant or prolonged increase in noise emissions across the project area. To remove the subsea installations, the cutting of flowlines will likely be done with shears, thereby minimising produced underwater noise during this activity. There is potential that external cuttings using diamond wire may be required; however, noise associated with this activity will be temporary and generated very close to the seabed, where absorption rates are highest. Similarly, noise generated by the CFE of the cuttings deposits will be directed towards the seabed and absorbed by the temporary increase in sediment within the water column. Geophysical surveys undertaken for post-decommissioned infrastructure left *in situ* will be assessed through the process of permit application. Multibeam echosounder survey equipment is likely to be used for imaging and identification of pipeline exposures. The Joint Nature Conservation Committee (JNCC) Guidelines will be employed for mitigation of identified noise impacts to marine mammals for future survey work involving seismic survey equipment (JNCC, 2017). All other noise generating activities associated with the decommissioning of the Greater Balmoral Area are considered

Potential impact	Further assessment?	Rationale
		negligible in the context of ambient noise levels and are likely to be masked by vessel activities related to the Project and within the wider region. None of the activities associated with the decommissioning of the Greater Balmoral Area are considered to generate significant noise levels which may cause injury or significant disturbance to marine species. The project is not located within a marine mammal protection area and EAs for offshore oil and gas decommissioning projects generally show no potential injury or significant disturbance associated with the non-survey decommissioning activities covered within the project scope. On this basis, underwater noise does not require further assessment.
Resource use	No	Generally, resource use from decommissioning activities requires limited raw materials and will be largely associated with vessel fuel use. Use of fuel resources is not typically an issue of concern in offshore oil and gas, which generates fuels. Regardless, Premier has committed to minimise fuel use throughout the decommissioning campaign where it is possible and safe to do so. In line with the BEIS (2018) Guidance, energy use was considered during the CA process and the options identified reflect the best possible outcomes for a variety of technical, environmental and safety and risk considerations. The estimated total energy usage for the project is 1,791,465.2 GJ, of which 1,102,963.4 GJ are associated with lifecycle energy use. The vast majority of energy use comes from the removal of mattresses and grout bags, as required by OSPAR Decision 98/3. The worst-case estimate of energy use assumes disposal of all mattresses and grout bags and this accounts for over 78% of the total lifecycle emissions. However, every attempt will be made to recycle or reuse the concrete in recovered mattresses. Methods for recycling or reuse of the mattresses will be agreed upon with the relevant regulators following their recovery. When the worst-case estimate from the disposal of all stabilisation materials is discounted from the energy use calculations, the lifecycle energy use is reduced to 256,233.5 GJ. It is likely that actual energy use will fall closer to this figure, as the base case is to reuse the stabilisation materials. The energy use anticipated for the decommissioning of the Greater Balmoral Area is considered minor compared to the resources generated during its production phase. Considering all of the above, resource use does not warrant further assessment.

Potential impact	Further assessment?	Rationale
Onshore activities	No	The OPRED Guidance states, that onshore activities are not in scope of Decommissioning EAs and this topic does not require further assessment. It should be noted that, only licenced contractors which can demonstrate they are capable of handling and processing the material to be brought ashore will be considered for onshore activities and this will form an integral part of the commercial tendering process.
Waste	No	The recycling and disposal of wastes are covered by the Balmoral Late Life Project (BLLP) Waste Management Strategy, which is compliant with relevant regulations relating to the handling of waste offshore, transfer of controlled, hazardous, and special waste, and TFSW and will be monitored through an Active Waste Management Plan (AWMP). The BLLP Waste Management Strategy is also guided by Premier's HSES Policy and commitments to best practice in waste management. This includes the mapping and documenting of waste management arrangements for each phase of the BLLP in individual Waste Management Plans and ongoing monitoring of waste procedures and performance review against target Key Performance Indicator (KPIs). Wastes will be treated using the principles of the waste hierarchy, focusing on the reuse and recycling of wastes where possible. Raw materials will be returned to shore with the expectation to recycle the majority of the returned material. There may be instances where infrastructure returned to shore is contaminated (e.g. by Naturally Occurring Radioactive Material (NORM), hazardous, and/or special wastes) and cannot be recycled. In these instances, the materials will require disposal; h0owever, the weight and/or volume of such material is not expected to result in substantial landfill use. On this basis, further assessment of waste is not necessary.
Unplanned events	No	As the decommissioning activities will be taking place after well P&A and pipeline flushing, well blowout and pipeline blowout scenarios have been ruled out as a possibility and any unplanned events during the decommissioning activities will be limited to vessel-related losses. The HLV to be used for removing rigid pipelines, large installations, and subsea installations is expected to have the largest fuel inventory of the vessels involved in the decommissioning activities. However, the inventory is expected to be less than the worst-case loss of containment modelled and assessed in the Balmoral Offshore Oil Pollution Emergency Plan (OPEP), which considered the full diesel inventory of the FPV, in

Potential impact	Further assessment?	Rationale
		addition to well blowout and pipeline loss of containment scenarios (Premier, 2018). The OPEP considered an instantaneous release of the full diesel inventory of the FPV of approx. 2,947.5 m^3, as well as crude releases of 2,682 m^3 from a well blowout scenario and 1,191 m^3 from a pipeline release scenario (Premier, 2018). These losses are expected to be greater than any instantaneous release from any large vessel proposed for decommissioning activities, such as the HLV or barge employed during removal of the template. Moreover, the decommissioning vessels are expected to have their fuel inventories split between a number of separate tanks, further reducing the potential for an instantaneous release of the full vessel inventory. The results of the dispersion modelling of the diesel release indicate a moderate probability of transboundary landfall of this diesel inventory to the Norwegian coastline (less than 70% after 15 days, limited to the summer months) and a low probability of landfall within the UK (less than 30% after 12 days, limited to the Autumn months) from the full release of this inventory. Any beached volume would be small (up to approximately 25 m^3 after 140 days), given the viscosity of diesel in comparison to oil. Impacts from unplanned events associated with decommissioning vessel activities will be less than the loss of containment scenarios previously assessed and mitigated against within the existing OPEP (Premier, 2018). However, management, response and control procedures will align with those detailed during the operational phase of Balmoral. Any spills from vessels in transit and outside the 500 m safety zone are covered by separate Shipboard Oil Pollution Emergency Plans (SOPEPs). Premier will support response of any vessel-based loss of fuel containment through the vessel owner's SOPEP (Premier, 2018). In addition to the mitigation measures outlined in the OPEP, Premier maintains manned bridges, navigational aids, and monitoring of safety zones (e.g. with Navaids, PowerBuoys, or other technology). Considering the above, the potential impacts from accidental chemical/ hydrocarbon releases during decommissioning activities do not warrant further assessment. As the methodology for the substructure and pipeline removal and return to shore has not been defined in detail, there exists the remote possibility that during transport of those materials, elements may dislodge and drop from the transport vessel. Premier will not undertake any cutting or lifting of pipelines, just reverse reel, which will minimise the likelihood of accidental loss of pipeline materials to the seabed. Moreover, all subsea installations

Potential impact	Further assessment?	Rationale
		are considered sound and no issues regarding their integrity have been identified. Dropped object procedures are industry-standard. All unplanned losses in the marine environment will be attempted to be remediated, and notifications to other mariners will be sent out. Seabed clearance verification surveys will aid in the identification of any dropped objects or debris in the decommissioning area. In line with the mitigation measures in place, unplanned loss of materials to the sea do not require further assessment.

The initial screening identified three potential environmental and societal impacts which require further assessment within the EA against the proposed decommissioning activities; they include: seabed disturbance, water quality, and impacts to commercial fisheries.

7 Environmental Management

The project has limited activity associated with it beyond the main period of preparation for decommissioning and removal of the Greater Balmoral Area infrastructure. The focus of environmental performance management for the project is therefore to ensure that the activities that will take place during the limited period of decommissioning happen in a safe, compliant, and acceptable manner. The primary mechanism by which this will occur is through Premier's accredited Environmental Management System (EMS) and Health, Safety, Environment, and Security (HSES) Policy.

To support this, a project Health and Safety Executive (HSE) Plan will be developed which outlines how HSE issues will be managed and how the policies will be implemented effectively throughout the project. The plan will apply to all work carried out, whether onshore or offshore. Performance will be measured to satisfy both regulatory requirements including compliance with environmental consents, as well as to identify progress on fulfilment of project objectives and commitments.

Premier also operates a Waste Management Strategy specific to the Greater Balmoral Area and will develop an AWMP for the decommissioning project to detail the types of materials identified as decommissioning waste and to outline the processes and procedures necessary to support the DP for the Balmoral FPV. The AWMP will detail the measures in place to ensure that the principles of the waste management hierarchy are followed during the decommissioning.

In terms of activities in the CNS, the National Marine Plan (NMP) has been adopted by the Scottish Government to help ensure sustainable development of the marine area. This Plan has been developed in line with UK, EU and OSPAR legislation, directives, and guidance. With regards to decommissioning, the Plan states that 'where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. As part of the conclusions to this assessment (Section 7), Premier has given due consideration to the Scottish NMP during project decision making and the interactions between the project and Plan.

8 Conclusion

Given the remote offshore location of the Greater Balmoral Area and the highly localised impacts of the proposed decommissioning activities, it is considered that there is no potential for decommissioning activities to impact any European or nationally designated protected sites.

This EA has considered the Scottish NMP, adopted by the Scottish Government to help ensure sustainable development of the marine area. Premier considers that the proposed decommissioning activities are in alignment with its objectives and policies.

Based on the findings of this EA, including the application of appropriate mitigation measures and Project management according to Premier's HSES Policy and EMS, it is considered that the proposed Greater Balmoral Area decommissioning activities do not pose any significant threat to environmental or societal receptors within the UKCS.

1 INTRODUCTION

In accordance with the Petroleum Act 1998, Premier Oil E&P UK Limited (from hereon, "Premier"), an established United Kingdom Continental Shelf (UKCS) operator, and on behalf of the Section 29 notice holders, is applying to the Department for Business, Energy and Industrial Strategy (BEIS) to obtain approval for decommissioning the surface and subsea infrastructure associated with the Balmoral, Brenda, Nicol, Glamis, and Stirling Fields (from hereon, "Greater Balmoral Area"). The Greater Balmoral Area is currently in a non-producing state and preparing for CoP, which is anticipated for October 2020. Approval was received from the OGA 23rd April 2018.

The ownership and operation of the fields associated with the Greater Balmoral Area is as follows:

- Balmoral Field is 78.12% owned and operated by Premier (15.13% by Repsol Sinopec North Sea Limited and 6.75% by Rockrose UKCS4 Limited);
- Brenda Field is 100% owned and operated by Premier;
- Nicol Field is 70% owned and operated by Premier (18% by Chrysaor and 12% by JX Nippon Exploration and Production (U.K.) Limited);
- Glamis Field is 85% owned and operated by Premier (15% by Repsol Sinopec North Sea Limited); and
- Stirling Field is 68.68% owned and operated by Premier (15.32% by Repsol Sinopec North Sea Limited and 16% by Rockrose UKCS4 Limited);

This Environmental Appraisal (EA) has been conducted to assess the potential environmental impacts which may arise from the planned activities for the staged decommissioning of the Greater Balmoral Area Fields and facilities. This EA supports the Decommissioning Programmes (DP) associated with the Greater Balmoral Area Fields; they include: Balmoral and the Balmoral Floating Production Vessel (FPV); Glamis; Brenda; Nicol; and Stirling (Premier, 2020a-e). These DPs will be submitted to the Offshore Petroleum Regulator for Environment & Decommissioning (OPRED), the offshore decommissioning regulator under BEIS which covers the statutory review of the decommissioning plans for the Greater Balmoral Area.

1.1 Project Overview

The Greater Balmoral Area (also referred to as 'B Block') sits in the Central North Sea (CNS), approximately 185 km northeast of Peterhead, Scotland and approximately 32 km west of the UK/Norway median line (Figure 1-1). The fields associated with the Greater Balmoral Area are located within Oil and Gas Authority (OGA) Licensing Blocks 16/21 and 15/25. The area comprises five fields with subsea drilling units tied back to a single FPV which is anchored beside the Balmoral Template in a water depth of 143 m below lowest astronomical tide (LAT).

The Balmoral FPV is a purpose-built semi-submersible vessel, which is moored above a 14-slot subsea Template, which contains a number of wells and manifolds. The FPV processes fluids from Balmoral (1986), Glamis (1989), Stirling (1994), Brenda (2007) and Nicol (2007) fields, and also for the Repsol-operated Beauly (2001) and Burghley fields (2010). The Blair (1990) field also produced across the FPV, but it was decommissioned in 1992. Some of the Blair subsea infrastructure was re-used for the Glamis development. The Repsol Sinopec fields, Burghley and Beauly, are also tied back to the Balmoral FPV via the Balmoral Template. Produced oil from the FPV is exported via a 14-in export line into the Brae-Forties Trunk Line.

The Balmoral Late Life Project (BLLP) is preparing for CoP, which is anticipated for October 2020. Approval was received from the OGA 23rd April 2018.

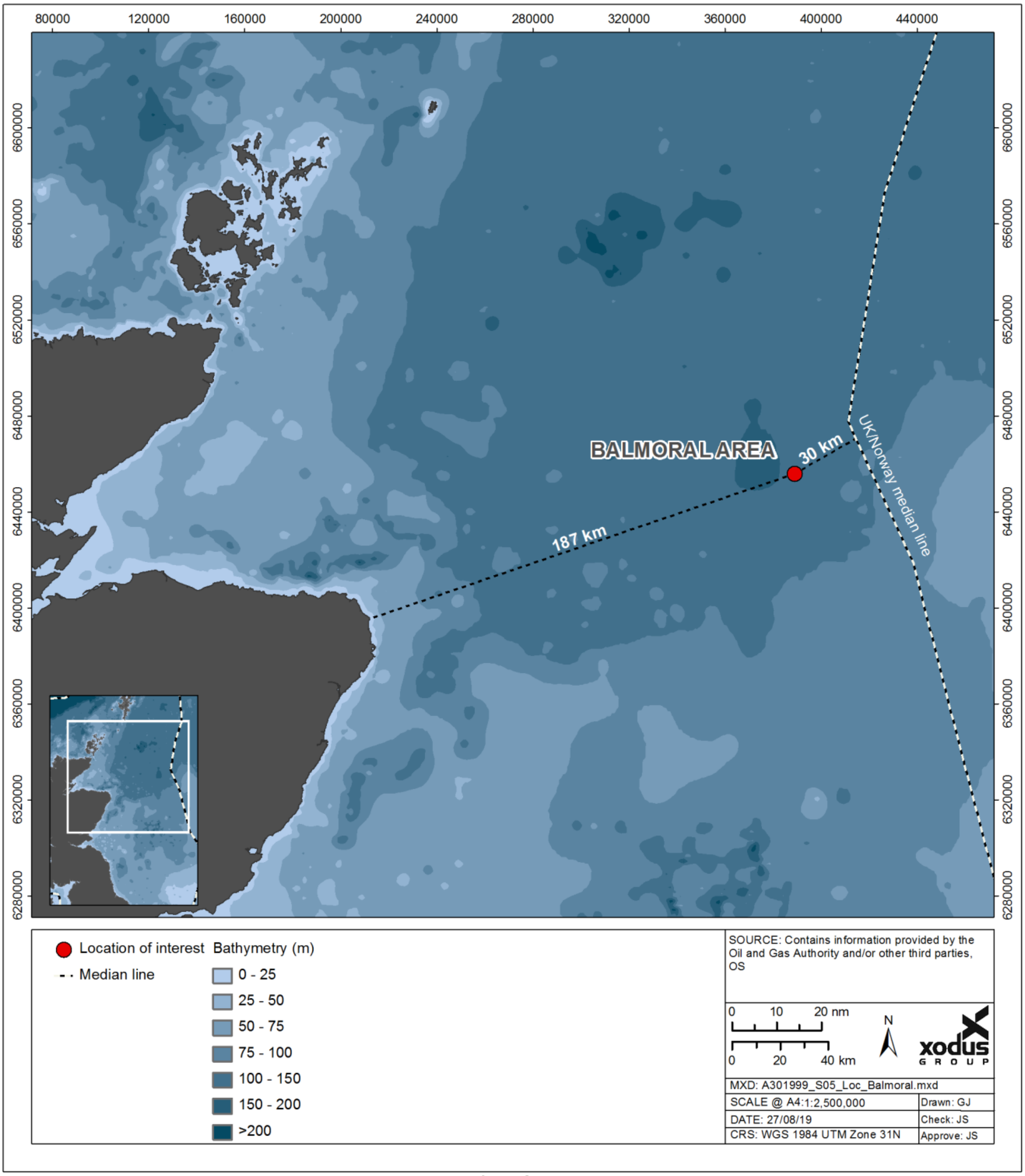

Figure 1-1 Location of the Greater Balmoral Area

Decommissioning at the Greater Balmoral Area will cover the decommissioning of subsea installations and subsea infrastructure associated with the Balmoral, Glamis, Nicol, Brenda, and Stirling fields, and the decommissioning of surface infrastructure, which is limited to the Balmoral FPV, as depicted in Figure 1-2. Activities associated with the decommissioning of the surface and subsea infrastructure in the Greater Balmoral Area are covered by this EA and the DPs for each of the associated Fields.

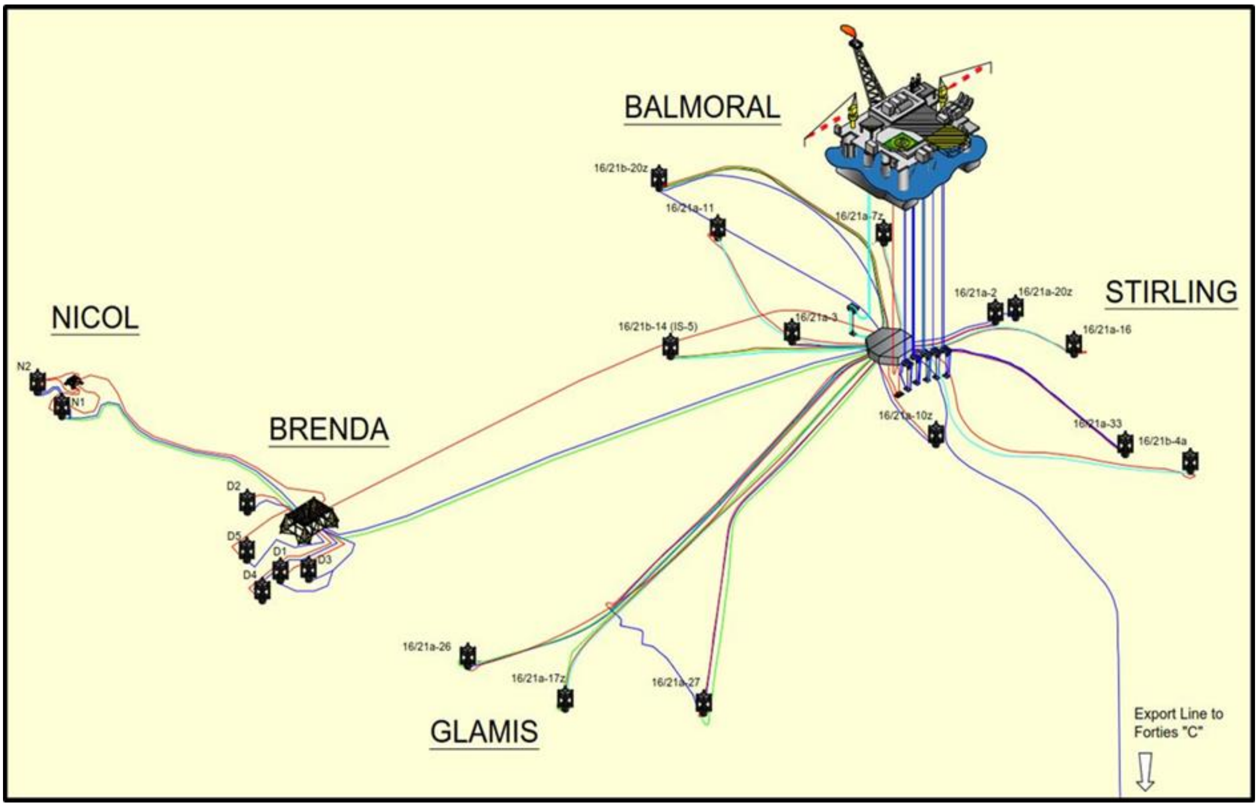

Figure 1-2 Greater Balmoral Area Overview

The proposed schedule for decommissioning activities associated with the Greater Balmoral Area commence in mid-2020, when detailed engineering will commence, and will be carried out through the end of 2028, after the post-decommissioning environmental and seabed clearance verification surveys are completed.

Well plugging and abandonment (P&A) will have been assessed, permitted, and completed prior to any of the surface or subsea decommissioning activities progressing. This means that each well will be systematically and permanently closed in accordance with well decommissioning best practice. Similarly, flushing and cleaning operations for subsea flowlines and subsea installations will also have been completed under existing operational permits prior to commencement of decommissioning activities.

1.2 Purpose of the Environmental Appraisal Report

This EA assesses the potential environmental impacts associated with the proposed Greater Balmoral Area decommissioning activities. The impact identification and assessment process considers stakeholder engagement, comparison of similar decommissioning projects undertaken in the UKCS, expert judgement, and the results of supporting studies which aim to refine the scope of the DP. This EA Report documents this process and details, in proportionate terms, the extent of any potential impacts and any necessary mitigation/control measures proposed.

1.3 Regulatory Context

The Petroleum Act 1998 (as amended) governs the decommissioning of offshore oil and gas infrastructure, including pipelines, on the UKCS. The Act requires the operator of an offshore installation or pipeline to submit a draft DP for statutory and public consultation. The DP must outline in detail the infrastructure being decommissioned and the method by which the decommissioning will take place. Responsibility for ensuring compliance with the Petroleum Act 1998 rests with Department of Business, Energy and Industrial Strategy (BEIS), and is managed through the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

Decommissioning is also regulated under the Marine and Coastal Access Act 2009 and Marine (Scotland) Act 2010 (the 'Marine Acts'). The UK's international obligations on decommissioning are primarily governed by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the Oslo Paris Convention (OSPAR)). OPRED is also the Competent Authority on decommissioning in the UK for OSPAR purposes and under the Marine Acts.

The primary guidance for offshore decommissioning from the regulator (BEIS, 2018), details the need for an EA to be submitted in support of the DP. The guidance sets out a framework for the required environmental inputs and deliverables throughout the approval process. It now describes a proportionate EA process that culminates in a streamlined EA report rather than a lengthy Environmental Statement (ES). The OPRED guidance is supported by Decom North Sea's (Decom North Sea, 2017) Environmental Appraisal Guidelines for Offshore Oil and Gas Decommissioning, which provide further definition on the requirements of the EA report.

In terms of activities in the CNS, the Scottish National Marine Plan (NMP) has been adopted by the Scottish Government to help ensure sustainable development of the marine area. This Plan has been developed in line with UK, European Union (EU) and OSPAR legislation directives and guidance. The relevant oil & gas policies with regards to decommissioning include Policy Oil & Gas 2 which states that 'where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process'. As part of the conclusions to this assessment (Section 7), Premier has given due consideration to the NMP during project decision making and the interactions between the project and Plan.

1.4 Scope and Structure of this Environmental Appraisal Report

This EA report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with decommissioning of the Greater Balmoral Area and to demonstrate the extent to which these can be mitigated and controlled to an acceptable level. This is achieved in the following Sections, which cover:

- The process by which Premier has arrived at the selected decommissioning strategy (Section 2);
- A description of the proposed decommissioning activities (Section 2);
- A summary of the baseline sensitivities and receptors relevant to the assessment area that supports this EA (Section 3);
- A review of the potential impacts from the proposed decommissioning activities and justification for the assessments that support this EA (Section 5);
- Assessment of key issues (Section 6); and
- Conclusions (Section 7).

This EA report has been prepared in line with Premier's environmental assessment requirements and has given due consideration to the regulatory guidelines (BEIS, 2018) and to Decom North Sea's Environmental Appraisal Guidelines for Offshore Oil and Gas Decommissioning (Decom North Sea, 2017).

2 PROJECT SCOPE

2.1 Consideration of Alternatives and Selected Approach

2.1.1 Decision Making Context

The latest guidance (BEIS, 2018) states that subsea installations (e.g. drilling Templates, wellheads and their protective structures, production manifolds and risers) must, where practicable, be completely removed for reuse or recycling or final disposal on land. Any piles used to secure such structures in place should be cut below natural seabed level at such a depth as to ensure that any remains are unlikely to become uncovered. Should an Operator wish to make an application to leave in place a subsea installation because of the difficulty of removing it, justification in terms of the environmental, technical or safety reasons would be required. With regards to pipelines (including flowlines and umbilicals), these should be considered on a case-by-case basis. The guidance does provide general advice regarding removal for two categories of pipelines:

- For small diameter pipelines (including flexible flowlines and umbilicals) which are neither trenched nor buried, the guidance states that they should normally be entirely removed; and
- For pipelines covered with rock protection, the guidance states that these are expected to remain in place unless there are exceptional circumstances warranting removal.

The guidance also highlights instances where pipelines could be decommissioned *in situ*. For example, pipelines that are adequately buried or trenched or which are expected to self-bury could be considered as candidates for *in situ* decommissioning. Where an Operator is considering decommissioning pipelines *in situ*, the decision-making process must be informed by Comparative Assessment (CA) of the feasible decommissioning options. This CA takes account of safety, environmental, technical, societal, and economic factors to arrive at a preferred decommissioning solution.

Finally, the guidance states that mattresses and grout bags installed to protect pipelines should be removed for disposal onshore, if their condition allows. If the condition of the mattresses or grout bags is such that they cannot be removed safely or efficiently, any proposal to leave them in place must be supported by an appropriate CA of the options.

2.1.2 Alternatives to Decommissioning

Options to re-use the Greater Balmoral Area infrastructure *in situ* for future hydrocarbon developments have been considered, but to date none have yielded a viable commercial opportunity. Reasons for this include the absence of remaining hydrocarbon reserves in the vicinity of the infrastructure, and the limited remaining design life of the Greater Balmoral Area infrastructure. It is considered unlikely that any opportunity to re-use the Greater Balmoral Area infrastructure for production purposes will be feasible and, as such, there is no reason to delay decommissioning of the infrastructure in a way that is safe and environmentally and socially acceptable.

All the Greater Balmoral Area subsea infrastructure was assessed for decommissioning against the *Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines* (BEIS, 2018). The recommended CA process was applied. Equipment was initially organised into groups of items with similar characteristics, this allows for greater efficiency in dealing with the large inventory. The guidance identifies certain equipment which much be fully removed and some categories of pipelines which may be left decommissioned *in situ* subject to CA. Once the equipment groups designated for full removal were identified the remaining groups were assessed further.

All possible decommissioning options for the remaining groups were coarsely screened against the primary criteria as specified within the BEIS (2018) Guidance: Safety; Environment; Technical; Societal; and Economics. The options were scored against each criterion either green, amber, or red, pertaining to attractive, acceptable, or unattractive respectively. This process eliminated the least favourable options from each equipment group in preparation for detailed evaluation of the remaining options. Those remaining options were then investigated in detail to develop quantitative and qualitative data for each option pertaining to the primary criteria and sub-criteria (e.g. safety data; environmental impact data; technical considerations; societal impacts; and costs). Once this data had been prepared in the form of published studies, a detailed evaluation was conducted to determine the final recommended decommissioning option for each item of equipment. This was facilitated by comparing the data for each sub-criterion across the options using a Multi Criteria Decision Analysis (MCDA) tool which employs pairwise comparisons of quantitative and qualitative data to produce a relative score for each sub-criterion that can be summed to produce an overall relative score for each option, enabling identification of the emerging recommendation for the group.

2.1.3 Subsea Comparative Assessment

Prior to the eventual recommended decommissioning options being identified, Premier followed the CA evaluation process in which the decommissioning options are assessed against the five main criteria defined in the BEIS (2018) Guidance (BEIS, 2018), which were equally weighted.

The CA options which have been considered for the decommissioning of the Greater Balmoral Area are outlined in Table 2-1 and further details are provided in the Balmoral Comparative Assessment & Associated Services CA Report. The selected options are bold, with details provided in the sections below.

Table 2-1 CA Decommissioning Options Considered

CA Group No.	Subsea Infrastructure Description	Decommissioning Options Considered (selected option in bold)
1	Surface Laid Flowlines & Umbilicals	• Disconnect ends and trench entire length to adequate depth to remove snag hazards; and • **Full removal by reverse reel.**
3	Trenched & Buried Rigid Flowlines	• Disconnect and remove ends with local rock placement at ends; • **Disconnect and remove ends and exposures with local rock placement at ends and exposures;** • Re-trench entire lines; • Disconnect ends and fully rock cover lines; and • Full removal by de-burial and cut and lift.
4	Trenched & Buried Flexible Flowlines & Umbilicals	• Disconnect and remove ends with local rock placement at ends; • **Disconnect and remove ends and exposures with local rock placement at ends and exposures;** • Re-trench entire lines; • Disconnect ends and fully rock cover lines; • Full removal by de-burial and reverse reel; and • Full removal by de-burial and cut and lift.
14	Mattresses – Other (incl. grout bags)	• Leave as is and rock cover; • Leave as is and bury; and • **Fully remove using remote mechanical means** Note 1
15	Mooring System incl. anchor piles	• Leave *in-situ* (minimal intervention) – leave as is • **Leave *in-situ* (minor intervention) – remove mooring chain at seabed and leave piles and buried chain *in situ*** • Leave *in-situ* (major intervention) – bury or rock dump chain

CA Group No.	Subsea Infrastructure Description	Decommissioning Options Considered (selected option in bold)
		• Leave *in-situ* (re-use) – leave piles/chains *in situ* for use in any potential new developments • Full removal

Notes:

1. The base position is to remove all mattresses if safe to do so, including the potentially unrecoverable (these are the older types which are known to potentially have no or reduced integrity). Should difficulties be encountered which would make it disproportionately problematic to remove any particular mattress, Premier will open a dialogue with OPRED to agree an alternative decommissioning approach.

2.2 Scope of Proposed Decommissioning Operations

2.2.1 Description of the Infrastructure being Decommissioned

The Greater Balmoral Area consists of the Balmoral, Glamis, Stirling, Brenda, and Nicol fields all tied back to the Balmoral FPV. A high-level summary of the infrastructure present across the Greater Balmoral Area fields is presented in Table 2-2, with details of the infrastructure provided within Appendix A.

Table 2-2 Quantities of Equipment Type Within Each of the Greater Balmoral Area Fields

Group	Equipment Description	Number of items					
		Balmoral	Brenda	Glamis	Nicol	Stirling	Total
1	Surface Laid Flowlines & Umbilicals	11		3		3	17
3	Buried Rigid Flowlines	14	2	4	2		22
4	Buried Flexible Flowlines & Umbilicals	1	1	5	1	3	11
5	Flexible Jumpers	48	14	7	6	4	79
7	Rigid Spoolpieces	16	12		4		32
9	Control & Chemical Jumpers		8		3		11
11	Large Subsea Installation – Balmoral Template	1					1
12	Small Subsea Installations	12 (7 Note 2)	10	3	5	0	28
13	Mattresses – Flexible Concrete Mattresses with Polypropylene Rope (Easy Recovery)	72	128	33	85	24	342

Group	Equipment Description	Number of items					
		Balmoral	Brenda	Glamis	Nicol	Stirling	Total
14	Mattresses – Other incl. Grout bags	25		53			78
15	Mooring System incl. anchor piles	8 Note 3					8
16	Flexible Risers	18					18
17	Surface Laid & Rock Covered Flexible Flowline	1					1
18	Drill Cuttings Piles	1					1

Notes:

1. The WHPS subsea installation at Stirling has already been decommissioned in 2018 under its own DP (Premier, 2020e).
2. There are 7 manifolds within the Balmoral Template structure which shall be removed individually.
3. The FPV mooring system consists of eight anchor chains 1,150m long. Mooring lines are evenly spread out from the FPV, two per corner, in a catenary to touch down. From touch down, they run along the seabed terminating in buried piles. Piles are 35m long and buried 6m beneath the seabed. The mooring chains are connected mid-way along the piles.

2.2.2 Description of Proposed Decommissioning Activities

Through the CA process the infrastructure to be decommissioned was organised into groups. Thereafter, groups of equipment required to be fully removed, in accordance with current guidance, were identified and the remaining groups were assessed against the required criteria, safety, environmental, technical, societal, and economic. Through evidence-based evaluation of those remaining groups final decommissioning recommendations were determined and presented to statutory stakeholders.

The finalised recommended decommissioning approach for each group is listed in Table 2-3.

Table 2-3 Recommended Decommissioning Options for Each Group

Group	Equipment Description	Decommissioning Approach
1	Surface Laid Flowlines & Umbilicals	Full removal: reverse reel either with a dedicated reel vessel or using mobile reels upon a suitably capable construction support vessel (CSV).
2	Trenched but not backfilled Umbilical	Full removal: reverse reel either with a dedicated reel vessel or using mobile reels upon a suitably capable CSV.
3	Buried Rigid Flowlines	Minimal / minor intervention: remove exposed ends, remove exposures where required. Remediate snag hazards with minimum amount of rock placement using either manned diving or using remotely operated equipment.
4	Buried Flexible Flowlines & Umbilicals	Full removal: de-burial and reverse reel using a controlled flow excavation (CFE) to expose the lines and recovering the lines with either with a dedicated reel vessel or using mobile reels upon a suitably capable CSV.
5	Flexible Jumpers	Full removal: Using Diving support vessel (DSV) or CSV to cut and recover the sections in manageable lengths.
6	Flexible Jumpers at Balmoral Template	Full removal: Using DSV or CSV to cut and recover the sections in manageable lengths.
7	Rigid Spoolpieces	Full removal: Using DSV or CSV to cut and recover the sections in manageable lengths.
8	Rigid Spoolpieces at Balmoral Template	Full removal: Using DSV or CSV to cut and recover the sections in manageable lengths.
9	Control & Chemical Jumpers	Full removal: Using DSV or CSV to cut and recover the sections in manageable lengths.
10	Control & Chemical Jumpers at Balmoral Template	Full removal: Using DSV or CSV to cut and recover the sections in manageable lengths.
11	Large Subsea Installations – Balmoral Template	Full removal: Disconnection and removal of internal equipment in preparation for structure recovery. Installation of lifting strops onto the structure primary members and recovery of the structure in a single piece using Heavy Lift Vessel. Lift on to barge or heavy lift vessel (HLV) deck as required. Deck grillage will be required to support the structure.
12	Small Subsea Installations	Full removal: Disconnection and recovery of structures via DSV or CSV with a suitable crane. Deck grillage will be required to support the structures.
13	Mattresses – Flexible Concrete Mattresses with Polypropylene Rope (Easy Recovery)	Full removal: DSV or CSV.

Group	Equipment Description	Decommissioning Approach
14	Mattresses – Other incl. Grout bags	Full removal: DSV or CSV. If mattresses are found to be disproportionately difficult to remove, the recommended approach is minor intervention: leave *in situ* rock placement using a fall pipe vessel to cover any unrecoverable mattresses and grout bags with profiled rock berm. However, any issues with mattress recovery which require alternative decommissioning methods shall be discussed with OPRED prior to execution.
15	Mooring System incl. anchor piles	Minor intervention: leave *in situ* remove mooring chain. Cutting of mooring chains at the mud-line and recovery of chains, leaving buried piles *in situ*.
16	Flexible Risers	Full removal: CSV and Reel Vessel. Following laydown of risers from FPV they shall be disconnected at the seabed and recovered onto a suitable reel vessel.
17	Surface Laid & Rock Covered Flexible Flowline	Full removal: reverse reel either with a dedicated reel vessel or using mobile reels upon a suitably capable construction support vessel (CSV). Rock will be left *in situ*.
18	Drill Cuttings Piles	Decommissioned *in situ*. Drill cuttings on the Balmoral Template shall be displaced to the surrounding seabed to facilitate removal of the Template.

The Balmoral FPV was not assigned to a Group for the CA. Suitably rated tugs shall secure the FPV to allow the mooring chains to be lowered to the seabed. Once the mooring chains have been released, the FPV will be towed off station by the tugs.

2.3 General Assumptions

All pipework will be flushed to an acceptable level of cleanliness prior to decommissioning activities commencing, reflecting current guidance from OPRED and the Health & Safety Executive (HSE). Wells are out of scope and will be plugged and abandoned, covered by their own permitting regime.

2.4 Method Statements

An appropriately licensed waste management company will be identified through a selection process which ensures that the selected facility demonstrates a proven record of: (1) waste stream management throughout the deconstruction process; (2) the ability to deliver innovative reuse/recycling options; and (3) ensures the aims of the waste hierarchy are achieved. Geographic locations of potential disposal yard options may require the consideration of Trans-Frontier Shipment of Waste (TFSW), including hazardous materials. Early engagement with the relevant waste regulatory authorities will ensure that any issues with TFSW are addressed. Premier will engage with other companies and industries to identify potential reuse opportunities. Premier believes that such opportunities are best achieved through the tendering and selection of a waste management contractor with the expert knowledge and experience in this area.

2.4.1 Balmoral FPV

The Balmoral FPV is a GVA 5000 semi-submersible design platform which is located on-station by an eight-point mooring system made up of eight 1,550 m chain lengths connected to anchor piles. For its removal, the FPV shall be secured by tugs before lowering the anchor chains to the seabed. Once released from its moorings the FPV shall be towed to a UK port where the process system shall be removed and cleaned. The remaining vessel shall then be taken overseas for recycling. The anchor chains shall be retrieved by anchor handling vessel with the chains being cut at the mud line leaving the buried anchor piles *in situ*.

Figure 2-1 Photograph of Balmoral FPV

2.4.2 Template

The Balmoral Template is a large steel framed piled installation, 33 m x 33 m x 10 m, with total weight of 1,625 Te, including a number of manifolds, junction boxes and control modules. Further detail on the structure dimensions is available in Appendix A.

CFE will be used to evacuate the cuttings and sediment deposits within the Template structure. Internal trees and manifold structures will be removed from within the Template using a mix of internal and external cutting techniques when required. The CFE will excavate around the base of the Template to ensure it is clear of sediments prior to recovery. Premier's intent is to remove all the drill cuttings from the Balmoral Template before it is recovered to surface. However, precautionary measures will be taken to contain any residual cuttings with the structure as it is transported to shore.

The piles which secure the Template (3 off) shall be dredged clear and are expected to be cut using internal abrasive water jet cutting tools, shears, or diamond wire.

The Template shall be recovered by HLV using rigging connected to the structural members in a single lift procedure. The Template shall be recovered to the deck of the HLV or a suitable barge, in each case a dedicated grillage will be pre-installed to support and seafasten the Template.

A post-removal seabed clearance verification survey will be conducted to ensure a clear seabed after the decommissioning of the Template.

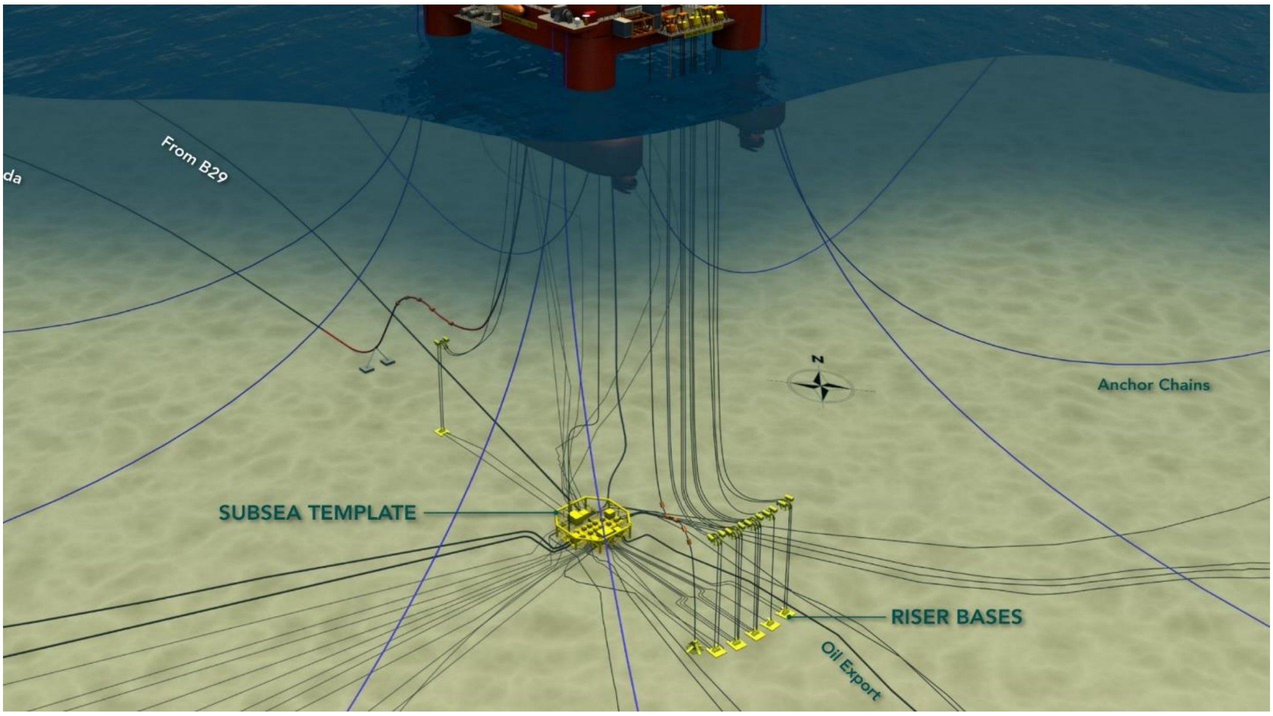

Figure 2-2 Balmoral Template Area Overview

2.4.3 Subsea Installations and Stabilisation Features

The Glamis Field contains three (3) WHPS which are currently shut in and disconnected and will be removed by the rig as a part of the well abandonment campaign. Environmental impacts associated with the removal of the wells will be considered as a part of the Well Intervention and Marine Licence applications, which will be submitted to OPRED, and therefore activities associated with the removal of those subsea installations are considered outwith the scope of this EA. However, they have been included as a part of the subsea decommissioning inventory for the Glamis Field.

The Brenda and Nicol fields collectively contain seven (7) Xmas Trees with Fishing Friendly Structures (FFS) which will be fully recovered as a part of the decommissioning campaign. Table 2-4 below provides a technical summary of the subsea installations at the Brenda and Nicol wells.

Table 2-4 Christmas Trees with Integrated Wellhead Protection Structures

Infrastructure	Number	Dimensions (m)	Weight (Te)
Brenda Xmas Trees with FFS	5	9.8 x 9.1 x 5.7 (height)	52.7
Nicol Xmas Trees with FFS	2	9.8 x 9.1 x 5.7 (height)	52.7

For the subsea installations which will be fully removed from the seabed as part of a campaign approach, an abrasive water jet will be used when possible to perform internal pile cutting. Where this is not achievable, a fall back of excavation and use of diamond wire cutting will be required. Structures will be lifted from seabed using CSV or DSV. A post-removal seabed clearance verification survey will be conducted to identify any locations where debris clearance or overtrawling are required to ensure a clear seabed.

Appendix A provides a detailed overview of the subsea installations and stabilisation features within the Greater Balmoral Area.

2.4.4 Pipelines

Surface laid flexible pipelines and umbilicals will be disconnected and fully removed using a reverse reel technique. Trenched and buried rigid pipelines will have their ends disconnected and ends and any exposures shall be cut and recovered. Cut ends will be deburied, however, rock placement may be required to remediate the seabed at cut locations where deburial is not possible. In these instances, the preference would be to reuse existing grout bags which are due to be decommissioned. Trenched and buried flexible flowlines and umbilicals will be fully removed using a reverse reel and flowline/umbilical cut ends will be trenched/buried to acceptable burial depth.

The comparative assessment recommended full removal of 28 of the lines across the fields: Balmoral (12), Glamis (8), Brenda (1), Nicol (1) and Sterling (6). A full detailed inventory of the Greater Balmoral Area pipelines is provided in Appendix A.

The PL980 flowline is comprised of two parts: a section of buried rigid flowline (previously known as PL643) joined to a section of buried flexible flowline. For this reason, PL980 is considered within both a rigid and flexible flowline context as each section will be treated with respect to its respective CA Group.

For those pipelines that are recommended to be decommissioned *in situ* the average burial depths vary; however, the 0.6 m average burial is achieved or exceeded for the majority of lines, as depicted in the Depth of Burial Profiles provided in Appendix C. Data from pipeline integrity surveys indicates a total of 28 mid-line exposures across these pipelines in two of the fields: Balmoral (26) and Glamis (2). An overview of the pipelines' status and exposures is provided in Table 2-5 below. There are no reportable spans on any of the pipelines. Spans have been defined in line with the BEIS (2018) *Decommissioning of Offshore Oil and Gas Installations and Pipelines Guidance Notes* as free spans in excess of 0.8 metres in height from the top of the pipeline and 10 metres in length and/or those which have been identified as being likely to present a hazard to fishing activities due to their location or physical characteristics. A single survey from 2016 is available, however, there have been no incidents recorded across the area since, indicating that there has not been any notable change to the burial status recorded at that time. A further survey shall be completed following decommissioning.

Table 2-5 Description and Locations of Pipeline Exposures Identified during the 2016 Field Survey[Note 1] and Expected Leave *In Situ* Lengths Following Removal of Exposures and Cut Ends

Field	Pipeline	Number of Exposures	Total Length Mid-Line Exposures (m)	Total Length (m)	Leave *in situ* Length (m)
Balmoral	PL218	7	180	14,460	13,565
	PL219 & PL220	1	38	1,302	676
	PL221 & PL222	7	225	5,059	4,160
	PL223 & PL224	3	33	1,698	1,033
	PL225	0	0	1,818	1,196
	PL226	0	0	1,625	992
	PL227	1	4	5,346	4,660
	PL228	4	266	3,311	2,352
	PL229	2	13	2,910	2,272
	PL230	1	25	2,701	1,966
	PL2565	0	0	3,917	3,583
Glamis	PL638	2	136	7,921	7,296
	PL639	0	0	6,944	6,359

Field	Pipeline	Number of Exposures	Total Length Mid-Line Exposures (m)	Total Length (m)	Leave *in situ* Length (m)
	PL640	0	0	7,6133	7,085
	PL980[Note 2]	0	0	8,149	5,268
Brenda	PL2329	0	0	9,272	8,274
	PL2330	0	0	9,272	8,330
Nicol	PL2350 & PL2351	0	0	9,583	9,363

Notes:
1. This is preliminary data which is still being finalised.
2. PL980 is comprised of both a flexible and rigid section. The total length quoted here is for the cumulative total of both sections however the exposures pertain to the rigid section of the flowline.

2.4.5 Mattresses and Stabilisation

The base position is to remove all grout bags and mattresses using a combination of ROV and diver-assisted lifts. Recovered concrete mattresses and grout bags will be cleaned of marine growth as required and reused as aggregate for infrastructure projects or disposed of in landfill sites. As recommended in the BEIS (2018) Guidance, existing rock placement used to protect pipelines will remain *in situ* to minimise disturbance to the seabed and to continue to mitigate potential snagging hazards associated with any *in situ* decommissioned pipelines.

Older grout bags with potentially compromised lifting points or concrete mattresses constructed with steel wires / bitumen may be difficult to remove due to reduced integrity. Recovery of these stabilisation materials shall be assessed on-site, and they shall be recovered where safe to do so. Should difficulties be encountered which would make it disproportionately problematic to remove any stabilisation materials, Premier will open a dialogue with OPRED to agree an alternative decommissioning approach. Where it is deemed unsafe to recover any grout bag(s) or mattress(es), decommissioning *in situ* is proposed. However, all alternative strategies to the base position for the decommissioning of mattresses shall be discussed with OPRED prior to execution to confirm the approach. Any agreed deviations from the decommissioning activities proposed in the DP will be covered under the requisite consents.

The locations of mattresses, rockdump and grout bags used to stabilise and remediate exposures along the midlines of flowlines are provided in Table 2-6 and Table 2-7, respectively.

Table 2-6 Mattresses Used for Stabilisation of Flowlines and Midline Exposures [Note 1]

Field	Number of matts by location			Number of matts by dimension (m^2)					Total mattresses per field
	Well end	Flowline	Template	5 x 2	6 x 2	6 x 3	4 x 5	10 x 2	
Balmoral	23 [Note 2]	61	13	30	0	46	21	0	**97**
Glamis	24	62	0	77	0	0	0	9	**86**
Stirling	24	0	0	8	0	16	0	0	**24**
Brenda	88	33	7	0	58	70	0	0	**128**
Nicol	39	0	46	0	38	47	0	0	**85**
Totals:	**198**	**156**	**66**	**115**	**96**	**179**	**21**	**9**	**420**

Notes:
1. This is preliminary data which is still being finalised.
2. For the Balmoral oil export line, this end is where it ties into the Forties pipeline system.
3. For the Nicol lines, the template end is at the Brenda manifold.

Table 2-7 Rock Dump and Grout Bags Used for Stabilisation of Flowlines and Midline Exposures

Field	Existing protection and support materials.	Number	Weight (Te)
Balmoral	Grout bags	1,600 (estimated)	40
	Rock dump	N/A	44,137
Brenda	Grout bags	560	14
	Rock dump	N/A	3,560
Glamis	Grout bags	1,200 (estimated)	30
	Rock dump	N/A	2,000 (estimated)
Nicol	Grout bags	560	14
	Rock dump	N/A	1,450
Stirling	Grout bags	1,600	40

2.4.6 Mooring System

Anchor chains will be lifted using an anchor handling tug and remotely cut at the seabed using mechanical shears. The anchor piles shall be left *in situ* as they are stably buried to a sufficient depth (i.e. the tops of piles are approximately 6 m below seabed). This will result in approximately 20 m of buried chain being left in situ with each of the anchor piles. The full dimensions of the mooring chains and anchor piles are in Table 2-8.

Table 2-8 Mooring chain and anchor pile dimensions.

Subsea installations including Stabilisation Features	Number	Size and weight
Mooring Chains	8	1,550 m (each) 260 Te (each)
Anchor Pile 1	1	ø1.58 x H36 63.9 Te
Anchor Pile 2	1	ø1.58 x H36 63.9 Te
Anchor Pile 3	1	ø1.58 x H36 63.9 Te
Anchor Pile 4	1	ø1.58 x H36 63.9 Te
Anchor Pile 5	1	ø1.58 x H36 63.9 Te
Anchor Pile 6	1	ø1.58 x H36 63.9 Te
Anchor Pile 7	1	ø1.58 x H36 63.9 Te
Anchor Pile 8	1	ø1.58 x H36 63.9 Te

2.4.7 Clear Seabed Verification

Following the decommissioning of all infrastructure, it is necessary to identify any potential snagging hazards associated with any changes to the seabed. A clear seabed will be validated by an independent verification survey of all of the installation sites and pipeline corridors, as well as any anchor points and 500-m exclusion zones. The aim of these clean seabed verification actions is to ensure the seabed is left in a safe condition for future fishing effort, in line with the current Decommissioning Guidance (BEIS, 2018).

Survey techniques which do not make contact with the seabed, such as Side Scan Sonar (SSS) and Remotely Operated Vehicle (ROV), will be implemented to verify the condition of the seabed during the post decommissioning survey. The survey methods will be discussed and finalised with OPRED prior to survey commencement to ensure the survey meets the requirements for clear seabed verification.

Non-intrusive verification techniques will be considered in the first instance, but where these are deemed inconclusive by the Scottish Fishermen's Federation (SFF), seabed clearance is likely to require conventional overtrawl survey methods. Where there is evidence of snagging hazards requiring intervention (e.g. any spans, berms, dropped objects, etc.), then overtrawling will be undertaken to ensure no residual risk of snagging remains post-decommissioning. Should overtrawling be required, it will be conducted by fishing vessel(s) using trawl gear that is appropriate for the area.

Where there is evidence of snagging hazards requiring intervention (e.g. any spans, berms, dropped objects, etc.), then overtrawling will be undertaken to ensure no residual risk of snagging remains post decommissioning. It is expected that such intervention would be limited to the following infrastructure:

- Deburial of flexible flowlines to be removed via reverse reeling;
- Footprint associated with infrastructure with a 500 m exclusion zone (following its removal); and
- Footprint associated with anchor points (following anchor system recovery to the FPV).

Removal of surface laid flowlines and other subsea infrastructure is not anticipated to generate any snagging hazards. Similarly, field debris will be small and are expected to be on the seabed surface or partially buried, precluding the requirement of intrusive methods of remediation. Any debris identified during the clear seabed verification survey will be removed with the area of disturbance minimised where practicable.

2.5 Summary of Material Inventory

The sections below summarise the inventory of materials associated with the subsea and surface infrastructure to be decommissioned. Comprehensive information about the materials present within the Glamis, Stirling, Brenda, Nicol, and Balmoral fields will be gathered.

2.5.1 Balmoral Field

The Balmoral Field subsea infrastructure includes the Balmoral Template structure, pipelines, umbilicals, risers and riser base structures.

Table 2-9, Figure 2-3 and Figure 2-4 summarise the total and proportional weight of each component's constituent materials for the Balmoral Field subsea infrastructure.

Table 2-9 Component materials of infrastructure to be decommissioned – Balmoral Field

Component Type	Weight (Te)				
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Concrete	Total
Pipelines	3,890	11	221	474	4,596
Installations	3,852	0	56	451	4,359
Total	**7,742**	**11**	**277**	**925**	**8,955**

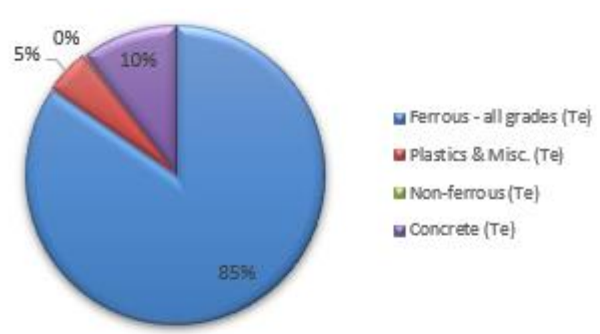

Figure 2-3 Proportion of Constituents for Pipelines in the Balmoral Field

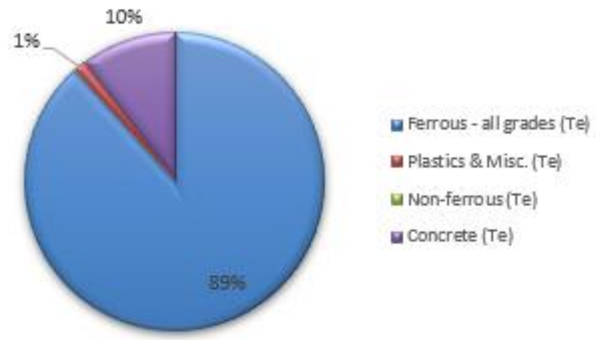

Figure 2-4 Proportion of Constituents for Installations in the Balmoral Field

2.5.2 Balmoral FPV

The Balmoral FPV is a semi-submersible production vessel made of steel and other metallic compounds. It remains on station secured by eight 1150 m chains connected to eight concrete anchor piles buried 6 m below the seabed.

Table 2-10 and Figure 2-5 summarise the total and proportional weight of each component's constituent materials for the Balmoral FPV.

Table 2-10 Component Materials of Infrastructure to be Decommissioned – Balmoral FPV

Component Type	Weight (Te)					
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Hazardous	Other	Total
Balmoral FPV	17,562	1,267	149	670	71	19,719
Total	**18,638**	**841**	**229**	**26.2**	**71**	**19,719**

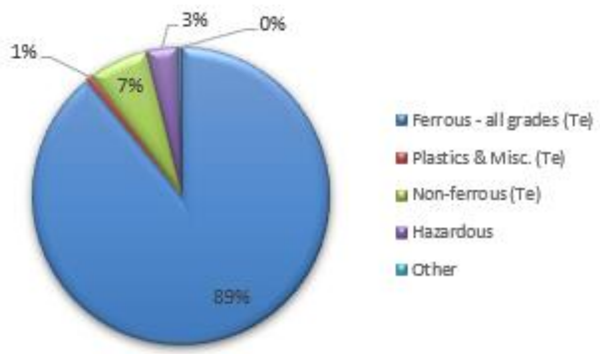

Figure 2-5 Proportion of Constituents in the Balmoral FPV

2.5.3 Glamis Field

The Glamis Field consists of two single well production tie-backs to the Balmoral Template and one water injection well. The pipelines are rigid steel pipelines with flexible jumpers at each end to tie-in at the wells and Template. The pipelines are trenched and buried. The tie-in jumpers on the surface are protected by concrete mattresses and grout bags. The Glamis Field also contains three (3) WHPS which are currently shut in and disconnected and will be removed by the rig as a part of the well abandonment campaign which will be considered as a part of the relevant licence applications (see Section 2.4.3).

Table 2-11, Figure 2-6 and Figure 2-7 summarise the total and proportional weight of each component's constituent materials for the Glamis Field.

Table 2-11 Component Materials of Infrastructure to be Decommissioned – Glamis field

Component Type	Weight (Te)				
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Concrete	Total
Pipelines	2,379	15	116	249	2,759
Installations	199	3	0	0	202
Total	**2,578**	**18**	**116**	**249**	**2,961**

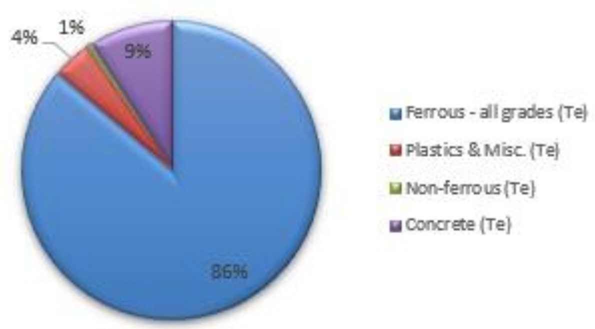

Figure 2-6 Proportion of Constituents for Pipelines in the Glamis Field

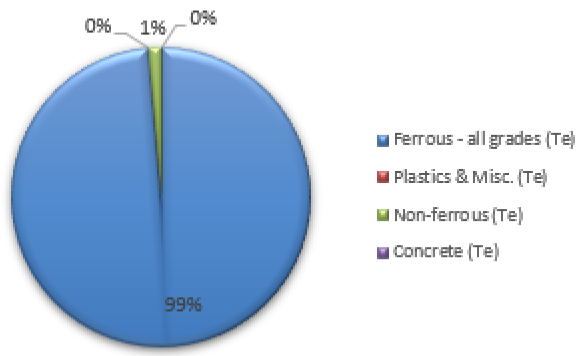

Figure 2-7 Proportion of Constituents for Installations in the Glamis Field

2.5.4 Stirling Field

The Stirling Field consists of two single well production tie-backs to the Balmoral Template each with gas lift. The pipelines are all flexible pipelines with flexible jumpers at the Template end. The A20 well pipelines are surface laid and the A33 well pipelines are trenched and buried. The tie-in jumpers on the surface are protected by concrete mattresses and grout bags.

Table 2-12 and Figure 2-8 summarise the total and proportional weight of each component's constituent materials for the Stirling Field.

Table 2-12 Component Materials of Infrastructure to be Decommissioned – Stirling

Component Type	Weight (Te)				
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Concrete	Total
Pipelines	331	0	88	96	515
Total	**331**	**0**	**88**	**96**	**515**

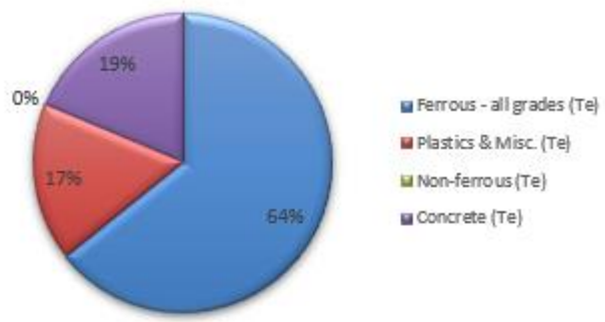

Figure 2-8 Proportion of Constituents for Pipelines in the Stirling Field

2.5.5 Brenda Field

The Brenda Field consists of a five well drill centre tied back to the Balmoral Template via a subsea manifold with a single rigid production pipeline and a single rigid gas lift line, both trenched and buried. Flexible jumpers are used at each end of the pipeline to tie-in to the manifold and Template respectively. Flexible jumpers are protected by concrete mattresses and grout bags.

Within the drill centre the individual wells are tied back to the manifold via surface flexible jumpers. Jumpers are protected by concrete mattresses and grout bags. The Brenda Field also contains five (5) steel Xmas trees with FFS at the individual wells which will be fully recovered.

Table 2-13 and Figure 2-9 and Figure 2-10 summarise the total and proportional weight of each component's constituent materials for the Brenda Field.

Table 2-13 Component Materials of Infrastructure to be Decommissioned – Brenda

Component Type	Weight (Te)				
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Concrete	Total
Pipelines	4,987	1	350	511	5,849
Installations	588	1	0	52	641
Total	**5,575**	**2**	**350**	**563**	**6,490**

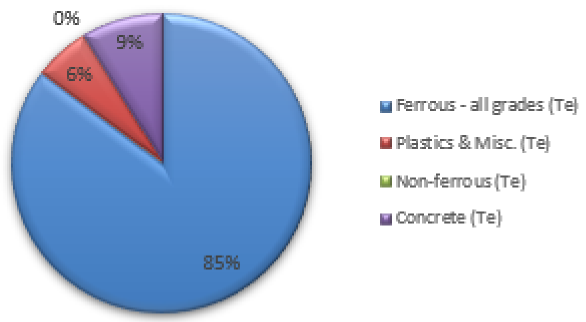

Figure 2-9 Proportion of Constituents for Pipelines in the Brenda Field

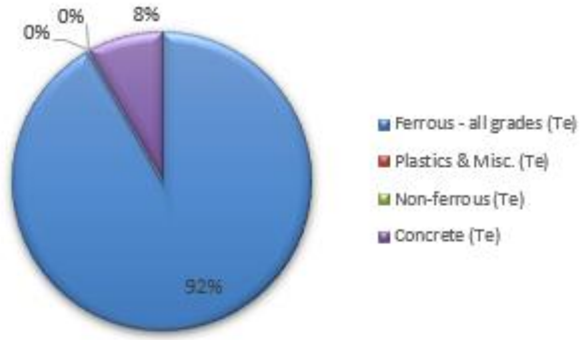

Figure 2-10 Proportion of Constituents for Installations in the Brenda Field

2.5.6 Nicol Field

The Nicol Field consists of a two well tie back via the Brenda Field manifold. A single rigid production pipeline and single rigid gas lift pipeline tie into Pipeline End Terminations (PLETs) at the Nicol end and are connected into the Brenda manifold via flexible jumpers. Flexible jumpers and tee spools are used to tie-in the Nicol wells to the PLETs. Both rigid pipelines are trenched and buried. Flexible jumpers are protected by concrete mattresses and grout bags at each end.

The Nicol Field also contains two steel (2) Xmas trees with FFS at the individual wells which will be fully recovered.

Table 2-14, Figure 2-11 and Figure 2-12 summarise the total and proportional weight of each component's constituent materials for the Nicol Field.

Table 2-14 Component Materials of Infrastructure to be Decommissioned – Nicol

Component Type	Weight (Te)				
	Ferrous – all grades	Non-ferrous	Plastics & Misc.	Concrete	Total
Pipelines	551	1	171	339	1,061
Installations	295	0	0	0	295
Total	**846**	**1**	**171**	**339**	**1,357**

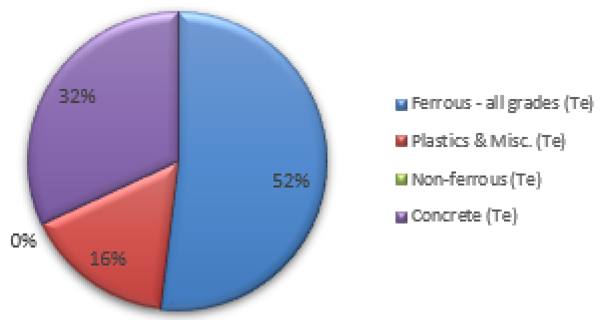

Figure 2-11 Proportion of Constituents for Pipelines in the Nicol Field

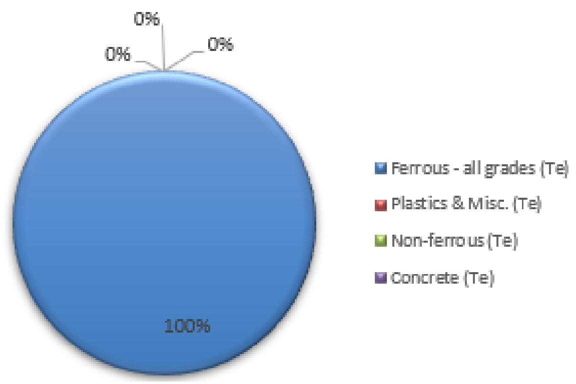

Figure 2-12 Proportion of Constituents for Installations in the Nicol Field

2.6 Waste Management

The management of waste during decommissioning is a highly regulated activity, which potentially requires compliance with both national and international legislation, depending on the destinations identified for dismantling and treating any wastes generated.

Premier's Health, Safety, Environment, and Security (HSES) Policy supports legal compliance and states that Premier will "do all that is reasonably practicable to prevent major accidents, ensure the safety of everyone involved with our operations and minimise environmental impacts".

Premier will meet statutory or supporting legislation requirements, assessing, and managing risks and seeking ways to continually improve performance with respect to waste management activities during the BLLP. Premier's commitments to waste management during decommissioning are to:

1. Manage waste from decommissioning activities in accordance with the applicable regulatory framework and all other obligations required by Premier's HSES Policy;
2. Manage the activities of all contractors and sub-contractors within the decommissioning supply chain that generate and manage waste and ensure their compliance with legal obligations and Premier's HSES Policy;
3. Treat wastes where practicable using the principles of waste hierarchy, with a focus on reuse and recycling of wastes whenever possible;
4. Measure and monitor the BLLP's performance with respect to waste management, including the setting of KPIs for the reuse and recycling of wastes.

2.7 Proposed Schedule

The proposed schedule for the decommissioning of the Greater Balmoral Area is summarised in Figure 2-13 below. This includes all decommissioning activities associated with the Brenda, Nicol, Glamis, Stirling, and Balmoral Fields operated by Premier.

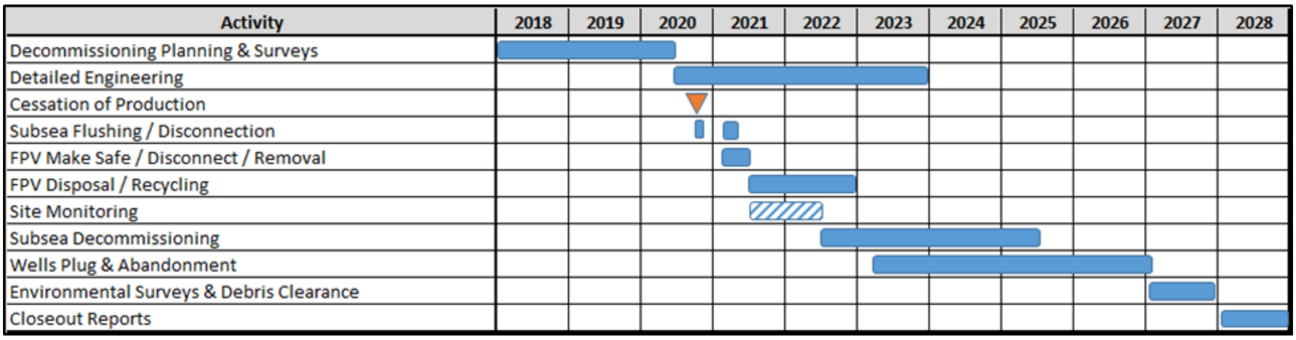

Figure 2-13 Gantt Chart of the Greater Balmoral Area Decommissioning Project Plan

2.8 Environmental Management Strategy

Premier is committed to operating responsibly and will never knowingly compromise our health, safety, or environmental standards to meet our operational objectives. We will do all that is reasonably practicable to prevent major accidents, ensure the safety of everyone involved with our operations and minimise environmental impacts. Premier's HSES signed policy is shown in Figure 2-14.

HEALTH, SAFETY, ENVIRONMENT & SECURITY POLICY

Premier Oil is committed to operating responsibly and securely, never compromising our Health, Safety, Environmental or Security standards. We will do all that is reasonably practicable to reduce HSES risks, ensure the safety and security of everyone affected by our operations, protect the environment by minimising our environmental impacts and protect our assets and business data.

To achieve this we will:

- Provide strong, visible leadership and commitment at all levels of the Company;
- Effectively identify hazards, threats and vulnerabilities to assess and manage risks;
- Meet or surpass our legal and other requirements (compliance obligations);
- Set objectives and targets to drive improvement;
- Support and train our people and assure their competence;
- Provide appropriate resources;
- Encourage open and honest communication;
- Effectively manage the HSES risks associated with contracted work;
- Maintain, safe, clean, healthy and secure workplaces to protect our people, environment, assets and data;
- Maintain protected high quality documented systems and processes;
- Plan and prepare for potential emergencies;
- Report, investigate and learn from any incidents and near misses;
- Routinely inspect the workplace and audit systems and processes;
- Seek opportunities to continually improve our performance.

It is the responsibility of everybody involved in Premier Oil to comply with our policies and Standards and to assist the Company in their implementation.

It is one of my primary duties to ensure that we all demonstrate strong leadership and visible commitment to Health, Safety, the Environment and Security.

Our goals to protect the environment and to continuously improve the health and safety of everyone involved with our operations, reflect how seriously I take this responsibility.

Achieving these goals goes beyond legal compliance: we must aspire to excellence and industry best practice in everything we do.

Our performance comes from the behaviours and actions of every one of us. We are all responsible for Health, Safety, the Environment and Security and I expect everyone:

- to follow procedures,
- intervene when we see unsafe acts or conditions;
- report all hazards and incidents; and
- seek to continuously improve our HSES management.

We must always be completely professional in every part of our business and show respect for our colleagues, partners, neighbours and the environment around us.

Premier Oil must be recognised as an environmentally and socially responsible company and as a safe and desirable place for our staff and contractors to work.

Tony Durrant
Chief Executive Officer
Premier Oil plc

1st January 2020

HEALTH, SAFETY & ENVIRONMENT. WE'RE ALL RESPONSIBLE.

NO SHORT CUTS. NO EXCEPTIONS. NO INCIDENTS.

PremierOil

Figure 2-14 Premier's HSES Signed Policy

3 ENVIRONMENTAL AND SOCIETAL BASELINE

3.1 Background

Information is provided here on the environmental baseline characteristics around the Greater Balmoral Area to help inform an assessment of the features that may be affected by the proposed decommissioning operations or may have a bearing on the nature and extent of relevant impacts. The potential interactions between project activities and environmental receptors are detailed and assessed in Section 6. As the activities associated with the DPs will form a nearly ongoing presence over seven years, environmental features and any relevant changes in their characteristics and sensitivities are described across the entire year.

The project scope (Section 2) and initial screening (Section 5) suggests that the majority of potentially significant environmental impacts would be felt within close proximity to the proposed development location. Therefore, environmental sensitivities are described on a local scale, with broader scale data only used where appropriate to certain ecological characteristics, such as broad scale habitat classification. Certain activities or events, such as water quality impacts, could potentially have more spatially extensive environmental impacts. In these instances, those environmental sensitivities that may be affected are described on a greater spatial scale.

In this regard, Table 3-3 provides an overview of all the environmental and societal sensitivities in the area. Details have been provided on the receptors most likely to be impacted by the proposed activities in the sections below. This baseline characterisation describes the current conditions of the receiving environment comprising the Greater Balmoral Area and is considered sufficient to enable effective evaluation of the potential environmental interactions from proposed decommissioning activities.

3.2 Summary of Environmental Surveys

Pre-decommissioning surveys for habitat assessment and environmental baseline data collection were conducted at the Balmoral development in 2016 (Fugro, 2018a&b). These surveys gathered seabed samples and imagery to acquire an understanding of the range of seabed habitats and communities present, including the potential presence of any species or habitats of conservation concern, such as pockmarks, prior to the commencement of decommissioning activities. The surveys were also designed to determine the nature and extent of any drill cuttings deposits at the development and establish a pre-decommissioning environmental baseline, focussing on areas of highest potential contamination.

3.2.1 Habitat Assessment Surveys

The pre-decommissioning habitat assessment survey was undertaken from June to July 2016 from a purpose built ROV support vessel. It used an ROV equipped with a video camera and digital stills system deployed from the survey vessel to gather footage of the seabed and associated visible animal communities to establish the nature of the seabed prior to decommissioning. The ROV was used as part of visual inspection to gather an inventory of the conditions of wells and other subsea infrastructure including protective concrete mattresses as well as a debris survey and inspection of burial depths and areas of exposure along pipelines.

As the ROV was already being used for this inspection work, the opportunity was taken to use it to investigate the seabed for habitat assessment purposes. The survey attempted to investigate the range of habitats present in the area via a good spread of video locations, within the limitations of the existing technical scope of work and operating restrictions of the ROV. As well as a general delineation of habitats, this investigation also placed emphasis on locating any areas of potential conservation value. Evaluation was also undertaken of specific features of relevance to potential environmental impacts associated with decommissioning activities, such as the nature and extent of any drill cuttings piles and the extent of any potential seabed scouring caused by the movement of FPV mooring chains over time. The features targeted for ROV investigation are summarised in Table 3-1 below.

Table 3-1 Summary of Features Investigated During Pre-Decommissioning Habitat Assessment Survey

Area of investigation	Features investigated	Method	No of locations
Well locations	Range of habitats and potential cuttings piles	Video transects and fixed locations	25
Seabed depressions	Range of habitats and potential submarine structures ("pockmarks")	Cruciform transects over depression (extended to surrounding seabed in some cases)	41
Mooring lines	Range of habitats and potential extent and depth of seabed scarring	Transects perpendicular to the mooring lines	8
Fishing activity	Range of habitats and evidence of fishing (e.g. trawl scarring and debris)	Single transect parallel to pipeline, one transect away from infrastructure	4
Seabed objects	General range of habitats based on pre-existing technical inspection locations	Single transect directed away from the object and other infrastructure	9
Additional locations	General range of habitats to cover gaps in the wider area	Single transect undertaken in a direction free from infrastructure	8

To investigate the seabed around wells, video footage and photographic stills were taken along transects around each well or, due to the proximity of wells, single fixed locations for group of wells. The locations of all video footage gathered are presented in Figure 3-1 below. To help characterise the full range of seabed habitats present in the Greater Balmoral Area, it was necessary to investigate a well-spaced spread of locations across the wider areas. To achieve this, a selection of sites already proposed for the technical investigation of unidentified seabed objects (USO) were chosen along with additional locations to cover any gaps in the wider Greater Balmoral Area. Transects were undertaken in directions away from existing infrastructure to establish the nature of the seabed surrounding those features.

Video footage and still photos were subsequently assessed to define the habitats present in accordance with the European Nature Information System (EUNIS) classification (EUNIS, 2016). Habitats and associated species composition and abundance were also further defined in relation to the key characteristics of the OSPAR threatened and/or declining habitat, "seapens and burrowing megafauna communities" (OSPAR, 2008). This also forms one of the biotopes which falls under the Scottish Priority Marine Feature (PMF) habitat "burrowed mud". The results of this analysis are discussed in Section 0.

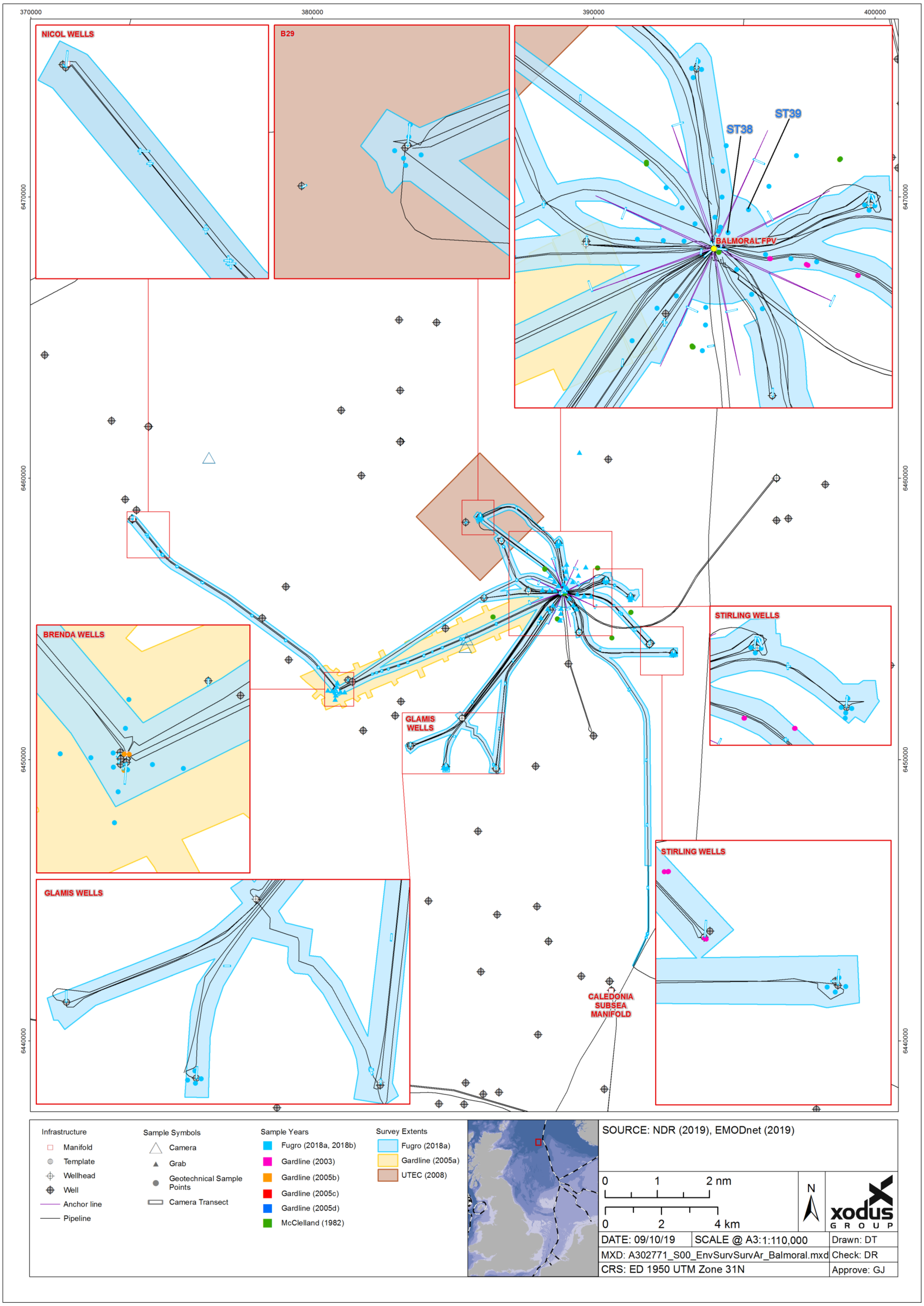

Figure 3-1 Greater Balmoral Area Geophysical Survey Effort and Sample Locations

3.2.2 Environmental Baseline Survey

The environmental baseline survey was conducted to establish the physical, chemical and biological characteristics of the seabed at Balmoral, providing a baseline prior to decommissioning for comparison. To ensure comprehensive coverage of key areas, the baseline survey sampling was sub-divided in to three major features, as follows:

- The Balmoral Template location (within and beyond 200 m);
- The Brenda field; and
- Remaining tiebacks and satellite fields.

This order reflects the sampling priority. The Balmoral central location, where most drilling activity has taken place, was given the highest priority. The baseline survey was conducted in December 2016. All grab sampling was conducted using a 0.1 m^2 dual van Veen grab. Samples gathered were sub-sampled, processed and stored as appropriate for a full suite of physical (sediment particle size analysis), chemical (including various hydrocarbon, organic matter, and heavy metal analyses) and biological (macrofauna) analyses. An overview of all successful baseline sampling during the pre-decommissioning baseline survey is provided in Figure 3-1. The results of this sampling are covered in Section 0.

3.2.2.1 Balmoral Template

A vessel- and diver-led sediment sampling regime was undertaken in 2018 within and surrounding the Balmoral Template to identify baseline conditions of the seabed habitat within which the large subsea installation sits (Fugro 2018a, 2018b). Examples of the seabed sediment types found at the Balmoral template can be seen in Figure 3-2.

The findings of these surveys indicate large variances in total hydrocarbon (THC) concentrations across the area surrounding the Balmoral Template. THC values recorded within sediment core samples ranged from 9.6 µg/g to 34,000 µg/g, with a mean of 2,550 µg/g and a median of 426 µg/g. THC levels exceeded the OSPAR (2006) ecological effects threshold of 50 µg/g in all core samples. This is an indication of some departure from baseline environmental conditions prior to the drilling of the wells supporting the Greater Balmoral development, particularly those at the Balmoral Field.

The sampling methods for the depths of interest are described in the sub-sections below.

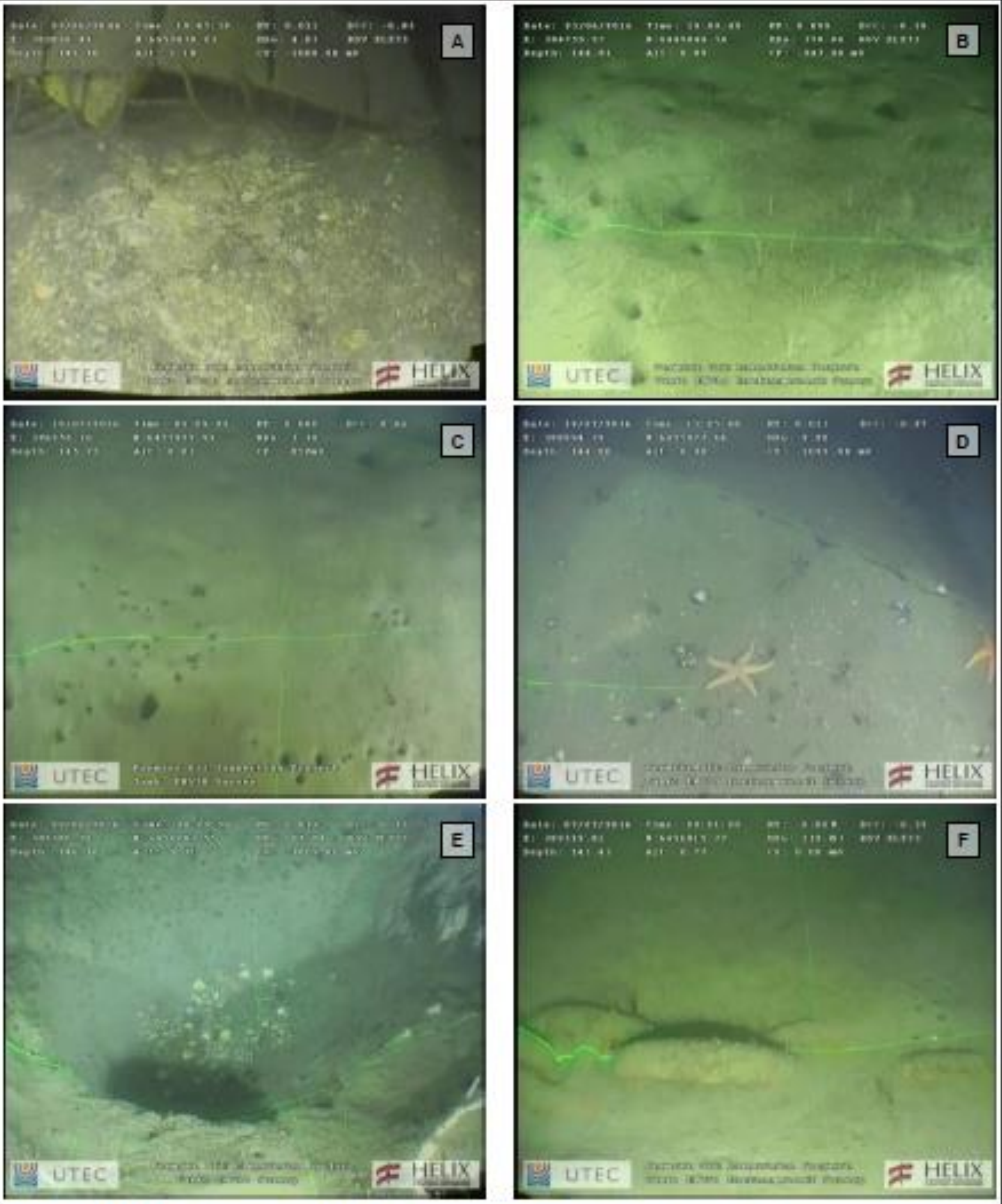

Photo A: ENV20: Industrial waste (J6.5). Possible drill cuttings accumulations, concrete mattress
Photo B: ENV12: Circalittoral find mud with faunal burrows and sea pens (*Virgularia mirabilis*) (A5.361)
Photo C: ENV78: Circalittoral fine mud with faunal burrows and sea pens (*V. mirabilis*) (A5.361)
Photo D: ENV79: Circalittoral fine mud (A5.36), shell fragments, faunal burrows, starfish (*A. rubens*)
Photo E: ENV28: Seabed depression with circalittoral fine mud (A5.36), shell fragments, faunal burrows, sea pen (*V. mirabilis*)
Photo F: ENV68: Circalittoral fine mud (A5.36) with anchor chain, faunal burrows, sea pens (*V. mirabilis* and *Pennatula phosphorea*)

Figure 3-2 Seabed survey sample examples (Fugro, 2018a).

Beyond 200 m of the Balmoral Template

The physical grab sampling of the seabed conducted as part of the pre-decommissioning surveys was focussed around the Balmoral Template, as this is the site of greatest historical drilling activity and associated discharges related to the development, including oil base drilling mud discharges. It is therefore expected to be the site of highest potential seabed contamination which, with respect to possible disturbance and redistribution of that contamination, has consequences for future decommissioning activities. Thus, sampling was concentrated in a radial pattern around it to ensure sufficient information was gathered to characterise the nature and extent of contamination for the purposes of decommissioning planning (Figure 3-1). The radial pattern consisted of a total of 33 proposed stations, including a transect of historical sample locations to allow for comparison with previous pre-development survey work (Figure 3-1).

From the 33 proposed stations, 29 were ultimately completed. The vessel based physical sampling of the Template area had to remain further than 200 m from the Balmoral FPV due to safety and logistical issues. Consequently, two stations could not be sampled as they were too close to the Balmoral Template to be reached safely by the survey vessel. Two further stations could not be completed due to operational issues on the FPV at the time, which prevented the survey vessel from entering the 500-m safety zone.

Within 200 m of the Balmoral Template

To complete the investigation of this area, it was decided that additional samples would be gathered from closer to the Template using divers. This would provide information on the physical and chemical characteristics of the sediments near the FPV and help evaluate the extent of any drill cuttings extending beyond the Template. Push cores were gathered during a DSV based campaign of pipeline operations in summer 2018. As some of these diver-based operations were to take place at the Template end of pipelines, the opportunity was taken to also gather sediment samples for analysis. Samples were gathered via push cores to allow for analysis of the extent of contamination in shallow sub-surface sediments. Sampling was proposed in a radial pattern covering the eight compass bearings at distances up to 150 m from the central location (Figure 3-1). However, due to logistical issues and safety concerns related to diver access from the vessel operating location, not all the proposed sample stations could be completed. A total of 10 out of 24 proposed stations were completed with samples only taken from along the three transects aligned to the north, northeast and east (Figure 3-1). Samples were taken at distances ranging from 10 to 150 m from the Template central location (Figure 3-1).

Unlike the vessel-based sampling which underwent a full suite of analyses, diver core samples from within 200 m have only undergone total hydrocarbon (THC) and total barium analysis (Fugro, 2019). The cores were divided by depth into three sections. The uppermost sections were consistently 0 to 2 cm deep, whereas the middle and bottom sections varied in height (up to 46 cm deep). All uppermost (surface) sections underwent THC analysis. It was observed that the four push core locations closest to the Template (cores 1, 4, 7 and 10), along with core 9, contained relatively high THC levels in the surface sediments (Figure 3-1). To further evaluate the extent of contamination into the local seabed, the associated middle and deepest push core sub-sections for these five sample stations also underwent THC analysis. Total barium analysis was undertaken for the upper section of all ten push cores to give an indication of the deposition of cuttings near the Balmoral Template (Table 3-2).

3.2.2.2 Brenda Field

Beyond the primary Template location, sampling investigated the Brenda field, where the proximity of wells suggests some potential for cuttings accumulation. Eleven out of twelve sample stations arranged in a cruciform pattern around the well cluster were successfully completed (Figure 3-1). The reference station was not completed as it was felt that data from the Balmoral Template reference stations would provide sufficient background for comparison (Fugro, 2018b).

3.2.2.3 Satellite Wells

Samples were also proposed at satellite wells within the Balmoral field itself and other tieback locations (Glamis, Stirling, and Nicol) to give an understanding of localised contamination at those sites. However, the extent of sampling was less extensive and given lower priority due to the lower levels of drilling involved at these locations. Twenty eight of the fifty-five proposed stations within the satellite well locations were not completed. The remaining twenty-seven stations were completed to help establish a comprehensive baseline understanding of the local seabed environment (Figure 3-1).

Overall, a total of 67 out of a proposed 100 stations were completed. Grab samples have undergone various analyses, which determine the physical nature of sediments (particle size analysis), hydrocarbon and heavy metal content (key environmental contaminants) and the make-up of invertebrate communities living in the seabed (macrofaunal analysis). Although not all sampling was completed, the baseline sampling, especially of key areas, was sufficient to provide a generalised inferred description of the physical, chemical, and biological characteristics of the site for this environment description.

3.2.2.4 Cuttings Deposit Study

The Balmoral Template is an arrangement of pipework through which oil is produced to the Balmoral FPV facility directly above it and gas lift and chemical injection can be provided to relevant wells. Eleven wells have been drilled through the Template with the discharge of drill cuttings leading to the formation of a cuttings deposit. A site-specific survey of the drill cuttings deposit accumulated over the Balmoral production Template was conducted in summer 2017 (Fugro, 2018c), and a characterisation of the cuttings pile and related environmental issues was compiled in 2019 (Premier, 2019f).

A total of 13 sampling locations were selected in a radial sampling pattern within the footprint of the Balmoral Template (primarily dictated by accessibility around infrastructure) to investigate the chemical and physical composition of the cuttings material present in the pile. Two replicate core samples were collected from the surface 0-50 cm layer of the pile at each of the designated sampling locations.

Divers were deployed to gather 75 cm deep push cores through the layers of drill cuttings accumulated over the Template (see Figure 3-3). A spread of samples was taken to help determine how the composition and concentration of contamination varied both across the structure and with depth. Two replicates were successfully gathered at each of the thirteen locations (Figure 3-3).

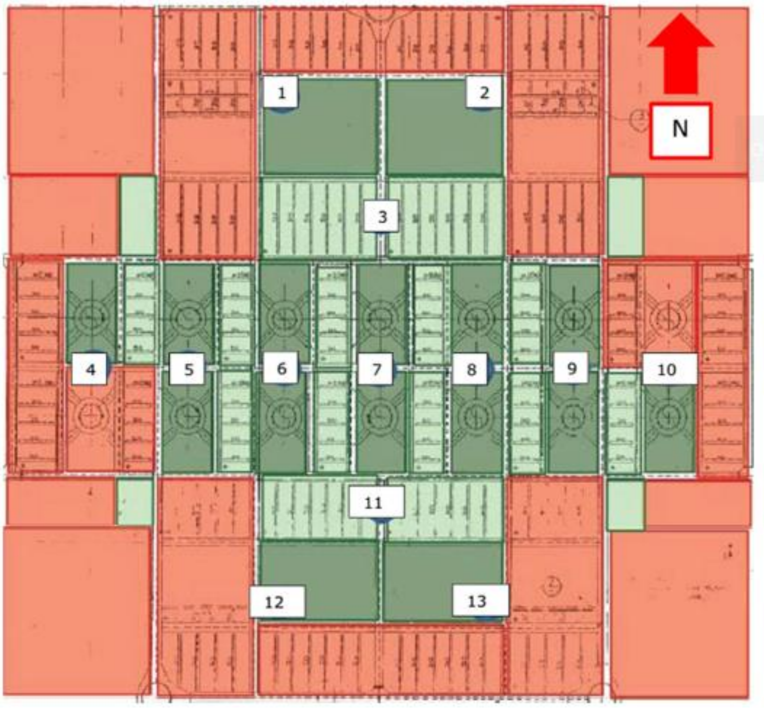

Figure 3-3 Balmoral Template Core Sampling Locations (Premier, 2019f)

All samples were cut into sub-sections representing different depths in the deposit and analysed for their THC concentrations (Figure 3-5). As well as the general analysis of THC levels from all samples, it was agreed that a full suite of physico-chemical analysis would be completed to further investigate a specific sub-set of the samples taken. This suite of analysis was undertaken for core locations 3, 6, 7, 9 and 13 (Figure 3-1), as these were the deepest cores taken, best represented the various parts of the deposit, and contained the highest THC levels observed in the original analysis. Results of cuttings deposit core sampling analysis are provided in Table 3-2 below.

Table 3-2 Results of the Balmoral Cuttings Pile Core Sampling Physicochemical Analysis (Fugro, 2018c)

Sample ID		Concentration (µg/kg)					
		THC	Arsenic	Cadmium	Lead	Mercury	Total Barium
Core 3	Top	19,300	5.03	0.371	59.0	0.044	9,870
	Mid	33,600	12.3	0.436	40.6	0.120	16,800
	Bottom	1,900	9.13	0.234	16.8	0.017	2,790
Core 6	Top	135	5.61	0.404	14.5	0.232	1,650
	Mid	2,210	6.79	4.79	33.7	0.112	7,930
	Bottom	15,600	6.81	0.969	35.7	0.056	13,600
Core 7	Top	168	11.2	0.836	41.0	0.056	4,830
	Mid	282	7.94	1.24	24.5	0.070	5,640
	Bottom	4,930	6.32	0.956	30.3	0.055	639
Core 9	Top	468	10.7	0.712	26.0	0.270	2,380
	Mid	1,500	8.83	1.89	43.9	0.206	7,110
	Bottom	4,080	12.9	0.221	37.0	0.056	18,900
Core 13	Top	452	24.0	2.08	42.7	0.379	1,520
	Mid	477	29.6	0.239	48.0	0.172	9,870
	Bottom	1,060	7.47	0.209	13.0	0.042	16,800

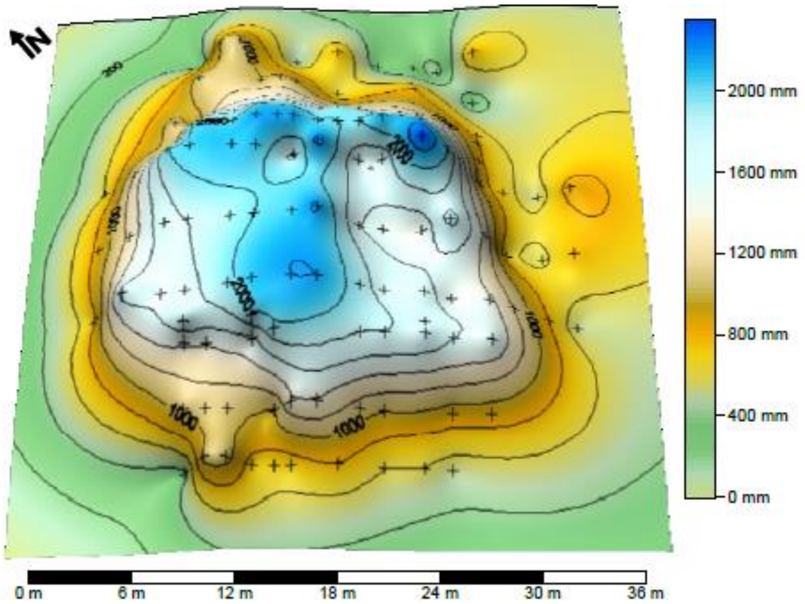

Figure 3-4 Balmoral Cuttings Pile Surface Plot (Based on Interpolation of Measured Cutting Depths) (Premier, 2019f)

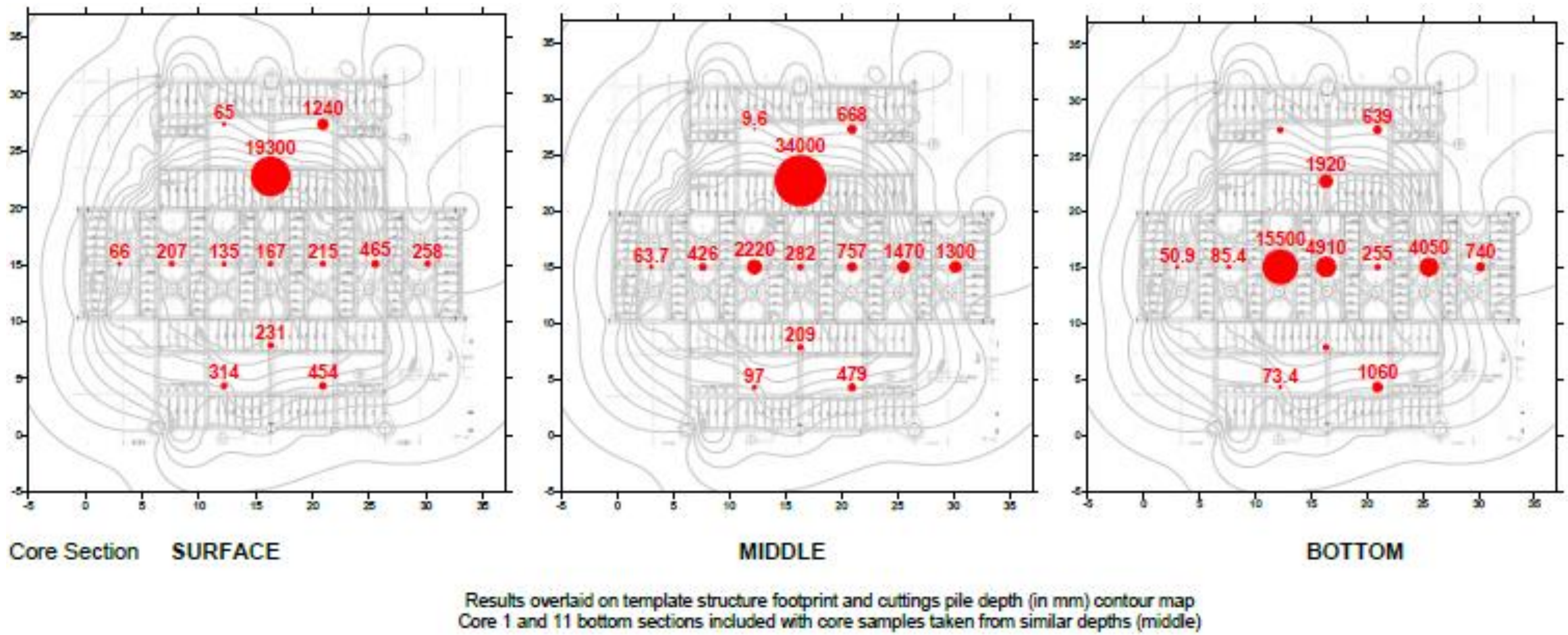

Figure 3-5 Balmoral Total Hydrocarbon Concentrations (mg/kg) in Core Section Recorded in June 2017 (Premier, 2019f)

3.2.3 Additional Environmental Surveys

A series of earlier site, habitat assessment and environmental baseline surveys have also been conducted in support of offshore operations at Balmoral and in adjacent licence blocks. These surveys have typically sought to characterise the seabed in the local area by using a combination of analogue techniques, such as side-scan sonar and multi-beam echo sounder, as well as seabed sampling methods, including digital stills camera/video systems and grab sampling. Information gathered regarding physical, chemical, and biological characteristics observed in the Balmoral development during this survey work is incorporated in the following sections where relevant.

3.3 Summary of Receptors

The baseline environment in the project area is summarised in Table 3-3. For most receptors, the information provided in Table 3-3 is considered sufficient to inform the environmental assessment of potential impacts within this EA. Receptors identified during the ENVID and consultation meetings as potentially of specific interest to stakeholders included commercial fisheries, seabed and benthic environment and water quality. These receptors are discussed in more detail in the following Sections.

Table 3-3 Baseline Summary of Environmental and Societal Receptors

Environmental Receptor	Description
Physical environment	
Weather and sea conditions	Water depth within the Greater Balmoral Area is approximately 151 m. The mean residual current surrounding the Greater Balmoral Area is approximately 0.1 m/s (Wolf *et al.*, 2016). Wave energy at the seabed ranges between 'low' (< 0.21 N/m^2) and 'high' (> 1.2 N/m^2) in the CNS region (McBreen *et al.*, 2011). The wave height within the area of proposed operations ranges from 2.11-2.40 m and the annual mean wave power is 24.1–30 kW/m, which is typical of the wider area (NMPI, 2019).
Key Conservation interests	
OSPAR (2008) List of Threatened and/or Declining Habitats and Species	
Ocean quahog (*Arctica islandica)*	Few juveniles were observed during habitat surveys, though in numbers too low and at too early a life history stage to be considered an 'aggregation'. Ocean quahog larvae are known to settle within the proximal Fladen Ground (Witbaard *et al.*, 2003) and aggregations are protected at designated sites within the CNS; including: the Norwegian Boundary Sediment Plain Marine Protected Area (MPA) (32 km) and East of Gannet and Montrose Fields MPA (77 km). However, the Greater Balmoral Area is not expected to protect any aggregations of this protected species.
Seapens and burrowing megafauna communities	During the Fugro (2017a) habitat assessment survey observations at the Greater Balmoral Area revealed the presence of seapens and burrowing megafauna communities.
Conservation sites	
Special Area of Conservation (SAC)	The nearest SAC to the Balmoral decommissioning project is the Scanner Pockmark SAC, which is situated 9 km from the project area. This site is designated for the presence of submarine structures formed by leaking gases,

Environmental Receptor	Description
	which are found within seabed depressions referred to as "pockmarks" and support reef-like communities distinct from the surrounding soft sediments (Premier Oil, 2018). The SAC is a singular large depression which contains Methane Derived Authigenic Carbonate (MDAC) blocks made by leaking gases, which support a fauna typical of rocky reefs, including anemones (*Urticina feline* and *Metridium senile)* and squat lobsters (JNCC, 2018a). Pockmarks have been observed in the Greater Balmoral Area; however, these have been suggested to be formed by leaking fluids as opposed to gases; therefore, there are no PMFs present in the Balmoral survey area (UTEC, 2008; SNH, 2014).
Nature Conservation Marine Protected Area (NCMPA)	The nearest NCMPA to the Greater Balmoral Area is the Norwegian Boundary Sediment Plain MPA located 29 km from the project area. The site is designated for the conservation of ocean quahog aggregation, including sands and gravels as their supporting habitat (JNCC, 2014). The Central Fladen MPA is located 88 km to the north west of the project area. The site is designated for features such as burrowed mud (seapens and burrowing megafauna and tall seapen components), and sub-glacial tunnel valley representative of the Fladen Deeps Key Geodiversity area (JNCC, 2018b). The East Gannet and Montrose Fields located 77 km to the south of the project area. The site is designated for the conservation of ocean quahog aggregation.
Special Protection Area (SPA)	There are no SPAs in the vicinity of the project area. The closest SPA is the Buchan Ness to Collieston Coast SPA located approximately 188 km to the south west of the project area. The site is of importance as a nesting area for a number of seabird species (gulls and auks). These birds feed outside the SPA in the nearby waters as well as more distantly.
Annex I Habitats	The Greater Balmoral Area is an area with characteristics similar to those supporting Annex I submarine structures which generate MDAC. However, no Annex I Habitats were identified in any of the site-specific surveys.
Conservation Species	
Coastal and Offshore Annex II species most likely to be present in the project area	
Pinnipeds – Harbour and Grey Seals	Pinnipeds are not expected in significant numbers across the project area, given its distance from shore. Densities are currently estimated at approximately 0-1 individuals per 25 km^2 for both harbour and grey seals (Russell *et al.*, 2017). This is due to the site being approximately 187 km offshore and even farther from important seal haul outs.
European Protected Species most likely to be present in the project area	
Harbour porpoise	The harbour porpoise (*Phocoena phocoena*) is a small, highly mobile species of cetacean that is the most commonly occurring cetacean in UK waters. As such, harbour porpoise can also be found in the waters of the proposed decommissioning area. Particularly large numbers occur in near the project area during the summer months, with a peak in numbers in July and August (Reid *et al.,* 2003; Hammond *et al.,* 2017). The density of harbour porpoise is roughly

Environmental Receptor	Description
	estimated at 0.6-0.7 animals/km^2 across the project area (Hammond *et al.,* 2017).
White-sided dolphin	The Atlantic White-sided dolphin (*Lagenorhynchus acutus*) species lives mainly in cool waters (7-12°C), particularly seaward or along the edges of the continental shelf in depths of 100-500 m (Reid *et al.,* 2003). However, the species can also be numerous in much deeper, oceanic waters. The species comes onto continental shelfs such as those of the north western North Sea (Reid *et al.,* 2003). *L. acutus* are found in deep waters around the north of Scotland throughout the year but enter the North Sea mainly in the summer (Reid *et al.*, 2003). The relative density of white-sided dolphin is estimated at 0.021 animals/km^2 in the project area (Hammond *et al.,* 2017).
Minke whale	Minke whales (*Balaenoptera acutorostrata*) are usually sighted in pairs or in solitude, though groups of up to 15 individuals can be sighted feeding within their seasonal feeding grounds. The relative density of minke whales is estimated at 0.037 animals/km^2 in the project area (Hammond *et al.,* 2017).
White- beaked dolphin	White-beaked dolphins (*Lagenorhynchus albirostris*) are usually found in water depths of between 50 and 100 m in groups of around 10 individuals, though groups of up to 500 animals have been seen. They are present in the UK waters throughout the year, however more sightings have been made between June and October. The relative density of white-beaked dolphin is estimated at 0.032 animals/km^2 in the project area (Hammond *et al.,* 2017).
Benthic environment	
Seabed type	SSS data from a survey by UTEC (2008) showed a seabed of uniform with moderate reflectivity. Published British Geological Survey (BGS) data described the seabed sediment in this area as sandy mud. The presence of coherent sediments at the seabed is confirmed by the presence and preservation of numerous trawl scars. Given the consistency of the sonar reflectivity characteristic, it is expected that this sediment type will occur across the Balmoral survey area. These results are comparable to the Gardline rig site and habitat survey (Gardline, 2008) at the Balmoral A33 well locations 4 km South East of Balmoral Template location). The seabed is a veneer of very fine silty sand underlain throughout the site by acoustically well-layered sediments of the Witch Ground Formation (reported by BGS to consist predominantly of very soft to soft clays and silts). A pre-decommissioning environmental baseline survey was undertaken for the Greater Balmoral Area by Fugro (2017b). During this survey, 100 grab samples were taken. The sediment type was classified as poorly sorted coarse to medium silt with moderate carbonate and low organic content. Hydrocarbon level showed similar distribution levels across the project site area and was typical of low level weathered petroleum residues commonly found in CNS sediments. The majority of the Balmoral survey area was identified as the EUNIS biotype, 'Circalittoral fine mud' (A5.35) (Fugro, 2017b). The Scottish PMF 'burrowed mud' and its component habitat, 'Seapens and burrowing megafauna in circalittoral fine mud', were prevalent throughout the area (Fugro, 2017b).

Environmental Receptor	Description
Benthic Fauna	The Fugro (2017b) pre-decommissioning survey found polychaetes to be the dominate species *(Paramphinome jeffreysii*, *Levinsenia gracilis)* and communities typical of the CNS. A total of 67 stations were sampled for macrofaunal content using a 0.1m^2 dual van Veen grab. The results showed that 181 taxa reported around the Balmoral Template, 91 (50.3%) were annelids, 36 (19.9%) were arthropods, 37 (20.4) were molluscs, 6 (3.3%) were echinoderms and 11 (6.1%) were other phyla.
Plankton	
Plankton	In both the northern and central regions of the North Sea, the phytoplankton community is dominated by dinoflagellates of the genus *Ceratium (fusus, furca, lineatum)* and diatoms such as *Thalassiosira spp*. and *Chaetoceros spp.* In recent years the dinoflagellate *Alexandrium tamarense* and the diatoms *Pseudo-nitzschia* (known to cause amnesic shellfish poisoning) have been observed in the area (DECC, 2016). Zooplankton communities in this area are dominated in terms of biomass and productivity by copepods, particularly *Calanus* species such as *C. finmarchicus* and *C. helgolandicus*. Other important taxa include *Acartia*, *Temora*, and *Oithona spp*. Larger zooplankton species such as *euphausiids* and decapod larvae are also important to the zooplankton community in this region (DECC, 2016). *Calanus finmarchicus* has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Analysis of Continuous Plankton Reader (CPR) surveys in the 10-year period between 1997 and 2007 shows that the biomass of *C. finmarchicus* in the CNS attains higher levels than in the Southern North Sea (SNS) but lower than in the NNS. The trend indicates a small increase in abundance between April and May within the CNS which corresponds to an increase in phytoplankton in April. Overall abundance of *C. finmarchicus* has declined dramatically over the last 60 years, which has been attributed to changes in seawater temperature and salinity (Beare *et al.,* 2002; FRS, 2004).
Fish – spawning and nursery grounds	
Spawning grounds	The Greater Balmoral Area is located within the spawning grounds of cod (*Gadus morhua)*, mackerel (*Scomber scombrus)*, *Nephrops* (*Nephrops norvegicus)* and Norway pout (*Trisopterus esmarkii)* (Coull *et al.*, 1998; Ellis *et al.*, 2012).
Nursery grounds	The following species have nursery grounds near the project: anglerfish (*Lophius piscatorius)*, blue whiting (*Micromesistius poutassou)*, cod, European hake (*Merluccius merluccius)*, haddock (*Melanogrammus aeglefinus)*, herring (*Clupea harengus)*, ling (*Molva molva)*, mackerel (*Scomber scombrus)*, *Nephrops*, Norway pout, sandeel (*Ammodytidae spp.)*, spotted ray (*Raja montagui)*, spurdog (*Squalus acanthias)*, and whiting (Coull *et al.*, 1998; Ellis *et al.*, 2012). However, fisheries sensitivity maps indicate that the probability of significant aggregations of juveniles of these species in the offshore project area is low (Ellis *et al.*, 2012).
Probability of 0 age group fish aggregation	Aires *et al.* (2014) provides modelled spatial representations of the predicted distribution of 0 age group fish. The modelling indicates the presence of juvenile fish (less than one year old) for multiple species: anglerfish, blue whiting,

Environmental Receptor	Description
	European hake, haddock, herring, mackerel, horse mackerel, Norway pout, plaice, sprat, and whiting. Across the Greater Balmoral Area, the probability of juvenile fish aggregations occurring is very low; <0.2 for all species.
Seabirds	
According to the density maps provided in Kober *et al.* (2010), the following species could be found within the Greater Balmoral Area: northern fulmar (*Fulmarus glacialis)*, Manx shearwater (*Puffinus puffinus)*, European storm-petrel (*Hydrobates pelagicus),* northern gannet (*Morus bassanus)*, Arctic skua (*Stercorarius parasiticus)*, great skua (*Stercorarius skua)*, black-legged kittiwake (*Rissa tridactyla)*, great black-backed gull (*Larus marinus)*, common gull (*Larus canus)*, lesser black-backed gull (*Larus fuscus)*, herring gull (*Larus argentatus)*, Arctic tern (*Sterna paradisaea)*, common guillemot (*Uria aalge)*, razorbill (*Alca torda)*, little auk (*Alle alle)* Atlantic puffin (*Fratercula arctica)*and pomarine skua *(Stercorarius pomarinus)*. Seabird Oil Sensitivity Index (SOSI) identifies areas at sea where seabirds are likely to be most sensitive to surface pollution (Webb *et al.*, 2016). Seabird vulnerability in Blocks 15/25 and 16/21 is low throughout the year with no data for November and December. Block 15/25 experiences a Medium SOSI value only in the month of June (Webb *et al.*, 2016). The risk of an oil spill from the proposed operations at Balmoral is considered remote and therefore the overall risk to birds is considered negligible.	

Seabird Oil Sensitivity Index

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
15/19	5*	5	5*	5*	5	5	5	5	5	5*	N	N
15/20	5*	5	5*	5*	5	4	5	5	5	5*	N	N
15/24	5*	5	5*	5*	5	4	5	5	4	4*	N	N
15/25	**5***	**5**	**5***	**5***	**5**	**4**	**5**	**5**	**5**	**5***	**N**	**N**
15/29	2*	5	5*	5*	5	5	5	5	4	4*	N	N
15/30	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/16	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/17	5*	5	5	4*	4	5	5	5	5	5*	N	N
16/21	**5***	**5**	**5***	**5***	**5**	**5**	**5**	**5**	**5**	**5***	**N**	**N**
16/22	5*	5	5	5*	5	5	5	5	5	5*	N	N
16/26	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16/27	5*	5	5	4*	4	5	5	5	5	5*	N	N

Key						
	1 = Extremely high	2 = Very high	3 = High	4 = Medium	5 = Low	N = No data
	* in light of coverage gaps, an indirect assessment of SOSI has been made					

Societal Receptor	Description
Commercial fishing	
The Greater Balmoral Area is in International Council for the Exploration of the Seas (ICES) Rectangles 45F1 and 45F0 (Scottish Government, 2019). Vessel Monitoring System (VMS) data from 2009-2013 for demersal, shellfish and pelagic species (Kafas *et al.,* 2013) indicates that fishing intensity within ICES rectangles 45F1 and 45F0 is low to medium for pelagic species (namely herring) and low for demersal species, but high for shellfish species (namely *Nephrops*) when compared to the wider area (Kafas *et al.,* 2013). In 2018 fishing effort in ICES rectangle 45F1 were highest for September and October, together accounting for 56% of the total number of days fished, with February, April, May, July, August, and November contributing for the remaining 44% of fishing effort with the rest of the months being disclosive (Scottish Government, 2019). In 2018 fishing effort in ICES rectangle 45F0 were highest for May and October, accounting for 51% of the total number of days fished, with all other months contributing for the remaining 49% of fishing effort (Scottish Government, 2019). Trawls were the most utilised gear in rectangle 45F1 and 45F0. In total, trawls contributed to more than 99% of total fishing effort in the ICES rectangle 45F1 and 45F0 with <1% made up from seine nets (Scottish Government, 2019).	

Fishery Landings in ICES Rectangle 45F0

Species type	2018		2017		2016		2015		2014	
	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)
Demersal	551	1,015,488	1,126	2,159,207	523	946,707	230	304,201	606	850,199
Pelagic	125	77,839	3,146	1,477,408	3,450	1,876,544	2,208	785,146	2,894	839,768
Shellfish	146	539,525	630	2,561,223	181	819,300	88	350,360	704	2,747,700
Total	**822**	**1,632,852**	**4,902**	**6,197,838**	**4,154**	**3,642,551**	**2,526**	**1,439,707**	**4,204**	**4,437,667**

Fishery Landings in ICES Rectangle 45F1

Species type	2018		2017		2016		2015		2014	
	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)
Demersal	365	643,789	536	1,007,325	627	1,034,037	482	620,334	388	543,272
Pelagic	1	674	0	5	421	189,494	1,892	676,413	352	119,962
Shellfish	293	988,946	323	1,236,543	218	1,045,948	241	1,012,362	421	1,832,176
Total	**659**	**1,633,409**	**859**	**2,243,873**	**1,266**	**2,269,479**	**2,615**	**2,309,109**	**1,161**	**2,495,410**

Other sea users	
Shipping activity	The Greater Balmoral Area is in an area that experiences very low shipping intensity (OGA, 2016).

<table>
<tr><th>Societal Receptor</th><th>Description</th></tr>
<tr><td>Oil and Gas</td><td>The Greater Balmoral Area is located in the CNS in an area of extensive oil development with several fields located nearby. Oil and Gas surface infrastructure within 40 km of the project area is described below[Note 1]:
<table>
<tr><th>Installation</th><th>Installation Type</th><th>Operator</th><th>Distance & direction</th></tr>
<tr><td>Alba North</td><td>Platform</td><td>Ithaca Energy Limited</td><td>19 km SW</td></tr>
<tr><td>FPSO Global Producer III</td><td>FPSO</td><td>Total</td><td>20 km NW</td></tr>
<tr><td>Britannia</td><td>Platform</td><td>Chrysaor</td><td>20 km SE</td></tr>
<tr><td>Alba FSU</td><td>FSU</td><td>Ithaca Energy Limited</td><td>21 km SW</td></tr>
<tr><td>Andrew</td><td>Platform</td><td>BP</td><td>27 km SE</td></tr>
<tr><td>Hummingbird FPSO</td><td>FPSO</td><td>Teekay</td><td>29 km SE</td></tr>
<tr><td>Tiffany</td><td>Platform</td><td>CNRI</td><td>29 km NE</td></tr>
</table></td></tr>
<tr><td>Telecommuni-cation</td><td>The closest submarine cable to the Greater Balmoral Area is the TAMPNET 3 cable, which is located 40 km to the east (KIS-ORCA, 2019).</td></tr>
<tr><td>Military activities</td><td>There are no military restrictions on Blocks 16/21 or 15/25 (OGA, 2018) and there are no known military activities within the area (NMPI, 2019).</td></tr>
<tr><td>Renewables</td><td>There is no renewable energy activity in the vicinity of the Greater Balmoral Area (NMPI, 2019).</td></tr>
<tr><td>Wrecks</td><td>There are two unknown wrecks in the vicinity of the project area, approximately 5km south east and 4 km north west of the project area. Additionally, there is one name wreck (Elhanan T) located approximately 8 km from the project area. This wreck is classified as a non-dangerous wreck (NMPI, 2019).
There are no protected wrecks in the vicinity of the project area (NMPI, 2019).</td></tr>
</table>

Notes:

1. FPSO = Floating Production Storage and Offloading; FSU = Floating Storage Platform; BP= British Petroleum; CNRI = Canadian National Resources International

3.4 Seabed Habitats and Benthos

The natural seabed depth across the project area ranges from approximately 138 m LAT at the easternmost satellite well locations south of the Stirling field, to 152 m below LAT at the Nicol wells in the far northwest of the area.

The Greater Balmoral Area has been surveyed on numerous occasions, with this review incorporating surveys conducted between 1982 and 2018. The extent of the geophysical survey effort conducted across the Greater Balmoral Area and the locations of camera stations and transects, environmental grab samples and geotechnical samples are illustrated in Figure 3-1.

The natural seabed generally comprises poorly sorted coarse to medium silt with moderate carbonate and low organic content. There are numerous seabed depressions present across the area, although none of the more than 40 depressions investigated in the Fugro (2018a) and Gardline (2005) surveys were found to support MDAC or associated communities that could classify these depressions as the Annex I habitat ‘Submarine structures made by leaking gases’.

Visible epifauna was generally consistent across the survey area and included starfish, sea urchins and hermit crabs. Where hard surfaces were available for attachment, anemones, soft corals, sponges, and hydrozoans were present. Seapens were common across the survey area, as were visible burrows. Assessment for the presence of the OSPAR protected/threatened habitat, 'Seapen and burrowing megafauna communities', suggested that the Greater Balmoral Area is a strong example of this habitat. No other protected habitats were identified (Fugro 2018a).

Some stations located close to existing drill centres exhibited rock dump/rubble and debris, and these areas were associated with higher incidence of shell fragments, starfish and fish of the cod family (gadoids). Areas of drill cuttings only appeared to support starfish, with other epifauna absent.

The benthic macrofauna was fairly uniform across the Greater Balmoral Area, with all sample clusters classified as EUNIS biotope A5.375, '*Levinsenia gracilis* and *Heteromastus filiformis* in offshore circalittoral mud and sandy mud'. The polychaete, *Paramphinome jeffreysii,* was the most abundant species at the majority of stations. While there were nine distinct clusters of stations identified, these all supported similar taxa and were differentiated from each other only by slight differences in species composition. The only clearly different result was at Station ST38, located 200 m northeast of the Balmoral Template, where the hydrocarbon-tolerant polychaete, *Cirratulus cirratus,* was the second most abundant taxon. This species did not occur in the top ten most abundant taxa in any of the other stations across the survey area and indicates the community at ST38 is affected by contamination from drilling activity.

Multivariate analysis showed that particle size was the single variable that best correlated with faunal community composition. A better correlation was found when combining three variables: sediment THC, carbonate, and chromium concentration. This indicates that community composition is affected by both natural variation in sediment distribution, and the influence of drilling contamination as evident at Station ST38.

Juvenile ocean quahog (*Arctica islandica*) were found in sparse numbers across the majority of stations (the maximum in any single sample was seven individuals). No adults were identified, indicating the survey area is not of particular importance to this species (Fugro, 2018b).

Chemical analysis showed that there was residual low-toxicity oil-based mud contamination within 300 m of the Balmoral Template and satellite drill centres, and THC exceeded background levels for the CNS at these locations. The Brenda cluster was free of this contamination. Heavy metal concentrations were also slightly elevated close to the Balmoral Template.

The cuttings accumulation on and around the Balmoral Template was investigated in Fugro (2018c and 2019). THC (measured over the nC10 – nC40 carbon range) ranged from 9.6 mg/kg to 34,000 mg/kg (mean 2,550 mg/kg) in the Template samples, and 8 mg/kg to 4,360 mg/kg (mean 410 mg/kg) in the samples surrounding the Template. United Kingdom Offshore Operators Association (UKOOA) (2005) gives a THC ecological effects threshold of 50 mg/kg. This threshold was exceeded in the top-most sections of sediment at all stations on the Template and the surrounding seabed. Some samples from the bottoms of the cores fell below this threshold, and these were generally interpreted as the core penetrating the natural seabed below the cuttings deposit. No sampling of the macrofauna on the cuttings deposit has been undertaken; however, the THC recorded across the deposit would be expected to have a strong effect on macrofauna community composition. This was evident at Station ST38 from Fugro (2018b), discussed previously. This station had a THC of 609 mg/kg, which is in line with some of the samples taken from the cuttings deposit but well below the maximum concentrations recorded. There was a clear effect on the macrofauna at this station as discussed above. The likely extent of the impact from drill cuttings on the benthos can be inferred by referring to Fugro (2018b). While ST38, located 200 m northeast of the Template showed elevated THC and a clear effect on community composition, the next station out on the same bearing, ST39 located 500 m from the Template showed THC well below the ecological effects threshold, and a macrofauna community comparable to stations remote from any development. Stations located 300 m or more from the Template on other bearings showed no significant differences in macrofauna composition when compared to more remote stations, suggesting that the cuttings contamination extends out from the Template in a predominantly northeast direction, and that the impact from this contamination fades away between 300m and 500 m from the Template depending on the bearing.

3.5 Other Sea Users

3.5.1 Maritime Activities

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields also generate moderate vessel traffic in the form of support vessels (DECC, 2016).

Regionally, the CNS contains numerous international ports and the area sees a moderate number of oil tankers, cargo vessels and ferries passing through (DTI, 2001). Shipping activity is assessed to be very low in Blocks 15/25 and 16/21 (DECC, 2016; OGA, 2016). Figure 3-6 below illustrates the relative vessel activity surrounding the Greater Balmoral Area.

An average of 5 or less vessel transits per week pass within the project area with the majority of traffic consisting of small to medium sized cargo ships (MMO, 2018). Additionally, to the north of the project area there is a cargo vessel route that averages between 2-10 vessels per week (NMPI, 2019). Other vessels that pass within the vicinity of the project area include tankers, passenger vessels, non-profit service vessels, dredging or underwater operation vessels, recreational vessels, and fishing vessels. A composite from Automatic Identification System (AIS) vessels tracks recorded within the Greater Balmoral Area in 2015 is presented in Figure 3-10.

There are no renewable energy sites within 40 km of the Greater Balmoral Area. The Hywind 2 Demonstration is the closest, located approximately 147 km to the south west of the Balmoral Area's subsea infrastructure (NMPI, 2019).

There are no military restrictions on Blocks 15/25 and 16/21 (OGA, 2018) and military activity does not generally take place in this region.

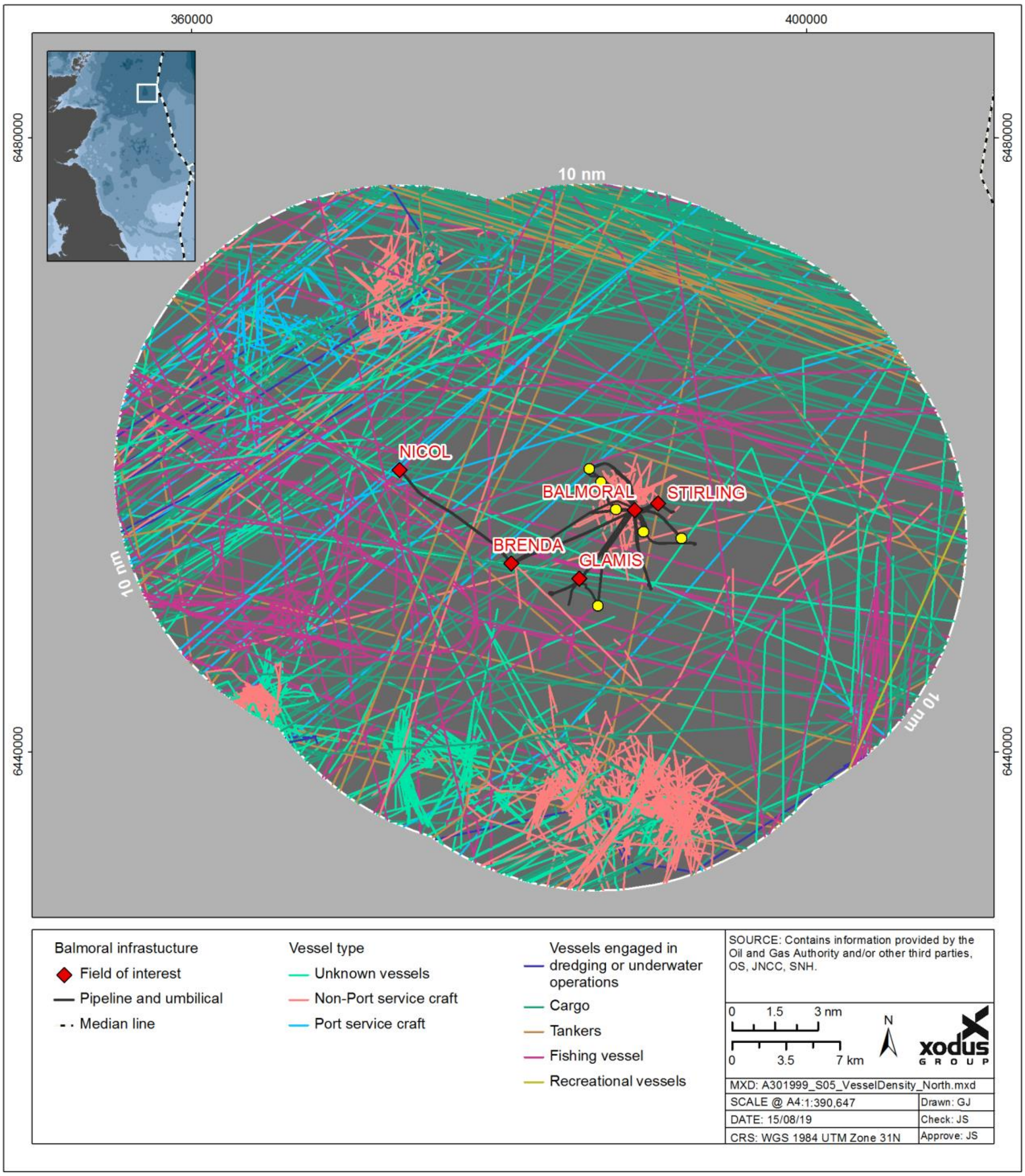

Figure 3-6 Vessel activity around the Greater Balmoral Area over period July 2016 - June 2017 (MMO, 2018)

3.5.2 Commercial Fisheries

This Section describes the type of fishing vessels occurring in the area, the weight and value of fish landed in the UK and the fishing effort. The study area considered to be relevant for the decommissioning activities is shown in relation to the ICES rectangles, 45F0 and 45F1. To provide the fullest picture of fisheries within the area, the associated landings and effort trends for ICES rectangles 45F1 and 45F0 have been provided for the five most recent fishing years (2014-2018 inclusive; Table 3-4 and Table 3-5).

According to fishing data from the Scottish Government (2019), the waters comprising the Greater Balmoral Area are fished for a variety of species by both UK and foreign vessels. ICES rectangle 45F1 is predominantly targeted for deep-water demersal and pelagic species, whilst the adjacent ICES rectangle 45F0 experiences a much greater amount of pelagic fishing (Table 3-4). For the last five fishing years, the total landings value was greater in ICES rectangle 45F0 than 45F1 by nearly £6.4M, and the live weight of those landings were greater by approximately 10,000 Te because of this discrepancy (Table 3-4).

This observation reflects the dramatically larger tonnage of pelagic fish species caught in ICES rectangle 45F0, comprising 71% of the total landings live weight in that region, and constituting over four times the average live weight of pelagic landings in 45F1 (Table 3-4). Nevertheless, the average landings values were relatively similar between the two ICES rectangles due to the relatively consistent landings of high value shellfish landed in both rectangles. Shellfish contributed the greatest total and greatest average monetary value between 2014 and 2018 across the Greater Balmoral Area. The total annual landings for the Greater Balmoral Area (as defined by ICES rectangles 45F0 and 45F1) were ≤1% of the total landings within the UKCS for each of the five most recent fishing years.

Table 3-4 Live Weight and Value of Fish and Shellfish from ICES Rectangles 45F1 and 45F0 Between 2014-2018 (Scottish Government, 2019)[Note 1]

ICES rectangle	Species type	2018		2017		2016		2015		2014	
		Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)	Live weight (Te)	Value (£)
45F0	Demersal	551	1,015,488	1,126	2,159,207	523	946,707	230	304,201	606	850,199
	Pelagic	125	77,839	3,146	1,477,408	3,450	1,876,544	2,208	785,146	2,894	839,768
	Shellfish	146	539,525	630	2,561,223	181	819,300	88	350,360	704	2,747,700
	Total	**822**	**1,632,852**	**4,902**	**6,197,838**	**4,154**	**3,642,551**	**2,526**	**1,439,707**	**4,204**	**4,437,667**
45F1	Demersal	365	643,789	536	1,007,325	627	1,034,037	482	620,334	388	543,272
	Pelagic	1	674	0	5	421	189,494	1,892	676,413	352	119,962
	Shellfish	293	988,946	323	1,236,543	218	1,045,948	241	1,012,362	421	1,832,176
	Total	**659**	**1,633,409**	**859**	**2,243,873**	**1,266**	**2,269,479**	**2,615**	**2,309,109**	**1,161**	**2,495,410**
Total for both Blocks		**1,481**	**3,266,261**	**5,761**	**8,441,711**	**5,420**	**5,912,030**	**5,141**	**3,748,816**	**5,365**	**6,933,077**
UK Landings Total		**552,564**	**751,777,445**	**564,152**	**715,187,693**	**564,677**	**729,366,238**	**547,426**	**574,430,034**	**604,344**	**665,509,833**

Notes:

1. All values are rounded to the nearest whole number. For purposes of identifying totals within the UK, disclosive data has not been included to limit the effects of zero-inflation on the results.

Average annual fishing effort, as a measure of total fishing days per annum, was slightly lower in ICES rectangle 45F1 and slightly higher in 45F0 than the UK average for the last five fishing years (Scottish Government, 2019). The average landings value and live weight tonnage followed a similar pattern, though the differences from the UK average were more marked. When comparing between data sets, it is worthwhile considering the catch per unit effort (CPUE), a measure of the weight of catches versus per number of effort days (an indirect measure of fish availability). The average CPUE for ICES rectangle 45F0 was 4.7 Te/day, which is only marginally higher than the average for the UKCS across this period (4.3 Te/day), whilst the CPUE for 45F1 was roughly half that of the UK average for the 2014-2018 fishing years (2.4 Te/day; Scottish Government, 2019). The observation of a slightly higher than average CPUE in 45F0 reflects the exceptional landings in that region in 2014, 2016 and 2017. Based on the level of pelagic fishing occurring in this region, these markedly large catch years are indicative of opportunistic catches of transient pelagic species (e.g. herring and mackerel) rather than catches of relatively stable demersal species (e.g. *Nephrops*, etc.).

Monthly fishing effort within ICES rectangle 45F0 has been recorded as disclosive or no data for several months (predominantly May, June, and July) each year between 2014 and 2016, indicating low levels of fishing activity during those times. Fishing effort is generally highest between September and November. Trawls were the most utilised gear type for ICES rectangle 45F0 over all the years, other gear types used include seine nets and miscellaneous gear (Scottish Government, 2019).

Total fishing effort amounted to 405 effort days in ICES rectangle 45F1 in 2018, and 516 days in 2017 as shown in Table 3-5. This represents a reduction in effort compared to the three preceding years, particularly compared to the 610 days spent fishing in 2014. Effort within ICES rectangle 45F1 has been recorded as disclosive or no data for several months (predominantly May, June, and July) each year between 2014 and 2018, indicating low levels of fishing activity during those times. Fishing effort is generally highest between September and November. Trawls were most utilised gear type used in the ICES rectangle 45F1 over all the years, other gear types used include seine nets (Scottish Government, 2019).

Table 3-5 Annual Fishing Effort by UK Vessels and Landings by All Vessels Landing in the UK for the Greater Balmoral Area and across the UKCS (Scottish Government, 2019)[Note 1]

Year	Within ICES Rectangle 45F0			Within ICES Rectangle 45F1			Average Across the UKCS		
	Fishing effort (days)	Landings Value (£)	Live weight (Te)	Fishing effort (days)	Landings Value (£)	Live weight (Te)	Fishing effort (days)	Landings Value (£)	Live weight (Te)
2014	1,184	4,437,667	4,204	610	2,495,409	1,161	660	3,261,196	2,963
2015	268	1,439,707	2,526	574	2,309,109	2,615	700	3,001,940	2,841
2016	523	3,642,550	4,155	562	2,269,479	1,267	693	3,599,692	2,785
2017	1,145	6,197,838	4,902	516	2,243,873	858	638	3,553,440	2,809
2018	383	1,632,852	822	424	1,633,409	659	620	3,768,936	2,779
Annual average	**701**	**3,470,123**	**3,322**	**537**	**2,190,256**	**1,312**	**662**	**3,439,711**	**2,835**

Notes:

1. All values are rounded to the nearest whole number. For purposes of identifying averages across the UK, disclosive data has not been included to limit the effects of zero-inflation on the results.

Table 3-6 Number of Fishing Days per Month (all gear) for vessels landing into Scotland in ICES Rectangles 45F1 and 45F0 in 2014-2018 (Scottish Government, 2019)Note 1

ICES rectangle	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
45F0	2014	16	D	20	65	101	D	D	59	376	271	249	13	1,184
	2015	51	76	D	D	D	D	D	18	D	42	36	8	268
	2016	78	136	11	14	D	D	22	7	12	95	101	40	523
	2017	11	165	118	92	200	11	15	53	92	266	112	D	1,145
	2018	48	27	9	15	91	9	23	7	29	105	12	8	383
45F1	2014	12	6	D	D	D	D	D	194	201	8	85	91	610
	2015	64	108	31	-	-	D	D	11	8	10	310	22	574
	2016	15	197	8	23	D	10	D	11	17	21	195	60	562
	2017	-	D	214	8	D	D	D	13	14	194	61	D	516
	2018	D	12	D	4	70	D	8	13	105	120	73	D	424

Notes:

1. Monthly fishing effort by UK vessels landing into Scotland: "-" = no data, D = Disclosive data (indicating very low effort) [1], green = 0 – 100 days fished, yellow = 101 – 200, orange =201-300, red = ≥301. Disclosive data has not been considered in the totals.

AIS recordings of fishing vessel movements from 2015 indicate vessel use is dominated by transiting vessels and trawling activity, based on the long 'legs' of vessel movement (Figure 3-7). Fishing vessel activity was generally low within the Greater Balmoral Area compared to the surrounding waters and mostly comprised of transiting fishing vessels (Figure 3-7). There is increased fishing vessel movement to the west of the Nicol and Brenda Fields which appears to be associated with pelagic fishing activity, such as pelagic seines and trawls (Figure 3-7). Additionally, fishing vessel movements to the southeast of the Stirling and Glamis Fields likely constitutes *Nephrops* trawling activity, based on the sweeping movement patterns (Figure 3-7).

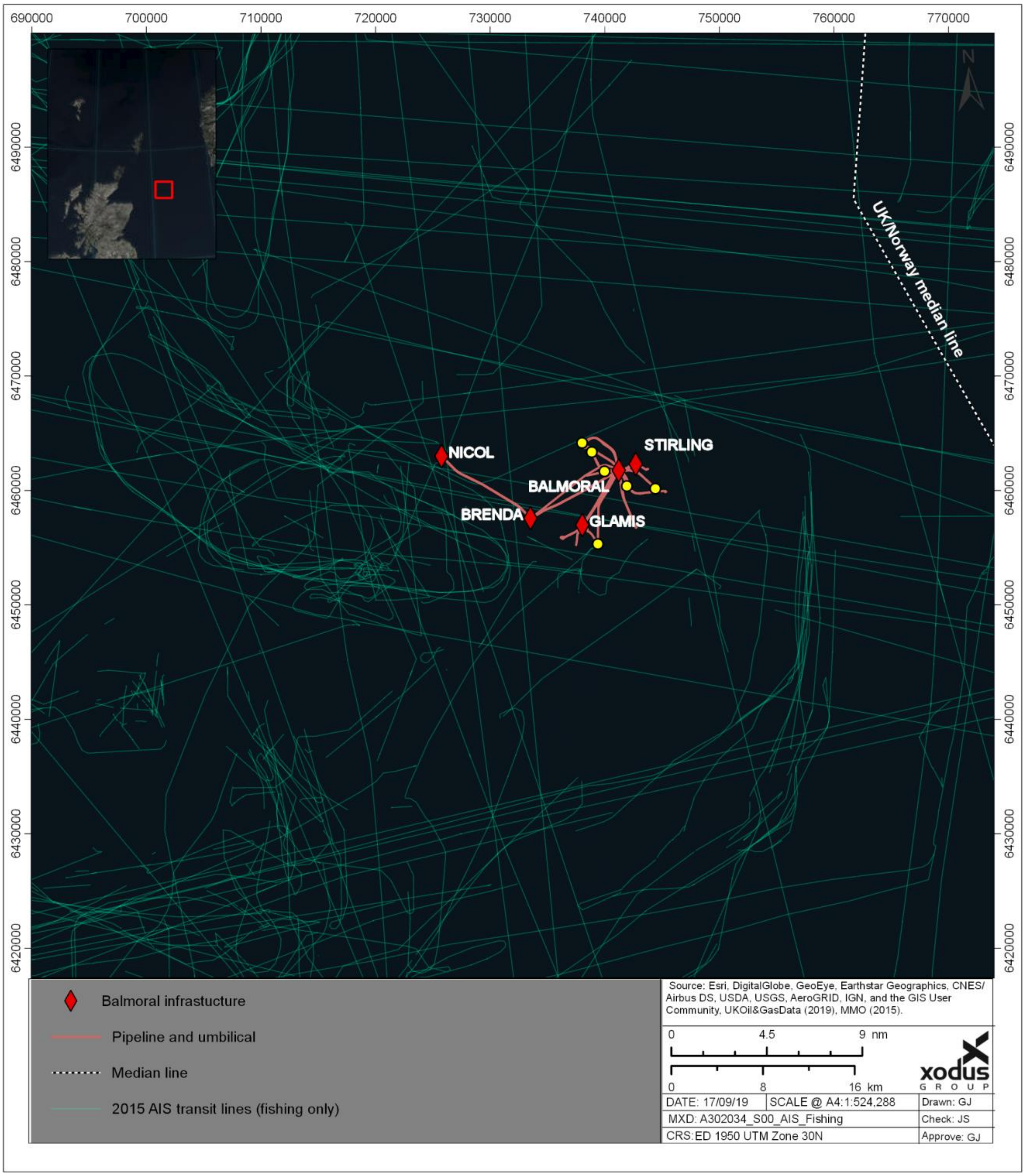

Figure 3-7 AIS Data for Commercial Fishing Vessels During the Year 2015 (MMO, 2015)

Amalgamated VMS data from 2007 – 2015 shows demersal trawling activity associated with oil and gas pipelines in this region from *Nephrops* and demersal trawling (Figure 3-8). The fishing intensity is generally low and increases slightly from west to east. ICES rectangle 45F0 experiences low levels of trawling activity (i.e. < 5 VMS tracks) over pipelines, whilst ICES rectangle 45F1 experiences low/low-moderate levels of trawling (i.e. between 5 – 20 tracks) on the majority of its pipelines, when compared to the rest of the UKCS (NMPI, 2019). Figure 3-8 suggests demersal trawling activity is highest to the south-east of the Stirling field along the associated pipelines and lowest around the Balmoral field. Furthermore, amalgamated VMS data from 2009-2013 which has been analysed to generate 'hotpots' of fishing density (i.e. through kernel density estimates) shows low levels of fishing by registered UK vessels (> 15 m) using *Nephrops* mobile gears and pelagic gear for herring (Figure 3-8). Levels of fishing intensity for *Nephrops* mobile gears was relatively high in the project area between 2009-2013 in comparison to other areas in the North Sea (Figure 3-8). In comparison, pelagic fishing intensity was low across the region between 2009-2013 (Figure 3-8).

Nephrops is the key commercial species landed from ICES rectangle 45F1 for both value and weight for the five most recent fishing years. Whilst both *Nephrops* and herring form the highest value species for ICES rectangle 45F0 during that period. Landings of *Nephrops* from ICES rectangle 45F1 comprised 1.2% of the total value and tonnage of *Nephrops* landed into the UK in 2018 (Scottish Government, 2019). Figure 3-9 shows the relative trawling activity associated with pipelines within the Greater Balmoral Area for both demersal and *Nephrops* fisheries between 2007-2015. *Nephrops* trawling activity is markedly higher, based on total trawls, than demersal trawling activity associated with the project's pipelines (Figure 3-9). Of the pipelines and subsea infrastructure present in the Greater Balmoral Area, the Nicol Production line (PL2350) experienced the greatest levels of *Nephrops* trawling, with between 150-286 trawls over the majority of the length of the pipeline, compared to 0-50 trawls along Brenda (PL2329) and Glamis Production pipelines (PL638 and PL639) and the region surrounding the Balmoral Template (Figure 3-9).

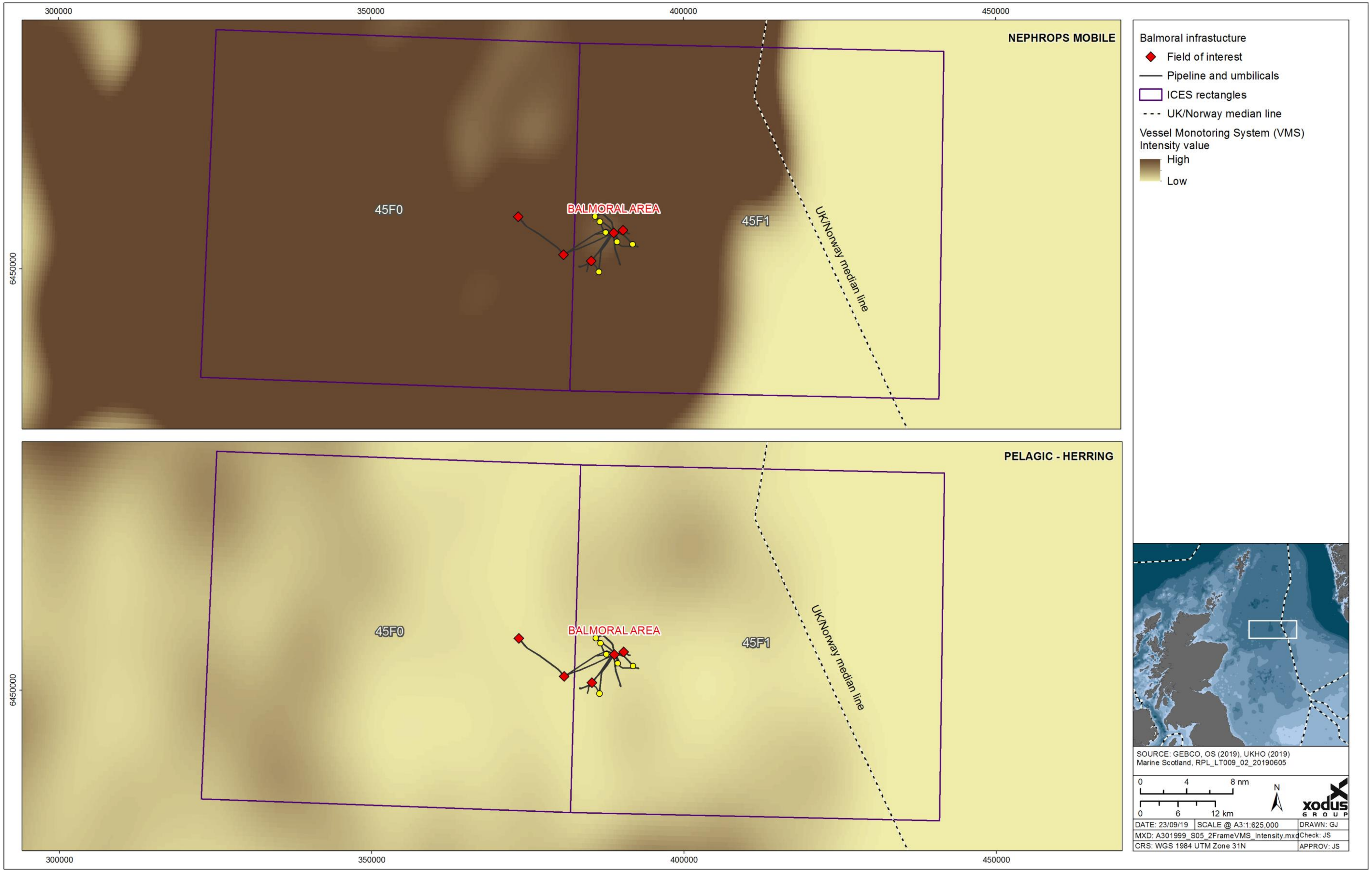

Figure 3-8 Vessel Monitoring Intensity for *Nephrops* (Mobile Gear) and Pelagic (Herring) Fisheries in ICES Rectangles 45F1 and 45F0 (2009 - 2013) (Marine Scotland, 2017)

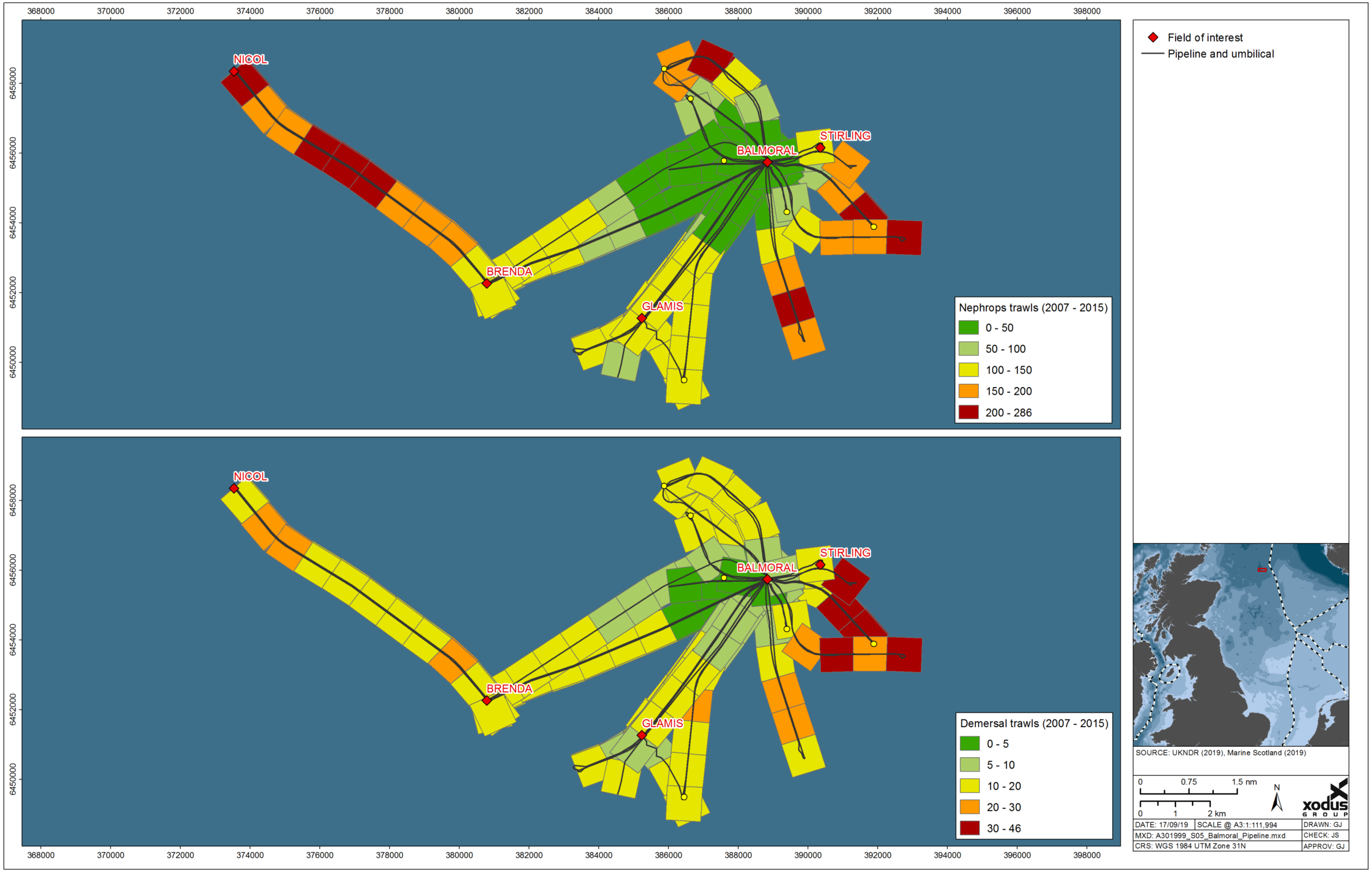

Figure 3-9 Relative Trawling Activity Associated with the Pipelines within the Greater Balmoral Area (Rouse *et al.*, 2018)

3.6 Conservation Sites and Species

3.6.1 Offshore Conservation

There are two protected area within 40 km of the Greater Balmoral Area; the closest of which is the Scanner Pockmark SAC located 9 km to the north west of the project area. This site is designated for the presence of Annex I habitat 'Submarine structures made by leaking gases' (JNCC, 2018a). The Norwegian Boundary Sediment Plain NCMPA is 32 km south east of the project area. This site is designated for the conservation of ocean quahog aggregations, including sands and gravels as their supporting habitat (JNCC, 2014). No living specimens of ocean quahog or infaunal siphons were observed on camera footage (Fugro, 2017b), although sparse numbers of juveniles (but no adults) were identified at several stations across the survey area (Fugro, 2018a). The closest known ocean quahog aggregation is located approximately 24 km to the west of the project area (NMPI, 2019). The Greater Balmoral Area is not located on any large-scale features of functional significance (NMPI, 2019).

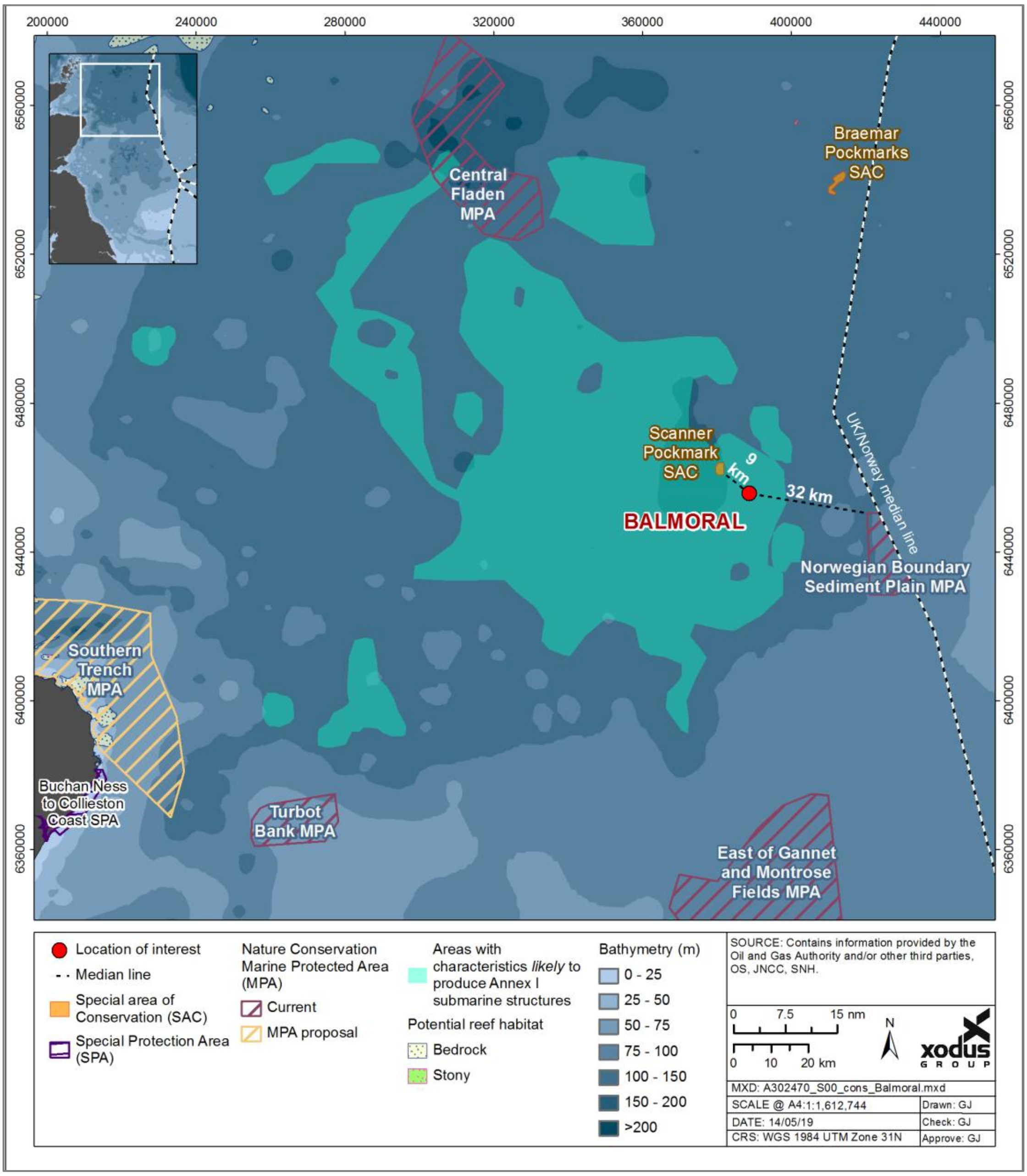

Figure 3-10 Protected Sites Proximal to the Greater Balmoral Area

3.6.2 Onshore Conservation

The Greater Balmoral Area is located approximately 187 km from the northeast coast of Scotland. The closest onshore conservation site is the Buchan Ness to Collieston Coast SPA which is located approximately 176 km to the south west (NMPI, 2019). Due to this distance, there will not be interactions with onshore conservation sites from routine operations taking place within the Greater Balmoral Area.

3.6.3 Protected Species

Four species listed under Annex II of the EU Habitats Directive are found in UK waters; harbour porpoise, bottlenose dolphin, grey seal, and harbour seal. Grey and harbour seals are unlikely to be observed near the Greater Balmoral Area with any regularity, as both species have very low densities (see Section 3.2). Harbour porpoise and bottlenose dolphin are the two Annex II species which could be present near the Greater Balmoral Area.

All species of cetacean recorded within the proposed operations area are listed as EPSs. Other marine species listed as EPSs include turtles and sturgeon (*Acipenser sturio*), which are not likely to be present within this area of the North Sea.

The habitat within the Greater Balmoral Area is reported as a suitable habitat for ocean quahog, which is commonly found in sandy or muddy sediments, such as those occurring within the nearby Fladen Grounds (Witbaard *et al.*, 2003; Section 3.2.1). Ocean quahog is therefore likely to be present in some form (i.e. as individuals or potentially aggregations) near the Greater Balmoral Area. This species is listed as PMF in Scottish waters (Tyler-Walters, 2016) and is on the OSPAR List of Threatened and/or Declining Species (OSPAR, 2008). Although the project area is located outside the area of distribution of ocean quahog defined by Defra (2010), the distribution of ocean quahog is relatively wide in the North Sea (OSPAR, 2009) and individuals may be found across the wider seabed habitat, even if such examples do not form 'aggregations' as such. Fittingly, several juvenile ocean quahogs were reported during a habitat survey of the Greater Balmoral Area undertaken by Fugro (2017b). However, numbers were too low to be considered an aggregation. No ocean quahog aggregations have been identified in the vicinity of the Greater Balmoral Area.

3.6.4 National Marine Plan

In addition to adhering to the suite of marine policies, regulations, and guidance for the offshore oil and gas industry, this project considers the objectives set by the Scottish National Marine Plan (NMP). The NMP covers the management of both Scottish inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles). The aim of the NMP 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 proposed operations described in this EA have been assessed against the NMP's objectives and policies, specifically GEN 1, 4, 5, 9, 12, 14 and 21.

The proposed operations do not contradict any of the NMP's objectives and policies, including those identified as of particular relevance to the project, and Premier will ensure compliance with all new policies which are introduced during the proposed activities. The following Sections describe the aims of each policy and how Premier's commitments will achieve them.

3.6.4.1 GEN 1 – General planning and principle

Development and use of the marine area should be consistent with the NMP, ensuring activities are undertaken in a sustainable manner that protects and enhances Scotland's natural and historic marine environment. Premier will ensure that any potential impacts associated with the Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.2 GEN 4 – Co-existence

Where conflict over space or resource exists or arises, marine planning should encourage initiatives between sectors to resolve conflict and take account of agreements where this is applicable. Premier will ensure that any potential impacts on other sea users associated with the proposed Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.3 GEN 5 – Climate change

Marine planners and decision makers should seek to facilitate a transition to a low carbon economy. They should consider ways to reduce emissions of carbon and other greenhouse gasses. Premier will ensure that any potential impacts associated with Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.4 GEN 9 – Natural heritage

Development and use of the marine environment must:

- Comply with legal requirements for protected areas and protected species.
- Not result in significant impact on the national status of PMF.
- Protect and, where appropriate, enhance the health of the marine area.

Premier will ensure that any potential impacts to protected species and sites associated with Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.5 GEN 12 – Water quality and resource

Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives that apply. Premier will ensure that any potential impacts to water quality associated with Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.6 GEN 14 – Air quality

Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits. Some development and use may result in increased emissions to air, including particulate matter and gasses. Impacts on relevant statutory air quality limits must be taken into account and mitigation measures adopted, if necessary, to allow an activity to proceed within these limits. Premier will ensure that any potential impacts to air quality with Greater Balmoral Area decommissioning operations will be kept to a minimum.

3.6.4.7 GEN 21 – Cumulative impacts

Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation. Premier will ensure that any potential impacts to air and water quality and biological communities with Greater Balmoral Area decommissioning operations will be kept to a minimum.

4 EA METHODOLOGY

The Impact assessment is designed to: (1) identify potential impacts to environmental and societal receptors from the proposed decommissioning activities; (2) evaluate the potential significance of any identified impacts in terms of the threat that they pose to these receptors; and (3) assign measures to manage the risks in line with industry best practice; and address concerns or issues raised by stakeholders through consolation.

The impact assessment was undertaken using the following approach:

1. The potential environmental issues arising from decommissioning activities were identified through a combination of the expert judgement of project engineers and marine environmental specialists in a screening workshop, and consultation with key stakeholders (Section 4.1). The potential environmental issues were grouped under the following key receptor risk groups:
    - Atmospheric emissions;
    - Disturbance to the seabed;
    - Physical presence;
    - Discharges to sea;
    - Underwater noise;
    - Resource use;
    - Onshore activities;
    - Waste; and
    - Unplanned events.
2. Undertake initial screening based on a high-level consideration of these aspects against the evaluation criteria. Screening aspects in or out of further detailed assessment. Justification statements will be compiled detailing the rationale for screening out any aspects from further assessment (Section 5.1).
3. For aspects which are considered potentially significant, evaluate significance of potential impacts against impact criteria definitions (Section 6); and
4. For any potentially significant impact, capture any potential mitigation and/or control measures to be used to further reduce any impact to ‘as low as reasonably practicable’ (ALARP).

4.1 Stakeholder Engagement

The consultation for the Greater Balmoral Area decommissioning has been largely based on sharing project expectations, approach and specific considerations with key stakeholders including:

- Scottish Fishermen’s Federation (SFF)
- Joint Nature Conservation Committee (JNCC)
- Marine Scotland
- Oil & Gas UK (OGUK)
- OPRED Environmental Management Team (EMT)
- OPRED Offshore Decommissioning Unit (ODU) (observers)
- Scottish Environmental Protection Agency (SEPA)
- Premier Oil E&P UK Limited
- Repsol Sinopec North Sea Limited
- Rockrose UKCS4 Limited
- Chrysaor (Conoco Phillips at time of engagement)
- Scottish Environmental Protection Agency (SEPA)

This is summarised in Table 4-1 and full details of the consultation to date are provided in Section 5 of the DP (Premier, 2020a-e).

Table 4-1 Stakeholder Issues and Concerns Raised Through Consultation

Relevant Party	Comments/Concerns Raised	Response & EA Section where addressed
Informal Consultations		
SFF, JNCC, Marine Scotland, OGUK, OPRED EMT, OPRED ODU (observers), Repsol Sinopec North Sea Ltd, Rockrose UKSC4 Ltd, Chrysaor (Conoco Phillips at time of engagement), Premier Oil E&P UK Ltd.	Premier Oil has engaged with interested parties and stakeholders who participated in CA workshops. No objections have been raised to date.	N/A
Statutory Consultations		
SFF	No objections have been raised to date.	N/A
SEPA	No objections have been raised to date.	N/A
OPRED EMT and ODU / BEIS	Draft EA has been issued and comments received. In addition to minor comments, the following important comments have been considered:	
	EA would benefit from more thorough characterisation of existing cuttings piles and their removal via CFE to inform the reader. Locations of cuttings piles and a demonstration of scale would be useful. Consideration of any potential for residual cuttings on the template when it is shipped to shore should be included.	Section 3.2.2.1 - Balmoral Template; Section 5.1 - Assessment of Potential Impacts
	It may be useful to set a brief context in terms of the physical environment namely water depths, wave height, tidal currents and wind direction, this will just assist consultees in understanding the conditions in the area and also is relevant given these aspects will influence the cuttings dispersal. In addition, given that section 6 includes consideration of impacts on plankton, these should be included in the baseline environment section.	Section 3.3 - Summary of Receptors
	It is noted that a potentially significant area of impact has been identified from overtrawling. Over-trawl verification surveys should normally only be required and undertaken if the area has not been open to fishing during the operational phase, and there is evidence that infrastructure, debris or any other obstructions could remain on the seabed and interfere with future fishing operations. Over-trawl verification surveys should be avoided in areas where there are sensitive seabed features or organisms that could be adversely impacted. Where geophysical surveys	Section 2.4.7 - Clear Seabed Verification; and Section 6.2 - Seabed Impacts

Relevant Party	Comments/Concerns Raised	Response & EA Section where addressed
	and ROV recovery operations have been undertaken and there is no evidence that infrastructure, debris or any other obstructions remain on the seabed, the report of the recovery operations should be accepted as equally valid verification that there is unlikely to be interference with future fishing operations. On that basis we request that the area of impact from overtrawl is reviewed and refined to focus on those areas where overtrawl will realistically be required.	
	Information regarding the number of samples taken and depth of the samples should be included.	Section 3.2 - Summary of Environmental Surveys
	Information on drill cuttings modelling, including the treatment of static points and long-term modelling, should be included.	Appendix D – Balmoral Template Cuttings Dispersal Modelling; and Section 6.2 - Seabed Impacts
JNCC	Scoping Report has been issued and comments received. In addition to minor comments, the following important comments have been considered:	
	Survey data should at least include the area of proposed operations, unless justification is provided as to why wider area surveys are sufficiently representative of conditions at the site of proposed operations.	Section 3.2 - Summary of Environmental Surveys
	Survey data should provide adequate evidence that habitats and species of nature conservation concern (including Annex I habitats) are or are not present.	
	It is good practice to include a diagram indicating the surveyed area in the context of the proposed activity and to identify any sample points or the location of photographic evidence. Data provided should also include high resolution acoustic data, video and / or still images. The figures 4-1, 4-2 and 4-3 are excellent starting points for this.	
	Any gaps or limitations in environmental information should be acknowledged with, where appropriate, strategies to address these gaps or limitations.	
	We would highlight that when using the SOSI for assessment that blocks surrounding the operations should also be reviewed and not just the “central” block. We look forward to seeing this fuller assessment within the DPs.	Section 3.3 - Summary of Receptors

Relevant Party	Comments/Concerns Raised	Response & EA Section where addressed
	Preference will be given to an approach not impacting on the seabed for example using side scan sonar data to show a clear seabed, although we note the assessment demonstrates the worst case impacts from overtrawl survey, suggest include option to utilise methods which minimise seabed impacts where possible as this seems to be an area of increasing concern from JNCC.	Section 2.4.7 - Clear Seabed Verification; Section 6.2 - Seabed Impacts; Section 6.3 - Commercial Fisheries

4.2 EA Process

4.2.1 Overview

The decision-making process related to defining if a project is likely to generate a significant impact on the environment is integral to the environmental impact assessment process; the methods used for identifying and assessing potential impacts should be transparent and verifiable.

The method presented here has been developed by reference to the Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines for marine impact assessment (CIEEM, 2018), the Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines (Tyler-Walters *et al.*, 2004) and guidance provided by Scottish Natural Heritage (SNH) in their handbook on environmental impact assessment (SNH, 2013b) and by The Institute of Environmental Management and Assessment (IEMA) in their guidelines for environmental impact assessment (IEMA, 2015; 2016).

Environmental impact assessment provides an assessment of the environmental and societal effects that may result from a project's impact on the receiving environment. The terms impact and effect have different definitions in environmental impact assessment, and one drives the other. Impacts are defined as the changes resulting from an action, and effects are defined as the consequences of those impacts.

In general, impacts are specific, measurable changes in the receiving environment (volume, time and/or area); for example, if several marine mammals are to be disturbed following exposure to underwater noise emissions. Effects (the consequences of those impacts) consider the response of a receptor to an impact; for example, the effect of the marine mammal/noise impact example given above might be exclusion from important habitat caused by disturbance, which may lead to reduced individual fitness and, potentially, population-level consequences. The relationship between impacts and effects is not always so straightforward; for example, a secondary effect may result in both a direct and indirect impact on a single receptor. There may also be circumstances where a receptor is not sensitive to a particular impact and thus there will be no significant effects/consequences.

For each impact, the assessment identifies a receptor's sensitivity and vulnerability to an effect and implements a systematic approach to understand the significance. The process considers the following:

- Assessment of the consequence/extent of the impact, defined by the nature and type of impact, and the spatial extent of the impact on the receptor;
- Identification of the duration and frequency of the effect of the receptor;
- Definition of magnitude of impact, based on the magnitude of the shift from the environmental baseline conditions;
- Definition of the probability of impacts; and
- Ranking of impact significance, considering the probability that it will occur, the spatial and temporal extent and the magnitude of the impact and any residual effects after mitigations are applied.

Each of these variables are expanded upon in the following Sections to provide consistent definitions across all EA topics. In each impact assessment, these terms are used in the assessment summary table to summarise the impact and are enlarged upon as necessary in any supporting text. It should be noted that all impacts discussed in this EA report are adverse unless explicitly stated otherwise.

Once the consequence of a potential impact has been assessed it is possible to identify measures that can be taken to mitigate impacts through engineering decisions or execution of the project. This process also identifies aspects of the project that may require monitoring, such as a post-decommissioning survey at the completion of the works to inform inspection reports.

For some impacts, significance criteria are standard or numerically based. For others, for which no applicable limits, standards or guideline values exist, a more qualitative approach is required. This involves assessing significance using professional judgement.

Despite the assessment of impact significance being a subjective process, a defined methodology has been used to make the assessment as objective as possible and consistent across different topics. The assessment process is summarised below. The terms and criteria associated with the impact assessment process are described and defined; details on how these are combined to assess consequence and impact significance are then provided.

4.2.2 Baseline Characterisation

To assess potential impacts on the environment it was necessary to firstly characterise the aspects of the environment that could potentially be affected (the baseline environment). The baseline environment has been described in Section 3 and is based on desk studies combined with additional site-specific studies such as surveys and modelling where required. Information obtained through consultation with key stakeholders was also used to help characterise specific aspects of the environment in more detail.

The EA process requires identification of potential receptors which could be affected by the Balmoral Decommissioning Project (e.g. commercial fisheries, water quality, and seabed impacts). Important receptors are identified within the impact assessments (Section 6).

4.2.3 Impact Definition

4.2.3.1 Impact Consequence/Extent

The impact consequence is based on the geographical extent, as described in Table 4-2.

Table 4-2 Impact Consequence Criteria

Ranking	Consequence	Criteria
High	**Major**	Extent of change: Impact occurs over a large scale or spatial geographical extent.
Medium	**Moderate**	Extent of change: Impact occurs over a local to medium scale/spatial extent and/or has a prolonged duration.
Medium	**Minor**	Extent of change: Impact occurs on-site or is localised in scale/spatial extent.
Low	**Negligible**	Extent of change: Impact is highly localised.

4.2.3.2 Duration/Frequency of Effect

The duration of effect is key to determining the final ranking of impact significance. This criterion considers the following:

- Duration over which the impact is likely to occur (e.g. days, weeks, etc.); and
- Frequency and/or intensity of impact (i.e. how often the impact is expected to occur).

These variables are defined in Table 4-3 and Table 4-4, and the overall ranking methodology of duration of effects is provided in Table 4-5.

Table 4-3 Definition of Duration Criteria

Duration	Definition
Short-term	Impacts that are predicted to last for a short duration (e.g. less than one year).
Temporary	Impacts that are predicted to last a limited period (e.g. a few years). For example, impacts that occur during the decommissioning activities and which do not extend beyond the main activity period for the works or which, due to the timescale for mitigation, reinstatement, or natural recovery, continue for only a limited time beyond completion of the anticipated activity.
Prolonged	Impacts that may, although not necessarily, commence during the main phase of the decommissioning activity and which continue through the monitoring and maintenance, but which will eventually cease.
Permanent	Impacts that are predicted to cause a permanent, irreversible change.

Table 4-4 Definition of Frequency Criteria

Frequency	Description
Continuous	Impacts that occur continuously or frequently.
Intermittent	Impacts that are occasional or occur only under a specific set of circumstances that occurs several times during the Balmoral Decommissioning Project. This definition also covers such impacts that occur on a planned or unplanned basis and those that may be described as 'periodic' impacts.

Table 4-5 Overall Duration/Frequency Ranking Criteria

Ranking	Duration	Criteria
High	**Major**	Frequency/intensity of impact: high frequency (occurring repeatedly or continuously for a protracted period) and/or at high intensity.
Medium	**Moderate**	Frequency/intensity of impact: medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring occasionally/intermittently for short periods of time but at a moderate to high intensity.
Medium	**Minor**	Frequency/intensity of impact: low frequency (occurring occasionally/intermittently for short periods of time) and/or at low intensity.
Low	**Negligible**	Impact is very short term in nature (e.g. days/few weeks).

4.2.3.3 Impact Magnitude

The impact magnitude requires an understanding of how far the receptor will deviate from its baseline condition because of the impact. The resulting effect on the receptor is considered under vulnerability and is an evaluation based on scientific judgement. Table 4-6 defines the criteria for impact magnitude.

Table 4-6 Impact Magnitude Criteria

Ranking	Magnitude	Criteria
High	Major	Total loss or major alteration to key elements/features of the baseline conditions.
Medium	Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions.
Medium	Minor	Minor shift from the baseline conditions. Impact is localised and temporary/short term with minor detectable change to site characteristics or a minor change to a small proportion of the receptor population. Low frequency impact occurring occasionally or intermittently.
Low	Negligible	Very slight change from baseline conditions. Impact is highly localised and short term resulting in very slight or imperceptible changes to site characteristics.

4.2.3.4 Impact Probability

The probability of an impact is another factor that is considered in this impact assessment. This captures the probability that the impact will occur and the probability that the receptor will be present and is based on knowledge of the receptor and experienced professional judgement.

Table 4-7 provides definitions of the different levels of probability of impact that are used in the Balmoral Decommissioning Project impact assessment.

Table 4-7 Impact Probability Criteria

Ranking	Probability	Criteria
High	Major	The impact is likely to occur.
Medium	Moderate	The impact is moderately likely to occur.
Medium	Minor	The impact is possible.
Low	Negligible	The impact is unlikely to highly unlikely.

4.2.4 Receptor Definition

As part of the assessment of impact significance it is necessary to differentiate between receptor sensitivity, vulnerability, and value. The sensitivity of a receptor is defined as 'the degree to which a receptor is affected by an impact' and is a generic assessment based on factual information whereas an assessment of vulnerability, which is defined as 'the degree to which a receptor can or cannot cope with an adverse impact' is based on professional judgement taking into account a number of factors, including the previously assigned receptor sensitivity and impact magnitude, as well as other factors such as known population status or condition, distribution and abundance.

4.2.4.1 Receptor Sensitivity

Receptor sensitivity to potential impact activities ranges from negligible to very high. Definitions for assessing the sensitivity of a receptor are provided in Table 4-8.

Table 4-8 Criteria for Assessment of Sensitivity of Receptor

Receptor Sensitivity	Definition
Very high	Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt.
High	Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt.
Medium	Receptor with low capacity to accommodate a particular effect with low ability to recover or adapt.
Low	Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt.
Negligible	Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt.

4.2.4.2 Receptor Vulnerability

Information on both impact magnitude and receptor sensitivity is required to determine receptor vulnerability. These criteria, described in Table 4-6 and Table 4-8 are used to define receptor vulnerability as per Table 4-9.

Table 4-9 Criteria for Assessment of Vulnerability of Receptor

Receptor Vulnerability	Definition
Very high	The impact will have a permanent effect on the behaviour or condition on a receptor such that the character, composition or attributes of the baseline, receptor population or functioning of a system will be permanently changed.
High	The impact will have a prolonged or extensive temporary effect on the behaviour or condition on a receptor resulting in long term or prolonged alteration in the character, composition or attributes of the baseline, receptor population or functioning of a system.
Medium	The impact will have a short-term effect on the behaviour or condition on a receptor such that the character, composition, or attributes of the baseline, receptor population or functioning of a system will either be partially changed post development or experience extensive temporary change.
Low	Impact is not likely to affect long term function of system or status of population. There will be no noticeable long-term effects above the level of natural variation experience in the area.
Negligible	Changes to baseline conditions or receptor population of functioning of a system will be imperceptible.

It is important to note that the above approach to assessing sensitivity/vulnerability is not appropriate in all circumstances and in some instances professional judgement has been used to determine receptor sensitivity. In some instances, it has also been necessary to take a precautionary approach where stakeholder concern exists regarding a particular receptor. Where this is the case, this is detailed in the relevant impact assessment in Section 6.

4.2.4.3 Receptor Value

The value, or importance, of a receptor is based on a pre-defined judgement established in legislative requirements, guidance or policy. Where these may be absent, it is necessary to make an informed judgement on receptor value based on perceived views of key stakeholders and specialists. Examples of receptor value definitions are provided in Table 4-10.

Table 4-10 Criteria for Assessment of Value of Receptor

Receptor Value	Definition
Very high	Receptor of international importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site). Receptor of very high importance or rarity, such as those designated under international legislation (e.g. EU Habitats Directive) or those that are internationally recognised as globally threatened (e.g. International Union for Conservation of Nature (IUCN) red list). Receptor has little flexibility or capability to utilise alternative area. Best known or only example and/or significant potential to contribute to knowledge and understanding and/or outreach.
High	Receptor of national importance (e.g. Nature Conservation Marine Protected Area (NCMPA), Marine Conservation Zone (MCZ)). Receptor of high importance or rarity, such as those which are designated under national legislation, and/or ecological receptors such as United Kingdom Biodiversity Action Plan (UKBAP) priority species with nationally important populations in the study area, and species that are near-threatened or vulnerable on the IUCN red list. Receptor provides the majority of income from the Greater Balmoral Area. Above average example and/or high potential to contribute to knowledge and understanding and/or outreach.
Medium	Receptor of regional importance. Receptor of moderate value or regional importance, and/or ecological receptors listed as of least concern on the IUCN red list but which form qualifying interests on internationally designated sites, or which are present in internationally important numbers. Any receptor which is active in the Greater Balmoral Area and utilises it for up to half of its annual income/activities. Average example and/or moderate potential to contribute to knowledge and understanding and/or outreach.
Low	Receptor of local importance. Receptor of low local importance and/or ecological receptors such as species which contribute to a national site, are present in regionally. Any receptor which is active in the Greater Balmoral Area and reliant upon it for some income/activities. Below average example and/or low potential to contribute to knowledge and understanding and/or outreach.
Negligible	Receptor of very low importance, no specific value or concern. Receptor of very low importance, such as those which are generally abundant around the UK with no specific value or conservation concern. Receptor of very low importance and activity generally abundant in other areas/ not typically present in the Balmoral installation area. Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach.

4.2.5 Impact Significance Ranking

The initial ranking of impact significance is based on the criteria described in Sections 4.2.3 and 4.2.5, which involves:

- Determination of the extent, duration/frequency, and magnitude of the impact and its probability;

Consideration of sensitivity, vulnerability, and value of the receptor and any existing controls which can be industry standards, legislation requirements or prescriptive.

The sensitivity, vulnerability and value of receptor are combined with the impact magnitude (and probability, where appropriate) using informed judgement to arrive at a significance assessment for each impact, as described in Table 4-11. The assessment of significance considers mitigation measures that are embedded within the proposed activities.

Table 4-11 Criteria for Assessment of Significance

Ranking	Significance	Criteria
High	**Major**	Impacts are likely to be highly noticeable and have long term effects, or permanently alter the character of the baseline, and are likely to disrupt the function and status/value of the receptor population. They may have broader systemic consequences (e.g. to the wider ecosystem/industry). The impacts are a mitigation priority to avoid or reduce the anticipated effects of the impact.
Medium	**Moderate**	Impacts are likely to be noticeable and result in prolonged changes to the character of the baseline and may cause hardship to, or degradation of, the receptor population, although the overall function and value of the baseline/ receptor population is not disrupted. Such impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.
Medium	**Minor**	Impacts are expected to comprise noticeable changes to baseline conditions, beyond natural variation, but are not expected to cause long term degradation, hardship, or impair the function and value of the receptor. However, such impacts may be of interest to stakeholders and/or represent a contentious issue during the decision-making process, and should therefore be avoided or mitigated as far as reasonably practicable.
Low	**Negligible**	Impacts are expected to be either indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.

4.2.6 Cumulative Impact Assessment

While the scope of this impact assessment is restricted to the decommissioning of the Greater Balmoral Area, there will be other marine activities which have the potential to interact with the activities completed under the decommissioning work scope. The impact assessments presented in the following Sections consider the potential for significant cumulative impacts to occur from overlapping activities.

4.2.7 Transboundary Impact Assessment

For most potential impacts from decommissioning, the likelihood of transboundary impact is low. However, where impacts on mobile receptors are of concern, the likelihood of a transboundary impact is higher. The impact assessments presented in the following Sections have identified the potential for transboundary impacts is considered within the definition of significance.

4.2.8 Mitigation

Where potentially significant impacts (i.e. those ranked as 'moderate' or 'major' in Table 4-11) are identified, mitigation measures must be considered. The intention is that mitigations should remove, reduce, or manage potential impacts to a point where the resulting residual significance is at an acceptable or insignificant level. Mitigation is also proposed in some instances to maintain the significance levels of impacts defined as 'not significant'. The impact assessment conclusions define the residual impact significance after mitigations are applied.

5 INITIAL ASSESSMENT SCREENING AND JUSTIFICATION

An impact assessment screening workshop was undertaken to discuss the proposed decommissioning activities and any potential impacts these may pose. This discussion identified eleven potential impacts based on the proposed removal methods identified in Section 2. Three of these potential impacts could not be screened out of further assessment based on the significance or likelihood of the impact occurring. The eleven potential impacts and their screening rationales are detailed in Section 5.1, and those impacts carried forward for further assessment are defined in Section 5.2.

5.1 Assessment of Potential Impacts

The screening of potential environmental impacts from the decommissioning of the Greater Balmoral Area for further assessment is provided in Table 5-1, including summarised rationales for the screening outcomes.

Table 5-1 Environmental Impact Screening Summary for the Greater Balmoral Area Decommissioning Project

Potential impact	Further assessment?	Rationale
Emissions to air	No	Emissions during decommissioning activities, (largely comprising fuel combustion gases) will occur in the context of the CoP. As such, emissions generated by infrastructure, equipment and vessels associated with operation of the Greater Balmoral Area assets will be replaced by those from vessels and equipment required for decommissioning activities, as well as the recycling of decommissioned materials. Assessment of impacts from onshore energy use and atmospheric emissions for P&A activities will be included in license applications for appropriate onshore disposal facilities. Reviewing historical EU Emissions Trading Scheme data and comparison with the likely emissions from the proposed workscope suggests that emissions relating to decommissioning will be minor relative to those generated during production. Review of available decommissioning EAs shows conclusively that atmospheric emissions in highly dispersive offshore environments do not present significant impacts and are extremely small in the context of UKCS and global emissions. Most submissions also note that emissions from short-term decommissioning activities are trivial compared to those previously arising from the asset over its operational life. The majority of atmospheric emissions for the Greater Balmoral Area decommissioning relate to vessel time or are associated with the recycling of material returned to shore. The estimated total CO_2 emissions to be generated by the selected decommissioning option activities is 83,380 Te, of which 50,757 Te is related to vessel emissions. This equates to 0.65% of the total annual UKCS vessel emissions (excluding fishing vessels) when considering 2017 data (7,800,000 Te; BEIS, 2019). The remaining 32,623 Te CO_2 will be generated through the life cycle of the project materials; those recovered and not reused or left *in situ*. The CO_2 emissions total has been calculated assuming an anticipated maximum of 614 days of operational vessel activity for

Potential impact	Further assessment?	Rationale
		the duration of the project. This is split across multiple vessel types (including, but not limited to: a DSV/CSV, trenching vessel, rockdumper, reel vessel, AHV, ROVSV, pipehaul vessel, supply vessel, trawler and survey vessel). This is a worst-case estimate of vessel days based on ample overtrawling, which is not expected to be required. Atmospheric emissions in highly dispersive offshore environments do not present significant impacts and are extremely small in the context of UKCS and global emissions. Furthermore, emissions from short-term decommissioning activities are small compared to those previously arising from the asset over its operational life. Considering the above, atmospheric emissions do not warrant further assessment.
Seabed disturbance	Yes	There is potential for decommissioning and legacy activities to generate disturbance to the seabed; these include activities associated with the removal of Greater Balmoral Area subsea installations and the vessel anchoring system and the removal of pipelines and umbilicals, as well as any associated remediation post-decommissioning, including overtrawling. Seabed impacts may range in duration from short-term impacts, such as temporary sediment suspension or smothering, to permanent impacts, such as the introduction of new substrate or any consequential habitat or community level changes which may transpire. Additionally, seabed disturbance from the removal of infrastructure has the potential to modify the habitat in a way which might impact upon other sea users which utilise the seabed. The reverse reeling of trenched and buried flexible flowlines has the potential to generate clay berms in the muddy benthic habitat which defines the Greater Balmoral Area. Clay berms may pose a potential snagging hazard to commercial fishing gears which make contact with the seabed. Post-decommissioning, the clear seabed will be validated by an independent verification survey over the installation sites and pipeline corridors. The methods used will be discussed and finalised with OPRED. Non-intrusive verification techniques will be considered in the first instance, but where these are deemed inconclusive by the SFF, seabed clearance is likely to require conventional overtrawl survey methods. Field debris items are anticipated to be located on the surface of the seafloor, or partially buried by surface sediments, and will be recovered with minimal intervention (e.g. using an ROV). The area of potential impact will be superficial, temporary, and largely limited to the dimensions of the debris item being retrieved, which will be determined during the Seabed Clearance Verification survey.

Potential impact	Further assessment?	Rationale
		As such, seabed disturbance associated with field debris items is considered negligible and has thus been screened out of further assessment. Impacts to the seabed from project activities have been assessed further in Section 6.2, whilst impacts to commercial fisheries generated by seabed disturbance are assessed in Section 6.3 below.
Physical presence of vessels in relation to other sea users	No	The presence of a small number of vessels for decommissioning activities will be short-term in the context of the life of the Greater Balmoral Area and assets. Activity will occur using similar vessels to those currently deployed for oil and gas installation, operation, and decommissioning activities. The vessels required will also generally be within the existing 500 m safety zones. The decommissioning of the Balmoral FPV will reduce the number of vessels occupying the area long-term and will increase access to commercial fishing grounds by removing the existing exclusion zone. The decommissioning of the Greater Balmoral Area is estimated to require various vessels, as listed in Emission to Air, depending on the selected method of removal; however, these would not all be on location at the same time. In general, vessel use will be split between the two phases of decommissioning: moving the FPV off-station (Phase 1); and subsea infrastructure decommissioning (Phase 2). For Phase 1, vessel use will comprise the intermittent employment of a DSV / ROVSV, CSV, four anchor handling vessels (13 days combined), the on-station FPV (16.8 days), Tug (3 days), and supply vessels for the limited period the FPV remains on-station (assumed two visits per week). During Phase 2, vessel use will comprise a combination of DSV / ROVSV (184.6 days total for both phases), CSV (104.5 days total for both phases), HLV (9 days), Reel Vessel (71.2 days), Barge (43.4 days), survey vessel (128.3 days) and trawler (40 days). In between the two phases, a guard vessel will be on site, generating a total of 613.8 days of vessel activity associated with the decommissioning activities. Other sea users will be notified in advance of planned activities through the appropriate mechanisms, meaning those stakeholders will have time to make any necessary alternative arrangements during the finite period of operations. Although the decommissioning of the Greater Balmoral Area is estimated to require various vessels depending on the selected method of removal, these would not all be on location at the same time. In consideration of the duration and location of vessel presence in conjunction with employment of standard practices, as well as the

Potential impact	Further assessment?	Rationale
		long-term decrease in vessel presence post-decommissioning, the short-term presence of vessels does not require further assessment.
Physical presence of infrastructure decommissioned *in situ* in relation to other sea users	Yes	All subsea installations and surface-laid pipelines will be fully removed, and the Balmoral FPV will be taken offsite for decommissioning. Trenched and/or buried flexible flowlines will be de-buried (as necessary) and reverse-reeled for removal and the seabed will be subsequently remediated. All jumpers, spoolpieces and risers will be fully removed. The only infrastructure to be decommissioned *in situ* are the trenched and buried rigid flowlines and mooring systems. Trenched and buried rigid flowlines will have the ends cut and lifted, with remediation. Depth of Burial (DoB) surveys have confirmed the integrity of these flowlines and they are not expected to pose any risk of interaction with other sea users (see Appendix C). However, long-term degradation may compromise the integrity of the buried flowlines and introduce free spans which pose a potential snagging hazard to commercial fisheries which utilise the seabed. Future monitoring work will ensure the integrity of the DoB of these structures, but further consideration of the proposed activities is necessary. Mooring chains will be cut at the mudline from the buried mooring blocks, which are located 6 m below the seabed and will be decommissioned *in situ*. BEIS Guidance (2018) on moorings dictates that, "any concrete anchor-base associated with a floating installation which does not, and is not likely to, result in interference with other legitimate uses of the sea...(is) not included in the definition of a disused steel or concrete installation in Decision 98/3 and as such may be left in place". The base position is to remove all mattresses if safe to do so, including the potentially unrecoverable (these are the older types which are known to potentially have no or reduced integrity). Should difficulties be encountered which would make it disproportionately problematic to remove any particular mattress, Premier will open a dialogue with OPRED to agree an alternative decommissioning approach. Where it is deemed unsafe to recover mattresses, they shall be decommissioned *in situ* and made safe for trawling using profiled rock placement to mitigate potential snagging hazards. However, alternative strategies to the base position for the decommissioning of mattresses shall be discussed with OPRED prior to execution to gain confirmation of the alternative decommissioning approach. These difficult to remove mattresses may be decommissioned *in situ*, in agreement with OPRED. In such circumstances, additional rock placement or intervention will be used to further reduce snagging risk. These activities will be covered by the requisite permitting.

Potential impact	Further assessment?	Rationale
		Post-decommissioning, the clear seabed will be validated by an independent verification survey over the installation sites and pipeline corridors. The methods used will be discussed and finalised with OPRED. Non-intrusive verification techniques will be considered in the first instance, but where these are deemed inconclusive by the SFF, seabed clearance is likely to require conventional overtrawl survey methods. Further assessment related to potential snagging risks associated with the decommissioning of infrastructure *in situ* is provided in Section 6.3 below.
Water quality	Yes	All the decommissioning activities in the Greater Balmoral Area will take place after the cleaning and flushing of its relevant infrastructure. The Balmoral subsea installations will be Drained, Flushed, Purged and Vented (DFPV) using Premier's DFPV management strategies prior to the commencement of any decommissioning activities. The wells are outwith the scope of this EA and will be P&A, covered by their own permitting regime. Vessel discharges are managed through existing, International Convention for the Prevention of Pollution from Ships (MARPOL) compliant controls, including bilge management procedures and good operating practices. Post-flushing and/or water jetting, residual liquids present during the decommissioning of pipelines and subsea installations will be treated before being discharged to sea, such that the discharge will comprise treated water. Any residual remaining material will be in trace levels/volumes following the DFPV regime and will not pose any significant risk to water quality. All residual solids will be shipped to shore for disposal. Cuttings deposits which remain within the Balmoral Template will require removal prior to the cutting and lifting of this substructure. This activity comprises controlled flow excavation (CFE). This tool enables both horizontal and vertical mass flow excavation of materials. Vertical means the jets will be directed towards the seabed and horizontal means the jet will be directed parallel to the seabed. Whilst the majority of cuttings will be discharged to the seabed immediately, some of the cuttings will remain within a plume within the water column, generating a temporary change in water quality. Whilst water quality in the vicinity of the cuttings will be reduced, the effects are anticipated to be minimised by rapid dilution in the dynamic receiving water column. Water quality impacts from the CFE of the cuttings deposits located within the Balmoral Template have been assessed in Section 6.1.
Underwater noise emissions	No	Vessel presence will be limited in scale (i.e. the size and number of vessels) and duration and, therefore, does not constitute a

Potential impact	Further assessment?	Rationale
		significant or prolonged increase in noise emissions across the project area. To remove the subsea installations, the cutting of flowlines will likely be done with shears, thereby minimising produced underwater noise during this activity. There is potential that external cuttings using diamond wire may be required; however, noise associated with this activity will be temporary and generated very close to the seabed, where absorption rates are highest. Similarly, noise generated by the CFE of the cuttings deposits will be directed towards the seabed and absorbed by the temporary increase in sediment within the water column. Geophysical surveys undertaken for post-decommissioned infrastructure left *in situ* will be assessed through the process of permit application. Multibeam echosounder survey equipment is likely to be used for imaging and identification of pipeline exposures. The Joint Nature Conservation Committee (JNCC) Guidelines will be employed for mitigation of identified noise impacts to marine mammals for future survey work involving seismic survey equipment (JNCC, 2017). All other noise generating activities associated with the decommissioning of the Greater Balmoral Area are considered negligible in the context of ambient noise levels and are likely to be masked by vessel activities related to the Project and within the wider region. None of the activities associated with the decommissioning of the Greater Balmoral Area are considered to generate significant noise levels which may cause injury or significant disturbance to marine species. The project is not located within a marine mammal protection area and EAs for offshore oil and gas decommissioning projects generally show no potential injury or significant disturbance associated with the non-survey decommissioning activities covered within the project scope. On this basis, underwater noise does not require further assessment.
Resource use	No	Generally, resource use from decommissioning activities requires limited raw materials and will be largely associated with vessel fuel use. Use of fuel resources is not typically an issue of concern in offshore oil and gas, which generates fuels. Regardless, Premier has committed to minimise fuel use throughout the decommissioning campaign where it is possible and safe to do so. In line with the BEIS (2018) Guidance, energy use was considered during the CA process and the options identified reflect the best possible outcomes for a variety of technical, environmental and safety and risk considerations. The estimated total energy usage for

Potential impact	Further assessment?	Rationale
		the project is 1,791,465.2 GJ, of which 1,102,963.4 GJ are associated with lifecycle energy use. The vast majority of energy use comes from the removal of mattresses and grout bags, as required by OSPAR Decision 98/3. The worst-case estimate of energy use assumes disposal of all mattresses and grout bags and this accounts for over 78% of the total lifecycle emissions. However, every attempt will be made to recycle or reuse the concrete in recovered mattresses. Methods for recycling or reuse of the mattresses will be agreed upon with the relevant regulators following their recovery. When the worst-case estimate from the disposal of all stabilisation materials is discounted from the energy use calculations, the lifecycle energy use is reduced to 256,233.5 GJ. It is likely that actual energy use will fall closer to this figure, as the base case is to reuse the stabilisation materials. The energy use anticipated for the decommissioning of the Greater Balmoral Area is considered minor compared to the resources generated during its production phase. Considering all of the above, resource use does not warrant further assessment.
Onshore activities	No	The OPRED Guidance states that onshore activities are not in scope of Decommissioning EAs, and this topic does not require further assessment. It should be noted that, only licenced contractors which can demonstrate they are capable of handling and processing the material to be brought ashore will be considered for onshore activities and this will form an integral part of the commercial tendering process.
Waste	No	The recycling and disposal of wastes are covered by the BLLP Waste Management Strategy, which is compliant with relevant regulations relating to the handling of waste offshore, transfer of controlled, hazardous, and special waste, and TFSW. The BLLP Waste Management Strategy is also guided by Premier's HSES Policy and commitments to best practice in waste management. This includes the mapping and documenting of waste management arrangements for each phase of the BLLP in individual Active Waste Management Plans (AWMPs) and ongoing monitoring of waste procedures and performance review against target Key Performance Indicators (KPIs). Wastes will be treated using the principles of the waste hierarchy, focusing on the reuse and recycling of wastes where possible. Raw materials will be returned to shore with the expectation to recycle the majority of the returned material. There may be instances where infrastructure returned to shore is contaminated (e.g. by Naturally Occurring Radioactive Material (NORM), hazardous, and/or special wastes) and cannot be recycled. In these instances,

Potential impact	Further assessment?	Rationale
		the materials will require disposal. However, the weight and/or volume of such material is not expected to result in substantial landfill use. On this basis, no further assessment of waste is necessary.
Unplanned events	No	As the decommissioning activities will be taking place after well P&A and pipeline flushing, well blowout and pipeline blowout scenarios have been ruled out as a possibility and any unplanned events during the decommissioning activities will be limited to vessel-related losses. The HLV to be used for removing rigid pipelines, large installations, and subsea installations is expected to have the largest fuel inventory of the vessels involved in the decommissioning activities. However, the inventory is expected to be less than the worst-case loss of containment modelled and assessed in the Balmoral Offshore Oil Pollution Emergency Plan (OPEP), which considered the full diesel inventory of the FPV, in addition to well blowout and pipeline loss of containment scenarios (Premier, 2018). The OPEP considered an instantaneous release of the full diesel inventory of the FPV of approx. 2,947.5 m^3, as well as crude releases of 2,682 m^3 from a well blowout scenario and 1,191 m^3 from a pipeline release scenario (Premier, 2018). These losses are expected to be greater than any instantaneous release from any large vessel proposed for decommissioning activities, such as the HLV or barge employed during removal of the template. Moreover, the decommissioning vessels are expected to have their fuel inventories split between a number of separate tanks, further reducing the potential for an instantaneous release of the full vessel inventory. The results of the dispersion modelling of the diesel release indicate a moderate probability of transboundary landfall of this diesel inventory to the Norwegian coastline (less than 70% after 15 days, limited to the summer months) and a low probability of landfall within the UK (less than 30% after 12 days, limited to the Autumn months) from the full release of this inventory. Any beached volume would be small (up to approximately 25 m^3 after 140 days), given the viscosity of diesel in comparison to oil. Impacts from unplanned events associated with decommissioning vessel activities will be less than the loss of containment scenarios previously assessed and mitigated against within the existing OPEP (Premier, 2018). However, management, response and control procedures will align with those detailed during the operational phase of Balmoral. Any spills from vessels in transit and outside the 500 m safety zone are covered by separate Shipboard Oil Pollution Emergency Plans (SOPEPs). Premier will support response of any vessel-based loss of

Potential impact	Further assessment?	Rationale
		fuel containment through the vessel owner's SOPEP (Premier, 2018). In addition to the mitigation measures outlined in the OPEP, Premier maintains manned bridges, navigational aids, and monitoring of safety zones (e.g. with Navaids, PowerBuoys, or other technology). Considering the above, the potential impacts from accidental chemical/ hydrocarbon releases during decommissioning activities do not warrant further assessment. As the methodology for the substructure and pipeline removal and return to shore has not been defined in detail, there exists the remote possibility that during transport of those materials, elements may dislodge and drop from the transport vessel. Premier will not undertake any cutting or lifting of pipelines, just reverse reel, which will minimise the likelihood of accidental loss of pipeline materials to the seabed. Moreover, all subsea installations are considered sound and no issues regarding their integrity have been identified. Dropped object procedures are industry-standard. All unplanned losses in the marine environment will be attempted to be remediated, and notifications to other mariners will be sent out. Seabed clearance verification surveys will aid in the identification of any dropped objects or debris in the decommissioning area. In line with the mitigation measures in place, unplanned loss of materials to the sea do not require further assessment.

5.2 Aspects taken Forward for Further Assessment

Based on the initial screening provided in Section 5.1, the following potential environmental and societal impacts have been identified as requiring further assessment within the EA:

- Water quality;
- Seabed impacts; and
- Commercial fisheries.

These potential impacts are addressed in detail within Section 6.

5.3 Proposed Mitigations and Existing Controls

To ensure that impacts remain as described above, Premier will follow routine environmental management activities, for example appropriate project planning, contractor management, vessel audits, activity permitting and legal requirements to report discharges and emissions, such that the environmental and societal impact of the decommissioning activities will be minimised. The activities associated with the decommissioning of the Greater Balmoral Area assets are not likely to result in significant impacts to the environment or other sea users, including fishing or seabed communities, if appropriate mitigation and control measures are effectively applied. A summary of the proposed control and mitigation measures is shown in Table 5-2.

Table 5-2 Proposed Mitigation and Control Measures

General and Existing

• Lessons learnt from previous decommissioning scopes will be reviewed and implemented as appropriate;
• Vessels will be managed in accordance with Premier's existing marine procedures, including:
  o The vessels' work programme will be optimised to minimise vessel use where possible;
  o The 500-m safety exclusion zone will remain in operation during the decommissioning activities reducing risk of non-project related vessels entering the area where decommissioning activities are taking place;
  o All infrastructure will be subject to a drain, flush, purge and vent philosophy that will be assessed and permitted under existing operational permits prior to decommissioning, to ensure minimal residual contaminants are present in the infrastructure before removal operations commence;
  o The OPEP is one of the controls included in a comprehensive management and operational control plan developed to minimise the likelihood of large hydrocarbon releases and to mitigate their impacts should they occur;
  o All vessels undertaking decommissioning activities will have a MARPOL-approved SOPEP;
  o Existing processes will be used for contractor management to assure and manage environmental and social impacts and risks;
  o Premier's management of change process will be followed should changes of scope be required;
  o Careful planning, selection of equipment, subsequent management, and implementation of activities; and
  o Impacts resulting from the disturbance of the drill cuttings deposits are expected to be minimal given their rapid resettlement and the fact that drill cuttings deposits will be directed to the immediate vicinity of the Template, minimising the extent of any seabed disturbance or reduction in water quality. Remediation of any potential impacts on seabed communities will be undertaken, where required.
• A post-decommissioning environmental seabed survey, centred around the well locations, will be carried out. The survey will focus on chemical, physical and biological changes, disturbances and will be compared with the pre-decommissioning survey. Results of this survey will be available once the work is complete, with a copy forwarded to OPRED.
• All pipeline routes and installation sites will be the subject of oilfield debris clearance and as-left verification surveys when decommissioning activity has concluded.
• The main risk from infrastructure remaining *in situ* is the potential for interaction with other users of the sea, specifically from fishing related activities. Where the infrastructure is trenched or trenched & buried greater than 0.6 m below seabed level, the effect of interaction with other users of the sea is considered negligible.
• The infrastructure is currently shown on Admiralty Charts and the FishSafe system. When decommissioning activity has been competed, updated information will be made available to update Admiralty Charts and FishSafe system.
• When decommissioning activities have been completed, and where applicable, the safety zones around offshore infrastructure will be removed.
• The licence holders recognise their commitment to undertake post-decommissioning monitoring of infrastructure left *in situ*. After the post-decommissioning survey reports have been submitted

to OPRED and reviewed, a post-decommissioning monitoring survey regime, scope, and frequency, will be agreed with OPRED. • Any snagging risk to other sea users will be minimised by continual monitoring of degrading structures or free spans.
Large-scale Releases to Sea
• Post-flushing water will be cleaned before it is discharged to sea in accordance with Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 controls, including MARPOL-compliant bilge management procedures and good operating practices. • All solid waste will be skipped and shipped to shore for disposal, rather than being discharged at sea. • Risk of full inventory loss from a vessel is very low given that the majority of vessels have multiple, separated fuel tanks, making full contaminant loss highly unlikely and the distance from shore would prevent any significant volume of diesel reaching any shoreline. Any potential diesel fuel spillages resulting from unplanned collisions will be minimised by approved OPEP/SOPEP, in which risks associated with the decommissioning activities have been appropriately assessed and planned for.
Waste Management
• All waste will be managed in accordance with the Waste Management Plan, including any marine growth waste, or NORM identified during flushing and cleaning of subsea installations. • The Waste Management Plan will involve the use of a waste inventory, and all residual wastes being shipped to shore for processing.

6 IMPACT ASSESSMENT

The following receptors have been identified as requiring further assessment against potential impacts from the proposed decommissioning activities:

- Water quality;
- Seabed impacts; and
- Commercial fisheries.

Sources and environmental response to potential impacts to these receptors are detailed in the Sections below.

6.1 Water Quality

This section covers impacts to water quality from decommissioning activities associated with the Greater Balmoral Area, along with measures proposed to minimise the scale and duration of the impact.

6.1.1 Approach

During the decommissioning of the Balmoral infrastructure and the associated vessel operations, there are several sources which have the potential to impact upon water quality from the discharge of materials to the sea, they include:

- Loss of containment from an unplanned event (i.e. vessel collision);
- Vessel-related discharges;
- Materials released from infrastructure decommissioned *in situ*; and
- Materials released from the removal of infrastructure.

Table 5-1 and Table 5-2 delineate the screening justification and mitigation measures which preclude the need for further assessment of unplanned events, vessel-related discharges and materials released from infrastructure decommissioned *in situ*.

The Sections below detail and assess residual impacts to water quality from the remaining source of discharges: materials released from the removal of infrastructure.

6.1.2 Sources of Potential Impacts

6.1.2.1 Overview

The removal of the Template for decommissioning forms the greatest potential to release contaminants into the surrounding marine environment, due to the resuspension of the cuttings materials found within and surrounding the Template.

The OSPAR (Oslo-Paris Convention) Recommendation 2006/5 (*'Management Regime for Offshore Cuttings Piles'*) has indicated that the best environmental option for the management of a drill cuttings pile is to leave it in place to degrade naturally and allow for a robust cuttings management plan, so long as the following conditions are met:

- The oil release rate from the pile remains less than 10 Te/year; and
- The area of persistence for the pile is less than 500 km^2/year.

Survey work was conducted to ensure the current condition of the cuttings pile is known, however, the most recent sampling campaign conducted in 2019 did not allow for a contemporary estimate of yearly oil loss (Fugro, 2019). Studies undertaken by the UKOOA Drill Cuttings Initiative have determined that the rate of oil release from cuttings, as mediated by erosion, degradation, and leaching, is very slow (i.e. will occur over several to many decades) and constitutes a small fraction (e.g. ca. 5%) of the total hydrocarbons content within cuttings piles which remain on the seabed. It is anticipated that there will be an initial instantaneous release of approximately 16.8 Te released from the cuttings pile; 9.38 Te of this 16.8 Te is deposited on the seabed and the remainder (7.38 Te) is in released to the water column of during the resuspension of the cuttings, followed by the slow release of oils due to natural degradation, which together fall below the OSPAR threshold of 10 Te/year and will continue to fall in subsequent years. The total area of seabed covered by the relocation of the cuttings pile is estimated to be 2.01 km^2 when considering a dispersed cuttings sediment thickness of 0.01 mm, which is well below the OSPAR threshold for area of persistence.

As the cuttings deposits meet the conditions for natural degradation proposed by OSPAR Recommendation 2006/5, it is proposed that the necessary disturbance of cuttings materials be managed through directed resuspension and resettlement which minimises impacts to the water column.

6.1.2.2 Characterisation of Impact Pathway

The drill cuttings deposits located at the Template will be resuspended and relocated to the seabed using the TRS2 controlled flow excavator (CFE) tool operated by ROTECH SUBSEA. This tool enables both horizontal and vertical mass flow excavation of materials. Vertical means the jets will be directed towards the seabed and horizontal means the jet will be directed parallel to the seabed.

The excavation of the cuttings deposits at the Template will be completed in three phases:

- Phase 1 - The TRS2 tool will be deployed directly above the template and will perform vertical jetting to remove the majority of the pile (70%). This will be modelled using 28 excavation locations;
- Phase 2 -The TRS2 tool will be deployed around the sides of the template on the seafloor and will perform horizontal jetting through the structure. The seabed disturbance is included in the model for this phase. This will be modelled using 8 excavation locations around the edge of the Template on the seafloor which will remove seabed material to allow access to the Template; and
- Phase 3 - The TRS2 tool will be deployed within the template performing both vertical and horizontal jetting depending on requirements. This phase will disturb 10% of the cuttings pile and will be modelled using 8 excavation locations.

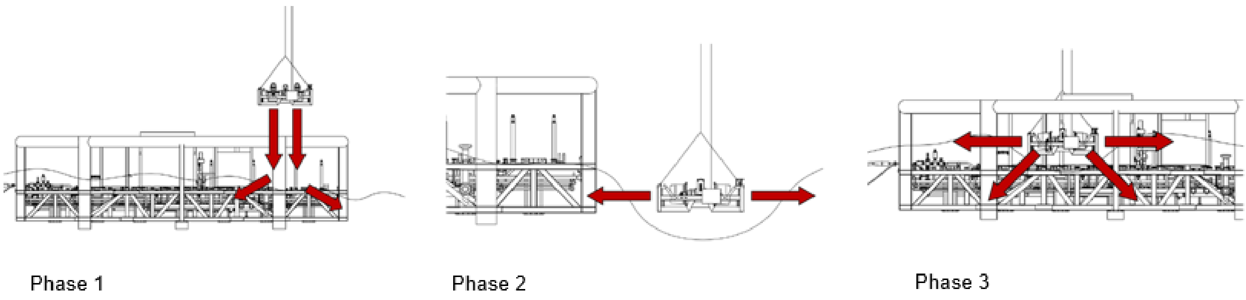

Figure 6-1 Phases of Excavation of the Cuttings Pile in and around the Balmoral Template (Premier, 2019f)

The redistribution of cuttings to the seafloor may impact the surrounding sediment composition and benthic habitat. Seabed impacts associated with the CFE of the cuttings deposits at the Template are assessed further in Section 6.2 below.

6.1.2.3 Quantifying Potential Impacts

To assist in determining the magnitude of impact, drill cuttings and fluids discharge modelling was conducted with the aid of the SINTEF Dose-related Risk and Effect Assessment Model (DREAM) ParTrack module (see Appendix D). DREAM is a 3-dimensional, time-dependent, exposure, fate, and effects assessment model. The ParTrack module is designed to simulate the release of drilling fluids and cuttings. Hydrodynamic data used in the model were obtained from several sources, including: (1) MyOcean (air and sea temperatures); (2) the European Centre for Medium-range Weather Forecasting Model (ECMWF; wind data); and (3) the Hybrid Coordinate Ocean Model (HYCOM; water currents).

The ParTrack module within DREAM has been designed to support rational management of environmental risks associated with operational discharges of complex mixtures. The dispersion of particulates and dissolved material in the water column and settling behaviour were assessed in vicinity of the Balmoral Template. An environmental impact factor (EIF) for the water column was calculated for the disturbed cuttings deposit to inform the assessment of the potential impacts of the DP on the marine environment (see Box 1 for details).

Box 1: Environmental Impact Factors

EIFs are a relative measure of risk to the biota in the marine environment and can be calculated for the water column or the seabed.

First, the entire modelled area is split into compartments. For the water column EIF, this is 100 m x 100 m x 10 m (0.0001 km^3), and for the seabed EIF, this is 100 m x 100 m (1 ha or 0.01 km^2).

In each compartment, the predicted environmental concentration (PEC)/predicted no effect concentration (PNEC) approach is used. In this approach the PEC of a contaminant in the compartment is divided by the PNEC (i.e. the highest concentration at which no environmental effect is predicted). The PNEC values within the model have been calculated using laboratory toxicity tests on a range of contaminants on a range of species.

Where PEC/PNEC ≥ 1, an unacceptable effect on organisms is likely to occur. Each compartment in which PEC/PNEC ≥1 contributes to the total EIF. By making various statistical assumptions, the stressors are extended to include others (in addition to toxicity), such as physical changes in sediment particle size, that are correlated with environmental impacts. This allows the contributions to the total EIF to be compared (e.g. how much risk is contributed from the chemical toxicity of various chemicals compared to the risk contributed by the effects of smothering).

The spatial development of the EIF can be represented by the risk to a species. An unacceptable effect is considered to occur when the probability of a species being affected by the stressor is more than 5% (i.e. the risk of adverse effects is more than 5%). The areas that are shown as having a higher than 5% risk contribute to the total EIF.

6.1.2.4 Potential Contaminants within the Cuttings Deposit

A total of 11 wells have been drilled at the Balmoral Template. Ten of these wells were drilled between 1984 and 1987 using a combination of water-based and oil-based muds and a further well was drilled using only water-based mud in 1991. The drill cuttings discharged have mainly accumulated within the footprint of the Template structure forming a cuttings pile with a maximum height of approximately 2 - 3 m.

There are no chemicals to be discharged that would pose any significant risk to the marine environment. The levels of radionuclides recorded in the cuttings deposit were determined to be well below the level that would be of environmental concern (Aurelia Environmental, 2019). Additionally, there are no radioactive materials that are expected to be discharged to sea during decommissioning.

The following contaminants are identified as likely to enter the marine environment as a result of CFE of the cuttings within and surrounding the Balmoral subsea Template:

- sediment;
- heavy metals, including zinc and cadmium; and
- entrained hydrocarbons, including total hydrocarbons, polycyclic aromatic hydrocarbons, nonylphenol and polychlorinated biphenyls.

The Sections below detail the characteristics of these potential contaminants.

Sediment

During Phase 2 of the CFE of the Template, the TRS2 will be on the seafloor. It is expected that 69 ppm of THC within the disturbed seabed will be released at each excavation location during Phase 2.

Heavy metals

Traces of the following heavy metals have been recorded in the cuttings deposit surrounding the Balmoral Template: arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc. However, only cadmium and zinc exceeded the CEFAS action level value and are therefore considered to have the potential to have significant risk to the marine environment.

During the decommissioning it is expected that 1.04 ppm of zinc and 188 ppm of cadmium will be released at each excavation location during each phase.

Entrained hydrocarbons

During decommissioning activities such as cutting of a subsea Template, there is opportunity for entrained fluids to enter the marine environment in small quantities. Contaminants within the cuttings deposit include residual hydrocarbons, along with dissolved organic and inorganic compounds that were present in the geological formation. These contaminants include polycyclic aromatic hydrocarbons (PAHs) and alkylphenols which are likely to have a detrimental impact on organisms within the water column. The concentrations of entrained hydrocarbons attached to particulates that are released during the decommissioning are presented in Table 6-1.

Table 6-1 Contaminants Characterisations of the Balmoral Cuttings Pile and Cuttings Piles within Analogous Fields

Survey	Hydrocarbons Note 1		Metals Note 1					
	THCs	Total PAHs	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury
Balmoral Cuttings Pile Survey								
Balmoral Cuttings Pile (Fugro, 2017a-c)	10 - 34,000	1 - 466	5 – 29.6	1,520 – 18,900	0.2 – 4.8	26 - 49	13 - 59	0.02 – 0.38
Balmoral Near-Template Surveys								
Balmoral Seabed Cores (Fugro, 2018a-c) Note 2	60 - 1020	-	-	1,760 – 100,000	-	-	-	-
Balmoral field – survey of sediments around the template, 1998 (Cordah, 1998) Note 3	103 - 409	-	-	3,186 – 4,789	< 1	52 - 56	23 - 72	-
Balmoral Seabed Survey								
Balmoral Pre-decommissioning Environmental Baseline Survey (Fugro, 2018) Note 4	7 - 609	0.2 – 3.1	2.9 – 6.2	26 – 2,150	0.06 – 0.26	42 - 95	15 - 22	0.01 – 0.05
Historical Cuttings Pile Surveys								
Cuttings Review (Cordah, 2000) Note 5	< 1,000 – 143,000	< 0.2 – 1,282	2.9 - 28	200 – 231,000	0.1 – 8.0	-	7 - 361	0.1 – 32.6
UKOOA cuttings Phase III (OGUK, 2004) Note 6	< 100 – 150,000	-	-	-	-	-	-	-
NW Hutton (BP, 2005) Note 7	49,000	773	-	101,000	1.5	87	170	-
Miller (Aquatera Ltd., 2007)	18,000 – 77,000	-	7 - 15	-	0.2 – 1.5	27 - 56	12 - 172	0.03 – 2.2

Murchison (BMT Cordah, 2013) Note 8	1,310 – 10,100	14 - 66	10 - 25	173,000 – 231,000	1.0 – 5.7	36 - 42	279 – 3,043	1.7 – 3.9
Ninian North (BMT Cordah, 2017) Note 9	24,700 – 96,300	2.5 - 347	9 – 15	142,000 – 154,000	1.0 – 2.0	34 – 52	200 – 203	1.6 – 2.1
Buchan (Benthic Solutions, 2019)	11 - 403	106 – 8,290	-	≤ 11,800	≤ 0.4	$\bar{x} = 36.1$	-	≤ 0.46

Notes:

1. Concentrations expressed as µgg-1 dry sediment.
2. 10 surface sediment samples collected between 10 m and 150 m from template
3. 4 surface sediment samples collected between 90m and 210 m from template
4. 29 surface sediment samples collected between 170 m and 1000 m from template
5. Range of mean data in core section collect from 15 cuttings piles
6. Data from cuttings pile cores taken from Clyde, Brent Alpha, Miller and Brent South
7. Average concentration
8. Based on total NPD (napthalenes, phenanthrenes and dibenzothiophenes)
9. Data obtained from analysis of three core samples

6.1.2.5 Modelling results

The plume of resuspended chemicals and particles is predicted to move north west in the direction of the ambient current. The maximum total concentration is approximately 8 ppm, which occurs 2 hours after the disturbance of the cuttings deposit begins. Subsequently, the concentration continues to decrease until the end of the model run. After 14 hours, the concentration is consistently below 1 ppm and after 2 days it falls below 0.1 ppm.

Figure 6-2 presents a time series of maps showing the predicted water column risk from the resuspended material over the duration of the modelling. These figures show that the extent of water impacted at greater than 5 % is variable and transient due to the varying currents and changing composition of the material. The risk to the water column remains within 32 km of the Template. Figure 6-3 presents a cross-section through the water column along the transect A-B in Figure 6-2, roughly south-east to north-west. The risk is predicted to move with the plume to the north west and will not reach the surface, remaining below approximately 105 m depth.

The development of the water column risk as described by the EIF values is presented in Figure 6-4. The maximum EIF is 13,444 and occurs at day 3, hour 12. However, after 7 days and 20 hours from the initial disturbance, the risk to the water column is below 5%, indicating impacts will be short-term and localised.

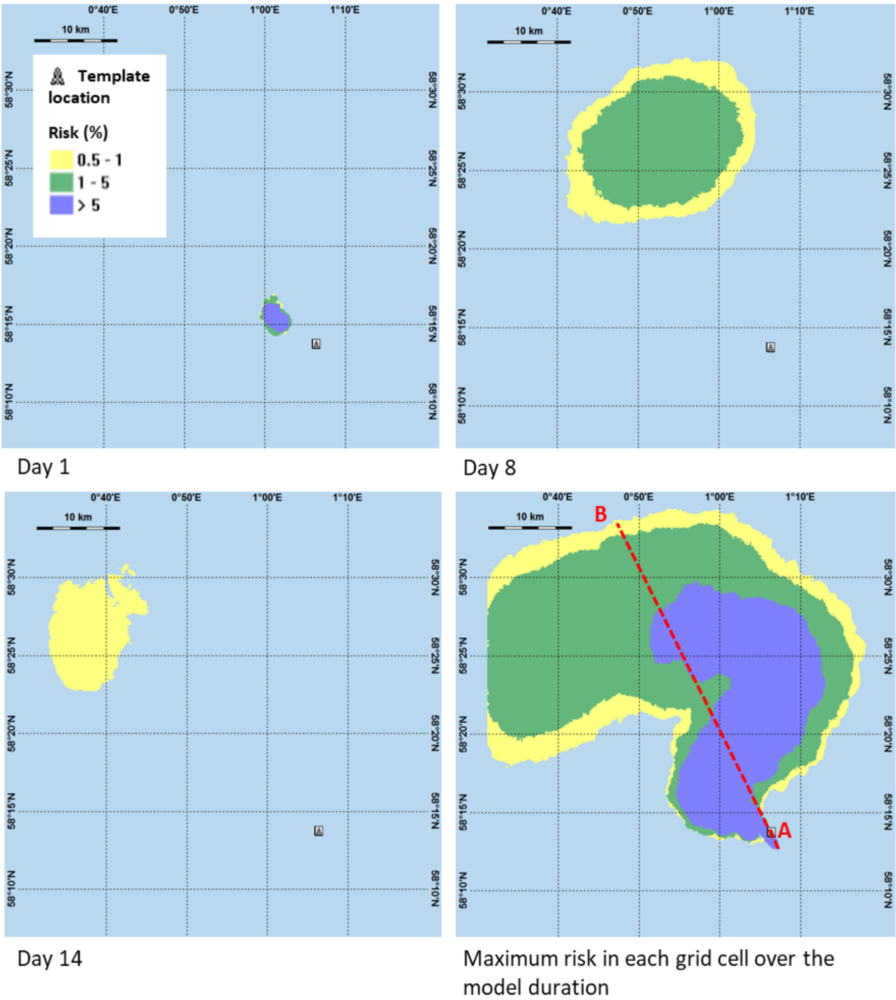

Figure 6-2 Water Column Impact from CFE of Drill Cuttings[1]

[1] Maximum risk is taken as the maximum risk recorded within each grid cell over the entire run of the model.

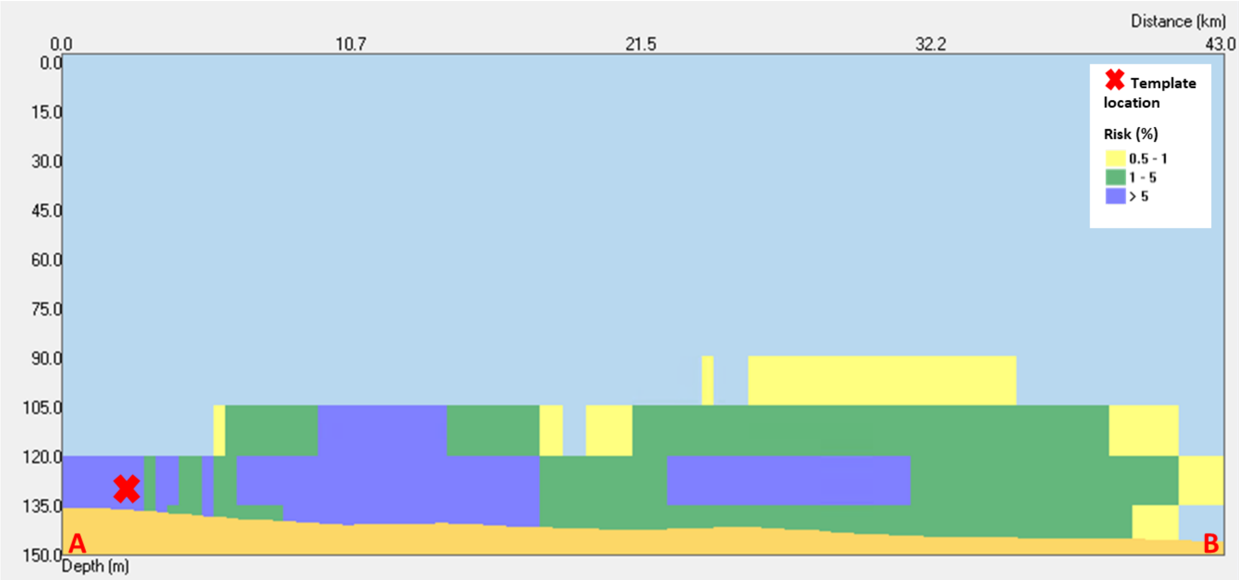

Figure 6-3 Water Column Impacts along Transect A-B

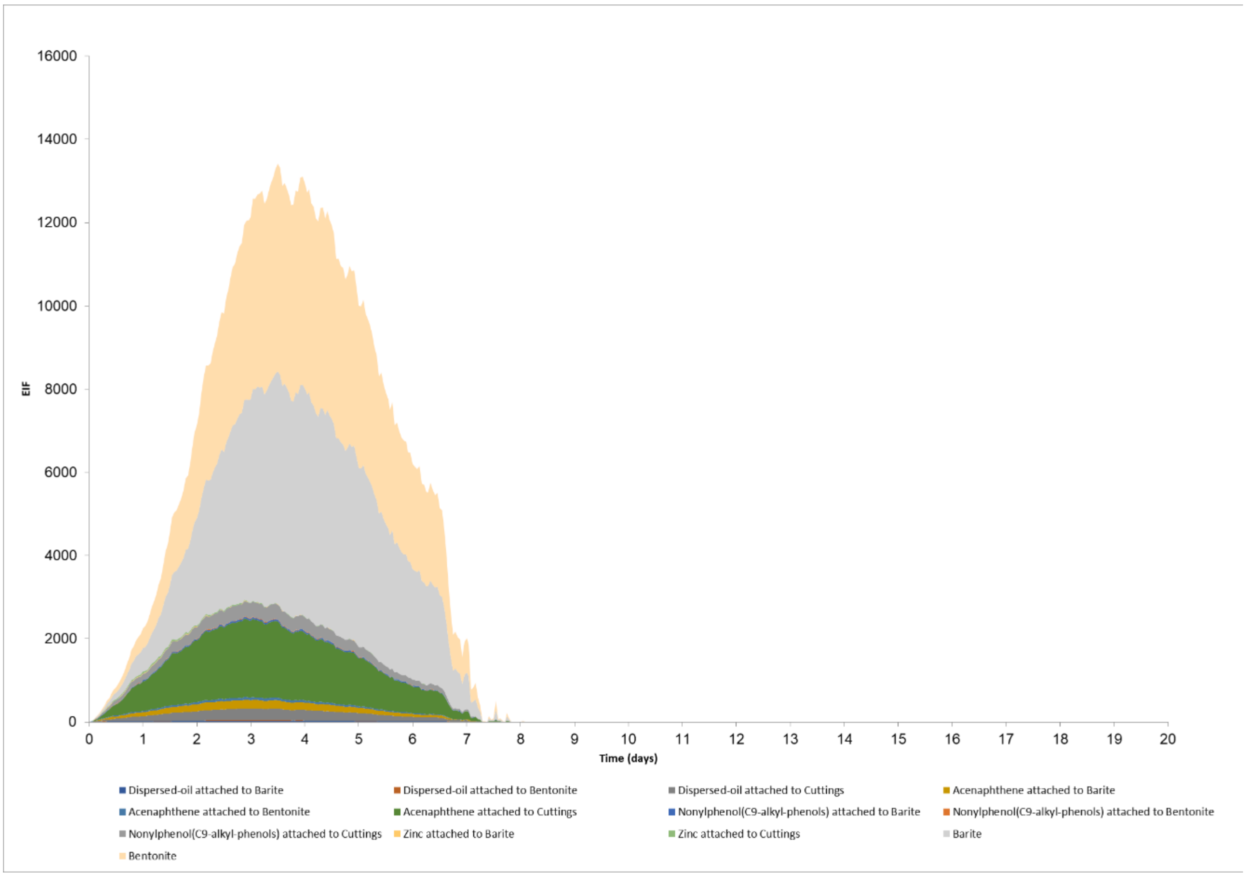

Figure 6-4 Development to the Water Column Impact (EIF)

6.1.3 Effects on Sensitive Receptors

The potential impact to the marine environment is dependent on several physical, chemical, and biological attributes, including: volume and density of discharge; dilution; volatilisation; and biodegradation of organic compounds. For example, compounds in residual fluids undergo weathering which tends to reduce their concentration within the receiving environment and decrease potential toxicity to marine organisms (Neff, 1987). The impact will also vary, depending on the receptor and the associated toxicological effects. Table 6-2 describes the potential impacts of contaminants within the water column on marine fauna.

Table 6-2 The Potential Toxicological Effects on Relevant Sensitive Receptors from Contaminants in the Marine Water Column (OSPAR, 2009)

Receptor	Eco-toxicological impact
Planktonic organisms	May experience toxic effects from hydrocarbons in water, but a high turnover rate due to short life expectancies associated with planktonic taxa mean potential population-impacts are relatively low.
Benthic fauna	Sensitivity is highly variable, with soft corals being the most sensitive species. There are also health risks associated with bioaccumulation of contaminants in shellfish which may impact marine species and human receptors. Seapens, which are part of the OSPAR listed habitat, 'seapens and burrowing megafauna communities', identified in the Greater Balmoral Area, are filter feeders and therefore there is potential for impacts on individual seapens and as a result on the protected habitat. Ocean quahog, an OSPAR listed species, is also a filter-feeder with potential to be impacted by changes in water quality. Potential impacts may arise from contaminants dispersed in the water column through sediment disturbance and discharges to sea, which may have toxicity effects, or changes in water clarity and siltation rate which may impair the feeding ability of filter-feeding organisms.
Fish and shellfish	Sensitivity is variable and dependent on phase of life. Eggs and larvae are more susceptible to toxic effects than adult fishes. Hydrocarbons may bioaccumulate in adult tissues which could affect the health of individuals and impact and predatory species. There may also be impacts to human health if commercial species are affected. The Greater Balmoral Area is predominantly targeted for *Nephrops*, which live in fine sediments and are therefore likely to be impacted by sediment contaminants. This species may be part of the OSPAR listed habitat 'seapens and burrowing megafauna communities'.
Marine mammals	Potential toxic effects from ingestion via bioaccumulation in prey sources. Additionally, contaminants in the water column could present sources of possible skin/eye irritation, which may impact health.

In the following Sections, potential impacts from the short-term change in water quality are assessed for the major taxonomic groups relevant to the marine environment at the Balmoral facilities to assess the scale of possible environmental interactions within the vicinity of the discharge. Overall, it is expected that any hydrocarbons present in the water column will disperse within a short distance of the excavation location and any impacts will be short lived.

6.1.3.1 Benthic fauna

Changes in the water quality arising from decommissioning activities at Balmoral may result in localised, short-term toxicity to the filter feeding benthic organisms (e.g. hydroids and bryozoans) that rely on suspended particles as a source of food. Mobile species may be able to avoid unfavourable conditions. The disturbed cuttings are expected to redistribute over a 0.16 km^2 of seabed to a depth of greater than 1 mm (see Table 6-5).

There are no Annex I species or habitats within the Greater Balmoral Area, however the biotope 'seapens and burrowing megafauna communities' and some juvenile ocean quahogs, both on the OSPAR (2008) Red List of Threatened and/or Declining Species and Habitats, have been identified in the Balmoral field. Seapens, which are a key component of the protected biotope mentioned above, and ocean quahogs are both filter-feeders. Therefore, an increase in contaminants levels in the water column present in re-suspended sediments may impact these species. The extent of toxicity within the benthic community is dependent on a number of variables including water column depth, dispersion rates, current speed and dilution (Lee and Neff, 2011). There is little information on the vulnerability of these species to hydrocarbons and polycyclic aromatic hydrocarbons typically present in sediments in the vicinity of offshore oil and gas fields. Sediment disturbance will be temporary and resuspended chemicals and particles are expected to settle relatively quickly, with their concentration in the water column expected to fall below 1 ppm after 14 hours and below 0.1 ppm after 2 days. Dispersion of resuspended chemicals and particles will be within 32 km of the Balmoral Template (see Section 0 for dispersion modelling results).

Seapens and ocean quahogs are assessed as having a low sensitivity to changes in water clarity, which may increase immediately after sediment disturbance during the decommissioning activities. Ocean quahogs and seapens typically occur in fine sediments where the surface is probably regularly mobilised and where accretion rates are moderate to high. Ocean quahog can also avoid sudden changes by burrowing for several days, whilst seapens, such as *V. mirabilis,* can secrete mucus to help polyps clearing of silt. Feeding ability for both species may be temporarily disturbed due to increases in suspended sediments, however, it will be resumed once water clarity returns to background levels and therefore recoverability is high (Tyler-Walters and Sabatini, 2017; Hill and Tyler-Walters, 2018).

There is little evidence that community-level impacts to benthic receptors will occur following a limited release of hydrocarbons. However, any impact that does occur could have a minor, temporary impact on the condition of benthos, with localised recovery occurring within 2-10 years. Consequently, the vulnerability and magnitude of potential impacts on the benthos are considered medium and moderate, respectively. Benthic value is considered medium despite the regional abundance of the fauna found in the project area. This is because the benthos comprising the Greater Balmoral Area has been characterised as the OSPAR threatened and/or declining habitat, '*Seapens and burrowing megafauna communities'.* Considering the above, the overall impact of the proposed CFE of the cuttings deposits on benthic receptors is considered **minor**.

6.1.3.2 Planktonic organisms

Plankton are particularly susceptible to impacts from changes in the water column because they are generally non-motile, depending upon currents to travel, and cannot move away from an affected area (Ikpeme *et al.*, 2013). Therefore, impacts to plankton are likely to occur in the immediate area of the release for the duration of the release due to the dissolution of aromatic fractions into the water column. Low concentrations of hydrocarbons (<0.05 mg/l) can stimulate phytoplankton growth, but above species-specific thresholds, acute toxic effects may lead to inhibited growth and/or mortality. According to the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), zooplankton communities are also likely to be affected by hydrocarbons, both directly through the toxicity of hydrocarbon content of their food and indirectly via changes in the ecosystem (SAHFOS, 2001).

Some localised toxicity to planktonic organisms may result from the disturbance of the cuttings deposit during the proposed decommissioning operations. However, as these localised dilutions will enter a turbulent offshore environment and become rapidly dispersed, the concentrations within the water column are unlikely to have lethal or sub-lethal effects to the planktonic community.

The consequences of changes to water quality will depend partly on the season, with greater impacts expected if the release coincided with the phytoplankton or zooplankton blooms. However, the value of plankton is considered low due to its abundance both locally and internationally. Furthermore, planktonic communities have some tolerance to accommodate a release and are expected to recover within a short-term period (i.e. 1 to 2 years), therefore sensitivity and vulnerability are also considered low.

The potential impacts of a worst-case scenario large release on plankton are likely to be temporary (1 to 2 years) and the magnitude of such an event is deemed to be minor. Given the low likelihood of such an event transpiring and the low vulnerability of planktonic populations to such perturbations, it is considered that potential impacts to plankton receptors are **negligible**.

6.1.3.3 Fish and shellfish

The decommissioning activities associated with the CFE of the cuttings deposit within the Template may potentially impact fish and shellfish in the vicinity of the works as a result of chemical and particle re-suspension, including the liberation of buried hydrocarbons into the water column. Potential sub-lethal effects of hydrocarbons on fish include impairment of reproductive processes and increased susceptibility to disease and predators. There may also be impacts to human health if commercial species are affected. The Greater Balmoral Area is predominantly targeted for *Nephrops*, which live in fine sediments and are therefore likely to be impacted by sediment contaminants. This species may be part of the OSPAR listed habitat ‘seapens and burrowing megafauna communities’.

There is a low probability of fish, shellfish or other epibenthic organisms being impacted by the disturbance of the cuttings deposits due to predicted low concentrations of hydrocarbons and other contaminants within the water column (see Section 0 for dispersion modelling results). As pelagic finfish are highly mobile, it is unlikely that there will be an impact on the finfish community. Following the controlled release of THC during CFE, the mortality of any less mobile individuals would be compensated for through the immigration of individuals from the surrounding areas. As a result, sensitivity and vulnerability are both ranked as low. For these reasons, impacts to fish and shellfish species from the proposed activities are considered **negligible**.

6.1.3.4 Marine mammals

Contaminants that may be re-suspended in the water column through sediment disturbance may have toxic effects on marine mammals via bioaccumulation of contaminants from ingestion of prey species. Annex II species sighted within the Greater Balmoral Area include the harbour porpoise and bottlenose dolphin, meaning the value of this receptor has been designated as high. However, since concentrations of hydrocarbons and other contaminants in the water column are expected to be low and will only rise temporarily, the vulnerability of marine mammals to this effect is low, and therefore the magnitude of impact on marine mammals is assessed as minor. The small number of animals likely to be found in the project area, coupled with their mobile nature and the localised risk to the water column, suggests that impacts to marine mammals, including Annex II and European Protected Species (EPS), will be **negligible**.

6.1.4 Cumulative and Transboundary Impacts

As discussed above, the impact to the local environment from the decommissioning of the Balmoral Template is negligible and temporary. Therefore, the potential for cumulative impacts is greatly reduced. Also, there are regulatory requirements in place to ensure that discharges to sea are ALARP or below certain thresholds.

Since the Balmoral infrastructure is located approximately 30 km south west of the UK/Norwegian median line and all identified impacts will be localised and limited to UK waters, no transboundary impacts are anticipated from the decommissioning of the Balmoral Template.

6.1.5 Mitigation Measures

Under the Petroleum Act 1998 the Balmoral Template must be removed (as discussed in Section 2.4) which requires full removal of cuttings deposit surrounding the Template. Premier will follow best practice by directing the majority of the resuspended cuttings deposit to the seabed during CFE, rather than jetting into the water column. For information on seabed impacts see Section 6.2.

6.1.6 Conclusion

Receptor	Impact Magnitude	Receptor Sensitivity	Receptor Vulnerability	Receptor Value
Benthos	**Minor**	**Medium**	**Low**	**Medium**
Plankton	**Minor**	**Low**	**Negligible**	**Negligible**
Fish & shellfish	**Minor**	**Low**	**Negligible**	**Medium**
Marine mammals	**Minor**	**Low**	**Negligible**	**Medium**

Validation

It is required, under the Petroleum Act 1998, that the Balmoral Template is removed (as discussed in Section 2.4). During the decommissioning period, the associated activities have the potential to temporarily reduce the water quality in the surrounding area. The vast majority of activities with the potential to impact water quality were screened out of further assessment based on existing regulatory controls and standards; however, drill cuttings dispersion remains as a potential impact pathway.

The decommissioning of the cuttings deposits through CFE within and surrounding the Balmoral Template may affect the surrounding water quality and its environmental features over a brief period (ca. 15 hours) and over the distance of up to several km, giving it an impact magnitude of **minor**. However, the resuspension of contaminated cuttings into the marine environment are predicted to have a **negligible** impact on the majority of marine species, due to the water quality impacts with noticeable effects being limited to the immediate vicinity of the Template (within several tens of meters). Only benthic features, which are often sessile and particularly sensitive to impacts from burial and smothering are considered to have a **medium** sensitivity but **low** vulnerability, based on the fact that the area of impact will be considerably limited in comparison to the wider benthic habitat. Moreover, receptor value is considered **medium** for all taxa but plankton. However, benthic species remain the taxa with the only likely discernible residual effect from the CFE of the drill cuttings. Whilst there is expected to be temporary variation in the benthos immediately surrounding the Balmoral Template, there is anticipated to be no long-term variation to any natural habitat or populations/communities, and all important species likely to occur in the impacted area form a very small component of a regionally important habitat.

Impacts to water quality resulting from the proposed decommissioning activities are considered **negligible**.

Residual Impact Significance	**Negligible**

6.2 Seabed Impacts

The impact of the Greater Balmoral Area decommissioning activities on seabed receptors is discussed in this Section, along with measures proposed to minimise the scale and duration of any potential impacts.

6.2.1 Approach

There are two seabed impact pathways associated with the decommissioning operations: direct and indirect disturbance.

Direct disturbance is considered the physical disturbance of seabed sediments and habitats. Direct disturbance has the potential to cause temporary or permanent changes to the marine environment, depending upon the nature of the associated activity. Activities which contribute to the direct disturbance impact pathway include the removal of infrastructure and remediation of snagging hazards, either from overtrawling or placement of material (rock armour) on the seabed. The total area of seabed expected to be impacted by direct physical disturbance has been calculated by adding together the individual areas of physical disturbance estimated for each activity and the expected duration of the direct disturbance has been provided.

The second impact mechanism, indirect disturbance, is that which occurs outside of the direct disturbance footprint. It may be caused by the suspension and re-settlement of natural seabed sediments and cuttings pile materials disturbed during CFE operations. This secondary impact pathway is considered temporary in all instances, based on the definitions provided in Section 4. The expected scale and duration of direct seabed disturbance due to cuttings re-settlement has been predicted using DREAM modelling (see Section 6.1). The scale of indirect disturbance due to re-suspension and re-settlement of natural sediment has been estimated based on the potential area of direct disturbance from overtrawling, as described in Section 2.4.7.

6.2.2 Sources of Potential Impact

6.2.2.1 Overview

The following activities have been identified as potential sources of seabed impacts:

- Balmoral FPV mooring system removal:
  - Removal of mooring lines between FPV and seabed piles (piles will remain *in situ*).
- Pipeline, flowline, and umbilical decommissioning:
  - Removal of surface laid flexible flowlines, umbilicals and jumpers, rigid spoolpieces, flexible risers;
  - Deburial and reverse-reel of flexible flowlines; and
  - Removal of cut ends and exposures of rigid flowlines.
- Decommissioning of subsea installations:
  - Removal of the Balmoral Template;
  - CFE of buried infrastructure and stabilisation materials; and
  - Removal of additional small installations or items.
- Stabilisation materials:
  - Removal of mattresses and grout bags; and
  - Deposition of new rock armour to protect ends and cut exposures of rigid flowlines decommissioned *in situ*.

- Clear seabed verification – potential remediation requiring direct intervention:
  - Flexible flowlines to be deburied and removed via reverse reeling;
  - Footprint associated with infrastructure with a 500 m exclusion zone (following its removal); and
  - Footprints associated with anchor points (following recovery of the anchor system to the FPV).

Field debris items are anticipated to be located on the surface of the seafloor and are therefore not expected to require intrusive remediation. The area of potential impact will be superficial, temporary, and largely limited to the dimensions of the debris item being retrieved, which will be determined during the Seabed Clearance Verification survey. As such, seabed disturbance associated with field debris items is considered negligible and has thus been screened out of further assessment.

Seabed disturbance may be classified as short-term, temporary, prolonged, or permanent, as defined in Table 4-3 above.

6.2.2.2 Balmoral FPV Mooring System Removal

As detailed in Section 2.4.1, the Balmoral FPV will be removed from site following cleaning and disconnection from all seabed infrastructure. The eight mooring lines (each measuring approximately 1,550 m in length) will be cut from the anchor piles at seabed level, leaving approximately 20 m of mooring line in the sediment between the top of the pile and seabed level. The anchor piles and the short sections of mooring line that remain attached will be decommissioned *in situ*, the free sections (approx. 1,530 m per line) will be recovered to the surface and returned to shore.

The disturbance areas associated with the proposed FPV Removal activities are summarised in Table 6-3. There is not expected to be any seabed disturbance associated with the float-off of the Balmoral FPV (i.e. the relocation of the vessel from the decommissioning area), or the decommissioning of the anchor piles or short sections of mooring line *in situ*. As such, these items have been excluded from the calculations in Table 6-3.

Table 6-3 Seabed Disturbance Associated with Balmoral FPV Removal

Activity	Quantity and dimensions	Expected duration of direct disturbance	Direct Disturbance (km^2)	Temporary Indirect Disturbance (km^2)
Lowering and subsequent removal of mooring lines from seabed	8 lines each of 1,530 m length and approximately 331.2 mm width [Note 1]	Temporary	0.0041	0.0082
		Total	**0.0041**	**0.0082**

Notes:

1. Balmoral FPV mooring lines are R4 studded chain of 92 mm link bar diameter (Noble Denton Europe Limited, 2006). Standard geometry of studded chain is link width of 3.6 x link bar diameter, giving an expected chain width of 331.2 cm (Noble Denton Europe Limited, 2006).

6.2.2.3 Pipelines, Flowlines, and Umbilicals Decommissioning

As described in Section 2.4.4, all surface laid lines (comprising flowlines, umbilicals, jumpers, risers, and rigid spools) will be recovered. Rigid flowlines that are trenched and buried will have their unburied ends, plus any exposures, cut and removed. The resulting exposed cut ends will be buried in the first instance. However, where adequate burial cannot be achieved, cut ends will be covered with rock armour to mitigate snag risk and future exposure due to scour. The trenched and buried sections will be decommissioned *in situ*. All other trenched and or buried lines (comprising flexible flowlines and umbilicals), will be de-buried using CFE and recovered. Only those buried sections will be considered for seabed impacts, as the act of deburial introduces snagging risk in instances when clay berms are generated.

The disturbance areas associated with the proposed activities associated with decommissioning of the pipelines, flowlines and umbilicals are summarised in Table 6-4. The area of seabed directly disturbed through the recovery of the surface laid flowlines and cut ends has been estimated by multiplying the length of each individual line by the outer diameter. Whereas, the area directly disturbed by the deburial of flexible flowlines is taken to be the length of the buried portion of the flowline (per Table 8-4 in Appendix A) multiplied by the outer diameter, with a buffer of 2 m on either side of the line applied (i.e. 4 m total) to account for the 'pull through' effect of reverse-reeling. The areas disturbed by recovery of each individual line have then been summed to give the overall area of disturbance affected. As described above, the indirect disturbance has been estimated as twice the area of direct disturbance.

Buried sections of rigid flowline that are decommissioned *in situ* are not expected to generate seabed disturbance and have therefore been excluded from the table.

Disturbance due to placement of rock armour to protect exposed ends of flowlines decommissioned *in situ* has been assessed separately in Section 6.2.2.4.

Table 6-4 Direct Seabed Disturbance Associated with Pipeline, Flowline, and Umbilical Decommissioning

Activity	Quantity and dimensions	Expected duration of direct disturbance	Direct disturbance (km^2)	Temporary Indirect Disturbance (km^2)
Removal of surface laid flowlines	18 individual lines with diameters ranging from 2.665 to 8.39 in.	Temporary	0.004	0.008
Deburial and reverse-reel of flexible flowlines	11 individual lines with diameters ranging from 0.5 to 7.539 in. with a buffer of 4 m centred on the line	Temporary	0.007	0.014
Removal of cut ends and exposures of rigid flowlines	14 individual lines and 4 sets of piggybacked lines with ends to be cut. Of these, 6 individual lines and 3 sets of piggybacked lines contain 28 exposures in total varying in length from 4 to 266 m.	Temporary	0.002	0.004
		Total	**0.013**	**0.026**

6.2.2.4 Decommissioning of Subsea Installations

As described in Sections 2.4.1 and 2.4.6, all seabed infrastructure will be excavated, cut free from any piles as necessary and recovered to the surface. Mooring lines will be at the seabed (i.e. the mudline), whilst other infrastructure will be removed below the seabed. Cut piles will be decommissioned *in situ*.

The disturbance areas associated with the proposed operations are summarised in Table 6-4. The area of seabed disturbed by recovery of each individual item has been estimated by multiplying the item length by the width. The areas disturbed by recovery of each individual item have then been summed to give the overall area of seabed disturbed. Cut piles that are decommissioned *in situ* are not expected to cause any seabed disturbance and have therefore been excluded from the table.

The area of seabed covered to a depth of greater than 1 mm by the re-settling of drill cuttings excavated from around the Balmoral Template during recovery operations was predicted using the DREAM particle model.

Table 6-5 Direct Seabed Disturbance Associated with Decommissioning of Seabed Installations

Activity	Quantity and dimensions	Expected duration of direct disturbance	Direct Disturbance (km^2)	Temporary Indirect Disturbance (km^2)
Excavation of Balmoral cuttings pile using CFE to expose piles for cutting	Disturbed cuttings are expected to settle out over a seabed area of approximately 160,200 m^2 (area covered by cuttings layer exceeding 1 mm thick)	Permanent	0.16	0.32
Removal of Balmoral Template	Large steel Template with dimensions 33 m x 33 m.	Temporary	0.0011	0.0022
Removal of other seabed installations	Twenty-eight individual items ranging from 3 m x 3 m (mud mats) to 28.9 m x 10 m (Brenda manifold)	Temporary	0.0032	0.0064
		Total	**0.16**	**0.33**

6.2.2.5 Stabilisation Materials

Rock armour, concrete mattresses and grout bags have previously been deployed across the Greater Balmoral Area to stabilise and protect seabed infrastructure.

As noted in Section 2.4.5, the intention is that all 420 concrete mattresses and approximately 5,520 grout bags will be recovered. In some cases, older mattresses may be unsafe to lift due to corrosion of the steel wires holding them together. Any such mattresses which have been identified as being potentially unsafe to recover during decommissioning activities will be reviewed with OPRED.

In line with the BEIS (2018) Guidance, existing rock armour will be left *in situ* to minimise disturbance to the benthic environment. This approach enables the continued protection of buried infrastructure from exposure and reduces potential snagging by fishing gears. However, additional deposits of rock armour may be required to protect the newly cut ends and any identified midline exposures of trenched and buried rigid pipelines to be decommissioned *in situ.* The addition of new rock armour at the cuts at pipeline ends or midline exposures has been calculated based on the rock deposition areas supplied in Pidduck *et al.* (2017), which provides for 5 m^2 of rock placement at cut ends of decommissioned pipelines.

The seabed disturbance associated with the stabilisation materials is summarised in Table 6-6. It has been assumed that where grout bags have been used, they will have been laid on top of either concrete mattresses or field infrastructure, and as such their removal will not entail any additional seabed disturbance. Grout bags have therefore been excluded from the table.

Table 6-6 Seabed Disturbance Associated with Stabilisation Materials (Including Existing Materials Decommissioned *in situ* and New Materials Deposited to Protect Pipeline Ends)

Activity	Surface Area (km^2)	Expected duration of direct disturbance	Direct disturbance (km^2)	Temporary Indirect disturbance (km^2)
Removal of existing concrete mattresses	0.0061	Temporary	0.0061	0.012
Deposition of new rock armour to protect other infrastructure decommissioned *in situ*	0.00046	Permanent	0.00046	0.00092
		Total	**0.0066**	**0.013**

6.2.2.6 Seabed Clearance Verification

As detailed in Section 2.4.7, a seabed clearance verification is required following all decommissioning projects to ensure there is no residual risk to other sea users, particularly those which make contact with the seabed (e.g. demersal trawl or dredge fisheries). Seabed clearance verification will include surveyance of the decommissioned area and independent review of the survey findings. Where residual risks have been identified, intervention in the form of overtrawling to re-level the seabed or the addition of rock placement (as covered in Section 6.2.2.5 above) may be required to limit risks to other sea users. Although an important activity for limiting the potential for safety hazards, the use of overtrawling constitutes the greatest potential impact to the benthic environment and therefore the worst-case assessment of overtrawl has been limited to only those decommissioning activities with the potential to generate clay berms or seabed anomalies.

The proposed overtrawling remediation has been limited to the following infrastructure:

- Flexible flowlines to be deburied and removed via reverse reeling;
- Footprint associated with infrastructure with 500 m exclusion zone (following its removal); and
- Footprints associated with anchor points (following anchor system recovery to the FPV).

The area of direct impact around the flexible flowlines is assumed to fall within a 100 m corridor (centred on the flowlines, per the BEIS (2018) guidance), and within a highly conservative 200 m buffer around the footprints for the anchor points and infrastructure with a 500 m exclusion zone. The footprint buffers have been selected to represent the lack of precision involved in overtrawling, most considerably for circular or complex geometries. As the manoeuvrability of trawl gear is limited, it is expected that the overtrawling of the footprints will take on cross-hatch pattern and therefore the buffers will be calculated as square shapes over the centre point of the existing infrastructure. Consequently, each of the footprints are expected to have an overtrawl area of 400 m^2.

The area predicted to be directly disturbed in the worst-case scenario is presented in Table 6-7.

In addition to the calculated direct disturbance from overtrawling, an estimate has been made of the possible indirect disturbance due to re-suspension and re-settlement of sediment. The area exposed to indirect disturbance was assumed to be twice the area of direct disturbance. Approximately half of the area affected by indirect disturbance will be within the direct disturbance area (Table 6-7).

Table 6-7 Temporary Seabed Disturbance Associated with Seabed Clearance Verification

Infrastructure		Location	Notes and assumptions	Overtrawl Area (m^2)	Temporary Direct Disturbance (km^2)	Temporary Indirect Disturbance (km^2)
Large infrastructure						
Balmoral Template		Balmoral	33 x 33 m with 200 x 200 m square buffer over centre point	40,000	0.04	0.08
Buried flexible flowlines						
PL222A	B29 Production	Balmoral	Buried length (4,460 m) x 100 m buffer	446,000	0.446	0.89
PL980[Note 1]	A27 Service	Glamis	Buried length (2,190 m) x 100 m buffer	219,000	0.219	0.44
PL644	A26 Chem Inj Umbilical		Buried length (7,740 m) x 100 m buffer	774,000	0.774	1.55
PL645	A27 Chem Inj Umbilical		Buried length (6,840 m) x 100 m buffer	684,000	0.684	1.37
PLU4356	A17z Control Umbilical		Buried length (7,450 m) x 100 m buffer	745,000	0.745	1.49
PL646	A13 Chem Inj Umbilical	Blair	Buried length (5,590 m) x 100 m buffer	559,000	0.559	1.12
PL2000	Stirling Production	Stirling	Buried length (3,540 m) x 100 m buffer	354,000	0.354	0.71
PL2001	Stirling Gas Lift		Buried length (3,570 m) x 100 m buffer	357,000	0.357	0.71
PLU2002	SES Control Umbilical		Buried length (3,550 m) x 100 m buffer	355,000	0.355	0.71
PLU2328	Brenda Control Umbilical (Static Section)	Brenda	Buried length (8,960 m) x 100 m buffer	896,000	0.896	1.79
PLU2352	Nicol Control Umbilical	Nicol	Buried length (9,380 m) x 100 m buffer	938,000	0.938	1.88
Anchor points						
Anchor points		Balmoral FPV	8 anchor points (Ø1.58 m) each with 200 x 200 m square buffer over centre point	320,000	0.32	0.64
			Total	**5,749,000**	**5.8**	**11.5**

Notes:

1. PL980 is comprised of both a flexible and rigid section of flowline. The buried length quoted here is for the flexible section which will be deburied and removed via reverse reeling.

6.2.2.7 Summary of Seabed Impacts

The contribution to seabed disturbance from the decommissioning activities discussed in Sections 6.2.2.2 to 6.2.2.6 are summarised in Table 6-8. This table illustrates the worst-case scenario for seabed disturbance, in which the majority of seabed disturbance will be due to overtrawling. Because all other seabed disturbance will occur in areas that will subsequently be overtrawled, all other sources of temporary disturbance are not included in the "Totals with overtrawling" temporary disturbance total, as this would be double counting. This does not apply to the "Totals with overtrawling" prolonged disturbance total however, as this is not affected by overtrawling. While the overtrawling and the activities leading to prolonged disturbance will occur in the same place, the prolonged disturbance area is distinct from the temporary disturbance expected from overtrawling.

Table 6-8 Total Potential Seabed Disturbance from Greater Balmoral Area Decommissioning Activities

Activity	Temporary direct disturbance (km^2)	Temporary indirect disturbance (km^2)	Permanent direct disturbance (km^2)
Balmoral FPV Mooring System Removal	0.0041	0.0082	0
Notes: Balmoral FPV mooring lines are R4 studded chain of 92 mm link bar diameter (Noble Denton Europe Limited, 2006). Standard geometry of studded chain is link width of 3.6 x link bar diameter, giving an expected chain width of 331.2 cm (Noble Denton Europe Limited, 2006). Pipelines, Flowlines, and Umbilicals Decommissioning	0.013	0.026	0
Decommissioning of Subsea Installations	0.0043	0.33	0.16
Stabilisation Materials	0.0061	0.013	0.00046
Total	**0.028**	**0.38**	**0.16**
Seabed Clearance Verification	5.8	11.5	0
Total with overtrawling	**5.8**	**11.9**	**0.16**

6.2.3 Effects on Sensitive Receptors

6.2.3.1 Direct Disturbance

Decommissioning activities are expected to lead to two types of direct physical disturbance. The first is temporary disturbance, which will result from the removal of infrastructure from the seabed, and from overtrawling. The sediment will be disturbed by the action of retrieving equipment from the seabed and by the trawl running over the seabed, but once decommissioning is complete, the affected areas will be free of anthropogenic material. This is expected to allow recovery in line with natural processes such as sediment re-suspension and deposition, movement of animals into the disturbed area from the surrounding habitat, and recruitment of new individuals from the plankton.

The second type of direct disturbance will be permanent disturbance caused by the decommissioning of stabilisation materials on the seabed (rock armour and potentially unrecoverable concrete mattresses), and the deposition of additional material (rock armour) on the seabed to protect infrastructure decommissioned *in situ*. This type of disturbance will effectively change the seabed type in the affected areas from the natural fine mud to a hard substrate. As these materials will be permanently left on the seabed, the duration of the disturbance is expected to be permanent, and will last until the deposited materials are fully buried by the deposition of new natural sediment.

The effects expected to be associated with each type of direct disturbance are discussed in the subsections below.

Temporary Direct Disturbance

As noted in Table 6-8, without overtrawling, approximately 0.028 km^2 of seabed would be affected by temporary disturbance. The scale of the disturbance is very small when compared to other forms of disturbance that occur in the area, such as commercial trawling. As noted in Section 3.5.2, the majority of demersal fishing effort in the area comprised trawling, and the most important target was *Nephrops*. In the CNS, this species is generally targeted with beam trawls or otter trawls (FRS, 2004). FAO (2019) indicates that commercial beam trawls may be up to 12 m wide, and trawl for shellfish at speeds of 1.3 m/s and above. A 12-m wide beam trawl being towed at 1.3 m/s would cover approximately 0.056 km^2 of seabed per hour, and would therefore take less than half an hour to cover the area expected to be disturbed by decommissioning operations (excluding overtrawling). Overtrawling of the removed infrastructure will increase the area disturbed by decommissioning operations to 5.8 km^2. This would be approximately equivalent to 103.5 hours of trawling. Average fishing effort per year in ICES rectangles 45F1 and 45F0 between 2014 and 2018 was 537 days (12,888 hours) and 701 days (16,824 hours), respectively. In this context, the scale of the disturbance associated with the decommissioning activities is clearly limited and can be further reduced through the selective employment of overtrawling for seabed clearance purposes.

Effects on the benthos are expected to include mortality and injury arising from crushing of benthic and epibenthic fauna that cannot move away from the activities, as well as disturbance of motile fauna. The sediment structure, including the burrows of any animals present, will be disturbed.

The EUNIS habitat A5.37 ‘Deep circalittoral mud’, which is thought to be representative of the Greater Balmoral Area (Fugro, 2018b), is predicted to cover approximately 18,900 km^2 of the CNS (UKSeaMap, 2016). As such, temporary disturbance of 5.8 km^2 of seabed is expected to have a **negligible** effect in the context of the regional environment.

The primary feature of conservation concern in the Greater Balmoral Area are seapens and their associated EUNIS habitat, ‘Seapens and burrowing megafauna in circalittoral fine mud’ (which falls within the broader OSPAR threatened or declining habitat ‘Seapen and burrowing megafauna communities'). Seapens have some resistance to being disturbed and generally can reinsert themselves into the sediment if removed, as long as they remained undamaged. However, damaged individuals show poor recovery, and therefore resilience is considered low, giving an overall sensitivity of medium (MarLIN, 2018a). As such, temporary disturbance is expected to cause some mortality to any seapens that are physically damaged during operations, but this is expected to be extremely localised and not have any effect on the viability of the local population. Replacement of damaged individuals would be expected to occur either from the plankton or from “adult” seapens moving in from the surrounding area. Survey of historical trawl scars in the Balmoral Area showed that seapens were common (Fugro, 2018b), suggesting there is good scope for recovery which would be expected to occur within ten years.

Permanent Direct Disturbance

Permanent direct disturbance will occur due to leaving hard substrate on the seabed in perpetuity. This encompasses both the leaving *in situ* of existing material that has previously been introduced (rock armour and potentially unrecoverable concrete mattresses), and the introduction of new rock armour to protect trenched and buried rigid flowlines that will be decommissioned *in situ.*

Approximately 0.16 km^2 of seabed will be subject to permanent direct disturbance due to the introduction of substrate during the decommissioning of subsea installations and flowlines.

The immediate effect of the introduction of new hard substrate will be mortality and injury of benthic and epibenthic fauna that cannot move away from the activities, as well as disturbance of motile fauna. Following the introduction of new material, the ongoing effect will be the change of a small area of soft muddy habitat to a hard substrate, and related change in the types of organisms that can use the habitat. Organisms such as seapens and burrowing bivalves, anemones and crustaceans will no longer be able to use the area affected, while new habitat will be created for other groups such as encrusting sponges and other species of anemone. In the Balmoral Area, survey effort at existing hard substrate deposits (Fugro, 2018a) shows that the hard substrate community will likely comprise molluscs (as evidenced by the increase in shells and shell debris), anemones, sponges, starfish (*A. rubens*), sea urchins, soft coral, and crabs. Gadoid (cod-like) fish were also commonly observed around the deposits. Seapens were noted to be common in the soft sediment directly surrounding the hard substrate deposits.

While the introduction of hard substrate clearly results in a change in the habitat type and associated fauna present (Fugro, 2018a), the scale of the impact is expected to be negligible considering the very large extent of soft mud habitat available in the CNS. Recovery of the affected areas is expected to take many years, but will eventually occur as the deposited material is gradually buried by new natural deposits of mud. Seabed photographs of the Balmoral Area (Fugro, 2018a) show that gradual burial of introduced hard substrate is ongoing.

6.2.3.2 Indirect Disturbance

Indirect disturbance to the seabed is expected to be caused by the re-suspension and re-settlement of seabed material disturbed during decommissioning operations. This will include cuttings excavated from around the Balmoral Template, as well as natural seabed sediments disturbed during decommissioning of other seabed infrastructure, and overtrawling.

Indirect disturbance is likely to affect seabed receptors through three mechanisms:

- Suspended sediment in the water column affecting the feeding of benthic fauna;
- Re-settlement of suspended sediment causing toxicity and smothering benthic organisms; and
- Re-settlement of suspended sediment changing the sediment type of the seabed in the affected area.

Cuttings disturbance was investigated using the DREAM model as discussed in Section 6.1, and disturbance of natural sediment was quantified in the manner detailed in Section 6.2.1. The three disturbance mechanisms listed above are discussed in the following sections.

Suspended Sediment

As detailed in Section 6.1, the concentration of suspended cuttings material was predicted to reach a maximum of 8 ppm two hours after the disturbance occurs. The concentration was then predicted to decrease steadily to less than 0.1 ppm two days after the start of disturbance, suggesting any effect on benthic fauna would be very short-lived. It is expected that the suspended sediment concentration from the disturbance of natural sediments would follow a similar pattern, increasing to a maximum within hours of disturbance occurring, and decreasing over hours to days once disturbance ceases. The difference would be that the cuttings disturbance will be strongly focused on one location, whereas the disturbance of natural sediment will occur in sporadic bursts, and in various locations, across the Balmoral area as decommissioning operations proceed.

There is also potential for sediment suspension following any overtrawling activities. The worst-case scenario modelled predicted a total temporary indirect disturbance area of 11.9 km^2. However, this is considered a worst-case scenario and the requirement for overtrawling will be verified during the post-decommissioning survey. In turn, any overtrawling of the decommissioned area will be carried out, only as required, following critical review of the clear seabed verification survey imagery. Currently, all the infrastructure is stably buried and not anticipated to require remediation with overtrawling.

Should overtrawling be required, the temporary disturbance area of the water column is expected to be confined to tens of meters from the disturbed seabed area and dissipate rapidly as generally it is the coarse, upper layers of sediment that would be disturbed. Increased suspended sediment may reduce feeding efficiency of filter feeders due to clogging of feeding structures. Experimental evidence suggests however that seapens, the main filter feeder of concern in the Balmoral Area, are not sensitive to increased suspended sediment. Both species observed in the area (*P. phosphorea* and *V. mirabilis*) are capable of cleaning themselves of excess sediment by the production of mucous (MarLIN, 2018b). As such, effects due to increased suspended sediment are expected to be **negligible.**

Smothering and Toxicity

Modelling indicated that the majority of re-suspended cuttings material would be re-deposited close to the disturbance location, with a maximum deposit depth of 1.2 m (Figure 6-5). Deposit depth was predicted to decrease rapidly with distance from the disturbance location. The total area of seabed anticipated to experience cuttings resettlement in excess of 1 mm depth is 0.16 km^2, whilst the area covered to a depth greater than 10 mm is 0.02 km^2. See Appendix D for further details.

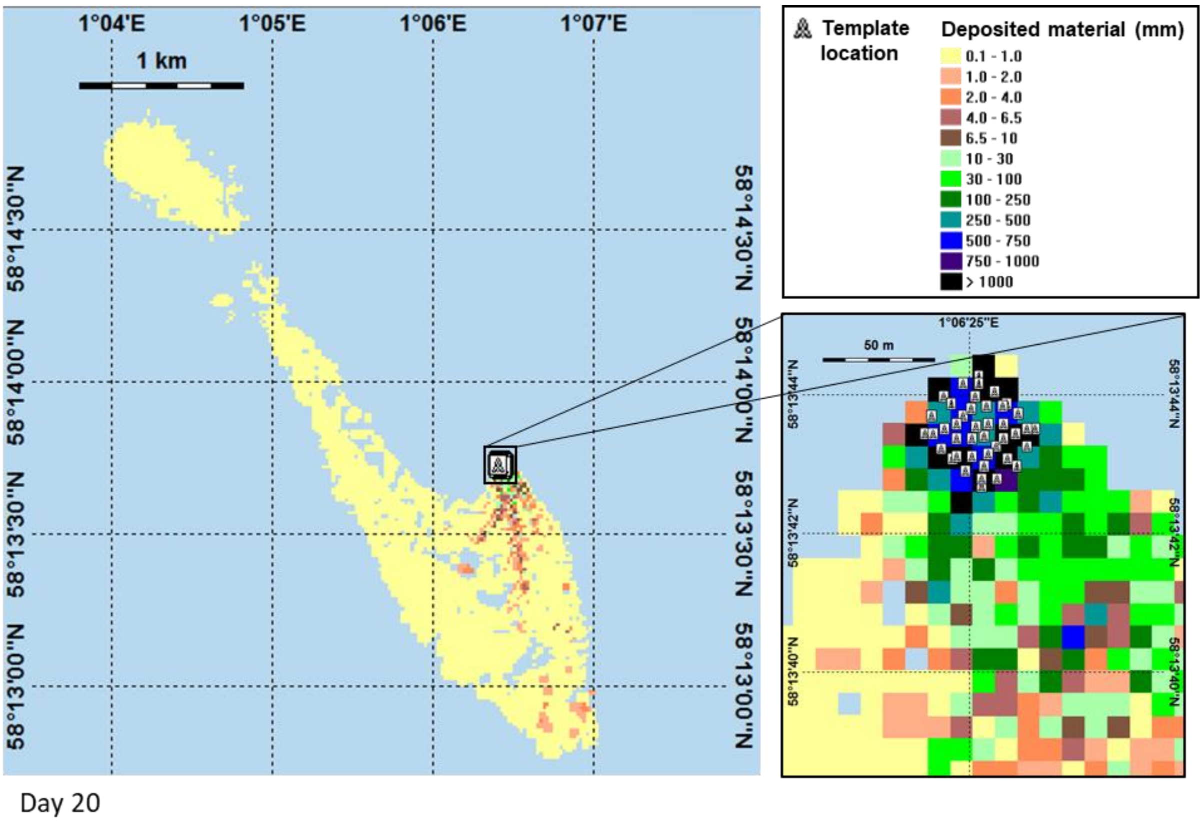

Figure 6-5 Deposited Material on the Seabed at 20 days After Disturbance

The sediment EIF (see Box 1 in Section 6.1 for an explanation) peaked at 0.48 after 4 hours following the disturbance where it remains at this value for the next 20 days, indicating a seabed area of 0.04 km^2 where the benthos would be subject to significant risk (Figure 6-6 and Figure 6-7). As the EIF value was so low and over a small area close to the template, the modelling was only carried out for 20 days and no long-term modelling was conducted.

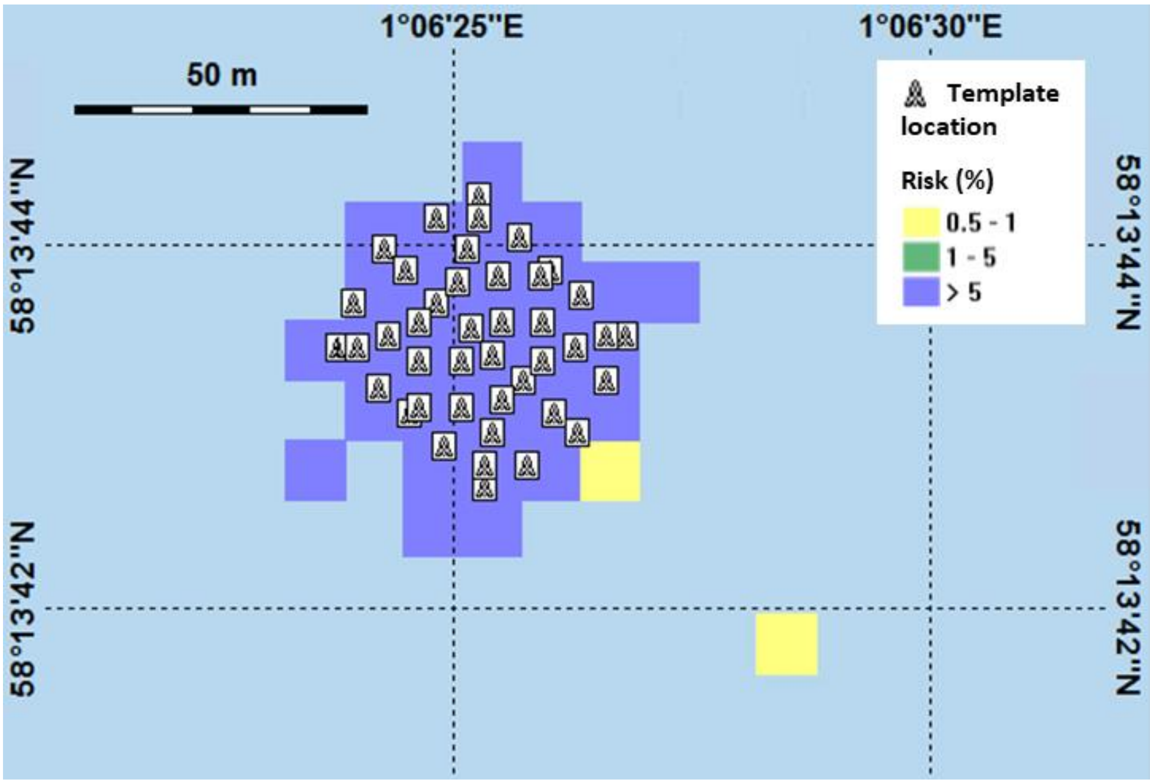

Figure 6-6 Risk to Sediment 4 Hours After Cuttings Pile Disturbance

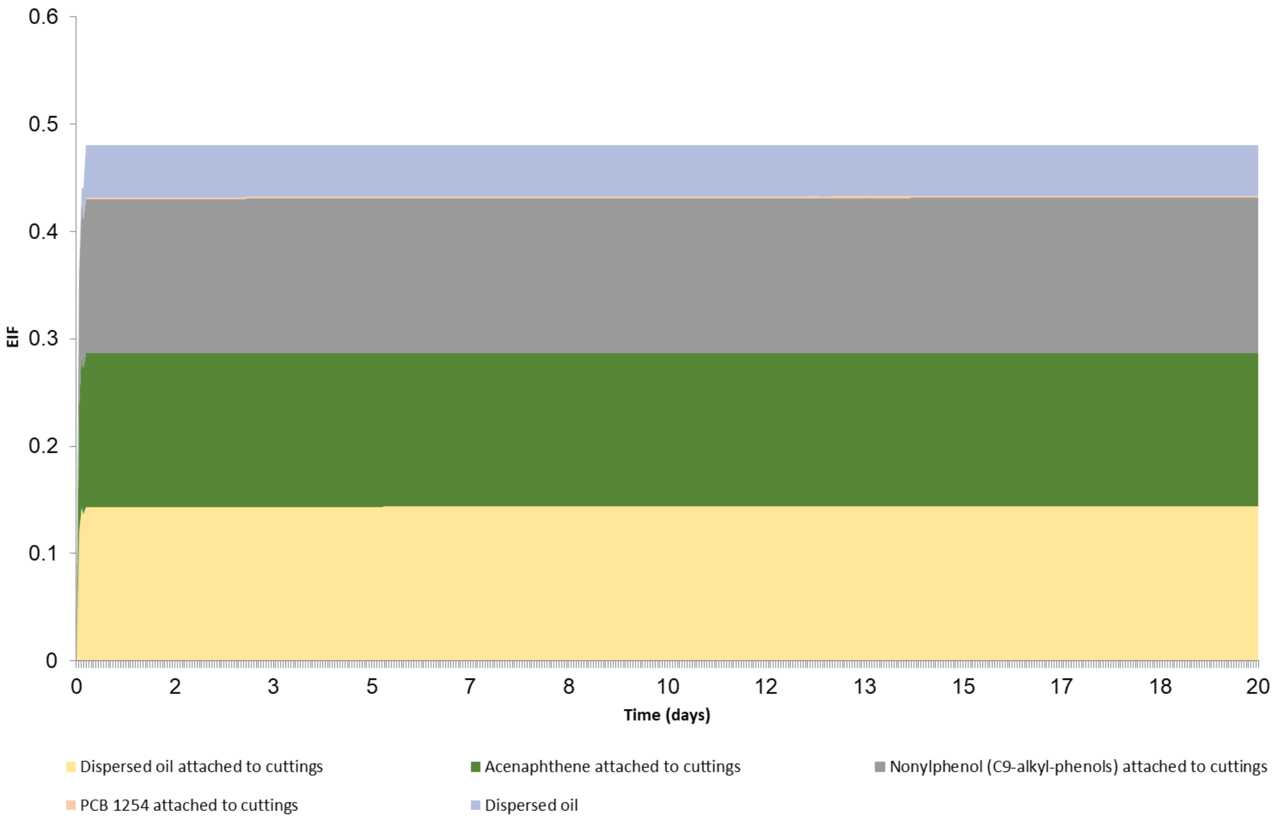

Figure 6-7 Development of the Sediment EIF

The modelled EIF value is indicative, and the actual effects at Balmoral will depend on the characteristics of the benthos present. The main features of concern, seapens and burrowing macrofauna, are not expected to be particularly sensitive to smothering (MarLIN, 2018a). Other species are likely to show a range of sensitivities to smothering, and it is possible that re-settlement of cuttings will result in a shift in the benthic community across the affected area towards species that are more tolerant of smothering.

The toxicity of the re-settled cuttings material will depend on the composition of the contaminants and the sensitivity of the benthos, which will vary between species. However, the existing benthic community at Balmoral only showed significant variation at stations which were heavily contaminated, suggesting that the toxic effect of a thin layer of drill cuttings material will be minor. In a relevant case study, OSPAR (2009b) recorded the effects of using high-pressure water jets to clear oil-based mud cuttings from the Hutton Tension Leg platform, causing significant re-suspension of cuttings. This was observed to have no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the original platform location. This reinforces the expectation that effects on the benthos due to toxicity and smothering from re-settled drill cuttings will be limited.

Given the relatively small area affected, the extensive availability of similar habitat available in the wider region, and the low sensitivity of the main species of concern, effects from toxicity and smothering due to re-settlement of drill cuttings material are expected to be minor, although they may persist for more than ten years over some of the area affected.

The area affected by re-settlement of seabed sediments as indirect disturbance from overtrawling is estimated as 11.9 km^2. Approximately half of the affected area will be within the area of direct disturbance from overtrawling and is expected to rapidly re-settle at or very close to the location from which it was disturbed. Finer sediments may spend more time within the water column, thereby increasing the likelihood of hydrographic movement causing them to settle further away. In all cases however, the layer of re-settled material is expected to be very thin, since only a thin layer of sediment will be resuspended in the first place. As such, there is not expected to be any discernible effects on receptors due to smothering, and there are expected to be no toxic effects as the seabed sediments across the majority of the area are at or below background levels for contaminants.

Change in Sediment Type

As predicted by the modelling, the majority of disturbed cuttings material is expected to re-settle close to the disturbance location. It is expected that larger cohesive lumps of material will settle rapidly, with smaller particle sizes re-settling progressively further away, travelling furthest in line with the prevailing current. As such, it is expected that close to the disturbance location, the re-settled material will be coarser than that found naturally, while at the furthest extent of re-settlement (which is likely to be several kilometres away), the re-settled material will be finer than what is found naturally. At distances of more than 1 km, where the maximum depth of re-settled material is expected to be 10 mm or less, it is unlikely that the particle size of the settled material will have a significant effect on the benthos, since the thin veneer of re-settled material would be expected to be rapidly re-worked into the sediment by burrowing fauna. Some portion of material re-settling within 1 km of the disturbance location is expected to comprise silt-sized particles, which are similar to the natural seabed composition. As such, it is only the thicker deposits close to the disturbance location where change in sediment type would be expected to have an effect on the benthos. This is supported by survey data from the Greater Balmoral Area (Fugro, 2018b). The macrofauna community at stations which were suspected of containing cuttings material, based on sample particle size distribution, generally did not differ significantly from the community in the surrounding area. Conversely, stations which were visually assessed as supporting thick drill cuttings deposits did exhibit a different epifauna to the surrounding area, including a lack of seapens.

Natural sediment that re-settles follow re-suspension by overtrawling will also become sorted to some extent, with coarser material re-settling very close to the disturbance point and finer material settling further away. However, overtrawling is expected to disturb a thin layer of sediment, resulting in a thin deposition layer which will be insufficient to have any discernible effect on the overall sorting of sediments across the affected area.

Permanent direct impacts from the addition of stabilisation materials will be limited to minor rock placement at the cut ends and exposures of the pipelines to be decommissioned *in situ* (i.e. ninety-two spot rock locations). Based on the calculations supplied in Pidduck *et al*. (2017), which supply a spot rock placement area of 5 m^2 at pipeline cut ends, the total area of additional substrate is expected to be 460 m^2 or 0.00046 km^2. Given the rock will be spread across the Balmoral, Glamis, Brenda, and Nicol field locations, there is negligible scope to significantly change the habitat within any one area. Moreover, the addition of a small amount of rock will be indiscernible against the vast area of similarly characterised habitat (i.e. 18,900 km^2) available in the wider region of the CNS. Therefore, rock placement during the proposed decommissioning activities is predicted to have a negligible impact on the benthic habitats and communities the Greater Balmoral Area supports.

6.2.4 Cumulative and Transboundary Impacts

The Scanner Pockmark SAC (located 9 km to the northwest of Balmoral) is not expected to be affected by re-settlement of cuttings material. Modelling suggests that the depth of re-settled sediment will be less than 0.1 mm at 3.5 km from the disturbance location, indicating that negligible amounts of cuttings material would still be in suspension by the time they reached the SAC.

The closest installation is the Alba North platform located 19 km south west of the Balmoral Area. It is not expected that impacts from the Balmoral Area decommissioning activities will interact with impacts from Alba North operations. The Balmoral Area is also located 32 km west south west of the UK/Norway median line and therefore, based on the potential extent of seabed impacts, no transboundary impacts are expected to benthic receptors.

6.2.5 Mitigation Measures

In addition to employing non-invasive techniques for the post-decommissioning clear seabed verification survey, several other mitigation measures relating to the placement of rock armour and the CFE of cuttings are in place to minimise the potential total seabed impacts. Rock armour will be placed by a fall pipe vessel equipped with an underwater camera on the fall pipe. This will ensure accurate placement of the rock armour and reducing unnecessary spreading of the rock armour footprint and ensuring that minimum safe quantity or rock is used. The CFE exhaust flow will be directed to the seabed as close to the existing cuttings accumulations as possible. This will minimise the seabed area covered by re-settled cuttings and reduce the effect on potentially sensitive receptors such as seapens.

6.2.6 Conclusion

Receptor	Impact Magnitude	Receptor Sensitivity	Receptor Vulnerability	Receptor Value
Seabed features	**Low**	**Medium**	**Low**	**Medium**

Validation

Decommissioning activities at the Greater Balmoral Area will result in temporary and permanent direct and indirect disturbance to the seabed.

Temporary direct disturbance has the potential to impact approximately 0.028 km^2 of seabed, or 5.8 km^2 when accounting for the worst-case estimated overtrawling for seabed clearance verification. Temporary indirect disturbance has the potential to impact approximately 0.38 km^2, or 11.9 km^2 when accounting for the worst-case estimate for overtrawling requirements. Finally, permanent direct disturbance from the addition of new substrate associated with the stabilisation materials or the *in situ* decommissioning of the cuttings pile has been identified as being able to potentially impact 0.16 km^2. However, these are considered highly conservative estimations of the likely impact of the proposed decommissioning activities, particularly when considering the conservative application of overtrawling activities following seabed clearance verification (see Section 2.4.7).

The seabed sediment analysis combined with the infauna data indicated that the seabed across the Greater Balmoral Area comprises EUNIS habitat A5.375 '*Levinsenia gracilis* and *Heteromastus filiformis* in offshore circalittoral mud and sandy mud', although the area was also suggested to be a strong example of EUNIS habitat A5.361 'Seapens and burrowing megafauna in circalittoral fine mud') (Fugro, 2018b). The EUNIS habitat complex A5.37 'Deep circalittoral mud' covers approximately 18,900 km^2 of the CNS (UKSeaMap, 2016), as such, the small area of disturbance modelled for the Greater Balmoral Area decommissioning may impact only a very small proportion (0.08%) of this characteristic habitat for the region. Therefore, while the receptor value is considered **medium** due to its regional importance, the scale or magnitude of the impact remains **low** when considered in the context of the wider region. As well, the vulnerability of benthic receptors to long-term changes in function or status remains **low**, given the small area of permanent impact from rock placement, and the minor impacts to benthic species associated with smothering and toxicity which are anticipated from the resettlement of the cuttings pile.

Based on the anticipated localised and predominantly temporary nature of the disturbance, the impact of Balmoral decommissioning activities on seabed receptors is considered **negligible**.

Residual Impact Significance	**Negligible**

6.3 Commercial Fisheries

The impact of Balmoral Area decommissioning activities on commercial fisheries is discussed in this Section, along with measures proposed to minimise the scale and duration of potential impacts.

6.3.1 Approach

Potential impacts to commercial fisheries from decommissioning of infrastructure is limited to the introduction of possible snagging risks to commercial trawl fisheries and other fisheries which utilise the seabed.

While vessel presence during decommissioning may impact commercial fisheries by temporarily modifying the available fishing area, access to available fishing grounds will increase following completion of decommissioning activities. Existing controls on vessel use across the project area, including notifications to mariners, ensure the vessel presence impacts are limited to a minor disturbance to localised fishing operations during decommissioning and during any post-decommissioning monitoring surveys. The removal of the Balmoral FPV and Template from the area will reduce area restrictions to fisheries operating in the Greater Balmoral Area over the long-term. For these reasons, potential impacts associated with vessel presence are considered, on balance, to be positive and do not require further assessment.

6.3.2 Sources of Potential Impacts

The greatest identified risk to commercial fisheries is the potential snagging of fishing gears on exposed infrastructure (e.g. deburied infrastructure or spans along rigid pipelines) or seabed modified by removal of infrastructure (e.g. clay berms generated by the removal of flexible umbilicals). For commercial fisheries, snagging can mean the loss of gear and catches or, in the worst-case scenario, the possible loss of life if a vessel is capsized (MAIB, 1998). Data from the Marine Accident Investigation Branch (MAIB) (www.gov.uk/maib) shows that 15 vessels have been sunk by snagged fishing gear between 1989 and 2014, resulting in 26 fatalities. According to the 2018 fisheries statistics, demersal mobile gear used in this block includes trawls and demersal seine nets which may be impacted by snagging (Scottish Government, 2019).

Trenched and buried rigid flowlines will be decommissioned *in situ*, whilst trenched and buried flexible flowlines will be removed via deburial and reverse-reeling. The buried flexible flowlines to be removed may share the trench with a buried rigid flowline, which may complicate the removals process. In such instances, reverse reeling will only take place where safe and technically practicable to do so. Both decommissioning options have the potential to introduce snagging hazards, should the buried rigid flowlines develop exposures or spans over time or if the reverse reeling of the flexible flowlines generates berms in the sediment encasing the infrastructure. As discussed in Section 4.2.2, a seabed survey of the location described the seabed at the Greater Balmoral Area as being ‘fine mud’ (Fugro, 2017b). Reverse reeling of flexible pipelines through fine muds and clays could potentially result in the formation of clay berms, which are a snagging hazard for fishing vessels.

The degradation of flowlines decommissioned *in situ* can result in free spans over time. The majority of pipelines are known to be stable and have remained buried throughout the lifetime of the Greater Balmoral Area fields. DoB information about the existing pipeline infrastructure indicates all the pipelines are suitably buried along their lengths, with only a few potential areas where exposures may develop along the pipelines associated with the Balmoral and Glamis Fields (Appendix C). All identified exposures are to be removed and remediated, per the selected CA decommissioning option. The average DoB for the pipelines associated with the Greater Balmoral Area is: between 0.32-1.7 m for the Balmoral Field; between 0.93-1.35 m for the Glamis Field; approximately 1.68 m for the Brenda Field; and 1.83 m for the Nicol Field. DoB information is currently unavailable for the Stirling Field. However, pipelines will be remediated should any pre-decommissioning or DoB/monitoring surveys indicate the integrity of the pipelines or DoB has been compromised or a free span has emerged. In such instances, other sea users would be notified via the appropriate communications channels (as described in Section 5). However, the potential for legacy impacts due to degradation of infrastructure decommissioned *in situ* remains and therefore warrants further assessment.

6.3.3 Effects on Sensitive Receptors

Potential impacts to commercial fisheries are most severe for demersal mobile fisheries, which utilise gears which are dragged along the seabed (e.g. bottom trawlers, dredgers, etc.), as exposures along buried pipelines or the creation of clay berms during removal of flexible flowlines increase the risk of snagging demersal mobile gears. Various data sources indicate that area use by these fisheries is generally low in the two ICES rectangles encompassing the Greater Balmoral Area (see Section 3.5.2). However, there is some inter-annual variability in the proportion of landings comprising demersal catches. For the two most recent fishing years (i.e. 2018 and 2017), demersal landings contributed up to 35% of the total liveweight and 41% of the value of the commercial landings in ICES rectangles 45F0 and 45F1. However, the average contribution of demersal catches is lower (i.e. between 18 – 26% for both ICES rectangles). Furthermore, VMS data suggests that demersal fisheries do not specifically target Oil and Gas pipelines as opportunistic aggregation devices in this region (Section 3.5.2) (Rouse *et al.*, 2017).

For the above reasons, the available data suggests that the Greater Balmoral Area is not of particular importance to demersal fisheries and the decommissioning of flowlines, either *in situ* or via full removal, will not have significant impacts on the safety or economic value of any fisheries operating within this region.

Regardless, Premier has a responsibility to ensure all potential residual impacts to fisheries from snagging risk are minimised, given the magnitude of its potential impact. A post-decommissioning seabed clearance verification survey will be employed to provide a collective profile of the buried flowline/seabed interface by which to identify potential free spans, as well as identify any remaining field debris, which may pose hazardous to fishing gears. Debris identified during previous surveys of the Greater Balmoral Area can be found in Table 6-7.

The survey will employ geophysical survey methods to ensure that decommissioning activities have not generated clay berms or other snagging risks, and to identify the requirement for overtrawling. Residual snagging hazards which cannot be remediated using overtrawling techniques may require rock placement or other stabilisation materials, however, these will be determined on a case-by-case basis, following a thorough review of the findings of the seabed clearance verification survey. Following verification of seabed clearance, continued monitoring and remediation will take place to ensure that all buried infrastructure remains stable and without exposures or spans.

6.3.4 Cumulative and Transboundary Impacts

The Greater Balmoral Area is located 32 km from the UK-Norway border (Figure 1-1). As such, this region experiences above average levels of fishing by foreign vessels compared to other regions of the UKCS (Scottish Government, 2018; MMO, 2015). Fishing fleets of several other nationalities may be found relatively frequently throughout the waters surrounding the Greater Balmoral Area; the most common of these being Norwegian, French, and Dutch vessels which predominantly operate pelagic fisheries (MMO, 2015).

As all infrastructure will either be removed or decommissioned *in situ* to an overtrawlable condition, no cumulative impacts to any foreign fishing fleets, demersal or otherwise, are expected to result from the Balmoral decommissioning project. Moreover, a positive outcome of the decommissioning of the Greater Balmoral Area will be the removal of the fishing exclusion zone surrounding the Balmoral FPV, once it is removed. This will increase the available fishing grounds for commercial fishing fleets of all nationalities which have been granted access to fishing in the UKCS.

6.3.5 Mitigation Measures

The existing controls of seabed clearance verification with independent review by the NFFO, continued monitoring for an agreed period, remediation where required, and accurate mapping of the locations and state of infrastructure which has been decommissioned *in situ* reduces the probability of important impacts to commercial fisheries through snagging risk.

The physical presence of vessels during decommissioning operations can cause disturbance to commercial fishing vessels. There are a number of existing controls which Premier is utilising for the impact of vessel presence on commercial fisheries. Stakeholder engagement will be continued prior to commencement of operations, including the promulgation of NtMs detailing any decommissioning activities. Appropriate navigation aids will be used in accordance with the Consent to Locate conditions to ensure that sea users are made aware of the presence of vessels undergoing decommissioning activities. In addition, there will be continual use of Automatic Identification System satellite vessel tracking and all decommissioning vessel activities will be in accordance with national and international regulations.

In addition, Premier keeps manned bridges to ensure that other sea users adhere to any safety zones which are in place, including temporary safety zones around decommissioning vessels.

Pipelines will be remediated should any pre-decommissioning or DoB/monitoring surveys indicate the integrity of the pipelines or DoB has been compromised or a free span has emerged. Given the stability of buried pipelines (see Appendix C), no such remediation is expected. However, should such an instance arise in future, other sea users would be notified via the appropriate communications channels (as described in Section 5).

The decommissioning operations will be designed and executed to minimise the area of seabed that is disturbed, therefore reducing the potential for these operations to generate clay berms in the process of reverse reeling (which will only take place where safe and technically practicable to do so). Furthermore, a seabed survey following completion of decommissioning will be carried out and on review of the results of this survey, an overtrawl survey will be considered.

In spite of the above, Premier has a responsibility to ensure all potential residual impacts to fisheries from snagging risk are minimised, given the magnitude of this impact factor. A post-decommissioning survey using geophysical survey methods to provide a collective profile of the buried flowline/seabed interface to identify potential free spans, as well as identify any remaining field debris will be carried out. Where necessary, overtrawl surveys will be undertaken to further verify that reverse reeling did not generate clay berms (in clay outcrop areas) or other snagging risks. Any identified snagging hazards will be remediated with rock placement or other stabilisation materials, as required and agreed upon with the regulator. Following this, continued monitoring and remediation will take place to ensure that all buried infrastructure remains stable and without exposures.

6.3.6 Conclusion

Receptor	Impact Magnitude	Receptor Sensitivity	Receptor Vulnerability	Receptor Value
Commercial Fisheries	**Minor**	**High**	**Negligible**	**Low**
Validation				
Long-term positive impacts of the proposed decommissioning activities include an increase in access to fishing grounds through the full removal of the Balmoral FPV and its associated exclusion zones. The removal of subsea infrastructure, subsea installations and stabilisation materials will also enable greater utilisation of the seabed by fisheries, post-decommissioning. Residual impacts from the degradation of buried pipelines decommissioned *in situ* will be managed through continued monitoring and communications with other sea users and are not expected to have any long-term impacts on the access or functioning of currently exploited fishing grounds. Considering the low utilisation of fishing vessels in the Greater Balmoral Area, the low likelihood of the proposed decommissioning operations generating snagging risk, and the management and control measures that will be in place to mitigate against residual potential snagging risk, it is considered that the decommissioning of flowlines *in situ* and all other infrastructure will not adversely impact upon commercial fisheries operating within the Greater Balmoral Area. For these reasons, impacts to commercial fisheries are considered **negligible**.				
Residual Impact Significance	**Negligible**			

7 CONCLUSIONS

Following detailed review of the proposed decommissioning activities, the environmental sensitivities characteristic of the Greater Balmoral Area, industry experience with decommissioning activities, and consideration of stakeholder concerns, it was determined that potential project-related impacts to water quality, the seabed, and commercial fisheries required further consideration. As the approach for the decommissioning of the Greater Balmoral Area infrastructure varies, the worst-case aspects from each method were considered and assessed in line with a tried and tested EA Methodology, described in Section 4. The technical evidence and results of these assessments are detailed in Section 6.

The CFE of the cuttings deposits within and surrounding the Template forms the greatest potential contributor to impacts to sensitive benthic marine receptors from the proposed activities, due to potential changes in water quality and direct and indirect impacts to the benthic environment. Impacts to water quality covered a large spatial extent, but were found to be exceptionally short-lived (i.e. concentrations are expected to fall below 1 ppm within 14 hours, based on dispersion modelling; see Section 6.1). Whilst impacts to the seabed from this activity were considered persistent, with elevated THC and heavy metal concentrations lasting decades after the CFE activities ceased, they are anticipated to be limited to an exceptionally small area, with residual contaminants concentrations attributable to the cuttings falling below 0.001 ppm within 20 m of the Template (Section 6.2). For these reasons, impacts to environmental receptors due to changes to water quality or the resettlement of the cuttings on the surrounding seabed from the proposed decommissioning activities were considered of **negligible** significance.

The Greater Balmoral Area is located well offshore in the CNS, remote from coastal sensitivities and approximately 9 km away from the nearest offshore conservation site, the Scanner Pockmark SAC. The potential to impact upon the integrity of this site, which has been designated for the protection of an Annex I habitat, was reviewed in the assessment of seabed impacts (Section 6.2). Given the limited spatial extent of anticipated seabed impacts and the short-term disturbance of seabed sediments from the decommissioning of the Greater Balmoral Area infrastructure, including the CFE of the cuttings deposits in the Balmoral Template, no significant impacts to any sensitive seabed features are expected.

The potential overtrawling required for the decommissioning area formed the greatest potential source for impacts to the seabed with potential for **minor** discernible change to the baseline of existing benthic receptors. However, in practical terms, the overtrawling of the project area will occur at specific areas determined using non-invasive techniques by a clear seabed validation survey, and all the infrastructure being decommissioned *in situ* is currently considered stably buried and not anticipated to require further intervention. All efforts to reduce overtrawling will be made, including consultation with OPRED on appropriate seabed clearance methods which minimise impacts to the seabed for any areas identified as posing a potential snagging risk. In line with these efforts to reduce the area of seabed disturbance and the potential worst-case area of impact relative to the surrounding available habitat (0.08%), the significance of residual impacts from seabed have been downgraded to **negligible**.

Activities with the potential to impact upon commercial fisheries were limited to the reverse reeling of flexible flowlines and possible legacy impacts from the degradation of pipelines *in situ.* However, such impacts are restricted to commercial fisheries which make active contact with the seabed, such as those which operate bottom trawl or dredging gears. The waters comprising the Greater Balmoral Area experience varying levels of demersal fishing between years, although various data sources suggest that the region does not constitute important fishing grounds for those fisheries, particularly when compared to the surrounding regions (see Section 6.3). Based on this observation, coupled with the continued stability of the flowlines within the Greater Balmoral Area and mitigation measures which include overtrawl surveys and monitoring for exposures, impacts to commercial fisheries from snagging risk from the decommissioning of the Greater Balmoral Area infrastructure are deemed **negligible**.

Finally, this EA has considered the objectives and marine planning policies of the NMP across the range of policy topics including biodiversity, natural heritage, cumulative impacts and the oil and gas sector. Premier considers that the proposed decommissioning activities are in alignment with these objectives and policies.

Based on the findings of this EA, including the identification and subsequent application of appropriate mitigation measures and Project management according to Premier's HSES Policy and Environmental Management System (EMS), it is considered that the proposed Greater Balmoral Area decommissioning activities do not pose any threat of significant impact to environmental or societal receptors within the UKCS or internationally.

8 REFERENCES

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APPENDIX A: GREATER BALMORAL AREA INVENTORY – INFRASTRUCTURE DETAILS

1 Surface Laid Flowlines & Umbilicals

Surface laid flowlines and umbilicals across the Greater Balmoral Area have a total length of 64.5 km and total weight of 290 Te. Umbilicals and logging cables are constructed from a combination of materials (i.e. polymers, steel, copper, and fibres). There are 15 items with a range of ODs (from 0.75 to 4.00 in) and lengths (1.4 to 7.9 km). Flexible flowlines are constructed from a combination of materials (i.e. polymers, steel and fibres) and are present as two items, each 2.1 km in length.

Table 8-1 Surface Laid Flowlines and Umbilicals Across the Greater Balmoral Area

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL983	20z Production	Stirling	6	2,056	82.7
PL984	20z Gas Lift	Stirling	2	2,056	29.1
PL985	A20z Chem Inj Umbilical	Stirling	0.375	2,000	31.1
PLU4342	B29 Sensor Umbilical Logging Cable	Balmoral	0.984	5,182	5.2
PLU4343	B14 Sensor Umbilical Logging Cable	Balmoral	0.984	3,353	3.3
PLU4344	A3 Chem Inj Umbilical	Balmoral	3.059	1,414	6.7
PLU4345	B14 Control Umbilical	Balmoral	2.665	3,247	13.3
PLU4346	A11 Control Umbilical	Balmoral	2.665	3,513	14.5
PLU4347	B29 Chem Inj Umbilical	Balmoral	3.059	5,157	24.1
PLU4348	A7z Control Umbilical	Balmoral	2.665	2,004	7.3
PLU4349	A2 Chem Inj Umbilical	Balmoral	3.059	1,736	8.2
PLU4350	A16 Control Umbilical	Balmoral	2.665	2,955	12.1
PLU4351	B4a Control Umbilical	Balmoral	2.665	5,617	23.8
PLU4352	A10z Control Umbilical	Balmoral	2.665	1,731	6.4
PL4540	B29 Production	Balmoral	8.39	4,282.5	N/A
PLU4353	A26 Sensor Umbilical Logging Cable	Glamis	0.98	7,900	7.9
PLU4354	A27 Sensor Umbilical Logging Cable	Glamis	0.75	7,900	7.0
PLU4355	A17z Sensor Umbilical Logging Cable	Glamis	0.75	7,700	7.7

2 Trenched Umbilicals

Trenched and exposed umbilicals across the Greater Balmoral Area have a total length of 18.2 km and a total weight of 406 Te. There are only two items with diameters approximately 4 and 6 in.

Table 8-2 Trenched Umbilicals

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PLU2328	Control Umbilical (static section)	Brenda	~6	9,670	278
PLU2352	Control Umbilical	Nicol	3.5	9,519	128

3 Trenched & Buried Rigid Flowlines

Trenched and buried rigid flowlines have a total length of 118 km and total weight of 6,650 Te. There are 22 items with a range of ODs (from 3.5 to 14 in) and lengths (1.2 to 14.4 km).

The PL980 flowline is comprised of two parts: a section of buried rigid flowline (previously known as PL643) and a section of buried flexible flowline. For this reason, PL980 is considered within both the rigid and flexible itineraries.

Table 8-3 Trenched & Buried Rigid Flowlines

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL218	Oil export	Balmoral	14	14,460	1,920.8
PL219	A3 Gas Lift	Balmoral	2.375	1,297	11.6
PL220	A3 Production	Balmoral	4.5	1,302	35.1
PL221	B29 Gas Lift	Balmoral	2.375	5,045	46.5
PL222	B29 Production	Balmoral	4.5	5,059	141.3
PL223	A2 Gas Lift	Balmoral	2.375	1,693	15.2
PL224	A2 Production	Balmoral	4.5	1,698	46.0
PL225	A7z Water Injection	Balmoral	6.875	1,818	68.3
PL226	A10z Water Injection	Balmoral	6.875	1,625	61.0
PL227	B4a Water Injection	Balmoral	6.875	5,346	204.7
PL228	A11 Water Injection	Balmoral	6.875	3,311	126.3
PL229	B14 Water Injection	Balmoral	6.875	2,910	110.4
PL230	A16 Water Injection	Balmoral	6.875	2,701	102.3
PL2565	Redundant B29 Production	Balmoral	6.626	3,917	213.5

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL2329	Brenda Production F/L	Brenda	10.75	9,272	720.0
PL2330	Brenda Gas Lift	Brenda	6.6	9,272	329.0
PL2350	Nicol Production	Nicol	6	9,576	356.0
PL2351	Nicol Gas Lift	Nicol	3	9,583	108.0
PL638	A26 Production	Glamis	6.675	7,921	621.8
PL639	A27 Production	Glamis	8.8774	6,943.5	763.7
PL640	A17z Water Injection	Glamis	8.874	7,613	486.5
PL980	A27 Service (ex-Blair)	Glamis	4.500	5,758	162.5

4 Trenched & Buried Flexible Flowlines & Umbilicals

Umbilicals are constructed from a combination of materials (e.g. polymers, steel, copper, and fibres). There are seven items with a range of ODs (from 4.00 to 6.00 in) and lengths (from 2.4 to 9.5 km).

Flexible flowlines are constructed from a combination of materials (e.g. polymers, steel, and fibres). There are four items with a range of ODs (from 2.00 to 7.75 in) and lengths (from 3.8 to 5.1 km).

The PL980 flowline is comprised of two parts: a section of buried rigid flowline (previously known as PL643) and a section of buried flexible flowline. For this reason, PL980 is considered within both the rigid and flexible itineraries.

There is a total of 11 items with a total length of 66 km and total weight of 1,441 Te.

Table 8-4 Trenched & Buried Flexible Flowlines & Umbilicals

ID	Description	Field	OD (in)	PWA Length (m)	Buried Length (m)	Weight (Te)
PL222A	B29 Production	Balmoral	7.539	5,083	4,460	109.0
PL980	A27 Service Gas Lift F/L	Glamis	2	2,390	2,190	33.9
PL644	A26 Chem Inj Umbilical	Glamis	3.8	7,995	7,740	104.0
PL645	A27 Chem Inj Umbilical	Glamis	3.8	7,098	6,840	92.5
PLU4356	A17z Control Umbilical	Glamis	2.665	7,714	7,450	82.3
PL646	A13 Chem Inj Umbilical	Blair	3.8	5,841	5,590	76.1
PL2000	Stirling Production	Stirling	7.7	3,820	3,540	152.7
PL2001	Stirling Gas Lift	Stirling	4.4	3,810	3,570	68.7

ID	Description	Field	OD (in)	PWA Length (m)	Buried Length (m)	Weight (Te)
PLU2002	SES Control Umbilical	Stirling	0.5	3,816	3,550	15.9
PLU2328	Brenda Control Umbilical (Static Section)	Brenda	6	9,670	8,960	278.0
PLU2352	Nicol Control Umbilical	Nicol	3.5	9,519	9,380	128.0

5 Flexible Jumpers

Flexible jumpers are constructed from a combination of materials (e.g. polymers, steel, and fibres). There are 47 items with a range of ODs (from 2.00 to 8.00 in) and lengths (from 25 to 256 m). The total length of flexible jumpers is 3.181 km and total weight is 155.22 Te.

Table 8-5 Flexible Jumpers

ID	Description	Field	OD (in) Note 1	Length (m)	Weight (Te)
PL219	16/21a-3 Gas Lift F/L	Balmoral	2	50	1.1
PL220	16/21a-3 flowline	Balmoral	4	60	3.06
PL221	16/21b-29 Gas Lift F/L	Balmoral	2	60	1.25
PL222	16/21b-29 flowline	Balmoral	4	60	3.05
PL223	16/21a-2 Gas Lift F/L	Balmoral	2	60	1.25
PL224	16/21a-2 flowline	Balmoral	4	70	2.36
PL225	16/21a-7Z flowline	Balmoral	6	55	3.68
PL226	16/21a-10Z flowline	Balmoral	6	50	3.4
PL227	16/21b-4a flowline	Balmoral	6	60	3.96
PL228	16/21a-11 flowline	Balmoral	4	50	3.51
PL229	16/21b-14 flowline	Balmoral	6	60	3.96
PL230	16/21a-16 flowline	Balmoral	6	50	3.4
PL231	Oil export riserbase F/L	Balmoral	8	30	4.7
PL232	Devonian riserbase F/L	Balmoral	6	30	2.32
PL233	PAL1 riserbase F/L	Balmoral	6	55	4.06
PL234	PAL2 riserbase F/L	Balmoral	8	35	3.2
PL235	Test/Kill riserbase F/L	Balmoral	4	30	1.3
PL236	Annulus Monitor F/L	Balmoral	3	30	1.03
PL237	Gas lift flowline	Balmoral	4	25	0.9
PL238	Water Inj. riserbase	Balmoral	8	25	2.43
PL334	Water Inj. riserbase	Balmoral	8	25	2.43
PL638	16/21a-26 flowline	Glamis	4	61	2.28

ID	Description	Field	OD (in) Note 1	Length (m)	Weight (Te)
PL639	A27 flowline	Glamis	6	71	4.78
PL640	A17z flowline	Glamis	6	77	5.11
PL641	Production riser and riserbase F/L (ex-Beauly)	Balmoral Template	4	364	7.1
PL642	A27 riserbase F/L	Glamis	6	143	7.8
PL980	A27 Service flowline (ex-Blair)	Glamis	4	31	1.17
PL983	16/21a-20z flowline	Stirling	8	56	3.46
PL984	16/21a-20z GL F/L	Stirling	4	56	1.38
PL2329	Production flowline	Brenda	8	256	17.26
PL2330	Gas lift flowline	Brenda	4	256	13.3
PL2350JN2	15/25b-N1 Prod flowline	Nicol	4	60.4	2.61
PL2351JN2	15/25b-N1 GL flowline	Nicol	2.5	112	2.81
PL2565	16/21b-29 flowline	Balmoral	6	162	13.46
PL2329J1	15/25b-D1z flowline	Brenda	4	43	1.08
PL2329J2	15/25b-D2 flowline	Brenda	4	45.5	1.14
PL2329J3	15/25b-D3y flowline	Brenda	4	27	0.68
PL2329J4	15/25b-D4 flowline	Brenda	4	60	1.5
PL2329J5	15/25b-D5 flowline	Brenda	4	61	1.13
PL2330J1	15/25b-D1z GL flowline	Brenda	2.5	44	1.1
PL2330J2	15/25b-D2 GL flowline	Brenda	4	45	1.13
PL2330J3	15/25b-D3y GL flowline	Brenda	4	28.5	0.71
PL2330J4	15/25b-D4 GL flowline	Brenda	2.5	60	1.5
PL2330J5	15/25b-D5 GL flowline	Brenda	2.5	50	0.88
PL2350JN2	15/25b-N2 Prod flowline	Nicol	4	50	1.25
PL2351JN2	15/25b-N2 GL flowline	Nicol	2.5	50	1.25

Notes:

1. Approximated and rounded to the nearest whole inch.

6 Rigid Spool-pieces

The rigid spool-pieces across the Greater Balmoral Area have a total length of 720 m and total weight of 35 Te. There are 14 items with a range of ODs (from 2 to 10.8 in) and lengths (7 to 77 m).

Table 8-6 Rigid Spool-Pieces

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL2350	Production Drop Down Tee Spool	Nicol	6	7	0.27
PL2351	Gas Lift Drop Down Tee Spool	Nicol	2	7	0.04
PL231	Oil export riserbase	Balmoral	10.8	64	6.1
PL232	Devonian riserbase	Balmoral	6.9	73	2.8
PL233	Palaeocene 1 riserbase	Balmoral	8.9	72	4.8
PL234	Palaeocene 2 riserbase	Balmoral	8.9	66	4.4
PL235	Test/Kill riserbase	Balmoral	4.5	75	1.7
PL236	Annulus Monitor riserbase	Balmoral	3.5	73	1.1
PL237	Gas Lift riserbase	Balmoral	4.5	70	1.6
PL238	Water Injection riserbase	Balmoral	8.9	77	5.1
PL334	Water Injection riserbase	Balmoral	8.9	76	5.1
PL237	Gas lift flowline	Balmoral	4	20	0.3
PL2329	Production Drop Down Spool	Brenda	8	20	1.2
PL2330	Gas Lift Drop Down Spool	Brenda	4	20	0.4

7 Control & Chemical Jumpers

Control and chemical jumpers are constructed from a combination of materials (e.g. polymers, steel, copper, fibres, etc.). There are 12 items with ODs of 3.00 and 4.00 ins and lengths from 10.0 to 90.0 m, with a total weight of 3.6 Te.

Table 8-7 Controls and Chemical Jumpers

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL2328J1	D1z Control jumper	Brenda	~3	45	0.25
PL2328J2	D2 Control jumper	Brenda	~3	46	0.25
PL2328J3	D3y Control jumper	Brenda	~3	29	0.25
PL2328J4	D4 Control jumper	Brenda	~3	90	0.3
PL2328J5	D5 Control jumper	Brenda	~3	90	0.3
PL2983	D1z Control jumper	Brenda	~3	90	0.3
PL2984	D2 Control jumper	Brenda	~3	90	0.3
PL2985	D3y Control jumper	Brenda	~3	50	0.3
PL2352	N1 Control Jumper	Nicol	~4	50	0.25
PL2600	N2 Control Jumper	Nicol	~4	90	0.3
PL2601	N1 Prod Chk Control Jumper	Nicol	~4	50	0.3

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL985	PLU985 Controls Jumper	Stirling	~4	10	0.5

8 Large Installations – Balmoral Template

The Balmoral Template is a large steel framed piled installation, 33 m x 33 m x 10 m, with total weight of 1,625 Te, including a number of manifolds, junction boxes and control modules. The structure is connected to the seabed with 3 off 1,067mm OD x 64.0m long piles. The wall thickness of the piles varies along their length from 25.4mm to 40mm WT.

Cement overspill is present beneath the structure. A significant quantity of drill cuttings is present within the structure that shall require to be removed prior to structure recovery.

9 Small Installations

Small subsea installations include equipment located on the seabed other than the Balmoral Template, such as: manifolds, riser bases, protection structures, Pipeline End Terminations (PLETs), Umbilical Termination Assemblies (UTAs) and Mid-Water Arches (MWA). There are 28 separate items identified, ranging from 3.4 to 240 Te in weight.

Table 8-8 Small Installations

Description	Field	Length (m)	Width (m)	Height (m)	Weight (Te)
Riser base RB01	Balmoral	8.25	6.99	3.12	90
Riser base RB02	Balmoral	9	8	3.12	90.3
Riser base RB03	Balmoral	9	8	3.12	90.3
Riser base RB04	Balmoral	8.25	6.99	3.12	68.6
Riser base RB05	Balmoral	8.25	6.99	3.12	90
Riser base RB06	Balmoral	9	6.99	3.12	79.4
MWA Gp1	Balmoral	5.5	4.5	6.7	22.5
MWA Gp2	Balmoral	5.5	4.5	6.7	27.6
MWA Gp3	Balmoral	5.5	4.5	6.7	27.6
MWA Gp4	Balmoral	5.5	4.5	6.7	15.9
MWA Gp6	Balmoral	5.5	4.5	6.7	21.9
Pre-Delivery Facility	Balmoral	15	15	3.5	50
Concrete protection Tunnel	Balmoral	17	4.9	1.65	68
Well B29 Production Valve skid and mud mats	Balmoral	3.4	2.9	1.5	3.79
Brenda Manifold	Brenda	28.9	10	5.9	240
Clump weight skid	Brenda	8.7	3.2	0.7	5.5
Brenda clump weights x 2	Brenda	2.75	2.75	0.7	10
Brenda Turn shoe	Brenda	ø5.5		1	15

Description	Field	Length (m)	Width (m)	Height (m)	Weight (Te)
Glamis 16/21a-26 Protection Structure	Glamis	17.5	17.5	9	50
Glamis 16/21a-17z Protection Structure	Glamis	17.5	17.5	7	45
Glamis 16/21a-27 Protection Structure	Glamis	17.5	17.5	8	47.5
Nicol Production PLET	Nicol	5	3.6	1	14.5
Nicol Gas Lift PLET	Nicol	5	3.6	1	14
Nicol UTA Structure	Nicol	8.2	8.2	4.425	18
UTA Suction Pile	Nicol	ø7.0	20mm WT	4	44.4
Stirling WPS	Stirling	17.5	17.5	9.27	90.2

10 Mattresses

There are 420 mattresses of all types across all the fields, covering a total surface area of 6,124 m^2. Their dimensions and locations are detailed in Table 2-6. The base position is to remove all mattresses, including any of the older mattress types which potentially have no or reduced integrity. Concrete mattresses and grout bags that are recovered will be cleaned of marine growth if required and recovered as aggregate for infrastructure projects or disposed of in landfill sites. Any mattresses which are assessed as potentially unrecoverable shall be reviewed during decommissioning activities for the safety and feasibility of their removal.

11 Mooring System (including Anchor Piles)

The Balmoral FPV is moored via 8 off mooring chains secured with fully buried piles. The mooring chains have a length of 1,550 m each (total length 12,400 m) and weight of 260 Te each (total weight of 2,080 Te). The 8 off mooring anchor piles each have a diameter of 1.58 m, are 36 m in length and weigh 63.9 Te (total weight of 511.2 Te).

12 Flexible Risers

The flexible risers within the Greater Balmoral Area are all located at the Balmoral FPV. There are 19 risers in total including oil, gas and water injection risers and controls umbilicals and signal cables. Sizes range from ¾ in signal cables, 4 in minimum up to 8 in maximum riser diameters. The combined length and weight of the risers is 4.706 km and 309.2 Te respectively.

Table 8-9 Flexible Risers

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL231	Oil Export Riser	Balmoral	8	249.5	29.1
PL232	Devonian Production Riser	Balmoral	4	242.5	11.5
PL233	Palaeocene (PAL 1) Production Riser	Balmoral	8	247.5	20.5
PL234	Palaeocene (PAL 2) Production Riser	Balmoral	8	247.5	27.2
PL235	Test and Kill Riser	Balmoral	4	242.5	11.5
PL236	Annulus Monitor Riser	Balmoral	4	242.5	11.5

ID	Description	Field	OD (in)	Length (m)	Weight (Te)
PL237	Gas Lift Riser	Balmoral	4	242.5	11.5
PL238	Water Injection Riser	Balmoral	8	245	20.9
PL334	Water Injection Riser	Balmoral	8	245	20.9
PL641	Beauly Production Riser	Balmoral	4	245	11.6
PL642	Burghley/Glamis Production Riser	Balmoral	4	245	11.6
PL2328	Brenda Umbilical (Dynamic Section)	Balmoral	6	510	41.6
PL2329	Brenda Production Riser	Balmoral	8	250	27.2
PL2330	Brenda Gas Lift Riser	Balmoral	4	250	21.5
PL2674	Burghley Umbilical Riser	Balmoral	5	218	20.4
PL3764	Main Control Umbilical Riser	Balmoral	4.8	213	3.9
PL3765	Chemical Injection Umbilical Riser	Balmoral	5	190	6.4
PL3766	Auxiliary Signal Cable 1 Piggybacked to PLU 3764	Balmoral	3/4	190	0.2
PL3767	Auxiliary Signal Cable 2 Piggybacked to PLU 3764	Balmoral	3/4	190	0.2
PLU4880	Burghley / Balmoral Electric/Hydraulic Bundle Riser	Balmoral	1.024	150	1.7
PLU4881	Burghley / Balmoral Electric/Signal/Hydraulic Bundle Riser	Balmoral	1.024	150	1.7

APPENDIX B: ENVID SUMMARY

The ENVID workshop was held to review environmental sensitivities and potential impact pathways for all of Premier's assets which are under consideration for decommissioning (i.e. Greater Balmoral Area (includes Balmoral, Glamis, Nicol, Brenda and Stirling), Caledonia, Huntington, Hunter & Rita, and Johnston Fields). As such, infrastructure and sensitivities associated with all of these assets are included in the ENVID Summary Table below.

Premier Oil UK Ltd. Decommissioning Project: Environmental Management Worksheet 06/08/2019

Environmental Impact Review					Controls, Mitigations, Review and Ranking												Identified Actions		
						Initial Ranking						Residual Ranking							
Operational Phase	Project Element	Operation / Aspect	Activity	Summary of Environmental Impact	Existing Controls (Standards, Legislative, or Prescriptive)	Consequence/Extent	Duration of Effect	Impact	Probability	Rank	Premier Specific / Best Practice Standards	Consequence/Extent	Duration of Effect	Impact	Probability	Rank	Description	Comment	Status
General	Vessels	Physical presence	Vessels	Disturbance to vessel operations offshore (e.g. fisheries and other maritime users); disturbance to marine species	Stakeholder engagement. Existing controls through DP Vessels and the usual notifications (key stakeholders).	L	M	L	M	M	In addition to existing controls, Premier keeps manned bridges.	L	M	L	M	M		Screened out	
			Discharges	Vessel discharge of grey water, bilge water, etc.	MARPOL compliant, bilge management procedures, good operating practices.	L	L	L	H	L		L	L	L	H	L		Screened out	
			Vessel engine noise	Underwater noise - behavioural modifications to marine mammals, turtles and potentially fish.	Vessel noise will not have significant sound levels - unlikely to be far above ambient noise levels.	L	M	L	M	L		L	M	L	M	L		Screened out	
		Power generation	Emissions	Gaseous emissions to atmosphere cause increased degradation of local/regional air quality (NOx and particulates). Transboundary air pollution. Contributing to global warming (CO2).	Lift vessel likely to dominate gaseous emissions.												Not assessed at this stage due to global scale. This would be a very small amount of CO2 emissions.	Screened out	
			Energy Use	Impact on climate change and reduction of resources of hydrocarbons. Products used for recycling.	Lift vessel and onshore smelting processes will dominate energy usage.												Not assessed at this stage due to global scale. This would be a very small amount of fuel usage.	Screened out	
	Waste	Waste management	Onshore	Use of landfill and landfill resource take (non-hazardous); special disposal (hazardous)	All waste will be handled and disposed of in line with regulations as detailed in the Waste Management Plan. Inventory of waste - tracking materials to final place. There are potential positive impacts from recycling of steel.	L					All wastes, including normal, hazardous and special wastes, will be shipped to shore for processing. Any transfrontier shipments of waste, including those for landfill, will be non-hazardous and will be managed under the Waste Management Plan and will comply with relevant legislation.	L						Screened out under Waste Management Strategies	
Preparation	Substructures	Template, wellheads, etc.	Flushing and cleaning	Liquid discharge to sea - Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Potential NORM impacts from sediment.	Treated water discharged to sea after cleaning.	L	L	L	M	L	Any NORM identified during flushing and cleaning of substructures are covered under the appropriate Waste Management Plan. This includes NORM from all subsea and topsides sources and from Non-Destructive Testing (NDT).	L	L	L	L	L	There is a higher risk of NORM at Balmoral and around the Voyageur FPSO. It is not significant at the moment, but likely to get worse. Brenda will undergo NDT, but this is covered by the handling of radioactive waste outlined in the Waste Management Strategy for Balmoral.	Screened out under Waste Management Strategies	
			Marine growth removal	Disposal to landfill. As a worst case assume landfill, but look for alternative route.	Waste management strategy.	L	H	L	H	M	All wastes, including special wastes, such as marine growth, will be shipped to shore for processing. Any transfrontier shipments of waste, including those for landfill, will be non-hazardous and will be managed under the Waste Management Plan and will comply with relevant legislation.	L	H	L	H	M	Soft growth will be jetted off the deck, *Lophelia* or other hard substrates/species would not be jetted off (it's a hard coral), may remain stuck on the structure when it's shipped to shore, but can't go to normal landfill because it's classed as biological waste.	Screened out under Waste Management Strategies	
	Pipelines & Umbilicals	Pipelines	Disconnect ends	Liquid / solid discharge to sea - Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Potential NORM impacts? Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Treated water discharged to sea after cleaning. Solids will be shipped to shore for disposal.	L	L	L	M	L		L	L	L	L	L	Residuals at cut ends released into the marine environment (post-flushing - should be low). Flooding into the pipeline only up to a certain level (pressure dependent), so displacement is not complete pipeline.	Screened out	
				Liquid /solid discharge to sea - Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Agate discharge as solid . Potential NORM impacts? Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Treated water discharged to sea after cleaning. Solids will be shipped to shore for disposal.	L	L	L	M	L		L	L	L	L	L	Low risk of substructures emitting fluids/solids - everything cut post-flushing. Residuals released in minute amounts.	Screened out	

Substructure	Template, wellheads, etc.	Internal cutting (water jetting)	Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	M	L	L	M	L		M	L	L	M	L	Impacts include localised deposition and localised smothering, leading to localised seabed disturbance.	Screened in
			Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	M	L	L	M	L		M	L	L	M	L	Impacts include localised deposition and localised smothering., leading to localised seabed disturbance. Wellheads around Brenda includes clean cuttings deposits (not classed as piles under OSPAR assessments). Assumes some level of residuals present in deposits, but all below OSPAR thresholds, given they're not classed as piles.	Screened in
		External cutting with diamond wire (as fallback option)	Underwater noise - behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.	Diamond wire cutting noise will not have significant sound levels.	L	L	L	L	L		L	L	L	L	L	Ambient noise levels in the SNS are already very high due to vessel traffic, and any noise impacts from cutting will be negligible and limited in duration.	Screened out
			Liquid / solid discharge to sea - Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Potential NORM impacts? Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Treated water discharged to sea after cleaning. Solids will be shipped to shore for disposal.	L	L	L	L	L	Transfer of controlled, hazardous and special wastes to UK ports for disposal will be governed by waste management plans.	L	L	L	L	L		Screened out under Waste Management Strategies
			Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	M	L	L	M	L		M	L	L	M	L	Perhaps there are old piles at Johnston (old), but cuttings will have dissipated in the currents of the SNS which run closer to the coastline.	Screened in
			Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	M	L	L	M	L		M	L	L	M	L		Screened in
			Water quality in immediate vicinity of the jetted cuttings will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Potential NORM impacts?	Approximately 2 Te of cuttings jetted to surrounding environment - dynamic environment means dispersal and resettlement anticipated to be rapid.	H	M	H	M	H	MFE will direct the majority of the cuttings pile to the seabed immediate to the template (i.e. within hundreds of metres).	M	M	L	L	M	The MFE plume will only carry approximately 0.001 ppm of particulates from the cuttings pile within the water column. Whilst the plume will travel quite far in the water currents, this level of contamination is highly diluted and anticipated to have negligible impacts on marine species within the water column.	Screened in
			Underwater noise - behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.	MFE will not generate sound levels which will generate injury or significant disturbance to any marine species.	L	M	M	L	L	Premier will undertake MFE outwith periods of concern for drilling activities, as this activity is considered greater than a worst-case analogue for underwater noise generated by MFE.	L	L	L	L	L	Noise emissions from MFE are likely to be lower than drilling sounds and will be masked to a certain degree by the excavation vessel. MFE will be limited in duration and unlikely to exceed emissions for any of the operational equipment assessed for noise impacts. It is noted that the JNCC's period of concern for drilling activities, which are anticipated to generate noise levels slightly above those produced during MFE, is October to December.	Screened out

Decommissioning		Template (and potentially old wellheads)	MFE of cuttings	Seabed disturbance - Template is 9 km outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles. Cuttings deposits - in and around template, jetting deposit (2K tonnes) into water column - modelling report	Volume of sediment/ cutting mobilised - Large quantities of material excavated and introduced into a dynamic environment - region of impact will be large, but dispersal and resettlement anticipated to be rapid.	H	M	H	H	H	MFE will direct the majority of the cuttings pile to the seabed immediate to the template (i.e. within hundreds of metres).	M	M	M	M	M	The area is characterised by benthic fauna which includes species sensitive to smothering, particularly seapens. Seabed impacts will be most marked within several hundred metres of the Balmoral template, though beyond this the template cuttings deposition rates fall below 1 mm . There will be some movement of cuttings material towards the Scannar Pockmarks SAC, located approx. 9 km NW of the template. However, the majority of sediment deposition will occur to the south and southeast of the template. Any sediment deposition which reaches the SAC is likely to fall below 0.01 mm, based on available modelling, which is indiscernible against background sedimentation levels. Moreover, the template structure needs to be removed to be legally compliant. For these reasons no significant impacts to the SAC anticipated.	Screened in	
			Lifting and removal	Underwater noise - behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.	Lifting and removal will not generate significant sound levels.	L	L	L	L	L		L	L	L	L	L		Screened out	
				Seabed disturbance - Template is 9 km outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles. Cuttings deposits - in and around template, jetting deposit (2K tonnes) into water column - modelling report	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation.	M	M	M	M	M		M	M	M	M	M		Screened in	
		Decommissioned *in situ*	Residuals	Liquid / solid discharge to sea - Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Treated water discharged to sea after cleaning. Solids will be shipped to shore for disposal.	L	L	L	L	L		L	L	L	L	L	There may be some residuals from when cuts take place, but small volumes to shoot out at end, but these will be permitted with flushing of pipelines.	Screened out	
			Free spans	Snagging risk to trawl and other demersal fisheries	Continued monitoring for an agreed period and remediation if required, accurate mapping of decommissioned in situ location and state	H	M	H	M	H	Almost all pipelines are stable and have remained buried. However, pipelines will be remediated regardless.	H	M	H	L	M	Majority of pipelines don't have free spans - except potentially around 'dog kennels' which protect locations where umbilicals have popped out. These protections cover the free spans, and would only expose free spans if they are removed.	Screened in	
			Rock dump	Introduction of new substrate which may alter habitat architecture, influencing water movement, sediment accumulation and light conditions.	Minimise introduction of material where possible	L	H	L	L	L		L	H	L	L	L		Screened in	
				Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	L	H	L	L	L		L	H	L	L	L	Relatively small footprint compared to volume of fishing taking place in surrounding edges.	Screened in	
				Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	L	H	L	L	L		L	H	L	L	L		Screened in	

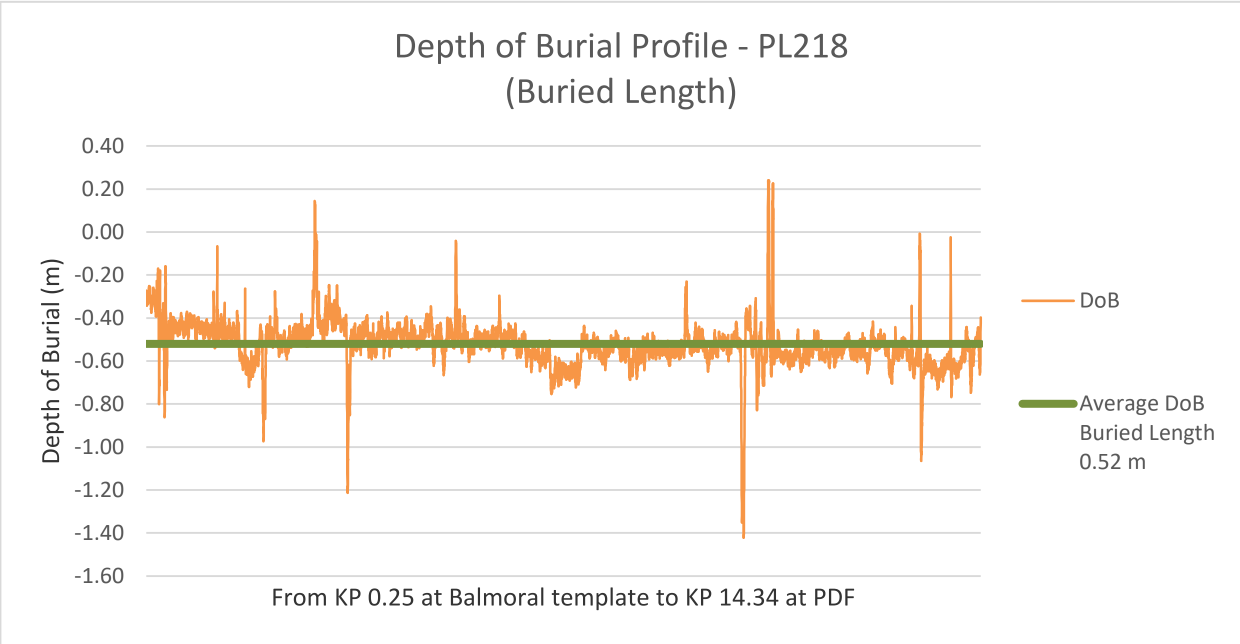
Pipelines & Umbilicals	Full removal		Liquid / solid discharge to sea - Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. Potential NORM impacts. Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Treated water discharged to sea after cleaning. Solids will be shipped to shore for disposal.	L	L	L	L	L	Transfer of controlled, hazardous and special wastes to UK ports for disposal will be governed by waste management plans.	L	L	L	L	L		Screened out under Waste Management Strategies
		Reverse reeling and cut & lift	Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	H	M	M	H	H	Remediation will be undertaken where required.	H	L	M	H	M	Clay berms may require remediation (overtrawl) so that lumps of clay exposed during reverse reeling do not pose a snagging risk.	Screened in
			Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	H	M	M	H	H	Remediation will be undertaken where required.	H	L	M	H	M	Clay berms may require remediation (overtrawl) so that lumps of clay exposed during reverse reeling do not pose a snagging risk.	Screened in
		Rock dump	Introduction of new substrate which may alter habitat architecture, influencing water movement, sediment accumulation and light conditions.	Minimise introduction of new material where possible	L	H	L	L	L		L	H	L	L	L		Screened in
			Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	L	H	L	L	L		L	H	L	L	L		Screened in
			Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	L	H	L	L	L		L	H	L	L	L		Screened in
Surveys	Surveys for post-decommissioned infrastructure left in-situ	Geotechnical survey activities - may include grab sampling	Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	L	L	L	L	L		L	L	L	L	L	Seabed disturbance from benthic surveys will be minute and limited to the immediate vicinity of the installations, with the odd grab sample along the pipelines, though this is unlikely. Only relevant to Rita/Hunter installations.	Screened out as no significant impacts identified
			Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	L	L	L	L	L		L	L	L	L	L	Seabed disturbance from benthic surveys will be minute and limited to the immediate vicinity of the installations, with the odd grab sample along the pipelines, though this is unlikely.	Screened out as no significant impacts identified

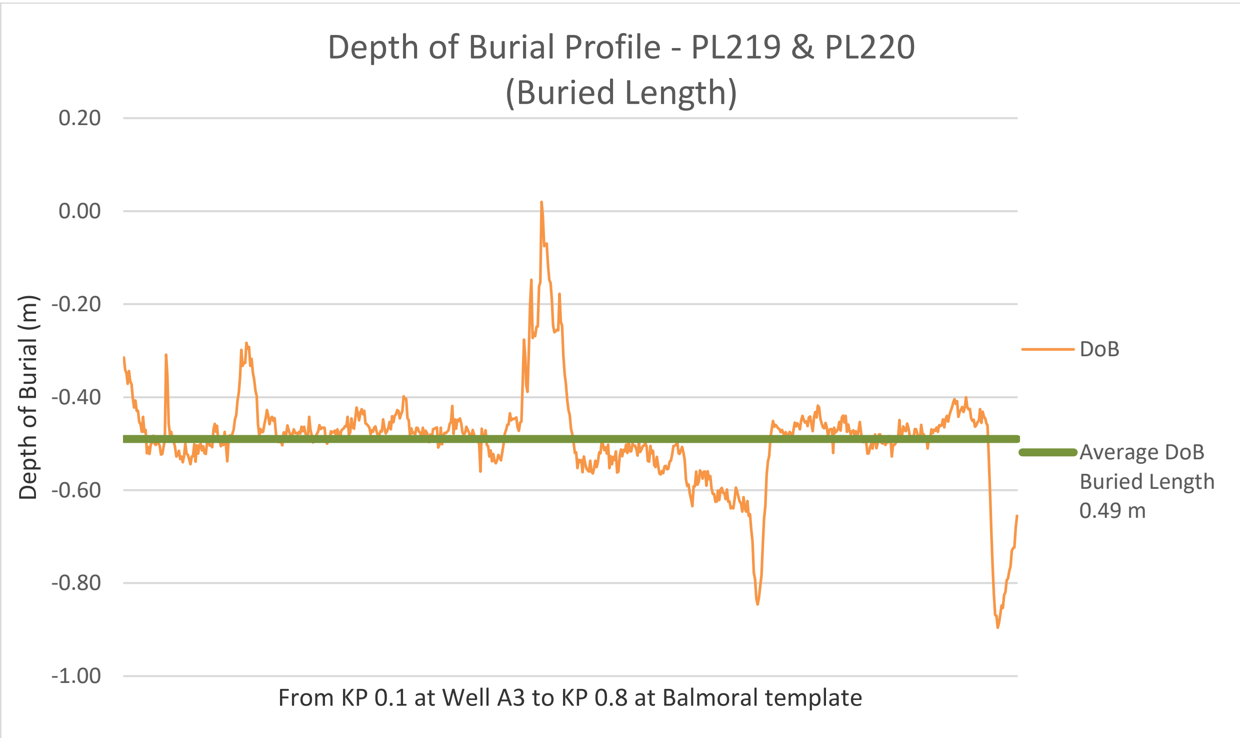
Legacy			Geophysical survey activities	Underwater noise - Physiological harm, behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.	Noise impacts to marine species from use of seismic, sub-bottom profiler, and other survey equipment. JNCC (2017) Guidelines will be employed for mitigation of noise impacts to marine mammals for future survey work involving seismic survey equipment.	H	L	H	M	H	Future permitting will cover post-decommissioning geophysical surveys. Multibeam will likely be used for imaging and identification of any exposures.	H	L	H	M	H		Screened out as covered by future permitting	
	Remediation	Remediation of spans	Rock dump/ reburial	Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	L	H	L	L	L	Exposures remediated primarily with rockdump rather than reburial, but with additional discussion inside SAC. However, the use of rockdump will be minimised where possible.	L	H	L	L	L		Screened in	
				Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	L	H	L	L	L	Exposures remediated primarily with rockdump, rather than reburial. However, the use of rockdump will be minimised where possible.	L	H	L	L	L		Screened in	
	Degradation	Degradation of substructure	Free spans	Snagging risk to trawl and other demersal fisheries	Continued monitoring for an agreed period and remediation if required, accurate mapping of decommissioned in situ location and state.	H	L	H	L	M	Eventual corrosion and collapse of structures pose a potential snagging risk. Continued monitoring and remediation will be undertaken where required. This includes deployment of a PowerBuoy at Balmoral.	H	L	H	L	M	This is primarily an issue at Balmoral, where additional monitoring will take place via a PowerBuoy.	Screened in	
Unplanned events	**Vessels**	Significant Hydrocarbon release	Unplanned collision	Catastrophic loss of containment Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Unplanned - Project will introduce new diesel inventory to the site with additional inherent spill / pollution risk e.g. from heavy lift vessel. OPEP MAS Navaids SOPEP	H	M	H	L	H	This will be covered in future Navigational Risk Assessment work.	H	M	H	L	M	SNS higher risk of collision, but manned wheelhouses, notifications, AIS, etc. No modelling required.	Screened Out; *Johnston may need assessment b/c seabirds, seals, etc.*	
		Dropped Objects	Unplanned loss of material to sea	Seabed disturbance - **inside Dogger Bank SAC** - edges mostly clay/not replaceable (CMS assets). Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - Dogger Bank is an extensive sublittoral sandbank which is characterised by moderately mobile, clean sediments. Impacts to fauna will be minor, due to community-level change from bottom-trawling. Impacts to the gross physical nature of the site are not expected.	L	H	L	L	L	Everything will be endeavoured to be retrieved. All unplanned losses in the marine environment will be attempted to be remediated, and notifications to other mariners will be sent out. Debris clearance surveys will aid in the identification of any dropped objects.	L	M	L	L	L	Not undertaking any cutting or lifting of pipelines, just reverse reel, and the integrity of all subsea structures is considered sound. No issues have been identified.	Screened out as no significant impacts identified	
				Seabed disturbance - outside SAC Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within EA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	Volume of sediment mobilised proportional to area of sediment disturbed - expected to be minor and in dynamic environment with frequent natural sediment mobilisation	L	H	L	L	L	Everything will be endeavoured to be retrieved. All unplanned losses in the marine environment will be attempted to be remediated, and notifications to other mariners will be sent out. Debris clearance surveys will aid in the identification of any dropped objects.	L	M	L	L	L	Not undertaking any cutting or lifting of pipelines, just reverse reel, and the integrity of all subsea structures is considered sound. No issues have been identified.	Screened out as no significant impacts identified	

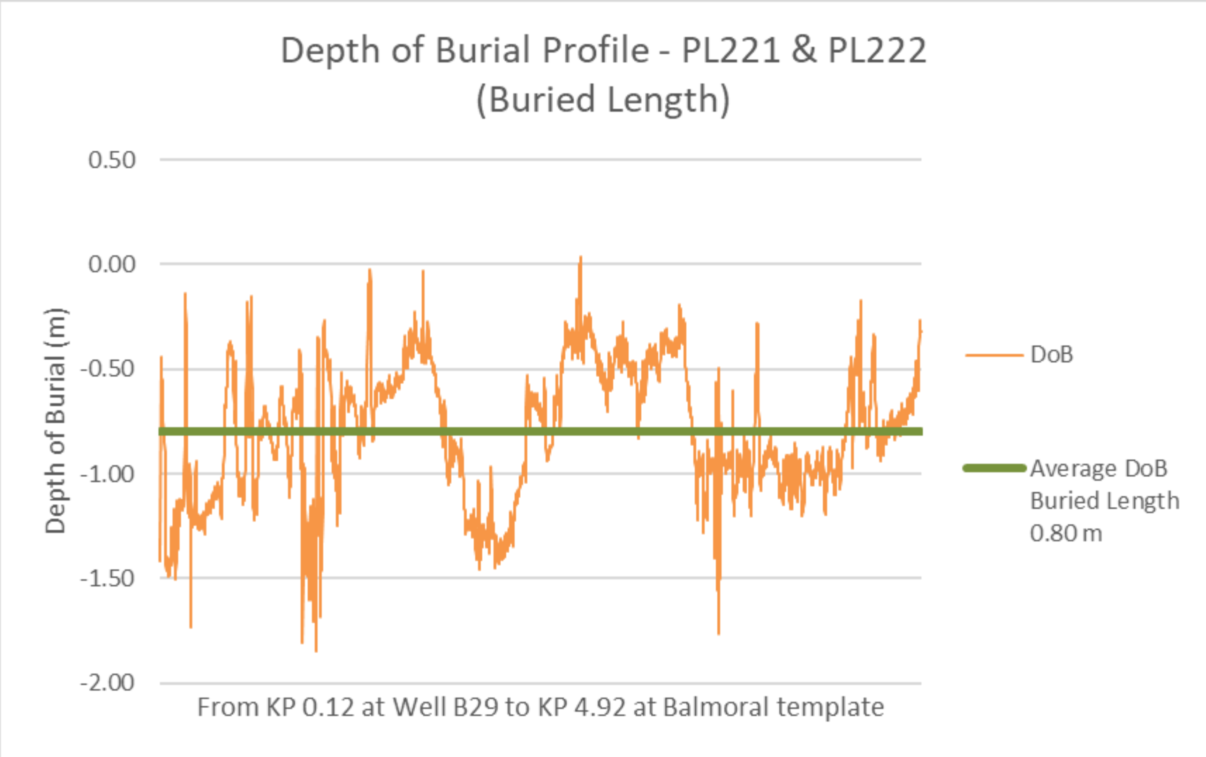
APPENDIX C: DEPTH OF BURIAL PROFILES

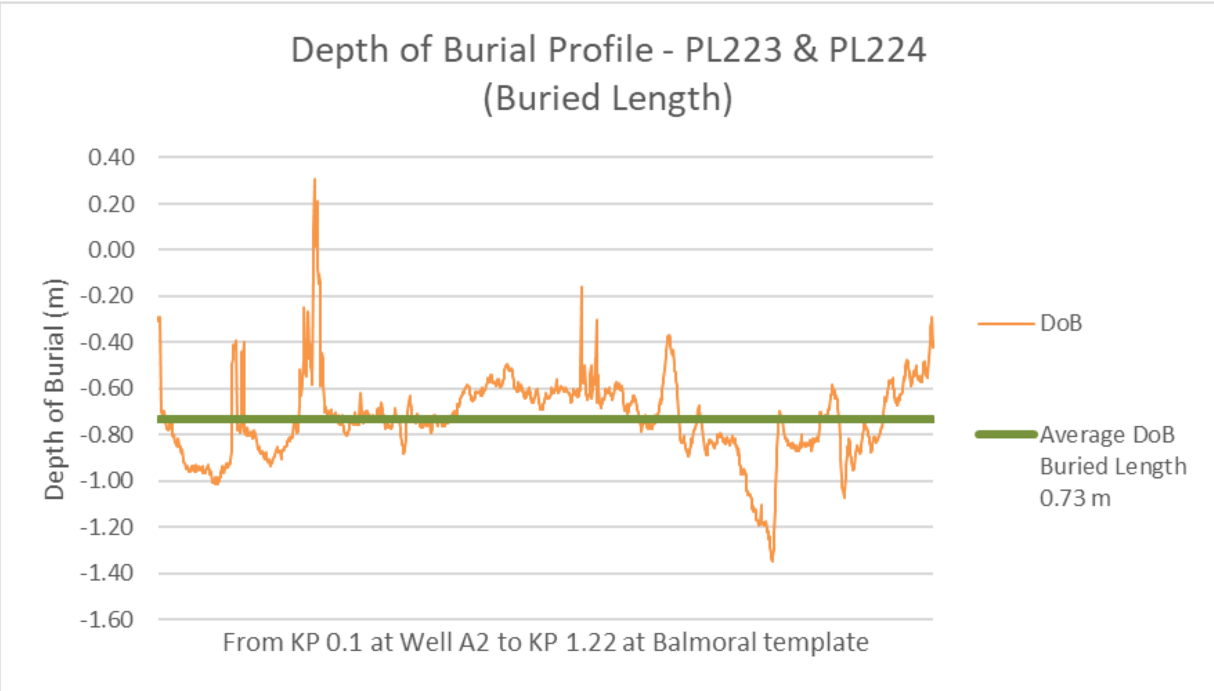
The sections below illustrate the depth of burial profiles for buried flowlines across the Greater Balmoral Area, including those within the Balmoral, Glamis, Brenda, and Nicol fields. There is not Depth of Burial information included for Stirling, as there are no buried rigid pipelines in this Field.

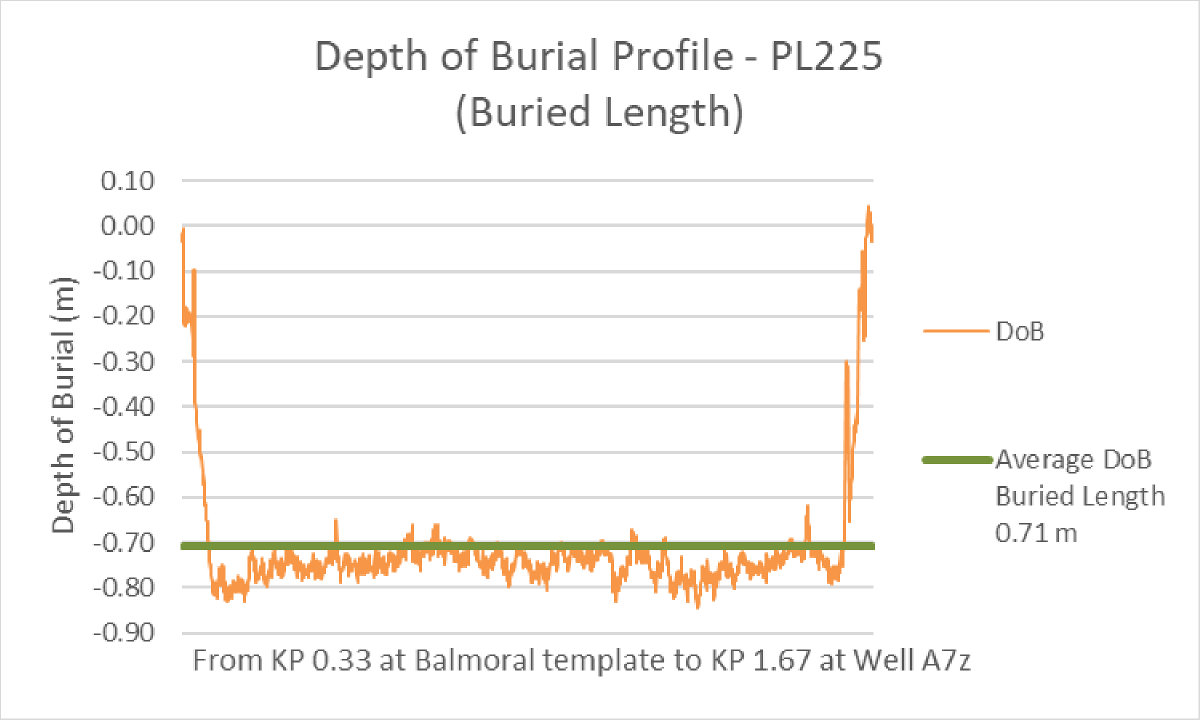
1 Balmoral Depth of Burial Profiles

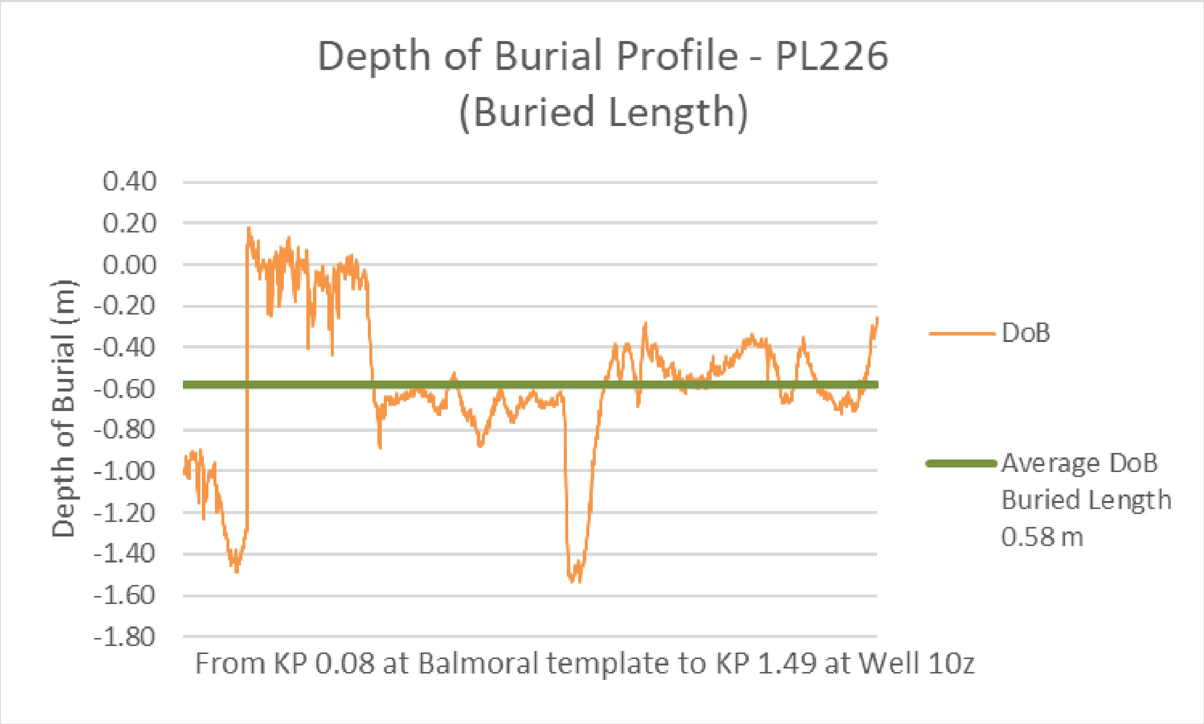


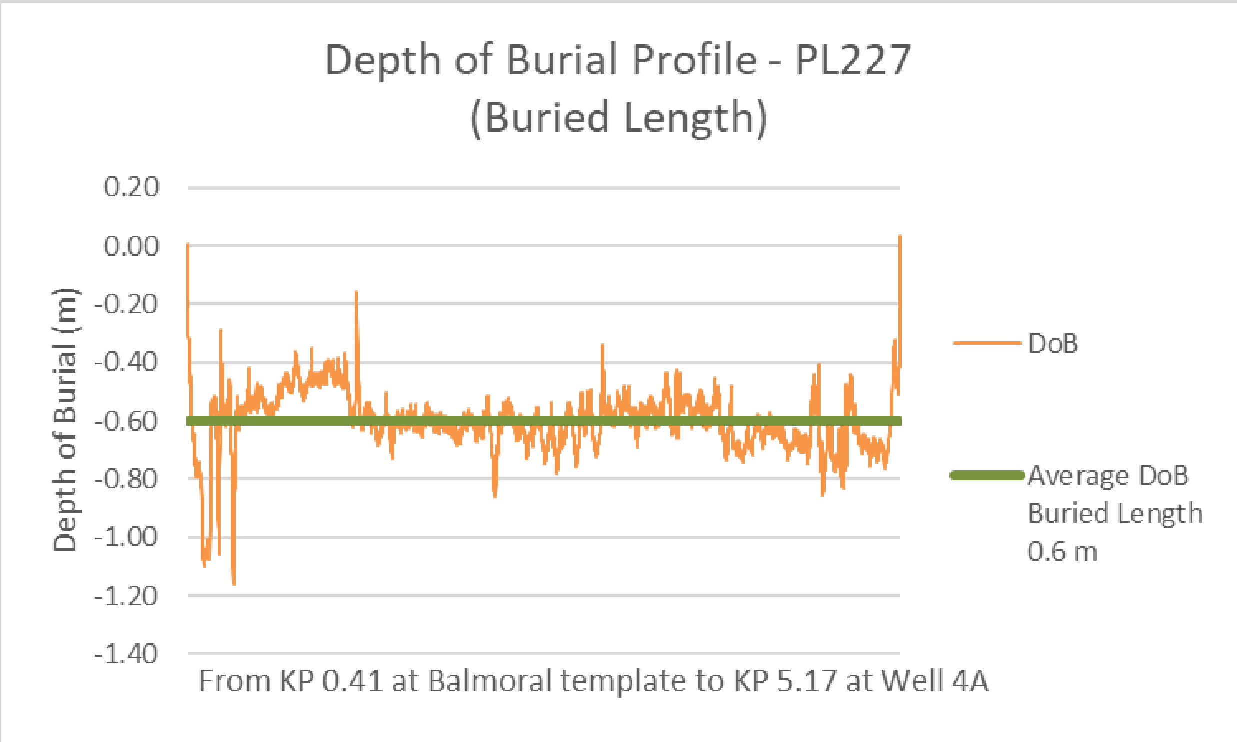


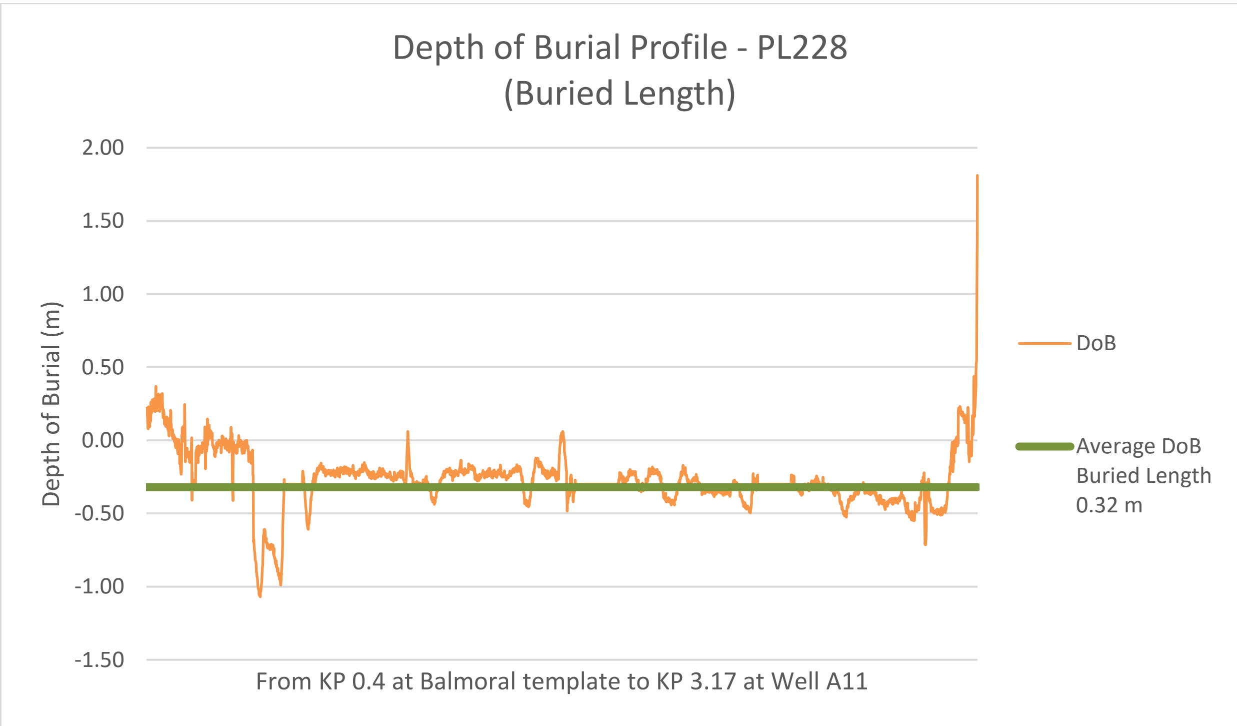

Depth of Burial Profile - PL221 & PL222
(Buried Length)
0.50
0.00
-0.50
-1.00
-1.50
-2.00
Depth of Burial (m)
From KP 0.12 at Well B29 to KP 4.92 at Balmoral template
DoB
Average DoB Buried Length 0.80 m

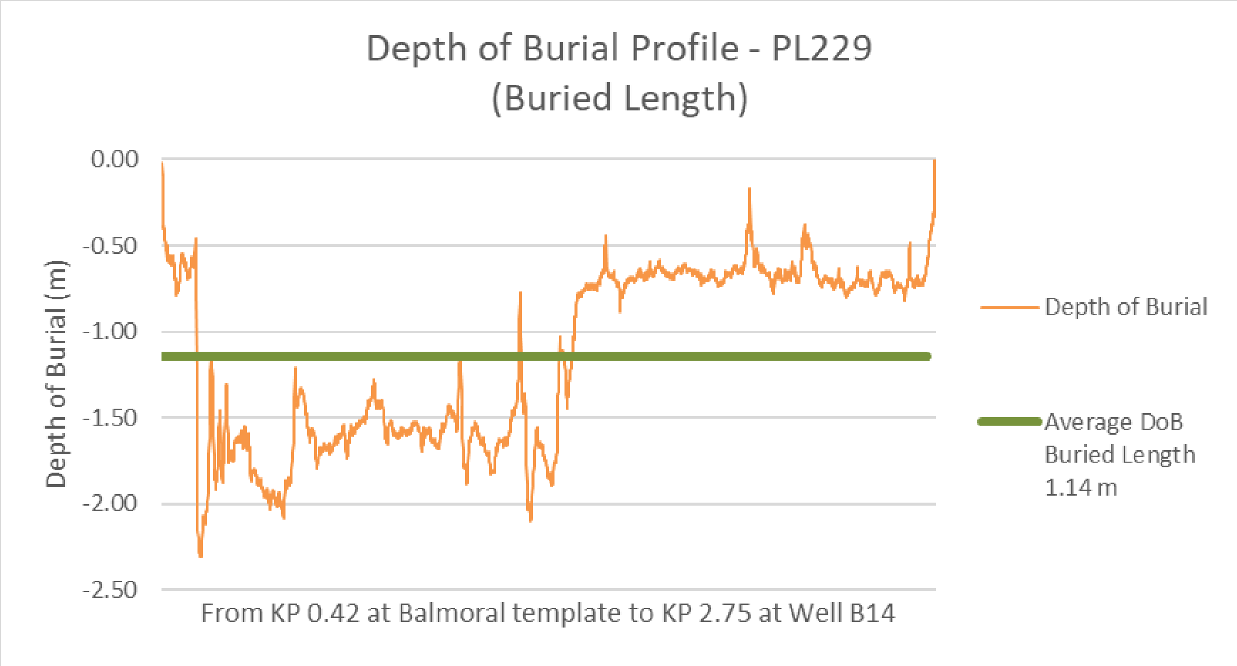

Depth of Burial Profile - PL223 & PL224
(Buried Length)
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
Depth of Burial (m)
From KP 0.1 at Well A2 to KP 1.22 at Balmoral template
DoB
Average DoB Buried Length 0.73 m

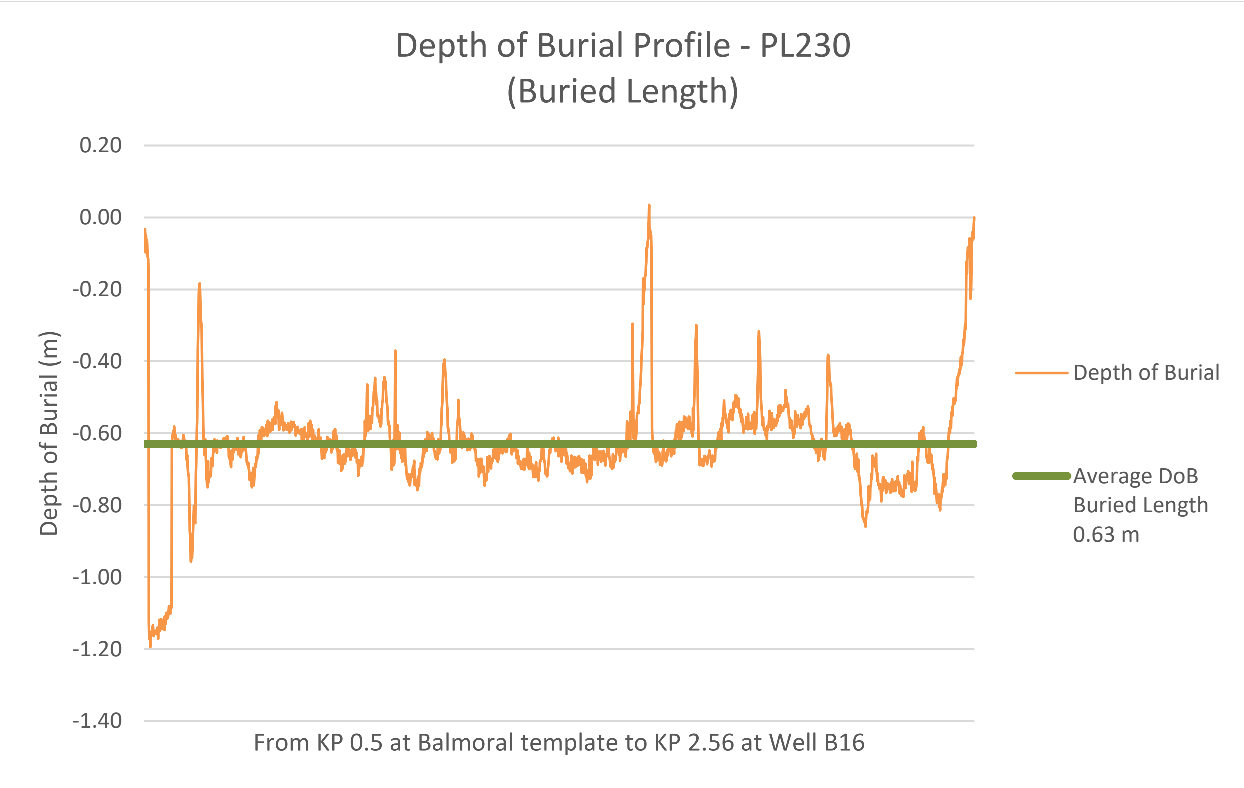

Depth of Burial Profile - PL225
(Buried Length)
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
Depth of Burial (m)
DoB
Average DoB Buried Length 0.71 m
From KP 0.33 at Balmoral template to KP 1.67 at Well A7z

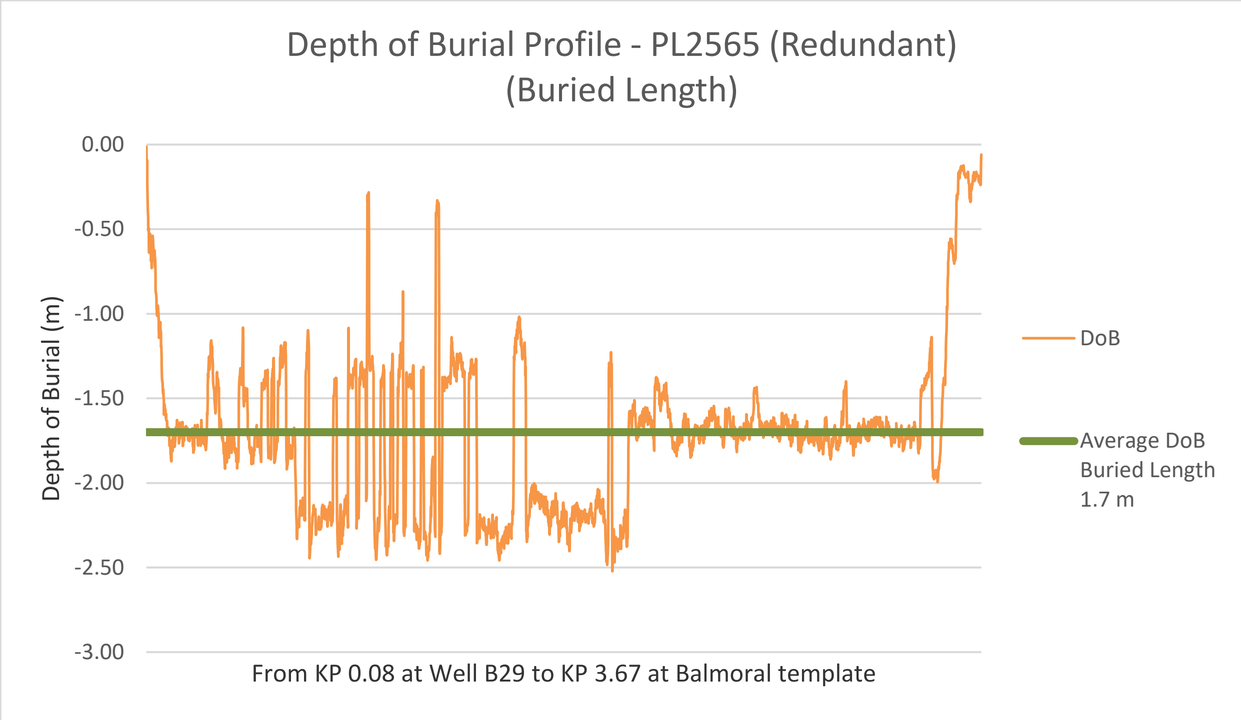

Depth of Burial Profile - PL226
(Buried Length)
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
Depth of Burial (m)
DoB
Average DoB Buried Length 0.58 m
From KP 0.08 at Balmoral template to KP 1.49 at Well 10z


Depth of Burial Profile - PL227
(Buried Length)
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
Depth of Burial (m)
DoB
Average DoB Buried Length 0.6 m
From KP 0.41 at Balmoral template to KP 5.17 at Well 4A

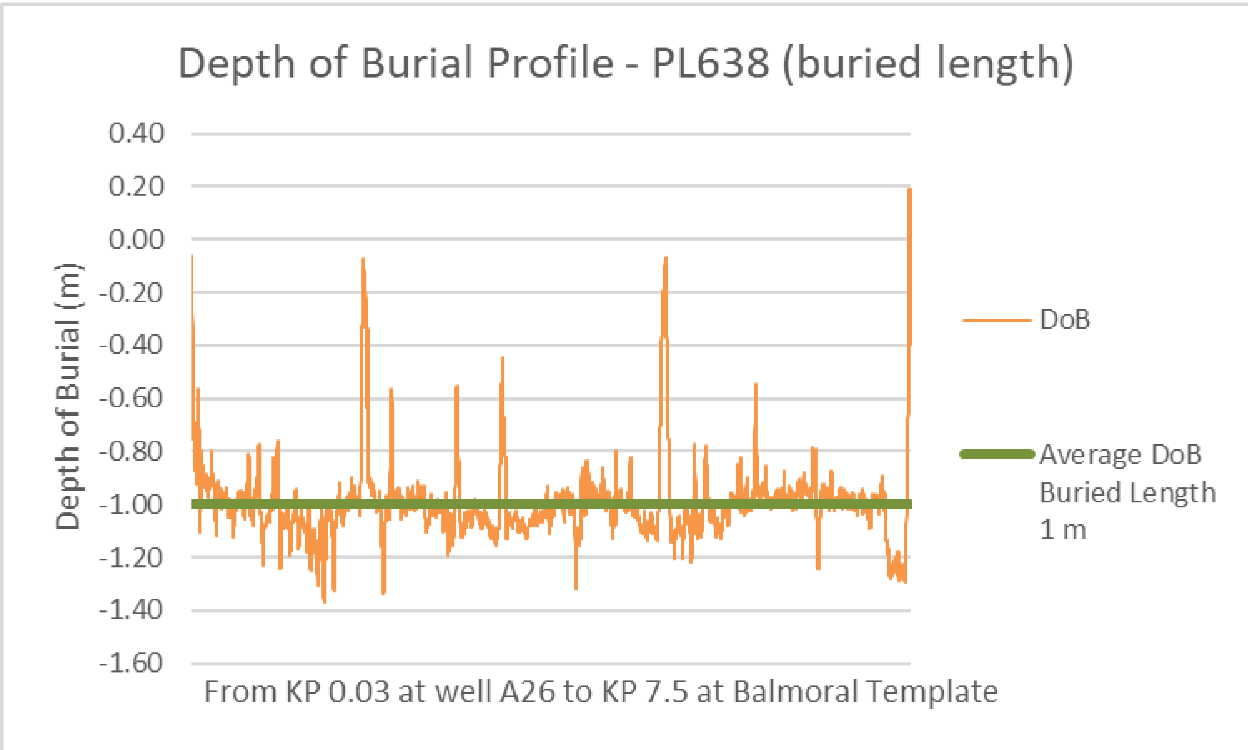

Depth of Burial Profile - PL228
(Buried Length)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
Depth of Burial (m)
DoB
Average DoB Buried Length 0.32 m
From KP 0.4 at Balmoral template to KP 3.17 at Well A11

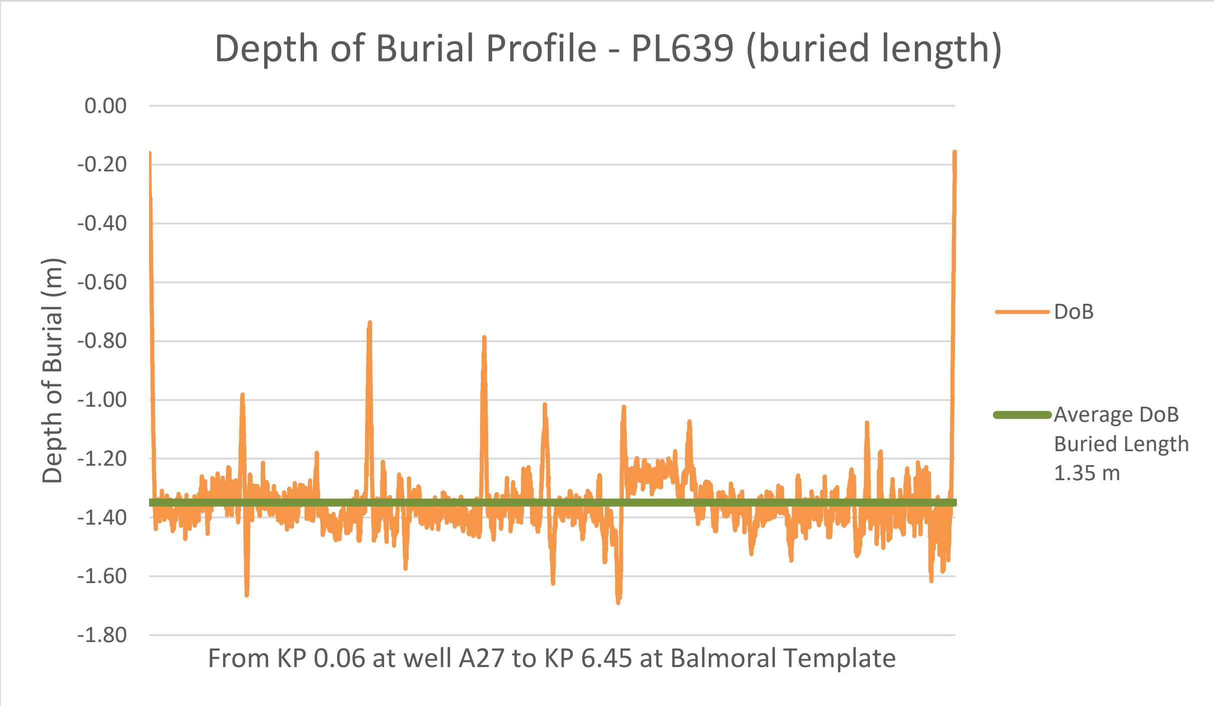

Depth of Burial Profile - PL229
(Buried Length)
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
Depth of Burial (m)
From KP 0.42 at Balmoral template to KP 2.75 at Well B14
Depth of Burial
Average DoB
Buried Length
1.14 m

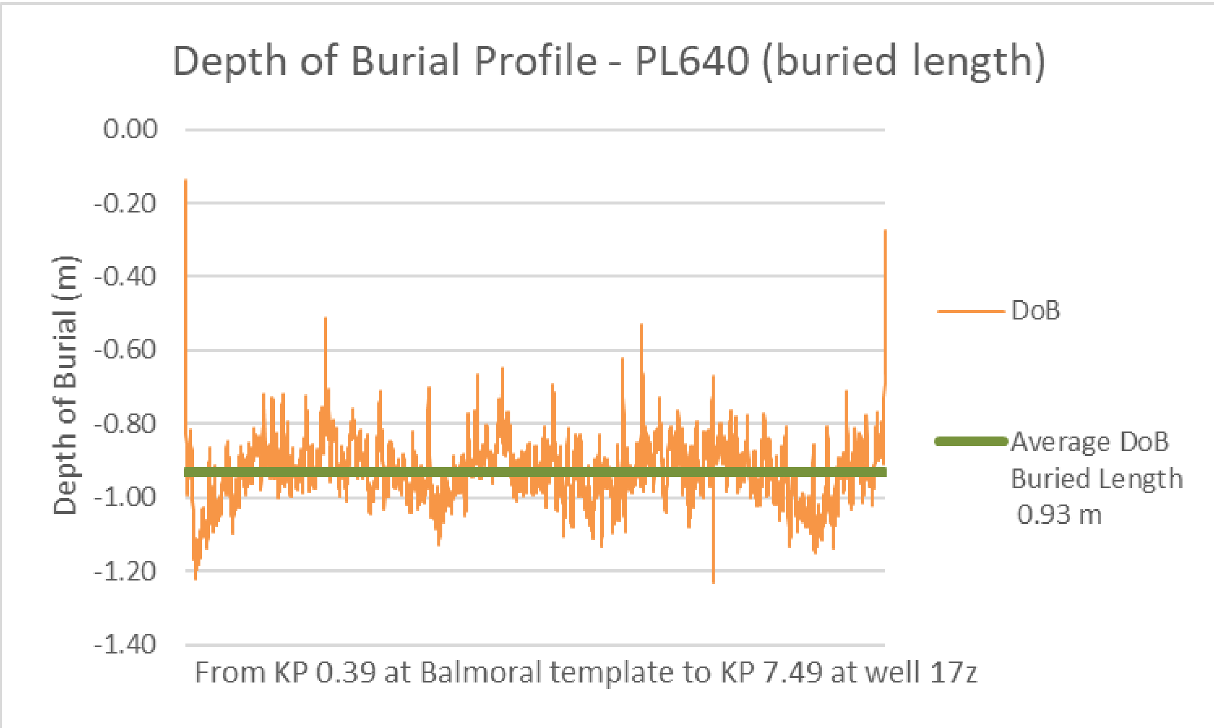

Depth of Burial Profile - PL230
(Buried Length)
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
Depth of Burial (m)
From KP 0.5 at Balmoral template to KP 2.56 at Well B16
Depth of Burial
Average DoB
Buried Length
0.63 m

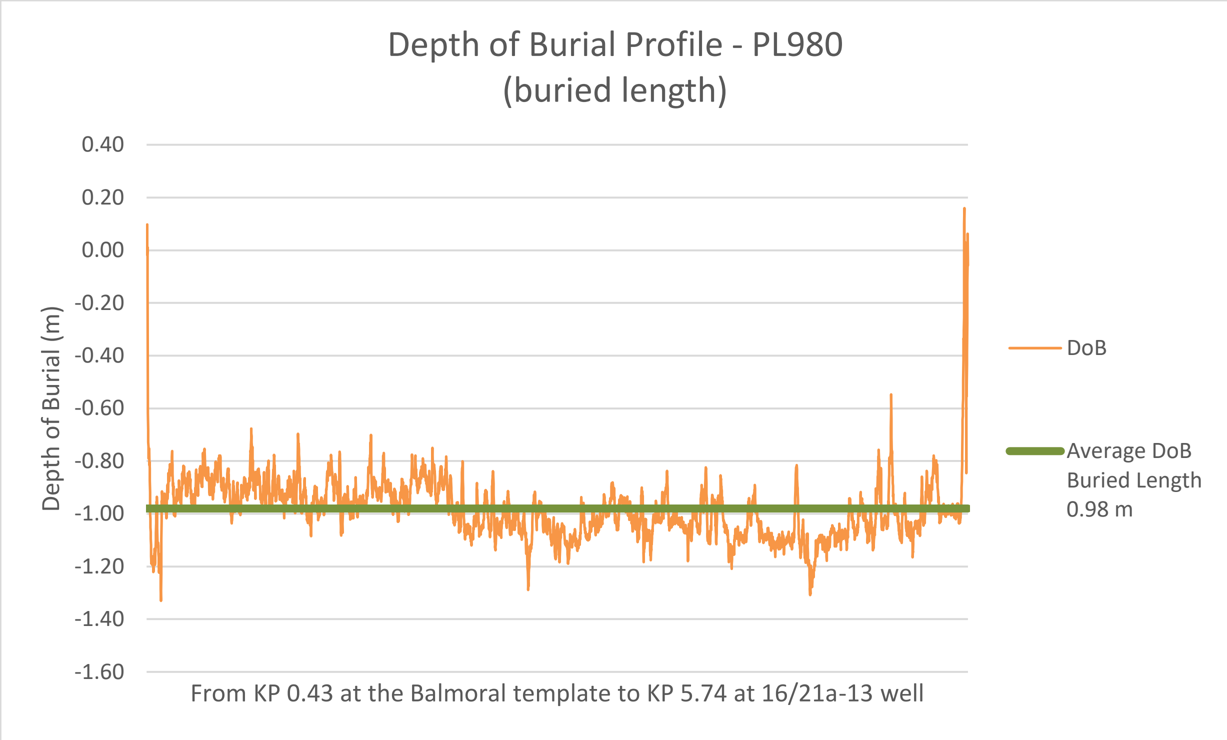


2 Glamis Depth of Burial Profiles

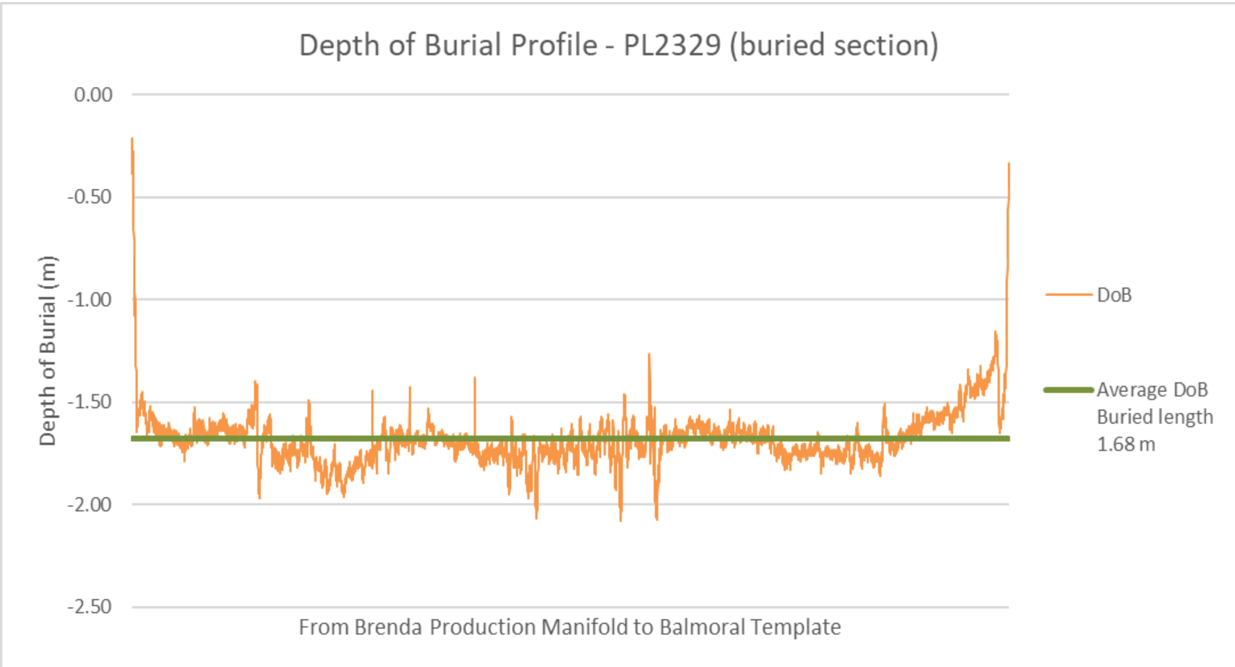


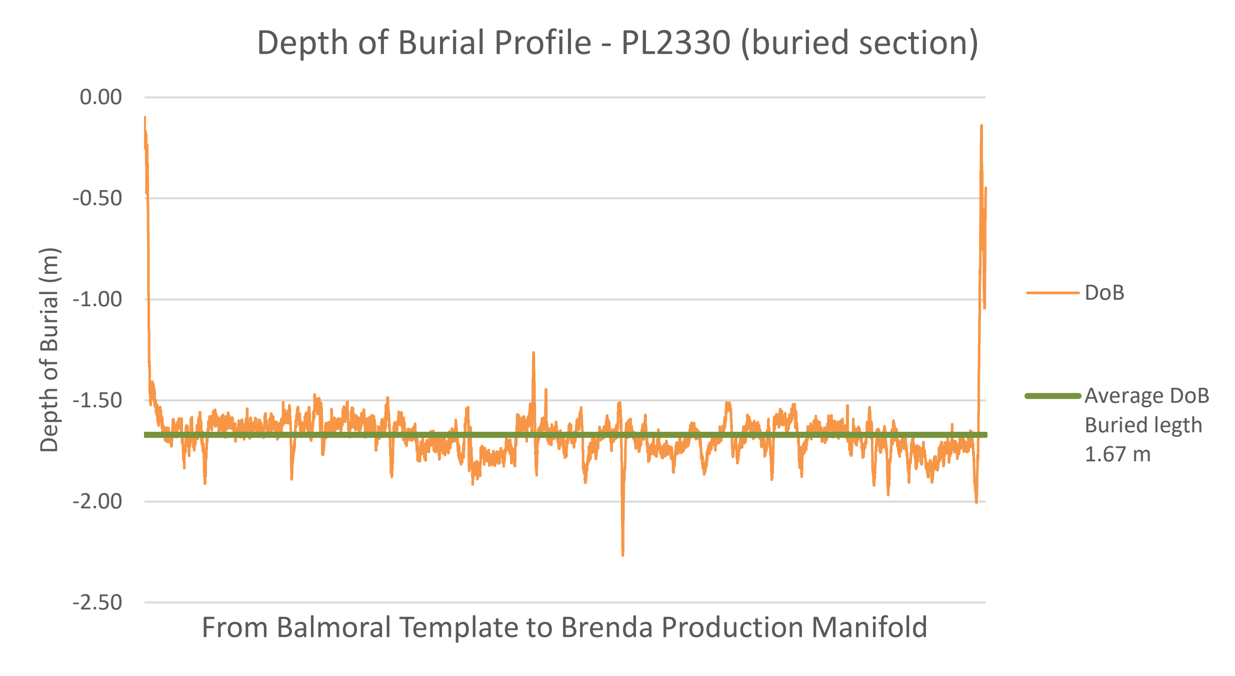

Depth of Burial Profile - PL639 (buried length)
Depth of Burial (m)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
From KP 0.06 at well A27 to KP 6.45 at Balmoral Template
DoB
Average DoB Buried Length 1.35 m


Depth of Burial Profile - PL640 (buried length)
Depth of Burial (m)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
From KP 0.39 at Balmoral template to KP 7.49 at well 17z
DoB
Average DoB Buried Length 0.93 m

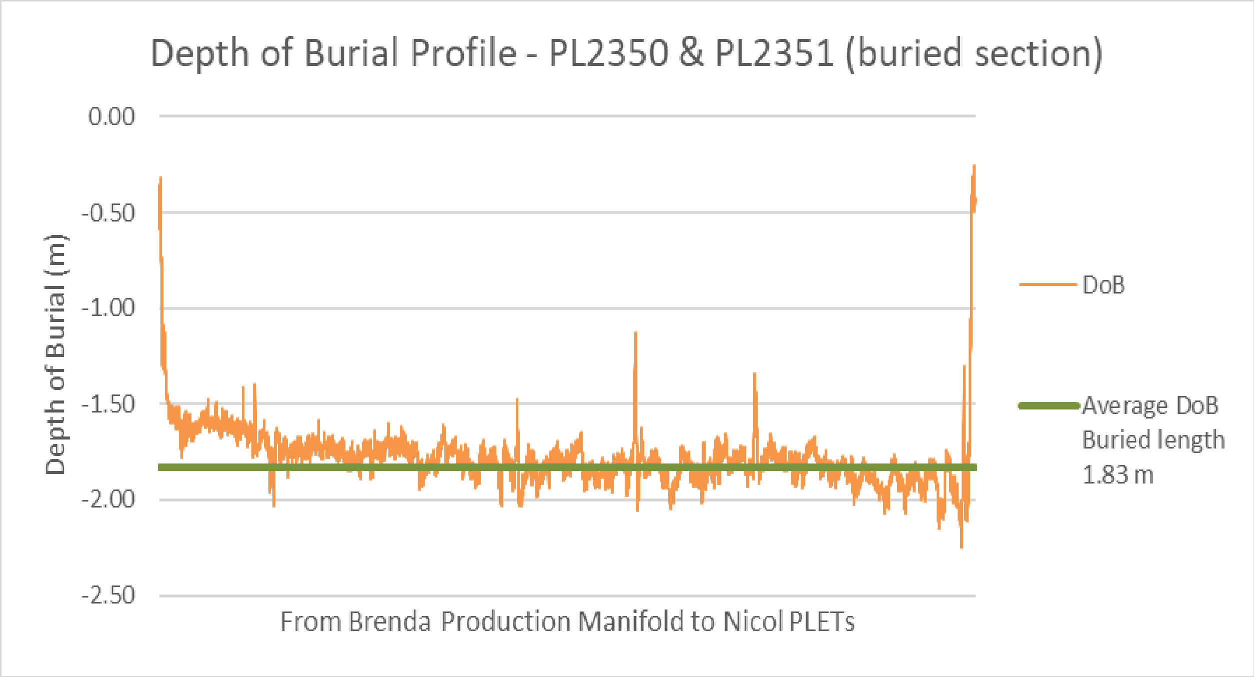


3 Brenda Depth of Burial Profiles




Depth of Burial Profile - PL2330 (buried section)
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
Depth of Burial (m)
From Balmoral Template to Brenda Production Manifold
DoB
Average DoB
Buried legth
1.67 m

4 Nicol Depth of Burial Profile



APPENDIX D: BALMORAL TEMPLATE CUTTINGS DISPERSAL MODELLING

PremierOil

BALMORAL TEMPLATE CUTTINGS DISPERSAL MODELLING		
CONTRACTOR DOCUMENT COVER SHEET	**Total # of Pages** (incl. Doc Cover Sheet)	25

Company Document No	AB-BL-XGL-HS-SE-RP-0001	**Revision No**	B03
Document Title	Balmoral Template Cuttings Dispersal Modelling		
Contract No	POUK/C1810		
Tag No	N/A		

Notes	**Contractor Name, Address and Logo**
	Xodus Group Limited, Xodus House, 50 Huntly Street, Aberdeen, AB10 1RS xodus GROUP

Contractor Document No	A-301999-S04-REPT-001	Contractor Rev No	A03

Rev	Issue Date	Status	Amendment Details	Originated By	Checked By	Approved By
B01	29/08/19	IFU	ISSUED FOR USE	JG	PB	PB
B02	17/04/20	IFU	ISSUED FOR USE	JG	AM	AM
B03	29/04/20	IFU	ISSUED FOR USE	JG PP Jennifer Smith Digitally signed by PP Jennifer Smith Date: 2020.04.29 16:00:07 +01'00'	AM PP Nic Duncan Digitally signed by PP Nic Duncan Date: 2020.04.30 07:37:07 +01'00'	AM PP Nic Duncan Digitally signed by PP Nic Duncan Date: 2020.04.30 07:37:25 +01'00'

CONTRACTOR DOCUMENT STATUS

Code	Comment	Action Required	Manufacture
01	Approved	Do not re-submit unless data is modified	May Proceed
02	Accepted with Comment	Approved subject to comments being incorporated	May Proceed
03	Rejected	Not Accepted, work may not proceed, revise and resubmit	May not Proceed
04	Information Only	Do not resubmit	May Proceed
Return Code		**Premier Oil Signature (Electronic)**	
Date		**Premier Oil - Approver Name**	

Review of contractor data does not relieve the contractor of responsibility for correctness under term of the contract.

XODUS
ASSURE

Balmoral Template Cuttings Dispersal Modelling

Premier Oil E&P UK Ltd

Assignment Number: A301999-S04
Document Number: A-301999-S04-REPT-001

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CONTENTS

EXECUTIVE SUMMARY

As part of the wider full decommissioning of the Premier Oil Balmoral development, removal of the Balmoral template will involve the disturbance and resuspension of material from the drill cuttings pile, and therefore potentially release contaminants. Xodus Group modelled the dispersion of this material from the decommissioning of the subsea template to understand any impact on the local environment.

The discharges from the cuttings disturbance scenarios were modelled using the ParTrack module within SINTEF's Dose related Risk and Effect Assessment Model (DREAM) (included in the Marine Environmental Modelling Workbench (MEMW) software). Dispersion of particulates and dissolved material in the water column and settling behaviour were assessed primarily in the immediate vicinity of Balmoral.

Environmental Impact Factors (EIF) are a relative measure of risk to the biota in the marine environment and can be calculated for the water column or the seabed. An unacceptable effect is considered to occur when the probability of a species being affected by the stressor is more than 5%.

The model predicts that a small plume of particulate and dissolved material will travel in a north westerly direction near the seabed. The main contributor to the impact on the water column is barite (41%) followed by bentonite (37%). The risk of adverse effects to the water column falls below 5% after 9 days and 20 hours from the initial disturbance.

After all, three phases of excavation, the worst case maximum thickness of redeposited material (1.2 m) was predicted to occur within the immediate vicinity of the Balmoral template, although rapidly decreases with distance from the template. The model predicts that the sediment risk from the resuspended material will occur within the immediate vicinity of the template and that the main contributors to the risk are dispersed oil attached to cuttings, nonylphenol attached to cuttings and acenaphthene attached to cuttings, all of which have an equal contribution to the EIF (30%).

The model predicts that there is no long-term impact on the seabed or water column due to the resuspension of cuttings pile material during excavation of the drill cuttings pile. The extent of water impacted at greater than 5% is variable and transient due to the varying currents and changing composition of the material. Although there may be a continued risk to the seabed, the EIF value is small and occurs within the immediate vicinity of the template. However, this does not consider the current status of the environment, the particular species present in the area, their sensitivity to smothering or contaminants, or the potential for recovery. The results from the modelling provide a line of evidence to be incorporated in the environmental impact assessment of the benthic compartment which will be reported separately from this report.

1 INTRODUCTION

Premier Oil E&P UK Ltd. (Premier) is the operator of the Balmoral field development, located in United Kingdom Continental Shelf (UKCS) Blocks 15/25 and 16/21. For further information on general physical environment characteristics surrounding the Balmoral template see “Rig Site and Habitat Assessment Survey” (UTEC, 2008).

Infrastructure associated with the Balmoral development is currently being prepared for future decommissioning. Decommissioning of the Balmoral template infrastructure will involve the disturbance and resuspension of the surrounding drill cuttings pile material using the TRS2 tool, and therefore will potentially release contaminants. Modelling the dispersion of this material from the decommissioning of the subsea template was conducted by Xodus Group to help understand any impact on the local environment.

1.1 Abbreviations

bbls	Barrels (oil)
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
Cefas	Centre for Environment, Fisheries and Aquaculture Science
cm	Centimetre
DREAM	Dose Related Risk and Effect Assessment Model (Sintef)
EA	Environmental Appraisal
ED50	European Datum 1950
EIF	Environmental Impact Factors
ft	Foot
Kg	Kilogram
Km	Kilometre
m	Metre
m/s	Metres per second
m2	Metre squared
m3	Metre cubed
MEMW	Marine Environmental Modelling Workbench
mg	Milligram
O2	Oxygen (gas)
OSCAR	Oil Spill Contingency And Response (Sintef)
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEC	Predicted Environmental Concentration
PNEC	Predicted No Effect Concentration
ppg	Parts per gallon
ROV	Remotely Operated Vehicle
s.f.	Significant Figures
Te	Tonne (metric)
THC	Total Hydrocarbons
TRS2	Controlled Flow Excavation System (Rotech Subsea)
UKCS	United Kingdom Continental Shelf

2 METHODOLOGY

2.1 About the Model

Cuttings pile disturbance was modelled using the ParTrack module within SINTEF's DREAM software (included in Marine Environmental Modelling Workbench (MEMW) version 10.0.1). Dispersion of particulates and dissolved material in the water column and settling behaviour were assessed in the immediate vicinity of the cuttings pile.

Various biological, chemical and physical processes which may take place after the resuspension of cuttings pile material include dissolution, bacterial degradation, transport, erosion and bioturbation. Some potential impacts from these processes include reduced visibility, smothering of benthic fauna and the saturation of filter membranes (Figure 2-1); these potential impacts are discussed further in the Balmoral EA (Xodus, 2020).

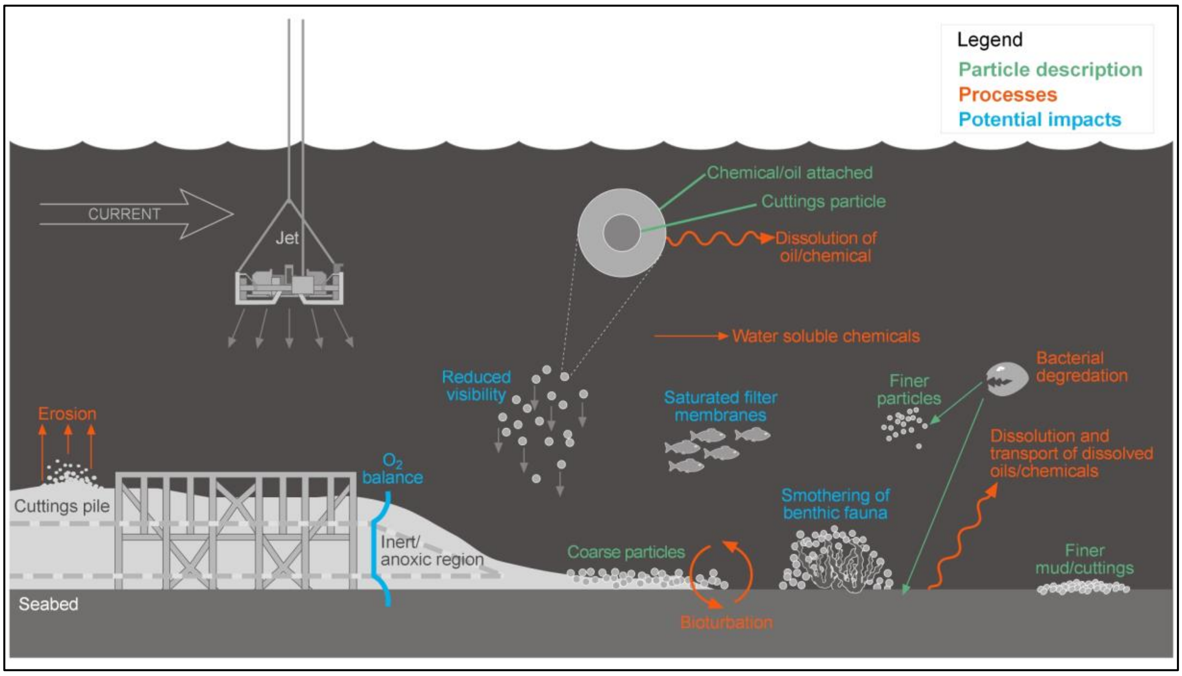

Figure 2-1 Biological and chemical processes resulting from resuspension of cuttings pile material and their potential impacts on environmental receptors

Environmental Impact Factors (EIFs) for the water column and seabed were calculated to inform the assessment of the potential environmental impacts of cuttings pile disturbance during the Balmoral decommissioning operations.

EIFs are a relative measure of risk to the biota in the marine environment and can be calculated for the water column or the seabed. First, the entire modelled area is split into compartments. For the water column EIF, this is 100 m x 100 m x 10 m[1] (0.0001 km^3), and for the seabed EIF, this is 100 m x 100 m (1 ha or 0.01 km^2). In each compartment, the predicted environmental concentration (PEC) of a contaminant in the compartment is divided by the predicted no effect concentration (PNEC; the highest concentration at which no environmental effect is predicted) (PEC/PNEC approach). The PNEC values within the model have been calculated using laboratory toxicity tests on a range of contaminants[2] on a range of species e.g. one or more marine algae, crustaceans and fish (Frost *et al*., 2006).

[1] Where 10 m is a vertical compartment/layer within the model water column

[2] Range of contaminants include: metals (cadmium, chromium, copper, lead, mercury and zinc), natural organic compounds (benzene, toluene, ethylbenzene and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAH), alkylated phenols (expected highly alkylated phenols) and aliphatic hydrocarbons) and added chemicals.

Where PEC/PNEC is equal to or greater than 1, an unacceptable effect on organisms is likely to occur, and so each compartment in which PEC/PNEC is equal to or greater than 1 contributes to the total EIF. By making various statistical assumptions, the stressors are extended to include others (in addition to toxicity), such as physical changes in sediment particle size and sediment smothering, that are correlated with environmental impacts. This allows the contributions to the total EIF to be compared, e.g. the proportion of the total impact contributed by the chemical toxicity of various chemicals can be compared to the risk contributed by the effects of smothering. Using measured physical and chemical properties of the cuttings pile, as detailed in Section 2.3.1, as inputs to the model allows the calculation of the EIF.

The spatial development of the EIF can be represented by the risk to a species. An unacceptable effect is considered to occur when the probability of a species being affected by the stressor is more than 5% (i.e. the risk of adverse effects is more than 5%). A risk of more than 5% is equivalent to a PEC/PNEC ratio of equal or greater than 1. For further details on the framework for the EIF for drilling discharges see Smith *et al.,* (2006). The areas that are shown as having a higher than 5% risk contribute to the total EIF.

It should be noted that SINTEF, the developers of DREAM (ParTrack), clearly state that the EIF is not a measure of absolute impact, but a comparative tool to support environmental management decision making. The modelling described in this report is intended to inform the assessment of the environmental impacts of the disturbance of the Balmoral cuttings pile and was based upon the information available at the time the work was conducted, as well as a specific tool and plan for excavation. Care should be taken in using this modelling for other purposes.

2.2 Excavation of Cuttings Pile

The cuttings pile surrounding the Balmoral template has a total volume of 1,610 m^3 (3 significant figures (s.f.)) (Aurelia Environmental, 2019), with a mass of 3,860 te (3 s.f.) assuming a specific gravity of 2.4 te/m^3. After analysis of data provided by Premier (see Appendix A), it was calculated to have a composition of cuttings (89%), barite (7%) and bentonite (4%).

The excavation of the cuttings pile around the template is required for decommissioning and will be performed by the TRS2 tool—a-controlled flow excavator which will be operated by ROTECH SUBSEA—in vertical or horizontal jetting mode. Vertical means the jets will be directed towards the seabed and horizontal means the jet will be directed parallel to the seabed. The jetting will be completed in three phases and the quantities to be relocated in each phase of the model were estimates based on discussion with Rotech (Figure 2-2):

- Phase 1 – The TRS2 tool will be deployed directly above the template and will perform vertical jetting to remove the majority of the pile (70%). This will be modelled using 28 excavation locations;
- Phase 2 – The TRS2 tool will be deployed around the sides of the template on the seafloor and will perform horizontal jetting through the structure to allow access to the template. The seabed disturbance is included in the model for this phase. This will be modelled using 8 excavation locations; and
- Phase 3 – The TRS2 tool will be deployed within the template performing both vertical and horizontal jetting depending on requirements. This phase will disturb 10% of the cuttings pile and will be modelled using 8 excavation locations.

Rotech will inspect the template with an ROV after the cuttings have been cleaned and in the unlikely case that any cuttings remain on the template additional jetting will be conducted to remove these from the structure. It is not the intention of this project that any cuttings will remain on the structure to be deposited through the water column as the template is lifted to the sea surface.

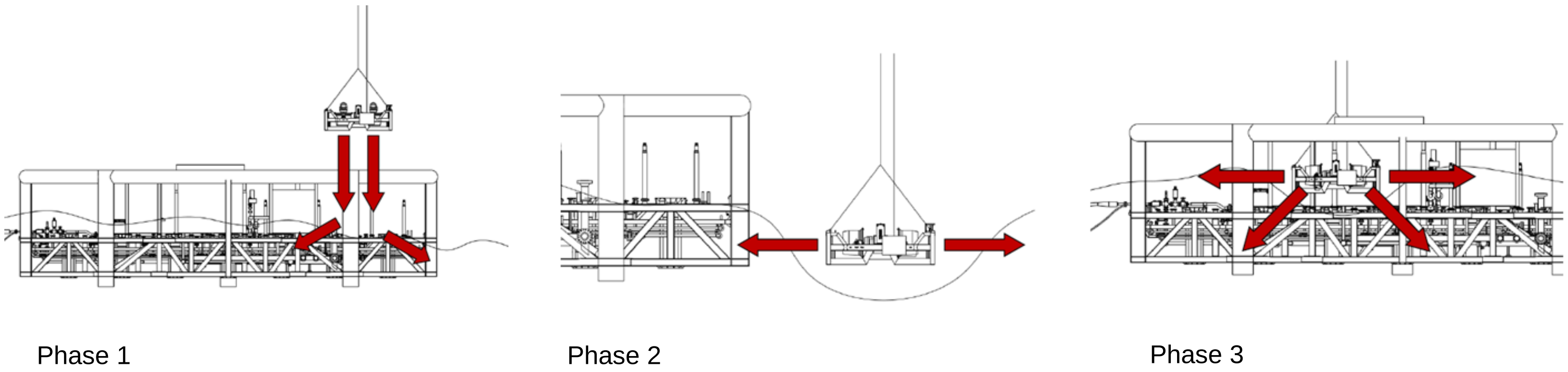

Figure 2-2 Phases of excavation of the cuttings pile in and around the Balmoral template (Rotech Subsea, 2019)

2.3 Modelled Parameters

2.3.1 Cuttings pile parameters

It was assumed, based on historical drilling information from Premier, that the vast majority of the cuttings pile is composed of cuttings (89%), barite (7%) and bentonite (4%) by volume (for further details, see Appendix A). The total mass of seabed discharged during phase 2 is based on an estimated volume of a trench encircling the template (based upon discussions with Rotech) (130 m long by 8.0 m wide by 1.5 m deep, i.e. 1,560 m^3) and assuming 1.6 Te/m^3 for the specific gravity[3].

Table 2.1 Cuttings pile summary*

	Phase 1	Phase 2	Phase 3
Excavation location in relation to template	Above	Around the edge, seabed	Within
Number of excavation locations	28	8	8
Proportion of cuttings pile to be disturbed (%)	70	20	10
Total mass of pile released (Te)	2,850	815	407
Total mass of cuttings released (Te)	2,400	688	344
Total mass of barite released (Te)	331	95.0	47.0
Total mass of bentonite released (Te)	113	32.0	16.0
Total mass of seabed released (Te)	0	2,500	0
Mass of cuttings released per location (Te)	86.0	86.0	43.0
Mass of barite released per location (Te)	11.8	11.8	5.92
Mass of bentonite released per location (Te)	4.03	4.03	2.01
Mass of seabed released per location (Te)	0	312	0

**rounded to three significant figures*

A total of 13 sampling locations were selected in a radial sampling pattern within the footprint of the Balmoral template (primarily dictated by accessibility around infrastructure) to investigate the chemical and physical composition of the cuttings material present in the pile. Two replicate core samples were collected from the surface 0-50cm layer of the pile at each of the designated sampling locations. The core samples from these locations were analysed for various contaminants (Aurelia Environmental, 2019). The concentrations of contaminants attached to particulates that could be released during cutting pile disturbance and any metal

[3] Core sample VC8 in ENI UK Ltd (2003) is the closest undisturbed seabed sample to the Balmoral template for which density data is available.

concentrations recorded within the pile that exceed Cefas action level 1[4] are presented in Table 2.2. Note that with the exception of the additional THC concentration from the seabed sediment redistributed during phase 2, the concentrations of contaminants are the same in each phase, and for simplicity, a mean value was used. It is these values that give the concentrations of contaminants that are “attached” to the three main components of the released material (cuttings, barite and bentonite).

It should also be noted that there are limitations to the core sample data, including:

> The cores were not long enough to reach all the way through the pile, so variation across the pile is not accounted for;

> Access issues and the template structure prevented sampling of all areas; and

> Limited samples were taken with no replicates.

Table 2.2 Contaminants released by disturbance (Aurelia Environmental, 2019)

Contaminant	Mean concentration in cuttings pile attached to particulates (mg/kg dry sediment)
Total hydrocarbons (THC)	2,550
Polycyclic aromatic hydrocarbons (PAH)	78.7
Nonylphenol	13.3
Polychlorinated biphenyls (PCB)	4.40×10^{-4}
Cadmium	1.04
Zinc	188

**rounded to three significant figures*

For Phase 2, an additional assumed total hydrocarbon (THC) concentration of 68.7 mg/kg was modelled to account for the seabed material released during this phase. This value was calculated based on the four closest core samples to the Balmoral template analysed for THC concentrations in Fugro (2019) as this would best represent the area to be impacted (Table 2.3). To calculate the concentration, it was also assumed that 1/15 is represented by the surface samples (i.e. top 10 cm), 2/15 is represented by the middle samples (i.e. 10-30 cm), and the rest is represented by the bottom samples (i.e. 30-150 cm – the bottom of the trench).

[4] Cefas action levels (Cefas, 1994) are widely used to determine the suitability of the disposal of dredged sediments at sea. Materials with concentrations of contaminants:
- below level 1 are of no concern and are unlikely to influence the licensing decision;
- between levels 1 and 2 - requires further consideration and testing before a decision can be made.
- above level 2 - generally considered unsuitable for sea disposal

Table 2.3 THC concentrations in seabed samples (Fugro, 2019)

Seabed	THC (mg/kg)
Location 1 (Surface)	1,020
Location 4 (Surface)	596
Location 7 (Surface)	300
Location 10 (Surface)	195
Mean surface (top 10 cm)	**528**
1/15 of mean surface	**35.2**
Location 1 (Middle)	316
Location 4 (Middle)	16.0
Location 7 (Middle)	255
Location 10 (Middle)	16.5
Mean middle (10 - 30 cm)	**151**
2/15 of mean middle	**20.1**
Location 1 (Bottom)	29.0
Location 4 (Bottom)	17.1
Location 7 (Bottom)	13.1
Location 10 (Bottom)	8.0
Mean of bottom (30 - 150 cm)	**16.8**
12/15 of mean bottom	**13.4**
Weighted mean seabed	**68.7**

2.3.2 Environmental parameters

Table 2.4 presents a summary of the environmental parameters used for this modelling study. The release location is the Balmoral subsea template.

Table 2.4 Environmental parameters summary

Parameter	Selection	Data source
Location (ED50 International Spheroid 1924)	01° 06' 31" E, 58° 31' 45" N	Fugro (2018)
Approximate depth to seabed (m)	135	DREAM bathymetry data[5]
Median initial seabed sediment grain size (mm)	0.35	Sample VC8, ENI UK Ltd (2003) [6]
Temperature (°C)	Air: 10	UK MetOffice[7]
	Sea surface: 14	MYOcean[8]
	Seabed: 8	
Salinity (‰)	35 (constant value)	DREAM default
Currents	Most quiescent month chosen from shelf hourly current data covering April 2011 – June 2014. For this location this was July 2012.	Supplied by Xodus to Oil & Gas UK for general use by members in OSCAR and DREAM modelling
Winds	European Centre for Medium Range Weather Forecasting dataset for the same time period as the current data	European Centre for Medium Range Weather Forecasting

Based on analysis of current speed and direction data, the modelling was performed using a start date of 1st July 2012 as it was identified as the most particularly quiescent period within the available input dataset (2011-2014). A quiescent period results in a greater rate of deposition due to minimal lateral movement and less kinetic energy so is therefore representative of a worst-case current period. The model was run for a period of 20-days to cover the jetting activities and subsequent resettlement of particulate materials.

2.3.3 Grid parameters

The model assigns portions of the discharge to model particles, the positions of which change over time in the model under the influence of currents, wind and gravity. These particles therefore have a range of properties associated with them that are assessed relative to a user defined model grid allowing the calculation of

[5] Bathymetry is defined by one or more gridded datasets, stored in a database within the model. This is taken from the Shelf Sea model available via the My Ocean website

[6] Core sample VC8 in ENI UK Ltd (2003) is the closest undisturbed seabed sample to the Balmoral template for which density data is available and is therefore representative of the surrounding area of the template. It should be noted that this value is high for this part of the North Sea.

[7] www.metoffice.gov.uk

[8] www.myocean.eu

thickness or concentration etc. This grid determines, along with the particle numbers, the resolution of the model output. A range of grid sizes are selected to provide the output required for different elements of the investigations being conducted. The three sizes used were:

- 50 km by 50 km with cell size of 100 m by 100 m - calculate water column effects (see Section 3.1);
- 20 km by 20 km with cell size of 20 m by 20 m - calculate wider seabed deposition patterns (see Section 3.2); and
- 2 km by 2 km with cell size of 10 m by 10 m - calculate local deposition patterns and the extent of the environmental risk to the seabed (see Section 3.2).

The grid size used does not affect where the material is deposited in the model, only the resolution of the outputs and the computational time. To minimise any approximation in assigning mass to particles, the number of particles modelled was set to 3,000.

To understand the water column effects and the seabed deposition patterns, a time step of 10 minutes was used. The time development of the risk (EIF) is calculated by the model by combining assumptions around biodegradation, bioturbation depths, oxygen profiles in the sediment, expected recovery times from burial, grain size change and changes in chemical and oil toxicity over time (see Section 2.1 for further details). It is important to remember that EIF values should not be compared between locations in absolute terms.

2.3.4 Parameterisation of the jet

The vendor assumes that the TRS2 tool (see Section 2.2 for further details) can clear sediment at a rate of approximately 0.25 m^3/s and has velocity contours as shown in Figure 2-3.

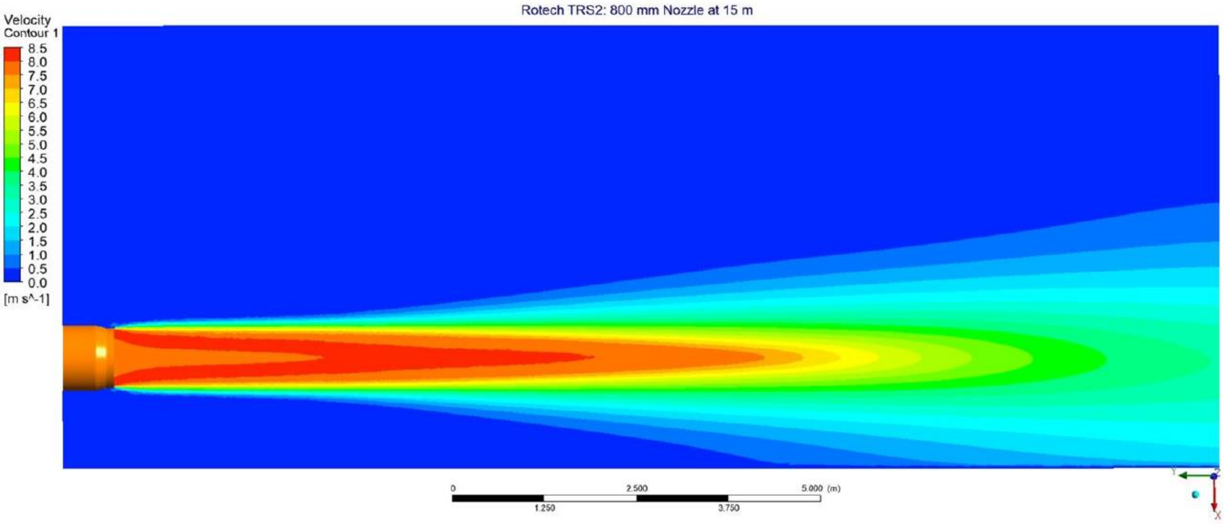

Figure 2-3 Rotech TRS2 800 mm Nozzle at 15 m

The natural shape of the jet is a fast-flowing core (up to 8.5 m/s) with slower moving edges. However, the simulation software does not allow a jet to be modelled with a velocity profile that varies across the cross-section of the output. To account for this and best represent the real world behaviour of the jet, three different profiles were developed (each of which matches the volumetric flowrate of the real jet) – a broad slow-moving jet, a medium width medium-speed jet and a narrow fast-moving jet. The three diameters of release to represent the different jets versions were 0.8 m, 0.4 m and 0.2 m (Table 2.5). As only one jet could be used in the definitive model, sensitivity testing was conducted to determine which of the jet scenarios resulted in the worst-case sediment risk calculations. The results are discussed in Section 3.

Table 2.5 Jet Parameters

Description	Velocity (m/s)	Cross-sectional area (m^2)	Diameter (m)
Broad, slow	0.5	0.5	0.8
Medium width, medium speed	2	0.13	0.4
Narrow, fast	8	0.03	0.2

In the definitive model, the movement of the jet was approximated by having a series of point source discharges for each phase of the cuttings removal that were activated sequentially. It should be noted that the template structure itself was not included in the model (this would only be possible in a computational fluid dynamic models) and that the intention of this model was to achieve an understanding of both the duration and extent of water column impact as well as the gross area of seabed over which an impact may be expected. This model is not intended to demonstrate that the ROTECH tool will clear all of the cuttings pile from the template or to exactly predict the deposition pattern of cuttings on the seabed. It is intended to use worst case assumptions about the tool (e.g. jet selection) to illustrate a worst-case impact of the relocation of the cuttings.

3 RESULTS

The three model runs used for sensitivity testing are described in Table 2.5. The EIF calculated by the model shows that there was minimal difference between the jet scenarios. The results presented here identify that the jet with the worst-case sediment risk calculations was from the narrow fast jet (Table 3.1). The results in the rest of this section are based on this type of jet.

Table 3.1 Maximum seabed EIF from each jet scenario during sensitivity testing

Description of jet scenario (using parameters from Table 2.5)	Maximum seabed risk (EIF value)
Narrow, fast	4.44
Medium width, medium speed	4.20
Broad, slow	4.04

3.1 Water Column

The plume of resuspended chemicals and particles, including oil, is predicted to move north west in the direction of the ambient current. The maximum total concentration of contaminants is approximately 8 ppm which occurs 2 hours (i.e. the second timestep) after the disturbance of the cuttings pile begins. After this, the concentration continues to decrease until the end of the model run (20 days after resuspension). After 14 hours the concentration within the plume is consistently below 1 ppm and after 2 days below 0.1 ppm.

3.1.1 Risk to the Water Column

Figure 3-1 presents a time series of maps showing the predicted water column risk from the resuspended material over the duration of the modelling as well as a map showing the maximum risk which occurs in each cell over the 20 days. As described in Section 2.1, a risk greater than 5% results in potential adverse effects. These figures show that the extent of water impacted at greater than 5% is variable and transient due to the varying currents and changing composition of the material. The risk to the water column remains within approximately 32 km of the template. Figure 3-2 presents a cross-section through the water column along a transect, roughly south east – north west. The risk is predicted to move with the plume to the north west and will not reach the surface, remaining below approximately 105 m depth.

The detailed time development of the water column risk as described by the EIF values are presented in Figure 3-3 and Figure 3-4. These figures show that from the input data, the largest contributor to the EIF is barite (41%) followed by bentonite (37%) and acenaphthene attached to cuttings (13%). Other contributors to the EIF include nonylphenol attached to cuttings (3%), acenaphthene attached to barite (2%) and dispersed oil attached to cuttings (2%).

The maximum EIF is 13,444 and occurs at day 3 hour 12 (see section 2.1 for further details on how EIF is calculated). After 7 days and 20 hours from the beginning of operations, all water column risk greater than 5% had dissipated. It should be considered that the potential impact will be dependent on a number of factors including the current status of the environment, the species present in the area, their sensitivity to changes in contaminant levels or the potential for recovery. Any impacts are discussed fully in the Balmoral EA (Xodus, 2020).

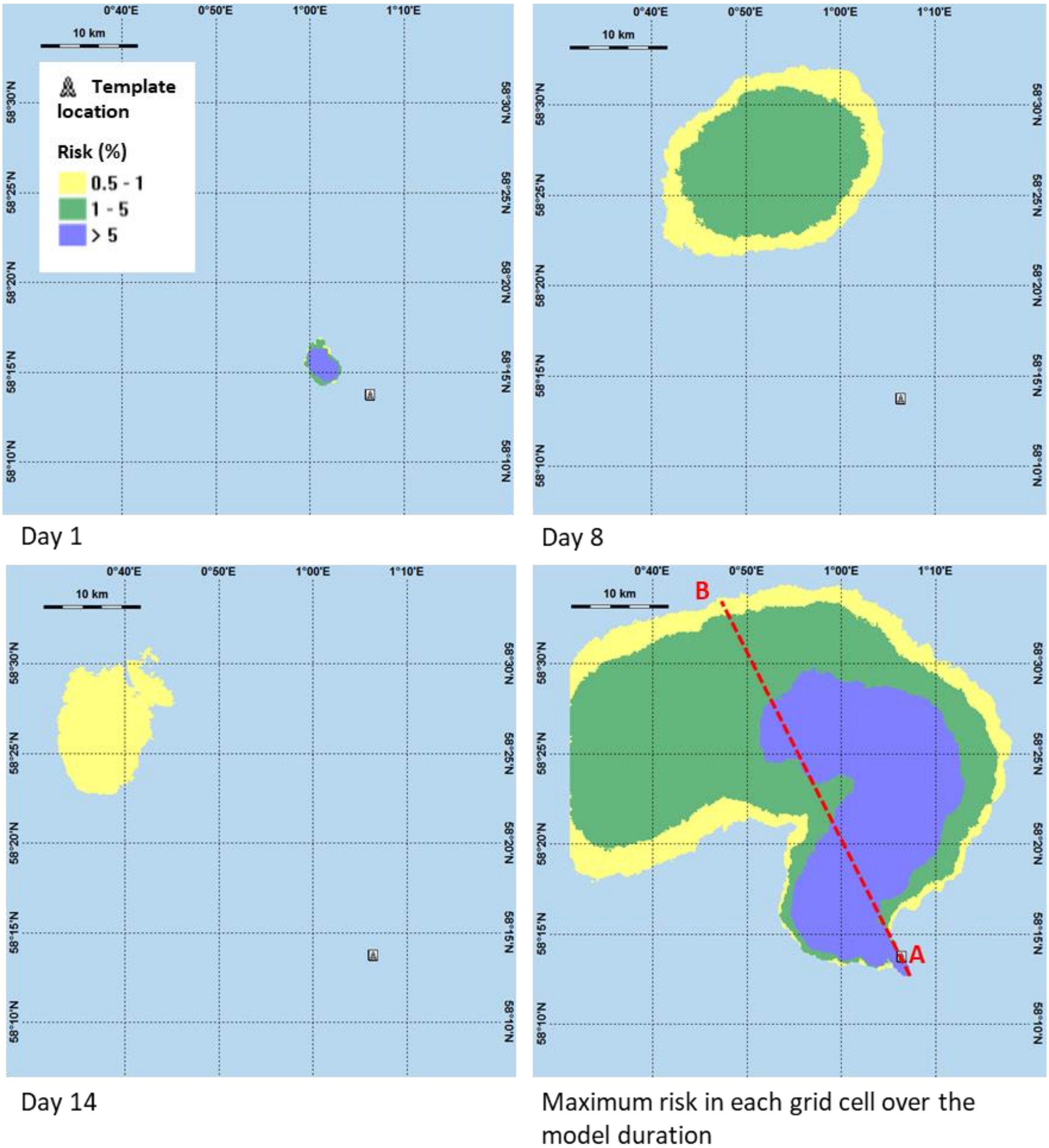

Figure 3-1 **Water column impact. Day 8 shows there is no risk greater than 5%. Day 14 shows there is no risk greater than 1% risk**

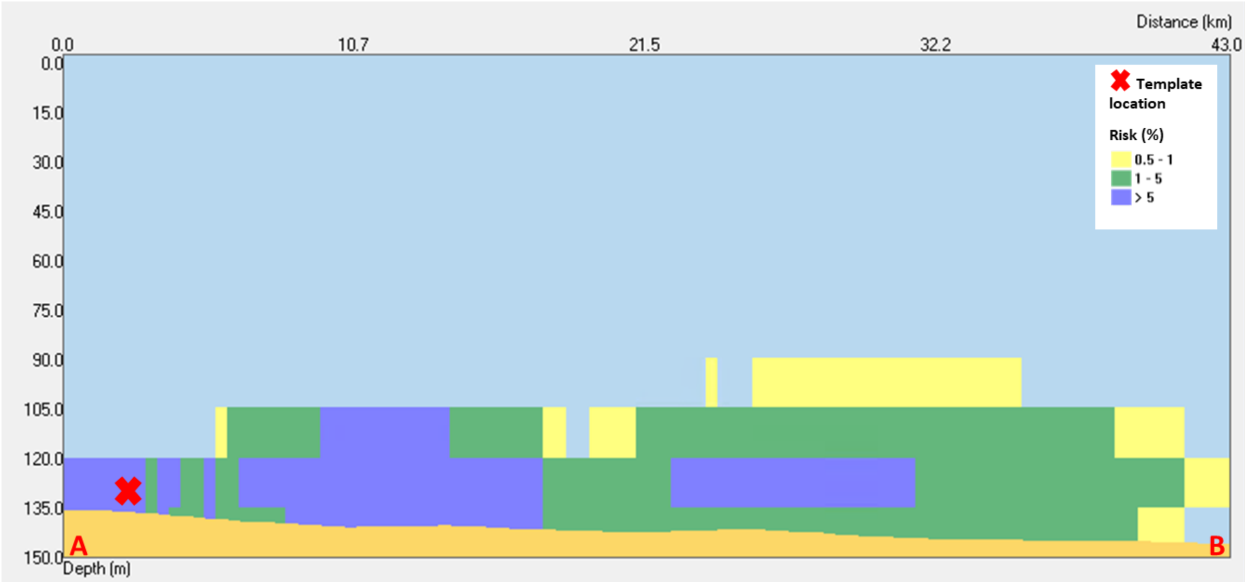

Figure 3-2 Water column impact along transect A-B. Note: this is taken from the maximum risk in each grid cell that occurs over the model duration.

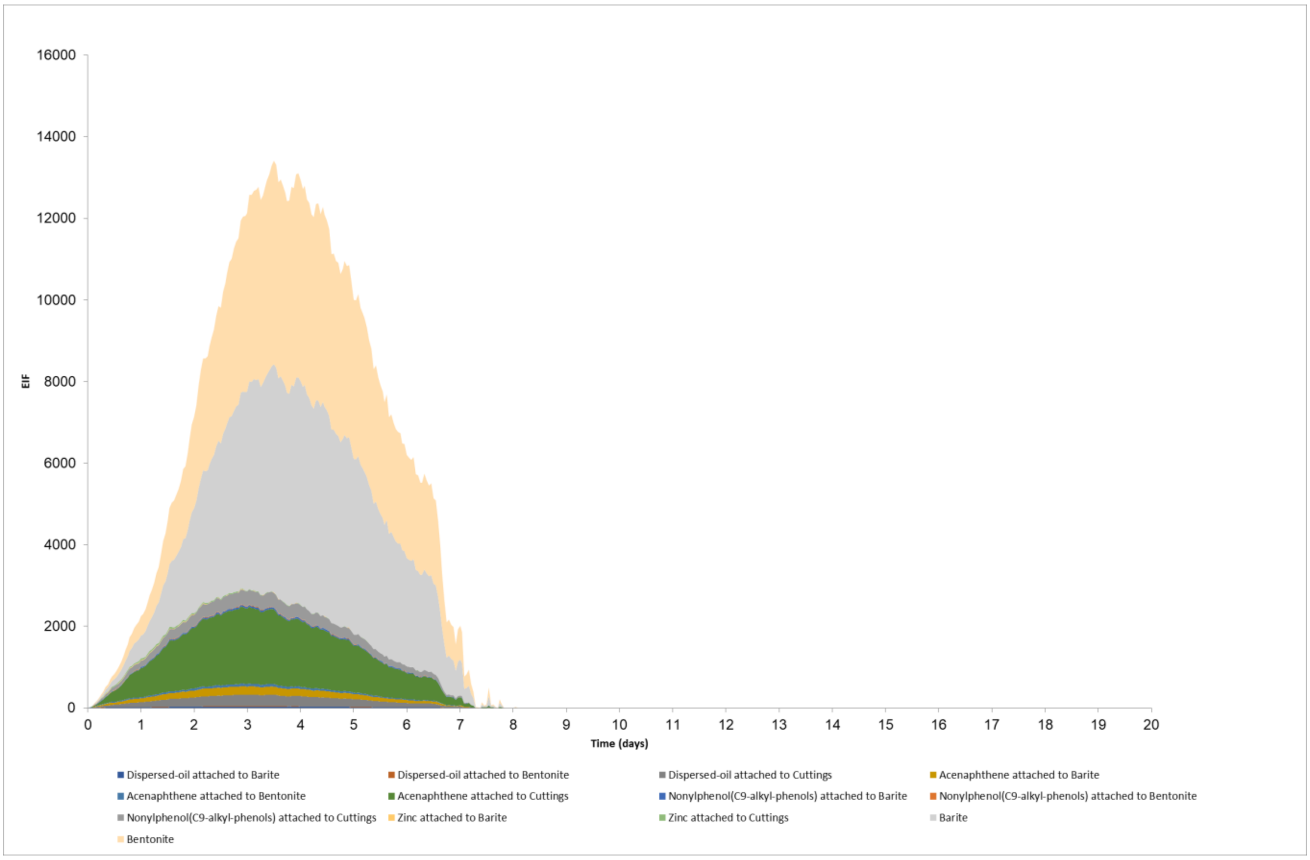

Figure 3-3 Development to the water column impact (EIF)

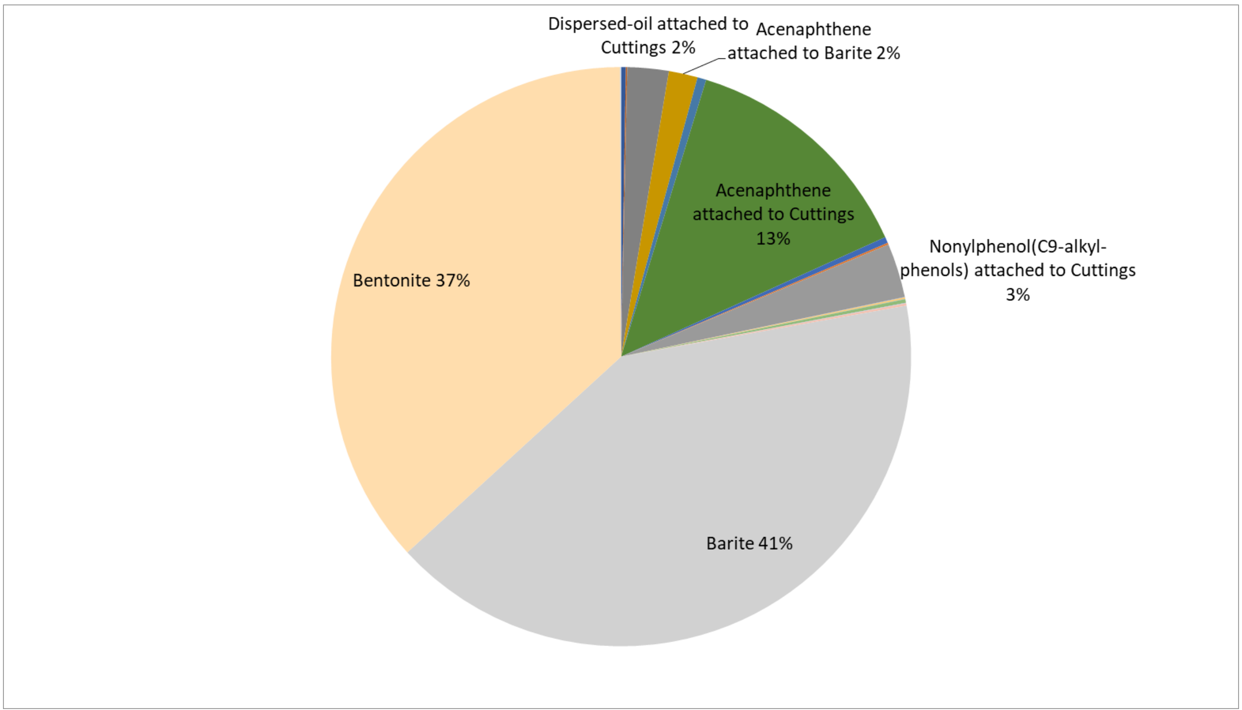

Figure 3-4 Contribution to the maximum risk

3.2 Seabed

3.2.1 Deposited Material

Using a grid size of 20 km by 20 km with cell size of 20 m by 20 m, material is predicted to be redeposited on the seabed in an overall north westerly direction from the Balmoral template, with the more heavily deposited areas to the south of the template (Figure 3-5). Deposition close to the resuspension location occurs immediately after the disturbance and after 1 hour the maximum thickness is 0.5 m over 400 m^2. After 4 hours the maximum thickness reaches 1.2 m over 800 m^2 within the immediate vicinity of the template and remains at this thickness and area for the remainder of the model. The model was run for 20 days and locations further afield receive resuspended material after a longer period of time. The thickness of deposited material is predicted to rapidly decrease as the distance from the template increases such that, within approximately 1 km the deposited material thickness has decreased to less than 10 mm and within approximately 3 km it has decreased to less than 1 mm. However, it should be noted that the deposition is patchy and that the thickness is not uniform at these distances all around the template. For the impact assessment of benthic species, refer to the Balmoral EA (Xodus, 2020). It should be noted that the seabed deposition predicted is based on conservative assumptions regarding the ROTECH tool and that the actual template structure was not included in this model. The use of the model in this context is therefore intended to provide information on the potential worst-case impact possible for the relocation of the cuttings pile and not to accurately predict the cuttings deposition to be expected when the tool is used. It should also be noted that ROTECH may conduct additional jetting if the template is not found to be cleared of cuttings after phase 3; this modelling assumes all cuttings and seabed material in the peripheral trench will be moved within the 3 phases.

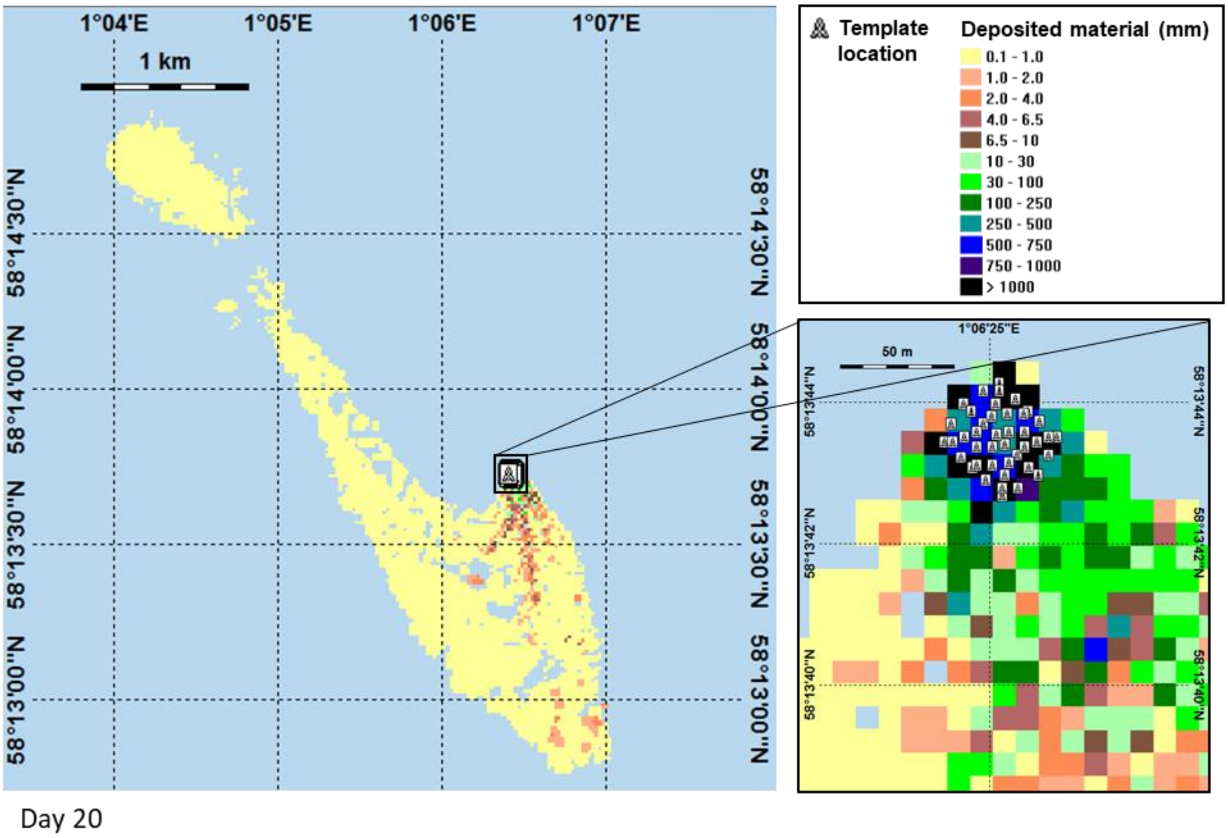

Figure 3-5 Deposited material on the seabed at 20 days after disturbance

3.2.2 Risk to the Sediment

Figure 3-6 presents a map showing that the predicted sediment risk from the resuspended material over the duration of the modelling is within the immediate vicinity of the template. The EIF reaches a maximum value of 0.48 after 4 hours where it remains at this value for the next 20 days (the model duration). This very small value reflects the high-resolution of the grid used in this model and it should be noted that an EIF of 1 is equivalent to an impact of 5% of species present in an area of 100 m by 100 m. It should be considered that the potential impact will be dependent on a number of factors including the current status of the environment, the species present in the area, their sensitivity to smothering or contaminants or the potential for recovery.

The detailed time development of the seabed risk as described by the EIF values are presented in Figure 3-7 and Figure 3-8. These figures show that dispersed oil attached to cuttings, nonylphenol attached to cuttings and acenaphthene attached to cuttings have equal contribution to the EIF (30%), followed by dispersed oil (10%).

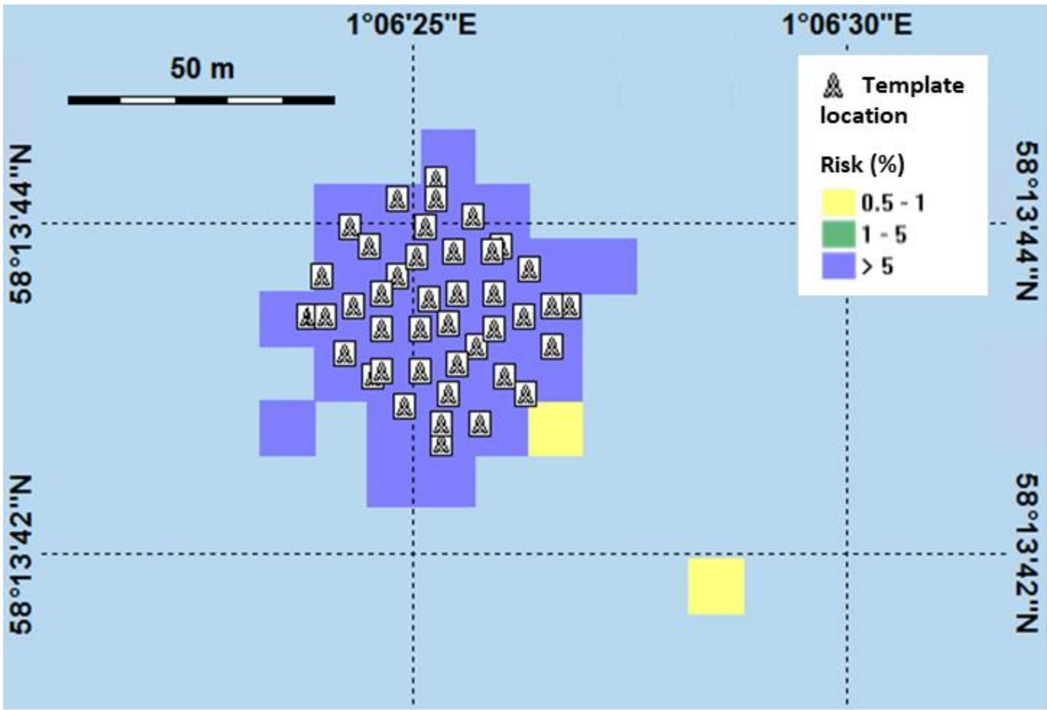

Figure 3-6 Seabed impact after 4 hours

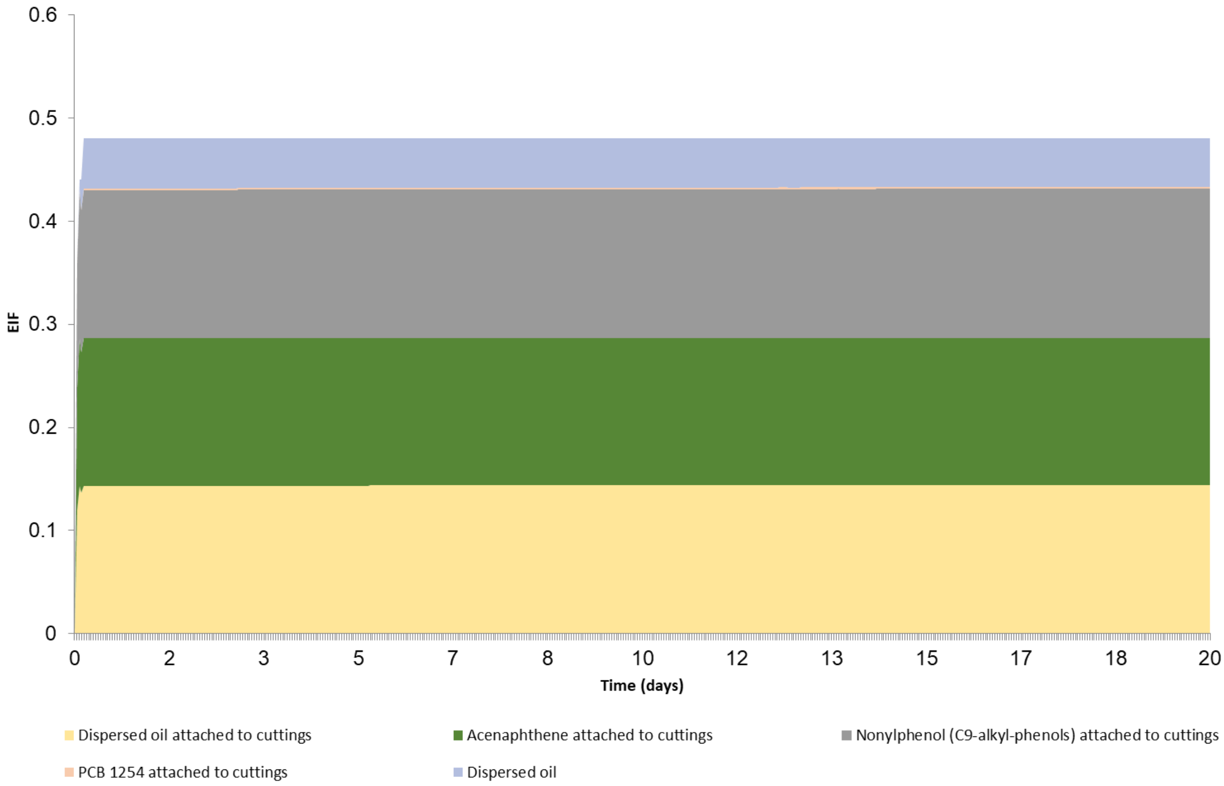

Figure 3-7 Development of the seabed impact (EIF)

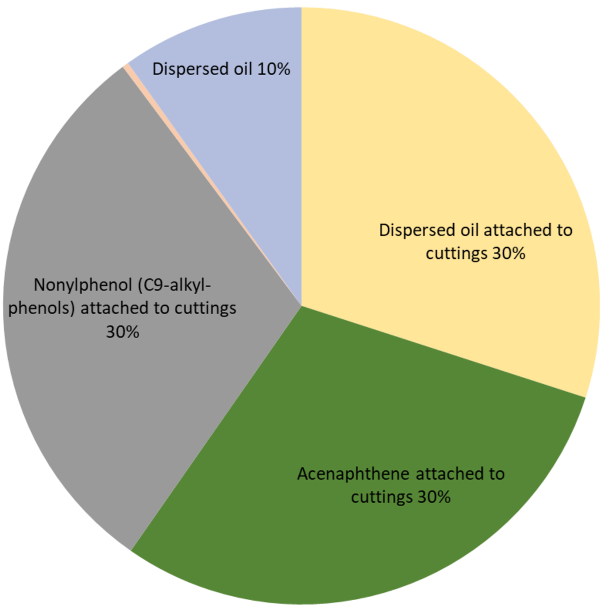

Figure 3-8 Contribution breakdown for the maximum EIF

4 CONCLUSIONS

In order to decommission the Balmoral template, it will be necessary to disturb the cuttings pile within the template using the TRS2 tool in vertical and horizontal jetting mode. EIFs were used to predict unacceptable effect on the environment, where the risk of adverse effects is more than 5%. However, it should be noted that the absolute value of the EIF is not meaningful and should only be used as one source of information to assist in developing an impact assessment.

Modelling the dispersion of disturbed seabed and cuttings predicts that a small plume of particulate and dissolved material will travel in a north westerly direction near the seabed. The main contributor to the impact on the water column is particle stress caused by barite (41%) and Bentonite (37%). After 7 days and 20 hours from the initial disturbance, the risk to the water column was less than 5% and therefore no longer an unacceptable effect on the environment. This suggests that there is no long-term impact predicted on the water column due to the resuspension and settlement of sediment from the cuttings piles during the decommissioning of the Balmoral template. This type of transient, spatially varying, short duration impact primarily resulting from particle stress in the water column is typical of the modelling predictions made for drilling discharges and cuttings relocation models.

After 4 hours, the maximum thickness reaches 1.2 m over 800 m^2 within the immediate vicinity of the template. The maximum thickness of redeposited material (1.2 m) was predicted to occur at the Balmoral template, although it rapidly decreases with distance from the template such that, within approximately 1 km the deposited material thickness has decreased to less than 10 mm and within approximately 3 km it has decreased to less than 1 mm. The risk to the seabed remains above 5% for the duration of the model with the EIF remaining at the same value from 4 hours to 20 days, with dispersed oil attached to cuttings, nonylphenol attached to cuttings and acenaphthene attached to cuttings contributing the most to the impact. This suggests that there is potential for a long-term impact from the decommissioning of the Balmoral template. The limited spatial extent and low EIF value (less than 1) are likely to rapidly reduce over relatively short periods of time both from the biodegradation of the oil components (reducing sediment toxicity and from oxygen levels returning to normal once biodegradation has ceased), bioturbation of the seabed (causing mixing and oxygenation of the upper layers) and natural deposition of new sediment (diluting the cuttings on the seabed). However, all modelled impacts are dependent on the current status of the environment, the particular species present in the area, their sensitivity to smothering or contaminants or the potential for recovery. Also, it should be noted that the simulation software does not allow a jet with a velocity profile that varies across the cross-section of the output to be modelled and the model reported here is based on conservative assumptions to determine a worst-case impact to the benthic environment. Whilst this model does not account for the complexity of flow around the template structure or the true nature of the jet, the results produced align with the expectation that the ROTECH tool will deposit the cuttings pile material in a relatively thin uniform layer around the template. In addition, the predicted impacts from the cuttings pile all arise from the toxicity of the components of the pile and not from any physical impacts (smothering, grain size chain, oxygen depletion). As the ROTECH tool is expected to perform at least as well in reality as predicted in this modelling then it is likely that the only seabed impact will be the limited toxicity from the chemical associated with the OBM components in the pile.

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APPENDIX A

Data for the Balmoral B3 well was provided via email by Bill Cruickshank via Pieter voor de Poorte (10/7/19), both at Premier.

RE_ _EXTERNAL_
FW_ Barite Bentonit

The information in the tables below has been simply reformatted for presentation in this report, except for where it has been clearly noted that Xodus performed some calculations.

Section	Size (in)	Top (ft)	Bottom (ft)	Length (ft)	Volume cuttings (bbls)	Volume cuttings (m3)
1	36	560	767	207	260.61	41.43
2	22	767	1010	243	114.25	18.16
3	14.75	1010	4238	3228	682.22	108.46
4	9.625	4238	9378	5140	462.56	73.54
5	6.5	9378	9850	472	19.37	3.08
Total released to environment					1,540	245

Section	Mud	Weight (ppg)	Total Mud made (bbls)	Total Mud lost (bbls)	Mud Backloaded (bbls)	Bentonite Used (MT)	Barite Used (MT)	Notes
1	Seawater Sweeps							Displaced to mud at end drilling
2	Seawater Sweeps	8.8	1,227	1,227		26.7		
3	Enviromul	9.1 - 9.4						76% of mud made lost to environment.
4	Enviromul	9.1 - 9.6	4,553	3,464	1,089		116.4	
5	Polymer Dextride	9.1	1,754	266				No weighting agent
Total released to environment						26.7	88.5	

	Cuttings	Bentonite	Barite	Total
Volume (m^3)	245	10.7	19.7	275
Mass (te)	612	26.7	88.5	727
SG	2.5	2.5	4.5	-
Proportion by volume*	0.89	0.04	0.07	-
Proportion by mass*	0.84	0.04	0.12	-

*Calculated by Xodus

This proportion of cuttings, bentonite and barite released into the environment and forming a cuttings pile are in line with the proportions used for cuttings pile redistribution/disturbance modelling during decommissioning for the Dunlin, Beatrice, Auk, Fulmar and Murchison cuttings pile modelling by Xodus and other organisations.