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Merlin Subsea Decommissioning Environmental Statement

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Contents

Acronyms

%	Percent
£	Pound sterling
°	Degrees
°C	Degrees Celsius
µm	Micrometre
$\mu g g^{-1}$	microgram per gram
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
BEIS	Department for Business, Energy and Industrial Strategy
BODC	British Oceanographic Data Centre
CA	Comparative Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Coordinated Environmental Monitoring Programme
CH_4	Methane
cm	Centimetre
CO_2	Carbon Dioxide
CPR	Continuous Plankton Reader
dB re 1 µP @ 1 m	Decibel relative to one micropascal measured at 1 m from the source
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DNV	Det Norske Veritas
DSV	Dive Support Vessel
DTI	Department of Trade and Industry
EC	European Community
EIA	Environmental Impact Assessment
EBS	Environmental Baseline Survey
EMS	Environmental Management System
ENVID	Environmental Issues Identification
EPS	European Protected Species
ERL	Effects Range Low
ES	Environmental Statement
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EUNIS	European Nature Information System
FEL	Fairfield Energy Limited
FLTC	Fisheries Offshore Oil and Gas Legacy Trust Fund
FOCI	Features of Conservation Importance
FRS	Fisheries Research Services

GHG	Greenhouse Gas
HRA	Habitats Regulations Assessment
HSE	Health and Safety Executive
ICES	International Council for the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IMO	International Maritime Organisation
IOGP	The International Association of Oil and Gas Producers
IP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kg	Kilogram
km	Kilometre
km/h	Kilometres per hour
km^2	Square kilometre
LTOBM	Low Toxicity Oil Based Fluid
m	Metre
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre
MarLIN	Marine Life Information Network
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MDC	Merlin Drill Centre
mg	Milligram
MMO	The Marine Management Organisation
MPA	Marine Protected Area
m/s	Metres per second
NCMPA	Nature Conservation Marine Protected Area
NFFO	National Federation of Fishermen's Organisations
NIFPO	Northern Ireland Federation of Fishermen's Organisations
NLGP	Northern Leg Gas Pipeline
Nm	Nautical mile
NMFS	National Marine Fisheries Service
NMPI	National Marine Plan Interactive
NO_2	Nitrogen Dioxide
NORBRIT	Norway-UK Joint Contingency Plan

NORM	Naturally Occurring 1993 Material
NOx	Nitrogen Oxide
O_3	Ozone
OGA	UK Oil and Gas Authority
OGUK	Oil and Gas UK
OSCAR	Oil Spill Contingency and Response
OSPAR	Oslo Paris Convention
PAH	Polycyclic Aromatic Hydrocarbons
PL	Pipeline
PLONOR	Poses Little Or No Risk
PMF	Priority Marine Feature
PPC	Pollution Prevention and Control
ppm	Parts per million
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SEL	Sound Exposure Level
SCI	Site of Community Importance
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SFF	Scottish Fishermen's Federation
SIMOP	Simultaneous operations
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SO_2	Sulphur Dioxide
SOPEP	Shipboard Oil Pollution Emergency Plans
SO_X	Sulphur Oxide
SPA	Special Protection Area
SPL	Sound Pressure Level
THC	Total Hydrocarbon Content
TOC	Total Organic Content
TOM	Total Organic Matter
TTS	Temporary Threshold Shift
UK	United Kingdom
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
UNESCO	United Nations Educational, Scientific and Cultural Organization

US CEQ	United States Council on Environmental Quality
WBM	Water-based Mud
WHS	World Heritage Site
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds

Non-Technical Summary

Introduction

Fairfield is the operator of the Dunlin, Merlin and Osprey fields (the ‘Greater Dunlin Area’), located in United Kingdom (UK) Continental Shelf Block 211/23 of the northern North Sea. Infrastructure associated with Dunlin, Merlin and Osprey is currently being prepared for decommissioning. The Merlin field lies approximately 132 km from the nearest landfall point, 192 km north east of Lerwick and 18 km west of the UK/Norway boundary. The Merlin field is a subsea tie-back to the Dunlin Alpha platform, located 7 km to the west-north west of the Dunlin Alpha platform (Figure 1). The Osprey field is a subsea tie-back located 6 km to the north-north west of the Dunlin Alpha platform. Production at the fields ceased in June 2015 and Fairfield now intends to decommission the Merlin subsea infrastructure as part of a wider programme to decommission all subsea infrastructure associated with the Greater Dunlin Area (the ‘Subsea Infrastructure Decommissioning Project’). The decommissioning of the Dunlin Alpha platform will be considered separately from the subsea activities at a later date. This Non-Technical Summary provides an overview of the Environmental Statement that has been prepared specifically for the proposed decommissioning of the Merlin field. The Osprey and Dunlin (subsea and platform) infrastructure will be the subject of separate Environmental Statements.

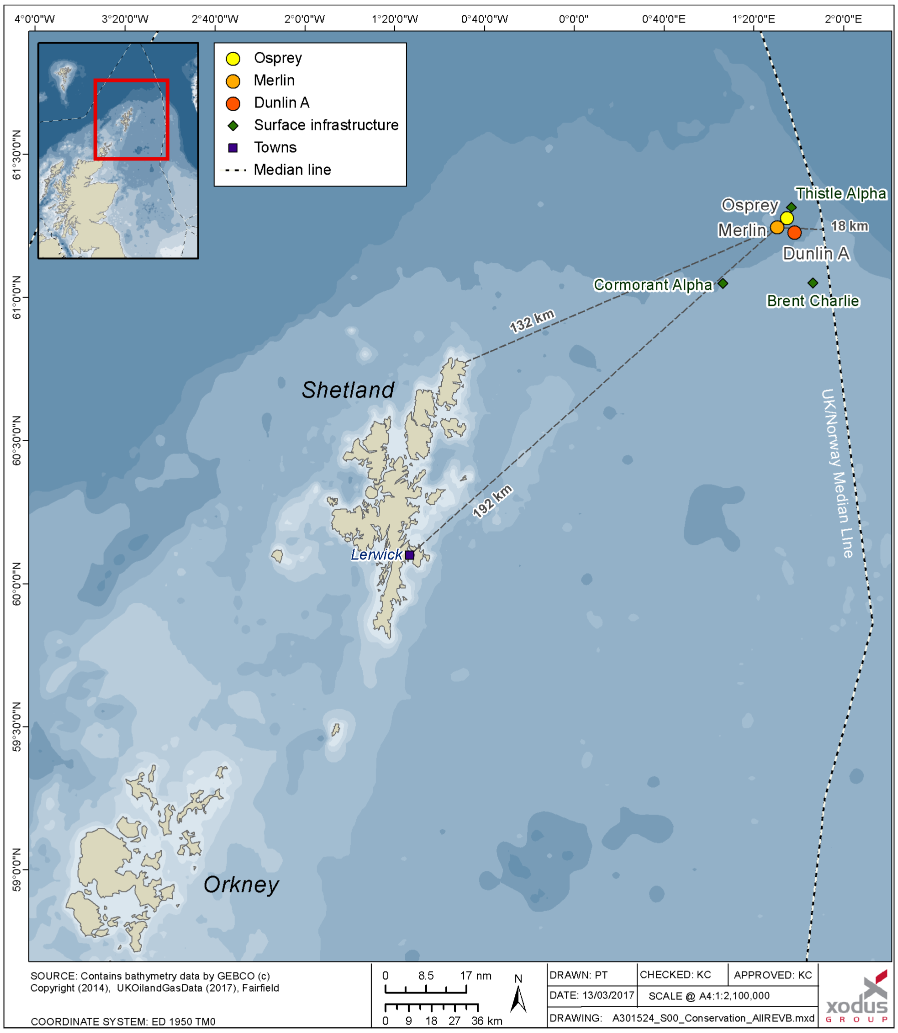


Figure 1 Location of Dunlin, Merlin and Osprey fields

The Merlin field comprises three production wells in a 'daisy-chain' arrangement (i.e. the first is linked to the second, which is linked to the third, which is linked to the production system) linked by a pipeline that previously carried hydrocarbons to the Osprey production system approximately 100 m from the Dunlin Alpha platform. There is also one water injection well at the Merlin field, which was used to inject water to maintain the pressure in the hydrocarbon reservoir, which helped keep hydrocarbons flowing from the wells. This water injection well is linked to the Osprey water injection system. A schematic of the field layout is shown in Figure 2.

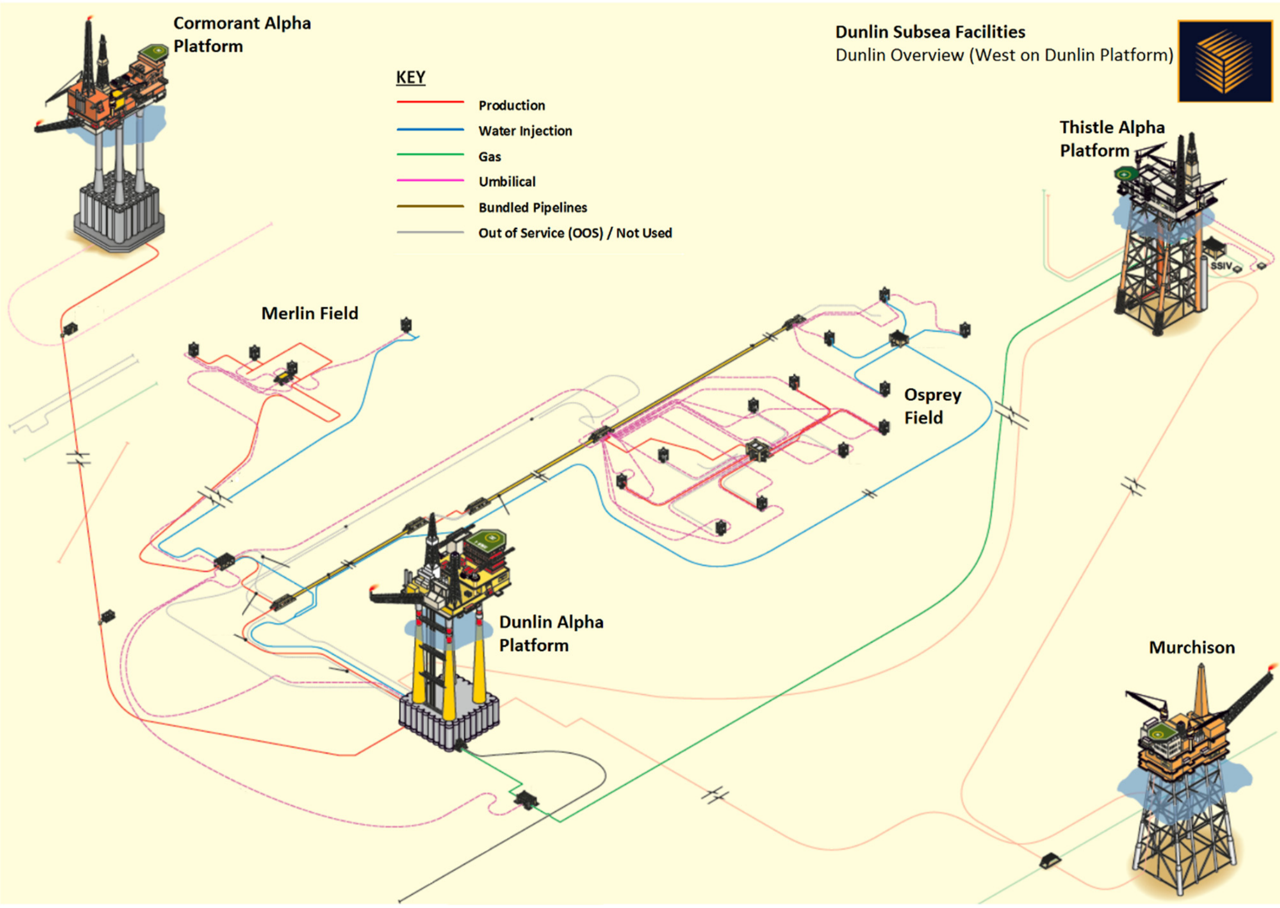


Figure 2 Merlin field infrastructure in the context of the wider area

Options for Decommissioning the Subsea Infrastructure

Following the end of production from Merlin in June 2015, options to re-use the infrastructure *in situ* for future hydrocarbon developments have been considered, but to date none have yielded a viable commercial opportunity. There are a number of reasons for this, including the absence of remaining hydrocarbon reserves in the vicinity of the Merlin subsea infrastructure, and the limited remaining design life of the Merlin subsea infrastructure (in terms of moving hydrocarbons, the Merlin system was calculated to be at the end of its functional life in 2015). It is now considered unlikely that any opportunity to reuse the pipelines and associated infrastructure will be feasible. As such, there is no reason to delay decommissioning of the Merlin field in a way that is safe and environmentally and socio-economically acceptable.

In line with the latest Department for Business, Energy and Industrial Strategy guidelines on decommissioning, Fairfield has committed to fully removing a number of structures from the Merlin subsea area; these structures are detailed in the Project Description below and in the following list:

- Surface-laid infrastructure:
    - Rigid spools (a spool is a connecting line between structures and lines);
    - Flexible jumpers (a jumper is like a spool); and
    - Umbilicals (an umbilical is a line that provides control and power to remote subsea infrastructure).
- Pipeline and umbilical components and structures; and
- Stabilisation material (deposits such as concrete mattresses, but not including rockdump).

For the remaining infrastructure, where the option to remove is not obviously the best option, Fairfield has followed the Department for Business, Energy and Industrial Strategy guidelines and undertaken a formal process called 'Comparative Assessment'. The Comparative Assessment process allows for the development of a preferred decommissioning methodology for infrastructure, based on consideration of safety risk, environmental impact, technical feasibility, societal impacts and economic factors. For the Merlin Subsea Infrastructure Decommissioning Project, Comparative Assessment was undertaken on the three infrastructure types in Table 1, with the selected options highlighted green.

To compare each option against the others to make a decision, Fairfield utilised a Multi Criteria Decision Analysis tool. This tool allows an assembled team to review the available data for each option and determine, using terms such as 'neutral', 'stronger', 'much stronger' (and so on), how each option compares to the other. This comparison was undertaken using the five criteria described in the Department for Business, Energy and Industrial Strategy Guidelines of safety, environmental, technical, societal and economic. The decision outcomes of the Comparative Assessment process, supported by an appropriate amount of specialist study work, are summarised in Table 1.

Table 1 Merlin subsea infrastructure subject to the Comparative Assessment process

Decision	Infrastructure Type - Description	Option 1	Option 2	Option 3
1	Trenched and rockdumped pipelines and umbilicals	Remove the ends, rockdump the cut ends and any areas that are not sufficiently buried.	Cut and remove the ends and any other areas that are not sufficiently buried. Place rockdump on all the cut ends of the line.	Remove the ends, dig the pipelines and umbilicals into the seabed and rockdump the ends.
2	Trenched and buried pipelines	Remove the ends, rockdump the cut ends and any areas that are not sufficiently buried.	Cut and remove the ends and any other areas that are not sufficiently buried. Place rockdump on all the cut ends of the line.	Full removal by winding the pipeline onto the back of a vessel (called 'reverse reeling').
3	Umbilical riser (a riser is a conduit between the seafloor and platform)	Cut the part of the riser that sits on the seabed and recover to a vessel. The remainder of the riser will be left in place within the Dunlin Alpha platform.	Cut the part of the riser that sits on the seabed and recover to a vessel. The remainder of the riser within the Dunlin Alpha platform will be pulled onto the top of the platform.	-

Given the above, it is proposed that the only infrastructure that will not be recovered during decommissioning will be the already trenched and rockdumped pipelines and umbilicals (as the seabed section of the umbilical riser will be removed and the remainder decommissioned within the Dunlin Alpha platform). Full details on how the infrastructure will be decommissioned are given in the Project Description below.

Project Description

Fairfield anticipates executing the Merlin Subsea Infrastructure Decommissioning Project activities in 2018/2019. An indicative schedule for the work is shown in Figure 3. However, the specific timing of decommissioning activities will be agreed with the Department for Business, Energy and Industrial Strategy and with the Health and Safety Executive. Applications for all relevant permits and consents will be submitted and approval sought prior to activities taking place.

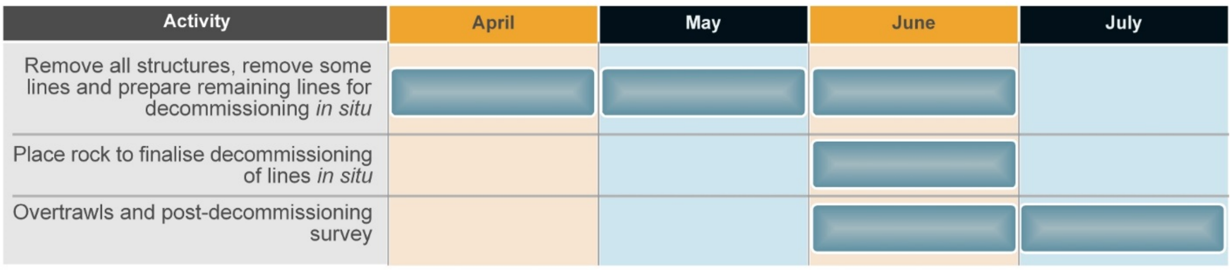


Figure 3 Indicative schedule 2018/2019

A subsea contractor (or multiple contractors) will mobilise a fleet comprising vessels with a range of crane capabilities for lifting objects of different sizes and weights off the seabed, vessels that can support underwater operations (including use of a Remotely Operated Vehicle, diving, cutting, excavation and rock placement) and survey vessels. The vessels' cranes will lift any disconnected/cut subsea infrastructure onboard and then transport it to an onshore dismantling site. Vessel types and the estimated days they are required during the decommissioning of Merlin are detailed in Table 2. Fairfield does not expect to need a guard vessel to be on site during the decommissioning activities, but it is possible that one would be required in the event of any schedule over-runs.

Table 2 Estimated requirement for vessel types and days

Vessel type	Approximate number of days		
	Mobilisation/demobilisation	In transit	In the field
Dive support vessel	6	13	63
Rockdump vessel	2	2	<1
Trawler	1	2	2
Survey vessel	22	23	14
Total	**31**	**40**	**80**

Taking into account both the requirement to fully remove many of the subsea structures and the outcome of the Comparative Assessment process, which determined some infrastructure should remain *in situ*, Fairfield has developed a 'campaign approach' to the Merlin decommissioning activities. This campaign approach means that Fairfield has considered how best to deploy vessels in the field to make best use of time, whilst helping to keep the vessel requirement to a minimum. Weather permitting, Fairfield intends to complete the activities in the spring and summer months, as described in Figure 3. Table 3 details the decommissioning activities to be carried out for the different infrastructure in the Merlin field, including a description of the vessels and methodology.

Table 3 Description of decommissioning activities for the Merlin subsea infrastructure

Infrastructure	Decommissioning approach	Method
Trenched and rockdumped pipelines and umbilicals	These two lines will be decommissioned by removing the ends and placing local rockdump at the cut ends and areas of low burial depth.	A dive support vessel and rockdump vessel will be mobilised to undertake these operations. Dredging will be undertaken around the ends of the lines before the pipeline and umbilical ends are cut and recovered to the vessel. A rockdump vessel will then be mobilised to provide remedial rockdump at the ends and spans/exposures, by way of a flexible fall pipe (Figure 4 shows an example of this occurring).
Trenched and buried pipeline	This line will be fully removed using a reverse reeling technique; this method involves winding the flexible pipeline onto the back of the vessel (an example is shown in Figure 5).	A dive support vessel will be mobilised to carry out this operation. The pipeline will be disconnected at each end, a recovery head will be attached to the pipeline (this tool allows a firm hold to be made on the pipeline), and then the reverse reeling will be initiated.

Infrastructure	Decommissioning approach	Method
Umbilical riser	This will be decommissioned by cutting and recovering the seabed section of the riser; the section within the Dunlin Alpha 'J-tube' (the conduit to the top of the platform) will remain *in situ*.	A dive support vessel will be mobilised to carry out this operation. The seal at the end of the J-tube will be removed, a cut made in the umbilical, and the J-tube will be re-sealed again. Recovery rigging will be attached to the riser to allow a firm hold on the umbilical to be made and it will be recovered to the vessel.
Surface-laid pipeline and umbilical components and structures	All of these components are to be fully removed and recovered to shore.	A dive support vessel will be mobilised to carry out these operations. Structures will be lifted directly to the vessel or placed in baskets that are then lifted to the vessel (an example of such a basket is shown in Figure 6).
Stabilisation material (note that this does not include rockdump)	Concrete mattresses and sand and grout bag deposits to be fully removed from the seabed at Merlin. Trawlboard deflectors (shown in Figure 7) located around the Merlin drill centre, which were installed to protect the wells from fishing activity, will also be recovered.	A dive support vessel will be mobilised to carry out these operations. Lifting gear that will allow multiple mattresses to be recovered to the vessel in one lift will be used (shown in Figure 8). Grout and sand bags will be removed into baskets that will then be recovered to the vessel. Trawlboard deflectors will be inspected and cleaned at the lift points, recovery rigging will be attached and they will then be recovered to the vessel. All stabilisation material is currently freely accessible, or will be accessible at the time that the infrastructure it protects is recovered. In the event of practical difficulties with these removals, BEIS will be consulted and a Comparative Assessment submitted as appropriate.

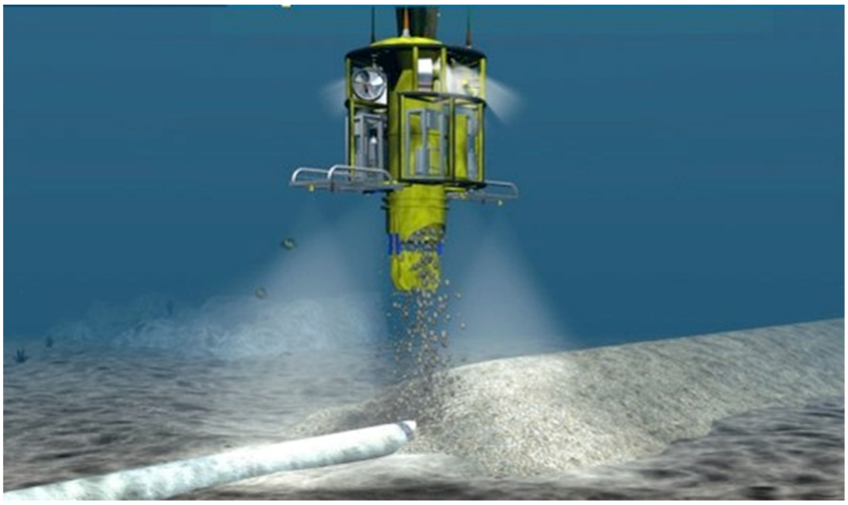


Figure 4 Illustration of a flexible fall pipe being used to deploy rock (system shown from Offshore Fleet)

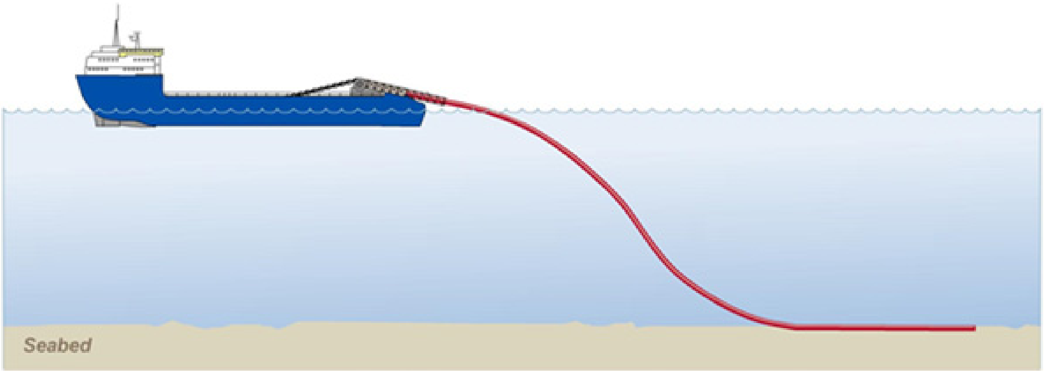


Figure 5 Illustration of a pipeline being recovered to a vessel in a process called 'reverse reeling'

Figure 6 Illustration of a basket used to collect subsea materials (system shown from WeSubsea)

Figure 7 Image showing two trawlboard deflectors at Merlin

Figure 8 Illustration of multiple mattresses being lifted (system shown from Subsea Protection Systems)

Table 4 summarises the infrastructure to remain *in situ* and Figure 9 shows how the seabed will look following completion of the decommissioning activities.

Table 4 Infrastructure to be decommissioned *in situ*

Item to be decommissioned *in situ*	Post-decommissioning status
Production pipeline and umbilical	These lines will be decommissioned in the trench that they currently reside in – the trench was previously filled with rock so that the lines are covered. As such, the lines will not be exposed to other sea users, but there will be a stretch of rock approximately 6.6 km in length remaining within the seabed (note that the rockdump is within the trench and below the level of the seabed around it).
Umbilical riser	The 180 m of the riser within the J-tube will remain within the J-tube on the Dunlin Alpha platform.

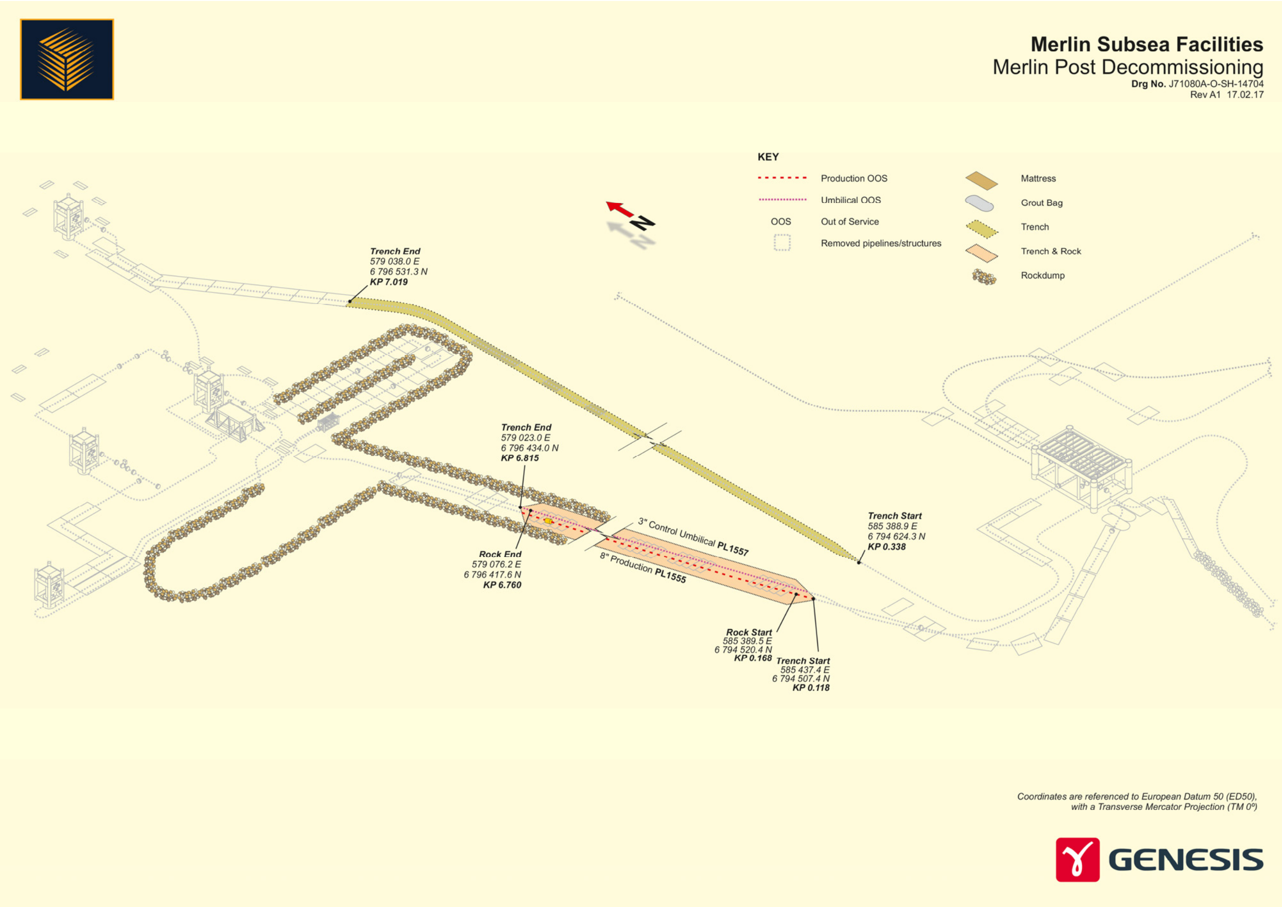


Figure 9 Subsea layout after completion of the decommissioning activities

Long-term liability survey monitoring will be undertaken as required by the Department for Business, Energy and Industrial Strategy for the infrastructure decommissioned *in situ.* Fairfield intends to set up arrangements to undertake post-decommissioning monitoring on behalf of the Licence Owners. The frequency of any monitoring that is required is likely to be determined through a risk-based approach based on the findings from each subsequent survey.

Drill Cuttings

During early drilling campaigns at the Merlin location, chemicals termed 'oil-based mud' were used. The rock from the well, called cuttings, was discharged to sea, along with some of the oil-based mud. There are oil-based cuttings still present on the seabed at the Merlin location, in the vicinity of the production wells and water injection well. Cuttings present at the water injection well do not constitute a cuttings pile but the cuttings present at the production wells do. The area of the cuttings pile present at the Merlin production wells is estimated to be approximately 1,876 m^2 with an estimated volume of 551 m^3.

An assessment of oil-based cuttings piles in the Merlin production centre was undertaken to determine the status of the drill cuttings and their most appropriate treatment. The Merlin cuttings pile was found not to exceed the OSPAR 2006/5 thresholds. These thresholds represent critical levels of certain measures of the cuttings pile, above which treatment must be proposed. Given that the cuttings pile does not pose an environmental risk if left *in situ*, Fairfield proposes to leave the cuttings *in situ*.

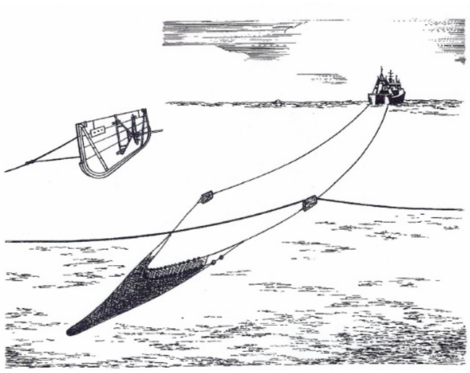
Environment Description

Based on previous experience, studies (including Fairfield-commissioned surveys), review of scientific data and consultation, it has been possible to identify the key environmental sensitivities in the Project area; these are summarised in Table 5.

Table 5 Summary of the key environmental sensitivities of the Project area

Animals living on or in the seabed
The habitat assessment undertaken for the Project determined the sediments to be mainly muddy sand and mixed sediment. The visible animals found across the survey area included polychaete worms and bivalve crustaceans. Species were generally considered to be intolerant of hydrocarbon contaminations. Surveys showed the seabed to host a relatively diverse range of species, with little variation across the area. 
Fish
 The fish populations in the Project area are characterised by species typical of the northern North Sea, including long rough dab, hagfish and Norway pout. Basking shark, tope and porbeagle are all also likely to occur in small numbers. The Project area is located within the spawning grounds of cod, haddock, Norway pout and saithe; meaning that these species use the area for breeding. Nursery grounds, where juvenile fish remain to feed and grow, for blue whiting, European hake, haddock, herring, ling, mackerel, Norway pout, spurdog and whiting are also found in the wider area.
Seabirds
The Project area is important for fulmar, northern gannet, great black-backed gull, Atlantic puffin, black-legged kittiwake and common guillemot for the majority of the year. Manx shearwaters are present in the vicinity of the Project area between the spring and autumn months. European storm petrels are present during September and November. Great skua, glaucous gull, Arctic skua and little auk may be present in low densities for the majority of the year. The seasonal vulnerability of seabirds to oil pollution in the immediate vicinity of the Project area has been derived from Joint Nature Conservation Committee data; the months of March, July, October and November are those when seabird species in the Project area are considered most vulnerable to surface pollution. Overall annual seabird vulnerability is reported to be low. 
Whales, dolphins and seals
 Spatially and temporally, harbour porpoises, white-beaked dolphins, minke whales, killer whales and white-sided dolphins are the most regularly sighted cetacean species in the North Sea. Given the distance to shore, species such as the bottlenose dolphin and grey and harbour seals are unlikely to be sighted in the Project area.

Conservation
None of the survey work undertaken in the Project area has identified any seabed habitats or species that are of specific conservation significance, apart from low numbers of juvenile ocean quahog, which is a threatened species. There are no designated or proposed sites of conservation interest in the Project area; the closest designated site, the European Site of Community Importance 'Pobie Bank Reef' lies 94 km to the south west of Merlin, off the east coast of Shetland.
Fisheries and other sea users
Saithe and mackerel (often targeted by the larger pelagic vessels in January and February) are the key commercial species landed from the Project area. However, they are of relatively low value when compared to total landings into Scotland. Combined, landings of these species from the wider area, within which the Project sits, comprise only 0.06% of the value of landings into Scotland. Other species of commercial value include megrim, cod and monks/anglers. There is very little shipping activity in the Project area, and no site of renewable or archaeological interest. There is also limited infrastructure related to other oil and gas developments.



Impact Assessment

The Merlin Subsea Infrastructure Decommissioning Project Environmental Impact Assessment has been informed by a number of different processes including; scoping with the Regulators and their statutory advisors, workshops with specialists and the Comparative Assessment process. Where potentially significant impacts have been identified, mitigation measures have been considered. The intention is that such measures should remove, reduce or manage the potential impacts to a point where the impacts are not significant. Table 6 presents the findings of the Environmental Impact Assessment for the potentially significant impacts identified for the Project. The potential for cumulative and transboundary impacts is also considered.

Table 6 Details of the potential environmental impact of the proposed activities

Key potential impacts assessed	Significance
Discharges to sea	
Impact assessment: Since most lines will have been cleaned by the time the decommissioning activities commence, there is only approximately 1.3 m^3 of hydrocarbon or chemical left in the infrastructure. This could potentially be discharged during removal activities, or over the longer period during which lines breakdown, if the infrastructure containing the chemicals and hydrocarbon is left *in situ*. This small release of relatively benign contents was deemed to have no potential to significantly impact species using the seabed or the water column around the Project area. **Cumulative**: In the context of the possible discharges from the nearby Osprey and Dunlin subsea decommissioning activities, and those made from the operation of installations in	Not significant

Key potential impacts assessed	Significance
the North Sea, there is no likelihood of the 1.3 m^3 of discharge from Merlin subsea decommissioning activities causing impact through cumulative means. **Transboundary**: Despite the proximity to the UK/Norway median line, the small discharge volume means there is expected to be no way of impacting species outside of UK waters. **Effects on protected sites**: The small discharge volume and the distance to the nearest protected site means there is expected to be no way of impacting protected sites, the nearest of which is 94 km away.	
Seabed	
Impact assessment: Interaction with the seabed will occur during decommissioning activities. In the main, this will come from the overtrawls that will be conducted to ensure the seabed is left in a suitable condition for future use by fisheries. This could result in a maximum of approximately 2.28 km^2 of seabed being trawled, and a slightly larger area experiencing an increase in sediment as it is stirred up into the water column. Despite the size of this area, the seabed in the Project area does not host particularly sensitive habitats or species and recovery is likely from the activities within a few years. The overtrawls may interact with the cuttings pile at Merlin, which may redistribute some of the contaminated seabed material. However, estimates suggest that only a few cubic metres of cuttings will be moved beyond the existing pile. Combined with the limited toxic effect of the cuttings, this is expected to result in no long term discernible change to the species using the seabed or water column. **Cumulative**: In the context of the possible cumulative impact from seabed disturbance occurring as part of the nearby Osprey and Dunlin subsea decommissioning activities, the absence of seabed habitats and species of conservation interest and the likely recovery of the seabed means that there is no likelihood of the subsea decommissioning activities causing impact through cumulative means. **Transboundary**: Despite the proximity to the UK/Norway median line, the highly localised nature of the seabed interaction means there is expected to be no way of impacting seabed habitat or species outside of UK waters. **Effects on protected sites**: The distance to the nearest protected site means there is expected to be no way of impacting protected sites.	Not significant
Underwater noise	
Impact assessment: Noise emitted from vessel use and cutting of some of the seabed structures could impact upon marine mammal and fish use of the Project area. However, the noise emissions are predicted to be sufficiently quiet that there is no prospect of injuring the animals or damaging their hearing. Since the cutting activities will occur for approximately two days and since only one or two vessels will be on site for the late spring/summer activities, there is no real prospect of disturbing animals sufficiently to disrupt feeding or breeding activities. **Cumulative**: In the context of the possible cumulative impact from noise emissions as part of the Osprey and Dunlin subsea decommissioning activities, the fact that the Project area is not of key importance to marine mammals or fish and that noise-emitting activities	Not significant

Key potential impacts assessed	Significance
will generally be limited to vessel use, there is no likelihood of the subsea decommissioning activities causing impact through cumulative means. **Transboundary**: Despite the proximity to the UK/Norway median line, the highly localised nature of the noise emissions means there is expected to be no way of directly impacting species outside of UK waters. It is likely, however, that animals experiencing noise emissions in UK waters will move to non-UK waters; since there is no likely injury or disturbance to animals in the Project area, animals moving outside of UK waters as part of normal behaviour does not constitute a significant impact. **Effects on protected sites**: Although it is possible that marine mammals from protected sites nearshore or in the Southern North Sea could experience noise emissions from the Project as they move through the Project area, there is expected to be no mechanism for impacting those species and thus no impact on the protected sites to which they belong.	
Other sea users	
Impact assessment: The limited number of vessel days required to execute the decommissioning project means there is no real prospect of significantly affecting fisheries users through temporary exclusion (i.e. where Project vessels stop them using the sea area). Additionally, the Merlin infrastructure will either be removed or decommissioned in a buried or sufficiently rockdumped state to mean that it will pose no risk to fisheries through snagging, which means there will also be no longer term exclusion. **Cumulative**: Since there will be no real short or long term exclusion resulting from the Merlin decommissioning activities, there will be no negative cumulative impact with the Osprey and Dunlin subsea decommissioning activities. In fact, decommissioning of the Merlin subsea area will result in the removal of the current 500 m exclusion zone around the Merlin wells. This means that seabed that was previously excluded from use will be re-opened to fisheries users. **Transboundary**: There are a number of non-UK vessels using the Project area. However, seabed that was previously excluded from use will be re-opened and those fisheries users will not be negatively affected by the decommissioning activities.	Not significant
Energy use and atmospheric emissions	
Impact assessment: Using energy to power vessels results in emissions to the air, which can contribute to local air quality issues; the absence of vulnerable receptors in the offshore area means this is not an issue for the Project. However, emissions to air can act cumulatively with those from other activities (such as onshore power generation and use of cars) to contribute to global climate change. These emissions from the Project may come from vessel use but also through linked activities such as the recycling of materials brought onshore. **Cumulative**: Since emissions to air offshore is largely a cumulative issue, it is important to consider how the Merlin, Dunlin and Osprey subsea decommissioning activities sit in the context of other UK emissions. Relative to UK offshore emissions, subsea decommissioning activities will contribute only 0.16% of annual emissions in the year in which they take place. Relative to the emissions which occurred annually from the	Not significant

Key potential impacts assessed	Significance
Greater Dunlin Area when it produced hydrocarbons, the total emissions from the subsea decommissioning activities represent less than half of the annual Dunlin Alpha production emissions. With such a small contribution during the activities themselves, and since the activities are proposed to facilitate the removal of the emissions associated with the operations of the fields, there is considered to be no cumulative impact possible. **Transboundary**: In the same way as described for cumulative impacts, there is considered to be no transboundary impact from the emissions, since the contribution of the emission to global climate change is negligible.	
Accidental events	
Impact assessment: The main potential impact from an accidental event associated with the Merlin decommissioning activities is the release of fuel from a vessel involved in a collision. To understand the extent of any potential impact, fuel spill modelling was undertaken. This showed that the area over which the fuel might disperse would be limited. The conditions in the offshore environment would also mean that any release would disperse relatively quickly. Given that fuel released from the vessel would not result in oiling of species using the area of any fuel release (since it is not a heavy oil like seen during tanker groundings), there is expected to be no significant impact from any release. **Cumulative**: Any accidental hydrocarbon release in the Merlin Project area is expected to dissipate within days. It is considered very unlikely that additional accidental releases from other sources would occur in the same timeframe and produce a cumulative impact. **Transboundary**: The fuel spill modelling showed only a 10 – 20% probability of fuel crossing the UK/Norway median line. Even if it did, the limited volumes and quick dispersion mean there is likely to be no significant cumulative impact. **Effects on protected sites**: The fuel spill modelling showed that it would not reach shore and would be highly unlikely to cross the boundaries of offshore sites. As such, there is expected to be no mechanism for impacting protected sites.	Not significant

Environmental Management

Beyond the main period of preparation for decommissioning *in situ* and removal of components of the Merlin subsea area, the Project has limited activity associated with it (there are likely to be a small number of post-decommissioning surveys). 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 manner acceptable to Fairfield (and to stakeholders). The primary mechanism by which this will occur is through Fairfield's Environmental Management Policy and specifically through the associated Environmental Management System that Fairfield operates.

Fairfield senior management is responsible for ensuring that Fairfield's Environmental Management System is applied to all activities. To support this, a Project Health, Safety and Environment Plan will be developed which outlines how Health, Safety and Environment issues will be managed and how Fairfield's Health, Safety and Environment policies and Environmental Management System will be implemented effectively throughout the Project. The Plan will apply to all work carried out on the Project, be it 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.

Fairfield has developed a Waste Management Strategy for the Project, in order to describe the types of materials identified as decommissioning waste, and to outline the processes and procedures necessary to support the Decommissioning Programme for the Merlin field (and the other fields in the Subsea Infrastructure Decommissioning Project). The Waste Management Strategy details the measures in place to ensure that the principles of the Waste Management Hierarchy are followed during the decommissioning (as described in Figure 10).

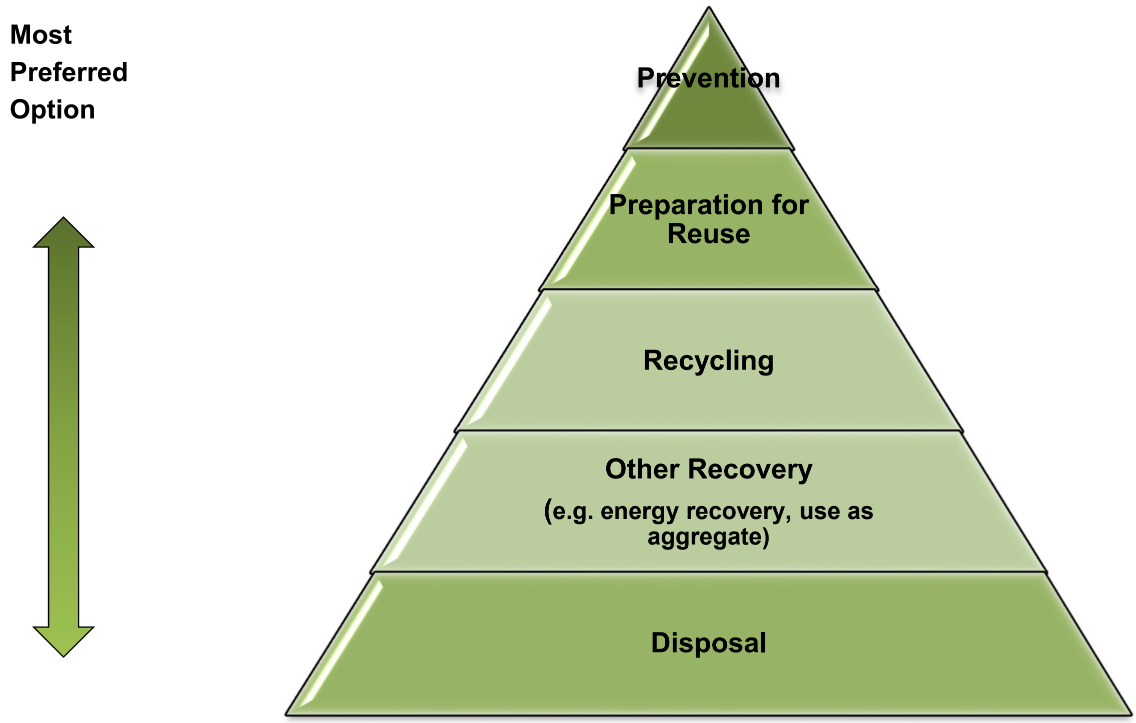


Figure 10 Waste hierarchy

Conclusions

The planned operations have been rigorously assessed through the Environmental Impact Assessment and Comparative Assessment processes, resulting in a set of selected options which are thought to present the least risk of environmental impact whilst satisfying safety, environmental, technical, societal and economic requirements. Based on the findings of the Environmental Impact Assessment and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact (which will be managed through the Fairfield Environmental Management System), it is concluded that the Project will result in no significant environmental impact.

1. Introduction

1.1. The Dunlin, Merlin and Osprey Fields

Fairfield Betula Limited and Fairfield Fagus Limited (collectively termed Fairfield), wholly owned subsidiaries of Fairfield Energy Limited, are the operators of the Dunlin, Merlin and Osprey fields (the ‘Greater Dunlin Area’), located in United Kingdom Continental Shelf (UKCS) Block 211/23 of the northern North Sea. Infrastructure associated with Dunlin, Merlin and Osprey is currently being prepared for decommissioning. The Merlin field lies approximately 132 km from the nearest landfall point, 192 km north east of Lerwick and 18 km west of the UK/Norway boundary. The Merlin field is a subsea tie-back to the Dunlin Alpha platform, located 7 km to the west-north west of the Dunlin Alpha platform (Figure 1.1). The Osprey field is a subsea tie-back located 6 km to the north-north west of the Dunlin Alpha platform. Production at the fields ceased in June 2015 and Fairfield now intends to decommission the Merlin subsea infrastructure as part of a wider programme to decommission all subsea infrastructure associated with the Greater Dunlin Area (the ‘Subsea Infrastructure Decommissioning Project’). The decommissioning of the Dunlin Alpha platform will be considered separately from the subsea activities. This Environmental Statement (ES) relates specifically to the proposed decommissioning of the Merlin field; the Osprey and Dunlin (subsea and platform) infrastructure will be the subject of separate ESs.

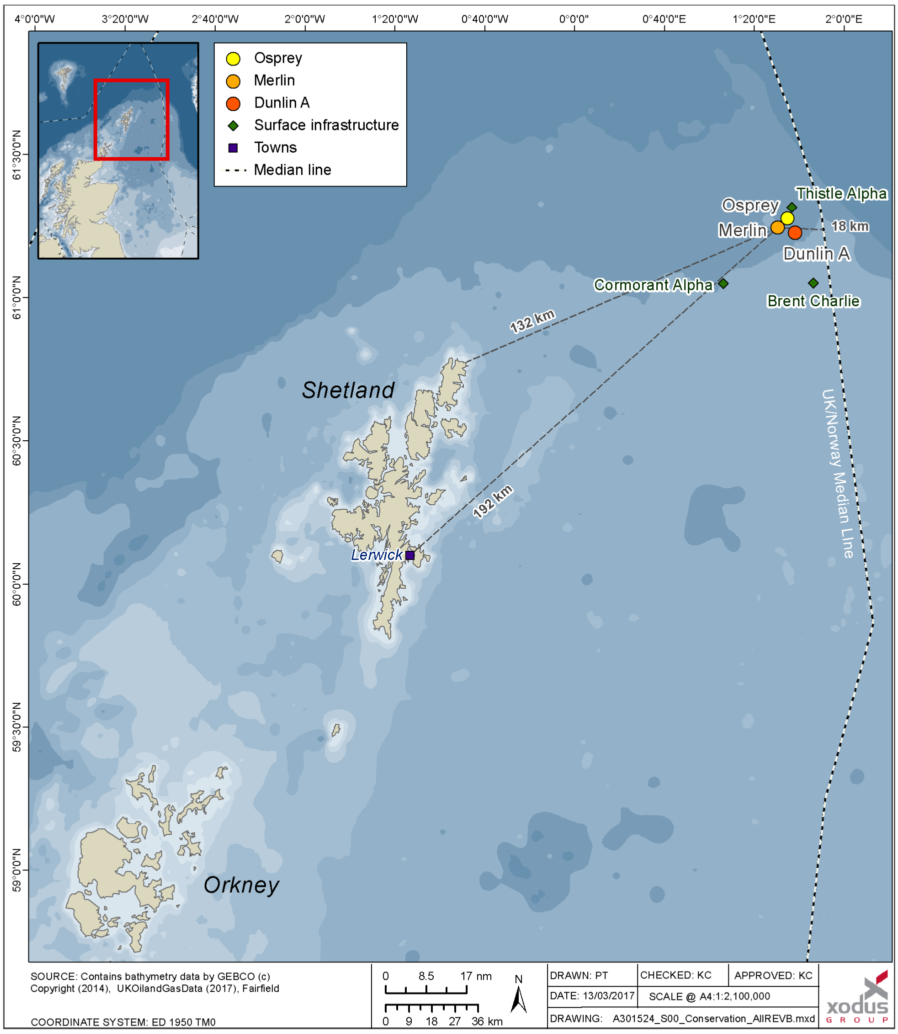


Figure 1.1 Location of Dunlin, Merlin and Osprey fields

1.2. The Merlin Subsea Infrastructure Decommissioning Project

The Merlin subsea field is located 7 km west-north west of the Dunlin Alpha platform in Block 211/23a-b, in a water depth of approximately 150 m. The field comprises three production wells in a 'daisy-chain' arrangement linked by a production pipeline to the Osprey production flowlines via a crossover manifold that is situated approximately 100 m from the Dunlin Alpha platform. There is also one water injection well at the Merlin field, linked to the Osprey water injection pipeline by a flexible flowline. A schematic of the field layout is shown in Figure 1.2.

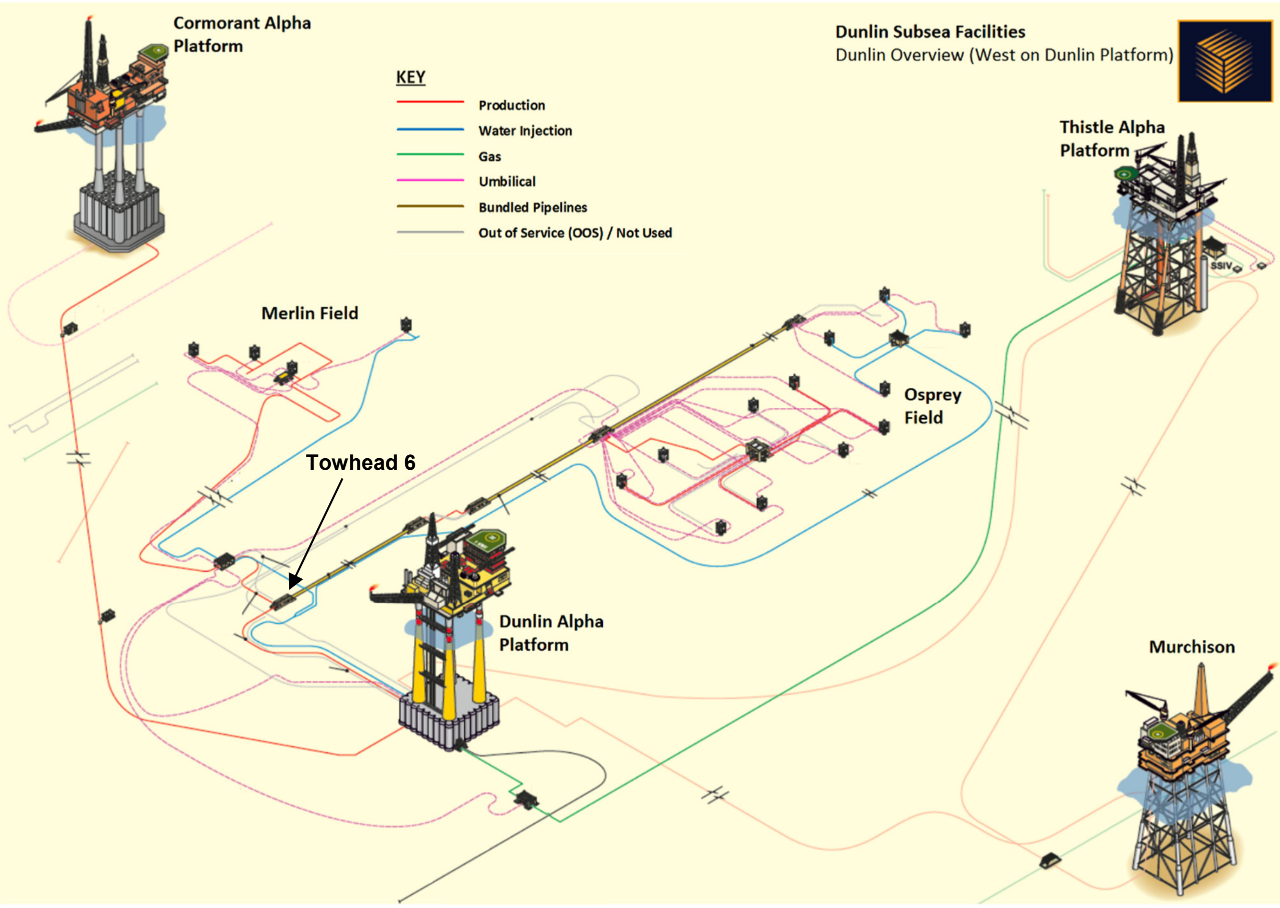


Figure 1.2 Merlin field infrastructure in the context of the wider area

Merlin subsea infrastructure will be decommissioned in accordance with Department for Business, Energy and Industrial Strategy (BEIS) guidelines (detailed in Section 1.5.2), with some of the infrastructure subject to a formal Comparative Assessment (CA) process. This process allows for the development of a preferred decommissioning methodology based on consideration of risk, environmental impact, technical feasibility, societal impacts and economic factors. Full details of how the decommissioning will be achieved, including a clear description of how this has been arrived at, are given in Section 2.

The geographical scope of the Merlin Subsea Infrastructure Decommissioning Project (referred to as the Project) covers:

- The Merlin water injection system (between the water injection well in the Merlin field and where the system joins the Osprey water injection system);

- The Merlin production system (between the production wells in the Merlin field and a point called 'Towhead 6' (shown on Figure 1.2), where it joins the Osprey production system); and
- The Merlin controls system (between the production and water injection wells and the Dunlin Alpha platform).

This area, termed herein as the 'Project area', is shown in Figure 1.3, highlighted orange. Other Greater Dunlin Area infrastructure is shown for context.

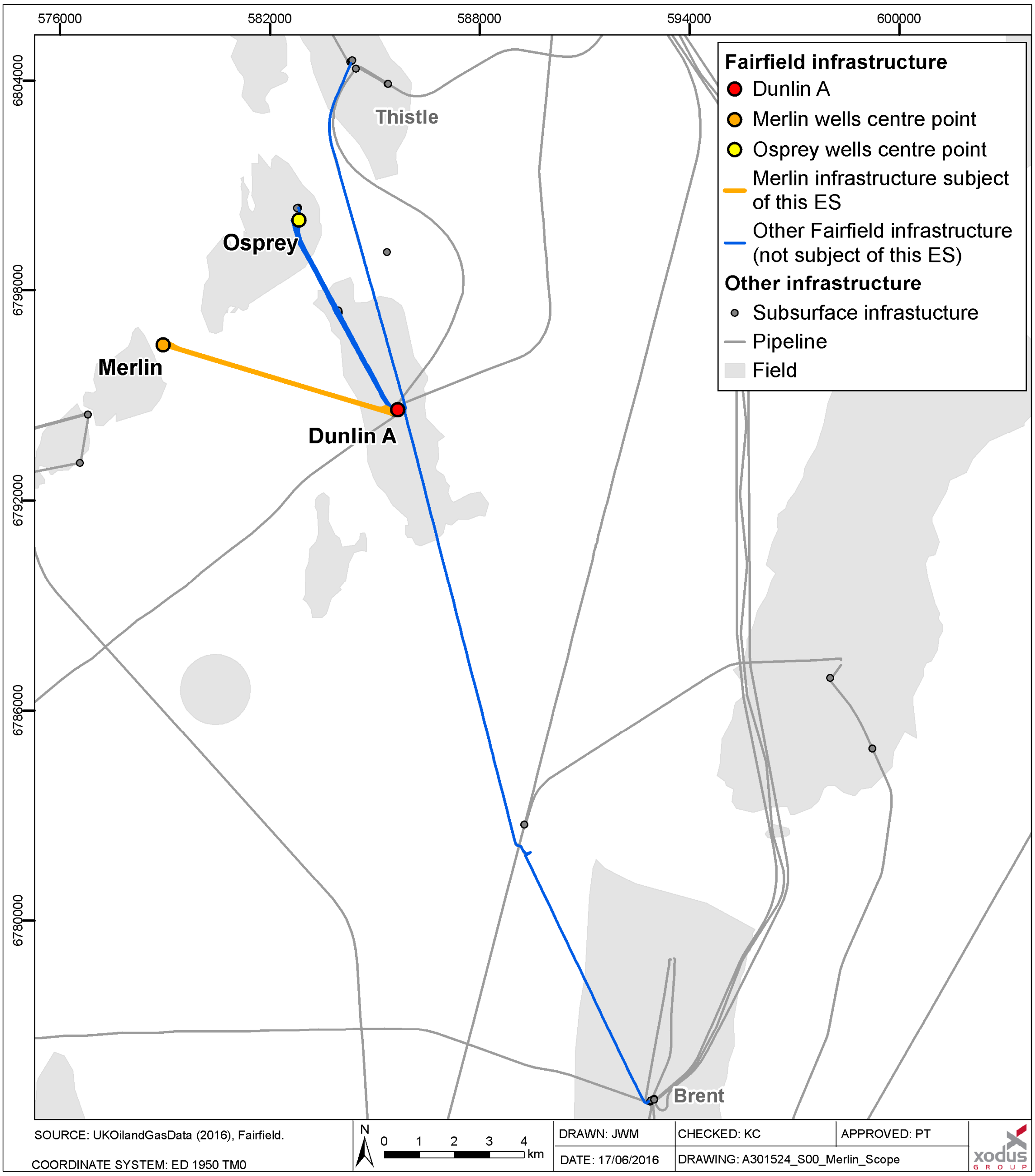


Figure 1.3 Project area

1.3. Purpose of this Document and of the Environmental Impact Assessment (EIA)

This ES reports the outcome of the EIA process undertaken in support of the proposed decommissioning activities for the Merlin subsea area. The scope of the EIA was developed during scoping and wider consultation (Section 5). Full details of the method applied during the EIA process are described in Section 4.

The overall aim of the EIA has been to assess the potential environmental impacts that may arise from the Project and to identify any measures that will be put in place to reduce the magnitude or likelihood of these potential impacts. The EIA process has run in parallel to the CA process and has informed decisions taken on the approach to decommissioning, and as such is considered integral to the Project. The EIA process also provides a framework for stakeholder involvement so that issues can be identified and addressed as appropriate at an early stage, as well as helping the planned activities comply with environmental legislative requirements and Fairfield's own environmental policies.

For clarity, the following are outside the scope of this EIA:

- Well plugging and abandonment will be undertaken by a drilling rig and will be covered under a Well Intervention Permit, which will include a Chemical Permit for abandonment operations. Removal of the wellhead and associated infrastructure will take place using an appropriate vessel. Fairfield will apply for a Marine Licence to undertake these operations. Any potential environmental impacts will be discussed in the impact assessment that will support these applications and they are not covered further in this ES;

- Flushing and cleaning of the production pipelines has already been completed. Flushing and cleaning of the umbilicals will be managed in environmental terms through application of permits (either under existing permits, under existing permits with amendments or under new permits) under relevant regulations (e.g. Offshore Chemical Regulations 2002 (as amended), Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)). Whilst the flushing and cleaning of the flowlines and umbilicals are out of scope of the EIA, potential impacts associated with the decommissioning of the lines is within the scope (e.g. discharge during preparatory work for removal, long-term release from any lines decommissioned *in situ*);

- The handling, treatment and disposal of waste will be undertaken by specialist third parties at facilities previously subject to environmental assessment and approved irrespective of this Project. Potential impacts arising from the onshore handling, treatment and disposal of waste in all its forms is therefore excluded from the scope of this EIA. However, Fairfield recognises its duty of care with respect to waste and details on how the company manages its activities with regards to the environment are detailed in this ES; and

- Decommissioning activities required for Dunlin and Osprey subsea infrastructure (these are subject to separate Regulatory submissions).

1.4. Structure of this Environmental Statement

To clearly and concisely report the findings of the EIA, this ES has been structured as follows:

- A non-technical summary of the ES;

- Description of the background to the Project; role of the EIA and legislative context (this section);
- Description of the Project and alternatives considered, including a description of the CA process (Section 2);
- Description of the environment and identification of the key environmental sensitivities which may be impacted by the Project (Section 3);
- Description of the methods used to identify and evaluate the potential environmental impacts (Section 4);
- Description of stakeholder engagement activities undertaken as part of the EIA (Section 5);
- Detailed assessment of key potential impacts, including assessment of potential cumulative and transboundary impacts (Section 6);
- Consideration of how waste will be managed through the Project (Section 7);
- Description of the environmental management measures (Section 8); and
- Conclusions (Section 9).

1.5. Legislation and Policy

1.5.1. Overview

The Merlin subsea decommissioning EIA process has given due consideration to the legislative basis under which decommissioning activities may be undertaken. This legislation and its influence on the Project are described in Section 1.5.2. Additionally, the implications for the Project from the recently issued Scottish National Marine Plan required consideration. This Marine Plan is summarised in Section 1.5.3.

1.5.2. Decommissioning

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is controlled through the Petroleum Act 1998 (as amended[1]). Decommissioning is also regulated under the Marine and Coastal Act 2009 and Marine (Scotland) Act 2010. 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 OSPAR Convention). The responsibility for ensuring compliance with the Petroleum Act 1998 rests with the BEIS (formerly the Department for Energy and Climate Change, or DECC). BEIS is also the Competent Authority on decommissioning in the UK for OSPAR purposes and under the Marine Acts.

Agreement on the process to be applied to the decommissioning of offshore oil and gas installations within the Convention area, and hence within the UKCS, was reached at the OSPAR Commission meeting held in July 1998. That agreement was reflected in OSPAR Decision 98/3, which entered into force on 9 February 1999

[1] The most recent amendment to the Petroleum Act 1998 was by the Energy Act 2016 which, amongst others, requires relevant persons to consult the UK Oil and Gas Authority (OGA) before submitting an abandonment programme to the Secretary of State, and to require the Secretary of State to consider representations from the OGA when deciding whether to approve a programme.

and which brought a prohibition on the dumping and leaving wholly or partly in place of offshore oil and gas installations. The provisions of OSPAR Decision 98/3 do not apply to pipelines. Guidance provided by BEIS states that all feasible decommissioning options for pipelines should be considered and a CA undertaken (DECC, 2011).

At present in the UK there is no statutory requirement to undertake an EIA to support the Decommissioning Programme that must accompany all applications for decommissioning in the UKCS (as per the Petroleum Act 1998). However, BEIS in their 'Guidance Notes on the Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' advise that the Decommissioning Programme should be supported by an EIA; this ES thus fulfils this requirement. In this regard, the BEIS Guidance Notes state that an EIA should include an assessment of the following:

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

In addition, BEIS has advised the oil and gas industry that any applications related to decommissioning made under the Marine and Coastal Act 2009 and Marine (Scotland) Act 2010 will need to be supported by an EIA. Although such applications are not being made by Fairfield at this time (they will be required later in the decommissioning process), Fairfield has undertaken the EIA to adequately support such applications when they are eventually required (this may include Marine Licences and Consent to Locates).

1.5.3. Scottish National Marine Plan

The Scottish Government adopted the National Marine Plan in early 2015 (Scottish Government, 2015) to provide an overarching framework for marine activity in Scottish waters, in an aim to enable sustainable development and the use of the marine area in a way that protects and enhances the marine environment whilst promoting both existing and emerging industries. This is underpinned by a core set of general policies which apply across existing and future development and use of the marine environment. Policies of particular relevance to the Project include:

- General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the Plan;
- Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan (economics has been considered in the CA; Section 2.2);
- 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 Priority Marine Features; and
  - Protect and, where appropriate, enhance the health of the marine area (protected sites and species have been considered within relevant impact assessments; Section 6).

- Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects (potential impacts from underwater noise are considered in Section 6.2.2 and controls for onshore noise are considered in Section 8.3);

- 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 (potential impacts from energy use and atmospheric emissions are considered in Section 6.3);

- Engagement: Early and effective engagement should be undertaken with the general public and interested stakeholders to facilitate planning and decommissioning processes (Fairfield has engaged actively with stakeholders during the development of the Decommissioning Programme; Section 5); and

- Cumulative impacts: Cumulative impacts affecting the ecosystem of the Marine Plan area should be addressed in decision-making and Plan implementation (the potential for cumulative impacts has been considered within each impact assessment; Section 6).

Specifically with regards to decommissioning of oil and gas facilities, the Marine Plan requires the following:

- 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 (the CA process that has been followed to arrive at the proposed decommissioning strategy is outlined in Section 2.2).

Fairfield has given due consideration to the Marine Plan during Project decision making and the interactions between the Project and Plan are summarised in Section 8.5.

1.6. Environmental Management

Relevant to the EIA, and to all of Fairfield's activities, is the company's commitment to managing all environmental impacts associated with its activities. Continuous improvement in environmental performance is sought through effective project planning and implementation, emissions reduction, waste minimisation, waste management, and energy conservation; this mindset has fed into the development of the mitigation measures developed for the Project. A summary of Fairfield's Environmental Management Policy is presented in Figure 1.4.

It is the policy of Fairfield Energy Limited (Fairfield) to seek to conduct its business in a responsible manner that prevents pollution and promotes the preservation of the environment. Fairfield appreciates that our activities can interact with the natural environment in many ways. We recognise that sustained development of Fairfield and our long term success depends upon achieving high standards of environmental performance. We are therefore committed to conducting our undertakings in an environmentally responsible manner. This means that we will:

- Integrate environmental considerations within our business and ensure that we treat these considerations with at least equal importance to those of productivity and profitability;
- Incorporate environmental risk assessment in our business management processes, and seek opportunities to reduce the environmental impact of our activities;
- Continually improve our environmental management performance;
- Comply with all environmental laws, regulations and standards applicable to our undertakings;
- Allocate necessary resources to implement this policy; and
- Communicate openly in matters of the environment with government authorities, industry partners and through public statements.

In particular, we will:

- Maintain an environmental management system in accordance with international best practice and with the BS-EN-ISO 14001:2015 standard, including arrangements for the regular review and audit of our environmental performance;
- Conduct environmental analyses and risk assessments in our areas of operation, in order to ensure that we understand the potential environmental impacts of our activities and that we identify the necessary means for addressing those impacts;
- Manage our emissions according to the principles of Best Available Techniques;
- Publish an annual statement on our public web site, providing a description of our environmental goals and performance; and
- Maintain incident and emergency systems in order to provide assessment, response and control of environmental impacts.

Ultimate responsibility for the effective environmental management of our activities rests with the Managing Director and the Board. This policy shall be implemented by line management through the development and implementation of working practices and procedures that assign clear responsibilities for specific environmental activities with our employees and contractors. In addition, each of our employees has a personal responsibility to conduct themselves in a manner that enables us to implement this policy and our environmental management system.

John Wiseman, Managing Director

Figure 1.4 Environmental management policy

2. Project Description and Comparative Assessment

2.1. Description of Facilities to be Decommissioned

2.1.1. Overview

The Merlin subsea field comprises three production wells in a daisy-chain arrangement (i.e. the first is linked to the second, which is linked to the third, which is linked to the production system) that passed hydrocarbons to a production pipeline as far as the Osprey production flowlines. The production pipeline passes via a crossover manifold, situated approximately 100 m from the Dunlin Alpha platform. A single water injection well is linked to the Osprey water injection pipeline by a flexible flowline via a Y-shaped connecting line called a spool. Figure 2.1 shows a schematic of the Merlin field, highlighting this infrastructure.

Termination of production from the Greater Dunlin Area was announced in May 2015, following achievement of maximum economic recovery from these oilfields. Termination of production was agreed with the UK Oil and OGA on 9th July 2015, with Cessation of Production confirmed by letter dated 15th January 2016, to have occurred on 15th June 2015.

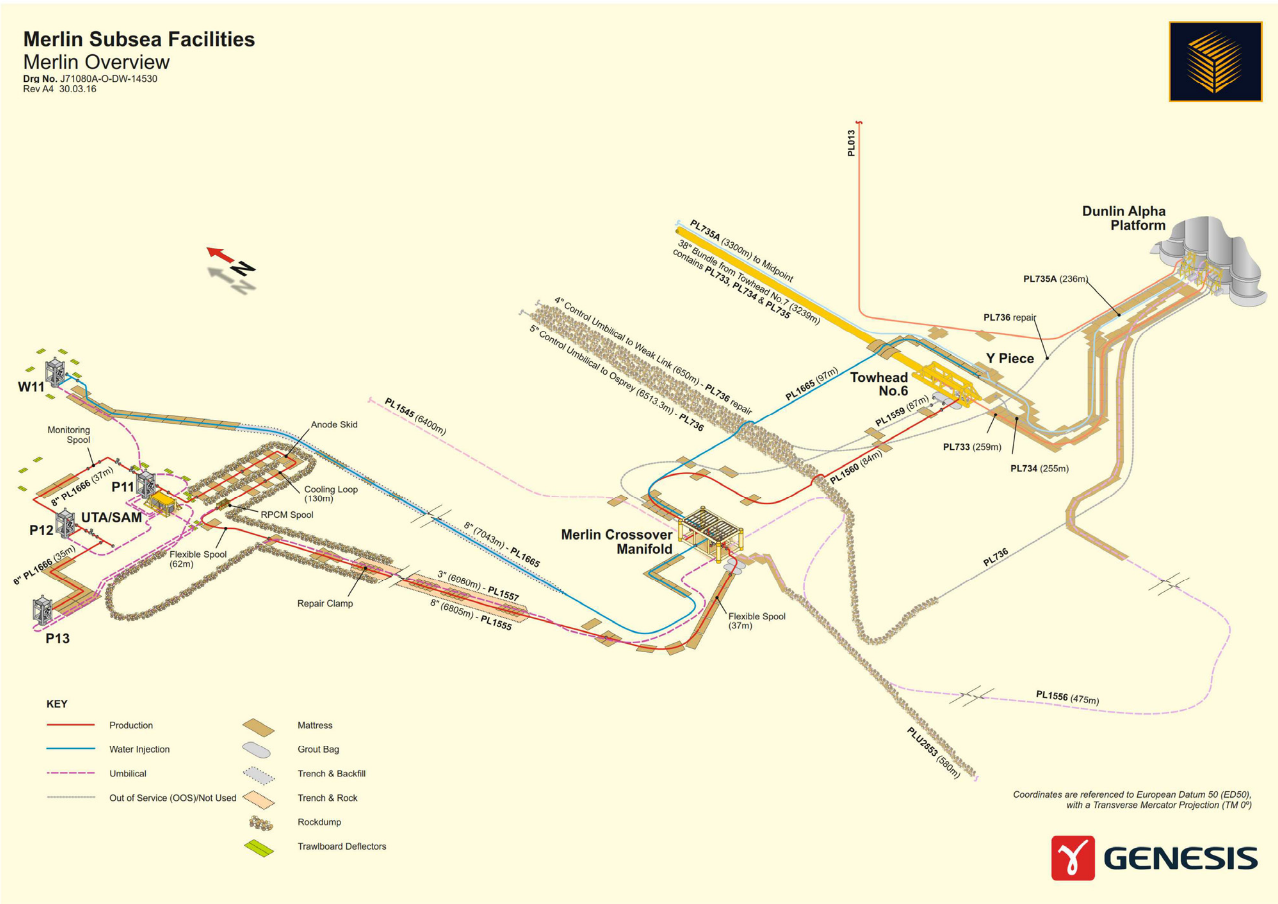


Figure 2.1 Merlin subsea facilities schematic

2.1.2. Pipelines and Umbilicals

The Merlin 8" production pipeline and 3" umbilical, routed from the Merlin drill centre to the Merlin crossover manifold, shown in Figure 2.1, are trenched and rockdumped, as detailed in Table 2.1.

Note: All dimensions, weights and quantities presented in this document are the best estimates based on the latest engineering studies; these values may be refined as project planning progresses.

Table 2.1 Trenched and rockdumped infrastructure at Merlin

Item	Material	Length (m)	Trenched		Rockdumped	
			Length (m)	Depth (m)	Length (m)	Depth (m)
PL1555 8" oil pipeline	Steel	6,805	6,673	1.1 – 1.6 below seabed	6,573	0.6
PL1557 3" umbilical	Polymer/ super duplex/ copper	6,980	6,673	1 – 1.6 below seabed	6,573	0.6

There is also a trenched and backfilled 8" water injection flexible flowline that connects the Merlin crossover manifold to the Merlin water injection well (Figure 2.1), detailed further in Table 2.2. There is also a partially-rockdumped umbilical riser that connects the Merlin control system to the Dunlin Alpha platform, detailed further in Table 2.3. The rockdump on the umbilical riser is overspill from operations unrelated to the Merlin subsea area – it was not placed on the umbilical by design.

Table 2.2 Trenched and backfilled infrastructure at Merlin

Item	Material	Length (m)	Burial status			
			Trenched	Backfilled	Mattress cover	Rockdump cover
PL1665 8" water injection pipeline	Steel	7,043	To a depth of 0.6 m for 6,683 m	To a depth of 0.6 m for 6,663 m	Spot locations that did not achieve burial	-

Table 2.3 Partially rockdumped infrastructure at Merlin

Item	Material	Length (m)	Burial status			
			Trenched	Backfilled	Mattress cover	Rockdump cover
PL1556 4" umbilical riser	Steel	475	-	-	-	To a depth of 0.5 m for 60 m

2.1.3. Other Subsea Infrastructure

There are a number of other components which have been identified as items which require decommissioning as part of the Project; these are described in Table 2.4. Table 2.5 describes the quantity and size of concrete mattresses (an example of what these look like is given in Figure 2.2) and sand and grout bag deposits that were previously placed in the field to provide level ground for structures or to provide protection from other sea users. Trawlboard deflectors made of concrete were also previously deployed around the Merlin drill centre to protect the other installed structures (Figure 2.3).

Table 2.4 Pipeline and umbilical components at Merlin

Description	Material	Total length (m)	Total weight (kg)	Quantity
Tree spool (a spool is a connecting line between structures and lines)	Super duplex	0.198	938	1
Ring pair corrosion monitoring spool	Steel	2.5	1,770	1
Merlin crossover manifold spool	Steel	2.34	924	1
Merlin umbilical termination assembly unit (an end point structure for the umbilical)	Steel	5.00	5,200	1
Tee spools	Steel	6.92	5,333	5
Spools (incorporating manual valves)	Steel	3.169	4,345	3
Corrosion monitoring spool	Steel	2.05	2,519	1
Merlin crossover manifold	Steel	12.10	77,151	1
Flexible jumper (a jumper is like a spool)	Polymer/steel	367	68,492	5
Cooling spool	Steel	130	12,950	1
Spool	Super duplex	72	4,780	2
3.5" umbilical jumpers	Thermoplastic/ stainless steel	289	1,721	4
1.5" jumpers	Stainless steel/ copper	289	268	4
Hose	Stainless steel/ elastomer	91	60	1
Hose	Thermoplastic	25	26	1

Table 2.5 Stabilisation material at Merlin

Description	Total quantity	Details of individual component			
		Length (m)	Width (m)	Height (m)	Weight (kg)
Small concrete mattress	108	5.00	2.00	0.15	3,600
Standard concrete mattress	41	6.00	3.00	0.15	6,750
Concrete blocks (trawlboard deflectors)	19	2.00	3.00	2.00	20,400
Sand bag	4,185	0.60	0.30	0.15	25
Grout bag	914	0.60	0.30	0.15	25

Figure 2.2 Example of a typical concrete mattress

Figure 2.3 Image showing two trawlboard deflectors at Merlin

2.1.4. Drill Cuttings

During early drilling campaigns at the Merlin location, oil-based cuttings were discharged to sea. There are oil-based cuttings still present on the seabed at the Merlin location; these are located in the vicinity of the production wells and water injection well. The cuttings present at the water injection well do not constitute a cuttings pile (see Section 2.3.2.2) but the cuttings present at the production wells do. The area of the cuttings pile present at the Merlin production wells is estimated to be approximately 1,876 m^2 with an estimated volume of 551 m^3. The fate of the cuttings piles at Merlin is further discussed in Section 2.3.2.2, whilst Figure 2.4 shows the cuttings pile in the context of the Merlin production location.

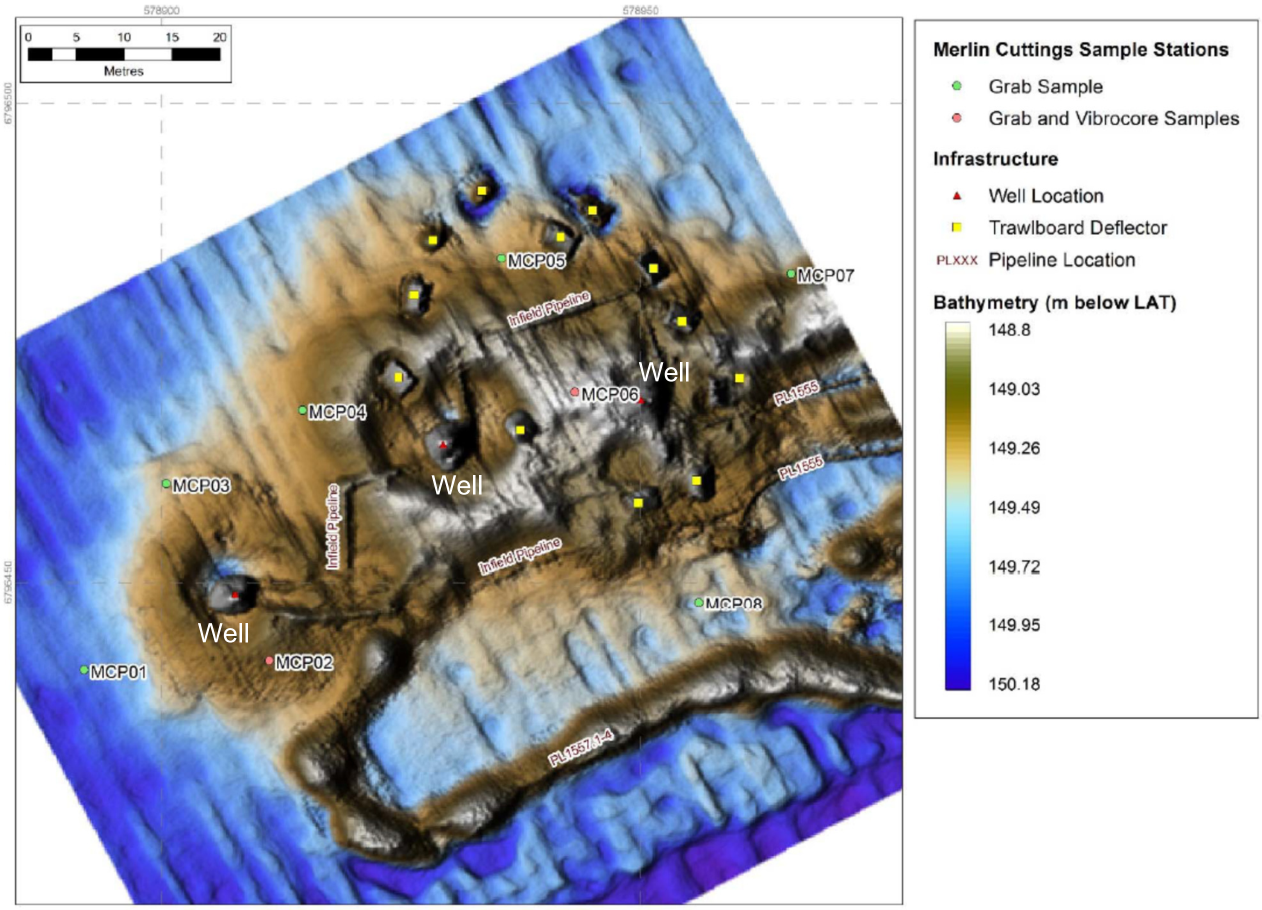


Figure 2.4 Merlin production wells and dispersed drill cuttings (Fugro, 2017)

2.2. Consideration of Alternatives and Selected Approach

2.2.1. Overview

This section presents the approach taken to considering alternatives to decommissioning and the various options available for decommissioning each item of subsea infrastructure.

2.2.2. Alternative to Decommissioning

Following cessation of production in June 2015, options to re-use the infrastructure *in situ* for future hydrocarbon developments have been considered, but to date, none have yielded a viable commercial opportunity. There are a number of reasons for this, including the absence of remaining hydrocarbon reserves in the vicinity of the Merlin subsea infrastructure, and the limited remaining design life of the Merlin subsea infrastructure (in terms of moving hydrocarbons, the Merlin system was calculated to be at the end of its functional life in 2015). It is now considered unlikely that any opportunity to reuse the pipelines and associated infrastructure will be feasible. As such, there is no reason to delay decommissioning of the Merlin field in a way that is safe and environmentally and socio-economically acceptable (and the 'do nothing' approach to the infrastructure is thus rejected).

2.2.3. Comparative Assessment

CA is a process by which decisions can be made on the most appropriate approach to decommissioning. As such, it is a core part of the overall decommissioning planning process being undertaken by Fairfield for the subsea infrastructure at Merlin. Guidelines for CA were prepared in 2015 by Oil and Gas UK (OGUK), where seven steps to the CA process were recommended. Table 2.6 provides commentary on each of these steps.

Table 2.6 Overview of the CA process

Title	Scope	Commentary
Scoping	Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase), and identify and map stakeholders	Scoping Reports prepared for Merlin, Dunlin and Osprey subsea infrastructure in advance of Screening (see below). Stakeholders identified and mapped and Stakeholder Engagement Plan prepared. CA methodology and criteria established for screening by early 2016.
Screening	Consider alternative uses and deselect unfeasible options	Screening workshops held in the first quarter of 2016 with external stakeholders for Merlin, Dunlin and Osprey. Specific studies identified and agreed that would help with the evaluation of options. CA methodology and criteria were also revisited following screening to support option selection.
Preparation	Undertake technical, safety, environmental studies plus stakeholder engagement	Studies covering engineering, cost, safety and environment/societal were undertaken alongside regular stakeholder engagement.
Evaluation	Evaluate the options using the chosen CA methodology	Fairfield conducted two internal CA workshops as part of the evaluation phase. The first, in August 2016, identified areas where further information was needed in order to make a recommendation (effectively recycling to the preparation phase). A second internal workshop was held in November where the results of recent study work were used to discuss and update the decision tool. An additional study (fisheries quantitative risk assessment) was commissioned to run in parallel and be used to either amend or validate the decision tool.
Recommendation	Create recommendation in the form of narrative supported by charts explaining key trade-offs	The two workshops described above under the Evaluation stage produced a set of emerging recommendations which Fairfield presented as emerging recommendations to external stakeholders. A Briefing Session was held in December 2016 to review these and provide additional data to stakeholders.

Title	Scope	Commentary
Review	Review the recommendation with internal and/or external stakeholders	Workshop held with external stakeholders on Tuesday 10th January 2017: Joint Nature Conservation Committee (JNCC), Scottish Fishermen's Federation (SFF), Marine Scotland, BEIS and OGA.
Submit	Submit to BEIS as part of/alongside Decommissioning Programme	This CA report is available alongside the Decommissioning Programme for Merlin subsea infrastructure.

Full details of the CA process are provided in the Merlin CA Report that accompanies the Merlin Subsea Infrastructure Decommissioning Programme.

2.2.4. Options for Decommissioning the Subsea Infrastructure

In line with the latest BEIS guidelines on decommissioning (DECC, 2011), Fairfield committed to fully removing a number of structures from the Merlin subsea area. For the remaining infrastructure, Fairfield followed the BEIS guidelines and undertook CA in order to arrive at a decision for the decommissioning method. The Merlin Subsea Infrastructure Decommissioning CA therefore focussed on the three groups of infrastructure shown in Table 2.9. Following the Scoping and Screening exercises outlined in Table 2.6, a series of options for how the Merlin subsea infrastructure could be decommissioned were established; these are also shown in Table 2.7.

Table 2.7 Merlin subsea infrastructure subject to the CA process

Decision	Infrastructure group (see Table 2.8)	Infrastructure group description	Option 1	Option 2	Option 3
1	7	Trenched and rockdumped pipelines and umbilicals	End removal, local rockdump of cut ends and areas of low burial depth	End, span and exposure removal, local rockdump of cut ends.	End removal, local rockdump of cut ends and backfill along length using mass flow excavator.
2	8	Trenched and buried pipelines	End removal, local rockdump of cut ends and areas of low burial depth.	End, span and exposure removal, local rockdump of cut ends.	Full removal using reverse reeling technique.
3	9	Umbilical riser	Cut the seabed section of the riser and recover. Remainder to remain *in situ* within the J-tube (the conduit to the platform topsides)	Cut the seabed section of the riser and recover. Remainder to be removed by topside pull.	-

2.2.5. Selected Decommissioning Strategy

To compare each option against the others for a decision, Fairfield utilised a Multi Criteria Decision Analysis tool. This tool uses pairwise comparisons to consider differences between options - essentially, the assembled team reviews the available data for each option and determines using terms such as 'neutral', 'stronger', 'much stronger' and so on, how each option compares to the other. This comparison was undertaken using the five criteria described in the BEIS Guidelines for Decommissioning of Offshore Oil and Gas Installations and Pipelines (DECC, 2011):

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

The CA process decision outcomes, supported by an appropriate amount of specialist study work, are summarised in Table 2.8. The Merlin Subsea Comparative Assessment Report outlines the decision-making process and procedure in more detail.

Table 2.8 Final recommendations for Merlin

Group	Infrastructure type	Subject of CA?	Decommissioning recommendation
1	Pipeline and umbilical components	No	Full removal
2a	Deposits	No	Full removal
2b	Structures	No	Full removal
3	Structures and deposits (pipeline route)	No	Full removal
4	Surface-laid flexible jumpers	No	Full removal
5	Surface-laid rigid spools	No	Full removal
6	Surface-laid umbilicals	No	Full removal
7	Trenched and rockdumped pipelines and umbilicals	Yes	Leave *in situ* – minimal intervention (rock placement)
8	Trenched and buried pipelines	Yes	Full removal
9	Umbilical riser	Yes	Cut the section outside of the platform and recover, with the remainder in platform to remain *in situ*.

Given the above, the only infrastructure that will not be recovered during decommissioning is proposed to be the already trenched and rockdumped pipelines and umbilicals (as the seabed section of the umbilical riser will be removed and the remainder decommissioned within the Dunlin Alpha platform[2]). Full details on how the infrastructure will be decommissioned are given in Section 2.3.

2.3. Decommissioning Activities

2.3.1. Schedule

Fairfield anticipates executing the Merlin Subsea Decommissioning Infrastructure Project activities in 2018/2019; an indicative schedule for the work is shown in Figure 2.5. However, the specific timing of decommissioning activities will be agreed with BEIS and with the Health and Safety Executive (HSE) and applications for all relevant permits and consents will be submitted and approval sought prior to activities taking place.

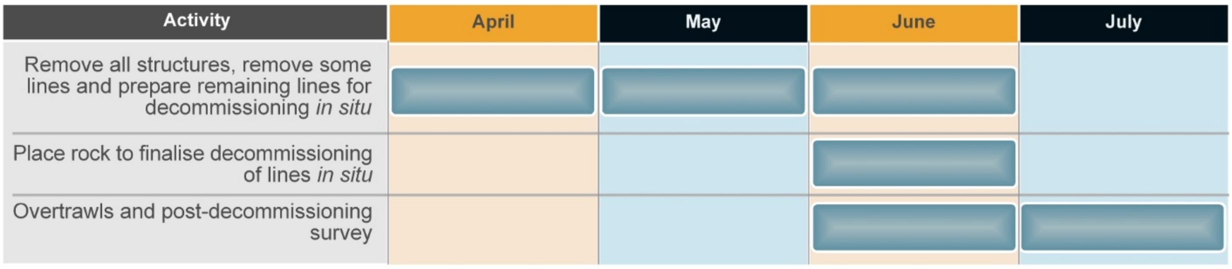


Figure 2.5 Indicative schedule 2018/2019

Fairfield will select one or more subsea contractors to mobilise a fleet comprising vessels with a range of crane capabilities for lifting objects of different sizes and weights off the seabed, vessels that can support underwater operations (including Remotely Operated Vehicle (ROV) deployment, diving, cutting, excavation and rock placement) and survey vessels. The vessels will also deploy ROVs (or divers when necessary) to disconnect the subsea infrastructure as required. The vessels' cranes will lift these to the vessels. Vessels to be used during the decommissioning of Merlin are detailed in Table 2.9.

Table 2.9 Vessel type and days[3]

Vessel type	Approximate number of days		
	Mobilisation/demobilisation	In transit	In the field
Dive support vessel (DSV)	6	13	63
Rockdump vessel	2	2	<1
Trawler	1	2	2
Survey vessel	22	23	14
Total	**31**	**40**	**80**

[2] The eventual fate of the umbilical riser that is decommissioned within the Dunlin Alpha platform boundary will be the subject of the outcome of the forthcoming Dunlin Alpha Decommissioning Programme.

[3] This estimate of vessel requirement represents a best estimate based on current project planning and it may be updated as the project progresses. All vessel day estimates are rounded up to the nearest whole digit. It should be noted that this estimate assumes no over-run in works; if such an over-run occurred then a guard vessel may also be required, to ensure that other users of the sea area do not come into contact with the partially-decommissioned structures whilst they await decommissioning finalisation.

It is expected that there will generally be only one vessel in the Merlin field at any one time. The DSV will largely have completed its activities before the rockdump vessel comes on site, whilst overtrawls by chain mat (Section 2.3.2.4) can only be conducted once rockdumping has been completed. There may be some limited overlap as vessels arrive and leave the field to complete their respective scopes, but in a worst case situation this would mean a maximum of 4 vessels present at any one time.

The infrastructure lifted from the seabed will be transported to an onshore dismantling site by the vessels described above.

2.3.2. Removal/Decommissioning *In Situ*

2.3.2.1. Infrastructure

Taking into account both the requirement to fully remove many of the subsea structures and the outcome of the CA process which determined some infrastructure should remain *in situ*, Fairfield has developed a 'campaign approach' to the Merlin decommissioning activities. This campaign approach means that Fairfield has considered how best to deploy vessels in the field to make best use of time, helping to keep the vessel requirement to a minimum. Weather permitting, Fairfield intends to complete the activities as described in Figure 2.5. Table 2.10 details the decommissioning options to be carried out for the different infrastructure in the Merlin field including a description of the vessels and methodology.

Table 2.10 Decommissioning options for the Merlin subsea infrastructure

Infrastructure	Decommissioning approach	Method
Trenched and rockdumped pipelines and umbilicals (8" production pipeline PL1555 and 3" umbilical PL1557)	This infrastructure will be decommissioned by removing the ends and placing local rockdump at the cut ends and areas of low burial depth.	A DSV and rockdump vessel will be mobilised to undertake these operations. Dredging will be undertaken around the cut locations before the pipeline and umbilical ends are cut and recovered to the vessel. A rockdumping vessel will then be mobilised to provide remedial rockdump at the ends and spans/exposures, by way of a flexible fall pipe (Figure 2.6).
Trenched and buried pipeline (8" water injection pipeline PL1665)	This flowline will be fully removed using a reverse reeling technique; this method involves winding the flexible pipeline onto the back of the vessel.	A DSV will be mobilised to carry out this operation. The pipeline will be disconnected at each end, a recovery head will be attached to the pipeline (this tool allows a firm hold to be made on the pipeline), and then the reverse reeling will be initiated.
Umbilical riser (4" umbilical riser PL1556)	This will be decommissioned by cutting and recovering the seabed section of the riser; the section within the Dunlin Alpha 'J-tube' (the conduit to the platform topsides) will remain *in situ*.	A DSV will be mobilised to carry out this operation. The seal at the end of the J-tube will be removed, a cut made in the umbilical, and the J-tube will be re-sealed again. Recovery rigging will be attached to the riser to allow a firm hold on the umbilical to be made and it will be recovered to the vessel.

Infrastructure	Decommissioning approach	Method
Pipeline and umbilical components (as detailed in Table 2.4)	All of these components are to be fully removed and recovered to shore.	A DSV will be mobilised to carry out these operations. The Merlin crossover manifold will be inspected and cleaned at the lift points and recovery rigging attached to enable it to be lifted. The Merlin crossover manifold will then be recovered to the vessel. The jumpers and hoses will be disconnected (where required) and recovered to the vessel by being placed in baskets that are then lifted to the vessel. The spools will be disconnected or cut, recovery rigging attached and lifted up to the vessel.
Stabilisation material (as detailed in Table 2.5)	Concrete mattresses and sand and grout bag deposits to be fully removed from the seabed at Merlin. This also includes the trawlboard deflectors which are located around the Merlin drill centre.	A DSV will be mobilised to carry out these operations. Lifting gear that will allow multiple mattresses to be recovered to the vessel in one lift will be used (Figure 2.8). Grout and sand bags will be removed into baskets that will then be recovered to the vessel (Figure 2.9). Trawlboard deflectors will be inspected and cleaned at the lift points, recovery rigging will be attached and they will then be recovered to the vessel. All stabilisation material is currently freely accessible, or will be accessible at the time that the infrastructure it protects is recovered. In the event of practical difficulties with these removals, BEIS will be consulted and a Comparative Assessment submitted as appropriate.

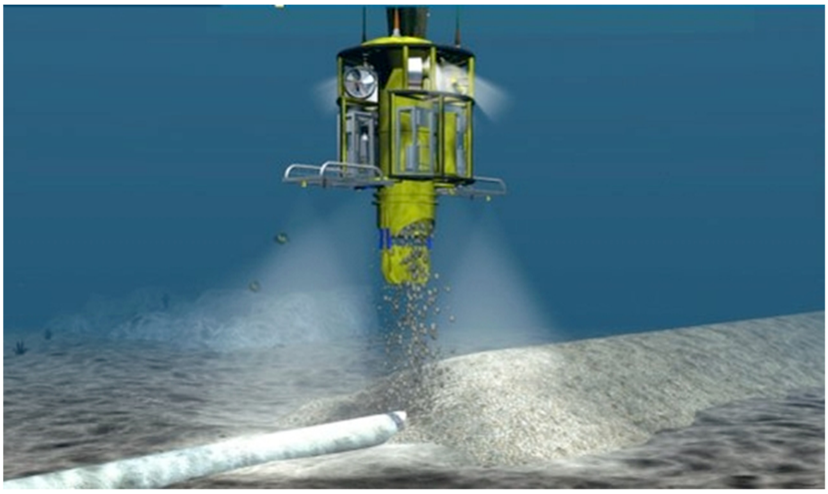


Figure 2.6 Illustration of a flexible fall pipe being used to deploy rock (system shown from Offshore Fleet, 2017)

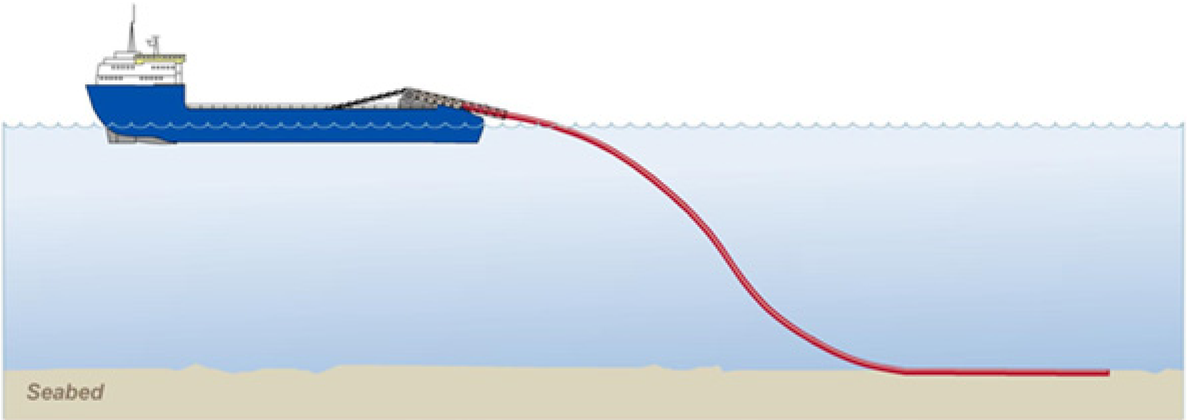


Figure 2.7 Illustration of a pipeline being recovered to a vessel in a process called 'reverse reeling'

Figure 2.8 Illustration of multiple mattresses being lifted from the sea floor (system shown from Subsea Protection Systems, 2017)

Figure 2.9 Illustration of a basket used to collected subsea materials (system shown from WeSubsea, 2017)

As per Table 2.10, there will be three pieces of infrastructure that will be decommissioned *in situ*; all other infrastructure will be removed. Table 2.11 summarises the infrastructure to remain *in situ* and Figure 2.10 shows how the seabed will look following completion of the decommissioning activities.

Table 2.11 Infrastructure to be left *in situ*

Item to be decommissioned *in situ*	**Post-decommissioning status**
8" production pipeline (PL 1555) and 3" umbilical (PL 1557)	These lines will be decommissioned in the trench that they currently reside in – the trench was previously filled with rock so that the lines are covered. As such, the lines will not be exposed to other sea users, but there will be a stretch of rock approximately 6.6 km in length remaining within the seabed (note that the rockdump is within the trench and below the level of the seabed around it).
PL1556 4" Umbilical riser - 180 m riser within J-tube	The riser will remain within the J-tube on the Dunlin Alpha platform.

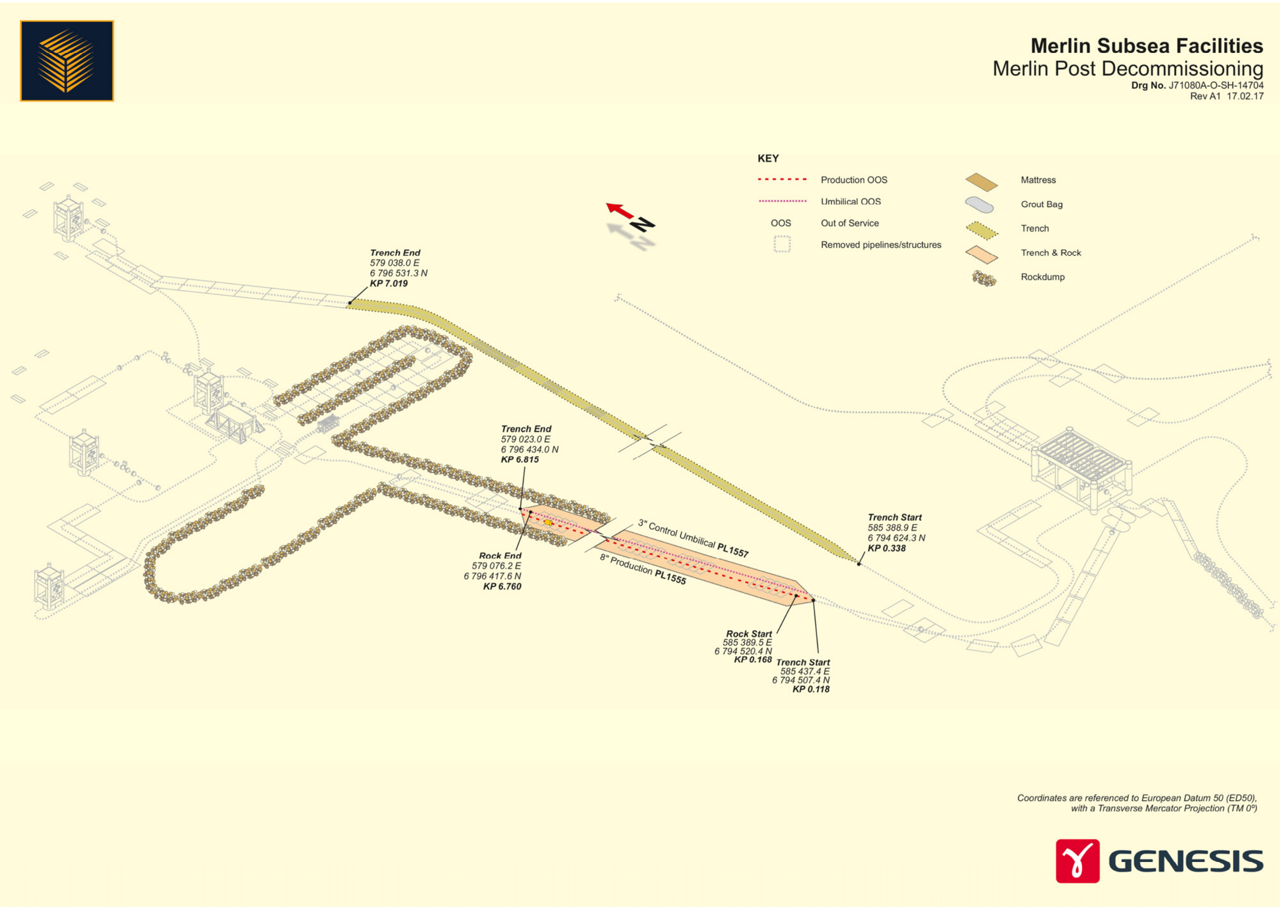


Figure 2.10 Subsea layout after completion of the decommissioning activities

2.3.2.2. Drill Cuttings

An assessment of oil-based cuttings piles in the Merlin production centre was undertaken to determine the status of the drill cuttings and to understand what the most appropriate treatment of the cuttings is (e.g. removal, leave *in situ*) (Xodus, 2017). The Merlin cuttings pile was not considered to exceed the OSPAR 2006/5 thresholds regarding the expected persistence and rate of loss of oil; estimates calculated by Fugro (2017), given in Table 2.12, show persistence to be below the 500 km^{2}year threshold and oil loss to be below the 10 tonnes per year threshold specified by OSPAR (2009a). Therefore, these cuttings piles will be left *in situ*. The potential environmental impact of future potential disturbance of these piles is discussed in Section 6.2.1.

Table 2.12 Estimates of Merlin cuttings piles in the context of the OSPAR 2006/5 thresholds

Site	Persistence (km^2year)	Yearly oil loss (tonnes)
Merlin	3.59	0.14 – 0.36

2.3.2.3. Post-Decommissioning Survey and Debris Clearance

A survey of the Merlin pipeline and umbilical routes will confirm the depth to which the decommissioned infrastructure is buried below the seabed. Environmental grab samples will be acquired to characterise the condition of the sediment chemistry and macrobenthos when decommissioning is complete. The results of the post-decommissioning survey will be compared with those of the pre-decommissioning survey to understand whether any changes in local conditions has taken place.

A post-decommissioning survey will identify any debris on the seabed within the 500 m safety zone at Merlin and within a 200 m corridor along each existing pipeline route. An ROV support vessel may be deployed to recover items of oilfield debris within the pipeline corridor and larger items within the 500 m safety zone, whilst chain mats may be deployed to clear smaller items of oilfield debris within the 500 m safety zone.

2.3.2.4. Overtrawls

An appropriate vessel will be engaged to verify that the seabed has been left in a condition that does not present a hazard for commercial fishing. This process, called overtrawling, will involve towing a chain mat (Figure 2.11) across the seabed. Fairfield will conduct overtrawling within the Merlin 500 m safety zone, with a geophysical study made within the pipeline corridors. However, it is possible that overtrawls may be required outside of the 500 m zone within the pipeline corridors to confirm absence of snag points (particularly after PL1665 removal) and the assessment presented in Chapter 6 considers this possibility. Final decommissioning activities will be considered to be complete only once evidence of a clear seabed has been submitted to BEIS, and once the Decommissioning Close-out Report has been accepted by BEIS. The 500 m safety zone around the Merlin drill centre will then be removed.

Figure 2.11 Chain mat shown on the quayside (system shown from SFF, 2016)

2.3.2.5. Monitoring

Long-term liability survey monitoring will be undertaken as required by BEIS for the infrastructure decommissioned left *in situ.* Fairfield intends to set up arrangements to undertake post-decommissioning monitoring on behalf of the Licence Owners. The frequency of any monitoring that is required is likely to be determined through a risk-based approach basis on the findings from each subsequent survey. For the purposes of this assessment, it has been assumed that up to 10 monitoring surveys will be undertaken as part of this requirement by a survey vessel every 5 years for 50 years.

2.3.3. Onshore Dismantling and Disposal

The Merlin subsea structures and equipment removed from the seabed will be delivered to one or more onshore dismantling sites. Although the dismantling site has not yet been selected, it will be chosen from a shortlist of existing onshore disposal yards and no new facilities will be required. At the dismantling site(s):

- Marine growth that has not fallen off subsea structures in transit will be removed and sent for appropriate disposal;
- Equipment suitable for reuse will be segregated;
- Pipework that has been in contact with hydrocarbons and potentially contains naturally occurring radioactive material will be assessed, and removed to a licensed facility if decontamination is necessary;
- Recovered sections of umbilical may be stripped to recover copper cable and other recyclable materials; and
- Recovered concrete will be segregated and stockpiled. The concrete will be sent for crushing and use as aggregate in new concrete where possible.

Management of waste is detailed in Section 7.

3. Environmental Description

3.1. Introduction

It is important in any EIA process that the main physical, biological and socio-economic sensitivities of the receiving environment are well understood. As such, this document describes the main characteristics and highlights key sensitivities of the environment in and around Merlin. It draws on a number of sources including published papers, relevant Strategic Environmental Assessments (SEAs) and site-specific investigations.

It is also important that the EIA recognises where gaps in the data may exist (although the North Sea and the Greater Dunlin Area have been extensively studied) and the degree of uncertainty in the baseline conditions; this is discussed in Section 4.7, along with an explanation of how any such issues have been addressed in the EIA.

Finally, the EIA must understand the sensitivity, vulnerability and value of receptors to be able to define the magnitude of any potential impact. This baseline provides the information that the impact assessments in Section 6 use to define such variables.

3.2. Physical Environment

3.2.1. Weather and Sea Conditions

3.2.1.1. Wind

Wind speed in the Project area is generally described as being either a calm to gentle breeze in the range 0 – 6 m/s or a moderate to fresh breeze in the range 6 – 10 m/s. Calm winds occur for approximately 31% of the year and moderate winds for 34.5% of the year. Gale conditions occur most frequently during the winter months (October to March) with the percentage of winds at or above 14 m/s in January being greater than 30% (BODC, 1998). The 1-year maximum wind speed over 1 hour is 31.1 m/s (PhysE, 2012). Figure 3.1 shows a wind rose for the Project area.

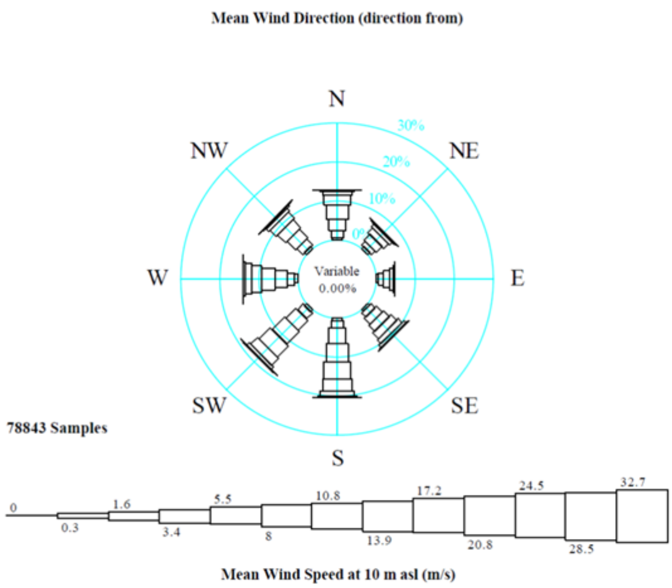


Figure 3.1 Wind rose for Project area (Fugro, 2001)

3.2.1.2. Sea

As shown in Figure 3.2, water masses of the North Sea circulate cyclonically, largely due to mass inflow from the Norwegian Sea, an influx which occurs along the Norwegian Trench at approximately 200 m depth. Water also enters the North Sea through two other routes; from the east of the Shetland Islands and between Shetland and Orkney at approximately 100 m depth (OSPAR, 2000). These inflows of water are balanced by the outflowing Norwegian Coastal Water mass, which flows predominantly along the Norwegian coast (OSPAR, 2000). As shown in Table 3.1, average current velocities in the Project area are 0.5 m/s at the surface, decreasing to 0.2 m/s near the seabed (PhysE, 2012), with an average current speed through the water column of 0.46 m/s.

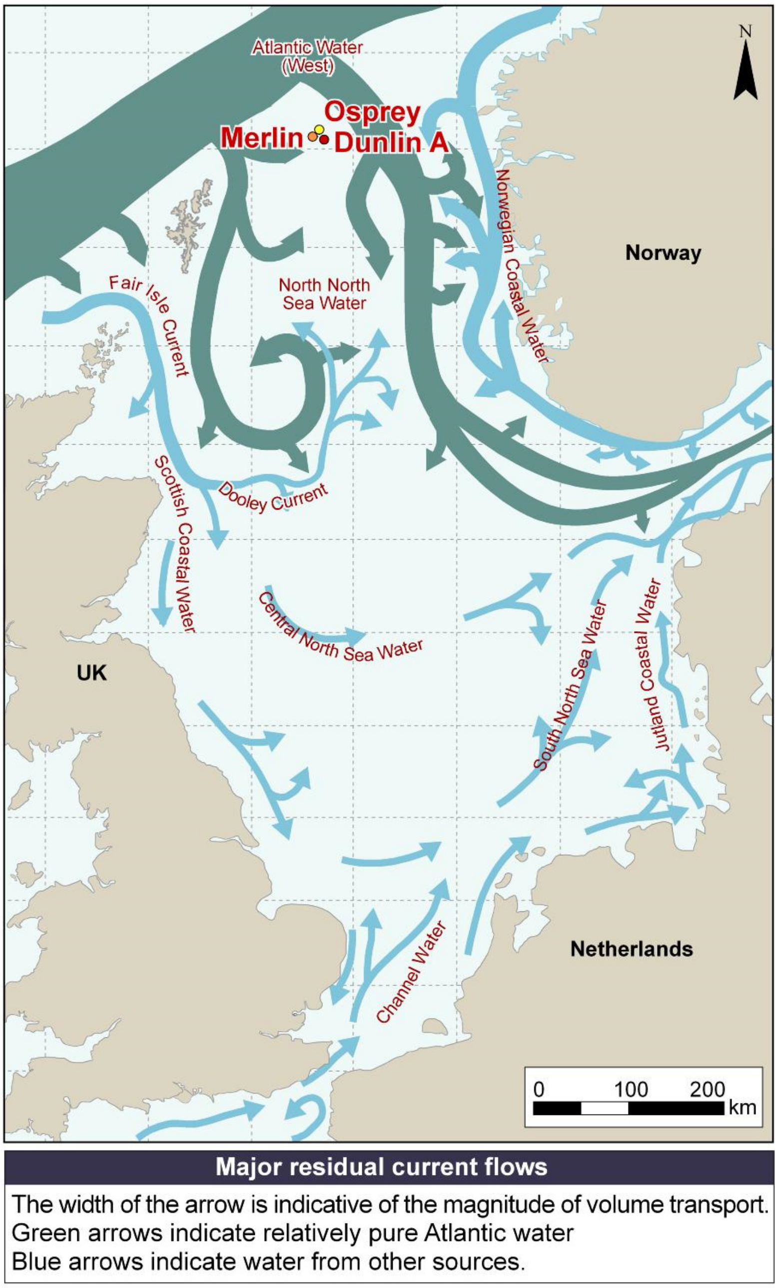


Figure 3.2 Oceanic currents in the North Sea (Caveen *et al.,* 2014)

Table 3.1 Maximum current speeds for the Project area

Depth	Current speed			
	1-year	10-year	50-year	100-year
Surface	0.50	0.66	0.79	0.86
50% of water depth	0.50	0.66	0.79	0.86
1% (near seabed)	0.20	0.27	0.32	0.35

Distinct density stratification occurs in the northern North Sea in the summer months at a depth of around 50 m and the thermocline becomes increasingly distinct towards deeper water in the north. This stratification breaks down in September as the frequency and severity of storms increases, causing mixing in the water column (DECC, 2016).

As shown in Table 3.2 wave height in the vicinity of the Project area ranges from a 1-year significant wave height of 11.5 m to a 1-year maximum wave height of 20.9 m. The maximum 100-year wave height is estimated to be 28.4 m (PhysE, 2012).

Table 3.2 Maximum extreme wave conditions for the Project area

Wave heights (m)	1-year	10-year	50-year	100-year	1,000-Year	10,000-Year
Significant wave	11.5	13.6	15.0	15.6	17.9	20.1
Maximum wave height	20.9	24.8	27.3	28.4	32.5	36.6

The average sea surface water temperature in the Project area varies seasonally between approximately 4°C in winter to around 17°C in summer. Sea bottom temperatures vary between 5°C in winter to 12°C in summer (PhysE, 2012).

3.2.2. Bathymetry and Seabed Conditions

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. Water depths gradually deepen from south to north (DTI, 2001). The northern North Sea has a depth ranging from 100 m at the southern point in the Fladen/Witch Ground to as deep as 1,500 m in the Faroe-Shetland Channel.

In the northern North Sea, and indeed across the North Sea, seabed sediments generally comprise a veneer of unconsolidated terrigenous and biogenic deposits, generally much less than 1 m thick, although areas of outcropping rock occur in coastal waters around and between Shetland, Orkney and the Scottish mainland. Sediments in the Project area are predominantly sand and muddy sand, although the deeper areas within the Fladen Ground consist of mud or sandy mud off the edge of the continental shelf to the north, the slope is characterised by areas of mixed and coarse sediments, while the floor of the Faroe-Shetland Channel is classified as mud (JNCC, 2010a).

As part of preparation for the Subsea Infrastructure Decommissioning Project, and as part of earlier operation of the Greater Dunlin Area, the following site-specific surveys have been undertaken in recent years:

- Decommissioning surveys
  - Osprey Pre-decommissioning Habitat Survey and Environmental Baseline Survey (EBS) (Fugro, 2016a; Fugro, 2016b);
  - Merlin Pre-decommissioning Habitat Survey and EBS (Fugro 2016c; Fugro 2016d);
  - Dunlin Field Pre-decommissioning Habitat Survey and EBS (Fugro, 2016e; Fugro 2016f);
  - Dunlin Fuel Gas Pre-decommissioning Habitat Survey and EBS (Fugro 2016g; Fugro 2016h); and
  - Dunlin Power Import Cable Pre-decommissioning Habitat Survey and EBS (Fugro 2016i; Fugro 2016j).
- Other surveys within and around the Project area
  - Osprey Debris Clearance and Environmental Survey (Gardline, 2009a);
  - Dunlin Development Debris Clearance, ‘Mud Mound’ and EBS (Gardline, 2009b);
  - Dunlin Fuel Gas Import Route Survey (Gardline, 2011);
  - Dunlin to Northern Leg Gas Pipeline (NLGP) Pipeline Route Survey (Gardline, 2010a); and
  - Quad 211 Infield Environmental Survey (Gardline, 2010b).

The majority of locations surveyed during these campaigns are illustrated in Figure 3.3 and Figure 3.4.

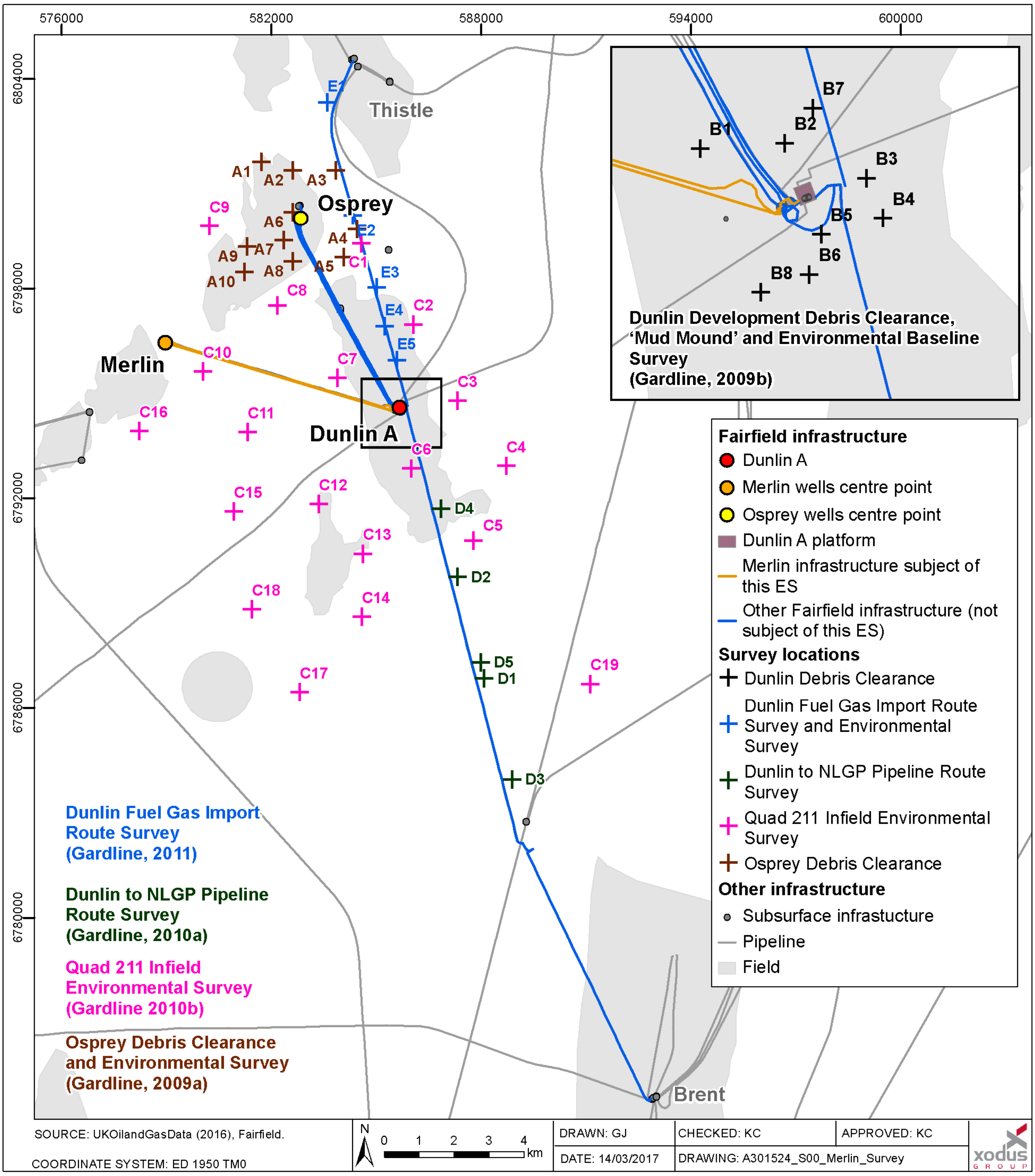


Figure 3.3 Environmental sampling locations (Gardline, 2009a, Gardline, 2009b, Gardline, 2010a, Gardline, 2010b, Gardline, 2011)

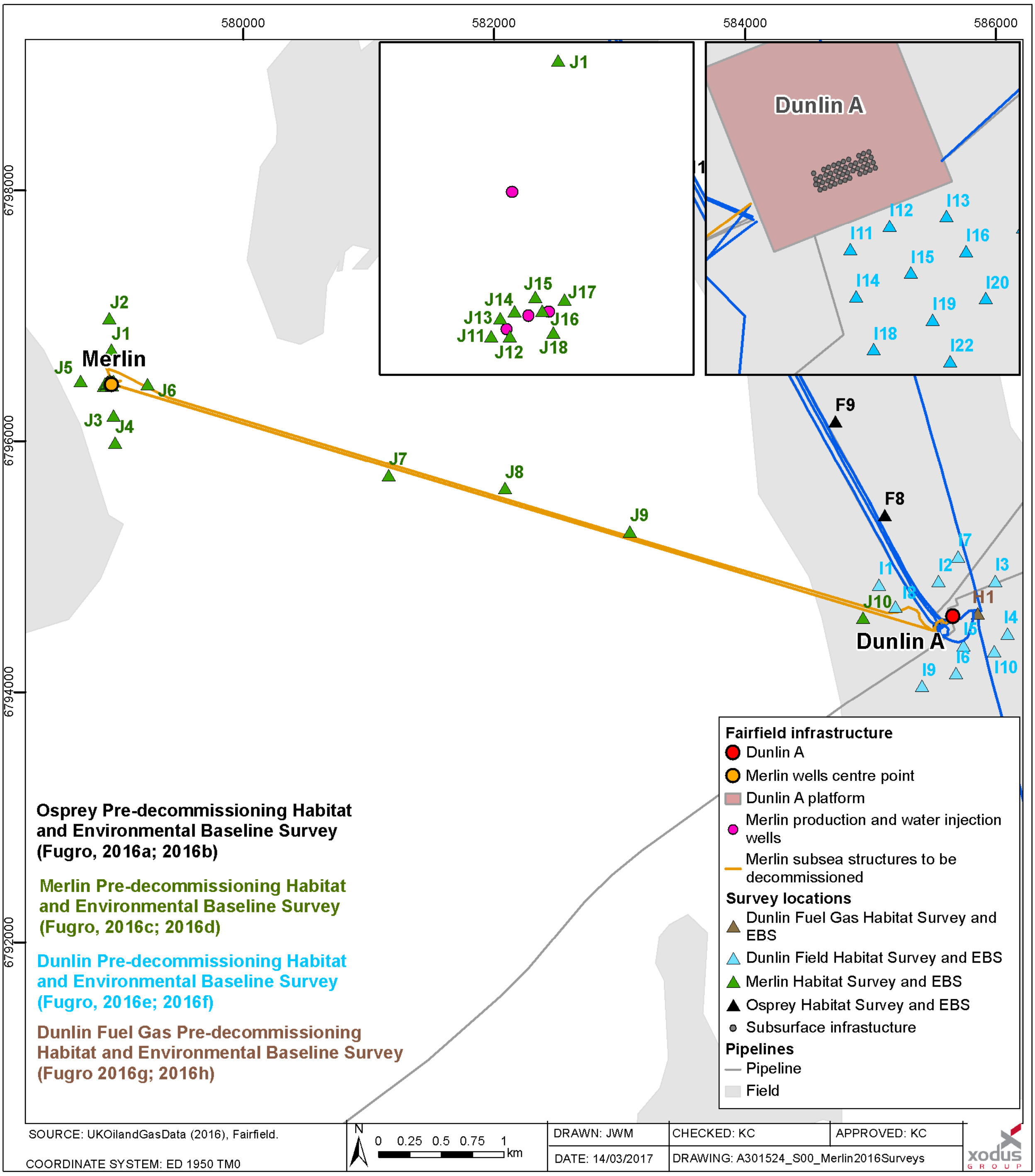


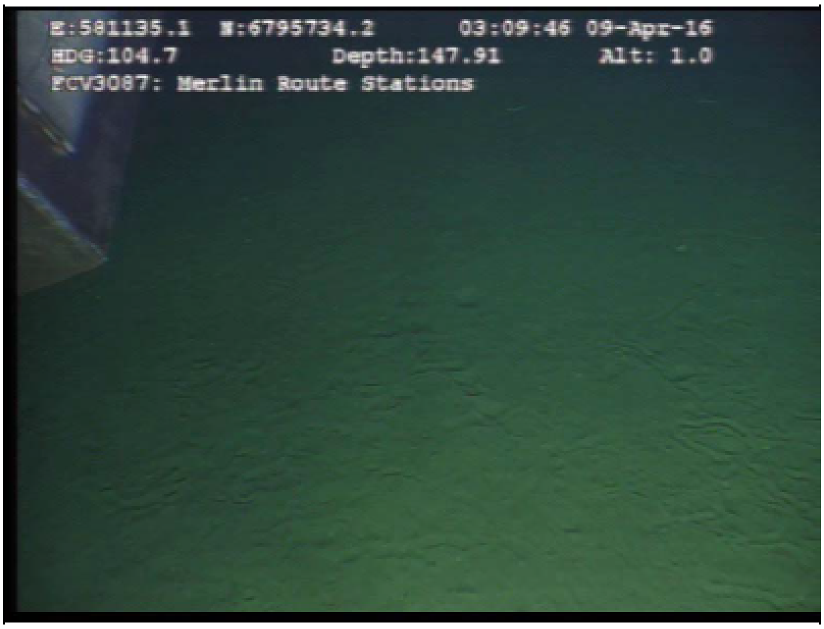
Figure 3.4 Pre-decommissioning environmental sampling locations (Fugro 2016a, Fugro 2016b, Fugro 2016c, Fugro 2016d, Fugro 2016e, Fugro 2016f, Fugro 2016g, Fugro 2016h)

The Merlin field is relatively flat, situated in a water depth of 150 m. Along the pipeline route from Merlin to Dunlin Alpha platform, the route is also relatively flat ranging from depths of approximately 150 m to the north west to 152 m in the south east (Fugro, 2016c).

As shown in Table 3.3, the sediments collected in the vicinity of the Merlin drill centre and along the pipeline route were mainly classified as fine sand (nine stations) (Fugro, 2016d). One sample (J7) contained higher proportion of gravel particles and was classified as medium sand. Mean particle diameter values recorded for all samples ranged from 167 μm to 365 μm (mean 208 μm). These sediment types were consistent with those recorded during the 2008 to 2009 baseline survey of UKCS Quad 211 (Gardline, 2010b). The sediment was regularly scattered with holes, burrows, small mounds and surface tracks (Fugro 2016d). Photographs of the seabed at Stations J7 and J10 are shown in Figure 3.5 and Figure 3.6. Photographs of seabed sediment samples taken at Stations J10 and J1 are shown in Figure 3.7 and Figure 3.8.

Table 3.3 Sediment particle size and hydrocarbon data from site surveys (Gardline, 2010b, Fugro, 2016d)

Survey	Station (Figure 3.3 and 3.4)	Sorting	Mean particle size			Total organic carbon (%)	Total hydrocarbon content (μgg^{-1})
			Phi	μm	Wentworth class		
Fugro (2016d)	J1	Very poor	2.58	167	Fine sand	0.33	12.6
	J2	Very poor	2.44	184	Fine sand	0.31	10.7
	J3	Very poor	2.32	200	Fine sand	0.29	16.0
	J4	Poor	2.44	184	Fine sand	0.34	12.7
	J5	Poor	2.45	183	Fine sand	0.30	11.5
	J6	Poor	2.20	217	Fine sand	0.26	12.9
	J7	Very poor	1.45	365	Medium sand	0.25	10.0
	J8	Poor	2.32	200	Fine sand	0.27	12.9
	J9	Poor	2.39	191	Fine sand	0.28	9.6
	J10	Very poor	2.37	194	Fine sand	<0.20	11.9
Gardline (2010b)	C10	Poor	1.99	251	Medium Sand	0.7	18.0
	C16	Poor	2.23	214	Fine Sand	0.9	18.8

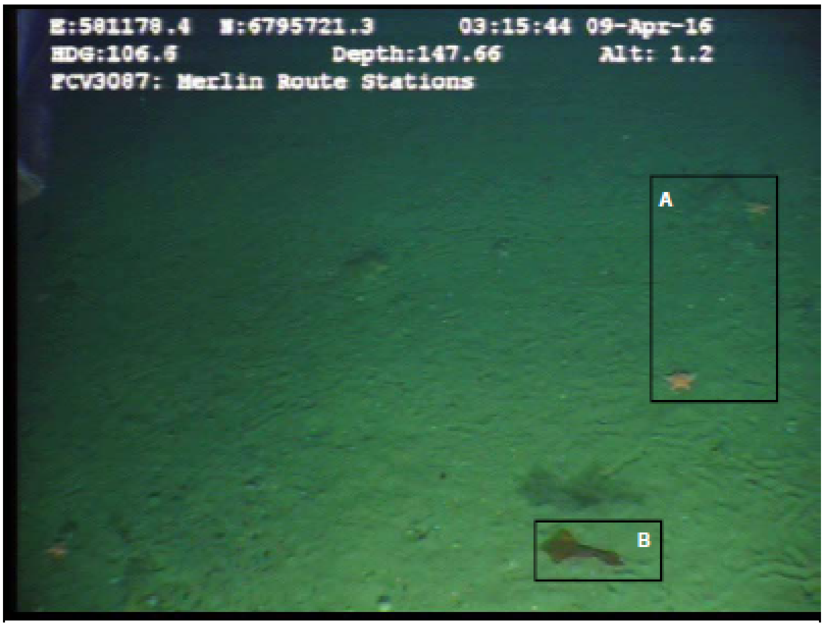


Photograph:
MR_STN03_VLC Snaps_1

Easting: 581 135.1 mE
Northing: 6 795 734.2 mN
Depth: 147.91 m

Sediment Type:
Muddy sand with shell fragments, occasional gravel and small cobbles

Fauna:
Burrows



Photograph:
MR_STN03_VLC Snaps_13.1

Easting: 581 178.4 mE
Northing: 6 795 721.3 mN
Depth: 147.66 m

Sediment Type:
Muddy sand with shell fragments, occasional gravel and small cobbles

Fauna:
A: Starfish (Asteroidea)

B: Squid (Loliginidae)

Figure 3.5 Seabed photographs of Station J7 (Fugro 2016c)

Photograph:
MR_STN05_VLC Snaps_2.1

Easting: 584 959.7 mE
Northing: 6 794 573.1 mN
Depth: 148.58 m

Sediment Type:
Muddy sand with shell fragments and occasional gravel

Fauna:
Cod fish (Gadidae)

Photograph:
MR_STN05_VLC Snaps_3

Easting: 584 954.0 mE
Northing: 6 794 573.9 mN
Depth: 148.69 m

Sediment Type:
Muddy sand with shell fragments and occasional gravel

Fauna:
A: Starfish (Asteroidea)

Figure 3.6 Seabed photographs of Station J10 (Fugro, 2016c)

Figure 3.7 Photograph of seabed sample taken at Station J10 (Fugro, 2016d)

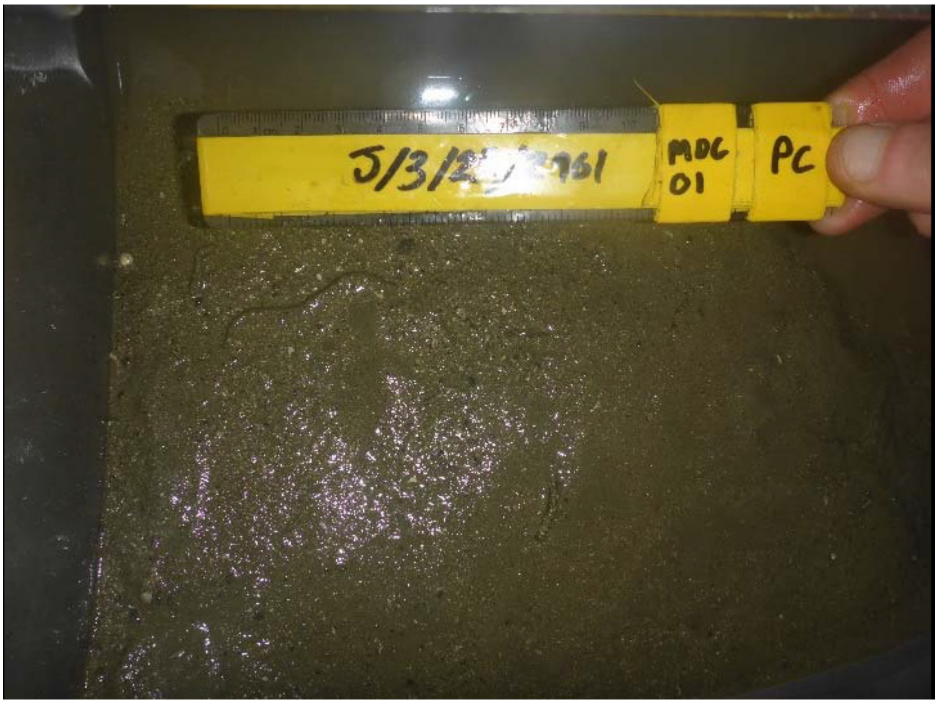


Figure 3.8 Photograph of seabed sample taken at Station J1 (Fugro, 2016d)

Total hydrocarbon content (THC) recorded in earlier surveys in the Project area showed levels at sample stations C10 and C16 of 18.0 μgg^{-1} and 18.8 μgg^{-1} respectively. Total hydrocarbon levels recorded for the Merlin drill centre and pipeline route stations (Fugro, 2016d) were relatively consistent and ranged from 9.6 μgg^{-1} at station J9 to 16.0 μgg^{-1} at station J3 (mean 12.1 μgg^{-1}). The recorded THC values were similar to the levels recorded at the other Merlin stations and comparable to the baseline values recorded during the 2008 to 2009 survey of UKCS Quad 211 (mean 16.9 μgg^{-1}) (Gardline, 2010b). The THC results were also comparable to the regional background concentration, calculated from environmental survey data collected between 1975 and 1995 in the northern North Sea area; 11.6 μgg^{-1} (Table 3.3, UKOOA, 2001).

Total 2 to 6 ring Polycyclic Aromatic Hydrocarbons (PAH) levels in the surface sediments collected from the Merlin area in 2015 (Fugro, 2016d) ranged from 0.057 μgg^{-1} to 0.112 μgg^{-1} (mean 0.085 μgg^{-1}), comparable to the background concentrations previously measured across the northern North Sea (mean concentration 0.260 μgg^{-1}, UKOOA, 2001) and the average background concentrations (0.070 μgg^{-1}) recorded during baseline survey of the area in 2009 (Gardline, 2010b).

3.2.3. Drill Cuttings

Sediment samples at the Merlin Drill Centre (MDC) were classified as poorly to very poorly sorted medium silt to very fine sand; mean particle diameter ranged from 27 µm at Station J15 (note: all station references are shown on Figure 3.4) to 109 µm at Station J11 and variability between stations was low. Surface sediments of the MDC (Stations J11 – J18) were finer (mean 70 µm) than those recorded away from the drill centre (Stations J1 – J5), where the mean diameter was 184 µm; this predominance of fine sediment is typical of areas contaminated with drilling mud.

Total organic carbon (TOC) and total organic matter (TOM) concentrations near the MDC (Stations J11 – J18) were 0.34% and 1.7% respectively, similar to values recorded in the wider area (Stations J1 – J5). Areas contaminated with oil-based drilling muds typically exhibit high TOC/TOM concentrations; this was not apparent at the MDC.

THC from surface samples ranged from 34.5 μgg^{-1} at Station J17 to 204 μgg^{-1} at Station J15; the mean value was 96.5 μgg^{-1}. Total n-alkanes (n12 to n36), another measure of hydrocarbon presence, ranged from 1.17 μgg^{-1} at Station J12 to 15.7 μgg^{-1} at Station J15 (mean 4.2 μgg^{-1}). THC exceeded the OSPAR (2006) ecological effects threshold of 50 μgg^{-1}; it was above the UKOOA (2001) northern North Sea background concentration of 11.6 μgg^{-1} but well below the UKOOA (2001) average for stations within 500 m of an active installation (12,000 μgg^{-1}).

Chromatograms suggested the presence of weathered low toxicity oil-based drilling mud (LTOBM) and synthetic olefin-based fluid. No drilling fluid signatures were identified from the core samples, except from one sample taken at Station J16 at 50 cm depth, where a synthetic olefin signature was identified.

Total polycyclic aromatic hydrocarbons (PAHs) content in the surface samples ranged from 0.175 μgg^{-1} at Station J12 to 1.63 μgg^{-1} at Station J16 (the mean concentration was 0.797 μgg^{-1}). The OSPAR (2014) effects range low concentration is 4.1 μgg^{-1}, indicating PAHs at Merlin are not at a level expected to cause environmental impacts. Merlin PAH concentrations are also well below the UKOOA (2001) average for stations within 500 m of an active installation (18.3 μgg^{-1}) and only slightly above the UKOOA (2001) northern North Sea background concentration (0.26 μgg^{-1}).

Metals analysis clearly indicated the presence of drilling muds at the site. Barium, which is used as a weighting agent in drilling muds was elevated at all surface stations, ranging from 5,560 μgg^{-1} at Station J12 to 193,000 μgg^{-1} at Station J16. Apart from one core sample taken at 50 cm depth at Station J16 where a concentration of 3,780 μgg^{-1} was recorded, the core samples were comparable with the average barium concentration in UKCS Quadrant 211 (478 μgg^{-1}; GEL, 2010), and only slightly exceeded the North Sea background concentration of 238.67 μgg^{-1} (bioavailable) (UKOOA, 2001). The barium concentrations in the remainder of the core samples do not indicate the presence of drill cuttings, suggesting the drill cuttings layer at Merlin is relatively shallow (shallower than the cuttings deposition depth of 1.16 m interpreted from the multi-beam echosounder data; Fugro, 2017). THC across the cuttings pile is low compared to the recorded barium concentrations; the low THC to barium ratio suggests either that oil based mud used to drill the wells has undergone significant weathering, or that the majority of the cuttings accumulation is composed of water-based muds.

A number of metals analysed, including cadmium, lead and mercury, exceeded UKOOA (2001) northern North Sea background concentrations. These elevated levels are consistent with the presence of drilling mud. Most metals were present at below effects range low (ERL) (OSPAR, 2014) concentrations.

Overall, the environmental data obtained from the pre-decommissioning survey of the MDC indicates the presence of a surface layer of cuttings within 65 m of the drill centre. There is evidence of oil based mud drilling fluids (synthetic and low toxicity), but the proportion of hydrocarbons to barite is low suggesting that a large proportion of the seabed deposits originate from discharges of water based muds cuttings. The cuttings deposits are relatively shallow (up to 50 cm deep) and bathymetric survey data provide no indication of the presence of a clearly defined cuttings pile.

3.3. Biological Environment

3.3.1. Plankton

Plankton consists of the plants (phytoplankton) and animals (zooplankton) that drift in the surface waters with the tides and currents. Plankton forms the basis of marine ecosystem food webs and the composition of planktonic communities is variable temporally, depending upon the circulation patterns of water masses, the season and nutrient availability. The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (Edwards *et al*., 2010). The majority of the plankton occurs in the photic zone (the upper 20 m or so of the sea) which receives enough light for photosynthesis (Johns and Reid, 2001). However, zooplankton distribution can extend to greater depths and many species undergo diurnal vertical migrations, rising to the surface to feed before returning to depth. Natural seasonality and high small-scale variability, both in species composition and abundance, is an important feature of planktonic communities. Many species of larger animals such as fish, birds and cetaceans, are dependent upon the plankton for food. The distribution of plankton therefore directly influences the movement and distribution of other marine species.

In both the northern and central areas of the North Sea, the dinoflagellate genus *Ceratium* dominates the phytoplankton community, although there has been a decline in dinoflagellates in the North Sea over the last decade (DECC, 2016). Densities of phytoplankton fluctuate during the year, with sunlight intensity and nutrient availability driving its abundance and productivity, which ultimately is affected by water column stratification (Johns and Reid, 2001). Based on the 10 year period between 1997 and 2007, phytoplankton levels within the central North Sea appear to spike in April. A second, lesser spike is seen in August before levels decrease through the winter months when light and temperature are less abundant (SAHFOS, 2015). The characteristics of this annual cycle are determined by local weather and oceanographic conditions and are important in biological terms as they provide important feeding areas for most animal groups within the marine ecosystem, including zooplankton, cephalopods, pelagic fish, seabirds and cetaceans (Johns and Reid, 2001).

Analysis of data provided by the Continuous Plankton Recorder (CPR) surveys suggest that the most abundant zooplankton species in the North Sea are the calanoid copepods, in particular *Calanus* spp. and smaller copepod species such as *Para-Pseudocalanus* spp., *Acartia* and the younger stages of *Calanus* (Johns and Reid, 2001). *Calanus finmarchicus* has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Analysis of data provided by the CPR surveys in the 10 year period between 1997 and 2007 shows that the biomass of *C. finmarchicus* in the central North Sea attains higher levels than in the southern North Sea but lower than in the northern North Sea. The trend indicates a small increase in abundance between April and May within the central North Sea which corresponds to an increase in phytoplankton in April.

Overall abundance of *C. finmarchicus* has declined significantly over the last 60 years. This has mainly been attributed to changes in seawater temperature and salinity (Beare *et al*., 2002, FRS, 2004). *C. finmarchicus* has been replaced to some degree by boreal and temperate Atlantic and neritic species; in particular, a relative increase in the populations of *C. helgolandicus* has occurred (DECC, 2016, Baxter *et al*., 2011).

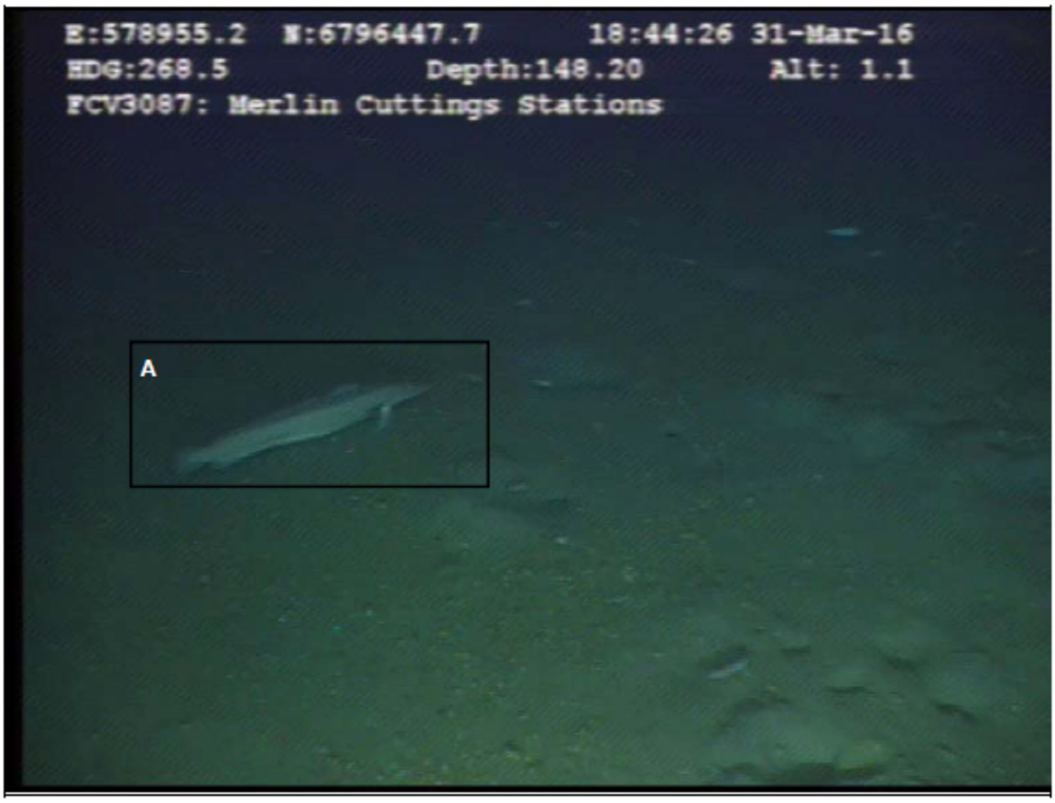
3.3.2. Benthos

3.3.2.1. Merlin subsea area

Knowledge of the composition of the infauna (invertebrates living within benthic sediments) and epifauna (mobile or sessile species living on the seabed) is important in predicting the potential impacts of the disturbance that could result from the proposed operations.

The benthos across the survey area were dominated by the polychaetes *Euchone incolor, Galathowenia oculata, Prionospio cirrifera, Amythasides macroglossus, Paradoneis lyra* and *Aonides paucibranchiata* and the bivalves *Adontorhina similis* and *Axinulus croulinensis*. These species are all considered to be hydrocarbon intolerant (Hiscock *et al*., 2005, Rygg and Norling, 2013) and are usually found to be absent or in reduced numbers in areas of contamination. Fugro (2016d) recorded a relatively diverse and homogeneous seabed with only one station close to the Dunlin Alpha platform showing a significantly different fauna community.

A habitat assessment for the Merlin survey area (Fugro, 2016c) classed it as the European Nature Information System (EUNIS) biotope complex ‘Circalittoral muddy sand’ (A5.26) and ‘Circalittoral Mixed Sediment (A5.4)’ (examples are shown in Figure 3.5). Large observable fauna was generally very sparse, a few cushion stars (Asteroidea), some starfish (Asteroidea) and sea urchins (potentially *Echinocardium cordatum*) were observed, but imagery was not sufficiently defined for conclusive identification. However, one starfish, *Luidia ciliaris* was identified. One sea cucumber (Holothuroidea) and two large whelks (Buccinoidea) were recorded along transect at Station J4 (shown on Figure 3.4). Burrows and small mounds were observed along the majority transects at abundances between Occasional to Frequent. Other than the presence of a small number of juvenile ocean quahog (*Arctica islandica*), which is on the OSPAR (2008) ‘List of threatened and declining habitats and species’, no benthos related species or habitats of conservation significance were observed during the 2015 survey (Fugro, 2016d).



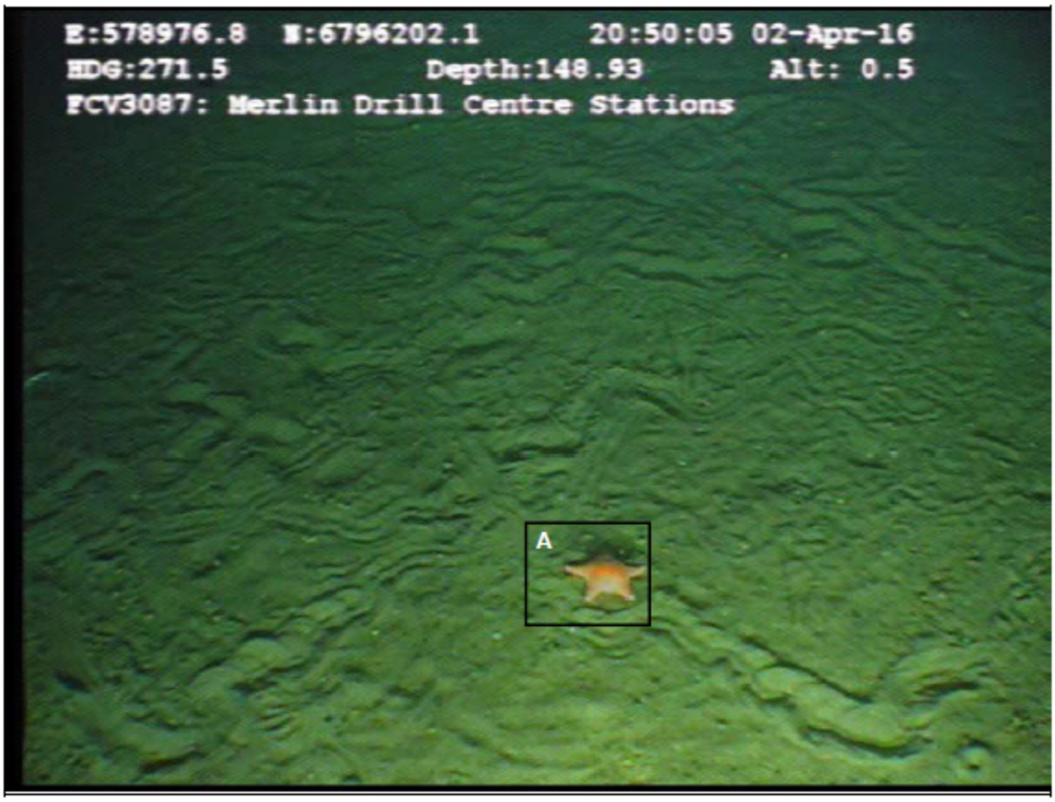


Figure 3.9 Merlin subsea area seabed photography, showing circalittoral mixed sediment in the upper image and circalittoral muddy sand in the lower image (a ling is identified by an 'A' in the upper image and a starfish in the lower) (Fugro, 2016c)

3.3.2.2. Drill Cuttings

The macrofauna survey of the MDC, excluding juvenile records, saw 73 taxa identified. Annelids dominated the taxa (64.4%), followed by molluscs (15.1%), arthropods (9.6%) and echinoderms (2.7%). Other taxa (including cnidarians and nemerteans) accounted for 8.2%. Annelids accounted for a greater proportion of taxa at the MDC compared to surveys in the wider area, and arthropod taxa were noticeably more scarce.

Across the MDC, *Galathowenia oculata* was the most abundant species at two stations and was within the top three taxa at the remaining stations, which were dominated by *Paramphinome jeffreysii* and *Aricidea catherinae*. Other abundant species included *Spiophanes kroyeri* and *Pterolysippe vanelli*. The majority of the species identified are considered to be intolerant of hydrocarbon pollution, however species considered indicative of hydrocarbon pollution also appeared in the top ten taxa (e.g. *Thyasira sarsi*). The secondary coloniser *Chaetozone setosa* was in the top ten taxa at some stations in the MDC.

Analysis of the macrofaunal data showed that the stations in the MDC were different to the stations sampled in the wider field, with a lower number of taxa, absence of several taxa in the MDC samples that were present in the wider survey area, and a relative abundance of *C. setosa*. Two sets of strongly correlated variables were observed during analysis; the first was distance from the drill centre, sediment size, carbonate content and iron content or related factors. The second was THC, sediment size and arsenic, iron and zinc concentrations.

Therefore, whilst the faunal community at the MDC is clearly being affected by the presence of the cuttings, there is no apparent strong dominance of contaminant-tolerant taxa. Instead, the fauna is more generally suppressed, with reduced numbers of individuals present across faunal groups, and some taxa completely absent. This is consistent with the relatively low levels of hydrocarbons and associated contaminants recorded in the area.

3.3.3. Fish and Shellfish

DECC (2016) report that species diversity within the fish community is not as great in the central and northern North Sea as in the southern North Sea. DECC (2016) also report that the fish community between 100 and 200 m (i.e. within the depth bounds of the Project area) is characterised by long rough dab (*Hippoglossoides platessoides*), hagfish (*Myxine glutinosa*) and Norway pout (*Trisopterus esmarkii*). Basking shark (*Cetorhinus maximus*), tope (*Galeorhinus galeus*) and porbeagle (*Lamna nasus*) are all also likely to occur in small numbers throughout the North Sea, and the common skate (*Dipturus batis*) occurs at low density throughout the northern North Sea. However, these species are considered to be rare in the waters surrounding the Project area (DECC, 2016).

Fisheries sensitivity data (Coull *et al*., 1998, Ellis *et al*., 2012) have been used to identify the spawning grounds (location where eggs are laid) and nursery grounds (location where juveniles are common) for fish species in the vicinity of the Project area (Table 3.4). These areas are illustrated in Figure 3.10 and Figure 3.11. No herring spawning benthic sensitivities are known to occur in the Project area (Coull *et al*., 1998, Ellis *et al*., 2012), or are likely to occur in the Project area (based on sediment type).

The fish populations in the Project area are characterised by species typical of the northern North Sea. There are a number of spawning and nursery regions for commercially important fish and shellfish species that occur in the vicinity of the Project area (Coull *et al*., 1998, Ellis *et al*., 2012). The Project area is located within the spawning grounds of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), Norway pout and saithe

(*Pollachius virens*). Nursery grounds of blue whiting (*Micromesistius poutassou*), European hake (*Merluccius merluccius*), herring (*Clupea harengus*), ling (*Molva molva*), mackerel (*Scomber scombrus*), Norway pout, spurdog (*Squalus acanthias*) and whiting (*Merlangius merlangus*). Information on spawning and nursery seasonality for the different species is detailed in Table 3.4.

Fisheries sensitivity maps produced by Aires *et al*. (2014), found the probability of blue whiting, cod, European hake, haddock, herring, ling, mackerel, Norway pout, saithe, spurdog and whiting aggregations in area of the planned operations as being low. The pre-decommissioning habitat assessment survey (Fugro, 2016c) highlighted the occasional fish transiting the Merlin area including cod, a few saithe, ling, which is listed on the International Union for Conservation of Nature (IUCN) red list, and various gadoid (cod-like) fish.

Table 3.4 Fish spawning and nursery timings in the Project area (Coull *et al*., 1998, Ellis *et al*., 2012)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Haddock	N	SN	SN	SN	SN	N	N	N	N	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Saithe	S	S	S	S								
Norway pout	N	N	SN	SN	SN	N	N	N	N	N	N	N
Ling	N	N	N	N	N	N	N	N	N	N	N	N
European Hake	N	N	N	N	N	N	N	N	N	N	N	N
Anglerfish	N	N	N	N	N	N	N	N				
Cod	SN	SN	SN	SN	N	N	N	N	N	N	N	N
Whiting	N	SN	SN	SN	SN	SN	N	N	N	N	N	N
Blue whiting	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Key			S = Peak spawning			S = Spawning			N = Nursery			

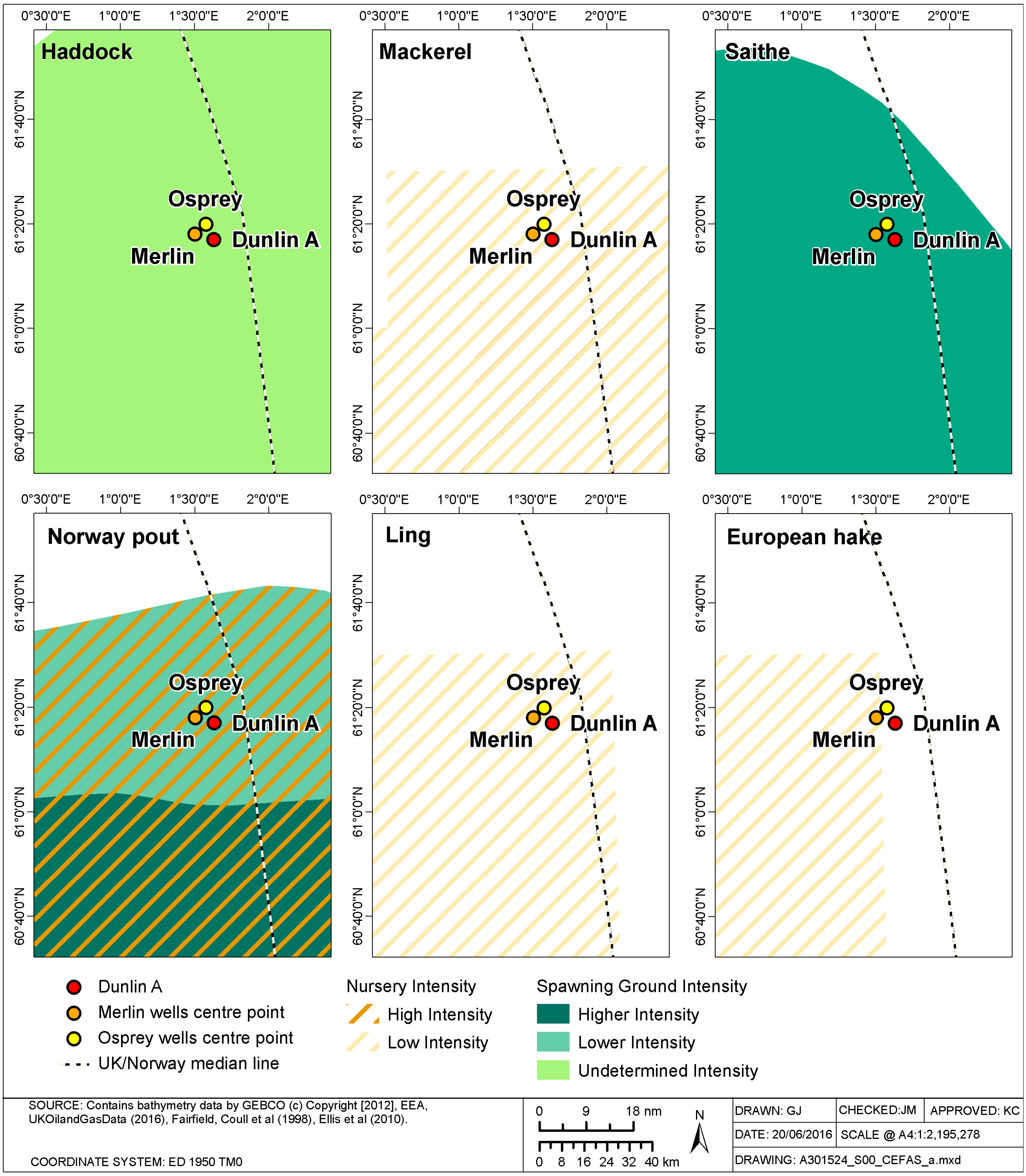


Figure 3.10 Fish spawning and nursery grounds around the Project area (Coull *et al.*, 1998, Ellis *et al.*, 2012)

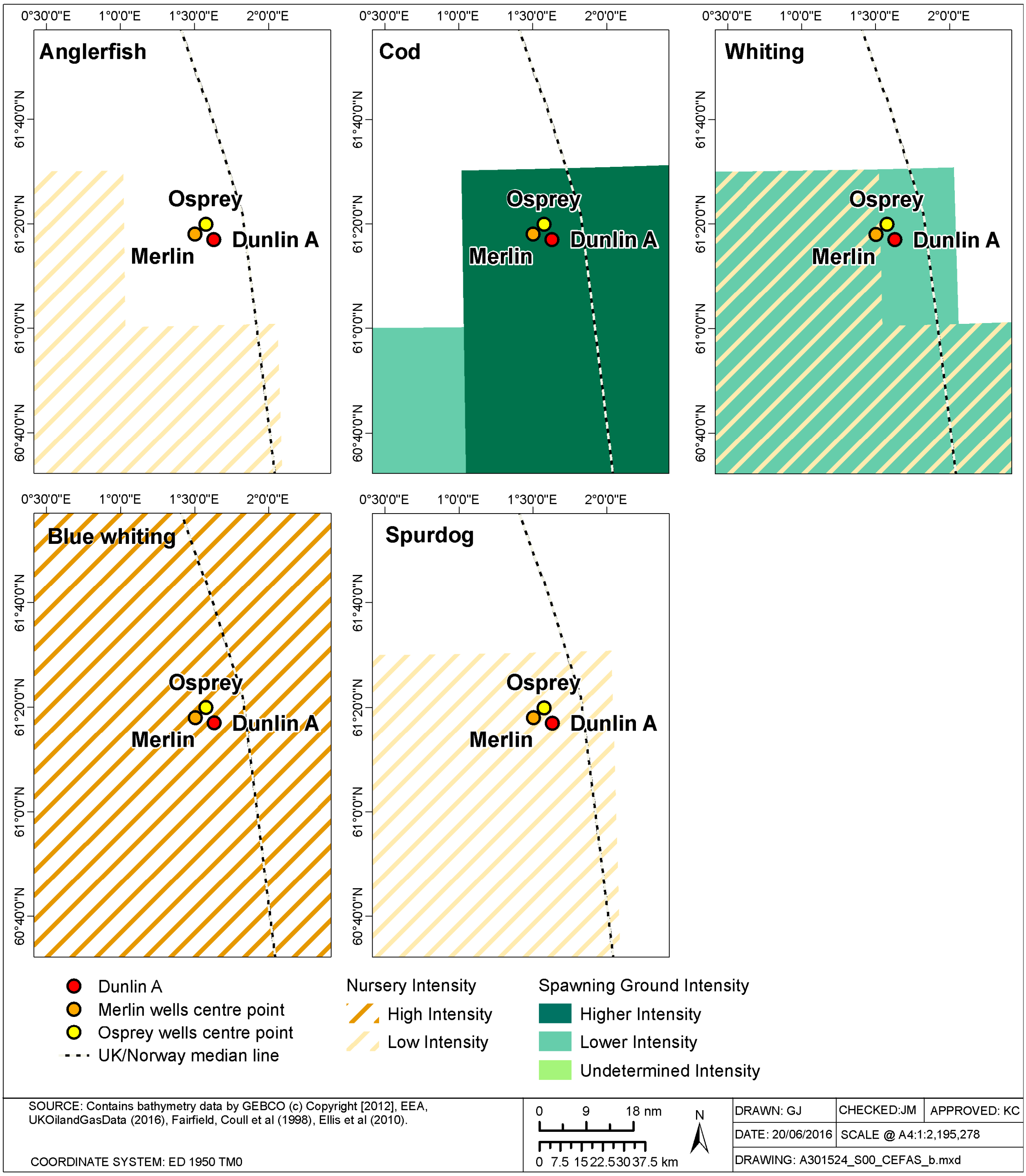


Figure 3.11 Fish spawning and nursery grounds around the Project area (Coull *et al*., 1998, Ellis *et al*., 2012)

3.3.4. Seabirds

The Project area is important for fulmar (*Fulmarus glacialis*), gannet (*Morus bassanus*), great black-backed gull (*Larus marinus*), Atlantic puffin (*Fratercula arctica*), kittiwake (*Rissa tridactyla*), and guillemot (*Uria aalge*) for the majority of the year (DECC, 2016). Manx shearwaters (*Puffinus puffinus*) are present in the vicinity of the Project area between spring and autumn months. European storm petrels (*Hydrobates pelagicus*) are present during September and November. Great skua (*Stercorarius skua*), glaucous gull (*Larus hyperboreus*), arctic skua (*Stercorarius parasiticus*) and little auk (*Alle alle*) are generally present in the northern North Sea in low densities for the majority of the year.

The seasonal vulnerability of seabirds to oil pollution in the immediate vicinity of the Project area has been derived from JNCC block specific data (Figure 3.12 and Figure 3.13, JNCC, 1999). The months of March, July, October and November are those when seabird species at the Project area are most vulnerable to surface pollution. Overall annual seabird vulnerability is reported to be low by JNCC (1999). It is recognised that JNCC has released further data on vulnerability, as reported by Hi Def (2016). For the Project area, review of these data indicate vulnerability of similar or lower magnitude. However, there are significant data gaps at times of the year, and this assessment has retained the higher sensitivity figures to ensure it is not underestimated.

3.3.5. Cetaceans

Twenty eight cetacean species have been recorded in UK waters from sightings and strandings. Of these, eleven species are known to occur regularly, while seventeen are considered rare or vagrant (DECC, 2016). Cetaceans regularly recorded in the North Sea include white-sided dolphin *Lagenorhynchus acutus*, bottlenose dolphin (*Tursiops truncatus)* (primarily in inshore waters), harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutorostrata*), pilot whale (*Globicephala melas*), common dolphin (*Delphinus delphis*) and white-beaked dolphin (*Lagenorhynchus albirostris*) (Reid *et a*l., 2003). Risso's dolphin (*Grampus griseus*) and some large baleen whales are also occasionally sighted. Spatially and temporally, harbour porpoises, white-beaked dolphins, minke whales, killer whales and white-sided dolphins are the most regularly sighted cetacean species in the North Sea (Hammond *et al*., 2001; Reid *et al*., 2003). The bottlenose dolphin is generally coastal in extent and thus is unlikely to be sighted in the vicinity of the Project area with any regularity.

Occurrence of the most frequently recorded species is detailed in Table 3.5.

3.3.6. Seals

Grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals will feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season.

Seal tracking studies from the Moray Firth have indicated that the foraging movements of harbour seals are generally restricted to within a 40 – 50 km range of their haul-out sites (SCOS, 2014). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred km from one haul-out to another have been recorded (SMRU, 2011). As the Project area is located approximately 132 km offshore, these species may be encountered in the vicinity from time to time, but are unlikely to use the area with any regularity or in great numbers. This is confirmed by the latest grey and harbour seal density maps commissioned by the Scottish Government which report the presence of grey and harbour seals in the Project area as between zero and one individual per 25 km^2 (Jones *et al*., 2013).

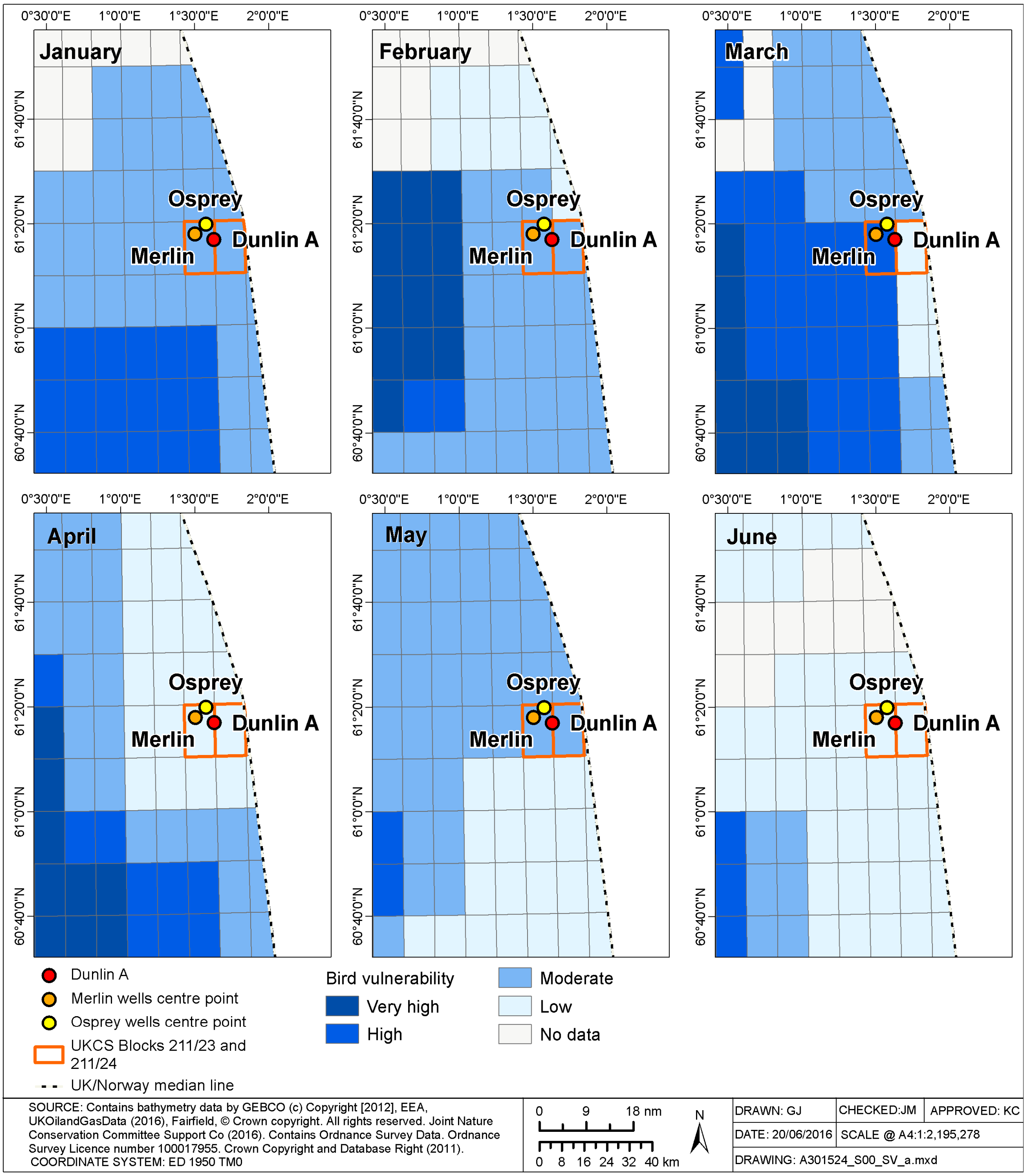


Figure 3.12 Seabird vulnerability within the vicinity of the Project area

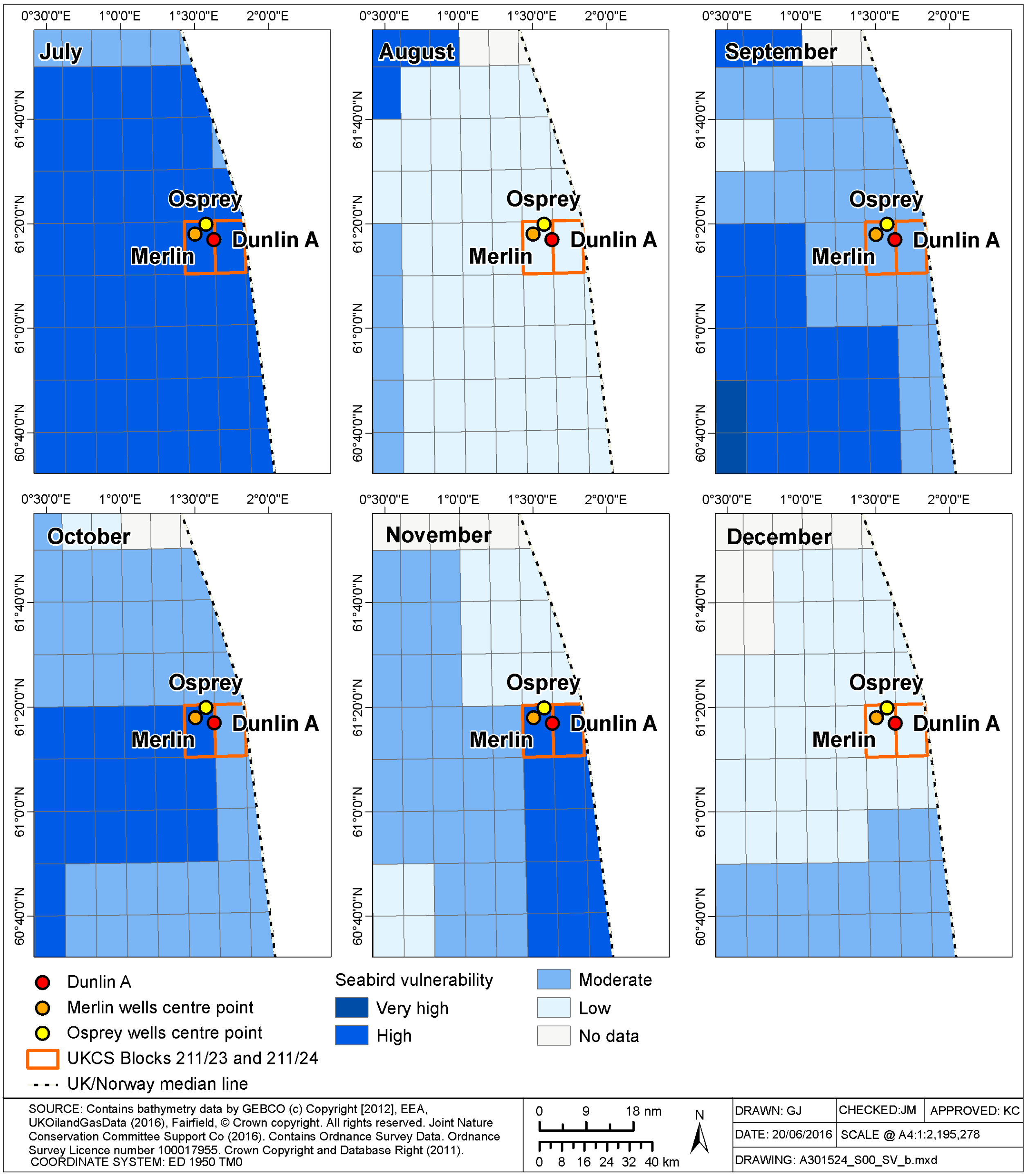


Figure 3.13 Seabird vulnerability within the vicinity of the Project area

Table 3.5 Occurrence of cetaceans likely to be most regularly observed in the Project area (Hammond *et al*., 2001, Reid *et al*., 2003)

Species	Description of occurrence
Harbour porpoise	Harbour porpoise are frequently found throughout the UK waters. They usually occur in groups of one to three individuals in shallow waters, although they have been sighted in larger groups and in deep water. It is not thought that the species migrate.
Killer whale	Widely distributed with sightings across the North Sea all year round; seen in both inshore waters (April to October) and the deeper continental shelf waters (November to March). May move inshore to target seals seasonally.
Minke whale	Minke whales usually occur in water depths of 200 m or less and occur throughout the northern and central North Sea. They are usually sighted in pairs or in solitude; however groups of up to 15 individuals can be sighted feeding. It appears that animals return to the same seasonal feeding grounds.
Atlantic white-sided dolphin	White-sided dolphin show both season and inter-annual variability. They have been sighted in large groups of 10 - 100 individuals. They have been sighted in waters ranging from 100 m to very deep waters, but also enter the continental shelf waters. They can be sighted in the deep waters around the north of Scotland throughout the year and enter the North Sea in search of food.
White-beaked dolphin	White-beaked dolphin are usually found in water depths of between 50 and 100 m in groups of around 10 individuals, although large 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.

3.4. Conservation

There are no designated or proposed sites of conservation interest in the Project area. The closest designated site, the Site of Community Importance (SCI) 'Pobie Bank Reef' lies 94 km to the south west of Merlin, off the east coast of Shetland (as shown on Figure 3.14). The site has been designated for its stony and bedrock rocky reefs (JNCC, 2013a). The closest Special Protected Area (SPA) is Hermaness, Saxa Vord and Valla Field which lies 132 km south west of Merlin.

Marine Scotland has put forward areas with PMFs for designation as Marine Protected Areas (MPAs) under the Marine (Scotland) Act (2010). The Marine Management Organisation (MMO) has put forward areas with features of conservation importance (FOCI) for designation as Marine Conservation Zones (MCZs) under the UK Marine and Coastal Access Act (2009). The closest MPA to the Project area is the North East Faroe Shetland Channel Nature Conservation MPA (NCMPA). The site is approximately 110 km from the project area and is the largest designated MPA in Europe (Figure 3.14). The site is designated for deep-sea sponge aggregations, offshore deep-sea muds, offshore subtidal sands and gravels, and continental slope (JNCC, 2017).

Details of the conservation sites in the vicinity of the Project area are given in Table 3.6.

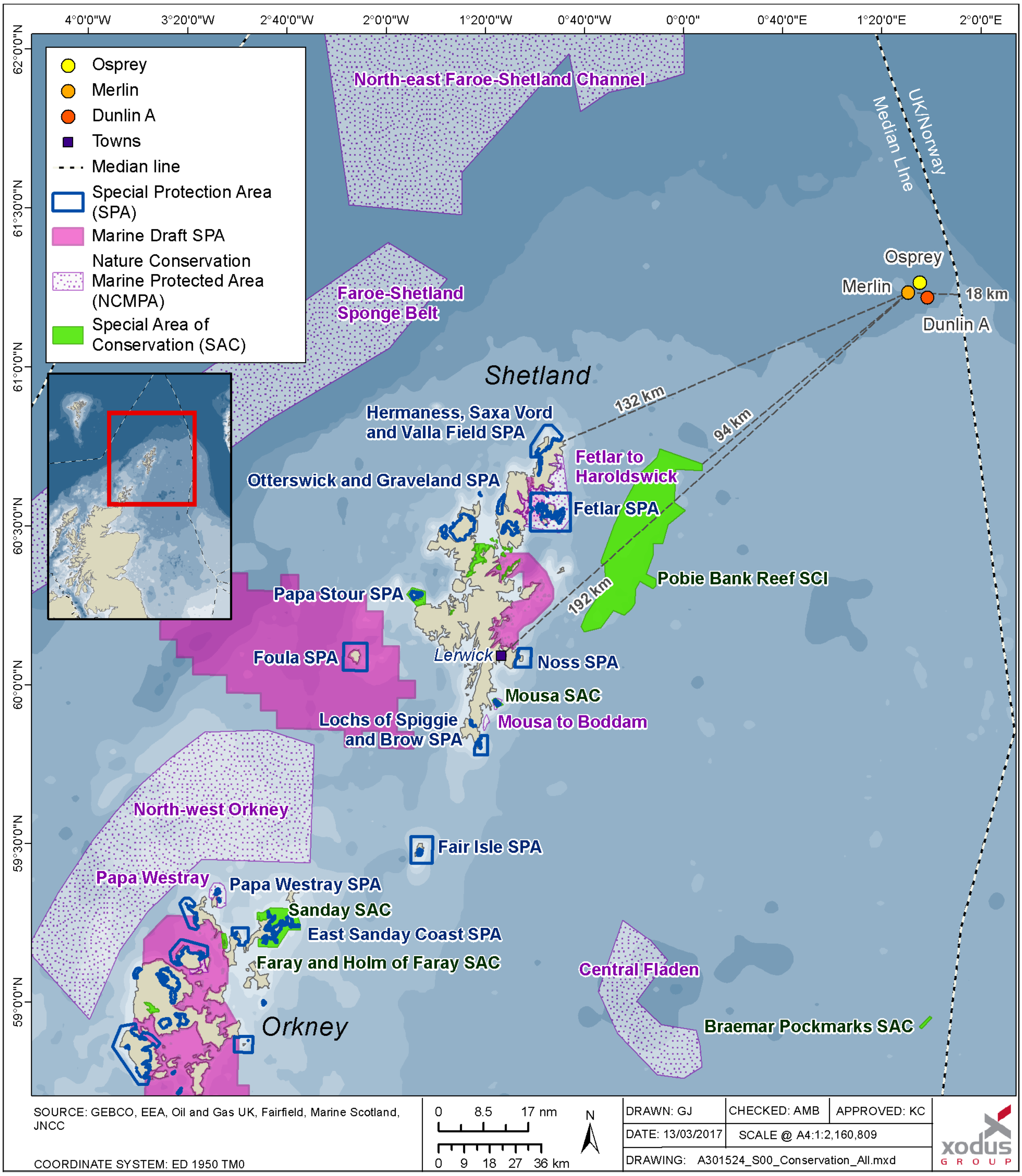


Figure 3.14 Sites of conservation importance

Table 3.6 Conservation sites in the vicinity of the Project area

Description	Distance to Project area (km)
Pobie Bank SCI	
Reefs are the primary reason for selection of this site. The stony and bedrock reefs of the site provide a habitat to an extensive community of encrusting and robust sponges and bryozoans and in the shallowest areas the bedrock and boulders also support encrusting coralline algae (JNCC, 2013a).	94
Hermaness, Saxa Vord and Valla Field SPA	
This site supports: A population of European importance of the Annex I species red throated diver (*Gavia stellata*) during the breeding season; Populations of European importance of the following migratory species during the breeding season: northern gannet, great skua and Atlantic puffin; and At least 20,000 seabirds. During the breeding season, the area regularly supports 152,000 individual seabirds including common guillemot, black-legged kittiwake, European shag (*Phalacrocorax aristotelis*), northern fulmar, Atlantic puffin, great skua and northern gannet (JNCC, 2005a).	132
North East Faroe Shetland Channel NCMPA	
This is the largest designated MPA in Europe and the protected features are deep sea sponge aggregations, offshore deep sea muds, offshore subtidal sands and gravel, continental slope and a wide range of features from the West Shetland Margin Palaeo-depositional, Miller Slide and Pilot Whale Diapirs that are considered to be 'Key Geodiversity Areas' (JNCC, 2017).	110
Faroe-Shetland Sponge Belt NCMPA	
The protected features of this NCMPA are deep sea sponge aggregations, offshore subtidal sands and gravels, ocean quahog aggregations, continental slope, continental slope channels, iceberg plough marks, prograding wedges and slide deposits representative of the West Shetland Margin paleo-depositional system Key Geodiversity Area and Sand wave fields and sediment wave fields representative of the West Shetland Margin contourite deposits Key Geodiversity Area (JNCC, 2016).	162
Fetlar to Haroldswick NCMPA	
This MPA supports a range of high energy habitats and species including horse mussel beds, kelp and seaweed communities and maerl beds. It encompasses over 200 km^2 of important black guillemot (*Cepphus grylle*) feeding grounds. The protected features of the site are black guillemot, circalittoral sand and coarse sediment communities; horse mussel beds, kelp and seaweed communities on sublittoral sediment, maerl beds, shallow tide-swept coarse sands with burrowing bivalves and marine geomorphology of the Scottish shelf seabed (SNH, 2014).	135

Description	Distance to Project area (km)
Fetlar SPA	
The SPA comprises a range of habitats including species-rich heathland, marshes and lochans, cliffs and rocky shores. The principal areas of importance for birds are the northernmost part of the island and the south-western peninsula of Lamb Hoga. This site supports: During the breeding season, a population of European importance of Arctic tern (*Sterna paradisaea*) and red-necked phalarope *(Phalaropus lobatus)*; Populations of European importance of the following migratory species during the breeding season: dunlin (*Calidris alpina schinzii*), great skua and whimbrel (*Numenius phaeopus*); and At least 20,000 seabirds. During the breeding season, the area regularly supports 22,000 individual seabirds including Arctic skua, northern fulmar, great skua, Arctic tern and red-necked phalarope (JNCC, 2005b).	138

None of the survey work undertaken in the Project area has identified any benthic habitats or species that are of specific conservation significance, apart from that for the Dunlin Fuel Gas Import route (Gardline, 2011) and the EBS (Fugro, 2016d) where low numbers of juvenile ocean quahog (*A. islandica*) were identified at one of the sampling stations. The ocean quahog is an OSPAR listed threatened and/or declining species (OSPAR, 2008) and a PMF (SNH & JNCC, 2014).

European Protected Species (EPS) are a group of animals and plants protected by law throughout the EU listed in Annexes II and IV of the Habitats Directive 92/43/EEC. Cetaceans are the EPS most likely to be recorded in the region, even if only in low numbers. The European sturgeon *Acipenser sturio* and leatherback turtle are also classed as EPS and occur in UK waters, although the Project area is located at the furthest extent of their ranges and their occurrence in any numbers is unlikely.

Annex II species are protected under the EU Habitats Directive. This forces core areas of habitat these species rely upon to be protected under the Natura 2000 Network. The only species listed on Annex II of the EC Habitats Directive that is likely to occur in the vicinity of the Project area with any regularity is the harbour porpoise. The harbour porpoise is the most common cetacean in UK waters, being widely distributed and abundant throughout the majority of UK shelf seas, both inshore and offshore. Due to the species' wide geographical distribution and the lack of knowledge with regards to their feeding and breeding habitats, there has been difficulty in selecting sites essential for their life and reproduction, as required under the Habitats Directive. Although potential calving grounds have been identified in the German North Sea (Sonntag *et al*., 1999) no such areas are currently recognised in UK waters. However, a number of sites have been designated as candidate SACs; none of these sites are located within the Northern North Sea. Grey and harbour seals are also Annex II species but due to the distance from shore they are unlikely to be present in any significant numbers in the area.

Basking sharks, spiny dogfish and blue sharks are the species listed on the IUCN red list most likely to be encountered in the vicinity of the Project area. The basking shark and spiny dogfish are classed as vulnerable under the IUCN red list. The blue shark is classed as near threatened. In addition, basking sharks are protected under the Wildlife and Countryside Act 1981 (as amended).

3.5. Socio-Economic Environment

3.5.1. Commercial Fisheries

3.5.1.1. Fishing Risk Assessment Report – Baseline Fishing Activity Analysis

Fairfield commissioned Anatec (2017) to complete a fishing risk assessment, which included an analysis of the potential impact of the subsea infrastructure decommissioning options on fisheries. As part of this, the baseline fishing activity in the vicinity of the Merlin and Greater Dunlin Area was reviewed (Anatec, 2017). The study considered to be relevant for the decommissioning activities is shown in relation to the International Council for the Exploration of the Sea (ICES) rectangles in Figure 3.15 (these rectangles are frequently used to understand how fishing effort varies in scale across the North Sea).

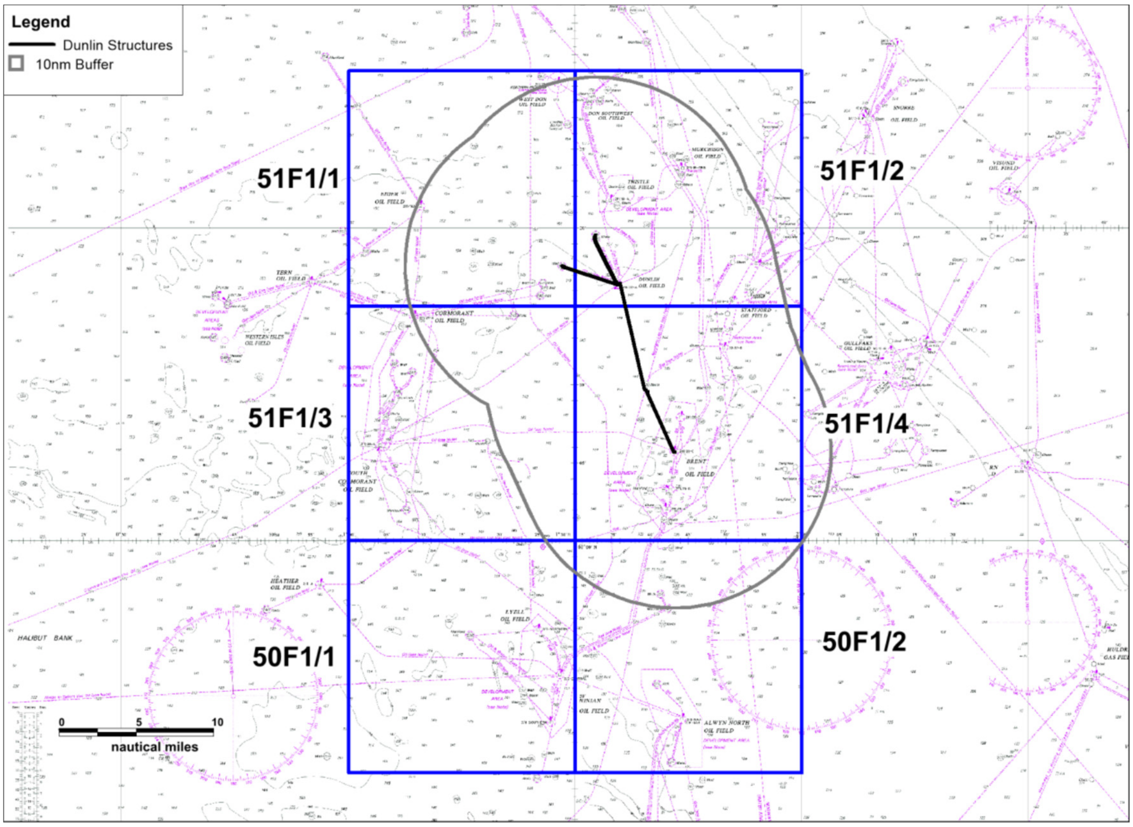


Figure 3.15 Baseline fishing activity study area: ICES rectangles (Anatec, 2017)

To further inform this assessment, SFF Services were contracted to carry out a consultation with relevant members of the fishing industry. SFF Services collected primary data by interviewing fishermen who utilise the waters around the Merlin field. The vessel representatives interviewed provided output from their Global Positioning System plotters to highlight the fishing areas within the study area that they made use of.

3.5.1.2. Types of Fishery

Commercial fishing is excluded within 500 m of the Dunlin Alpha platform and Merlin and Osprey subsea infrastructure as a result of safety zones having been implemented, but beyond this area within the surrounding ICES rectangle 51F1 there are two main types of fishery:

- Demersal (whitefish); and
- Pelagic.

Demersal fisheries target species which occur on or near the seabed whilst pelagic fisheries target species which occupy the water column. The area surrounding the Dunlin, Merlin and Osprey fields is used by pelagic and demersal fisheries with the demersal fishery being most productive in terms of landings values and liveweight landed. Some shellfish species are landed from ICES rectangle 51F1 but both value and tonnes landed are very low (Figure 3.16).

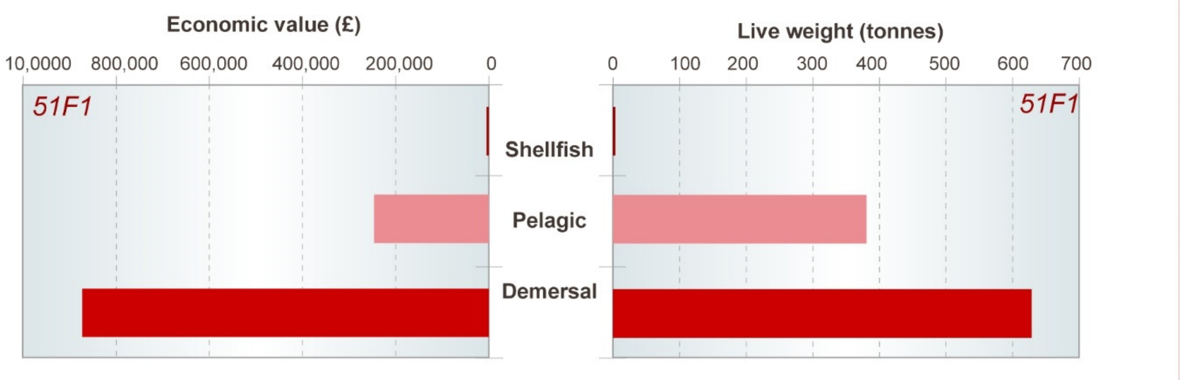


Figure 3.16 Annual average economic value and liveweight tonnage from ICES rectangle 51F1 from 2010 – 2014 (Scottish Government, 2016)

3.5.1.3. Fishery Value

Kafas *et al*. (2012) report the Greater Dunlin Area as being at the northern extent of a large band of higher value demersal fishing effort, which stretches from the Outer Hebrides in the west, around Orkney and Shetland and down into the southern North Sea. Kafas *et al.* (2012) also report the Greater Dunlin Area being at the eastern most extent of a large band of higher value pelagic fishing area that runs from the northern North Sea out to the west of the Outer Hebrides.

Saithe and mackerel (often targeted by the larger pelagic vessels in January and February) are the key commercial species landed from ICES rectangle 51F1 by both value (46% combined) and weight (66% combined). However, they are of relatively low value when compared to total landings into Scotland; combined, landings of these species from ICES rectangle 51F1 comprise only 0.06% of the value (£) of landings into Scotland (averaged from 2010 – 2014). Other species of commercial value in the same ICES rectangle include megrim, cod and monks/anglers.

3.5.1.4. Gear and Fishing Effort

The only gear type used for fishing in ICES rectangle 51F1 by UK vessels is the trawl net. Trawls include demersal trawls (typically contact the seabed) and midwater trawls which operate in the water column.

Baseline fishing activity analysis suggests that single demersal trawlers are the single most common trawl type (Anatec, 2017). Gear used by vessels of other nationalities includes long lines and seine nets (Anatec, 2017).

3.5.1.5. Seasonality

The average fishing effort (days at sea) in ICES Rectangle 51F1 is 130 days per year (average over 2010 - 2014) (Scottish Government, 2016). Data on monthly fishing effort were obtained from the MMO for the time period 2010 – 2014 and analysed to establish seasonal trends. The Vessel Monitoring System (VMS) data show that most activity is concentrated in the spring and early summer months when five to twelve vessels are active in the area compared with fewer than four vessels per month at other times, as shown in Figure 3.17 (MMO, 2016). Review of Automatic Identification System (AIS) data, which represents an alternative method of tracking fishing activity, suggests that activity peaked earlier in the year in 2015 (Anatec, 2017) (Figure 3.18). Seasonality must therefore be viewed as changeable over time, depending on market conditions, quota availability and weather.

Fishing effort evidence from Vessel Monitoring System (VMS) data collected and analysed by the MMO, representing a five year timescale from 2010 – 2014, has been mapped in Figure 3.19. This figure presents the average annual effort (time spent fishing in minutes) within ICES sub-rectangles and ranked into four categories, from the lowest to the highest effort, giving an indication of the relative importance of the study area compared to the effort across the north east UKCS. For demersal fishing vessels, where there is the potential for interaction with subsea structures, Anatec (2017) estimate there to be one such vessel actively fishing in the study area every two days (Anatec, 2017).

3.5.1.6. Active Fishing Vessels and Ports

Peterhead and Lerwick are the nearest major commercial UK fishing ports to the Dunlin, Merlin and Osprey fields (MMO, 2014). Data held by the MMO demonstrate that landings into Peterhead, Lerwick and Scrabster have been recorded from ICES rectangle 51F1 in each year from 2010 – 2014. Landings from ICES rectangle 51F1 were recorded at four foreign ports, demonstrating that vessels come from afar to exploit the area. On average, 39 vessels fish from ICES rectangle 51F1 every year with the greatest proportion landing at Peterhead or Lerwick.

MMO data averaged from 2010 – 2014 showed that four vessels (most likely from France and Norway) landed from ICES rectangle 51F1 annually, with a combined annual average liveweight tonnage of 284 tonnes (28% of the average annual liveweight landed from ICES rectangle 51F1). The relatively high proportion of landings weight associated with these four vessels is most likely because they are larger than the majority of UK vessels active in the area.

The baseline fishing activity analysis (Anatec, 2017) indicates that the most common nationality of vessels actively fishing in the study area was Norwegian (39%) followed by the UK (38%) and then France (23%).

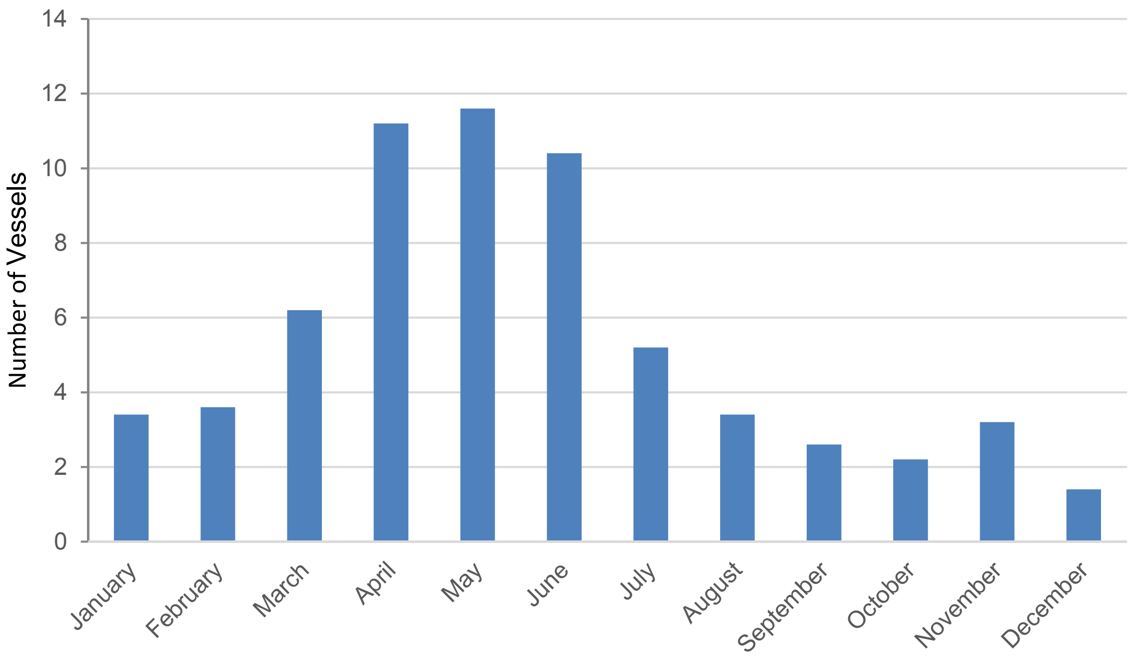


Figure 3.17 Seasonal distribution of vessel presence in ICES rectangle 51F1 indicated by VMS data (average 2010 – 2014) (MMO, 2016)

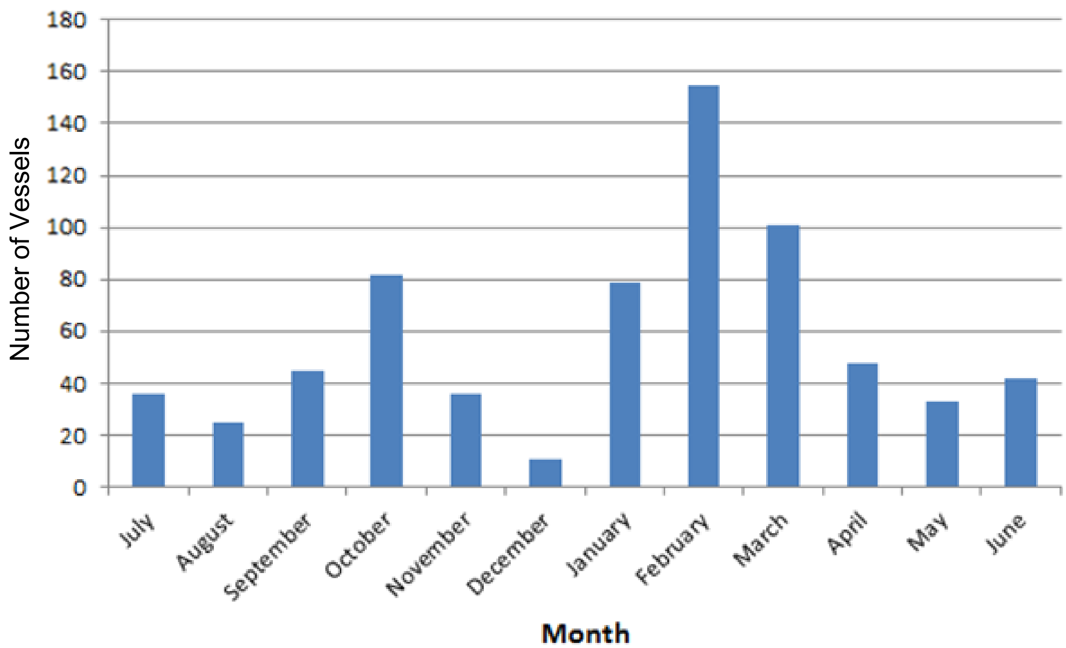


Figure 3.18 Seasonal distribution of vessel presence in the 10 nautical miles (nm) surrounding the Greater Dunlin Area, based on AIS data for July 2015 – June 2016 (Anatec, 2017)

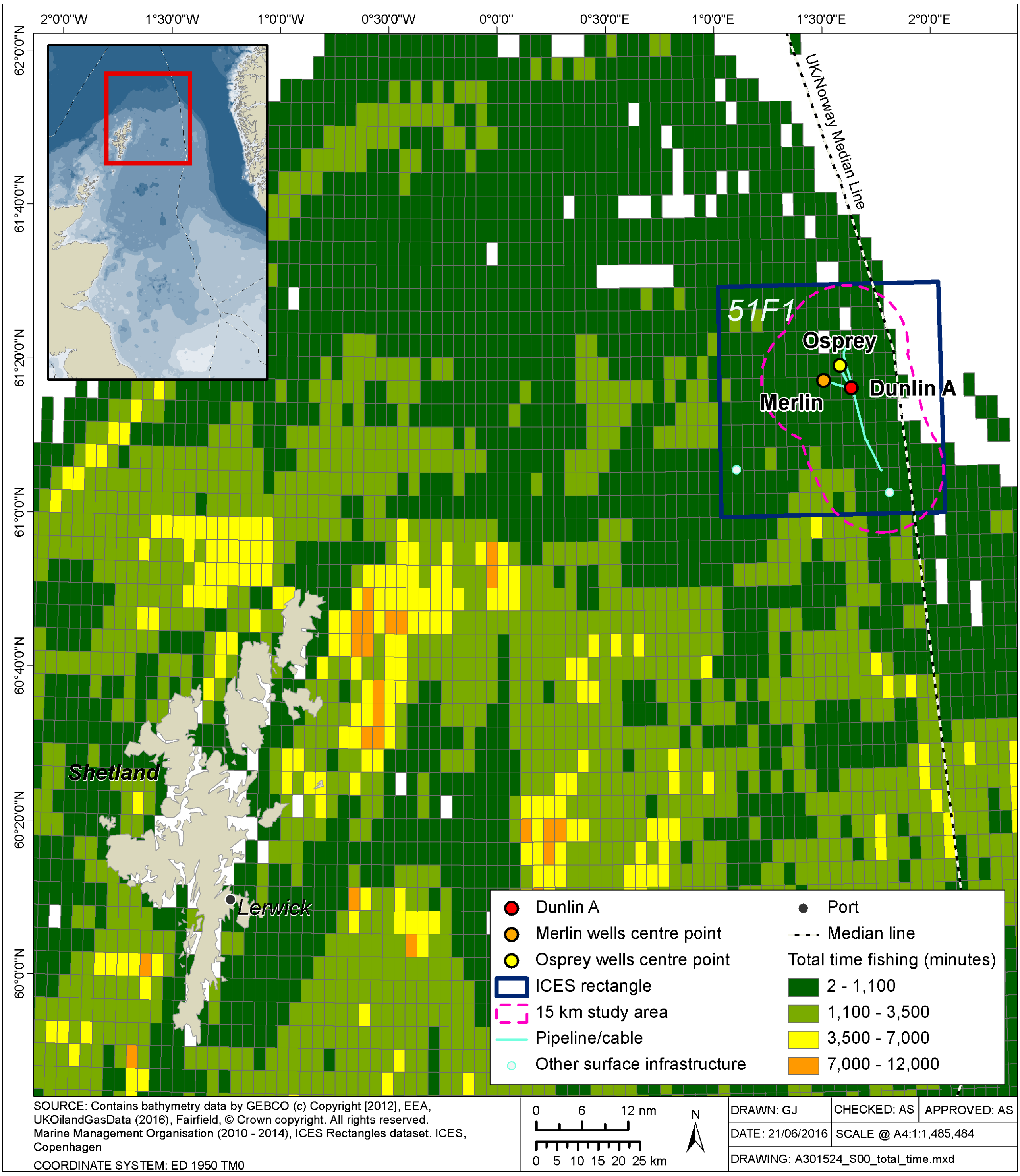


Figure 3.19 Relative distribution of fishing effort (time in minutes) of vessels using mobile gear (average 2010 – 2014) (MMO, 2016)

3.5.2. Oil and Gas Activities

The planned decommissioning activities are located in an area of extensive oil and gas development. There are a number of installations located within the vicinity of the Project area as detailed in Figure 3.20 and Table 3.7.

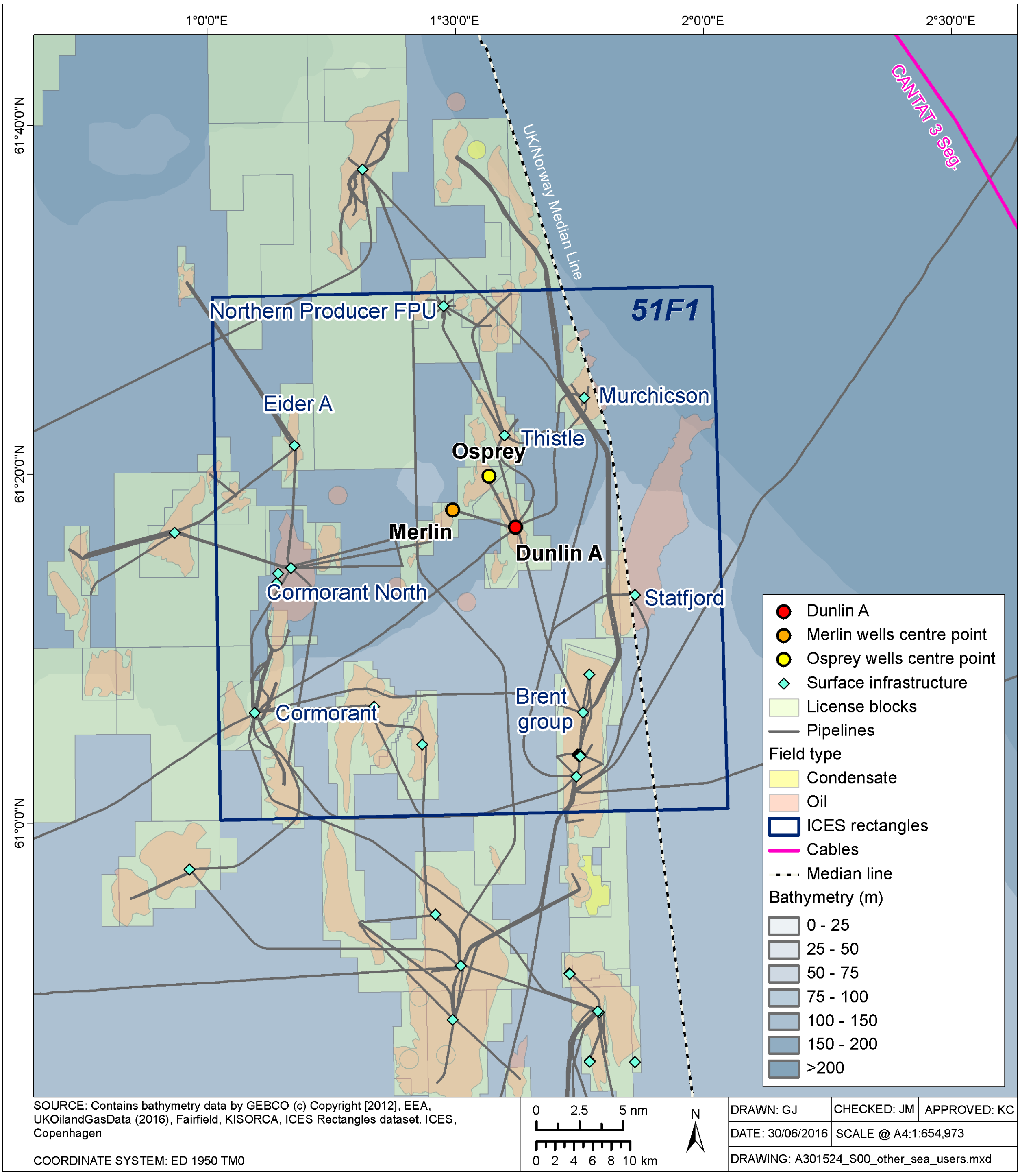


Figure 3.20 Other sea users in the vicinity of the Project area

Table 3.7 Surface oil and gas installations within 20 km of the Project area

Installation	Approximate distance from nearest point of Project infrastructure (km)
Thistle A	9.2 north east
Statfjord B	14.6 south east
Murchison	15.6 north east
Brent D	17.5 south east
Eider A	18.2 north west
Cormorant North	18.3 west

3.5.3. Military Activity

No routine military activities are known to occur in the vicinity of the Project area (DECC, 2016).

3.5.4. Shipping Activity

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). An average of between 0.1 to 5 vessels per week pass the vicinity of the Project area with the majority of traffic consisting of small to medium sized cargo ships and tankers (MMO, 2014). Other vessels that pass within the vicinity of the Project area include dredging or underwater operation vessels and fishing vessels.

3.5.5. Renewables

There is no renewable activity in the vicinity of the Project area.

3.5.6. Cables and Pipelines

There are no cables other than the Dunlin Power Import cable (running from the Dunlin Alpha platform to the Brent Charlie platform) in the vicinity of the Project area. In addition to the pipelines associated with the Greater Dunlin Area (Figure 1.3), pipelines in the vicinity of the Project area include Dunlin Alpha to Cormorant A, Thistle A to Dunlin Alpha, Murchison oil export pipeline, Magnus to Brent A, Statfjord B spur, Brent C to Penguin, Brent C to Cormorant A and Thistle to Murchison spur.

3.5.7. Archaeology

There are no designated wreck sites in the vicinity of the Project area (DECC, 2016).

4. EIA Methodology

4.1. Overview

This section provides detail on how the process of EIA has been applied to this Project and describes the key components that have fed into the assessment. Figure 4.1 below presents an overview flow diagram of the EIA process used for this ES.

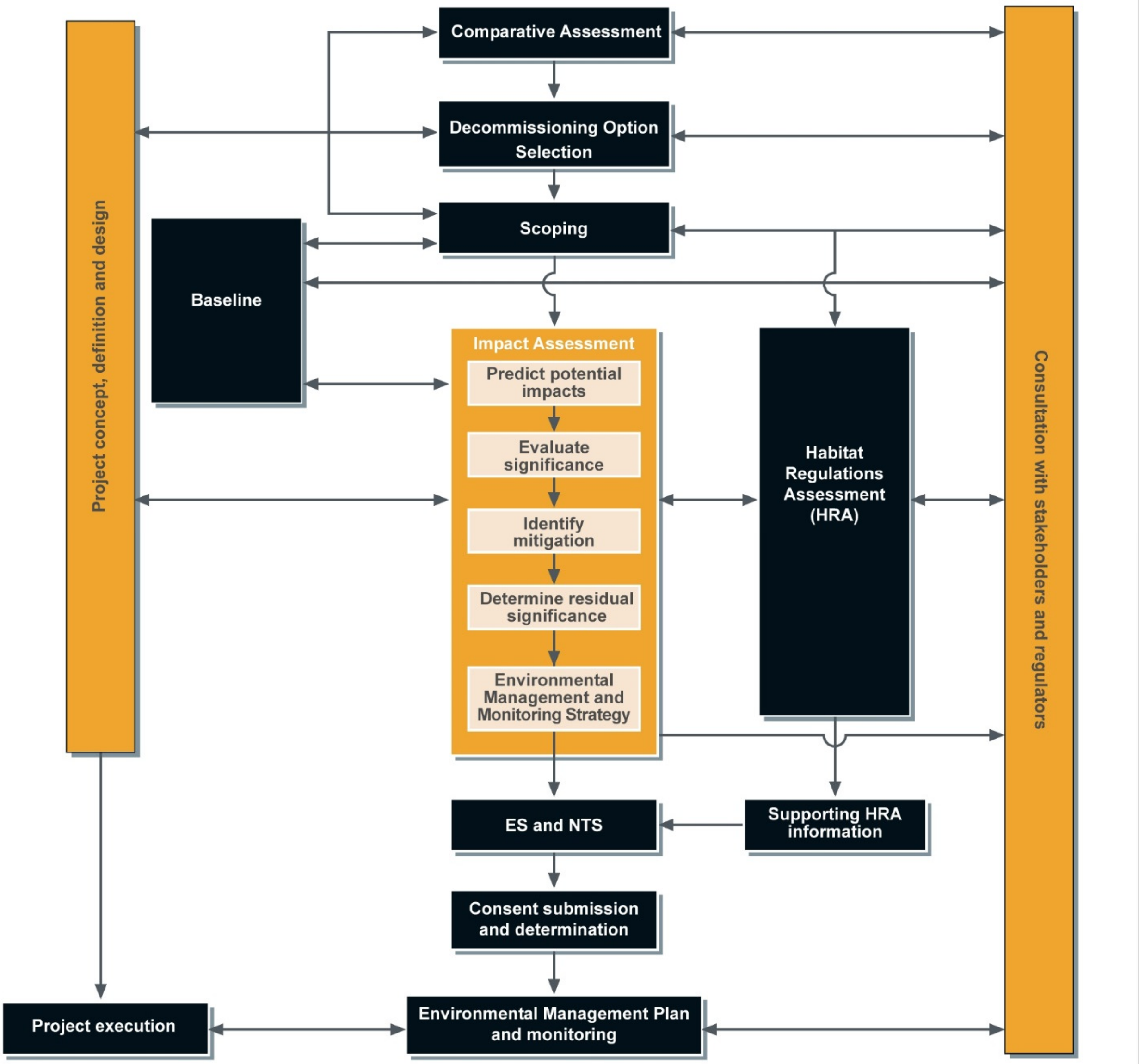


Figure 4.1 The EIA process

4.2. Environmental Issues Identification

The main objective of the environmental issues identification process is to identify the key potential environmental issues requiring discussion and assessment, and to agree practicable measures (mitigation) to eliminate or minimise harm to the environment.

Environmental Issues Identification (ENVID) has taken place based on:

- Known potential environmental issues specifically related to the Project area. These are already well understood due to the amount of environmental work that has been conducted during the Project's lifetime;
- An ENVID workshop, which brought together informed judgement of environmental practitioners and project engineers; and
- Stakeholder engagement through screening workshops and consultation meetings.

The ENVID process was kept under review throughout the EIA, with mitigation revised as understanding of the Project increased and as consultation continued. The key issues that were assessed in this ES are therefore a combination of issues identified as significant during the early environmental issues identification process (including ENVID workshop, the output of which is detailed in Appendix A), issues of importance raised by consultees, and issues that have become clearer with enhanced Project definition. Issues that have not been described in this ES were screened out; details of why issues were screened out are included in the ENVID output in Appendix A.

4.3. Environmental Significance

4.3.1. Overview

The decision process related to defining whether or not a project is likely to significantly impact on the environment is the core principle of the EIA 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 Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment (IEEM, 2010), the Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines (Tyler-Walters *et al*., 2001) and guidance provided by Scottish Natural Heritage (SNH) in their handbook on EIA (SNH, 2013) and by The Institute of Environmental Management and Assessment (IEMA) in their guidelines for EIA (IEMA, 2015, 2016).

EIA provides an assessment of the environmental effects that may result from a project's impact on the receiving environment. The terms impact and effect have different definitions in EIA 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, measureable changes in the receiving environment (volume, time and/or area); for example, were a number of marine mammals to be disturbed following exposure to vessel 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 an area caused by disturbance, leading to a population decline. 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 that effect and implements a systematic approach to understand the level of impact. The process considers the following:

- Identification of receptor and impact (including duration, timing and nature of impact);
- Definition of sensitivity, vulnerability and value of receptor;
- Definition of magnitude and likelihood of impact; and
- Assessment of consequence of the impact on the receptor, considering the probability that it will occur, the spatial and temporal extent and the importance of the impact. If the assessment of consequence of impact is determined as moderate or major, it is considered a significant impact.

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.

4.3.2. Baseline Characterisation and Receptor Identification

In order to make an assessment of potential impacts on the environment it was necessary to firstly characterise the different 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.

Where data gaps and uncertainties remained (e.g. where there are no suitable options for filling data gaps), as part of the EIA process these have been documented and taken into consideration as appropriate as part of the assessment of impact significance (Section 4.3.5).

The EIA process requires identification of the potential receptors that could be affected by the Project (e.g. marine mammals, seabed species and habitats). High level receptors are identified within the impact assessments (Section 6).

4.3.3. Impact Definition

4.3.3.1. Impact Magnitude

Determination of impact magnitude requires consideration of a range of key impact criteria including:

- Nature of impact, whether it be beneficial or adverse;
- Type of impact, be it direct or indirect etc.;
- Size and scale of impact, i.e. the geographical area;
- Duration over which the impact is likely to occur i.e. days, weeks;
- Seasonality of impact, i.e. is the impact expected to occur all year or during specific times of the year e.g. summer; and
- Frequency of impact, i.e. how often the impact is expected to occur.

Each of these variables are expanded upon in Table 4.1 - Table 4.5 to provide consistent definitions across all EIA 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. With respect to the nature of the impact (Table 4.1), it should be noted that all impacts discussed in this ES are adverse unless explicitly stated.

Table 4.1 Nature of impact

Nature of impact	Definition
Beneficial	Advantageous or positive effect to a receptor (i.e. an improvement).
Adverse	Detrimental or negative effect to a receptor.

Table 4.2 Type of impact

Type of impact	Definition
Direct	Impacts that result from a direct interaction between the Project and the receptor. Impacts that are actually caused by the introduction of Project activities into the receiving environment. E.g. The direct loss of benthic habitat.
Indirect	Reasonably foreseeable impacts that are caused by the interactions of the Project but which occur later in time than the original, or at a further distance from the proposed Project location. Indirect impacts include impacts that may be referred to as 'secondary', 'related' or 'induced'. E.g. The direct loss of benthic habitat could have an indirect or secondary impact on by-catch of non-target species due to displacement of these species caused by loss of habitat.
Cumulative	Impacts that act together with other impacts (including those from any concurrent or planned future third party activities) to affect the same receptors as the proposed Project. Definition encompasses "in-combination" impacts.

Table 4.3 Duration of impact

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 Geographical extent of impact

Geographical extent	Description
Local	Impacts that are limited to the area surrounding the proposed Project footprint and associated working areas. Alternatively, where appropriate, impacts that are restricted to a single habitat or biotope or community.
Regional	Impacts that are experienced beyond the local area to the wider region, as determined by habitat/ecosystem extent.
National	Impacts that affect nationally important receptors or protected areas, or which have consequences at a national level. This extent may refer to either Scotland or the UK depending on the context.
Transboundary	Impacts that could be experienced by neighbouring national administrative areas.
International	Impacts that affect areas protected by international conventions, European and internationally designated areas or internationally important populations of key receptors (e.g. birds, marine mammals).

Table 4.5 Frequency of impact

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 course of the Project. This definition also covers such impacts that occur on a planned or unplanned basis and those that may be described as ‘periodic’ impacts.

4.3.3.2. Impact Magnitude Criteria

Overall impact magnitude requires consideration of all impact parameters described above. Based on these parameters, magnitude can be assigned following the criteria outlined in Table 4.6. The resulting effect on the receptor is considered under vulnerability and is an evaluation based on scientific judgement.

Table 4.6 Impact magnitude criteria

Magnitude	Criteria
Major	Extent of change: Impact occurs over a large scale or spatial geographical extent and /or is long term or permanent in nature. Frequency/intensity of impact: high frequency (occurring repeatedly or continuously for a long period of time) and/or at high intensity.
Moderate	Extent of change: Impact occurs over a local to medium scale/spatial extent and/or has a prolonged duration. 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.
Minor	Extent of change: Impact occurs on-site or is localised in scale/spatial extent and is of a temporary or short term duration. Frequency/intensity of impact: low frequency (occurring occasionally/intermittently for short periods of time) and/or at low intensity.
Negligible	Extent of change: Impact is highly localised and very short term in nature (e.g. days/ few weeks only).
Positive	An enhancement of some ecosystem or population parameter.
Notes: Magnitude of an impact is based on a variety of parameters. Definitions provided above are for guidance only and may not be appropriate for all impacts. For example an impact may occur in a very localised area (minor to moderate) but at very high frequency/intensity for a long period of time (major). In such cases informed judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

4.3.3.3. Impact Likelihood for Unplanned and Accidental Events

The likelihood of an impact occurring for unplanned/accidental events is another factor that is considered in this impact assessment. This captures the probability that the impact will occur and also the probability that the receptor will be present.

4.3.4. Receptor Definition

4.3.4.1. Overview

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 an 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.

4.3.4.2. Receptor Sensitivity

Example definitions for assessing the sensitivity of a receptor are provided in Table 4.7.

Table 4.7 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.

4.3.4.3. Receptor Vulnerability

Information on both receptor sensitivity and impact magnitude is required to be able to determine receptor vulnerability as per Table 4.8.

Table 4.8 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.

Receptor vulnerability	Definition
Negligible	Changes to baseline conditions, 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 in determining sensitivity. In some instances it has also been necessary to take a precautionary approach where stakeholder concern exists with regard to a particular receptor. Where this is the case, this is detailed in the relevant impact assessment in Section 6.

4.3.4.4. Receptor Value

The value or importance of a receptor is based on a pre-defined judgement based on 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 4.9.

Table 4.9 Value of receptor

Value of receptor	Definition
Very high	Receptor of international importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site (WHS)). 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. 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. NCMPA, 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 Project area. Above average example and/or high potential to contribute to knowledge and understanding and/or outreach.

Value of receptor	Definition
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 Project 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 Project 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 Project area. Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach.

4.3.5. Consequence and Significance of Potential Impact

4.3.5.1. Overview

Having determined impact magnitude and the sensitivity, vulnerability and value of the receptor, it is then necessary to evaluate impact significance. This involves:

- Determination of impact consequence based on a consideration of sensitivity, vulnerability and value of the receptor and impact magnitude;
- Assessment of impact significance based on assessment consequence;
- Mitigation; and
- Residual impacts.

4.3.5.2. Assessment of Consequence and Impact Significance

The sensitivity, vulnerability and value of receptor are combined with magnitude (and likelihood, where appropriate) of impact using informed judgement to arrive at a consequence for each impact, as shown in Table 4.10. The significance of impact is derived directly from the assigned consequence ranking.

Table 4.10 Assessment of consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance
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 or industry). These impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant
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.	Significant
Low	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	Not significant
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.	Not significant
Positive	Impacts are expected to have a positive benefit or enhancement. 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.	Not significant

4.3.5.3. Mitigation

Where potentially significant impacts (i.e. those ranked as being of moderate impact level or higher in Table 4.10) are identified, mitigation measures must be considered. The intention is that such measures should remove, reduce or manage the impacts to a point where the resulting residual significance is at an acceptable or insignificant level. For impacts that are deemed not significant (i.e. low, negligible or positive in Table 4.10), there is no requirement to adopt specific mitigation. However, mitigation can be adopted in such cases to ensure impacts that are predicted to be not significant remain so. Section 8 provides detail on how any mitigation measures identified during the impact assessment will be managed.

4.3.5.4. Residual Impacts

Residual impacts are those that remain once all options for removing, reducing or managing potentially significant impacts (i.e. all mitigation) have been taken into account.

4.4. Cumulative Impact Assessment

The European Commission has defined cumulative impact as being those resulting "from incremental changes caused by other past, present or reasonably foreseeable actions together with the project" (European Commission, 1999). As outlined in studies by the European Commission (1999) and US CEQ (1997), identifying the cumulative impacts of a project involves:

- Considering the activities associated with the project;
- Identifying potentially sensitive receptors/resources;
- Identifying the geographic and time boundaries of the cumulative impact assessment;
- Identifying past, present and future actions which may also impact the sensitive receptors/resources;
- Identifying impacts arising from the proposed activities; and
- Identifying which impacts on these resources are important from a cumulative impacts perspective.

To assist the assessment of cumulative impacts, a review of existing developments (including oil and gas, cables and renewables) that could have the potential to interact with the Project was undertaken; the output of this review is reported in the Environment Description (Section 3). The impact assessment has considered these projects when defining the potential for cumulative impact (Section 6).

Although the scope of this EIA is restricted to the decommissioning of the Merlin facilities, it must be recognised that the decommissioning workscope is one part of the Subsea Infrastructure Decommissioning Project. As such, when considering cumulative impact with other developments in the North Sea, the potential impacts associated with the Merlin subsea activities must be considered along with those from the Osprey and Dunlin decommissioning activities, rather than in isolation. To this end, the cumulative impact assessment presented within each assessment sub-section deals with the potential cumulative impacts that may arise from the Subsea Infrastructure Decommissioning Project and other projects in the North Sea.

4.5. Transboundary Impact Assessment

The impact assessment presented in Section 6 contains sections which identify the potential for, and where appropriate, assessment of transboundary impacts. For the Project, this is an important issue for consideration given the proximity to the UK/Norway median line (18 km).

4.6. Habitats Regulation Appraisal (HRA)

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority to make an Appropriate Assessment of the implications of a plan, programme or in this case project, alone or in combination, on a Natura site (SAC or SPA) in view of the site's conservation objectives and the overall integrity of the site.

As part of the assessment of impacts on key receptors, for those receptors that are a qualifying feature of a Natura site, relevant information on SACs or SPAs has also been provided as part of the impact assessment process. This information will then be used by the Competent Authority to determine the need for, and subsequently carry out (if required), an appropriate assessment of the Project.

For offshore areas (12 – 200 nm) the requirements of the Habitats Directive are transposed through the Offshore Marine Conservation Natural Habitats Regulations (2007) as amended. In accordance with these Regulations, the impacts of a project on the integrity of a European site are assessed and evaluated as part of the HRA process. In an analogous process, the Marine (Scotland) Act and the Marine and Coastal Access Act require the potential for significant risk to the conservation objectives of NCMPAs and MCZs (respectively) being achieved to be assessed.

4.7. Data Gaps and Uncertainties

The North Sea has been extensively studied, meaning that this EIA has been able to draw on a significant volume of published data. This bank of published data has been supplemented by a site survey programme and studies undertaken on behalf of Fairfield to collect Project specific environmental data, ensuring a robust baseline is available against which to assess impact. Where appropriate, studies have been commissioned to inform the impact assessment, including:

- Survey work
    - A campaign covering environmental baseline, habitat assessment, drill cuttings and subsea ROV survey of the pipelines, umbilicals and subsea structures has been undertaken for the Project area.
- Commercial fisheries study;
    - The aim of the assessment was to gain an up-to-date understanding of current and future fishing activity in the Project area and undertake a high-level assessment of potential socio-economic impacts to the fishing industry of decommissioning activities. Publicly available fishing data including fishing effort, landings value and VMS data have been used to inform the baseline description in Section 3.5.1 and the impact assessment (Section 6). Additionally, an engagement exercise has been performed by SFF Services Limited involving spending approximately three days interviewing and collecting data from vessel owners from the relevant ports likely to be fishing within the Project area. Information collected by this study has been supplemented with that collected as part of the Anatec (2017) fisheries risk assessment.
- Energy and emissions inventory;
    - In order to provide an indication of the energy and emissions produced during the proposed decommissioning activities, the methodology detailed in The Institute of Petroleum (IP, 2000) guidelines for the calculations of estimates of energy use and gaseous emissions in the decommissioning of offshore structures methodology has been used to estimate the potential energy use and gaseous emissions to inform the impact assessment in Section 6.

- Waste Management Strategy;
    - A Waste Management Strategy has been developed to account for the generation and treatment of waste. This includes consideration of the presence of hazardous and radioactive wastes.

When evaluating and characterising potential impacts that could be associated with the Project, a variety of inputs are used, including baseline environmental data, modelling results, estimation of emissions and Project footprint. These inputs carry varying levels of uncertainty and conservatism and although potential impacts may occur, they are not certain to occur (for example, there is some uncertainty in marine mammal response to certain noise emissions). As such, all the potential impacts (whether predicted, residual, cumulative or transboundary) described in this ES are to a greater or lesser extent potential impacts which may or may not occur. To account for this uncertainty, worst case assumptions have been made, and where key uncertainties exist they have been outlined within the relevant section of the impact assessment (Section 6).

5. Stakeholder Engagement

5.1. Engagement Strategy

Fairfield recognises that early and ongoing engagement with stakeholders is a critical part of the development of robust, respectful programmes for the decommissioning of North Sea installations. To ensure the efficacy of stakeholder engagement, Fairfield has developed a Stakeholder Engagement Strategy and Action Plan. This Plan outlines how and why stakeholder engagement should occur. It has assisted in driving engagement through both the CA and EIA, and has been supported by a continually updated Stakeholder Engagement Workbook and Stakeholder Alignment Plan/Matrix, through which stakeholder engagement is tracked.

5.2. Pre-Submission Consultation

As a demonstration of Fairfield's execution of its stakeholder strategy and the extent to which external stakeholders have had the opportunity to influence the decommissioning project, a summary of the key engagement activities prior to formal submission of the DP and supporting documents is given in Table 5.1. As well as working with key regulatory and environmental stakeholders, Fairfield has sought to understand the lessons that other UKCS Operators have learned during their decommissioning activities to date. In addition, Fairfield makes information available to the general public via a dedicated decommissioning website accessed through www.fairfield-energy.com.

Table 5.1 Summary of key stakeholder engagement activities

Activity	Date	Stakeholders
Introduction to the Greater Dunlin Area Decommissioning Project	January 2010	Aberdeenshire Council, BEIS, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Decom North Sea, HSE, JNCC, Marine Scotland, Maritime and Coastguard Agency, Greenpeace, Scottish Enterprise, Scottish Environmental Protection Agency (SEPA) (Radioactive waste), SEPA (Marine), SFF, University of Aberdeen
Between 2010 and 2015, Fairfield continued engagement with stakeholders, including OSPAR and those outlined above, to guide the development of Fairfield's decommissioning strategy for the Greater Dunlin Area.		
Meet with statutory stakeholders to discuss progress	December 2015/January 2016	JNCC, Marine Scotland, SFF
Merlin Subsea CA Screening Workshop	March 2016	BEIS, JNCC, Marine Scotland, SFF
Update on Greater Dunlin Area decommissioning	April 2016	BEIS

Activity	Date	Stakeholders
Fisheries update on Greater Dunlin Area decommissioning	May 2016	UK Fisheries Offshore Oil and Gas Legacy Trust Fund (FLTC) National Federation of Fishermen's Organisations (NFFO), Northern Ireland Fish Producers' Organisation Limited (NIFPO)
Issue of note to advise on progress	June 2016	BEIS, JNCC, OGA, SFF
Update on Greater Dunlin Area decommissioning	July 2016	OGA
Workshop on decommissioning of concrete mattresses	September 2016	SEPA, Decom North Sea
Update meetings on Greater Dunlin Area decommissioning	September 2016	SFF, JNCC
Update on Greater Dunlin Area decommissioning	October 2016	SEPA
Briefing session for Merlin Subsea CA	December 2016	BEIS, JNCC, Marine Scotland, OGA, SFF
Merlin Subsea CA workshop	January 2017	BEIS, JNCC, Marine Scotland, OGA, SFF

5.3. Issues Raised during Pre-Submission Consultation

The stakeholder engagement process identified a range of potential issues associated with the decommissioning activities which were considered and taken forward into the CA and EIA processes. Where appropriate, responses were compiled to gather details of the issues and further meetings arranged. Table 5.2 summarises the main feedback provided to date and explains how Fairfield has dealt with the issue. Reference to the section of this ES that deals with the issue raised is also provided.

Table 5.2 Issues raised during stakeholder engagement to date

Comment	Fairfield response
JNCC	
JNCC stated a preference in decommissioning solutions which are not disruptive to the environment and which leave the seabed in the condition in which it was originally found. JNCC did note that this was not always possible and so approached every project or plan on a case by case basis.	Fairfield has considered this position within the CA, and this is detailed in the CA report that accompanies the Decommissioning Programme. Where additional rockdump is required, or where trenching or dredging is being proposed, this EIA has assessed the impact to understand the significance and mitigation requirements. This is presented in Section 6.2.1.

Comment	Fairfield response
JNCC requested that figures be made available showing the location and vintage of environmental surveys and the location of any SAC or MPAs in or around the Project area.	A full description of the pre-decommissioning surveys is given in Section 3. Other recent, relevant surveys are also described, and both sets have been used to inform the assessment of impacts upon the seabed (and the species using it). Sets of figures support the description of the baseline environment, and these are also given in Section 3. A review of protected sites and species, accompanied by appropriate figures, is given in Section 3.4.
JNCC stated that rockdump is considered a permanent change to the environment.	The potential impact of the limited additional rockdump proposed for the decommissioning activities is assessed in Section 6.2.1.
Marine Scotland	
Fairfield should review the fisheries value information from Kafas *et al*. (2012) as part of the preparation of the environment baseline.	This information is presented in Section 3.5.1, supported by two project-specific fisheries studies. This extensive data review provides a robust baseline against which the impact assessment on other sea users has been made.
Fairfield should provide clear, precise and concise map-based data during the engagement process which explains the regional context.	The environment baseline presented in Section 3 makes extensive use of graphics to describe the area within which the Project is sited. Additionally, each impact assessment specifically considers the scale of the proposed activities within the context of other use of the northern North Sea.
Decommissioning of *in situ* pipelines and other equipment that are not already trenched and buried create a greater potential impact on fishing activities. A key objective for Marine Scotland is to minimise interaction with other users of the sea.	Fairfield has considered this position within the CA, and this is detailed in the CA report that accompanies the Decommissioning Programme. As a result, only a limited number of lines are decommissioned *in situ* and none are outside of a trench or rock berm. The impact assessment on other sea users presented in Section 6 considers the potential impact of limited infrastructure being decommissioned *in situ*.
Fairfield should provide details of any contamination found at the seabed.	Fairfield undertook a suite of pre-decommissioning surveys to understand the current condition of the seabed (details are given in Section 3). These pre-decommissioning surveys included investigation of the cuttings pile in the Merlin field; details are given in Section 3. This information has been used to support the assessment of impacts, including from the potential disturbance of sediments contaminated with oil-based mud (given in Section 6.2.1).

Comment	Fairfield response
SEPA	
SEPA stated their expectation that Fairfield will not just put all materials returned to landfill but will instead look for opportunities to reuse/recycle/recover as far as possible.	Fairfield's aspirations with regards reusing, recycling and recovering material. This is summarised in Section 7 of this ES, with estimates for reuse/recycling/recovering provided.
Reuse of materials is the only fate that removes items from the waste stream. All other materials are considered waste and Fairfield will continue to be accountable for the fate of these items under their duty of care. The 'end of the line' is either landfill, or at the point where the material is fully recycled e.g. aggregate for civil works or feed into steelworks.	Fairfield has developed a Waste Management Strategy to ensure that its duty of care in terms of waste being returned to shore is appropriately executed. This is summarised in Section 7 of this ES.
Fairfield may be required to demonstrate due diligence when addressing duty of care. This could involve undertaking site visits or reviewing compliance history when tendering/negotiating contracts with waste management contractors.	Environmental auditing may occur as part of the tendering process for the work (Section 8).
Landfill capacity is diminishing and alternative disposal routes must be found for concrete mattresses. SEPA is developing a sampling regime to understand potential leaching of contaminants from mattresses and will engage with Fairfield once this is developed.	Fairfield welcomes the work that SEPA describes and will actively engage when further information is made available. Fairfield's Waste Management Strategy details the approach to minimising landfill, and this is summarised in Section 8.
SEPA advised that Fairfield should confirm that marine growth returns to shore should be appropriately licenced (e.g. hazardous waste licenses/Pollution Prevention and Control (PPC) permits should include animal bi-products for marine growth). SEPA also advised that some waste licences and PPC permits may have conditions regarding smell and SEPA could undertake enforcement notices on sites should odour issues arise.	As detailed in Section 8, Fairfield will require that onshore dismantling yards conduct a review of records of engagement with communities and close-out any outstanding issues, including those related to odour.

Comment	Fairfield response
SFF	
SFF stated that each decommissioning project presents different challenges from a fishing perspective but that the opening position will always be that all infrastructure should be removed. SFF also stated that additional rock coverage creates risks to fishermen.	Fairfield has considered this position within the CA, and this is detailed in the CA report that accompanies the Decommissioning Programme. This EIA has assessed the impact of the decisions made to understand the significance and mitigation requirements. This is presented in Section 6.
SFF observed that in and around the Dunlin area at certain times of the year could see medium-to-high levels of fishing activity with the larger pelagic fleet vessels targeting the shoals of mackerel in January and February.	This information has been included in the wider fisheries baseline presented in Section 3.5.1. This has in turn informed the impact assessment presented in Section 6. It is worth noting that the indicative schedule for the decommissioning activities will see the majority of the work undertaken in summer months.
SFF noted a concern regarding the cumulative impacts of decommissioning structures *in situ*, with regards to access to sea area.	Each impact assessment has considered the potential for cumulative impact. For access to sea area, the potential issues associated with the *in situ* decommissioning of the rockdumped production and water injection lines has been considered alongside the return of the sea area currently occupied by the Merlin 500 m safety zone (Section 6).

5.4. Stakeholder Feedback on the Consultation Draft

Fairfield received a number of comments on the consultation draft of the DP. Issues raised which were relevant to the ES and to potential environmental impacts were broadly related to:

- Baseline data, including for the drill cuttings, either clarification of existing data or supplementary information requested;
- Queries regarding the potential environmental impacts of different options considered in the CA; and
- Clarification regarding status of existing infrastructure and of the footprint of the proposed activities (including overtrawling).

Fairfield has provided written responses to each stakeholder query, and updated the DP documentation as relevant. This ES has also been updated where relevant; changes are largely in Section 3, where additional baseline data have been added, and in Section 6, where minor changes to text supporting the impact assessments have been made.

6. Impact Assessment

6.1. Discharges to Sea

6.1.1. Introduction

The Merlin decommissioning activities have the potential to impact on the water column and users of the water column through the release of chemicals and hydrocarbons. This may happen during the disconnection and cutting of lines in preparation for decommissioning, or over a longer period of time from infrastructure decommissioned *in situ*.

6.1.2. Description and Quantification of Potential Impact

6.1.2.1. Trenched and Rockdumped Pipeline and Umbilical

The Merlin main line PL1555 and Umbilical PL1557 will be decommissioned by removing the ends of the lines and placing local rockdump at the cut ends and areas of low burial depth. Upon disconnection of the lines, an initial release of contents to sea is expected as hydrostatic equilibrium is reached with the surrounding water column. Following this, contents will be exchanged with ambient water at a slower rate through the open ends, being largely dependent on line topography at this stage. It is also possible that contents may disperse out over a longer period of time as the lines degrade *in situ*, particularly with PL1555 where wall thickness is already low in some places.

Pipeline PL1555 contains approximately 187 m^3 of suspension water that has a hydrocarbon content of approximately 19 mg/l oil in water and chemicals that are considered to pose a low risk to the environment (e.g. ‘gold’ band and those classified as ‘poses little or no risk’ (PLONOR)) chemicals, as shown in Table 6.1). Umbilical PL1557 will contain ambient temperature potable water at the time of decommissioning with no residual chemicals or hydrocarbons. Therefore, the potential impacts of discharge to sea from the umbilical are not considered further within this section.

6.1.2.2. Trenched/Buried Flowline

The water injection flexible flowline (PL1665) will be disconnected at each end and fully removed from the seabed using a reverse reeling technique onto the vessel. The flowline contains 216 m^3 of water injection fluid, consisting of environmentally low-risk chemicals (Table 6.1). There are no residual hydrocarbons present, so the flowline will not be further flushed, and the full contents of the line will be discharged to sea during the removal operation.

6.1.2.3. Umbilical Riser

The umbilical riser (PL1556) will be decommissioned by cutting and recovering the seabed section, with the 180 m remaining in the J-tube of the platform being decommissioned *in situ*. The umbilical riser will contain ambient temperature potable water at the time of decommissioning with no residual chemicals or hydrocarbons. Therefore the potential impacts of discharges to sea from this umbilical riser are not considered further within this section.

6.1.2.4. Pipeline and Umbilical Components

A number of pipeline and umbilical components (described in Table 2.4) will be fully disconnected, removed and recovered to shore. Some lines (e.g. the cooling spool described in Table 2.4) may be cut into shorter sections to facilitate recovery.

Where these components contain inhibited seawater, they will have been flushed with filtered seawater to substantially reduce the volume of hydrocarbons in the line and the expected contents are summarised within Table 6.1. Otherwise, components that contain produced fluid will be recovered to the surface with the end valves shut to contain the hydrocarbons (i.e. there will be no discharge to sea).

The umbilical jumpers will be recovered with the incumbent fluids (including hydraulic oil and chemicals) remaining in the jumper; this will be effected by capping the ends of the lines during disconnection.

Where infrastructure is recovered, there is a potential for discharge of a limited fraction of the inventory, resulting from subsea pressure testing. Where required, this operation would be included within the relevant chemical permit and has not been quantified further in this assessment at this time.

Accidental events which may result in loss of contents during recovery are discussed in Section 6.4.

6.1.2.5. Stabilisation Material and Deposits

Concrete mattresses, including sand and grout bag deposits (as described in Table 2.5) will be fully removed from the seabed at Merlin. These materials are inert, self-contained and will not result in any discharge of hydrocarbons or chemicals to sea. Therefore there are no potential impacts of stabilisation material and deposit removal.

6.1.2.6. Summary

Table 6.1 quantifies the chemicals and/or hydrocarbons contained within the pipelines, flowlines, umbilicals and associated infrastructure at the time of decommissioning. Pipeline and umbilical components have been grouped and stabilisation material and deposits excluded. These concentrations have been taken together with the dimensions of equipment within the Project scope (Section 2) to calculate the potential worst-case volumetric chemical discharges from infrastructure to be decommissioned, shown in Table 6.2.

Table 6.1 Chemical discharge inventories of infrastructure to be decommissioned

Chemical name	**Infrastructure**				
	Pipeline PL1555	**Umbilical PL1557**	**Flowline PL1665**	**Umbilical riser PL1556**	**Pipeline and umbilical components[4]**
Hydrocarbon oil in water	18.6 mg/l				18.6 mg/l
XC85383	1,000 ppm[5]				1,000 ppm
RO IM C317	100 ppm				100 ppm
Methanol	0.512 m^3				0.512 m^3
OSW80490	100 ppm		30 ppm		100 ppm
WCW82816			10 ppm		
DFW82243			1 ppm		
Brayco Micronic SV/3[6]					0.8 litres

Note: Grey shading indicates absence of chemical in the infrastructure at the time of decommissioning. Clear shading indicates presence in the infrastructure at the time of decommissioning (where the final status is not known, the worst-case assumption of the chemical being present at the time of decommissioning is assumed).

[4] Assumed to be mixed with inhibited seawater and to contain the same concentration of oil in water as the connected main line.
[5] ppm = parts per million.
[6] 0.4 l contained within each core of Merlin subsea accumulator module hydraulic hoses.

Table 6.2 Potential worst-case volumetric chemical discharges from infrastructure to be decommissioned

Chemical name	Chemical type	Cefas (2017) classification	Maximum which could be released to sea (m^3)[7]
Hydrocarbon oil in water	Hydrocarbon	N/A	0.004
XC85383	Biocide	Gold	0.202
RO IM C317	Corrosion inhibitor	Gold	0.020
Methanol	Other	PLONOR	1.024
OSW80490	Oxygen scavenger	PLONOR	0.027
WCW82816	Scale inhibitor	Gold	0.002
DFW82243	Antifoam (Water Injection)	Gold (there are plans in place to phase out use of this chemical on the UKCS)	<0.001
Brayco Micronic SV/3	Hydraulic Fluid	C	<0.001
		Total	**1.28**

6.1.3. Mitigation Measures

The relevant permits and consents will be in place for the discharge of chemicals and residual hydrocarbons from the removal of subsea infrastructure. These will include a robust chemical risk assessment and justifications (where applicable) for any discharges associated with these activities. The majority of chemicals to be discharged have a low predicted environmental impact (see the Cefas classifications identified in Table 6.2). Decommissioning activities are expected to take place over a number of months, as per the indicative schedule in Figure 2.5. Therefore, the release of chemicals and any residual hydrocarbons will not all take place at the same time, further limiting the potential for environmental impact compared to an instantaneous release of the total discharge volumes for all lines. Additionally, the only chemical with a plan in place to phase out its use on the UKCS (DFW82243) is present at very low levels (dosed at 1 ppm), making the volume released when PL1665 is disconnected negligible.

The cleanliness of the flushed oil-containing pipelines represents the lowest reasonably practicable level that can be achieved and the maximum potential quantity of hydrocarbons discharged during the operations will be very small.

[7] A conservative estimation of the total volume of pipeline and umbilical components has been used.

6.1.4. Cumulative Impact Assessment

It is possible that chemical and hydrocarbon discharges occurring within the Project area, and from other assets in the area (during other planned decommissioning activities), could act cumulatively to result in an adverse impact to the surrounding environment.

In terms of how the likely discharges from the Subsea Infrastructure Decommissioning Project fit into the context of existing discharges into the North Sea, information reported by (OGUK, 2016a) on operational discharges is useful. For example, there is estimated to be 165,000,000 m^3 of produced water discharged annually from North Sea installations, containing more than 28,500 tonnes of production chemicals. There is estimated to be less than 1.3 m^3 of chemicals remaining in the lines that could be discharged during decommissioning activities or as the decommissioned lines degrade; the small scale of the Merlin activities is clearly demonstrated by this comparison. For hydrocarbons, there is estimated to be a maximum of 0.004 m^3 that could be discharged either during decommissioning activities or as the lines degrade; this is a very small volume in comparison to annual values for oil discharged in produced water for both Dunlin Alpha (approximately 73 m^3 discharged during the last full year of production) and annually from installations on the UKCS (approximately 2,700 m^3; OGUK, 2016a).

Furthermore, it is important to note that the activities described herein are being executed to facilitate the decommissioning of the Merlin field; decommissioning means that there will be no further operational discharges to sea associated with the Merlin field.

There will be other discharges to sea as a result of future decommissioning of the Osprey and Dunlin fields. The decommissioning methodology developed during the CA process has sought to minimise the cumulative impact of those operations in a holistic manner, and it is expected that only a further 12.9 m^3 could be released from the Osprey and Dunlin subsea decommissioning activities. As a result of the water depth (150 m) and the operations occurring over an extended duration, any discharge of chemicals and/or residual hydrocarbons is expected to dissipate relatively rapidly and have a very limited environmental impact. Additionally, the Subsea Infrastructure Decommissioning Project area is a sufficient distance from other assets in the area that there is unlikely to be any direct cumulative impact from other oil and gas production facilities.

6.1.5. Transboundary Impact Assessment

The Merlin Subsea Infrastructure Decommissioning Project sits in reasonably close proximity to the UK/Norway median line (18 km) and there is a possibility that discharges to sea could therefore cross median lines. However, the sea conditions experienced within the northern North Sea would be expected to rapidly dilute and disperse the limited potential volume discharge of chemicals and/or of residual hydrocarbons such that they are undetectable away from the field. As such, they will have no transboundary impact.

6.1.6. Protected Sites

As detailed in Section 3.4, there are no designated or proposed sites of conservation interest within the Project area. The closest designated site, the SCI ‘Pobie Bank Reef’ lies 94 km to the south west of Merlin whilst the closest SPA is Hermaness, Saxa Vord and Valla Field which lies 132 km south west of Merlin. As with other chemical and hydrocarbon discharge activities in the North Sea, the prevailing hydrodynamic conditions will assimilate these discharges to ambient conditions through natural dispersion and dilution. The pipeline and umbilicals decommissioned *in situ* within the Project area could see a slow release of chemicals as the lines degrade, but the highly limited volumes and extended period of release will have no impact on current designated or proposed sites of conservation. As such, there will be no effect (called a 'Likely Significant Effect') on any SAC or SPA. Similarly, there will be no significant risk to the conservation objectives of any NCMPA or MCZ being achieved.

6.1.7. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Biological features of the seabed and water column	Low	Low	Low	Minor
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Users of the water column and seabed around discharge locations will have some tolerance to accommodate the particular effects that could result from discharges (as a result of depth and refreshing of water column) and sensitivity is low. As potential impacts are not likely to affect the long term function of a system or a population, there will be no noticeable long term effects above the level of natural variation experienced in the area and vulnerability is low. The fish populations in the Project area are characterised by species typical of the northern North Sea, with some spawning and nursery regions for commercially important fish and shellfish species occurring in the vicinity of the Project area. There appear to be low densities of cetaceans and seals within the Project area. There are no designated or proposed sites of conservation interest in the Project area. None of the survey work undertaken in the Project area has identified any benthic habitats or species that are of specific conservation significance. Value is therefore defined as low. The impact magnitude is minor because any chemicals that may be discharged will be negligible in volume and have a low marine toxicity ranking. The total volume of hydrocarbons that may be discharged is low and at concentrations below recognised marine discharge toxicity thresholds.				
Consequence		**Impact Significance**		
Low		Not significant		

6.2. Physical Presence

6.2.1. Seabed

6.2.1.1. Introduction

The Merlin decommissioning activities have the potential to impact the seabed in the following ways:

- Direct impacts through:
    - Dredging around pipeline termination locations;
    - Removal of infrastructure;
    - Rockdumping for pipeline/umbilical span remediation; and
    - Overtrawls by chain mats (note: although Fairfield expect to overtrawl within the Merlin 500 m zone, this EIA considers the worst case scenario of overtrawls across the Merlin field).
- Indirect impacts through:
    - Re-suspension and re-settling of sediment; and
    - Disturbance of drill cuttings material.

6.2.1.2. Description and Quantification of Potential Impact

In order to assess the impacts of the proposed operations, the area of potential disturbance must be quantified. The area of direct and indirect disturbance expected for each activity is presented in Table 6.3. Areas where decommissioning activities overlap have been accounted for, ensuring that the extent of potential for impact is not unrealistically overestimated (for example rockdumping will occur in the same location as dredging and is expected to have a bigger impact, so the area of direct impact from dredging is not included). As noted above, overtrawls are not likely to be conducted across the full Merlin subsea area but Fairfield has included the possibility of the activity occurring in order to ensure the worst case scenario is assessed in this ES. As such, the area potentially impacted by overtrawls has therefore been reported separately in Table 6.3.

Table 6.3 Estimate of direct and indirect impact areas

Activity	Direct impact (m^2)	Indirect impact (m^2)
Decommissioning of pipelines, umbilicals, jumpers, hoses	6,680	187,060
Removal of spools, manifolds and other structures	0	5,448
Removal of old deposits	0	5,700
Placement of new deposits	833	13,392
Total from decommissioning operations above	**7,513**	**211,600**
Overtrawls	**2,283,957**	**2,436,614**[8]

The impact area estimates have been based on the following assumptions:

- Where structures sitting on the seabed are removed, there is considered to be no direct impact since the seabed directly under the structure being removed is experiencing no additional impact. However, there is expected to be an indirect impact due to re-suspension of sediments around the structure as it is removed;
- Where seabed sediments are disturbed by operations (e.g. dredging), or by placing material on the seabed (e.g. rockdump) the area of direct impact is assumed to be equal to the area of the operation or item's physical footprint;
- Where buried pipelines are removed by reverse reeling, there is considered to be a direct impact within a 1 m corridor along the length of the removed pipeline, and an indirect impact due to re-suspension of sediments;
- The area of indirect impact (due to sediment re-suspension and re-settlement) is assumed to be equal to the area of the item removed or placed, plus a 10 m buffer. Bottom current speeds at Merlin are in the order of 0.2 m/s, and the seabed sediments and presence of visible faunal tracks indicate the seabed environment is quiescent. Re-suspended sediments are therefore expected to re-settle within 10 m of the point of disturbance. Although finer particles may remain suspended for some time before resettling, the relatively low bottom currents suggest they will not be carried far;
- For mattresses, sand bags, grout bags and concrete blocks, which may be covered in some sediment, the area of indirect impact is assumed to be twice the direct area to ensure the potential disturbance is not underestimated;
- It is assumed as a worst case that the following will be trawled during overtrawls: a radius of 500 m around the three production and one water injection wellheads and the Merlin Umbilical Termination Assembly, and a corridor of 100 m either side and at each end of PL1665, PL1560, PL1555, PL1556, PL1557 and PL1559, excluding the area within the Dunlin Alpha 500 m safety zone. The direct impact area for overtrawls is therefore taken to be equal to the area shown in Figure 6.1. The indirect impact area for overtrawls is assumed to be equal to the direct area plus an additional 10 m buffer to allow

[8] Note that the indirect impact area encompasses the direct impact area, since areas subject to direct impact will also be subject to resuspension and re-settling of sediments.

for sediment re-settlement. The direct and indirect impact areas were calculated using ArcGIS mapping software and are illustrated in Figure 6.1. It should be noted that Fairfield expects this to be the maximum area in which overtrawling will occur[9]; and

- The Merlin drill cuttings accumulation area is approximately 1,876 m^2. For the purposes of the estimates of seabed area impacted given in Table 6.3, it is assumed overtrawls will disturb an area of drill cuttings equal to the area of the accumulation, and the disturbed cuttings will settle within 10 m of the accumulation boundary.

Review of Table 6.3 and Figure 6.1 show that the main cause of direct and indirect disturbance will be the overtrawls, which at a worst case will directly disturb an area of approximately 2.28 km^2 and indirectly disturb approximately 2.44 km^2.

[9] As noted in Section 2.3.5, Fairfield will conduct overtrawling within the Merlin 500 m safety zone, with a geophysical study made outside of the 500 m zone. However, it is possible that overtrawls may be required outside of the 500 m zone to confirm absence of snag points and assessment of this additional potential overtrawling has therefore been conducted.

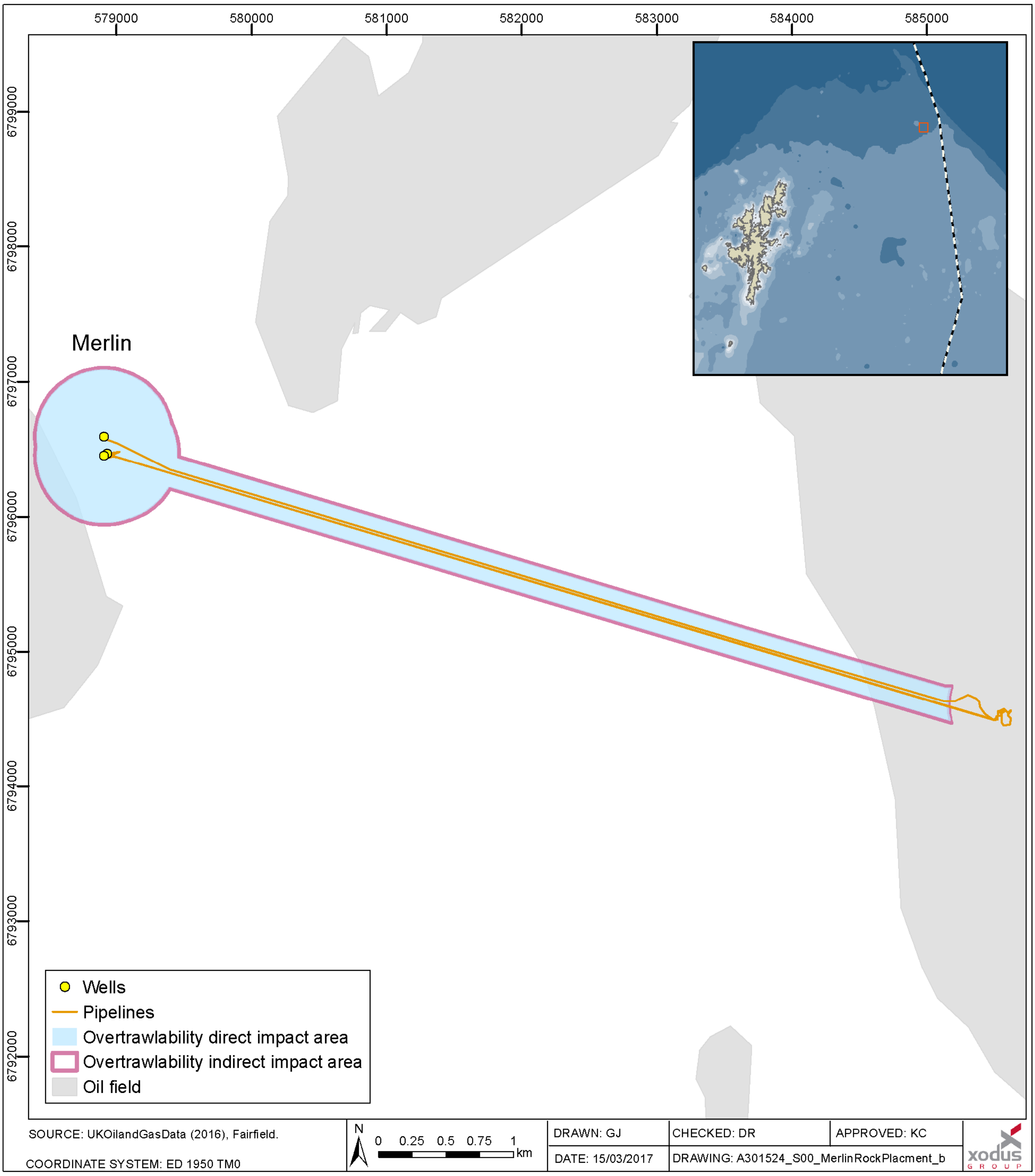


Figure 6.1 Maximum expected overtrawl direct and indirect impact areas

6.2.1.3. Direct Disturbance of Seabed Habitats

Mechanism of potential impact

Direct interaction by physical disturbance can cause mortality or displacement of benthic species in the potential impact zone. Potential direct impact to the seabed could occur from the placement of rock over exposed ends of lines and from dredging, deburial, rock placement and overtrawling.

Dredging is not considered further in this assessment of direct impact as the rock placement will occur in the same location and the rockdump is considered to have the greater impact (permanent change in seabed conditions). The sites of all the decommissioning direct impacts will also be subject to overtrawling, therefore to avoid double-counting, the total area of direct impact quoted here corresponds to the area covered by overtrawling. It is estimated that a maximum of approximately 2.28 km^2 of seabed will be directly impacted during overtrawling operations, and this is the main focus of the assessment. Other activities are however discussed below where they are considered to present different impacts.

Rockdump

Approximately 833 m^2 of rockdump will be placed to protect cut pipeline ends and low burial areas. Impacts associated with this will include direct mortality through crushing of non-mobile benthic fauna, displacement of mobile benthic fauna and permanent loss of approximately 833 m^2 of natural habitat. Surveys (Fugro, 2016d, 2017) show that the natural seabed in the Merlin subsea area is well represented in the wider area, meaning the rockdump area comprises a very small proportion of the available similar habitat. The same surveys reveal a diverse faunal community, suggesting there is good scope for replacement of individuals that may be lost through rockdumping. Mortality and displacement of benthos are therefore not expected to have significant effects at the population level. Whilst the loss of natural habitat will be a permanent impact, it is not expected to be significant when set against the area of similar natural habitat available in the wider area (e.g. Gardline, 2010b), and the freeing-up of seabed surface habitat (approximately 3,200 m^2) through removal of the selected Merlin seabed infrastructure.

Overtrawls

The main mechanism of direct disturbance will come from overtrawling at the end of decommissioning activities. Impacts from the overtrawling may include mortality and injury, arising from crushing of benthic and epibenthic fauna that cannot move away, as well as disturbance of motile fauna as they move away from the area of disturbance. The sediment structure, including burrows of any animals present, will be disturbed. However, the scale of these impacts is small when compared to commercial trawling in the North Sea. A commercial trawler with a 15 m wide beam trawl trawling at 4 km/h would take approximately 38 hours to cover the entire Merlin overtrawl area. Average fishing effort in ICES rectangle 51F1 between 2010 and 2014 was 130 days per year, or 3,120 hours. In this context the scale of the area of impact from the overtrawls is small and, unlike commercial fishing, will not occur on repeated occasions over many years.

The disturbance will occur within two main habitat biotope complexes, as identified in Section 3.3; EUNIS biotope complex ‘Circalittoral Muddy Sand’ (A5.26) and ‘Circalittoral Mixed Sediment’ (A5.4). Tyler-Walters *et al*. (2004) reported tolerance, recoverability and sensitivity related to disturbance of offshore biotope complexes. ‘Circalittoral Mixed Sediment’ was deemed to be of intermediate intolerance to disturbance and moderate recoverability, and therefore moderate sensitivity. Information on the ‘Circalittoral Muddy Sand’ complex is currently deemed insufficient to assign such rankings, but two biotopes that sit within the complex have sensitivity information available to describe them:

- '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' was deemed to have low sensitivity (with medium resistance and high recovery) to abrasion, increases in suspended solids and smothering (De-Bastos, 2016); and

- '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' was deemed to have medium sensitivity to abrasion (low resistance and high recoverability), no sensitivity to increased suspended solids and low sensitivity to smothering (medium resistance and high recovery) (Tillin and Budd, 2016).

It is expected that some damaged individuals will recover *in situ*, and lost individuals will be replaced by recruitment from the surrounding area. The seabed in the area is relatively homogenous with a diverse fauna and represents a good source of larvae and migrating adults to support population recovery.

The ocean quahog is listed on the OSPAR (2008) List of threatened and declining habitats and species and is a qualifying species for a UK National protected site (the Norwegian Boundary Plain NCMPA). Three juvenile ocean quahog were identified from 30 samples recovered in the Merlin area and it is therefore considered that the area is not currently important to this species. The ocean quahog is considered to be moderately tolerant of smothering. It is a burrowing species that can switch between suspension and surface deposit feeding. It is thought to preferentially engage in suspension feeding, remaining buried in the sediment with its inhalant and exhalent siphons exposed. It periodically buries itself further in the sediment, respiring anaerobically often for one to seven days (although the longest record is 24 days) before returning to the surface (Tyler-Walters and Sabatini, 2008). It is therefore likely that any specimens that are buried by overtrawling will be able to recover to the surface before succumbing to anoxia. Ocean quahog is thought to be tolerant of increased suspended sediment levels. It is expected that it will be able to maintain its position in the sediment, and may temporarily switch to deposit feeding whilst disturbed sediment settles out (Tyler-Walters and Sabatini, 2008).

Hiddink *et al*. (2006) modelled the recovery time for benthic communities following disturbance by beam-trawling in the southern and central North Sea, which indicated that mud habitats on average took longer to recover (approximately 4 years) than higher energy sand and gravel areas (approximately 2 years). Merlin is located in the northern North Sea, in deeper waters than the communities investigated by Hiddink *et al*. (2006), however the seabed energy is likely to be the important factor. Bottom currents at Merlin are low and the seabed is predominantly fine sand, indicating a probable recovery time in the middle of the quoted range. Based on the information above, trawling will impact habitats in the Merlin area, but impacts will be local and recovery is likely to occur within a matter of a few years.

6.2.1.4. Indirect Disturbance of Seabed Habitats

The proposed activities may also lead to the smothering of benthic species and habitats due to sediment suspension and re-settlement (indirect disturbance). The estimated area of indirect impact is approximately 2.44 km^2, which represents the entire direct impact area with a 10 m buffer within which sediments may settle. As stated in the direct impacts section above, this area is negligible compared to the area of ICES rectangle 51F1 trawled every year by commercial fishing vessels.

Indirect impacts will be increased suspended sediment load and re-settlement of sediments. The creation of higher than normal loads of sediment suspended in the water column, and the subsequent re-settling of that sediment has the potential for negative impacts on habitats and species through burial and/or smothering. This may particularly affect epifaunal species (Gubbay, 2003) with the degree of impact related to individuals' ability to clear particles from their feeding and respiratory surfaces (e.g. Rogers, 1990).

There is no smothering sensitivity assessment available for the 'Circalittoral Mixed Sediment' biotope complex. However, sensitivity of the two biotopes within the 'Circalittoral Muddy Sand' complex that are described above is low, with medium to high resistance and high recovery (Tillin and Budd, 2016, De-Bastos, 2016). Species characterising these biotopes are expected to be exposed to, and tolerant of, short term increases in turbidity following sediment mobilization by storms and other events. There may be an energetic cost expended by species to either re-establish burrow openings, to self-clean feeding apparatus or to move up through the sediment, though this is not likely to be significant. Most animals will be able to re-burrow or move up through the sediment within hours or days.

With regard to the settlement of re-suspended sediments, the infaunal community is adapted to fluctuations in sedimentation levels and not likely to be particularly sensitive to temporary and localised increases. Tillin and Budd (2016) report on the abilities of buried fauna to burrow back to the surface. Results indicate bivalves are able to burrow between 20 – 50 cm depending on species and substrate, with results for the polychaete *Nephtys hombergii* (found in the Merlin field) ranging from 60 cm in mud to 90 cm in sand. The abilities of the Merlin fauna to recover to the sediment surface will depend on the species and the burial depth, but as overtrawling is not expected to result in deep burial, success should generally be high.

Defra (2010) states that generally impacts to the benthic environment arising from sediment re-suspension are short-term (over a period of a few days to a few weeks). These impacts on benthic habitats and species will be localised and are not expected to result in changes to the benthic community in the long-term.

6.2.1.5. Disturbance of Drill Cuttings

Disturbance of the Merlin cuttings will result in re-distribution of some of the contents of the accumulation onto the surrounding seabed, along with entrained contaminants. This disturbance may occur to a small degree during removal of seabed structures, such as trawlboard deflectors or mattresses, but the main mechanism of disturbance will be during the overtrawls at the end of the decommissioning activities. Modelling conducted by DNV (DNV, 2006 reported in OSPAR, 2009a), undertaken as part of wider research on the potential impact of drill cuttings being left *in situ*, estimated that trawling a medium sized oil-based cuttings pile would disturb only the top 20 cm of material. Of that disturbed sediment, 96.7% would immediately re-settle without becoming suspended in the water column. 3.3% of the top 20 cm of the drill cuttings would become suspended, with 2.47% re-settling within the existing accumulation area and only 0.83% of the top 20 cm re-settling outside of the existing accumulation area. The predicted limited extent of disturbance is corroborated by the observations of several instances of cuttings pile disturbance reported in OSPAR (2009a), which were as follows:

- High intensity overtrawling of a cuttings accumulation in 70 m water depth resulted in spread of contamination, but not be at a rate likely to pose wider contamination or toxicological threats to the marine environment;
- Dredging of the North West Hutton platform cuttings pile (much larger than the small accumulation at Merlin) including repeated dredge backflushes resulting in significant re-suspension of cuttings material showed:

- Drifting of re-suspended material was low during operations;
- Hydrocarbon concentrations on dredged cuttings were similar to those on undisturbed cuttings, and whilst levels of alkylphenol ethoxylates and barium were higher in the dredge-recovered water at the platform topsides, hydrocarbon levels in the water remained low, indicating that the majority of hydrocarbons remained bound to the cuttings and did not become free in the dredged water;
- Corroborating the above, hydrocarbons were not increased significantly in the seawater samples from monitoring stations as a result of the dredging, and there was no detectable oil in the plumes generated during the trial; and
- There were no visible indications of an oil sheen at the surface, and little discernible effect was seen in the water column more than 100 m from the dredging operations.

- Use of high-pressure water jets to clear oil-based mud cuttings from the Hutton Tension Leg platform, causing significant re-suspension of cuttings, had no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the original platform location.

Using the DNV modelling results reported in OSPAR (2009a) it is possible to estimate the effects of overtrawling the Merlin cuttings accumulation:

- The Merlin cuttings accumulation has an area of 1,876 m^2. Assuming as a worst case that the entire accumulation was trawled to a depth of 20 cm, a total volume of 375.2 m^3 of material would be disturbed;
- Of this, 362.8 m^3 would resettle immediately without becoming suspended and 9.3 m^3 would become suspended and re-settle within the existing cuttings accumulation; and
- Only 3.1 m^3 would become suspended and settle outside the existing cuttings accumulation boundaries.

The investigations at North West Hutton and the Hutton Tension Leg Platform suggest that release of hydrocarbons into the water column from disturbed drill cuttings is minimal, and the majority of hydrocarbons present would remain bound to the cuttings (OSPAR, 2009a). On this basis, the potential impact on receptor groups is likely to be minimal; this is described for the key groups in Table 6.4. It should be noted that although the emphasis here is on drill cuttings disturbance by overtrawls (since that activity represents the greatest potential for interaction with the cuttings), the assessment is equally applicable to any disturbance of the cuttings that may occur during the removal of the other Merlin field infrastructure, at either the production or water injection locations.

Table 6.4 Potential impacts on receptor groups as a result of disturbance of the drill cuttings pile

Receptor group and discussion of potential impact
Plankton
IOGP (2016) cites a number of sources indicating the impacts of drill cuttings discharge on plankton are negligible. Recorded deleterious effects on phytoplankton are generally attributed to light attenuation due to suspended solids. The majority of the disturbed material is expected to re-settle almost immediately, and

Receptor group and discussion of potential impact
material disturbed at the seabed (at 150 m depth) is unlikely to interact with the photic zone. No impacts on plankton are expected.
Benthic fauna
Toxicity Fugro (2017) indicated that the majority of the drilling fluid present at Merlin is a synthetic-based mud, specifically a synthetic olefin-based mud, consistent with an ITOPF Group III low to negligible aromatic fluid. One sample contained an unresolved complex mixture consistent with an LTOBM, equivalent to an ITOPF Group II moderate aromatic content fluid. Weathering (as indicated by laboratory analysis) is likely to have removed the majority of the aromatic content of this material, which is the main driver of direct toxicity. In addition, the survey data indicates that the drill cuttings layer is less than 50 cm deep, reflected by lower hydrocarbon concentrations as sampling depth within the accumulation increased, the assumption being that the lower portions of the accumulation represent Water Based Mud (WBM) cuttings (Fugro, 2017). Toxicity of synthetic-based mud to benthic organisms is, as summarised by Neff *et al*. (2000), generally low. Neff *et al*. (2000) conclude that a proportion of observed harmful effects are probably due to nutrient enrichment and subsequent anoxia in affected sediments. Hydrocarbon concentrations within the Merlin cuttings average 96.5 μgg^{-1}. Neff *et al*. (2000) suggest that if the majority of the THC is made up of synthetic-based mud, toxic effects are unlikely. Reference to the OSPAR (2006) THC ecological effects threshold of 50 μgg^{-1} suggests there may be a limited impact. This apparent discrepancy arises in that the term 'THC' incorporates all types of hydrocarbon material, and toxic effects vary widely within the hydrocarbon grouping. Groups which tend to cause toxicity include PAHs, which are hydrocarbons containing rings of only carbon and hydrogen atoms. The OSPAR Coordinated Environmental Monitoring Programme (CEMP) identified nine PAHs of specific concern. Fugro (2017) reported that maximum concentrations of these nine PAHs across the Merlin cuttings accumulation were typically below ERL concentrations, below which toxic effects are not expected. Only C1 naphthalene slightly exceeded the ERL concentration at one station but even then only marginally (0.193 μgg^{-1} compared to ERL of 0.155 μgg^{-1}). These results suggest the cuttings accumulation has low potential for toxic impact outside of the existing cuttings pile, even if resuspended. Fugro (2017) noted that the macrofauna at the Merlin cuttings did not exhibit a classic response to drill cuttings presence. There is no strong dominance of hydrocarbon-tolerant taxa, the majority of the most abundant taxa are considered hydrocarbon-intolerant. There was however a greater prevalence of annelids compared to the wider area, and hydrocarbon-tolerant taxa such as *Chaetozone setosa* were present in greater numbers in the cuttings samples. The fauna is considered impoverished at the cuttings accumulation in terms of individuals and taxa present compared to the surrounding area, but the even spread of individuals across the taxa results in a high diversity score (this means that the community is not dominated by any one or few species, which might be expected in a contaminated environment). Fugro (2016d) indicates that the most common species identified in the wider Merlin area included *E. incolor*, *G. oculata*, *P. cirrifera*, *A. macroglossus*, *P. lyra* and *A. paucibranchiata* and the bivalves *A. similis* and *A. croulinensis*, which are all considered to be hydrocarbon intolerant (Hiscock *et al*., 2005, Rygg and Norling, 2013). Many of these species were also identified in the cuttings accumulation samples (albeit in slightly reduced numbers compared to the wider Merlin area) (Fugro, 2017).

Receptor group and discussion of potential impact
The available information regarding the toxicity of the cuttings accumulation, as well as the macrofaunal community present indicates that the accumulation is having a slight effect on the composition of the benthos, but is not causing any major community changes. Faunal composition at stations 250 m from the Merlin cuttings is similar to more distant stations, despite showing indications of slight synthetic-based mud and barium contamination. This suggests that the faunal community at Merlin is reasonably stable and tolerant of the contaminants in the area. It is therefore likely that re-settling of small amounts of cuttings around the fringes of the existing accumulation will not cause community level changes through toxicity. Whilst disturbance of the drill cuttings will result in some spreading of contaminated material over a small additional area, it is deemed unlikely to result in significant toxic effects; especially when considering that much larger scale disturbance events (such as the Hutton Tension Leg Platform operations described above) have been found to have no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the disturbance location (OSPAR, 2009a). *Burying* IOGP (2016) reports a threshold drilling fluid/cuttings burial depth causing mortality of benthic organisms of 0.65 cm. Given that only a small proportion of material is expected to re-settle outside the original cuttings accumulation boundaries it is not expected that surrounding sediments will be buried to depths greater than 0.65 cm, and therefore no adverse effects on fauna, from burial by re-settling cuttings accumulation material, are expected. *Anoxia* In addition to toxicity and burial, drill cuttings can impact the benthos through anoxia caused by a combination of organic enrichment (which increases the biochemical oxygen demand) and introduction of fine sediments (which restricts oxygen penetration into sediments). The Fugro (2017) survey results indicate that the grab samples from the cuttings accumulation were anoxic below the surface, with a characteristic odour of hydrogen sulphide and a black sediment colouration (also indicative of hydrogen sulphide) below 5 mm sediment depth. Laboratory analysis showed that the TOM content of the samples taken from the cuttings accumulation was comparable to samples taken from the surrounding area and the pipeline route (which were not anoxic). Further analysis indicated that the LTOBM portion of the organic material is weathered (Fugro, 2017). While it was not possible to identify the degree of weathering to the synthetic-based mud it is likely that it too will have undergone weathering since the initial cuttings deposition. The low TOM content of the samples in conjunction with the weathering of the LTOBM and the relatively diverse infauna suggests the majority of the organic enrichment in the top layer of the accumulation has already been metabolised and the sediment is undergoing recovery. The presence of a diverse (if reduced) fauna in the cuttings accumulation samples indicates that anoxia is not currently having a significant impact on the fauna at the accumulation. The potential for re-settling of disturbed material to cause organic enrichment and subsequent anoxia of the surrounding sediments is therefore likely to be limited. In conclusion, the small amount of material likely to be moved outside the existing cuttings accumulation area, the expected low toxicity of the cuttings, and the limited potential for smothering and anoxia suggest there will be no significant impacts on the benthos from disturbance of the cuttings accumulation (whether by overtrawl or other interaction during removal of the seabed infrastructure).

Receptor group and discussion of potential impact
Fish
Neff *et al*. (2000) reports that synthetic-based fluids have very low toxicity to fish, and do not bioaccumulate meaning there is no risk of synthetic-based mud being concentrated in the food chain. The weathered LTOBM material is considered unlikely to be highly toxic to fish since the aromatic (toxic) components have already disappeared. The most significant effect on fish is interference with feeding behaviour due to increased sediment load in the water column. As discussed above, increased sediment load as a result of overtrawls is expected to be short-term.
Seabirds
The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in flightlessness and lack of insulation, compounded by ingestion of toxins through preening during attempts to remove contamination. The decommissioning of the Hutton Tension Leg Platform and the large-scale disturbance of the cuttings accumulation resulted in no visible surface sheen. It is therefore highly unlikely that overtrawls at the Merlin cuttings accumulation, which are anticipated to cause less disturbance than the Hutton Tension Leg Platform operations, will result in any hydrocarbon contamination at the surface. It is anticipated that there will therefore be no effect on seabirds from disturbance of the cuttings accumulation.
Marine mammals
There is little published data available on the impacts of synthetic-based fluid on marine mammals. The available data on other fauna suggests that synthetic-based fluids are low in toxicity and non-bioaccumulating. Fugro (2017) indicates the LTOBM in the accumulation is weathered, and therefore toxic effects should be reduced. Since the majority of the drilling fluid disturbed by overtrawling events is expected to remain bound to the drill cuttings particles, which are expected to re-settle close to the original cuttings accumulation, marine mammals in the area will experience minimal exposure.

6.2.1.6. Mitigation Measures

Fairfield will select one or more an appropriate subsea contractors in line with its commitments to management of environmental impact. As part of this, Fairfield will require the contractor(s) to ensure that seabed interaction occurs in a controlled manner. For example, rock will be placed using a vessel with a flexible fall pipe, assisting with positional accuracy and controlling the spread of the material. Additionally, the localised dredging undertaken to enable recovery of infrastructure on the seabed will be highly targeted and controlled by diver or ROV.

Disturbance of the cuttings pile during decommissioning operations is expected to occur during the removal of a small number of seabed structures and from the overtrawls, but also from future fishing activity. Fairfield will ensure that data are made available to enable the cuttings pile to be marked on Kingfisher charts and FishSAFE plotter files. This will highlight the presence of the cuttings pile to fishermen, and assist in reducing the frequency of trawling occurrences (over which time the cuttings pile will continue to naturally degrade).

6.2.1.7. Cumulative Impact Assessment

DECC (2016) specifies that impacts are considered cumulative only if:

- The physical or contamination “footprint” of a predicted project overlaps with that of adjacent activities; or
- The effects of multiple sources clearly act on a single receptor or resource (for example a fish stock or seabird population); or
- Transient effects are produced sequentially.

There are several oil and gas production facilities within the vicinity of the Merlin subsea area. The Dunlin and the Osprey subsea infrastructure are due to be decommissioned as part of the Subsea Infrastructure Decommissioning Project. Potential impacts from the Dunlin and Osprey decommissioning operations are expected to act on the same receptors as the Merlin operations and there is the potential for cumulative impact with the Dunlin and Osprey operations.

Commercial fishing produces significant physical disturbance; “in a UKCS context, the contribution of all other sources of disturbance are minor in comparison to the direct physical effects of fishing” (DECC, 2016). The physical footprint of the Merlin decommissioning operations is not likely to overlap with fishing activity while decommissioning activity is ongoing, since the area experiences low fishing activity and fishing vessels will be advised not to enter the operations area. Overtrawls at Merlin could be considered to target the same receptors as fishing vessels, although the intent with the overtrawls is not to remove any fauna from the seabed, and the only impact will be direct injury or mortality from the trawl mat. Merlin decommissioning effects are expected to be transient, and fishing events are expected to be intermittent (the Merlin area is not considered to be of high importance relative to surrounding area, as described in Section 3.5.1).

Commercial fishing may begin immediately after decommissioning activities have finished and could therefore qualify as a sequential transient event. The Merlin decommissioning operations could be expected to produce cumulative impacts with commercial fishing. However, the main impact mechanism at Merlin will be conducted over approximately only two days (overtrawls), so that the impact will be spread temporally and spatially. Overtrawls at Osprey and Dunlin will be similarly spread out, and there will also be periods of weeks or months between the overtrawls at each field, such that recovery of sediments at Merlin will be underway before impacts occur at Dunlin or Osprey. Overtrawling at Dunlin and Osprey will cover a maximum area of approximately 8.71 km^2 over a period of approximately 8 days. The seabed area covered by overtrawls at all three locations is likely to equate to impacts created by just a few days’ fishing effort. As such, overtrawls are therefore not expected to contribute to a significant cumulative impact.

In addition to the drill cuttings accumulation at Merlin, there are also cuttings pile present in the Subsea Infrastructure Decommissioning Project area at the Osprey production wells (2,130 m^3) and the Osprey water injection wells (922 m^3). In UKCS waters there are approximately 174 “potentially significant” cuttings piles (OSPAR, 2009b), all of which fall below the OSPAR threshold values for persistence and rate of loss of oil to the water column. As UKCS oil and gas infrastructure is decommissioned over the coming years, these cuttings piles may be subject to disturbance either during decommissioning operations or by future commercial fishing activity. The available literature indicates that even extensive disturbance of large cuttings piles, such as the Hutton Tension Leg Platform, results in minimal impacts that are indistinguishable at distances greater than 100 m from the disturbance location. Given the potential spatial extent of any disturbance will be so limited, it is considered unlikely that the cumulative impacts of UKCS cuttings pile disturbance will be significant.

Finally, Fairfield proposes to deposit a small amount of rockdump as part of the *in situ* decommissioning of the Merlin 8" production pipeline and 3" umbilical. The total expected mass of new rockdump is approximately 5,051 tonnes. This will be placed on or next to the existing rock berm, which is made up of approximately 35,000 tonnes; in the context of the existing rockdump on these lines, the highly limited scale of the addition of only a further 5,051 tonnes is clear. The rockdump is not being added to cover lines that have previously been unburied – the rock is being added to make safe for fishing the lines that are being decommissioned *in situ*.

6.2.1.8. Transboundary Impact Assessment

The Offshore Energy SEA 3 for UKCS waters (DECC, 2016) states that seabed impacts from oil and gas operations are unlikely to result in transboundary effects and even if they were to occur, the scale and consequences of the environmental effects in the adjacent state territories would be less than those in UK waters and would be considered unlikely to be significant. Although the Merlin infrastructure is close (18 km) to the UK/Norway median line, direct seabed impacts will be limited to the immediate footprint of the overtrawls, and indirect impacts from sediment re-suspension and re-settlement will not travel more than a few metres. Significant transboundary impacts are therefore not expected.

6.2.1.9. Protected Sites

Any potential seabed impacts associated with the Merlin Subsea Infrastructure Decommissioning Project will not occur within any SAC, SPA, NCMPA or MCZ. In addition, any seabed impacts do not spread sufficiently far to interact with any protected areas. As such, there is considered to be no Likely Significant Effect on SACs, SPAs, NCMPAs and MCZs and hence no impact on conservation objectives or site integrity.

6.2.1.10. Residual Impact

Receptor	**Sensitivity**	**Vulnerability**	**Value**	**Magnitude**
Seabed habitat and benthos	Low	Low	Negligible	Minor
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Data on sensitivity of the dominant benthic species present in the area is sparse, but there is good data on the sensitivity of the biotope complexes present. Biotope tolerance (resistance) to direct disturbance ranges from medium to low and ability to recover or adapt ranges from high to medium. Tolerance is therefore characterised as low and ability to recover as medium, giving a receptor sensitivity of low. The impact is not likely to affect long term function of the benthic system or the status of the benthic population. There will be no noticeable long-term effects above the level of natural variation experienced in the area. Receptor vulnerability is therefore deemed to be low.				

The impact area contains small numbers of ocean quahog, which is listed on the OSPAR (2008) List of threatened and declining habitats and species. However, only three juvenile individuals were identified in three of the 30 grab samples recovered from the area, indicating the area is not currently important for the species. Apart from ocean quahog there is no specific value or concern about the site, which supports biotopes that are abundant across the wider area. The value of the receptor is therefore deemed to be negligible. Overtrawls are expected to directly impact a maximum of approximately 2.28 km^2 of seabed. The impact is expected to be temporary, with recovery within a matter of a few years. The seabed in the area is reasonably homogenous, and the available habitat is extensive, with the impact affecting a small proportion of the total available habitat. The geographical extent of the impact is therefore deemed to be local. The impact will have a defined start and end point, and is likely to be intermittent over the course of several days, with the point of impact moving around the development area. The magnitude of the impact is therefore deemed to be minor.	
Consequence	**Impact significance**
Low	Not significant

6.2.2. Noise

6.2.2.1. Introduction

Underwater sound is generated by natural sources such as rain, breaking waves and marine life, including whales, dolphins and fish (termed ambient sound). Industrial use of the marine environment adds additional sound from numerous sources including shipping, oil and gas exploration and production, aircraft and military activity. In this assessment, sound is used as a term for anything that an individual animal can hear. The term noise is used in this assessment to mean sound that may have some form of potential impact (for example, it may affect behaviour). Whilst all 'noise' is also 'sound', not all 'sound' is considered 'noise'.

Many species found in the marine environment use sound to understand their surroundings, track prey and communicate with members of their own species. Some species, mostly toothed whales, dolphins and porpoise, also use sound to build up an image of their environment and to detect prey and predators through echolocation. Exposure to natural sounds in the marine environment may elicit responses in marine species; for example, harbour seals have been shown to respond to the calls of killer whales with anti-predator behaviour (Deecke *et al*., 2002).

In addition to responding to natural sounds, marine species such as fish and marine mammals may also respond to man-made sound. The potential impacts of industrial noise on species may include impacts to hearing, displacement of the animals themselves and potential indirect impacts which may include displacement of prey species. Whilst there is a lack of species specific information collected under controlled or well-documented conditions, enough evidence exists for fish and marine mammals to suggest that sound may have a potential biological impact and that noise from man-made sources may affect animals to varying degrees depending on the sound source, its characteristics and the susceptibility of the species present (e.g. Nowacek *et al*., 2007, report this specifically for cetaceans).

As well as potential behavioural impacts of noise, marine mammals and fish exposed to an adequately high sound source may experience a temporary shift in hearing ability (termed a temporary threshold shift; TTS) (e.g. Finneran *et al*., 2005). In some cases, the source level may be sufficiently high such that the animal exposed to the sound level might experience physical damage to the hearing apparatus and the shift may not be reversed; in this case there may be a permanent threshold shift (PTS) (Southall *et al*., 2007), and the animal could be considered as being injured.

6.2.2.2. Description and Quantification of Potential Impact

There are a number of activities that will occur during the decommissioning activities that could emit noise to the marine environment:

- Use of vessels;
- Underwater cutting;
- Where pipelines and umbilicals are to remain *in situ*, exposed ends of the lines will be cut and removed, and they may be cut into shorter sections to facilitate recovery to the vessel;
- The pipeline end spools may be cut rather than disconnected – although that will not be the base case for the activities, it is considered here as a worst-case possibility; and
- The umbilical riser will be cut where it joins the J-tube on Dunlin Alpha.

Fairfield does not intend to use explosives as part of the decommissioning activities.

Vessels and Marine Mammals

Noise emissions from vessels occur continuously during operation of the vessel, appearing louder as animals approach the vessels, and appearing quieter as animals move away. Such continuous noise sources are generally of less concern than intermittent sources (e.g. such as seismic conducted during exploration activities) where relatively high doses of noise can be received by animals over a very short period of time with little warning. In terms of the typical noise emissions from the vessels to be deployed in the decommissioning activities, including during the post-decommissioning surveys, a review of the literature suggests that they will be in the range 174 – 188 dB re 1 µP @ 1 m (e.g. Hannay *et al*., 2004, MacGillivray and Racca, 2006, McCauley, 1998). Published thresholds at which injury (defined as permanent shift in hearing ability) might occur for marine mammals (Southall *et al*., 2007) suggest that noise emissions of in excess of 215 dB re 1 µ @ 1 m would be required for injury to occur[10].

Although noise emissions from vessels are not expected to cause injury, they may be sufficiently loud for marine mammals to find the noise a nuisance and to remove themselves from the area for the duration of activities. Such exclusion might be considered significant if it occurred for extended periods of time in areas that were important for breeding or feeding (which does not apply to the Merlin field; see Section 3.3). Southall *et al*. (2007) note that behavioural reactions to noise by marine mammals are by no means consistent across species or individuals, and it is difficult to therefore state specific thresholds for impact. However,

[10] Source levels are given as sound pressure level (SPL) in root mean square, which means that the sound pressure level has been averaged over the length of the noise emission. For the purposes of this comparison, this is equivalent to the sound exposure level (SEL) threshold given by Southall *et al.* (2007), which is also measured over a period of time (usually 24 hours). Source levels are presented relative to 1 m from the source (abbreviated in the text to '@ 1 m').

considering published data on noise emissions from vessels against possible thresholds for disturbance (e.g. NMFS, 2005, Southall *et al*., 2007) it is clear that there is the potential for animals to be disturbed to some degree.

It is important to note that behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved (JNCC, 2010b). Temporarily affecting a small proportion of a population for a limited period of time would be unlikely to result in population level effects and would be considered as trivial. In contrast, affecting a large proportion for a long period of time may be considered non-trivial. The majority of vessels will be on site for a matter of a few days; even those that will remain longer will only be in the field for a matter of weeks across the duration of the Merlin decommissioning activities. In the context of low number of marine mammals likely to be found in the Merlin field, the likelihood of significant disturbance is low. There will be vessel use in nearshore waters as vessels transit to and from the offshore Merlin field. However, the time spent in nearshore waters will be extremely limited and the likelihood of significant disturbance is low.

Cutting and Marine Mammals

A number of subsea cuts will be made during the decommissioning of the Merlin infrastructure. As JNCC (2010b) report, although advances in cutting technology have reduced the requirement to use explosives to decommissioning structures in recent years (there will be no explosives use), the possibility of injury or disturbance occurring to marine mammals from cutting activities must still be assessed here. Anthony *et al*. (2009) reports the peak source level for oxy arc cutters as 148 dB re 1 μPa @ 1 m and for cable cutters at 163 dB re 1 μPa @ 1 m. Since field measurements undertaken to record cutting emissions in the context of potential effects on marine life are otherwise limited, a possible worst case assumption has been made that noise emissions from cutting may extend up to 195 dB re 1 μPa @ 1 m. Injury from these noise levels is not considered likely, should animals approach the cutting activity. However, if cutting activities continued for a sustained period of time and animals remained within close proximity then there exists the potential for injury through cumulative exposure. This is not considered a likely outcome for the Project, however, as cutting activities are likely to be intermittent and of limited duration (a matter of hours) at any one time.

As with vessel emissions, cutting noise could cause disturbance. The key proxy for the potential to disturb will be the length of the period over which the cutting will take place. For the Merlin decommissioning activities as a whole, it is estimated that cutting activities will take approximately 1 – 2 days over the period of the decommissioning project. In the context of the Merlin field being of no specific importance to marine mammals, this very short period of cutting operations is unlikely to result in disturbance that will significantly affect life functions such as breeding or nursing.

Fish

Popper *et al*. (2014) outline the possibility of fish being affected by various noise emitting industries, of which oil and gas is one. In the same way as marine mammals can be affected, it is possible that fish could be injured or disturbed if noise emissions are sufficiently high (e.g. De Robertis and Handegard, 2012). However, the vessels will be slow moving and fish will not experience any sudden bursts of sounds, such that they may choose to approach or move away, thus avoiding injury. For cutting, the emissions could be considered intermittent (even if the noise source is continuous), but the sound levels are predicted to be low. Even if some fish were to be injured by the emissions, many millions of individuals make up most species populations (e.g. Mood and Brooke, 2010) and limited injury is not likely to result in significant impacts at the population level.

Similarly, should the noise emissions disturb fish, the short-term movement away from the short-term activities would not constitute a large-scale movement by individuals of a species and would be highly unlikely to result in population level impacts.

6.2.2.3. Mitigation Measures

The primary measure of reducing potential impact will be to limit the duration of the noise emitting activities; for example, vessels will only be deployed where necessary and the number of cuts will be limited as far as is practicable. Indeed, Fairfield has prepared a campaign approach to the activities, such that vessels can undertake multiple tasks. It should be noted that the decommissioning of the Merlin field will result in the minimisation of ongoing noise emissions associated with the field (there will be periodic surveys required).

6.2.2.4. Cumulative Impact Assessment

It is possible that the various noise sources associated with the Merlin decommissioning activities (i.e. multiple vessels operating at the same time, or cutting occurring at the same time as vessels being used) could result in an impact to marine mammals and fish. However, noise levels will be sufficiently low that injury is not expected for marine mammals, and potential disturbance zones are likely to be small and, for the most part, highly limited in temporal extent. For fish, the potential for injury or disturbance to result in any detectable changes at the population level is very low. Cumulative impact from sources within the Merlin decommissioning activities are therefore not expected. In the context of the number of vessels that use the North Sea for fishing, shipping, passenger transport, oil and gas activity, recreation and others, which will all emit noise, the scale of the additional 80 – 120 days of in-field/transit time required for vessels associated with the Merlin Subsea Infrastructure Decommissioning Project is clearly limited.

In theory, any project that regularly emits underwater noise has the potential to act cumulatively with the Merlin decommissioning activities – this includes the decommissioning of Dunlin and Osprey subsea structures that will occur as part of the Subsea Infrastructure Decommissioning Project. Cetacean and fish populations are free-ranging and long-distance movement is likely to be frequent, and in some cases predictable through seasonal migration (e.g. mackerel; ICES, Undated). Any animal experiencing a noise from one part of the Subsea Infrastructure Decommissioning Project is likely to belong to a much wider ranging population and there is the potential for that same animal to subsequently come into contact with noise from activates related to other parts of the Project (or indeed even from other unrelated projects). However, potential injury and disturbance impacts resulting from any individual element of the Project are not expected to be significant (e.g. animals will not be excluded from the area), and significant cumulative impact from an animal encountering noise emissions from multiple activities within the Greater Dunlin Decommissioning Project within a short period of time is therefore considered highly unlikely.

6.2.2.5. Transboundary Impact Assessment

The Merlin field is approximately 18 km from the UK/Norway median line. Given the noise sources involved in the project, direct transboundary impact from noise emissions is not likely to occur. However, marine mammals and fish are free-ranging animals and any impact that occurs in UK waters is likely to occur on animals that belong to a much wider ranging population and thus likely to cross median lines. Such a potential impact could qualify as a transboundary impact. However, since injury and disturbance from the limited operations associated with the Merlin decommissioning activities are not expected to result in significant impact to any population, potential transboundary impacts are also therefore considered not significant.

6.2.2.6. Protected Sites

As described in Section 3.4, only one species listed on Annex II of the Habitats Directive is likely to occur in the Merlin field; this is the harbour porpoise. For harbour porpoise, animals making use of the Southern North Sea candidate SAC may also make use of the Merlin field; harbour porpoise within the North Sea are known to form one biogeographical population that spans the North Sea as a whole (JNCC, 2015). However, there is expected to be no injury to harbour porpoise from the Project activities, and no effect of disturbance at the population level. As such, there will be no Likely Significant Effect on this protected site. It is possible that vessel transits nearshore could overlap with grey and harbour seal use of an area, but the presence by vessels in such areas would be highly limited in temporal extent and there would be no significant effect on any nearby protected sites. This assessment also considers there to be no potential for underwater noise emissions to interact with protected features of an NCMPA or MCZ (primarily as there are no sites designated for features that may be affected by noise emissions close to the Merlin field or wider North Sea) and there is therefore no significant risk to the conservation objectives of any NCMPA or MCZ being achieved.

6.2.2.7. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Marine mammals (except harbour porpoise) and fish	Low	Low	Low	Negligible
Harbour porpoise	Low	Low	Medium	Negligible
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Marine mammals and fish either originate from populations with sufficient size to accommodate limited impact, or are likely to be present in sufficiently low numbers that it would be impossible to impact the population and the group is thus considered to be able to accommodate limited impact. As such, they are ranked as Low sensitivity. Since the limited impact will have no effect on the long-term function of the populations, vulnerability is Low. Although most marine mammals and fish are of Low value (as defined in Section 4.3.4.4), harbour porpoise using the site belong to the same population for which the Southern North Sea candidate SAC has been designated and are ranked separately as Medium value. On the basis of the extent of any possible change being highly localised and very short term in nature, magnitude of impact is negligible.				
Consequence		**Impact significance**		
Negligible		Not significant		

6.2.3. Other Sea Users

6.2.3.1. Introduction

The Merlin decommissioning activities have the potential to impact upon other users of the sea. This may happen during the decommissioning activities themselves, when vessels working in the field and transiting to shore occupy space, and after decommissioning should any infrastructure decommissioned *in situ* interact with activities such as fishing.

6.2.3.2. Description and Quantification of Impact

Increased vessel traffic leading to temporary exclusion from sea area

The temporary physical presence of Project vessels has the potential to interfere with other sea users that may be present in the area. Vessels will be required intermittently over approximately four months for a duration of approximately 80 days (Section 2.3.1). Once decommissioning activities are complete, vessel traffic associated with the Merlin field will cease, except for limited vessel requirements to fulfil post-decommissioning monitoring requirements. Therefore, once the removal/decommissioning *in situ* activities are complete, vessel traffic will be much reduced compared to current levels.

Snagging risk and long-term exclusion from the Merlin field area

The Marine Accident Investigation Branch shows there have been 15 sinkings resulting from snagged fishing gear between 1989 and 2014, resulting in 26 fatalities (Anatec, 2017). Once decommissioning activities have been completed at the Merlin field, although most infrastructure will be removed, there remains the potential for fishing gear to snag on infrastructure that has been decommissioned *in situ*; this is limited to the 8" production pipeline, 3" umbilical and umbilical riser. However, the production pipeline and umbilical are currently trenched and buried by rockdump and will see further small volumes of rock (at the ends of the current rockdump and at a small number of areas of low coverage) will ensure they remain inaccessible to fishing gear. Appropriate monitoring and remediation will take place to ensure that the two lines remain suitably buried. The rockdump is currently appropriately graded to allow fishing gear to trawl across it without snagging. As such, the decommissioning *in situ* of these lines presents no long-term snag risk. The umbilical riser piece that is decommissioned *in situ* will sit within the J-tube of the Dunlin Alpha platform; it will therefore be inaccessible to fisheries and thus pose no snag risk (note that the decommissioning of the Dunlin Alpha platform will be considered as part of a separate CA and EIA process).

There is the potential for the loss of objects during decommissioning activities. Depending on size, dropped objects may present a hazard to fishing activities. Should objects pose a snag hazard and it should they not be recovered, it is possible that fisheries will not make use of the re-opened areas, resulting in continued, long-term exclusion from the Merlin field area (but see mitigation measures in Section 6.2.3.3 for proposed recovery strategy).

The current 500 m exclusion zone in place for fishermen at the Merlin field will be removed. This will allow access to areas which fishermen have previously been excluded. However, there is a risk, albeit low, that if trawl nets were used over the drill cuttings pile that the gear could dredge up cuttings, potentially tainting fish within the net. As it will be important for the fishermen to avoid tainting their catch, it is assumed that fishermen will avoid the drill cuttings pile and, in effect, fishing would be excluded from this small area. In the context of the return of the 500 m zone to fishing, this would mean that less than 1% would remain inaccessible. It is also important to note that the hydrocarbon content of the cuttings pile will decline over time; Fugro (2017) estimate between approximately 0.14 and 0.36 tonnes of hydrocarbon will leach out annually. As each year passes, the hydrocarbon content of the cuttings pile will decline and the potential for impact on fisheries will also decline.

6.2.3.3. Mitigation Measures

A number of mitigation measures will be employed to reduce the impact on other sea users:

- During decommissioning the number of vessels and length of time required on site will be reduced as far as practicable through careful planning of the decommissioning activities and information on the location of vessel operations will be communicated to other sea users through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings (as appropriate);

- The Merlin subsea infrastructure is currently shown on Admiralty Charts and the Fishsafe system. Once decommissioning activities are complete, updated information on the Merlin subsea area (i.e. which infrastructure remains *in situ* and which has been removed) will be made available to allow the Admiralty Charts and the Fishsafe system to be updated;

- The limited infrastructure decommissioned *in situ* will be buried to a sufficient depth and any exposed areas and cut ends will undergo additional rockdumping;

- Any objects dropped during decommissioning activities will be removed from the seabed as appropriate;

- A post-decommissioning survey will identify any debris on the seabed within 100 m of any infrastructure left *in situ*. An ROV support vessel may be deployed to recover large items of oilfield debris whilst chain mats are likely to be deployed to clear smaller items of oilfield debris;

- The post-decommissioning survey will confirm the depth to which the *in situ* decommissioned infrastructure is buried below the seabed as appropriate. Environmental samples will be acquired to characterise the condition of the sediment chemistry and macrobenthos when decommissioning is complete;

- An appropriate vessel will be engaged to carry out overtrawls to verify that the seabed has been left in a condition that does not present a hazard to commercial fishing. Final decommissioning activities will be considered to be complete subject to certification of seabed clearance by the SFF (or a similarly qualified body) and acceptance of the Decommissioning Close-out Report by BEIS. The 500 m safety zone around Merlin will then be removed; and

- Fairfield recognises its commitment to monitor any structures decommissioned *in situ* and therefore intends to set up arrangements to undertake post-decommissioning monitoring on behalf of the Licence Owners. The frequency of the monitoring that will be required will be agreed with BEIS and future monitoring will be determined through a risk-based approach based on the findings from each subsequent survey. During the period over which monitoring is required, the status of the infrastructure decommissioned *in situ* would be reviewed and any necessary remedial action undertaken to ensure it does not pose a risk to other sea users.

6.2.3.4. Cumulative Impact Assessment

Fishing effort in the vicinity of the Merlin field is considered low to moderate compared to the wider are of the North Sea shown in Figure 3.19, with a peak of 11 vessels a day using the area. Considerably more effort is focused elsewhere across the wider Northern North Sea, specifically targeting *Nephrops* grounds in the Fladen Ground. Baseline fishing activity analysis undertaken by Anatec (2017) indicates that there are demersal fishing vessels within 10 nm of the Greater Dunlin Area only once every two days, and that there are only, on average, approximately 0.3 crossings of infrastructure per day in the Greater Dunlin Area (109 crossings in the period July 2015 – June 2016). Considered alongside the relatively low levels of shipping activity in the vicinity of the Merlin field, the wide expanse of water available to navigate in and the limited number of vessels to be deployed for the Project, it is not anticipated that there will be any significant cumulative impacts with respect to temporary use of the sea area by decommissioning vessels.

As all infrastructure will either be removed or decommissioned *in situ* in an overtrawlable condition, as the drill cuttings represent such a small area, and as monitoring will be conducted to ensure the decommissioned *in situ* infrastructure remains overtrawlable, there is expected to be no cumulative impact (with regards exclusion from areas) with other structures decommissioned as part of the Subsea Infrastructure Decommissioning Project, or indeed with other North Sea decommissioning projects.

In terms of the scale of the decommissioning activities with regards to other sea users, there are estimated to be 457 safety zones in the central and northern North Sea on the UKCS (UKOilAndGasData, 2016). Since the decommissioning of the Merlin field will see the removal of the Merlin safety zone, approximately 0.79 km^2 of the total of approximately 360 km^2 sea area occupied will be returned as navigable waters of the North Sea. This will assist in reducing the areas of the North Sea currently unavailable to other sea users and thus in reducing the potential for cumulative impact from decommissioning of North Sea structures.

6.2.3.5. Transboundary Impact Assessment

As the Merlin field is beyond the UK's 12 nm limit, EU and non-EU vessels are also permitted to fish in the area, subject to management agreements including, for example, quota allocation and days at sea. Anatec (2017) report vessels of Norwegian origin to be present in the Greater Dunlin Area (up to 50% of vessels). Of the demersal trawlers actively fishing in the study area, 38% were of Norwegian origin. It was also shown that the majority (64%) of vessels crossing the subsea infrastructure were of Norwegian origin with an average of 0.18 subsea infrastructure crossings occurring each day by Norwegian vessels (Anatec, 2017). Despite this, the vessel presence is still regarded as relatively low, and combined with the removal of much of the infrastructure and the overtrawlable nature of the infrastructure that is decommissioned *in situ*, there is no mechanism by which significant transboundary impacts could occur.

6.2.3.6. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Other sea users, excluding fisheries	Negligible	Negligible	Negligible	Minor
Fisheries	Low	Low	Low	Minor
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Sea users other than fisheries relates to shipping, which is capable of accommodating any short term interference (thus low sensitivity) without changing behaviour (thus low vulnerability), makes limited use of the Merlin area (thus low value) and will experience only very localised effects (thus minor magnitude). On this basis, the consequence is negligible and the impact not significant. For fisheries, there is some tolerance to short-term interference (thus low sensitivity) and given the low fishing effort in the area, unlikely to be an impact during the decommissioning activities or in terms of longer-term snag risk or exclusion (thus low vulnerability). On the basis of the estimated catch values from the Merlin area, the value is defined as Low. In terms of magnitude, although there will be localised exclusion during decommissioning itself, the removal of the safety zone will return sea area to the fishing community, which is considered a positive magnitude. Combined with the *in situ* decommissioning leaving the seabed in an overtrawlable condition, the magnitude is considered to be minor relative to complete removal of all seabed structures. Combining these rankings, the impact significance is defined as negligible and thus not significant.				
Consequence	**Impact significance**			
Negligible	Not significant			

6.3. Energy Use and Atmospheric Emissions

6.3.1. Introduction

This section examines the energy use that will occur as a result of decommissioning the Merlin field and presents an analysis of the atmospheric emissions associated with this energy use.

6.3.2. Description and Quantification of Potential Impact

The use of fuel to execute the Merlin Subsea Infrastructure Decommissioning Project will result in emissions of gases to air that could potentially result in impacts at a local, regional, transboundary and global scale. Local, regional and transboundary issues include the potential generation of acid rain from nitrogen and sulphur oxides (NO_X and SO_X) released from combustion, and the human health impacts of ground level nitrogen dioxide (NO_2), sulphur dioxide (SO_2), both of which will be released from combustion) and ozone (O_3), generated via the action of sunlight on NOx and volatile organic compounds (VOCs). On a global scale, concern with regard to atmospheric emissions is largely focused on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report states that the dominant cause of observed warming is anthropogenic greenhouse gas (GHG) emissions (IPCC, 2014). GHGs include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxides, O_3 and chlorofluorocarbons. The most abundant GHG is water vapour, followed by CO_2. IPCC (2007) states that the combustion of fossil fuels is the primary contributor to CO_2 emissions.

Atmospheric emissions from the decommissioning of the Merlin field will occur as a result of:

- Fuel consumption by vessels;
- Movement and treatment of materials brought to shore; and
- Replacement of anthropogenic materials decommissioned *in situ* offshore.

The assumptions on vessel use and on the materials inventory for the Project that have been used to inform the energy use and atmospheric emissions calculations are detailed in Section 2.3 and Section 7. An estimate of the energy use and associated atmospheric emissions is provided in Table 6.5. These estimates include vessel use, recycling of material brought to shore and the replacement of any materials decommissioned *in situ* (materials decommissioned *in situ* will not be available for reuse or recycling and this is accounted for in the assessment by considering the energy and emissions associated with creating that material).

Table 6.5 Estimated energy use and resulting atmospheric emissions from the decommissioning of the Merlin subsea facilities

Project activity	Energy use (Gigajoules)	Atmospheric emissions (tonnes)		
		CO_2	NOx	SO_2
Vessel movement	87,087	6,420	119	24
Onshore activities (such as transportation, dismantling and recycling of materials)	32,289	1,166	4	5
Replacement of material decommissioned *in situ*	14,599	1,033	2	4
Total	**133,975**	**8,619**	**125**	**33**

The majority of the decommissioning activities are too remote from other human receptors (including other offshore oil and gas activity) for there to be any impact on local air quality (the dispersive offshore environment will limit the potential further). Vessel movement nearshore as they transit to the field will be limited to a matter of days. As such, local air quality issues are not likely. For onshore activities, including recycling and movement of material returned to shore, Fairfield will ensure that appropriate management plans are in place for the selected decommissioning facilities to ensure that no local air quality issues occur.

6.3.3. Mitigation Measures

Fairfield commits to the correct management procedures being in place to ensure the following:

- Use of low sulphur diesel (as per UK regulatory requirements);

- Operations carefully planned to reduce vessel numbers and the duration of operations;
- All vessels comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014;
- All vessels have the appropriate UK Air Pollution Prevention or International Air Pollution Prevention certificates in place as required; and
- Onshore facilities have appropriate management procedures in place to ensure that atmospheric emissions, including those from movement of materials, are below levels that could affect local air quality.

Where a dismantling yard is selected that is outside of the UK, Fairfield will ensure the adoption of any control measures for atmospheric emissions that exist in the selected country.

6.3.4. Cumulative Impact Assessment

6.3.4.1. Local Air Quality

The vast majority of the decommissioning activities are too remote from other industrial activities (including other offshore oil and gas activity) for there to be any likely cumulative effects in terms of local air quality. Whilst there may be an increase in emissions nearshore or onshore, the additional potential emissions are sufficiently low that no cumulative impact on local air quality is expected.

6.3.4.2. Global Climate

The issue of atmospheric emissions in terms of global climate is a specifically cumulative one. To understand the potential impact from the atmospheric emissions associated with the Project, it is useful to set the emissions in the context of wider UK emissions. Whilst, an exact figure for offshore emissions in UK waters does not exist, the contribution of emissions from shipping activities can be summed with oil and gas industry emissions to provide a benchmark against which the Project can be considered. The latest available total annual CO_2 emissions from oil and gas activity on the UKCS is estimated at 13,232,726 tonnes (for 2015, OGUK, 2016a) and the latest total annual CO_2 emissions estimate for UK shipping is approximately 11,000,000 tonnes (for 2013, DECC, 2015, cited in Committee on Climate Change, 2015), giving a total of 24,232,726 tonnes of CO_2. The total CO_2 emissions from the decommissioning activities at the Merlin field are estimated to be approximately 8,619 tonnes. This increases to 38,902 tonnes when combined with the estimated figures for Osprey and Dunlin to give a total CO_2 figure for the Subsea Infrastructure Decommissioning Project. This will represent approximately 0.16% of the atmospheric emissions associated with UK offshore shipping and oil and gas activities. The emissions from the Project will thus likely have a limited cumulative effect in the context of the release of GHGs into the environment and their contribution to global climate change.

Emissions figures for the last full year of operation of the Dunlin Alpha platform (which processed produced hydrocarbons from Dunlin, as well as Merlin and Osprey) showed 83,392 tonnes of CO_2 were emitted (this does not include supply vessel activity). The decommissioning operations from the Merlin field will emit approximately 8,619 tonnes of CO_2 and the Subsea Infrastructure Decommissioning Project as a whole will release 38,902 tonnes of CO_2. Although these emissions will add CO_2 to the atmosphere that would otherwise not be emitted should the Subsea Infrastructure Decommissioning Project not have been pursued, they are also emitted in the context of the cessation of operational emissions from the Greater Dunlin Area itself. On the basis of the last full year of production (2014), where annual CO_2 emissions from the Dunlin Alpha platform were 83,392 tonnes, the Subsea Infrastructure Decommissioning Project activities will be offset by the eliminated emissions from the operation of the Greater Dunlin Area in just over two years.

6.3.5. Transboundary Impact Assessment

The Merlin field is located approximately 18 km from the Norwegian median line. Despite this close proximity, the lack of human receptors in the offshore Norwegian sector means no significant transboundary impacts will occur as a result of changes in air quality in the Merlin field. As the dismantling yard has not yet been selected, it is possible that it may be outside of the UK and there could therefore be some local impacts as vessels move in non-UK waters. However, receptors offshore are sparse and emissions will be limited. With the application of mitigation measures described in Section 6.3.3, significant impacts will not occur.

The impact assessment presented above for cumulative impact demonstrates that the Merlin Subsea Infrastructure Decommissioning Project activities will make no significant contribution to UK emissions to the global atmosphere. As such, there will be no significant transboundary impacts. It should be noted here, as above, that the activities are being enacted to decommission the Merlin field, thus eliminating emissions should the facilities not be decommissioned, and having the net effect of reducing annual emissions to air over time.

6.3.6. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Atmosphere	Low	Low	Low	Minor
Rationale				
The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. On the basis that the atmosphere has the capacity to accept the emissions without change, the receptor sensitivity is ranked as Low. As the sensitivity is ranked as low and the magnitude is ranked as minor, vulnerability is considered to be low. A ranking of low has been assigned to the value of the receptor as there are no air quality issues identified in the vicinity and the impact will only impact on a small area of the atmosphere in the immediate vicinity of Merlin. In a global climate context, the anticipated emissions from the Project activities are limited and will be offset by the elimination of the operational emissions from the Merlin field. Considering this, including that effects unlikely to be discernible or measurable, the magnitude of impact is ranked as minor.				
Consequence		**Impact significance**		
Negligible		Not significant		

6.4. Accidental Events

6.4.1. Introduction

The potential impact of any accidental hydrocarbon or chemical release will be determined by the chemical characteristics of the release (including weathering potential), the circumstances and volume of the release, the environmental conditions at the time, the direction of travel of the release and the presence of environmental sensitivities in the path of the release. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of the release occurring against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present in that area at the time of hydrocarbon or chemical release.

6.4.2. Description and Quantification of Potential Impact

6.4.2.1. Sources and Likelihood of Occurrence

Potential sources of accidental releases were reviewed during the ENVID and scoping process and the following were identified:

- Dropped object causing pipeline rupture;
- Accidental release at onshore decommissioning facilities; and
- Accidental release from a vessel.

The Merlin production lines have been flushed of residual hydrocarbons and the main umbilicals will be flushed of chemicals prior to starting the activities described in this EIA. The umbilical jumpers described in Table 2.4 will have some limited chemical and hydraulic oil inventory at the time of decommissioning and there is the potential that a dropped object could trigger a release of the contents. However, it is likely that the maximum volume of chemical or hydraulic oil in any one core would be limited to a maximum of tens of litres. Additionally, in general the contents of the cores are chemicals which pose limited potential for environmental impact (e.g. methanol). Given the limited inventory in the field, and the limited lengths of the lines that will contain residual chemicals and hydraulic oil, it is considered extremely unlikely that there could be an accidental release of any significant volume and these potential events are therefore not discussed further within this impact assessment.

The only other chemicals expected to be present on the decommissioning vessels are small volumes associated with general vessel operations and in the recovered jumpers. There are not expected to be any bulk chemicals present (such as might be expected for drilling or workover operations). As such, chemicals are not expected to be present in sufficient quantities to result in a significant environmental impact. Chemical releases have therefore been excluded from further assessment.

As noted in Section 7, there are limited inventories of chemicals or hydrocarbons being returned to shore and thus unplanned releases with the potential to result in significant impact onshore are scoped out of further assessment.

Accidental release of hydrocarbons from a vessel is therefore the only accidental event given further consideration in this impact assessment.

6.4.2.2. Accidental Release from a Vessel

Potential sources of accidental releases from vessel operations include:

- Release of fuel during bunkering operations whilst the vessel is in port;
- Release of hydraulic oils from ROV or tools; and
- Release of fuel inventory (e.g., as a result of collision, grounding or fire).

Release of fuel during bunkering operations in port, if it were to occur, would be likely to be observed quickly, with spill response procedures initiated to stop the release and mitigate the impacts. Any hydraulic oil release during operations (such as ROV or tool use) would be likely to comprise a small volume of hydrocarbons which would not have the capacity to result in environmental impact in an open sea situation. Release of a vessel fuel inventory is therefore considered to be scenario of greatest concern and is thus considered in more detail below.

The likelihood of a vessel fuel inventory release is dependent on several factors including the seaworthiness of the vessel, the quality of vessel procedures, adherence to those procedures, sea conditions, water depth and density of shipping in the area. The vessels used for the Merlin operations will undergo auditing to ensure seaworthiness and quality of procedures as detailed in the mitigation measures in Section 6.4.3. The Merlin site is in deep water, excluding the possibility of grounding, and vessel activity is low, reducing the possibility of a collision between vessels.

6.4.2.3. Behaviour of Hydrocarbons at Sea

Fairfield has commissioned modelling of the instantaneous release of the entire fuel inventory of a vessel operating at the Dunlin Alpha platform to inform the Subsea Infrastructure Decommissioning Project. The scenario parameters are presented in Table 6.6, Table 6.7 and Table 6.8. The results of the modelling are summarised in Table 6.9.

Stochastic modelling indicated that a release of 3,500 m^3 of fuel at the Dunlin Alpha platform would result in a small area of visible surface oiling. The probability of surface oiling exceeding 0.3 μm is illustrated in Figure 6.2. The 0.3 μm threshold is the thickness above which an iridescent (rainbow coloured) sheen is visible. As shown in Figure 6.2 and Table 6.9, there is a maximum 10 – 20% probability that a sheen exceeding 0.3 μm will cross the UK/Norway transboundary line. There is zero probability of the fuel arriving to a UK shoreline during six months of the year and very low probability in the other six months (between 1 and 5%).

Table 6.6 Modelling oil type and release scenario

Oil type	ITOPF group	Specific gravity	Viscosity (temperature)	Pour point (°C)	Wax content (%)	Asphaltene content (%)
Marine diesel	II	0.843/36.4	3.9 (13°C)	-36	No data	No data

Release source	Fuel inventory	**Release volume**	3,500 m^3
Justification for worst case volume		Loss of entire marine diesel inventory	
Latitude	61° 19' 26.397" N	**Longitude**	01° 32' 48.20" E
UKCS block	211/23a	**Type of release**	Surface
Release duration	1 hour	**Release depth**	0 m below sea level
Total simulation time	20 days	**Persistence duration**	20 days
Release rate	Instantaneous	**Total release**	3,500 m^3

Table 6.7 Modelling simulation details

Number of simulations	25 per season	**Release period**	Multi-year statistic (Seasonal)
Total number of simulations		In excess of 100	
Oil spill modelling software used		OSCAR (Marine Environmental Modelling Workbench v8.0.1)	

Table 6.8 Modelling metocean parameters

Metocean parameters			
Air temperature	Variable (6°C - 17°C)	**Sea temperature**	Variable (8.6°C – 13.2°C)
Wind data (years covered)	2008 – 2014	**Wind data reference**	European Centre for Medium-Range Weather Forecasts
Current data (years covered)	2008 – 2014	**Current data reference**	Hybrid Coordinate Ocean Model

Table 6.9 Modelling surface and shoreline oiling predictions

Shortest time to reach and probability (≥1%) of surface oil (≥0.3 µm) crossing median line				
North Sea coastal states	**Dec – Feb**	**Mar – May**	**Jun – Aug**	**Sep – Nov**
Norwegian Waters	6 hours	6 hours	6 hours	6 hours
	10 – 20%	10 – 20%	10 – 20%	10 – 20%
Shortest time and probability (≥1%) for arrival of fuel to the shore after 20 days				
Shetland	No arrival	No arrival	1 – 5%	1 – 5%
	N/A	N/A	9 days	6 days
Norway	No arrival	1 – 5%	No arrival	1 – 5%
	N/A	13 days	N/A	18 days

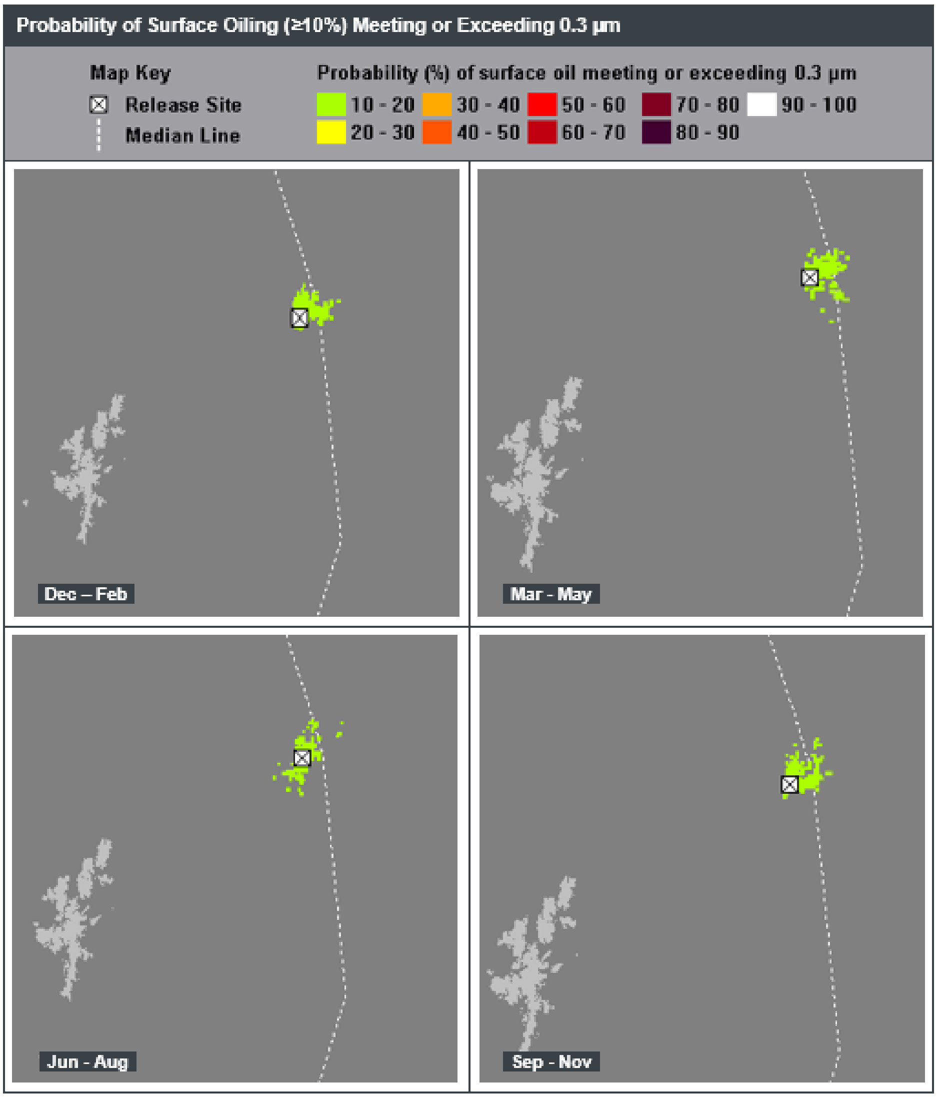


Figure 6.2 Stochastic modelling probability of sea surface oiling (>0.3 µm)

6.4.2.4. Environmental Vulnerability to Accidental Releases

Environmental vulnerability is a function of both the likelihood of impact (as considered in previous sections) and the sensitivity of the environment. Offshore and coastal vulnerabilities need to be considered separately as different parameters will apply.

There may be impacts on plankton in the immediate area of the release for the duration of the release due to the dissolution of aromatic fractions into the water column (Brussaard *et al*., 2016). Such effects will be greater during a period of plankton bloom and during fish spawning periods. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain. These could have long-term chronic effects such as breeding failure in fish, bird and cetacean populations. This may affect stocks of commercially fished species. The relatively small size of any release in comparison to the available habitat and the widespread populations of plankton and small fish is expected to limit the significance of these impacts.

Juveniles and eggs are potentially the fish life-stages most vulnerable to hydrocarbon releases. As outlined in Section 3.3.2.2, a number of commercially important pelagic and demersal fish species are found in the vicinity of the Merlin field. Eleven species are expected to use the project area for spawning and/or nursery grounds at various times of the year. However, any accidental release is not expected to result in significant impacts on fish spawning or recruitment success as the maximum release volume is small and the available spawning and nursery areas are very large.

In a nature conservation context, seabirds are the group at greatest risk of harm due to surface oil pollution in the offshore environment (JNCC, 2011). The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in the inability to fly and loss of insulation and waterproofing, which alone may cause death. Individuals surviving these primary impacts are prone to ingest toxins whilst preening in attempts to remove contamination; this may result in secondary toxic effects.

The seasonal vulnerability of seabirds to surface pollutants in the immediate vicinity of the Merlin field, derived from JNCC block-specific data, suggest that seabirds in this area have a low vulnerability to surface pollution, although some of the blocks exhibit high vulnerability at certain times of the year (see Section 3.3.4). The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to hydrocarbons and their recovery rates from oil pollution. Modelling suggests that the area of sea surface contaminated by hydrocarbons in the event of a spill will be small, with a low (10 – 20%) probability of a surface sheen exceeding 0.3 μm extending outside of the Project area.

Cetaceans are also present in the vicinity of the Merlin subsea decommissioning area (see Section 3.3.5). The potential impact of an accidental release will depend on the species and their feeding habits, the overall health of individuals before exposure, and the characteristics of the hydrocarbons. Baleen whales are particularly vulnerable whilst feeding, as oil may adhere to the baleen if the whales feed near surface slicks (Gubbay and Earll, 2000). Cetaceans are pelagic (move freely in the oceans) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas (Gubbay and Earll, 2000). It is considered unlikely that a population of cetaceans in the open sea would be affected in the long-term.

The likelihood of an accidental hydrocarbon release impacting the coastal environment is a function of the likelihood of such an event occurring and the probability of the hydrocarbon beaching. The level of impact is also directly related to the volume of the hydrocarbons released, the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of beach and receptors present on the shore at the time of beaching. Based on the available modelling of the fuel inventory being released at the Dunlin Alpha platform, it is considered highly unlikely that any vessel inventory release at the Merlin site would reach a UK shoreline (zero probability for six months of the year and between 1 and 5% for the other six months).

6.4.3. Mitigation Measures

The following provides an overview of proposed measures that either reduce the probability of an accidental release, or reduce the consequences:

- All accessible Merlin infrastructure will be flushed of hydrocarbons prior to starting decommissioning operations;
- Vessels will be selected which comply with International Maritime Organisation (IMO)/Maritime and Coastguard Agency (MCA) codes for prevention of oil pollution;
- Vessel pre-mobilisation audits will be carried out and will cover:
  - Review of spill prevention and response procedures;
  - Procedural controls;
  - Bunkering and storage arrangements;
  - Vessel condition certificates;
  - Vessel maintenance records;
  - Evidence of crew competency; and
  - Certification of equipment.
- Vessel personnel will be given full training (by Fairfield or the contractor(s) as appropriate) in chemical release prevention and actions to be taken in the event of an accidental chemical release;
- Operational procedures onboard vessels will include use of drip trays under valves, use of pumps to decant lubricating oils and use of lockable valves on storage tanks and drums;
- Shipboard Oil Pollution Emergency Plans (SOPEPs) including modelling and appropriate response planning will be in place where appropriate;
- The Dunlin Alpha Oil Pollution Emergency Plan, which includes both the Merlin and Osprey fields , will be adhered to within the Merlin 500 m safety exclusion zone;
- AIS and other navigation controls will be used to reduce collision risk;
- Simultaneous operations (SIMOPs) will be actively identified and managed;
- Hoses and connections will be visually inspected prior to use; and

- Tool box talks will highlight the importance of minimising the likelihood of an accidental release occurring.

6.4.4. Cumulative Impact Assessment

It is important to consider the potential for cumulative impacts to arise from accidental events generated by the Project acting in conjunction with accidental events generated by other projects or activities occurring in the area.

Decommissioning of the Osprey production and water injection clusters, the Dunlin subsea infrastructure and the Dunlin Alpha platform will overlap temporally and geographically with the decommissioning activities at Merlin. The overlapping execution of these projects will result in higher than normal vessel densities in the area, increasing the risk of a vessel collision (two moving objects striking each other) or allision (a moving object striking a stationary object). Mitigation measures, including identification and management of SIMOPS and use of AIS, are considered to reduce this additional risk to as low as reasonably practicable (ALARP). An alternative would be to conduct decommissioning operations consecutively instead of concurrently, however it is considered that the increased cost associated with doing this would be grossly disproportionate to the reduction of risk achieved.

Any accidental hydrocarbon release at the Merlin site is expected to dissipate within days. It is considered very unlikely that additional accidental releases from other sources would occur in the same timeframe and produce a cumulative impact.

6.4.5. Transboundary Impact Assessment

There is a low probability that an accidental hydrocarbon release in the Project area would cross into the Norwegian sector. Modelling of a release at Dunlin Alpha suggested that the probability of a surface sheen extending into Norwegian waters was no more than 10 – 20%. If released hydrocarbons did cross the transboundary line the volumes would be small, with limited scope for environmental impact.

As outlined in Section 6.4.2.3, fuel released is not predicted to reach a Norwegian shore with a greater probability than between 1 and 5% for six months of the year – there is zero probability of fuel arriving at shore for the other six months. The maximum volume of fuel that could arrive at any shoreline is predicted to be approximately 1% of that released.

In the event of an accidental hydrocarbon release entering Norwegian waters, it may be necessary to implement the NORBRIT Agreement (the Norway-UK Joint Contingency Plan). The NORBRIT Agreement sets out command and control procedures for pollution incidents likely to affect both parties, as well as channels of communication and available resources. The MCA Counter Pollution and Response Branch also have agreements with equivalent organisations in other North Sea coastal States, under the Bonn Agreement 1983.

6.4.6. Protected Sites

This section considers the potential for accidental events related to the Project to impact upon the conservation objectives (and ultimately site integrity) of important protected sites, specifically SPAs, SACs, NCMPAs and MCZs. The output of the accidental hydrocarbon release modelling described in Section 6.4.2.3 has been compared against the location of SPAs, SACs, NCMPAs and MCZs to determine where there is considered to be the potential for interaction.

6.4.6.1. Direct Interaction with Coastal Sites

As outlined in Section 6.4.2.3, fuel released is not predicted to reach shore in the UK with a greater probability than between 1 and 5% for six months of the year – there is zero probability of fuel arriving at shore for the other six months. The maximum volume of fuel that could arrive at any shoreline is predicted to be approximately 1% of that released. Considering the very low probability and the very low volumes involved, direct interaction with any coastal or onshore protected sites is not expected.

6.4.6.2. Direct Interaction with Receptors from Coastal Sites found Offshore

In addition to direct interaction with a site (i.e. hydrocarbons crossing the boundary of a site), it is necessary to acknowledge that qualifying features of some sites are mobile (e.g. seabirds and marine mammals) and that some individuals may forage or move through the area within which an accidental release has occurred. In terms of marine mammals for which sites are designated, as outlined in Section 3.4, the Southern North Sea candidate SAC, for which harbour porpoise is the proposed qualifying feature, is located 640 km south of the Merlin project area. Harbour porpoise are highly mobile, and records exist of individuals travelling over 1,000 km (JNCC, 2013b). It is not expected however that individuals associated with the Southern North Sea candidate SAC will occur in the Project area in sufficient numbers during any limited period over which a release would take to disperse to have a significant impact on the harbour porpoise population associated with the candidate SAC.

Sites designated for bottlenose dolphin, harbour seal and grey seal are present along the east coast of Scotland, however the distance of the sites from the project suggests no individuals from these sites will occur in the Project area and they are therefore excluded from further assessment.

It would be very difficult to assign seabirds identified within the Merlin Project area to specific SPAs. For many species, once breeding is complete, individuals are no longer restricted to foraging within certain distances (i.e. foraging ranges) from their breeding colony as there is no longer any requirement to return to eggs or chicks. Furness (2015) defines biologically appropriate, species-specific, geographic non-breeding season population estimates for seabirds. For a number of key species there is strong evidence that once birds leave the breeding colony they become widely dispersed over large distances, often intermingling with birds from other breeding colonies (typically of the same species) and in some cases birds that have migrated from overseas breeding colonies (Furness, 2015). Consequently, the potential for an accidental vessel inventory release at Merlin to have population level impacts on birds from any single SPA is much reduced. Potential impacts on birds from protected sites during the non-breeding season (i.e. when they are offshore) are therefore expected to be negligible.

6.4.6.3. Direct Interaction with Offshore Sites

For direct interaction with offshore sites without a land component, surface occurrence of released hydrocarbon within the site is taken as an indication that the site has the potential to be impacted. Modelling suggested that in a fuel inventory release scenario, the probability of a surface sheen 0.3 µm thick extending outside of the Project area would not exceed 10% and even then would not extend much beyond the Project area (Figure 6.2). The closest protected site to the Project area is the Pobie Bank SCI, which is 94 km away at the closest approach. This site is designated for seabed features that would be unaffected by a limited volume of fuel oil being present on the surface. It is therefore considered unlikely that there would be a significant impact on any offshore protected sites.

6.4.6.4. Protected Species

There are several species that are known or expected to occur in the area which are protected but not associated with a site designation. Potential impacts on these species are discussed below.

The ocean quahog is on the OSPAR list of threatened or declining species, and is a PMF. This species is known to occur in the area at low densities as detailed in Section 3.4, although the area is not thought to be particularly important for the species. Ocean quahog is a benthic species, and since the majority of any released hydrocarbon is expected to remain at the surface it is considered unlikely that an accidental release from a vessel at Merlin would have a significant impact on the ocean quahog population in the area.

Basking sharks, spurdog and blue shark are all on the IUCN red list; basking sharks are also protected under the Wildlife and Countryside Act 1981 (as amended). All three species are expected to occur in the area, although not in numbers that are important in a population context, especially for the limited period over which a release would take to disperse. It is not expected that a release from a vessel at Merlin would have a significant impact on any of these three species.

6.4.7. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Seabirds	High	Low	Very high	Minor

Rationale

The information in the Environment Description (Section 3) has been used to assign the sensitivity, vulnerability and value of the receptor as follows.

The worst case accidental event during Merlin decommissioning operations is expected to be the release of a vessel fuel inventory, expected to comprise a maximum of 3,500 m^3 of fuel oil. Direct impacts may occur in the event of a release, the most serious of which could be the oiling of seabirds at the surface. Impacts are expected to be short-term and local, although there is a low probability of a localised transboundary impact. The frequency of the impact is expected to be a one-off. The likelihood of a vessel inventory release at Merlin is considered very low. The likelihood that seabirds will be in the area in high numbers during the summer months when the vessels will be operating is high, although the number of seabirds present is expected to be low during most months (especially so during the summer months when they are breeding onshore and feeding nearshore). Taking all this into account, the impact magnitude is expected to be minor.

Seabirds are especially sensitive to surface oil pollution as it affects both their ability to fly and the effectiveness of their insulation. Receptor sensitivity is therefore expected to be high. It is however considered unlikely that there will be sufficient seabirds affected by a release at Merlin to cause population-level impacts, and receptor vulnerability is therefore considered to be low.

It is likely that seabirds from the coastal SPAs on Shetland as well as other protected sites will use the Merlin area. In addition, the majority of species expected to use the Merlin site are protected under the Birds Directive (2009/147/EC). The receptor value is therefore considered very high.

Seabirds are considered highly sensitive to surface oil pollution, and are considered to be very high value receptors. Seabird vulnerability to an accidental release at Merlin is considered low. The likelihood of a vessel inventory release at Merlin is considered to be very low. Should an accidental release occur there are likely to be visible impacts on seabirds. The severity of these impacts will depend on the time of year and the number of seabirds using the area, however even during periods of high seabird density, the small size of any potential release means that the consequences are likely to be local in extent. In combination, these factors indicate a low consequence level and the impact is therefore considered not significant.	
Consequence	**Impact significance**
Low	Not significant

7. Waste

7.1. Introduction

The duty of care with regards to appropriate handling and disposal of waste rests with Fairfield. In order to enable Fairfield to manage waste appropriately, it is necessary to first understand the types and sources of waste. A description of the Merlin subsea facilities to be decommissioned is provided in Section 2.1 and a summary of the types and quantities of materials associated with the Project is provided in Table 7.1.

Table 7.1 Merlin subsea material summary

Item	Description	Approximate weight (tonnes)
Metals	Ferrous (steel)	1,528
	Non-ferrous (e.g. copper, aluminium, zinc, indium)	6.7
Concrete	Aggregates (mattresses, grout bags, sand bags)	1,181
Plastic	Rubbers, polymers	264
Hazardous substances	Residual fluids (hydrocarbons, chemicals, control fluid)	0.64
	Naturally occurring radioactive material (NORM)	5.7
Other	Fibre optics	0.1
	Total	**2,986**

Table 7.1 provides an estimate of the total weight of subsea materials associated with the Merlin Subsea Decommissioning Programmes, including approximately 212 tonnes of steel associated with the removal of Merlin wellheads.

Section 7.2 describes the regulatory control of waste material whilst Section 7.3 outlines the types and quantities of materials to be decommissioned. Section 7.4 details the measures that will be in place to ensure waste is appropriately managed. Although the focus of this ES is the Merlin Subsea Decommissioning Infrastructure Project, it should be noted that waste operations for the Subsea Infrastructure Decommissioning Project (Dunlin, Merlin and Osprey) will be managed as one.

7.2. Regulatory Control

The EU's Revised Waste Framework Directive (Directive 2008/98/EC) was adopted in December 2008. The aim of the directive is to ensure that waste management is carried out without endangering human health and without harming the environment. Article 4 of the directive also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

The Waste (Scotland) Regulations 2012 control the generation, transportation and disposal of waste within the European Union and the shipment of waste into and out of the EU. It covers controlled waste, duty of care, registration of carriers and brokers, waste management licensing, landfill, hazardous waste, producer responsibility, packaging waste, end-of-life vehicles, waste electrical and electronic equipment and the trans-frontier shipment of waste.

Whether a material or substance is determined as a 'waste' is determined under EU law. The Waste Framework Directive defines waste as "any substance or object in the categories set out in Annex 1 of the Directive which the holder discards or intends or is required to discard". Materials disposed of onshore must comply with the relevant health and safety, pollution prevention, waste requirements and relevant sections of the Environmental Protection Act 1990.

Management of radioactive materials is governed under Radioactive Substances Act 1993, Trans-frontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008. The handling and disposal of radioactive waste requires additional authorisation. Onward transportation of waste or recycled materials must also be in compliance with applicable legislation, such as the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, a highly prescriptive regulation governing the carriage of dangerous goods by road.

7.3. Waste from Onshore Dismantling

Facilities requiring removal as part of the Merlin Subsea Infrastructure Decommissioning Project were determined following completion of the CA process described in Section 2.2. A summary of the types and quantities of waste materials being removed from the subsea area is provided in Table 7.2. It should be noted that the majority of the material described under 'Residual Fluids' will be discharged to sea under an approved permit and will therefore not be brought onshore.

Table 7.2 Summary of materials being removed from the Merlin subsea area

Item	Description	Approximate weight (tonnes)
Metals	Ferrous (steel)	980
	Non-ferrous (e.g. copper, aluminium, zinc, indium)	1.9
Concrete	Aggregates (mattresses, grout bags, sand bags)	1,181
Plastic	Rubbers, polymers	121
Hazardous substances	Residual fluids (hydrocarbons, chemicals, control fluid)	0.4
	NORM scale (scale is a deposit that can form on the inside of lines)	0.6
Other	Fibre optics	0.1
	Total	**2,284**

Steel and other recyclable metal are estimated to account for the greatest proportion of the materials inventory. Typically, around 95% of the materials from decommissioning projects can be recycled (OGUK, 2016b). OGUK (2016a) report that all of the 4,300 tonnes of scrap metal brought onshore from decommissioning projects in 2015 was reused or recycled. Given that much of the material returned to shore from the decommissioning of the Merlin field will be recyclable, it is expected the same high proportion of recycling will be true for the Merlin Subsea Infrastructure Decommissioning Project. A summary of Fairfield's waste management aspirations for material brought to shore is given in Table 7.3.

Table 7.3 Waste management aspirations

Waste stream	Reuse	Recycle	Other recovery	Landfill
Ferrous metal	0 - 15%	95 - 98%	0%	0 - 5%
Non-ferrous metal	0%	95 - 98%	0%	0 - 5%
Concrete (aggregates)*	0 - 50%	0%	50 - 100%	0 - 25%
Plastics	0%	50 - 75%	15 - 40%	0 - 10%
Residual hydrocarbons	0%	0%	85 - 100%	0 - 15%
NORM	0%	0%	0%	100%**
Marine growth	0%	0%	75 - 100%	0 - 25%

** Reuse/recovery opportunities will be dependent on availability of infrastructure projects*

*** NORM may be sent for incineration prior to landfill in order to reduce volume*

For materials where reuse or recycling is not an option, these will be sent to appropriate disposal facilities for recovery, or landfill where other options are not viable. In terms of the waste hierarchy, recovery is more beneficial than landfill since it means a waste product is used to replace other materials that would otherwise have been used to fulfil a particular function; in the case of concrete, for example, the mattresses may be crushed to form construction aggregate, meaning that construction aggregate need not be created from scratch.

Any hazardous wastes remaining in the recovered infrastructure will be disposed of under an appropriate permit. It is likely that there will be small volumes of residual hydrocarbons, chemicals (such as in the umbilical jumpers) and naturally occurring radioactive material; such equipment will disposed of in accordance with relevant Safe Operating Procedures and the Fairfield Waste Management Strategy with consideration of specific sampling, classification, containment, and consignment conditions.

Most of the marine growth will be soft marine growth (e.g. anemones and the soft coral), but hard marine growth is likely to include tube worms, barnacles and mussels. The receiving dismantling yard will strip the installation into its components before they undergo further processing and it is proposed that marine growth be either disposed of to landfill or composted. An alternative option is to send some of the marine growth to be disposed of at an anaerobic digestion facility for use as a fertiliser on land. However, these facilities can only take limited volumes of material.

With regards transboundary movement of waste, OGUK (2016a) report that 98% of all waste brought to shore from offshore oil and gas activities was processed in the UK, with just 1% transferred outside of the UK for processing (the disposal route for the remaining 1% of waste was not specified). Should Fairfield select a dismantling yard outside of the UK, all appropriate transboundary reporting and tracking of waste will occur.

7.4. Fairfield Waste Management Strategy

Environmental management of the Merlin Subsea Infrastructure Decommissioning Project activities will include waste management as a key factor in limiting potential environmental impact. Management of waste will therefore be dealt with in accordance with Fairfield's EMS, certified to the international standard ISO 14001:2015.

As Operator of the Merlin field, Fairfield recognises its duty of care for all waste materials generated from the forthcoming decommissioning activities. As a result, Fairfield must consider the complete life cycle of decommissioning waste, including:

- Waste identification;
- Offshore treatment and storage;
- Offshore preparation/cleaning;
- Shipment of waste;
- Onshore deconstruction;
- Onshore transportation;
- Final disposal/recovery; and
- Ongoing monitoring.

To this end, Fairfield has developed a Waste Management Strategy for the Project, in order to describe the types of materials identified as decommissioning waste, and outline the processes and procedures necessary to support the Decommissioning Programme for the Merlin field (and the other fields in the Subsea Infrastructure Decommissioning Project). The Waste Management Strategy details the measures in place to ensure that the principles of the Waste Management Hierarchy are followed during the decommissioning (as described below). For example, transfer notes will accompany all non-hazardous waste to shore and consignment notes will be in place for any hazardous waste. Furthermore, radioactive waste will be processed by a licensed facility capable of taking contaminated material under appropriate licences and disposing accordingly. The Waste Management Strategy details the checks that Fairfield will undertake on the selected dismantling yard and any onward disposal facilities to ensure all permits and licenses are in place for the handling and disposal of the waste types identified. Fairfield will ensure that waste is transferred by an appropriately licensed carrier who should have a Waste Carrier Registration, Waste Management Licence or Exemption, as appropriate for the type of waste. The contractor(s) that Fairfield will assign to the work will be required to maintain a waste audit trail through to recycling or disposal facility. The strategy will be kept under constant review and appropriately updated throughout the decommissioning activities.

The Waste Management Strategy is underpinned by the waste hierarchy shown in Figure 7.1. The hierarchy is based on the principle of waste disposal only where re-using, recycling and waste prevention cannot be undertaken[11]. Fairfield will communicate the Waste Management Strategy to all relevant members of the decommissioning team (including contractors where relevant).

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[11] For decommissioning projects, the transfer of material to shore is difficult to limit in the context of the need to leave the seabed offshore in an appropriate condition. As such, waste prevention with regards the main sources of waste may not be possible. However, it is important that waste prevention is considered for other aspects, such as during day to day vessel use.

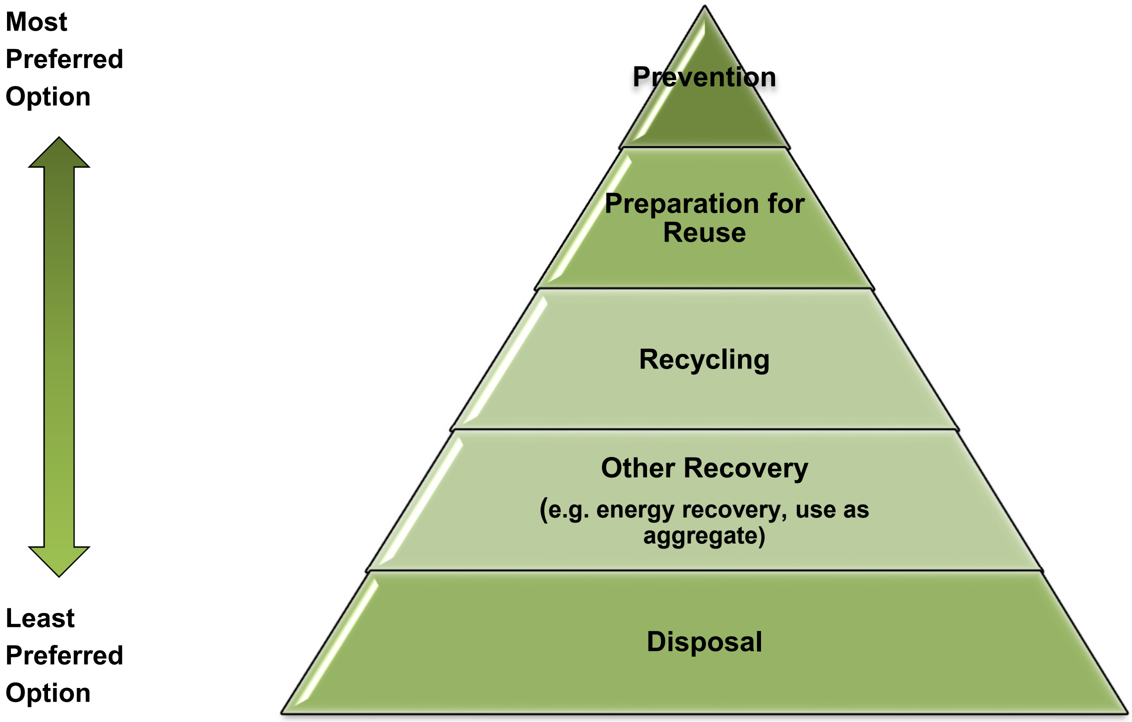

Figure 7.1 Waste hierarchy

8. Environmental Management

8.1. Introduction

Beyond the main period of preparation for decommissioning *in situ* and removal of components of the Merlin subsea area, the Project has limited activity associated with it (there are likely to be a small number of post-decommissioning surveys). 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 manner acceptable to Fairfield (and to stakeholders). The primary mechanism by which this will occur is through Fairfield's Environmental Management Policy, described in Section 1, and specifically through the EMS that it requires be operational.

8.2. Health, Safety and Environment Plan

Fairfield senior management is responsible for ensuring that Fairfield's Environmental Management System is applied to all activities. To support this, a Project Health, Safety and Environment Plan will be developed which outlines how Health, Safety and Environment issues will be managed and how Fairfield's Health, Safety and Environment policies and EMS will be implemented effectively throughout the Project. The Plan will apply to all work carried out on the Project, be it 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.

8.3. Onshore Management

There is the potential for the onshore phase of decommissioning to interact with communities in the vicinity of the dismantling yard. The onshore location has yet to be confirmed, but locations within and outside of the UK may be considered. Whether in or outside of the UK, dismantling will be carried out at existing sites which will have in place site management plans and the correct licences for the proposed dismantling operations and as such will limit potential impacts to local communities. The site selected for decommissioning activities will have in place correct and up to date licences for operation and relevant site management plans. These will ensure operations on site minimise any potential impacts to the local community. For example, specific requirements are likely to include:

- Noise will be managed as part of the onshore dismantling contract and as part of the selection process for the dismantling yard, noise management will be taken into consideration. Noise emitting activities should not occur at particularly sensitive times such as early morning and late night;

- In order to mitigate odour from marine growth, Fairfield will require selection of a dismantling yard that has procedures in place to dispose of marine growth in a manner that will avoid odour nuisance occurrences. This could take the form of an odour management plan being in place within the dismantling yard, management measures could include rapid removal of marine growth and spraying of odour suppressants; and

- Fairfield may require that onshore dismantling yards conduct a review of records of engagement with communities and close-out any outstanding issues.

Environmental auditing may occur as part of the tendering process for the work.

8.4. Commitments

With regards commitments to management interaction between the Project and the environment, the key mitigation and management measures identified during the EIA process that are above and beyond regulatory requirements are summarised in Table 8.1. Each commitment will be reviewed regularly to ensure that it is being met; in this way, environmental management is an ongoing process and will continue beyond implementation of mitigation measures identified during this EIA. The Health, Safety and Environment Plan for the Project will detail how these commitments are managed over the Project.

Table 8.1 Summary of key commitments

Commitment
Seabed interaction
Fairfield will require that contractors ensure seabed interaction occurs in a controlled manner. For example, rock will be placed using a vessel with a flexible fall pipe, assisting with positional accuracy and controlling the spread of the material.
A post-decommissioning survey will be undertaken to collect environmental samples to characterise the condition of the sediment chemistry and macrobenthos.
Other sea users
Fairfield will ensure that data are made available to enable the cuttings pile to be marked on Kingfisher charts and FishSAFE plotter files.
Once decommissioning activities are complete, updated information on the Merlin subsea area (i.e. which infrastructure remains *in situ* and which has been removed) will be made available to allow the Admiralty Charts and the Fishsafe system to be updated.
The number of vessels and length of time required on site will be reduced as far as practicable through careful planning of the decommissioning activities and information on the location of vessel operations will be communicated to other sea users through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.
Any objects dropped during decommissioning activities will be removed from the seabed as appropriate.
The 500 m zone will be subject to an overtrawl trial post-decommissioning, with the intention of confirming a clear seabed. For the pipeline corridors, a geophysical survey will be undertaken and any oilfield related objects/debris identified will be removed by an ROV. Evidence of a clear seabed will be submitted to BEIS in place of a clear seabed certificate.
Fairfield intends to set up arrangements to undertake post-decommissioning monitoring on behalf of the Licence Owners.
Noise
The duration of noise emitting activities will be limited; for example, vessels will only be deployed where necessary and the number of cuts will be limited as far as is practicable.
Energy use and atmospheric emissions
Onshore facilities have appropriate management procedures in place to ensure that atmospheric emissions, including those from movement of materials, are below levels that could affect local air quality.

Commitment
Where a dismantling yard is selected that is outside of the UK, Fairfield will ensure the adoption of any control measures for atmospheric emissions that exist in the selected country.
Accidental events
Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution.
Vessel personnel will be given full training in chemical release prevention and actions to be taken in the event of an accidental chemical release.
Operational procedures onboard vessels will include use of drip trays under valves, use of pumps to decant lubricating oils and use of lockable valves on storage tanks and drums.
AIS and other navigation controls will be used to reduce collision risk.
SIMOPs will be actively identified and managed.
Hoses and connections will be visually inspected prior to use.
Tool box talks will highlight the importance of minimising the likelihood of an accidental release occurring.
Waste
Fairfield will follow the principles of the waste hierarchy, which allows waste disposal only where re-using, recycling and waste prevention cannot be undertaken.

8.5. Scottish National Marine Plan

In addition to consider environmental performance in the execution of the Project, Fairfield has considered Project strategy in the context of the objectives and marine planning policies of the Scottish National Marine Plan. Fairfield considers that the Subsea Infrastructure Decommissioning Project is in broad alignment with such objectives and policies; the extent to which the Project is aligned with oil and gas objectives and policies that are relevant to decommissioning is summarised in Table 8.2.

Table 8.2 Alignment between the Project and the Scottish National Marine Plan

Objective/policy	Project details
Maximise the recovery of reserves through a focus on industry-led innovation, enhancing the skills base and supply chain growth.	The Greater Dunlin Area has extracted hydrocarbons to the point that maximum economic recovery has been achieved. The decommissioning activities will provide high-skilled work in an emerging industry.
An industry which delivers high-level risk management across all its operations and that it is especially vigilant in more testing current and future environments.	Extensive mitigation measures and response strategies have been developed for identified risks.
Where possible, to work with emerging sectors to transfer the experience, skills and knowledge built up in the oil and gas industry to allow other sectors to benefit and reduce their environmental impact.	The Project will draw on experienced engineers, environmental specialists and other groups that are not necessarily limited to oil and gas experience.

Objective/policy	Project details
Where reuse 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. Reuse or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	Fairfield has given full consideration to all available decommissioning options, including reuse and removal, as part of the development of the Project.
Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	The proposed activities have been developed in a way that there will not be a significant impact on the physical, biological and socio-economic environment, now or in the longer-term.
Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Potential environmental impacts have been reviewed as part of this EIA and relevant mitigation measures developed.

9. Conclusion

9.1. Introduction

The EIA presented in this ES has been undertaken in support of the Decommissioning Programme that will be submitted for the Merlin Subsea Infrastructure Decommissioning Project. The EIA has assessed the proposed decommissioning strategy in the context of the environmental sensitivities of the Project area and described the control measures that will be in place during Project execution. The EIA has also given due consideration to the decisions that remain to be made (e.g. dismantling yard location). The key findings of the EIA are summarised in the following sections.

9.2. Protected Sites

There will be no significant impact on any Annex I habitat (of the Habitats Directive). There are a number of offshore and coastal conservation areas on the Scottish mainland that have been designated under the Habitats Directive as SACs, under the EU Birds Directive as SPAs and under the Marine Scotland Act 2010 and Marine and Coastal Access Act 2009 as NCMPAs and MCZs. The potential for significant impacts on any such site has been considered within each impact assessment. Given the short-term duration of the decommissioning activities, the mitigation measures in place and the expected recovery from activities, the Merlin Subsea Infrastructure Decommissioning Project is considered unlikely to affect the conservation objectives or site integrity of any SAC, SPA, NCMPA or MCZ.

The majority of species protected under Annex I of the Birds Directive that are present within the North Sea will generally be found much closer to shore and may only encounter the Project with any regularity during the limited period of the vessel activity. Given such vessel use will result in only limited interaction with individuals of those protected species, the Merlin Subsea Infrastructure Decommissioning Project will not result in significant impacts to those populations.

The presence within the Merlin Project area of species protected under Annex II of the Habitats Directive is limited to marine mammals. Marine mammal species that may be present in the area (or nearshore during vessel transit) occur in relatively low densities, or occur only occasionally, or as casual visitors. Fairfield has assessed whether the noise emitting operations associated with the Project have the potential to result in injury or disturbance to any marine mammal species. This assessment concluded that there is a very low likelihood of injury (such as temporary or permanent hearing loss), or disturbance as a result of the activities associated with the Project and that potentially significant environmental impacts would not result in population level impacts.

Considering all of the above, no significant impacts are expected upon protected species and habitats.

9.3. Cumulative and Transboundary Impacts

A review of each of the potentially significant environmental impacts associated with the Project, and the mitigation measures proposed against the range of other activities in the region indicates that no significant cumulative impacts are expected.

A review of each of the potentially significant environmental impacts associated with the Project and the mitigation measures proposed, indicates that no significant transboundary impacts are expected.

9.4. Environmental Impacts

The residual environmental impact for the Project (i.e. following application of any mitigation) is summarised in Table 9.1.

Table 9.1 Summary of residual environmental impact

Impact	Key potential impacts assessed	Mitigation identified?	Consequence	Significance
Discharges to sea	Short-term release of chemicals and hydrocarbons during removal activities, and longer-term release from lines decommissioned *in situ*	Yes	Low	Not significant
Seabed	Effects of disturbance of seabed on habitats and species, disturbance of drill cuttings	Yes	Low	Not significant
Underwater noise	Vessel use and cutting noise on marine mammals and fish	Yes	Negligible	Not significant
Other sea users	Short and longer-term effects on fisheries use of the Project area	Yes	Negligible	Not significant
Energy use and atmospheric emissions	Emissions resulting from vessel use and use/recycling/replacement of materials	Yes	Negligible	Not significant
Accidental events	Vessel-vessel collision	Yes	Low	Not significant

9.5. Final Remarks

The planned operations have been rigorously assessed through CA and ENVID, resulting in a set of selected options which are thought to present the least risk of environmental impact whilst satisfying safety risk, technical feasibility, societal impacts and economic requirements. Based on the findings of the EIA and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact (which will be managed through the Fairfield EMS), it is concluded that the Project will result in no significant environmental impact.

APPENDIX A ENVID WORKSHOP OUTPUT

Overarching Factor	Sub-Factor	Assumed Mitigation	Commentary of Potential Effects of Option	Potentially Significant in EIA terms?	Stakeholder Expectation to Present Assessment in Environmental Statement?	Take Forward Further in EIA?
Physical disturbance	Noise (e.g. pipeline cutting, vessel noise, explosives) causing injury and disturbance	- Adoption of JNCC measures. - No use of explosives.	Noise from cutting Vessel noise Short duration activity No SIMOPS at different locations. Where possible to reverse reel recovery will be via carousel which will avoid cutting noise emission	No	Yes	Scoped In
	Light emissions affecting migratory bird species	Lights below the horizontal plane where appropriate for H&S	24 hour ops Multiple vessels but no SIMOPS	No	No	Scoped Out
	Short term disturbance of the seabed, including resuspension of sediments (to include rock dump as required, vessel anchoring, removal of materials and structures)	- Use of flexible fall pipe vessel for rock dump - Minimise interaction with seabed - Where applicable, anchor plan, including restricting number of anchor movements OR use of DP vessels	Some activities involve some or all of: rock dump, dredging, backfill, trawl sweeps, mass flow excavation, recovery baskets. Type and magnitude of disturbance, plus shape of area of disturbance, can all affect recovery (e.g. long narrow corridor of disturbance is likely to see more rapid recovery than wide square of the same area). DP vessel so no anchors.	Yes	Yes	Scoped In
	Interaction with protected sites	No specific mitigation, but measures to limit other potential impacts may need to be initiated if there is a potential interaction with protected sites identified	SPA designated birds may forage at site Sensitivity is similar all year round	No	Yes	Scoped In
Atmospheric emissions	Power generation from facilities leading to emissions of greenhouse gases that may affect global climate, or local air quality	- Low sulphur diesel. - Demonstration of BAT. - Maintenance according to manufacturer's recommendations	N/A	N/A	N/A	Scoped Out
	Fuel use by vessels, leading to emissions of greenhouse gases that may affect global climate, or local air quality	- Vessel movement plan to reduce movement as much as possible. - Emissions according to Air Quality Standards and within limits set under MARPOL, maintenance according to manufacturer's recommendations	One vessel Few days at each site No crew change	No	Yes	Scoped In
	Energy use and atmospheric emissions from material recycling or replacement	N/A	Advantageous vs returning to landfill	No	Yes	Scoped In

Overarching Factor	Sub-Factor	Assumed Mitigation	Commentary of Potential Effects of Option	Potentially Significant in EIA terms?	Stakeholder Expectation to Present Assessment in Environmental Statement?	Take Forward Further in EIA?
Discharges to sea	Chemical discharge, which may have toxic effects to species using the water column	- Selection of chemicals with less potential for environmental impact. - Selection of chemicals with less potential for environmental impact - Environmental risk assessment through the MATs/SATs system (OCR) where appropriate	Inhibited water within flushed pipelines Baseline is to flush all lines prior to disconnection but there may be some that can't be flushed. Potentially expected discharge from one or two lines in order of few litres discharge. Assessment will focus on what is left in following flushing/cleaning and how that might be released in the short or long term	No	Yes	Scoped In
	Domestic waste (grey and black water) from vessels that may enrich the water column and alter community composition	Treatment and maceration to IMO standards	Standard practice	No	No	Scoped Out
	Pipeline and structure cleaning, which may release chemicals or hydrocarbons to sea, resulting in toxic effects to marine species	Treated to ALARP	Pipelines already flushed No discharge from umbilical flushing as returned to platform No cleaning of infrastructure on deck	No	No	Scoped Out
	Release of hydrocarbons from disturbance of drill cuttings	N/A	Potential for disturbing drill cuttings	Unsure	Yes	Scoped In
Accidental events	Hydrocarbon and chemical spills / loss of containment, leading to toxic or other effects on marine species, including over an extended period of time if structures are left in situ and subsequently degrade to release what is contained within	- Hydrocarbon free prior to works occurring. Maintenance procedures. - Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution . - Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures. - Preferred operational procedures to be in place onboard vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums. - SOPEP. - OPEP within 500 m. - Vessel condition certificates. - Evidence of crew competency. - Use of Automatic Identification System (AIS) and other navigation controls.	Reservoir abandonments already complete Only source of accidental hydrocarbon release is from vessel Accidental release of any chemical on board the vessels Release of hydraulic oils from ROVs, MFEs, etc. Potential collision risk at Dunlin covered by marine ops procedure within 500 m zone	Yes	Yes	Scoped In

Overarching Factor	Sub-Factor	Assumed Mitigation	Commentary of Potential Effects of Option	Potentially Significant in EIA terms?	Stakeholder Expectation to Present Assessment in Environmental Statement?	Take Forward Further in EIA?
	Dropped objects, impacting upon the seabed	- Installation and SIMOPS procedures will be in place to reduce the potential for dropped objects. - Lift planning will be undertaken to manage risks during lifting activities, including the consideration of prevailing environmental conditions and the use of specialist equipment where appropriate - All lifting equipment will be tested and certified - Procedures will be put in place to make sure that the location of any lost material is recorded and that significant objects are recovered where practicable - Debris clearance surveys will be carried out at appropriate points.	Potential effect not materially different to planned activities.	No	No	Scoped Out
Waste	Radioactive waste/NORM	- Project waste management plan. - Use of licensed waste contractors/sites. - Waste transfer notes	Measurements will be taken on deck	No	No	Scoped Out
	Removed infrastructure and materials, including marine growth, taking up space for landfill	- Project waste management plan. - Use of licensed waste contractors/sites. - Waste transfer notes	Covered in waste management strategy Potential for carousels with umbilicals full of chemicals/hydraulic oils. Potential for some pipelines to be returned with inhibited seawater.	No	No	Scoped In
Commercial impact on Fisheries (Impacts from both the decommissioning operations and the end-points of the present commercial fisheries in and around the Field)	Displacement/exclusion caused by vessel presence during decommissioning activities	- UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings. - Consultation will be undertaken with relevant authorities and organisations. - Development and implementation of a fishery liaison strategy.	Short duration activities over a long (potentially) period of time.	No	Yes	Scoped In
	Returned access made available by removing structures or leaving in situ in such a way that they do not restrict fishing, or continued exclusion by leaving structures in place in such a way that do not allow fishing of the area	N/A	500 m zones around Merlin and Osprey will be removed so fishing access returned. Some improvements where spans or exposures removed.	N/A	N/A	Scoped In

Overarching Factor	Sub-Factor	Assumed Mitigation	Commentary of Potential Effects of Option	Potentially Significant in EIA terms?	Stakeholder Expectation to Present Assessment in Environmental Statement?	Take Forward Further in EIA?
	Long-term risk of snagging/damage to fishing gear	- Pipeline route inspection surveys. - Information on the location of all subsea infrastructure that remains in place will be communicated to other sea users (via the United Kingdom Hydrographic Office, UKHO) through the standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings. Consultation will be undertaken with relevant authorities and organisations with the aim to reduce potential interference impacts resulting from project activities as far as practicable, through the development and implementation of a fishery liaison strategy.	Some infrastructure may remain in situ. Potential for continued long-term exposure of left pipeline - long-term monitoring required to ensure no free spans formed over time.	Yes	Yes	Scoped In
Socio-economic impact on communities and amenities (The impact from any near-shore and onshore operations and end-points (dismantling, transporting, treating, recycling and land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.)	Waste transport and landfill, including noise, dust and land take for landfill	- Waste contractor dealing with the onshore disposal of solid/general waste should have ISO 14001 or equivalent. - Project Waste Management Plan to be developed. - Waste audits to be conducted. - Bridging documents issued to ensure awareness of responsibilities. - Transportation management plan to be incorporated to project specific plan.	Covered in waste management strategy	No	No	Scoped In
	Interaction with other businesses	No mitigation required as any use of business will be positive.	Potential business areas include rock quarrying and the recycling or disposal of materials returned to shore. Some interactions with other operators due to crossings.	No	No	Scoped Out
	Movement of naturally occurring radioactive material to shore, which poses risks to health	- Project waste management plan. - Use of licensed waste contractors/sites. - Waste transfer notes	Covered in waste management strategy	No	No	Scoped Out
	Hazardous waste (oily rags, filters etc.), which poses a risk to health	- Project waste management plan. - Use of licensed waste contractors/sites. - Waste transfer notes	Covered in waste management strategy	No	No	Scoped Out
	Consumption of materials, reducing that available for other industries	As part of cost reduction on the project, engineering work will be ongoing to limit the addition of any new material (such as rock dump or steel).	N/A	N/A	N/A	Scoped Out

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