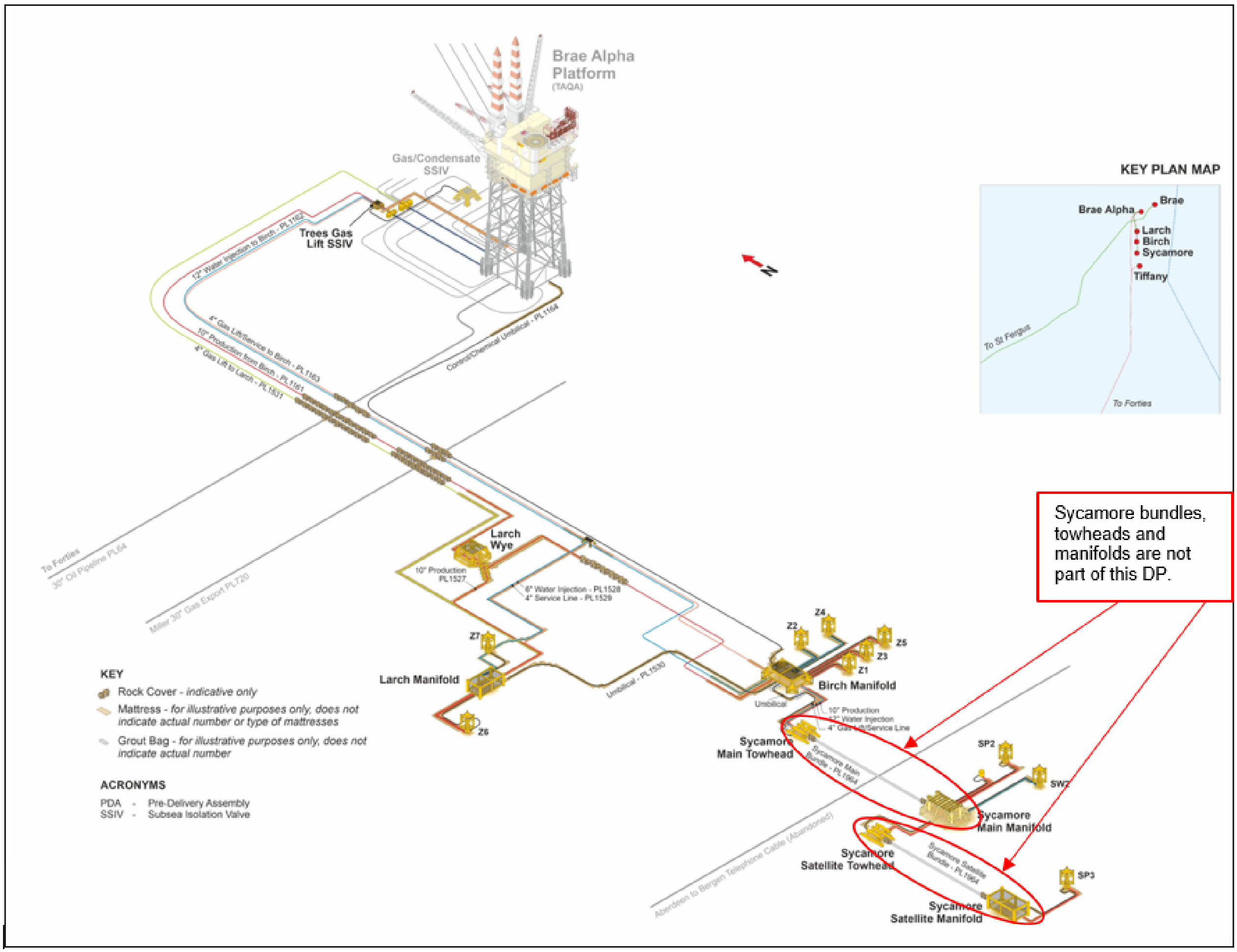
Trees Decommissioning Environmental Appraisal (Birch, Larch and Sycamore)



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Consultation Draft

SPIRIT ENERGY

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ACRONYMNS AND ABBREVIATIONS

Acronym/Abbreviation	Description
ALARP	A Low As Reasonably Practicable
BEIS	Department for Business, Energy & Industrial Strategy, now the Department for Energy Security & Net Zero
Brae A	Brae Alpha
CA	Comparative Assessment
CNS	Central North Sea
DESNZ	The Department for Energy Security & Net Zero
DP	Decommissioning Programme
EA	Environmental Appraisal
EET	Ecological Effects Threshold
EIA	Environmental Impact Assessment
EMT	Environmental Management Team
EMOBF	Enhanced Mineral Oil Based Fluid
EMODnet	European Marine Observation and Data Network
ENVID	Environmental Issues Identification (workshop)
ERL	Effects Range Low
EUNIS	European Nature Information System
GC-FID	Gas Chromatography – Flame Ionisation Detection
GHG	Greenhouse Gas
GWP	Global Warming Potential
HMPA	Historic Marine Protected Area
ICES	International Council for the Exploration of the Seas
IoP	Institute of Petroleum
IWS	International Waste Shipment
KPI	Key Performance Indicator
LTOBF	Low Toxicity Oil Based Fluid
MARPOL	International Convention for the Prevention of Pollution
MAT	Master Application Template
MMO	Marine Management Organisation
MNCR	Marine Nature Conservation Review
MoD	Ministry of Defence
MPA	Marine Protected Area
NSTA	North Sea Transition Authority
NCMPA	Nature Conservation Marine Protected Area
O&G	Oil and Gas
OEUK	Offshore Energies UK
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PAH	Polycyclic Aromatic Hydrocarbon
PAO	Polyalphaolefin Based Fluid
PETS	UK Energy Portal Environmental Tracking System
PL, PLU	Pipeline (or umbilical) identification numbers
PMF	Priority Marine Feature
PWA	Pipeline Works Authorisation
ROV	Remotely Operated Vehicle
SAC	Special Areas of Conservation
SACFOR	Superabundant, abundant, common, frequent, occasional and rare (semi-quantitative abundance scale)
SAT	Subsidiary Application Template
SBF	Synthetic Base Fluid
SCANS	Small Cetaceans in European Atlantic water and the North Sea
SE11	NSTA Stewardship Expectation #11
SFF	Scottish Fishermen's Federation

Acronym/Abbreviation	Description
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
Spirit Energy	Spirit Energy North Sea Oil Limited
SSIV	Subsea Isolation Valve
TAQA	TAQA Bratani Limited
THC	Total Hydrocarbon Concentration
TOC	Total Organic Carbon
TOM	Total Organic Material
UHB	Upheaval buckling
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf

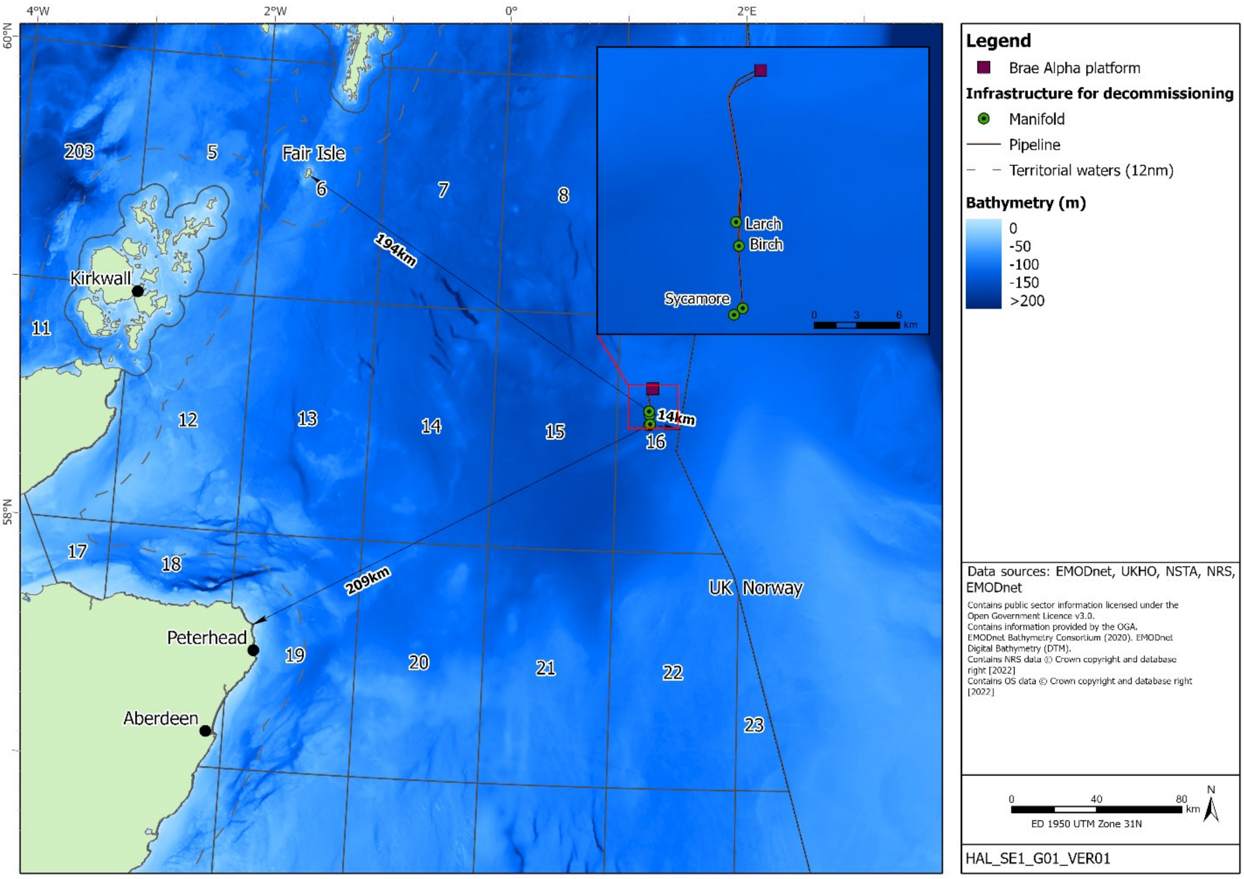
EXECUTIVE SUMMARY

Introduction and Background

Spirit Energy North Sea Oil Limited (Spirit Energy) is planning to decommission the Trees development, which comprises a number of fields (Birch, Larch and Sycamore (Main and Satellite)). The Birch and Larch fields became operational in the mid to late 1990s, (first oil was achieved in 1995) while the Sycamore field development became operational in 2002. Spirit Energy is seeking approval for decommissioning programmes, prepared under the *Petroleum Act 1998* (as amended), in order to proceed with the decommissioning of the Trees fields; this Environmental Appraisal (EA) supports the submission of the combined Trees Decommissioning Programme (DP) to the Department for Energy Security & Net Zero (DESNZ). This summary provides an overview of the facilities to be decommissioned, the baseline environment, the identification of impacts from the proposed decommissioning activities and the findings from the assessment process. The Sycamore bundles, towheads and manifolds will be addressed in a separate DP and comparative assessment, and activities associated with their decommissioning are therefore not included within this EA.

The Trees fields are located in UK Central North Sea (CNS) block 16/12a (Licence P.212) and are tied back to the TAQA Bratani Limited (TAQA) operated Brae Alpha (Brae A) installation located in block 16/07. The Trees fields are *ca*. 209km from the Scottish mainland (194km to Fair Isle), *ca*. 14km from the UK/Norway Median Line, in water depths of 125m (Figure 1).

Figure 1: Trees fields location



Decommissioning Facilities and Activities

In consultation with the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), of DESNZ, Spirit Energy has prepared a combined DP covering the Trees fields infrastructure (Figure 2).

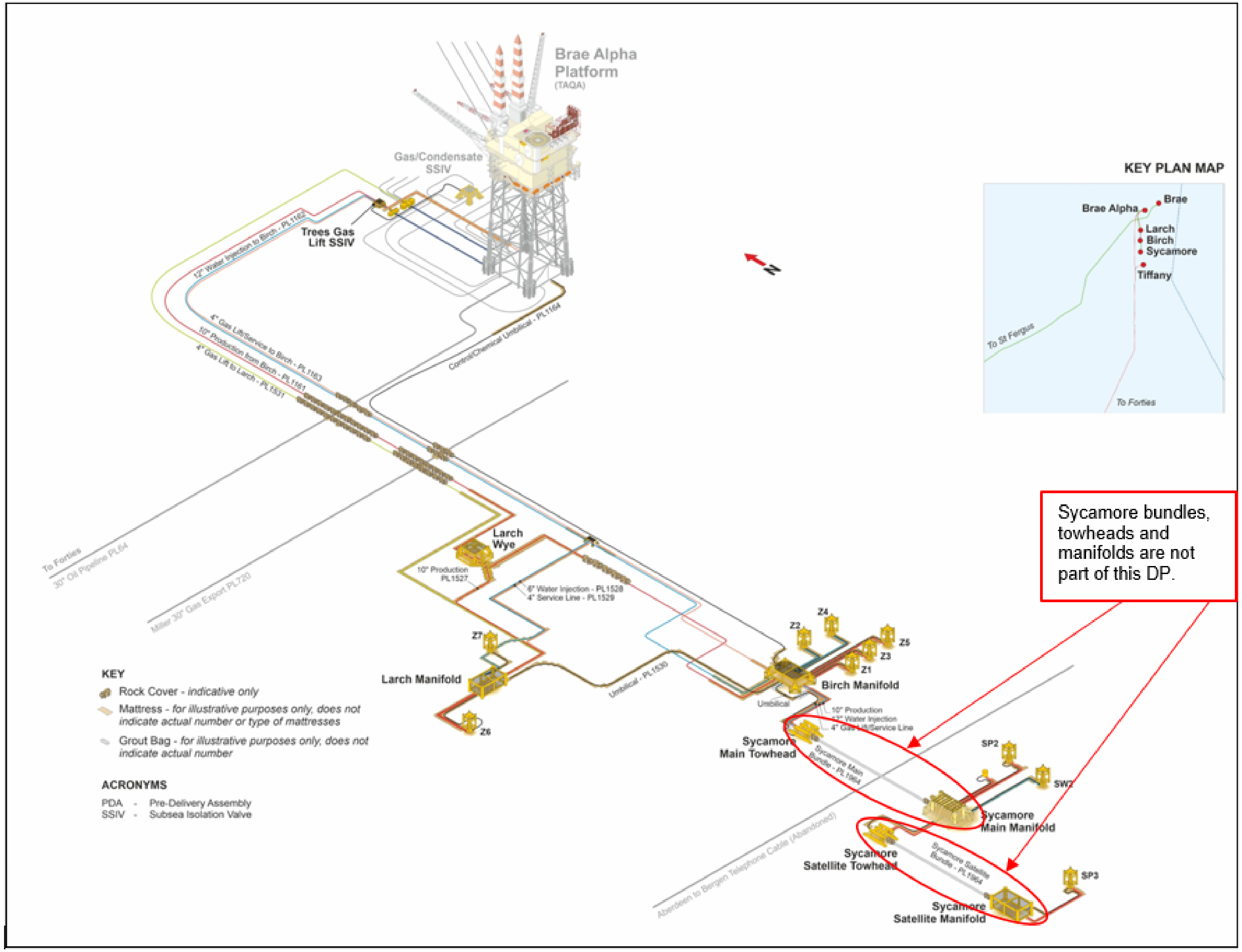
The technical options to remove the subsea infrastructure and to decommission the pipelines and umbilicals, have been identified through a comparative assessment of options. The following approaches to decommission the Trees fields are summarised in Table 1.

Table 1: Decommissioning solutions for the Trees fields

Planned Decommissioning Activities	Description
Complete removal of subsea structures and recovery to shore: • Birch field: manifold, crossover bundle assembly and supports at Brae A, subsea isolation valve (SSIV) protection structure, anode skids. • Larch field: gas lift and production manifold, Wye-piece assembly (original), Wye-piece assembly (new), Wye T-piece, Wye-piece extension spool protection structure • Sycamore field: the SW1 (formerly known as SP1) wellhead (this does not have an integrated protection structure) Note, the decommissioning of the xmas trees and integrated protection structures are addressed in a separate DP and not included here.	All subsea manifolds will be completely removed from the seabed and recovered to shore for reuse (where possible), recycling, or disposal. Structures which are secured to the seabed with piles will be recovered by cutting the piles at a depth of 3m below the seabed. If any practical difficulties are encountered, Spirit Energy will consult OPRED.
Complete recovery of surface laid jumpers and spools at Birch, Larch and Sycamore fields, and recovery to shore. Partial removal of pipelines with sufficiently trenched sections decommissioned *in situ* and exposed sections cut and recovered to shore. • Birch field: production, water injection, chemical injection and gas lift pipelines and umbilicals. • Larch field: Larch production pipeline, Larch water injection pipeline, service pipeline, control umbilicals, gas lift pipeline	Surface laid jumpers and tie-in spools will be completely removed from the seabed and recovered to shore for reuse, recycling or disposal. Pipelines and umbilicals will be flushed and cleaned to an agreed acceptable level of cleanliness prior to decommissioning. Sections of pipelines and umbilicals trenched to a depth of at least 0.6m below the seabed will be decommissioned *in situ,* with exposed pipeline ends cut at depths of at least 0.6m within the trench and then protected by rock cover. A 37m section of PL1527 (Table 2-3) is in a shallow trench and will require remedial trenching to achieve the required trench depth (≥0.6m), if remedial trenching is not successful the section of line will either be covered with rock or cut and recovered (with remaining pipeline ends protected using rock).
Removal of all exposed concrete mattress and grout bags (not associated with pipeline crossing) to shore	All exposed mattresses and grout bags will be recovered to shore. Concrete mattresses and grout bags buried beneath protective rock cover will be decommissioned *in situ*. Stabilisation features within trenches and below seabed level will be left *in situ*. It is estimated that *ca*. 80% of mattresses and grout bags are exposed and will be recovered, and *ca*. 20% of mattresses and grout bags will remain permanently under deposited rock on the seabed.

Planned Decommissioning Activities	Description
Decommission *in situ* existing deposited rock and concrete blocks (at pipeline crossings)	Third party pipeline crossings will not be disturbed and stabilisation materials associated with the crossings will be decommissioned *in situ*.

Figure 2: Trees fields layout and decommissioning scope of activities[1]



Note [1]: Birch, Larch and Sycamore wells shown here, but these are the subject of a separate DP. SW1 (formerly SP1) well at Sycamore Main shown, but not labelled, this well was drilled and plugged and never produced from.

Environmental Baseline

Spirit Energy conducted a pre-decommissioning environmental survey in March 2022 for the Trees fields at the Birch, Larch, Sycamore and the Brae A locations (Fugro 2022a-c). This survey is supported by results from two previous surveys of the Trees fields area. This, along with other information from the Trees fields and wider area, were used to construct a description of the Trees fields environment. A summary of the main environmental features of the area and their seasonal variability is shown in the table below.

<table>
<tr><th>Aspect</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Block licence constraints</td><td colspan="12">Blocks 16/12a and 16/07
There are no block sensitivities on the blocks (i.e. no periods of concern for seismic surveys (Marine Scotland), there is no requirement on the blocks to confirm whether there are any herring spawning sites present and there is no special conditions on the blocks).</td></tr>
<tr><td>Climate, Oceanography, Hydrography</td><td colspan="12">Winds are variable, although predominately from the south-west and north east. In winter, wind strengths are typically in the range Beaufort scale force 4-6 (6-11m/s) and winds of force 5 (8m/s) and greater are recorded 60-65% of the time. Winds of these forces are much less frequent in summer months, being recorded 22-27% of the time. Annual mean significant wave height is ca. 2.1-2.4m, varying seasonally. Tidal currents in the region are generally weak and are readily influenced by other factors (e.g. winds and density driven circulation). The anti-clockwise movement of water through the North Sea results in a general residual water movement to the south and east. The water column stratifies thermally in summer and is broken down in autumn/winter with increased wind and convective mixing. Surface water temperatures typically range between 6.5-7ºC in winter and 13.5-14ºC in summer; bottom temperatures are similar to winter, but typically 7-8ºC in summer.
Water depths are around 125m. A thermocline develops during summer, typically forming between 30 and 50m depth. This generally breaks up with the onset of autumnal gales.</td></tr>
<tr><td rowspan="3">Plankton</td><td colspan="12">The phytoplankton community is dominated by the dinoflagellate genus Tripos (T. fuscus, T. furca, T. lineatus), with diatoms such as Thalassiosira spp. and Chaetoceros spp. also abundant. Dinoflagellates typically comprise a greater proportion of the phytoplankton community than diatoms from June to October, when waters will be most stratified. Two phytoplankton blooms occur, typically the spring bloom is stronger relative to the autumn bloom, before levels decrease through winter months, when light and temperature are less abundant. Zooplankton species richness is higher in the region, compared to the southern North Sea and the community displays greater seasonal variability. Zooplankton abundance follows a similar seasonality to phytoplankton, although peak abundances lag slightly. The zooplankton community is dominated by calanoid copepods, although other groups such as Paracalanus and Pseudocalanus are also abundant. There is also a high biomass of Calanus spp. larval stages present in the region. Calanus finmarchicus has historically dominated the zooplankton in the North Sea, however, overall abundance of this has declined over the last 60 years, attributed to changes in seawater temperature and salinity and this has largely been replaced by boreal and temperate Atlantic and neritic (coastal water) species in particular, with an increase in populations of C. helgolandicus.</td></tr>
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<tr><td colspan="12">Key: Period of increased plankton abundance shown in darker blue</td></tr>
<tr><td>Seabed and sediments</td><td colspan="12">The seabed is relatively flat across the Trees area, with localised variations. Water depths range from ca.110m at Brae A, to ca. 129m at Sycamore Main and Sycamore Satellite. At Brae A, the water depth deepens very gently towards the south and south-east. Water depths at Larch and Birch range from 125m to a maximum depth of 129m with localised variations, with similar depths at Sycamore Main and Sycamore Satellite. Throughout the area there are scattered semi-circular depressions, some up to 40m wide and 0.9m deep, from previous surveys, (e.g. Gardline 2009) there was no evidence on the seabed or within shallow soils of soft clays or gas seepages; the 2022 survey (Fugro 2022a) suggests the presence of possible Methane Derived Authigenic Carbonate (MDAC) to the north of the Larch Manifold. There is no designated site for these features within the Trees fields. Seabed sediments comprise sandy mud or muddy sand and are classified (European Nature Information System (EUNIS)) as ‘circalittoral muddy sand’, ‘deep circalittoral sand’ and ‘deep circalittoral mud’ (Fugro 2022a), with occasional accumulations of shell and coarse material present. The main habitat in the area was identified a ‘deep circalittoral mud’. Areas of gravelly mud/angular gravel observed, interpreted as representing drill cuttings. The potential volume of cuttings material was estimated from geophysical survey data as ca. 464m^3 in the Birch field, and ca. 684m^3 in the Sycamore field (Fugro 2022a). An assessment based on the OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles was undertaken for the Birch and Sycamore Main drill cuttings piles as part of decommissioning planning. The screening assessment indicates that both of the Birch and Sycamore Main drill cuttings pile fall below the OSPAR 2006/5 thresholds, such that the piles may be left in situ to degrade naturally (Hartley Anderson 2023). Anchor scars and anchor pull outs were also identified as present across the survey area.
Hydrocarbon/chemical contamination summary data from Fugro (2022c), indicate that the majority of samples were at or below background levels (with the exception of samples around Brae A). There were some notable higher than background samples recorded, with the two highest samples recorded at Birch and Sycamore Main.</td></tr>
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<table>
<tr><th>Aspect</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Benthos</td><td colspan="12">Benthic communities are traditionally considered as two groups: infauna (living within the seabed sediment) and epifauna (live on the surface of the sediment). Benthic diversity and biomass is dependent on a number of factors including sediment type (including the presence/absence of hard substrate), water depth, salinity, local hydrodynamics and degree of organic enrichment (DECC 2016). Previous surveys (e.g. Gardline 2009), noted a uniform faunal community, typical of sandy mud sediments and found faunal abundance generally low across the area, with some variability in abundance of the most dominant taxa; the most abundant species was the polychaete Paramphinome jeffreysii. Other infaunal taxa recorded included the polychaete Nephtys hystricus, Abyssoninoe hibernica and Spiophanes kroyeri. Epifaunal species were relatively sparse.
The 2022 pre-decommissioning baseline survey (Fugro 2022a) also recorded a generally sparse epifauna across the area. The most frequently observed taxa in areas of muddy sand and shell fragments included anemones (Metridioidea), starfish (Asteroidea, including Asterias rubens and Astropecten irregularis) and hermit crabs (Paguridae), in sandy mud, epifaunal communities were dominated by sea pens (Pennatula phosphorea) and sea snails (Aporrhais sp.). At two stations at the Larch Wye, bivalve siphons (possible Arctica islandica) were also observed, however, no live adult specimens were recovered within grab samples. Other fauna identified in the area included cuttlefish (Sepiidae), squat lobster (Galatheoidea and Munidae sp.), squid (Loliginidae) and flatfish (Pleuronectiformes).
Sea pens and burrows were found to occur in sufficient density to comprise the Oslo and Paris Commission (OSPAR) listed threatened and/or declining habitat 'sea pen and burrowing megafauna community'. It should be noted, that the Trees area do not sit within any designated area for this habitat, or for any other habitat or species of conservation significance and the closest Nature Conservation Marine Protected Area (NCMPA) designated for the habitat Burrowed Mud (sea pens and burrowing megafauna and tall sea pen components) (the Central Fladen NCMPA) is >60km from the Trees area.
Sensitivity is considered the same throughout the year</td></tr>
<tr><td rowspan="3">Fish</td><td colspan="12">The Trees area overlap with reported spawning grounds of 5 commercially important fish and shellfish species (cod, mackerel, Norway pout, saithe and Nephrops), all of which are Priority Marine Features, with the exception of Nephrops. The area is also within reported nursery grounds for these species (except saithe) and a further 10 species (anglerfish, blue whiting, haddock, European hake, herring, ling, sandeel, spotted ray, spurdog and whiting).</td></tr>
<tr><td>4</td><td>4</td><td>4</td><td>4</td><td>2</td><td>2</td><td>2</td><td>2</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="12">Key: 1 = 1 species spawning, 2 = 2 species spawning etc</td></tr>
<tr><td rowspan="6">Birds</td><td colspan="12">The Trees area can be considered of relatively low importance to seabirds in the context of the North Sea as a whole – this is related to the distance from breeding colonies and the availability of prey. The Scottish mainland coast and islands (e.g. Fair Isles and the coasts of the Northern Isles, are of international importance to breeding seabirds, with many colonies designated as Special Protection Areas (SPAs) not just for individual species, but also for seabird assemblages, which can number in the 10s of thousands. The Trees area is more than 200km from the Scottish mainland and more than 190km from Fair Isle and the Northern Isles, which is out with the mean maximum foraging distance for many species, with European storm petrel, northern fulmar, northern gannet and great skua amongst the only species expected to forage out to these distance during breeding season. Species present offshore vary seasonally and being far offshore, birds present will predominately be those transiting through the area during migration, non-breeding juveniles and post breeding dispersion from colonies.
The Seabird Oil Sensitivity Index (SOSI) has been used in conjunction with JNCC 2017 guidance to determine seabird sensitivity within the Trees area.
Where there is no data coverage and this cannot be reduced, this is shown as N and marked orange, where data gaps have been filled by previous or next adjoining months, these are shown in red with *, where filled by adjoining blocks, this is shown as purple with *.
The sensitivity for blocks 16/12a and 16/07 is shown below. Sensitivity is generally low, and for blocks 16/12 and 16/07 only two months remain with no coverage.
Block 16/12a (top) and 16/07 (bottom)</td></tr>
<tr><td>5*</td><td>5</td><td>5*</td><td>5*</td><td>5</td><td>5*</td><td>5</td><td>5</td><td>5</td><td>5*</td><td>N</td><td>N</td></tr>
<tr><td>5*</td><td>5</td><td>5</td><td>5*</td><td>1*</td><td>5*</td><td>5</td><td>5</td><td>5</td><td>5*</td><td>N</td><td>N</td></tr>
<tr><td colspan="12">Key: Darker colours reflect months when marine mammals most frequently observed</td></tr>
<tr><td colspan="2">1= Extremely high</td><td colspan="2">2 = Very high</td><td colspan="2">3 = High</td><td colspan="2">4 = Medium</td><td colspan="2">5 = Low</td><td colspan="2">N = No coverage</td></tr>
<tr><td colspan="12">The Trees area is far from coastal areas, and not considered important in terms of wintering waterbirds.</td></tr>
<tr><td rowspan="3">Marine mammals</td><td colspan="12">The central North Sea has a moderate to high density of cetaceans, with a general trend of increasing diversity and abundance. Seven species can be considered regular visitors to waters around the Trees area, harbour porpoise, white-sided dolphin, white-beaked dolphin, minke whale, killer whale, Risso's dolphin, and bottlenose dolphin, only three of these (harbour porpoise, white-sided dolphin and minke whale) were recorded in the area from the SCANS-III survey conducted in summer 2016 (blocks 16/12a and 16/07 are within SCANS III survey strata 'U').</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Key: Darker colours reflect months when marine mammals most frequently observed
The grey seal and harbour seal are the only two species of seals that live and breed in UK waters. While both species tend to be concentrated close to shore, particularly during pupping and moulting seasons, they will feed inshore and offshore depending on the distribution of prey species. The movement of harbour seals are generally restricted to ca. 40-50km range of their haul-out sites, while grey seal movements can involve larger distances, with trips of several hundred kilometres being recorded.</td></tr>
</table>

Aspect	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conservation sites	The closest designated sites to the Trees area are two Special Areas of Conservation (SAC), the Scanner Pockmark SAC and the Braemar Pockmark SAC, more than 30km from Trees. These two sites are designated for similar features 'submarine structures made by leaking gases' and specifically methane-derived authigenic carbonates (MDAC) which are formed through bacterial activity centred on gas seep areas. No such features are designated within the Trees area; from the Fugro (2022a) survey, two sonar contacts interpreted as biogenic features are observed in pockmarks towards the north-western corner of the Larch survey area and they are interpreted to represent possible MDAC, although no further investigation of the features was carried out. The closest NCMPA to Trees are the Norwegian Boundary Sediment Plain and Central Fladen sites, *ca.* 42km and 69km from the Trees area respectively. The Norwegian Boundary Sediment Plain has been designated for the presence of shelf offshore subtidal sands and gravels, and ocean quahog aggregations, while Central Fladen has been designated for burrowed mud (sea pen and burrowing megafauna and tall sea pen components) and sub-glacial tunnel valley, representative of the Fladen Deeps Key Geodiversity Area. Designated features are habitats, geological features and/or low/limited mobility species. The pre-decommissioning survey identified the presence of sea pens (*Pennatula phosphorea* and *Virgularia* sp.), and burrows, although mounds were not recorded. The report concluded that sea pens and burrows occurred in sufficient density to comprise the Oslo and Paris Commission (OSPAR) listed threatened and/or declining habitat 'sea pen and burrowing megafauna communities'. It should be noted however, that the Trees area is not located within or near (closest site more than 60km away) any designated site for this habitat. Sensitivity is considered similar throughout the year.											
Other users	Trees are located within ICES rectangle 46F1 and the area is mainly targeted for demersal species. In comparison with UK total landings, landings from 46F1 (weight and value) are relatively small, typically less than 1%. Fishing effort in the area is considered low to moderate, and while fishing activity can occur throughout the year, fishing effort (days at sea) typically peaked in spring and summer months, higher numbers has also been seen towards the latter part of the year. The Trees area is located in a mature area of the North Sea for oil and gas activity, where development has been extensive, evident by the number of installations/FPSOs within 40km of the Trees area. There are no areas of renewable development within or near to the Trees area; the closest of these being the Cerulean Winds INTOG area, 59km away. Trees is relatively close *ca.* 3km) to the CNS Area 1, an area provisionally awarded in the recent North Sea Transition Authority (NSTA) carbon storage licensing round; the Trees area (Larch Wye) is close to (2km), and sections of the pipelines traverse through, the INTOG area of search and exclusion NE-d, however, none of the 13 projects offered exclusivity agreements are located within NE-d and it is unknown when, or if this area is to be offered again. There are no operational telecommunication cables in the vicinity, however, the TAMPNET 3 part 7 cable passes *ca.* 20km to the east. There are no military interests, dredging areas, or marine disposal sites or any designated wrecks, in the vicinity. Shipping density data (NSTA website) shows block 16/12a as having moderate and block 16/07 has having low levels of shipping; typical vessels are likely to be oil and gas supply and support vessels, the majority of which are expected to originate from service ports in Peterhead and Aberdeen.											

Impact Assessment

An Environmental Issues Identification (ENVID) workshop was held to identify the aspects of the project and assess these considering their potential to have a significant impact on the environment. The majority of impacts identified were categorised as low significance and therefore screened out from requiring further assessment; these are summarised in Table 2.

Table 2: Potential effects considered minor

Environmental Effect	Consideration
Physical presence	The potential disruption to fishing activities was considered to be of low significance based on: short durations of vessel transits out with the 500m safety zone represents a small increment to the existing level of shipping activity in the region and deposited rock will be over-trawlable and monitored to ensure they do not pose a snagging risk. Removal of the 500m safety zone is considered to be a beneficial impact, potentially increasing the area available to fishing activities.
Underwater sound	The potential impact to marine mammals was considered to be of low significance based on: the nature of the sound (continuous, not pulsed); short duration of vessel activities; relatively small number and short duration of cuts, existing level of shipping activity in the region.
Discharges to sea	Impacts associated with discharges of contaminants to sea were considered to be of low significance as pipelines will be flushed with seawater to an agreed acceptable cleanliness level prior to decommissioning activities; relatively small quantities of seawater and chemical/hydraulic fluid will be discharged during pipeline and umbilical decommissioning or degradation over time (with no further discharges associated with these other than the contents of the lines at time of decommissioning); a small volume of drill cuttings will be disturbed and any dissolved organics will be diluted and rapidly disperse within the water column, with particulates settling out of the water relatively quickly (within hours).
Resource use	Impacts associated with resource use are considered to be of low significance as the vessel campaign is relatively short with a small number of vessels; the estimated quantity of steel decommissioned *in situ* is considered to be negligible as a percentage of UK annual steel production.
Waste production	Relatively small quantities of materials will be returned to shore with the majority of material (*ca*. 90% steel) readily recyclable.

Only one potential impact, seabed disturbance was categorised as having medium significance (or above), and this was taken forward for further assessment; although the workshop did not identify atmospheric emissions as a source of significant impact from the decommissioning activities, an emissions assessment was carried out in order to align with the decommissioning guidance (BEIS 2018).

Seabed Disturbance

The sources of seabed disturbance associated with the Trees fields decommissioning include the cutting and removal of subsea structures and pipeline ends; removal of exposed protection and stabilisation materials; deposition of remedial rock over pipeline and umbilical ends and over the exposed section of the Larch production pipeline (Figure 2, PL1527).

Seabed disturbance will result in direct physical effects which may include mortality of fauna as a result of physical trauma, smothering from resettlement sediments and change in habitat type from addition of deposited rock. Recovery of the seabed through natural sediment mobility is expected to be rapid (<1 year). Recovery of faunal communities will also be rapid through a combination of larval settlement and migration from adjacent seabed. Impacts will be localised to the existing Trees fields development footprint.

The use of deposited rock to protect pipeline and umbilical ends would introduce additional hard substrate into the area, which might facilitate colonisation and allow short lived larvae to spread to areas using the rock substrate as ‘stepping stones’. A concern of introducing hard substrate to an area of predominantly soft substrate is that it could adversely affect species with habitat preferences for soft substrate. The areas of rock cover would be unsuitable for existing habitats in the Trees area which include the OSPAR threatened and/or declining habitat ‘sea pens and burrowing megafauna communities’ and the OSPAR species ocean quahog to recolonise and would result in permanent loss of habitat. However, the introduction of hard substrate at the scale proposed will result in only a modest expansion of the habitat and associated faunal communities already present, and the loss of only a small proportion of the available soft substrate.

The disturbance of contaminated drill cuttings during removal and (if required) excavation of Trees fields subsea infrastructure is expected to be limited to small volumes of material that will resettle within the existing contamination footprint near the Birch and Sycamore Main Manifold. Biodegradation of contaminants within the surface layers of disturbed and background sediments would be expected to reduce contaminants to background levels over the following 10-20 years. The overall significance of impact to the benthic community is considered to be moderate, however, this will be limited to a small area of seabed within an existing contamination footprint. Disturbance to the seabed and any sediments contaminated with historic drill cuttings will be managed to as low as reasonably practicable (ALARP).

Atmospheric Emissions

The sources of emissions assessed are from the combustion of diesel by vessels to be used to complete the decommissioning programme; vessels including construction and heavy lift vessels, along with rock installation vessels and vessels to be used in the post decommissioning and ongoing monitoring of the decommissioned area, were included in the assessment.

Using estimated time on location, daily diesel usage (tonnes/day), standard emission factors for diesel (engine) and the Global Warming Potential (GWP) metrics for the relevant gas species, estimated atmospheric emissions from decommissioning the Trees fields infrastructure were calculated; the overall result is a value in tonnes of CO_2 equivalent (CO_2eq) based on the radiative forcing effect of each greenhouse species relative to CO_2 and the atmospheric residence time of each gas, amongst other factors.

The decommissioning activities are estimated to result in emissions of ~4,014teCO_2eq. In context, and using figures from 2019, the most recent pre COVID-19 pandemic year for comparison, UK total emissions of greenhouse gases were *ca.* 454.8 million tonnes (Mte) CO_2eq; CO_2 being the most dominant of these, accounting for ca. 81% of the emissions (365.1Mte) (BEIS 2021).

From available information from Offshore Energies UK, approximately 14.63 MtCO_2eq was attributable to installations in the UKCS in 2018 (OGUK 2019). Atmospheric emissions from the Trees fields decommissioning activities, would represent an increment of 0.0009% on those emitted from all UK sources in 2019, or 0.03% of those from installations on the UKCS 2018 (OGUK 2019) and, as such, are not considered to result in a significant impact.

<u>Overall Conclusion</u>

The overall conclusion of the environmental appraisal of the decommissioning of the Trees fields are:

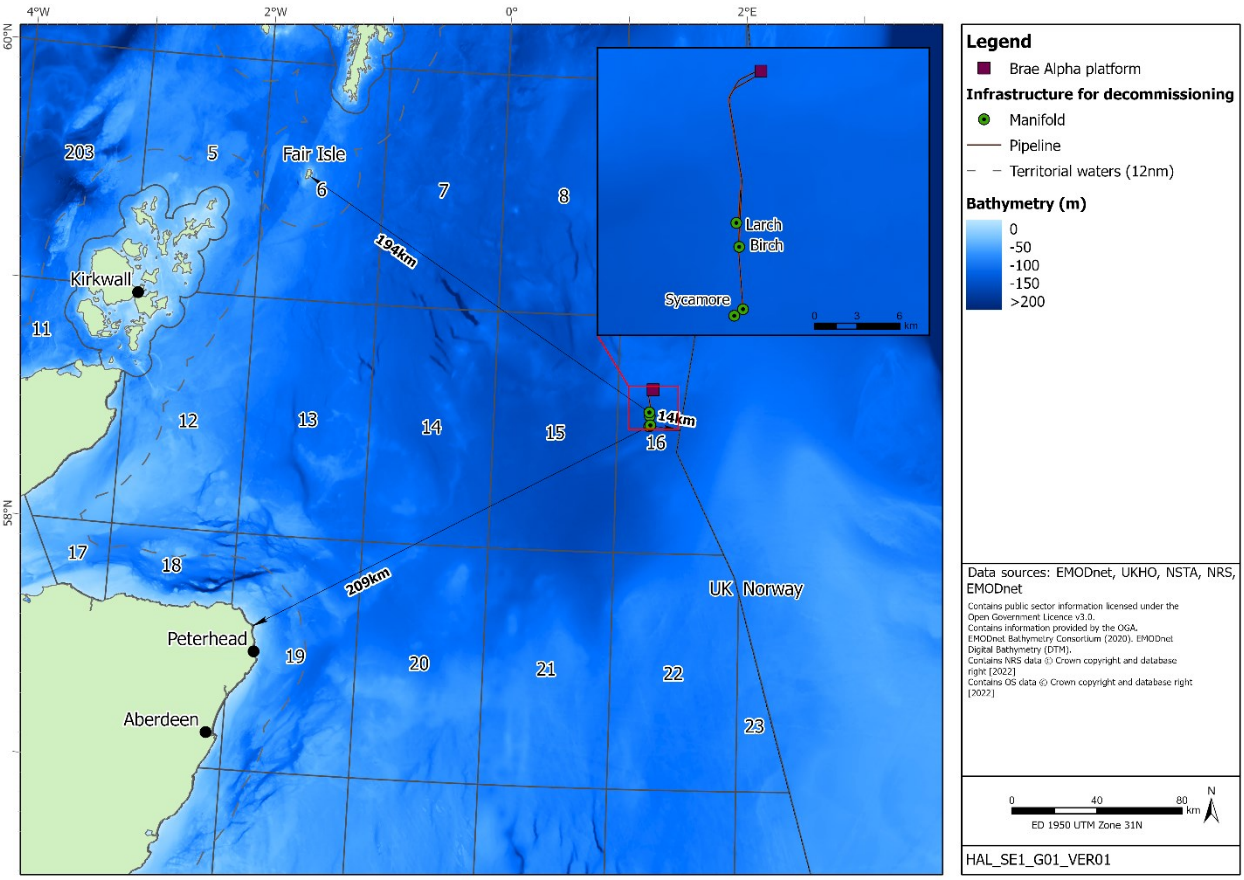
- No significant environmental or adverse effects on benthic habitats or faunal communities in the area are expected from the estimated seabed disturbance as a result of decommissioning operations.
- No significant environmental or adverse effects are expected from estimated atmospheric emissions as a result of decommissioning operations.
- No significant environmental, or adverse effects on other users of the sea are expected from the planned activities associated with the decommissioning operations.

   - Some Trees fields infrastructure is to be decommissioned *in situ*, however, this will be monitored on a basis to be agreed with OPRED to ensure this does not become a hazard for other users of the sea and periodic reviews will be conducted by Spirit Energy of new and emerging technologies for safe removal.
- No impacts on conservation interests are expected; the Trees fields are not located within, or close to, a designated area.
- No specific, additional controls are considered necessary for activities beyond application of regulatory requirements, established Spirit Energy management processes, operational controls and following industry guidelines and best practice where applicable.
- A range of environmental management commitments and actions have been identified and will be carried forward through the detailed planning and execution phase of the decommissioning project to further avoid, or minimise adverse environmental impacts, as far as technically feasible.

1 INTRODUCTION

Spirit Energy North Sea Oil Limited (Spirit Energy) is planning for the decommissioning of the Trees fields' infrastructure located in block 16/12a in the United Kingdom (UK) central North Sea (CNS). Trees is a multi-production and injection well subsea development covering three separate oil fields Birch, Larch and Sycamore (the latter comprises Sycamore Main and Sycamore Satellite), and which are tied back to the Brae Alpha (Brae A) platform[1] in block 16/07 (Figure 1-1, and Figure 2-2 (Section 2.3), for field infrastructure schematic).

Figure 1-1: Trees fields location



Birch is a single subsea manifold with three production and two water injection wells, that is tied back to Brae A via a *ca.*14km 10" production pipeline, 12" water injection pipeline, 4" gas lift / service line and control umbilical. Larch comprises one production and one water injection well, tied into the existing Birch infrastructure. Sycamore Main comprises a well cluster and manifold, about 4.5km south of the Birch Manifold and Sycamore Satellite, a single well and manifold 800m beyond that. Sycamore field hydrocarbons are routed back to the Birch Manifold via the Sycamore Main and Satellite Bundles which also contain water injection, service line, control and chemical services. At the opposite end of each bundle are the Sycamore Satellite Towhead and the Sycamore Main Towhead (Figure 2-2).

The Sycamore bundles, towheads and manifolds will be addressed in a separate DP and comparative assessment, and activities associated with their decommissioning are therefore not included within this EA, with the exception of the tie-in spools and jumpers which are included as their removal has no impact on future decommissioning options for the bundle facilities. There is

[1] Brae A is operated by TAQA Bratani Limited (TAQA) and is not part of the Trees Decommissioning Programme, other than as tie-in host installation for the fields.

also one platform based well (South Sycamore) located on Tiffany, operated by CNR International (U.K.) Limited.

Due to a decline in oil rates, the Sycamore field has been offline since 2012, and Birch and Larch have had restricted uptime since 2016 and 2019 respectively, largely due to issues at the Brae A installation and the low arrival temperatures of the producing wells to Brae A. Work has been carried out to identify options for continuing production from the fields, but, as no economic opportunities have been identified, Spirit Energy is preparing to cease production from the Trees fields, in discussion with the North Sea Transition Authority (NSTA), and the Department for Energy Security & Net Zero (DESNZ), with the decommissioning of the infrastructure thereafter.

There is a regulatory requirement to submit a Decommissioning Programme (DP) to the competent authority (the Offshore Petroleum Regulator for Environment and Decommissioning, Department for Energy Security & Net Zero – OPRED), for the decommissioning of offshore infrastructure. In agreement with OPRED, Spirit Energy have submitted a single, combined DP document, which contains six decommissioning programmes, one for each set of notices under Section 29 of the *Petroleum Act 1998*.

In addition, to fulfil Spirit Energy's requirements under the *Petroleum Act 1998* (as amended) to assess the environmental impacts[2] of decommissioning proposals, and in line with regulator guidance (BEIS 2018), the DP for the Trees fields infrastructure are supported by an Environmental Appraisal (EA) which is documented in this report.

1.1 Offshore Decommissioning Regulatory and Policy Context

OSPAR Decision 98/3 prohibits the dumping and leaving wholly or partly in place disused offshore installations within the OSPAR Maritime area. As subsea tie-backs, the only form of Trees fields installations present which fall under OSPAR 98/3 are 'steel installations' such as wellheads and manifolds, and these must be fully removed (BEIS 2018).

Although there is no statutory requirement to undertake an Environmental Impact Assessment (EIA) at the decommissioning stage, (e.g. as required for other *Petroleum Act* related activities under the *Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020*), BEIS (2018) guidance states that, "Under the *Petroleum Act 1998*, there is a "…requirement to undertake an assessment of the potential environmental impacts of the decommissioning proposals…" and also that an EA must be submitted alongside the DP. The Trees Decommissioning EA report follows the guidance (BEIS 2018), including conducting an Environmental Issues Identification (ENVID) exercise as part of the overall assessment process.

The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations), and *The Conservation of Offshore Marine Habitats and Species Regulations 2017* (the Offshore Habitats Regulations), provide for the designation of sites for the protection of habitats and species of international importance (Special Areas of Conservation (SACs)). These Regulations also provide for the classification of sites for the protection of rare and vulnerable birds and for regularly occurring migratory species within the UK and internationally (Special Protection Areas (SPAs)). SACs and SPAs together form part of the UK's national site network. Sites designated under these regulations, and other sites within the national site network, along with OSPAR threatened and/or declining habitats, have been identified in the EA and the potential for effects on these from the decommissioning activities have been considered.

A range of permits, consents and licences are required under various legislation in order to undertake activities required to decommission the Trees fields infrastructure. The Trees fields decommissioning activities (Table 2-1) will be undertaken in compliance with Health and Safety Executive regulations and with Offshore Energies UK (OEUK) (previously the Oil and Gas UK

[2] The words 'impact' and 'effect' are used interchangeably throughout the document

(OGUK)) guidelines. Relevant applications will be submitted to OPRED-EMT (Environmental Management Team) (i.e. Master Application Templates (MAT) and the relevant Subsidiary Application Templates (SAT)) in support of the proposed activities and the environmental baseline from this EA, along with the pre-decommissioning survey, will inform those applications.

The Trees fields infrastructure does not include any topside or jacket structures, therefore, a relatively small amount of material will be returned to shore on its removal and the final receiving port for this is still to be determined. Therefore, geographic locations of potential disposal yard options may require an International Waste Shipment (IWS) notification. Early engagement with the relevant waste regulatory authorities will be undertaken.

Approvals for these permits, consents and licences are contingent on complying with the applicable legislation. This EA will support these applications in due course. Legislation and compliance requirements may change over time and as part of their management system, Spirit Energy has processes in place to monitor for new legislation relevant to their activities and will ensure that all relevant regulations are complied with for the decommissioning of the Trees fields infrastructure.

1.2 Marine Planning

The Trees fields are located within an area covered by Scotland's National Marine Plan (Scottish Government 2015). Spirit Energy is cognisant of the plan and polices which are relevant to their operations in Scottish waters, including those which are consistent with decommissioning taking place in line with standard practice and as allowed by international obligations (e.g. policy Oil&Gas 2).

The Trees fields decommissioning activities have been assessed against the relevant general and oil and gas policies (Table 1-1).

Table 1-1: Scotland Marine Plan polices relevant to the proposed Trees fields decommissioning

Policy and Topic	Assessment
National Marine Plan General Policies	
GEN1 – General planning – activities undertaken in a sustainable manner	The decommissioning activities will be undertaken in a manner consistent with the Marine Plan policies, in a sustainable manner that ensures any potential impacts associated with the activities are kept to a minimum.
GEN4 – Co-existence	The decommissioning project considers other sea users in the decision making process (e.g. assessing other vessel usage of the area) and Spirit Energy actively engages stakeholders who utilise the marine area. Decommissioning activities are to be conducted in a phased manner, with notification given of vessel movements and duration on location. Existing 500m safety zones are in place, with the majority of activity being undertaken within these, with no new/additional safety zones required. Any pipeline infrastructure decommissioned *in situ* will allow safe over-trawling.
GEN5 – Climate Change	There are potential opportunities to reduce emissions i.e. vessel work programmes optimised to minimise vessel use, supply visits and fuel use where possible.
GEN6 – Historic Environment	The Trees fields are not located near any designated wreck site, or known sites of heritage significance.
GEN9 – Natural Heritage	The Trees fields are not located within, or near, any area with protected species or habitats, the closest of these being the Scanner Pockmark (*ca.* 31km away) and the Braemar Pockmark (more than 31km away). The potential for the presence of the OSPAR habitat Sea pen and burrowing megafauna communities, and the potential for impact on priority marine features has been identified and assessed.
GEN11 – Marine Litter	All vessels associated with decommissioning activities will be equipped to meet MARPOL and related merchant shipping regulations for the prevention of pollution from ships.

Policy and Topic	Assessment
GEN12 – Water Quality	The decommissioning activities will not result in a deterioration of water quality. Chemical use and discharge will be fully assessed as part of the DESNZ Portal Environmental Tracking System (PETS) permit/consent process.
GEN13 – Noise	There are no explosives to be used during decommissioning activities, with all cutting required to be carried out using mechanical tools. The only noise sources will be from vessels on location and cuttings tools, with all noise sources being of a non-pulsed/continuous nature. The Trees fields are not located in or near any designated area for marine mammal, the receptor group considered the most sensitive to impacts from underwater noise.
GEN14 – Air Quality	Emissions will be from vessel engine use (power generation). Aim will be to identify campaign synergies, contract selection (e.g. vessels with upgraded systems for reducing emissions), minimise as far as practicable offshore trips (supply trips/waste returns/personnel changes).
GEN18 – Engagement	Spirit Energy have and will continue to engage with stakeholders (e.g. Scottish Fishermen's Federation) as well as early engagement with OPRED.
GEN19 – Sound Evidence	A pre-decommissioning survey has been conducted at the Trees fields, information from this, along with other relevant peer reviewed and grey literature and data sources and previous experience and knowledge from similar activities, has been used in this environmental appraisal.
GEN21 – Cumulative Impacts	The cumulative impacts from the decommissioning of the Trees fields infrastructure have been assessed within the EA, in relation to other users of the marine environment, and existing and planned activities in the region.
National Marine Plan Oil and Gas Policies	
O&G 1 – Maximise and prolong O&G exploration and production – activity should be carried out using principles of BAT And BEP.	The Birch and Larch fields have had restricted uptime since 2016 and 2019 respectively, and the Sycamore field has been offline since 2012. Work has been carried out to assess the potential of reinstating production from existing wells, and drilling additional wells in order to prolong production from the fields, but no economic opportunities have been identified. As a result, the fields are being prepared for cessation of production, with BAT and BEP principles being applied to the planning of decommissioning activities. Activities will follow industry practices, and aim to reduce waste generated as far as practicable, i.e. by prioritising recycling and re-use before disposal (see narrative against O&G 2,). A comparative assessment for pipeline system decommissioning (Spirit Energy 2022) has been carried out which has taken into consideration the environmental impact of the different options identified. An ENVID has also been conducted, whereby potential impacts have been screened against environmental receptors and sensitivities, identifying those which are potentially significant and which should be subject to further assessment in this EA, identifying further mitigation where required.
O&G 2 – Where re-use of O&G infrastructure is not practicable, decommissioning must take place in line with standard practice and as allowed by international obligations.	Re-use of the infrastructure offshore (i.e. for carbon capture and storage) is not feasible, with decommissioned material being recovered to shore for re-use, recycling or disposal. All decommissioning activities will be conducted in line with regulations, industry guidelines and best practices in place at the time.
O&G 6 – Operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Spirit Energy already have in place appropriately approved emergency response plans for the fields, and these will be reviewed and revised where relevant/required, ahead of any offshore decommissioning activities being undertaken.

1.3 Net Zero and Emissions Reduction

In 2016, the Oil and Gas Authority (now trading as the NSTA) introduced a series of Stewardship Expectations, including Net Zero (Stewardship Expectation #11 (SE11)). This conveyed the expectation on the Upstream Oil and Gas Industry, to reduce, as far as reasonable, emissions from all aspects of their upstream operations, and this includes the abandonment and decommissioning of fields. In support of the British Government's aim to reach a target of reducing greenhouse gas emission to net zero by 2050, the NSTA unveiled further strategies (6th May 2020) to enable the oil and gas industry to reduce greenhouse gas emissions while also encouraging progress on carbon capture and storage and hydrogen projects. The NSTA believes that maximising economic recovery of oil and gas need not be in conflict with the transition to net zero and that the industry has the skills, technology and capital to help unlock solutions required to help the UK achieve the net zero target (OGA 2021).

An updated Decommissioning Strategy document was published by NSTA in 2021, which along with SE11 sets out expectations on operators to carry out decommissioning activities consistent with the NSTA strategies, including, for example, developing emission minimising options and developing decommissioning emissions based key performance indicators (KPIs) (OGA 2021).

Spirit Energy acknowledges these steps made by the NSTA and the UK government and are currently working on delivering these measures. With regards to its wider activities Spirit Energy is an endorsing company of the World Bank Zero Flaring Initiative, and with regards to the Trees decommissioning activities Spirit Energy will comply with the requirements of both SE11 and the NSTA Decommissioning Strategy document.

1.4 Document Purpose and Scope of Environmental Appraisal

This Environmental Appraisal (EA) supports the combined Trees DP submitted by Spirit Energy to OPRED, as required under the *Petroleum Act 1998* (as amended). The scope of the EA is aligned with the Trees DP scope and covers:

- The Birch subsea installations (one manifold) and the associated Birch pipelines / umbilicals.
- The Larch subsea installations (one manifold) and the associated Larch pipelines / umbilicals.
- The Sycamore subsea installations SW1 wellhead (formerly known as SP1) (no protective structure)).
- Pipeline and umbilical jumpers associated with the Sycamore installations and bundles.
- Surface laid / exposed pipeline/umbilical protective material (concrete mattresses, and protective stabilisation materials, grout bags).

Spirit Energy has also submitted a Comparative Assessment (CA) in support of the combined DP. This describes and assesses the decommissioning options considered for the pipelines.

The Sycamore Main and Sycamore Satellite manifolds, bundles and their associated towheads will be the subject of a separate CA and EA, and the DP for these will be submitted at a later date. Therefore, the decommissioning assessment of the Sycamore manifolds, bundles and towheads, including the application of remediation at the bundle ends, if required, is not described further here. The assessment in this EA, therefore relates to the pipelines/umbilicals associated with the Trees fields, except the Sycamore Main and Sycamore Satellite bundles and their associated towheads; where bundles and towheads are mentioned, this is for field description only.

The Birch (5), Larch (2) and Sycamore (3) well xmas trees with integrated protective structures are also the subject of a separate DP which contains a supporting environmental appraisal of decommissioning activities, and, as such, these are not described further here. Reference to the wells in this document is for context only. The platform based well (South Sycamore) located on Tiffany, will be subject to future decommissioning plans and not discussed further here.

The scope also excludes other preparatory activities (i.e. pipelines cleaning and flushing), which will be assessed under the OPRED-EMT permits and consents processes and, in alignment with guidance (BEIS 2018), the EA does not include an assessment of wastes returned to shore for treatment or disposal, or the impact of accidental events, e.g. accidental releases (spills) from vessels.

The SW1 (formerly SP1) well at Sycamore, which was drilled and plugged and never produced from, has already been Phase 1 & 2 abandoned, with only the wellhead and flowbase remaining (no integrated protective structure); this has not been included in the wells DP and the wellhead for this well is instead included in the Trees Decommissioning Programmes (Birch, Larch and Sycamore).

1.5 Stakeholder Engagement and Consultation

Although there is no legal requirement for informal consultation, Spirit Energy recognises the importance of stakeholder engagement throughout the decommissioning process to identify stakeholder issues and concerns associated with the proposed decommissioning activities.

Through ongoing engagement, Spirit Energy provided the Scottish Fishermen's Federation (SFF) with a detailed update of the proposed Trees fields decommissioning activities. Feedback was positive and generally supportive in principle, acknowledging that further comments can be made during formal consultation. Formal consultation (which includes a period of public consultation) will commence with the submission of the consultation DP to OPRED, supported by this EA and the CA. During this time, the documents will be available on Spirit Energy's website, and sent to statutory consultees (as described in BEIS 2018, and which includes the SFF), and stakeholders are able to make comment.

2 DESCRIPTION OF PROPOSED ACTIVITIES

The Birch field was the first of the three fields to be developed in 1995. The field comprises three production and two water injection wells (Table 2-1) the fluids of which were routed through the Birch Manifold, which is tied back to the Brae A platform via a 10" production pipeline, 6" water injection line and 4" gas lift / service pipeline and control umbilical.

The Larch field was developed in 1998 as a single production well and one water injection well (Table 2-1). The production well is tied into the Birch 10" production pipeline via the Larch Wye-piece assembly, and the water injection well is connected to the Birch pipeline system by T-pieces to the 6" water injection and 4" service pipelines. Gas lift is provided to the production well from Brae A by a separate 12.1km 4" pipeline connected to a T-piece in the West Brae gas lift line, and controls and chemicals supplied by the Larch umbilical which is connected to the Birch Manifold.

The Birch and Larch pipelines cross two third party pipelines, the Miller to St. Fergus gas export pipeline (PL720) and the Forties Charlie oil export pipeline (PL64). Concrete mattresses have been used to separate the pipelines at the crossing locations with deposited rock over the crossings to mitigate snagging risk to demersal fishing activities. These pipeline sections and buried mattresses will be decommissioned *in situ*. Close to the Brae A platform (*ca*. 20m north-north-east of Brae A), the 4" gas lift line (PL1531) crosses the West Brae chemical injection bundle (PL1446), at the time of writing the Trees Decommissioning EA, the timing for decommissioning the pipeline crossings within the Brae A 500m safety zone were under discussion with Brae Group, which includes TAQA and Spirit Energy.

The Sycamore field commenced production in 2003 and comprises one production well, one water injection well and one well that was drilled and plugged and not competed as a production well, located at the Sycamore Main Manifold, and a further production well at the Sycamore Satellite Manifold located *ca*. 800m to the south of the main manifold (Table 2-1).

The recommended decommissioning solutions for the various pipelines were determined by comparative assessment (CA) of the available options, and are summarised below along with the proposed decommissioning solution for the remaining field infrastructure.

- All pipelines were installed in open trenches and left to naturally backfill. The pipelines were trenched to a depth between 1.0m and 2.0m below the adjacent seabed. The pipelines will be decommissioned by partial removal. The exposed pipeline ends will be cut at depths of at least 0.6m in the trench transition, while the trenched pipeline and any rock covered sections (at pipeline crossings and in areas of upheaval buckling) will remain *in situ*. A 37m section of PL1527 (Table 2-3) is in a shallow trench and will require remedial trenching to achieve the required trench depth (0.6m), if remedial trenching is not successful the section of line will either be covered with rock or cut and recovered (with remaining pipeline ends protected using rock).
- The Birch manifold will be recovered for reuse, recycling, or disposal.
- Other pipeline structures such as the Larch Wye-piece assemblies, Larch T-piece and Larch Manifold will be fully recovered, with any piles cut to 3m below seabed level. At the time of writing the Trees decommissioning EA, the timing for decommissioning the Birch subsea isolation valve (SSIV) protection structure, and Birch anode skids were under discussion with the Brae Group.
- Exposed concrete mattresses, grout bags and exposed concrete protection covers will be fully recovered. Buried stabilisation materials will be decommissioned *in situ*.
- Deposited rock will be left *in situ*.

Table 2-1: Trees fields infrastructure summary

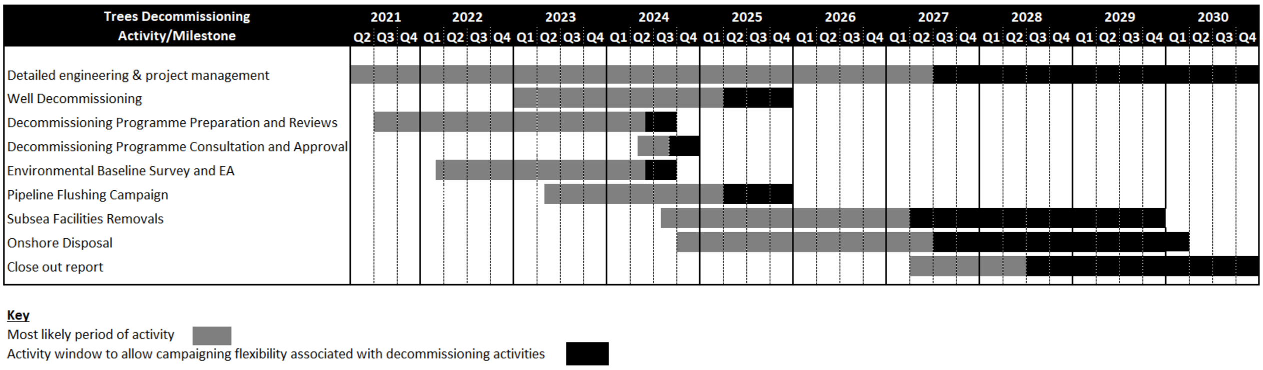
Trees Fields Infrastructure	Birch	Larch	Sycamore Main	Sycamore Satellite
Wells	-	-	16/12a-25 (SW1)[1]	-
Subsea installations (manifolds)	1	1	0	0
Pipeline structures	4	3	0	0
Pipelines, cables, umbilicals	13	9	0	0

Note: [1]For the purposes of the EA, the main elements of the infrastructure only have been described here, and the associated spools/jumpers are not described separately; some of these will have individual PL numbers and these are listed in the DP. [2]Well 16/12a-25 (SW1 (formerly SP1)) was drilled and plugged and never produced from.

2.1 Schedule

The proposed schedule for the decommissioning of the Trees fields shows indicative dates for major high-level milestones (Figure 2-1). Offshore removal activities are likely to be complete in the window between 2024 and the end of 2029, which allows for uncertainty and any future unavoidable constraints.

Figure 2-1: Trees fields decommissioning indicative project schedule



2.2 Trees Fields Infrastructure Decommissioning

2.2.1 Subsea Infrastructure and Pipeline Structures

The Trees fields subsea structures to be subject to decommissioning, are presented in Table 2-1 and Figure 2-2.

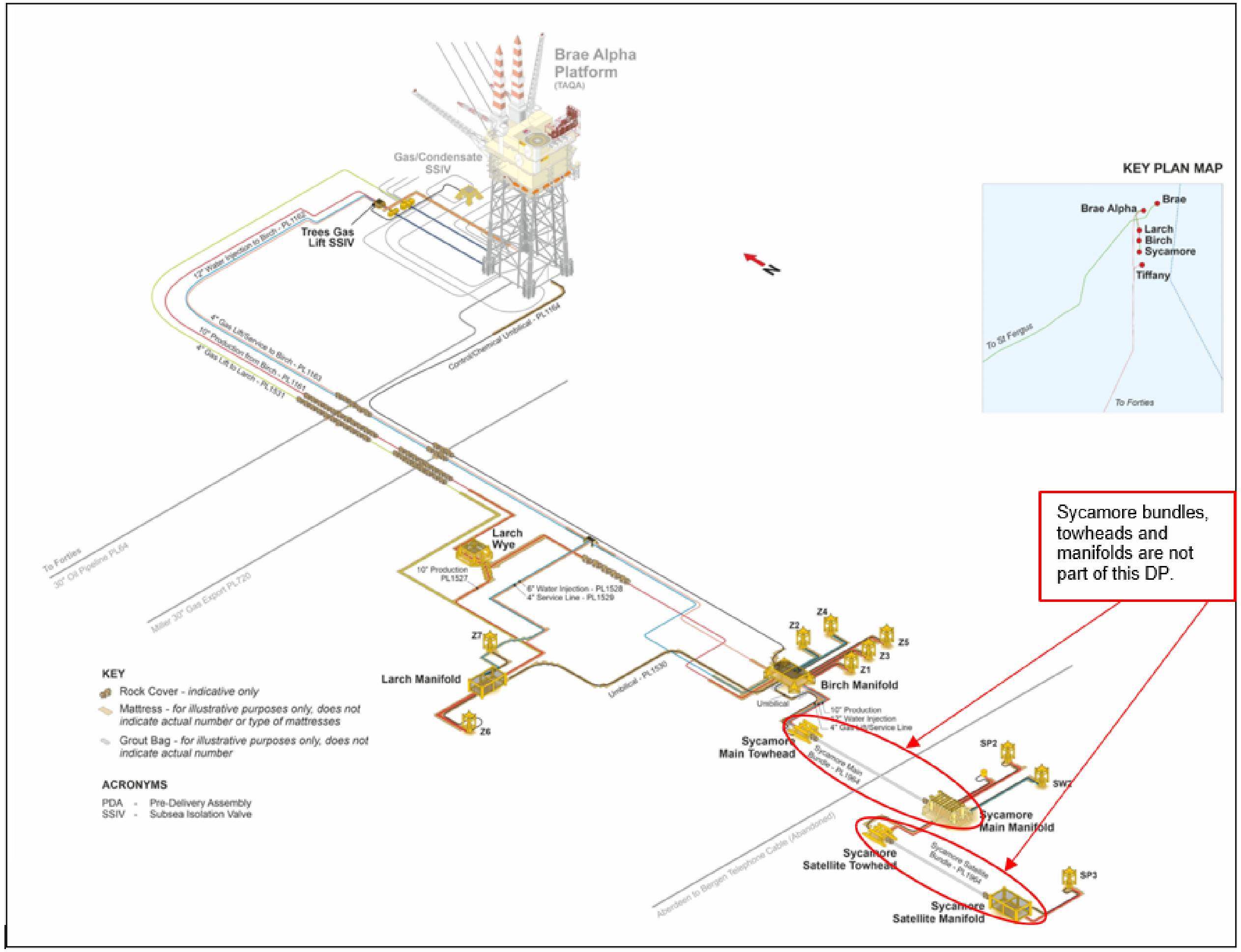
All structures will be removed and recovered to shore for reuse (where possible), recycling, or disposal. Structures which are secured to the seabed with piles will be recovered by internally cutting the piles at a depth 3m below the seabed. If any practical difficulties are encountered to achieve this, Spirit Energy will consult OPRED.

Table 2-2: Trees fields subsea structures and decommissioning solution

Description	No.	Dimensions (m)	Decommissioning Solution	Comments
Birch Field				
Birch Manifold	1	20.0 x 16.0 x 3.5	Complete removal	Gravity base structure.
Crossover bundle assembly	1	37.5 x 8.0 x 8.0	Complete removal	Structures secured to the seabed by three steel piles – piles to be cut 3m below seabed[2].
SSIV protection structure[1]	1	1.7 x 1.0 x 1.9	Complete removal	-
Anode skids[1]	2	1.0 x 1.4 x 0.1	Complete removal	-
Larch Field				
Larch gas lift and production manifold	1	12.0 x 11.5 x 3.0	Complete removal	Structure secured to the seabed by four steel piles – piles to be cut 3m below seabed[2].
Larch Wye-piece assembly (original)	1	8.4 x 6.5 x 2.0	Complete removal	Original Wye-piece assembly.
Larch Wye-piece extension spool protection structure	1	4.5 x 3.0 x 2.0	Complete removal	Connected to the Wye-piece assembly.
Larch Wye-piece assembly (new)	1	6.5 x 3.8 x 2.3	Complete removal	Additional Wye-piece assembly. Connected to the Wye-piece extension spool protection structure.
Sycamore Field				
Wellhead[3]	1	4.0 x 3.5 x 1.5	Complete removal	SW1 (formerly SP1) well

Note [1]: At the time of writing the Trees Decommissioning EA the timing for decommissioning the SSIV protection structure and anode skids were under discussion with the Brae Group. [2] If any practical difficulties are encountered to achieve this, Spirit Energy will consult with OPRED. [3]Well SW1 (formerly SP1) at Sycamore Main was drilled and abandoned but never completed as a production well, the wellhead and flowbase will be recovered.

Figure 2-2: Trees fields layout and decommissioning scope of activities



Note [1]: SW1 (formerly SP1) well at Sycamore Main shown, but not labelled, this well was drilled and abandoned but never completed as a production well, the wellhead and flowbase will be recovered.

2.2.2 Pipelines, Umbilicals, Spoolpieces and Jumpers

The Trees fields pipeline system for the Birch and Larch fields comprises production, water injection and chemical injection pipelines and a control umbilical which are all installed in open trenches at a depth of 1-2m below seabed level (Table 2-3). Limited and variable natural backfill has occurred within the trenches and numerous exposures noted along most pipelines.

The length of pipelines (or portions of pipeline), and the number of protection and stabilisation materials planned for removal has been determined from a number of sources (including original design, installation and 'as built' documentation, and historic and contemporary marine surveying records) that are of variable quality and utility for this purpose. Furthermore, historical engineering modification and remediation practices undertaken at various times over the lifetime of the asset may also have installed, repositioned or removed protection and stabilisation materials without necessarily updating documentation. It should be noted that the most recent marine surveying records, where and if available, have been used as the primary data source for these quantitative determinations.

The production and gas lift pipelines will be flushed and cleaned (with untreated seawater and gel for the production pipeline) back to the Brae Alpha platform. Topsides sampling of the seawater returns from the production pipelines[3] will ensure an acceptable level of cleanliness is achieved (agreed with OPRED prior to any pipeline decommissioning activity) and the lines will be left filled with untreated seawater. For umbilical decommissioning, (given the impracticality due to core size and that the fluid has no discharge point other than to sea) the hydraulic cores (containing the hydraulic fluid Oceanic HW443ND) will not be flushed and instead will eventually discharge to sea; this discharge will occur over a period of time, as the umbilical degrades and the contents of the lines slowly displace to seawater. As the wells have been disconnected, the chemical cores can not be flushed to their respective well trees, with the final flushing / discharge programme to be determined. It may be possible to flush the chemical cores during production pipeline conditioning using loops and round tripping fluids to / from Brae Alpha, alternatively, the cores may have to be discharged to sea. The latter of these has been assumed as the base case for the purpose of this assessment, representing the worst case.

Surface laid jumpers and tie-in spools will be fully removed from the seabed and recovered to shore for recycling. The recommended solution for the remaining trenched pipeline infrastructure was determined via the Spirit Energy CA process.

Results of the CA indicated the recommended decommissioning solution for the sections of the Trees (Birch and Larch) pipelines and umbilicals which are protected by deposited rock or are trenched to at least 0.6m depth is to decommission *in situ*. Exposed pipeline and umbilical ends exiting the trench transitions will be cut to trench depth of at least 0.6m and recovered. The cut pipeline will be remediated within the trench using deposited rock to mitigate any potential snagging risk to fishing activities. Pipeline burial depth survey (PDI 2021) results indicate a 37m section of pipeline PL1527 is trenched to an insufficient depth (less than 0.6m) and will require remedial work to achieve the desired depth of burial. The shallow section of pipeline will be decommissioned *in situ* by trenching the section to at least 0.6m depth using a mass flow excavator, or other suitable means. In the event that remedial trenching is unsuccessful the line will be covered with rock or cut and recovered (with remaining pipeline ends protected using rock).

[3] Given the service of the gas lift pipelines, (clean dry gas), a simple displacement to seawater shall be sufficient with no topside sampling requirements for these.

Table 2-3: Trees fields main pipeline information and decommissioning solution

Description	Pipeline Number	Diameter (inches)	Length (km)	From-To End Points	Burial Status	Decommissioning Solution
Birch Field						
Production pipeline	PL1161	10	14.26	Birch Manifold to Brae A	Open trenched, rock covered sections	Partial recovery – trenched sections (<0.6m depth) to be decommissioned *in situ*. Approaches and trench transition sections to be cut and recovered
Water injection	PL1162	12	13.92	Brae A to Birch Manifold	Open trenched – limited natural backfill	
Chemical injection	PL1163	4 to 3 at manifold	13.91	Brae A to Birch Manifold	Open trenched – limited natural backfill. Piggybacked to PL1162	
Umbilical	PL1164	0.38	13.91	Brae A to Birch Manifold	Open trenched	
Larch Field						
Production pipeline	PL1527	10	2.39	Production Well 16/12a-23 to Larch Wye-piece assembly	Trenched to a depth >1.0m except for an exposed section with depth <0.6m over a length of *ca.* 37m, limited natural backfill, rock covered sections	Partial recovery – (as above) Remediation of shallow trenched section (<0.6m depth) by dredging/trenching, cut and recovery, or rock protection
Water injection	PL1528	6	2.17	Larch water injection well to Larch T-piece assembly	Open trenched	Partial recovery – trenched sections (≥0.6m depth) to be decommissioned *in situ*. Approaches and trench transition sections to be cut and recovered
Service pipeline	PL1529	4	2.4	Larch production well to Larch T-piece assembly	Open trenched, piggybacked to PL1528	
Control umbilical	PL1530	119mm	1.8	Birch Manifold to Larch production wells	Trenched – limited natural backfill	
Gas lift pipeline	PL1531	4	12.10	West Brae gas lift pipeline T-piece to the Larch gas lift Manifold	Trenched – limited natural backfill. Rock covered sections, piggybacked to PL1527 for 2.3km	
Sycamore						
Only jumpers and spool infrastructure at Sycamore will be recovered under this scope, full details of these are provided in the DP						

Note [1]Individual jumpers (including their PL numbers) at Birch, Larch, and Sycamore have not been included in the table above; for the purposes of the EA the jumpers and spools are captured under the associated pipeline and umbilical entries. All jumpers are fully described in the DP.

2.2.3 Stabilisation Materials

There are three third-party pipeline crossings of the Trees fields infrastructure, the 30" Miller gas export pipeline (PL720), the 30" Forties oil export pipeline (PL64) and the West Brae control and chemical injection umbilical (PL1446) (Table 2-4). Concrete mattresses have been used to separate the pipelines at the crossing locations and deposited rock was installed over the crossings to prevent snagging risks to fishing activities where the pipelines come out of the trench and are exposed on the seabed. Third party pipeline crossings will not be disturbed during the Trees fields decommissioning activities and protective stabilisation materials associated with third party crossings will be decommissioned *in situ*.

Stabilisation materials such as concrete mattresses, grout bags and rock cover have also been installed around subsea structures, e.g. manifolds; in trench transition areas where pipelines exit the trench; along pipeline approaches to the Brae A platform and other subsea structures; and to rectify upheaval buckling and free spans along the pipelines. All deposited rock will be left *in situ*. All exposed mattresses and grout bags not associated with pipeline crossings will be recovered to shore for recycling and disposal. Concrete mattresses and grout bags buried beneath protective rock cover or in trenches and below seabed level will be left *in situ*. Based on a review of the original design, installation and as-built documentation it has been estimated that *ca.* 20% of mattresses and grout bags installed with associated rock cover are buried beneath the rock cover and would therefore be decommissioned *in situ*. Approximately 80% of mattresses and grout bags are exposed and will be recovered. Table 2-5 and Table 2-6 provide an inventory, burial status and estimated recovery percentage of stabilisation materials.

Table 2-4: Pipeline 3rd party crossings

Pipeline / Umbilical / Cable crossing	Location	Protection
Birch pipelines		
PL1161 crossing over PL720 (Miller to St. Fergus 30" pipeline – out of use)	KP8.75	Concrete mattress/block supports under the pipeline, covered by rock protection.
PL1162 & PL1163 crossing over PL720 (Miller to St. Fergus 30" pipeline – out of use)	KP8.800	
PL1164 crossing over PL720 (Miller to St. Fergus 30" pipeline – out of use)	KP8.800	
PL1161 crossing over PL64 (Brae A to Forties Charlie 30" pipeline – active)	KP11.32	
PL1162 & PL1163 crossing over PL64 (Brae A to Forties Charlie 30" pipeline – active)	KP11.27	
Larch pipelines		
PL1531 crossing over PL720 (Miller to St. Fergus 30" pipeline – out of use)	KP7.20	Concrete mattress/block supports under the pipeline, covered by rock protection.
PL1531 crossing over PL64 (Brae A to Forties Charlie 30" pipeline – active)	KP9.75	Concrete mattress/block supports under the pipeline, covered by rock protection.
Inside Brae A 500m safety zone		
PL1531 crossing over PL1446 (Brae A to West Brae control and chemical injection umbilical)	*Ca*. 18m downstream of crossover bundle outboard support at Brae A	Concrete mattresses/grout bags.
Crossover bundle for PL1161, PL1162, PL1163 & PL1531 crossing over PL360, PL361 and control umbilical for SSIV protection structure.	*Ca*. 20m north-north-east of Brae A	Crossover bundle piled. No additional protection.

Table 2-5: Trees fields subsea infrastructure concrete mattresses and grout bag stabilisation materials and decommissioning solution

Location	Number in Place	Burial Status	% to be Removed
Concrete mattresses			
Brae A 500m (Birch PL1161, PL1164)	40	Exposed, except trench transition where burial is expected	80
Brae A 500m (Larch PL1531)	31	Exposed.	100
Birch 500m	123	Exposed, except trench transition where burial is expected	80
Birch-Miller PL720 crossing	28	Buried under deposited rock, some mattresses may be exposed out with the rock cover	0
Birch-Forties PL64 crossing	33		
	13	PL1164 adjacent to crossing, within trench.	0
Larch Wye-piece & Birch T-piece (Birch)	52	Exposed	100
PL1162/PL1163 along pipeline route	27	Within trench providing stabilisation and protection (KP10.8-11.0)	0
Larch Manifold	167	Exposed, except trench transition where burial is expected	80
Larch to Birch PL1161 between 500m zones (infield upheaval buckling and freespan rectification)	36		
West Brae PL1446 crossing	2	Exposed	100
Larch-Miller PL720 crossing	78	Buried under deposited rock, some mattresses may be exposed out with the rock cover	0
Larch-Forties PL64 crossing	80		
Larch Wye-piece and Larch T-piece (Larch)	78	Exposed	100
Larch Wye-piece (original)	8	Underneath Larch Wye-piece assembly (original)	100
Larch Wye-piece extension spool protection frame	4	Underneath Larch Wye-piece extension spool protection frame	100
Larch Wye-piece (new)	12	Underneath and on top of Larch Wye-piece	100
Sycamore 500m zone	88	Exposed	100
Total Number	900	Total number to be removed	568
Grout bags			
Brae A 500m zone (Birch PL1161, PL1164)	500	Mostly exposed, some beneath spools and buried in trench transitions	80
Birch 500m zone (Larch PL1531)	500		
Birch 500m zone	500		
Protection covers near Birch Manifold	500	Exposed	100
Birch-Miller PL720 crossing	2,000	Buried under deposited rock	0
Birch-Forties PL64 crossing	2,000		
Larch Wye-piece & Larch T-piece (Birch pipeline protection)	500	Mostly exposed, some beneath spools and buried in trench transitions	80
Larch Manifold (gas lift / production)	500		
Larch to Birch (PL1161 infield upheaval buckling and freespan rectification)	500		
PL1162/PL1163 along pipeline route	200	Within trench between and around mattresses (KP10.8 - KP11.0)	0
Protection cover near Larch Wye assembly	500	Exposed	100
West Brae PL1446 crossing	500		

Location	Number in Place	Burial Status	% to be Removed
Larch-Miller PL720 crossing	500	Buried under deposited rock	0
Larch-Forties PL64 crossing	500		
Larch Wye-piece & Larch T-piece (Larch pipeline protection)	500	Mostly exposed, some beneath tie-in spools and buried in trench transitions	80
Larch Wye-piece (original)	250	Exposed, around structures	100
Larch Wye-piece (new)	250		
Sycamore 500m safety zone (freespan rectification)	320		80
Sycamore 500m safety zone (around tie-in spools)	500	Exposed	100
Total Number	11,200	Total number to be removed	5,300

Table 2-6: Trees fields subsea infrastructure concrete protection covers, rock cover and concrete block stabilisation materials and decommissioning solution

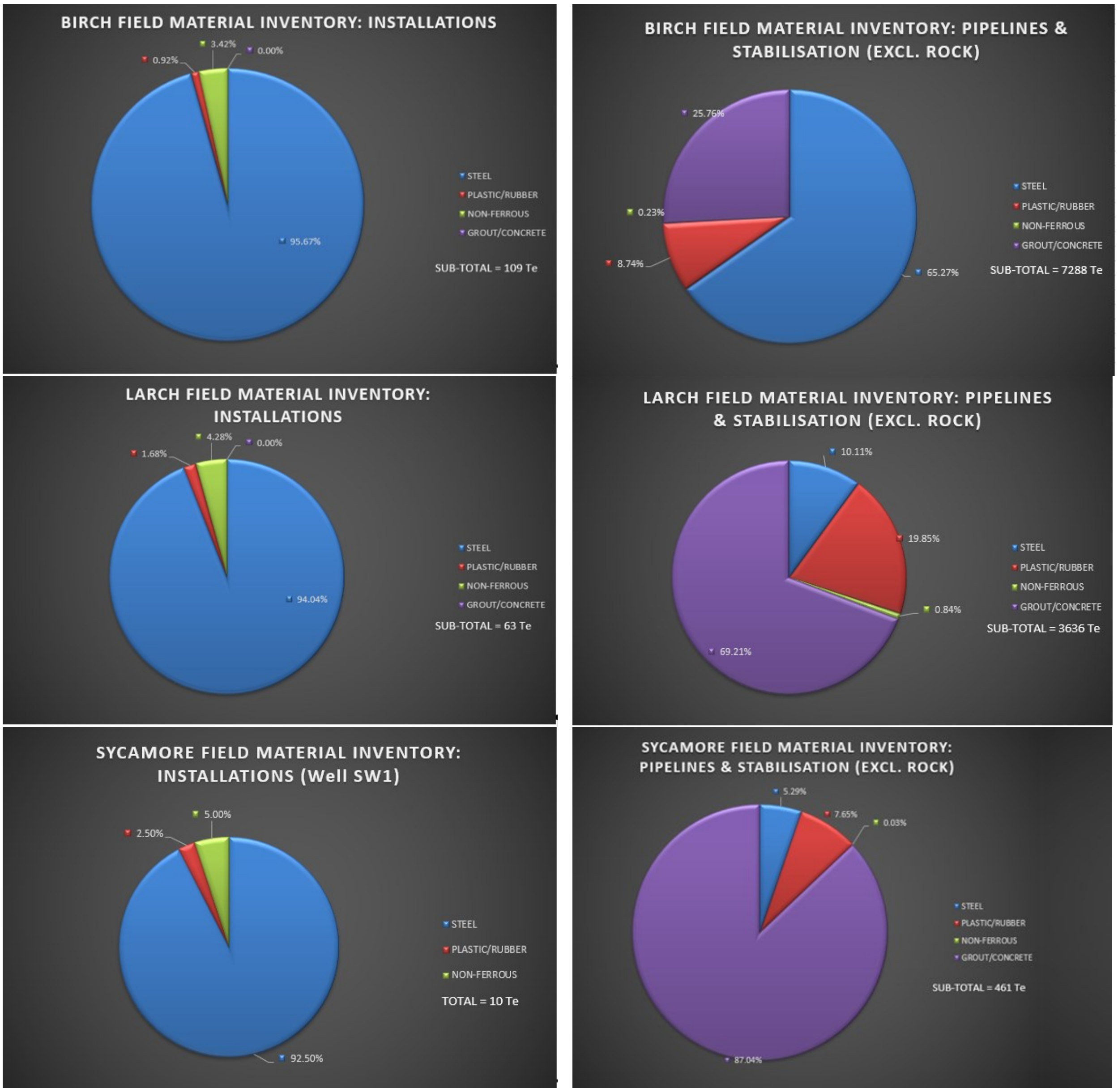
Location	Quantity in Place	Burial Status	Decommissioning Solution
Protection covers			
Birch Manifold	No. 8	Exposed.	Complete recovery
Larch Wye assembly	No. 10	Exposed	Complete recovery
Deposited rock			
Birch-Forties PL64 crossings	35,118 te	n/a	Leave *in situ*
Larch PL1527 & PL1531 from Larch Manifold to Brae A	3,050 te	n/a	Leave *in situ*
Concrete blocks – pipeline crossings			
Birch-Miller PL720 crossing	No. 8	Buried under deposited rock.	Leave *in situ*
Birch-Forties PL64 crossing	No. 8		Leave *in situ*

2.2.4 Management of Waste and Recovered Material

A high level estimate of the materials that comprise the Trees fields structures, pipelines and stabilisation materials is presented in Table 2-7 (these taken from the Trees DP, see Figures 2.1.1 – 2.3.2 and associated tables in the DP for full details). Wastes generated during the decommissioning activities will be segregated and transported to shore to a licensed waste contractor. It is expected that the majority of materials will be recycled on shore and reuse opportunities will be investigated where possible in accordance with the principals of the waste hierarchy. However, until the materials are recovered and their condition can be assessed along with the market demand, Spirit Energy will endeavour to reuse equipment where possible. Spirit Energy intend to minimise as far as possible waste to landfill, consequently it is expected that any plastic / rubber materials associated with the pipelines will be incinerated with the resultant heat being used for energy.

At present, the Trees fields remain tied back to the Brae A platform. Brae A decommissioning is not part of the Trees fields DP and not included within the scope of this assessment, other than in the context of understanding in-combination/cumulative effects.

Table 2-7: High-level inventory of waste from Trees fields decommissioning



2.2.5 Post-decommissioning Survey

Upon completion of decommissioning activities, Spirit Energy will undertake a multibeam echo sounder (MBES) survey (or equivalent) and any significant debris identified will be recovered for onshore recycling or disposal.

A post-decommissioning survey will then be undertaken within the 500m safety zone located at Larch and along a 100m wide corridor (50m either side) of all flowlines and umbilicals, from which independent verification of the seabed state will be obtained for the flowline areas and installation locations. Evidence of a safe seabed will be provided to all relevant governmental and non-governmental organisations. The EA assumes a worst case of an over-trawl trial being carried out; final seabed verification method will be discussed with OPRED, in line with the *Guidance on decommissioning debris surveys and recovery and seabed clearance verification* (OPRED May 2024). The post-decommissioning 500m safety zone surveys at Birch and Sycamore will be undertaken following decommissioning of the Sycamore bundles which will be subject to a separate DP.

Post decommissioning close out report submission, a survey programme for monitoring infrastructure decommissioned *in situ*, will then be agreed with OPRED.

2.2.6 Vessel Use

A variety of vessels will be required during the Trees fields decommissioning activities. At the time of preparing the EA the specific vessel selection has yet to be made, therefore engineering judgement has been used to estimate the types of vessels and the schedule required for execution. Typical fuel consumption for vessel types being used are based on the IoP Guidelines (2000) (summarised in Table 2-8). In the absence of named vessels, this information and estimated duration on locations, forms the basis of estimating vessel atmospheric emissions from the decommissioning activities.

Table 2-8: Vessel summary

Activity	Approximate no. Days on Site	Fuel Consumption Rate (te/day)	Fuel Type	Total Fuel Consumption
Vessel support				
Pipeline flushing				
Construction vessel	10	12	Diesel	120
Subsea infrastructure removals (structures and pipelines)				
Construction vessel	57	12	Diesel	684
Heavy lift vessel	3	19	Diesel	57
Subsea rock installation vessel	10	11	Diesel	110
Post-decommissioning survey				
Survey vessel	10	4	Diesel	40
Legacy monitoring surveys				
Survey vessel – year 3	18	4	Diesel	72
Survey vessel – year 5	18	4	Diesel	72
Survey vessel – year 10	18	4	Diesel	72

3 ENVIRONMENTAL DESCRIPTION

The Trees fields are located in UKCS blocks 16/12a and 16/07 of the central North Sea (CNS), *ca*. 209km from Peterhead and in 125m water depth. The fields are located to the south of the Brae A platform, to which they are tied back, and positioned linearly along an approximate north-south bearing. The description of the environment within which the Trees fields are located, draws information from a number of different sources, including site specific surveys, (Fugro 2022a-c) and regional surveys, and e.g. fisheries (ICES rectangle) data (spawning / nursery), bird and marine mammal distribution data. The following description therefore summarises the Trees fields in respect of site specific survey data and the Trees area in the wider regional context.

3.1 Environmental Surveys

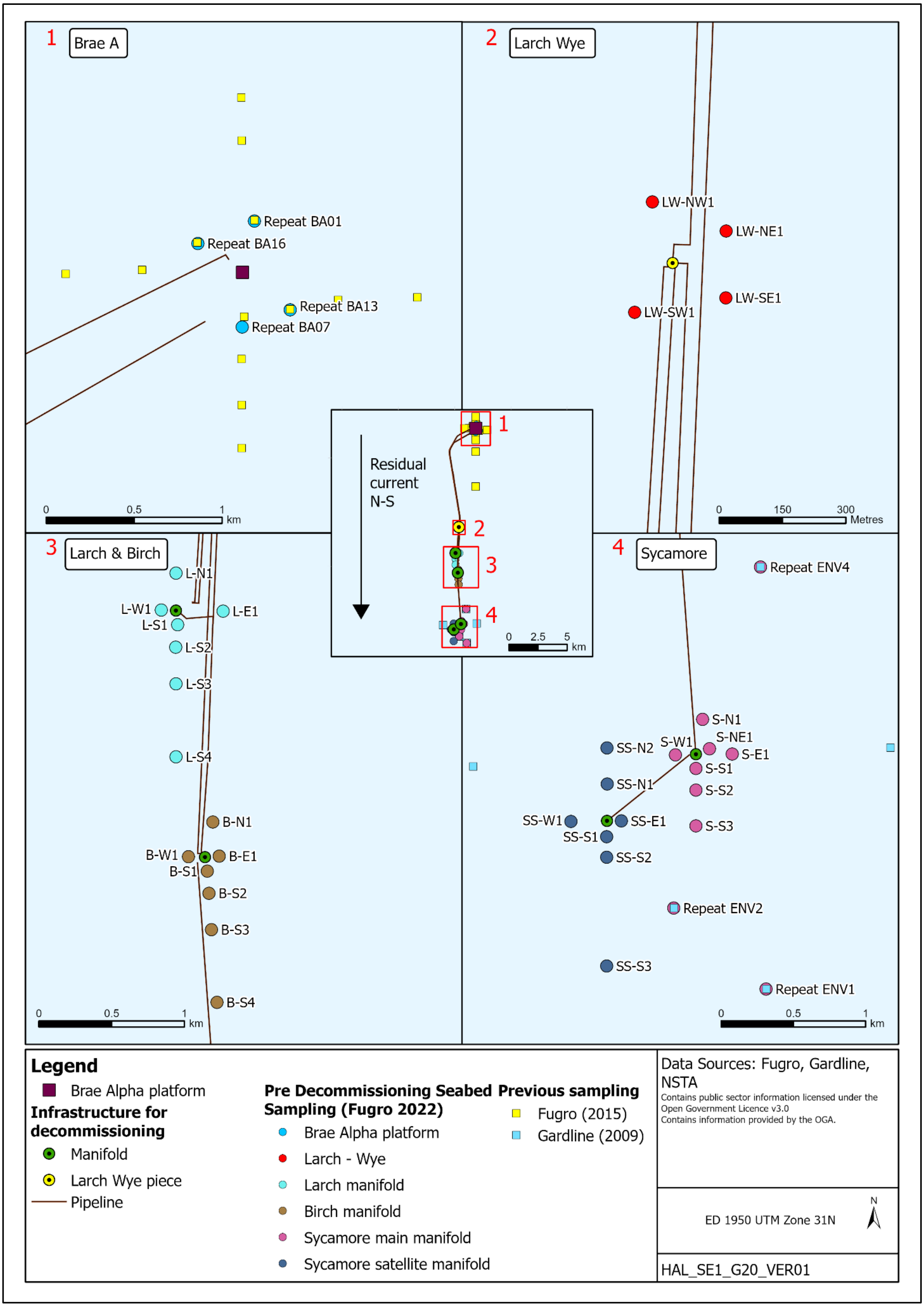
Spirit Energy conducted a pre-decommissioning environmental survey in March 2022 for the Trees fields at the Birch, Larch, Sycamore and the Brae A locations. This survey is supported by results from two previous surveys of the Trees area (Table 3-1 and Figure 3-1).

The pre-decommissioning survey objectives were to characterise the benthic environment, identify and delineate potential sensitive habitats; identify indications of historic drill cuttings discharge around the well locations; and to repeat several stations from the two historic surveys of the Brae A and Sycamore areas to allow temporal comparisons. The pre-decommissioning survey comprised a geophysical survey using side-scan sonar and multibeam echosounder, video and still photos taken using drop down camera and benthic grab samples using a dual Van Veen grab. Survey stations were positioned in a cruciform pattern around each field manifold location, with the main axis aligned with the residual current direction.

Table 3-1: Environmental surveys in the Trees area

Field Area	Year	Survey Operator	Purpose	Details
Trees (Birch, Larch, Sycamore)	2022	Fugro	Pre-decommissioning environmental survey	38 sampling stations, repeating 3 stations from the Sycamore Main Manifold (SP5 survey) in 2009 and 4 stations from Brae A 2015 survey. Geophysical, habitat, physico-chemical, fauna.
Brae A	2015	Fugro	Pre-decommissioning environmental survey	18 sampling stations centred on Brae A. Geophysical, habitat, physico-chemical, fauna.
Sycamore	2009	Gardline	Environmental baseline survey for well SP5	Five sampling stations centred on SP5 well. Geophysical, habitat, physico-chemical, fauna.
Brae A	2006	Hartley Anderson	UK Government / Industry Environmental Monitoring Committee long-term monitoring of contaminant persistence around specific North Sea platforms.	Six sampling stations south of the Brae A platform from 250m to 5000m distance. Physico-chemical analysis.

Figure 3-1: Trees fields pre-decommissioning environmental survey sampling stations and wider area surveys



3.2 Climate, Oceanography and Hydrography

Sub-surface water circulation in the Trees area is primarily influenced by the influx of Atlantic water into the North Sea via the Fair Isle Channel and around the north of Shetland, with the main outflow of water travelling northwards along the Norwegian coast. Near bottom circulation to the south west is driven by the Fladen Eddy (Turrell *et al*. 1992).

Relative current velocities remain largely uniform between surface and midwater and reduce towards the seabed with both near-surface and deep currents running along a north-south axis. The predominant surface current is moderately constant (50-70% of the time) at a rate of $0.26ms^{-1}$ (0.51 knots) (UKHO 2012). Tides in the region are predominantly semi-diurnal, typically with their axis in a north / south direction.

Meteorological conditions in the area are typical of the CNS. The influence of the prevailing south-westerly winds and the warming influence of the North Atlantic Drift results in relatively high winter temperatures (5-6ºC in January) and relatively low summer temperatures (13-14ºC in July) (UKHO 2012). Throughout the year winds with an average strength of Beaufort scale 4-6, predominantly in a south-westerly direction, are frequent, with the highest frequency of gales (Beaufort scale 7 and over) occurring between October and April. Wave heights of 4-7m are not uncommon during winter. Throughout the summer months a thermocline develops in the CNS at between 30-50m resulting in the bottom waters becoming isolated from vertical mixing. Gales and lower surface temperatures lead to the breakdown of the thermocline in autumn. Salinity in the area is relatively constant, in the range 34,500–35,000ppm at the sea surface, and the range 35,100–35,250ppm at the bottom. Widespread rain and low cloud are common in the area, especially during the winter months. Sea fog is most common during the summer.

3.3 Seabed Characteristics

3.3.1 Seabed Sediments

Sediments across the area, were generally characterised as coarse silt or fine / very fine sand on the Wentworth scale, with a bimodal distribution of sands and fines (the combined silt and clay fractions). In comparison, the stations at Brae A had a unimodal sediment particle size distribution and were dominated by the sand fraction, being described as fine to very fine sand on the Wentworth scale. The mean proportion of gravel in the sediments was typically very low (<1%) with the exception of the Sycamore Main Manifold sampling area where S-NE1 contained 10.44% gravel, which was attributed to the presence of rock chippings associated with deposition of drill cuttings in the area.

The mean proportion of sand across the Brae A and Trees fields generally decreased in a southerly direction from the Brae A field (86.27%) and the Larch Wye location (61.23%) in the north to the Sycamore Satellite field in the south (47.92%). This decrease in mean proportion of sand was mirrored by an increase in the mean proportion of fines from the Brae A field (13.63%) and the Larch Wye location (38.59%) in the north to the Sycamore Satellite field in the south (52.02%).

Where available, comparison with historic survey data indicated similar mean particle sizes at both the Brae A and Sycamore Main repeat sample stations when compared to 2015 and 2009 data. Accordingly, the overall sediment composition at both Brae A and Sycamore Main was consistent with previous surveys, with sand the dominant fraction at Brae A and an approximately equal proportion of sand and fines at Sycamore Main.

Mean values of total organic material (TOM) followed a similar pattern to the distribution of fines across the Brae A and Trees fields, with the mean TOM values increasing in a southerly direction from the Brae A (1.16%) and Larch Wye location (1.73%) in the north to the Sycamore Satellite field in the south (2.58%). The proportion of TOM also exceeded the CNS background mean percentage (1.63%) at all stations within the Trees fields, but remained below the CNS background

95th percentile (4.48%). The mean TOM percentage did not exceed the CNS background mean percentage at any station within the Brae A field.

Total organic carbon (TOC) concentrations were below the CNS background mean for all stations within the both the Trees and Brae A fields. Mean TOC content followed a similar north to south pattern as the TOM content with the lowest values at Brae A (0.24%) and the highest at Sycamore Satellite field in the south (0.61%). The mean TOC values in the current survey were broadly comparable to the 2015 survey, while samples from Sycamore Main had a lower TOC content than reported in 2009.

Generally, sediments demonstrated low in-field variability for all parameters across all of the fields.

3.3.2 Sediment Chemistry

Hydrocarbon Concentrations

Hydrocarbons in marine surface sediments originate from a number of sources, including terrestrial run-off in coastal areas, vessel spills and discharges, plant origin, natural seeps, atmospheric deposition and hydrocarbon extraction. The composition of aliphatic and aromatic hydrocarbons in sediments can be indicative of their origins, and along with the total organic carbon (THC) are indicative of potential levels of contamination above the regional background sediment concentrations.

The sediment THC levels at Larch Wye, Larch, Sycamore Main (excluding S-NE1) and Sycamore Satellite are generally considered to be typical of background sediment for this area of the CNS (Figure 3-2, Figure 3-3 and Figure 3-5). The North Sea Quality Status Report (NSTF 1993) suggests that typical THC levels (i.e. 'background') in sediments remote from anthropogenic activities range from 0.2µg/g to 5µg/g, although in some areas values may be as high as 15µg/g.

Sediment THC levels within the Birch field were elevated above the CNS 95th percentile at B-W1 (115m west of the Birch Manifold) and B-S1 (100m east of the Birch Manifold), with the THC levels at B-S1 also exceeding the OSPAR ecological effects threshold (EET) (50µg/g; OSPAR 2006) (Figure 3-4). On the southerly Birch transect the THC levels at B-S2 (250m south) were considered to be at approximately background levels, with THC levels at the southerly B-S3 (500m south) and B-S4 (1,000m south) below the CNS background mean.

Sediment THC values from the Brae A repeat sample stations were generally lower than those recorded in 2015, with the exception of BA01 which exceeded both the CNS 95th percentile and the 2015 THC values. Of the remaining three stations BA13 was below the CNS background mean, and BA07 and BA16 exceeded the background mean values.

Analysis of the gas chromatography profiles and n-alkane concentrations across the Trees fields indicate that a number of different drilling fluid inputs are evident within the sediments reflecting the changes in the regulatory regime over the development of the Trees fields. These fluids were primarily recorded in sediments at sample stations close to the drilling centres and in some cases extended along the residual current direction to the south (Figure 3-4 and Figure 3-5). The drilling fluids identified in the sediments can be summarised as follows:

- Larch Wye – Low toxicity oil based fluid (LTOBF) at all stations.
- Larch Manifold – Synthetic base fluids (SBF) & Polyalphaolefin based fluid (PAO) at L-N1, L-W1, L-S1, L-S2.
- Birch Manifold – SBF & PAO at B-N1, B-W1, B-S1, B-S2, B-E1.
- Sycamore Main – LTOBF & enhanced mineral oil based fluid (EMOBF) at S-NE1, S-S1, S-S2.
- Sycamore Satellite – LTOBF / weathered SBF at SS-E1, SS-S1, SS-S2.

- Brae A – low level LTOBF & diesel/light lubricating oil at BA01, BA07, BA16.

Concentrations of polycyclic aromatic hydrocarbons (PAHs) were found to be below the CNS background concentration at the Trees fields sampling stations. PAH concentrations within the Brae A field were found to exceed the CNS background mean at two stations, BA01 and BA07, but were below the effects range low (ERL) concentration and not considered to pose a significant risk to the environment.

Heavy Metal Concentrations

Total metal concentrations in the sediments were variable across the Trees fields. Stations at which one or more heavy metal concentration exceeded the ERL threshold generally coincided with stations that also exhibited elevated THC levels, with the exception of Larch Wye where THC at all stations was below or close to the CNS background mean THC levels but concentrations of chromium exceeded the ERL at two stations (Figure 3-2 to Figure 3-6). Concentrations of metals above the ERL indicate that these metals are at levels which could pose a risk to the environment and impacts at a population or community level may be expected. The stations where sediments exceeded the ERL thresholds for one or more metal were generally located close to the central manifold location within the Larch Wye, Birch, Sycamore Main and Brae A fields. Total metal concentrations exceeding the ERL and can be summarised as follows:

- Larch Wye – chromium at LW-NE1, LW-NW1.
- Birch Manifold – mercury at B-S1.
- Sycamore Main – chromium at S-E1 ENV-1; chromium, copper, mercury, lead at S-NE1.
- Brae A – chromium, copper, mercury, zinc at BA01.

Across the Brae A and Trees fields survey area, total barium concentrations ranged from 304μg/g to 9,230μg/g (Fugro 2022c). The highest total barium concentration was recorded at B-S1 where THC levels exceeding the 50ppm EET (OSPAR 2006) were also recorded indicating the presence of discharged drill muds and cuttings at this station.

Across the Brae A and Trees fields survey area, elevated total barium concentrations were restricted to stations ≤ 255m from a manifold or platform, with the highest total barium concentrations recorded at stations where drilling fluid inputs were evident in the GC-FID profiles.

Figure 3-2: Larch Wye summary of pre-decommissioning survey results (amended from Fugro, 2022a)

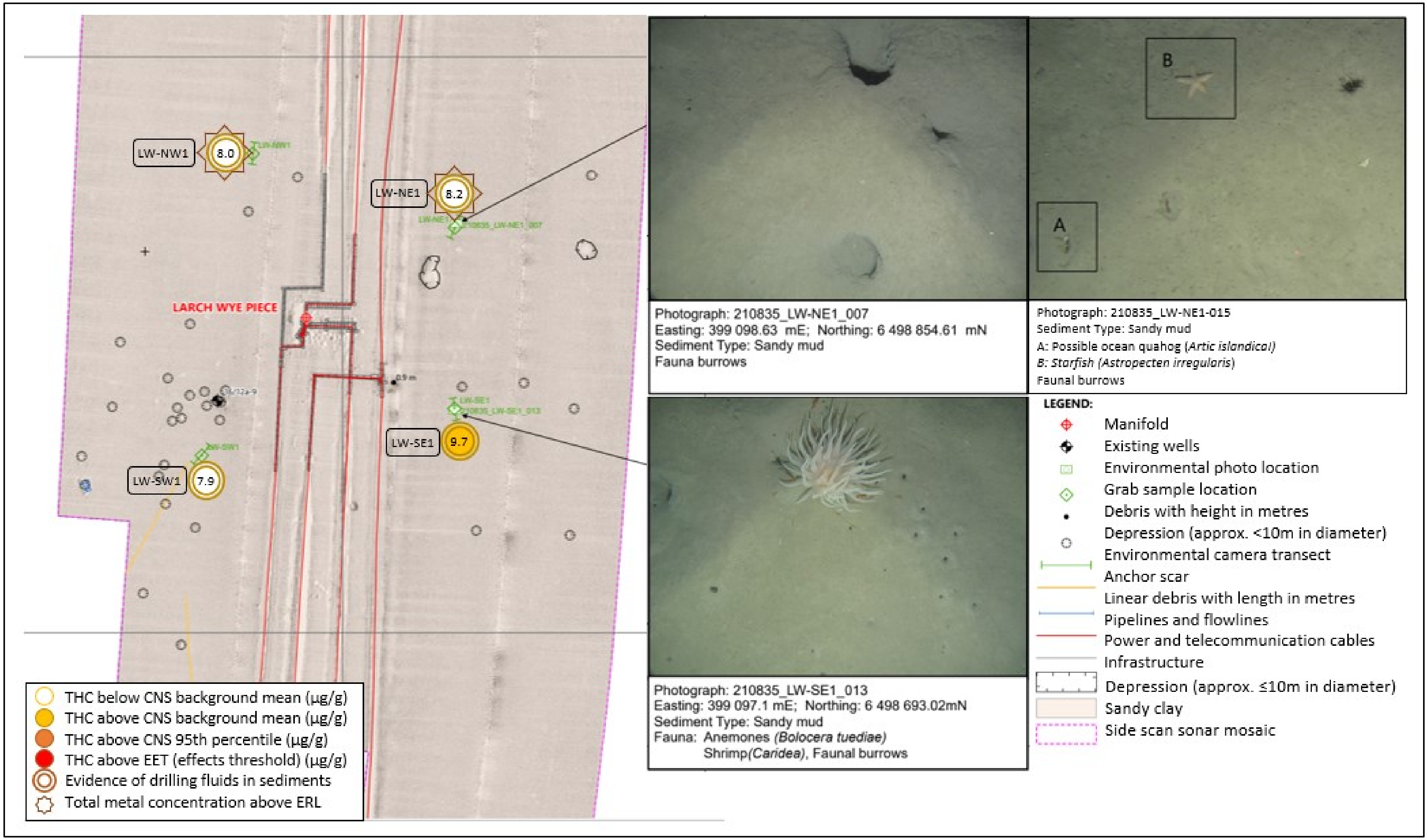


Figure 3-3: Larch Manifold summary of pre-decommissioning survey results (amended from Fugro, 2022a)

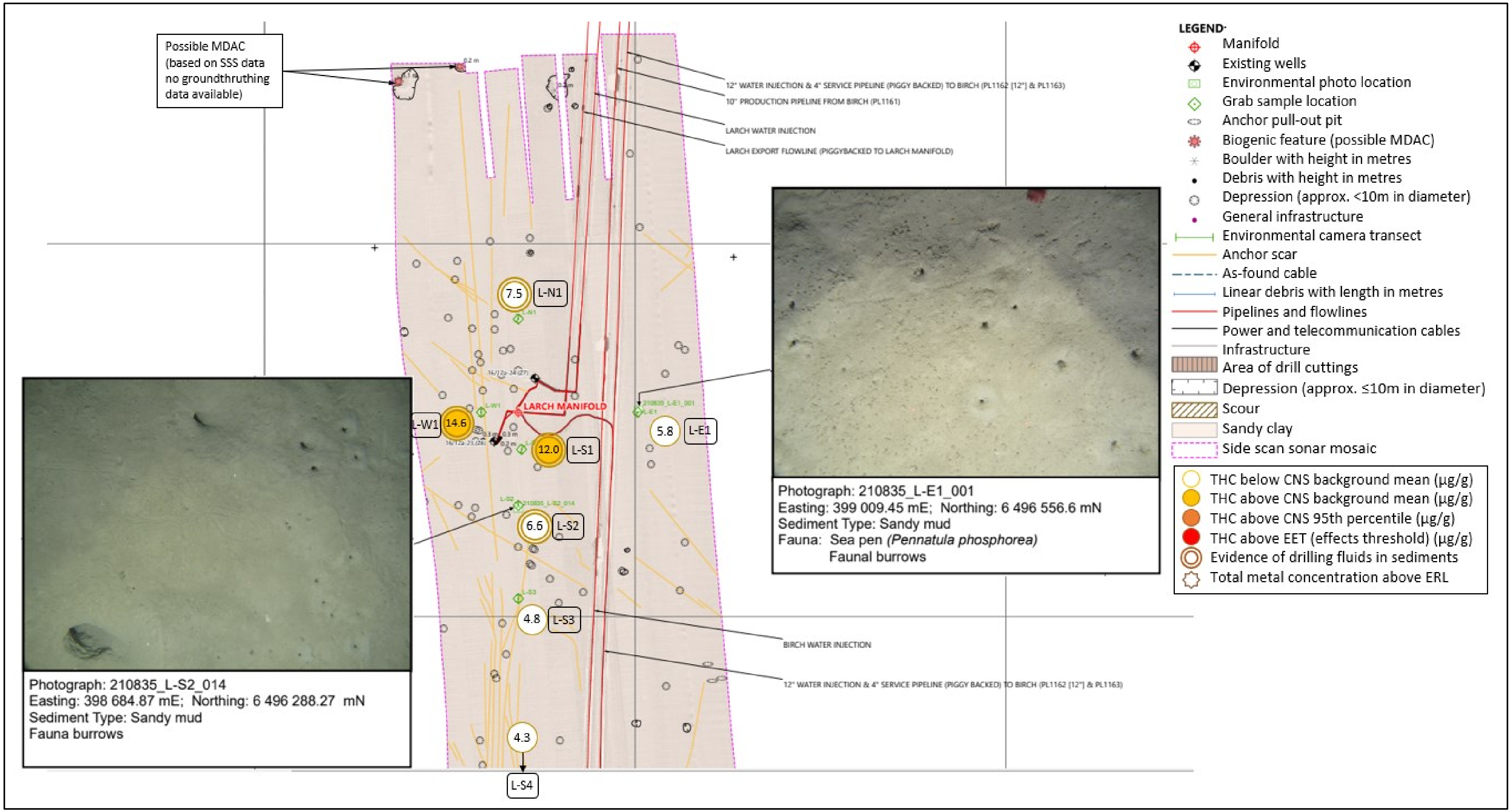


Figure 3-4: Birch Manifold summary of pre-decommissioning survey results (amended from Fugro, 2022a)

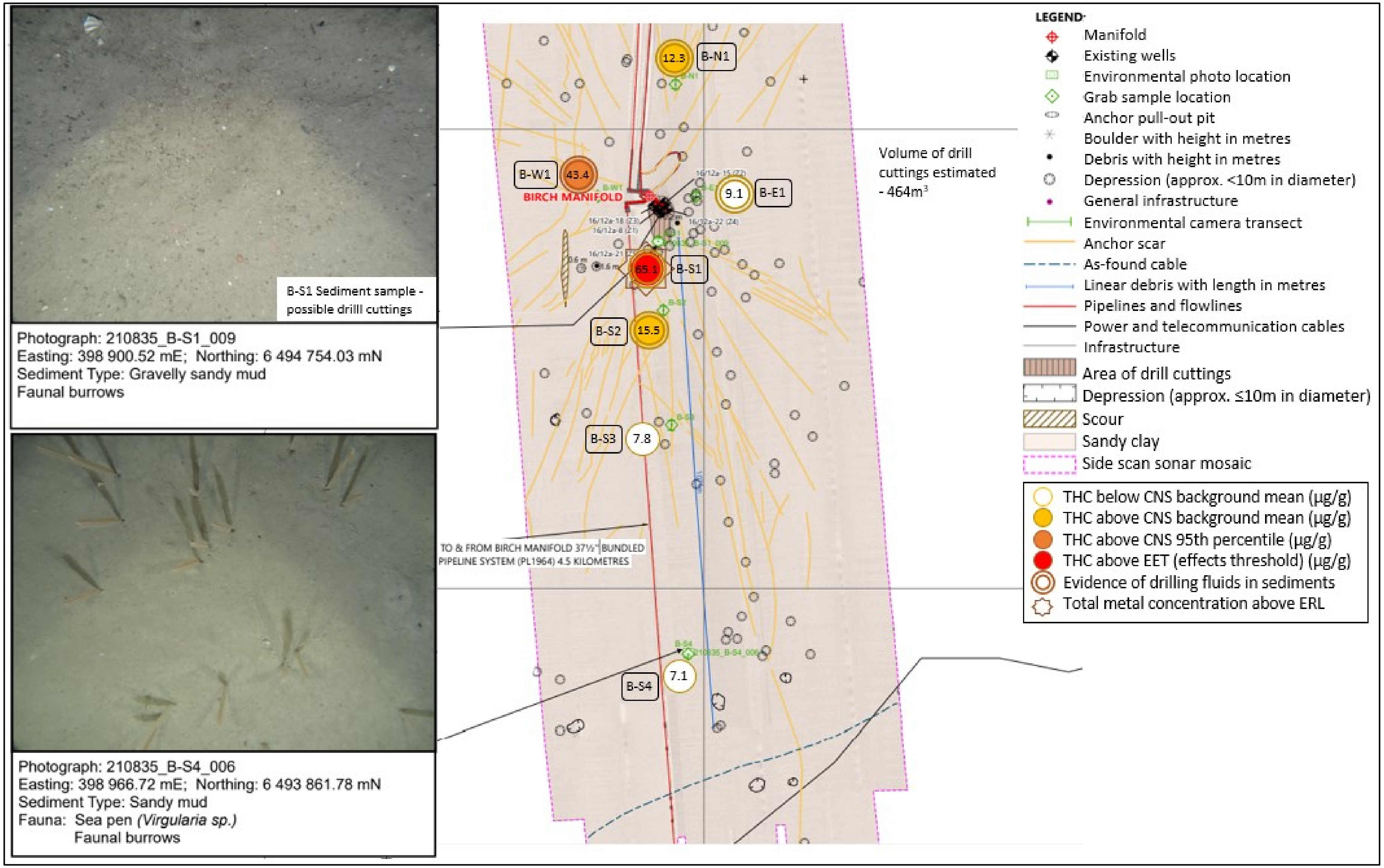


Figure 3-5: Sycamore Main and Sycamore Satellite summary of pre-decommissioning survey results (amended from Fugro, 2022a)

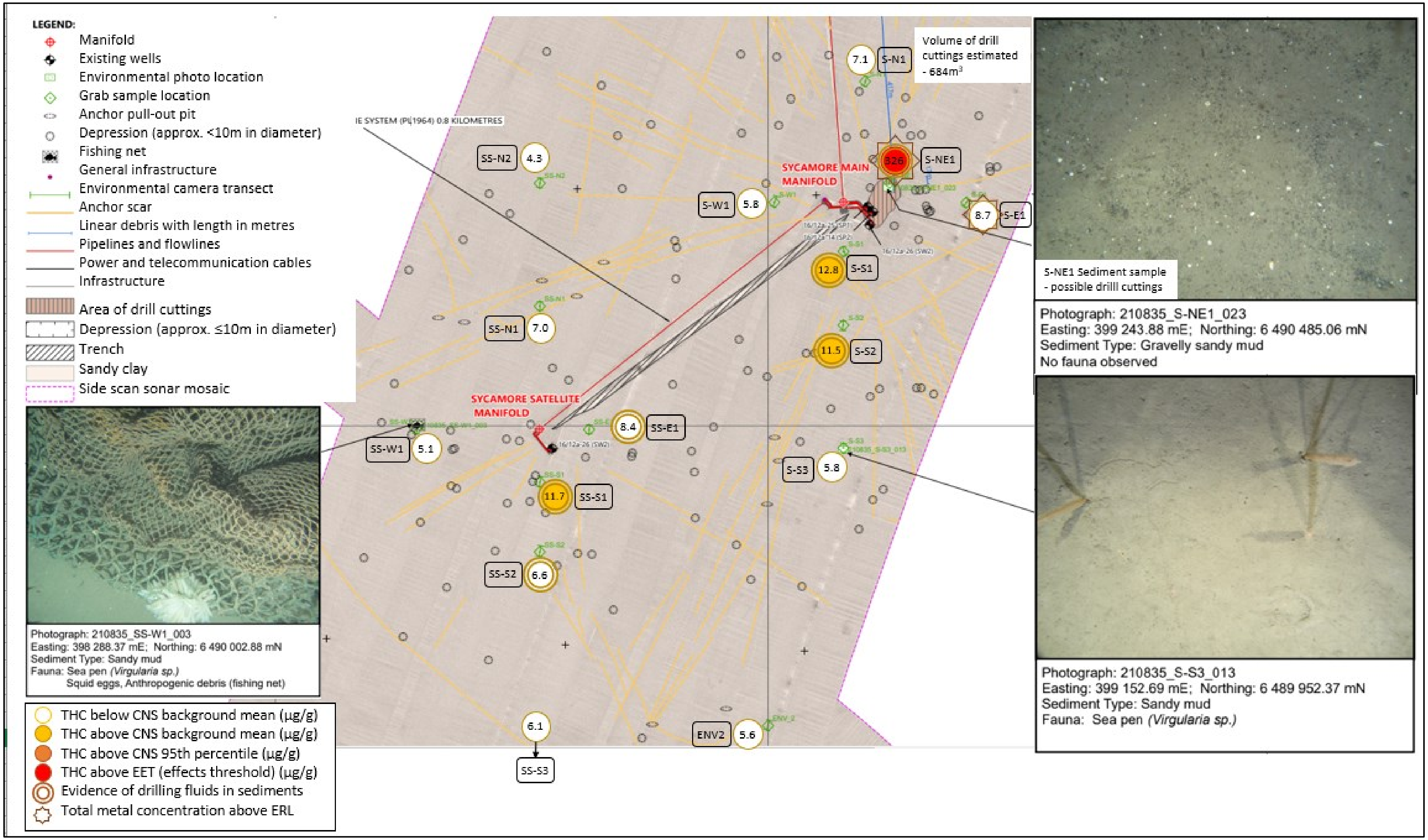
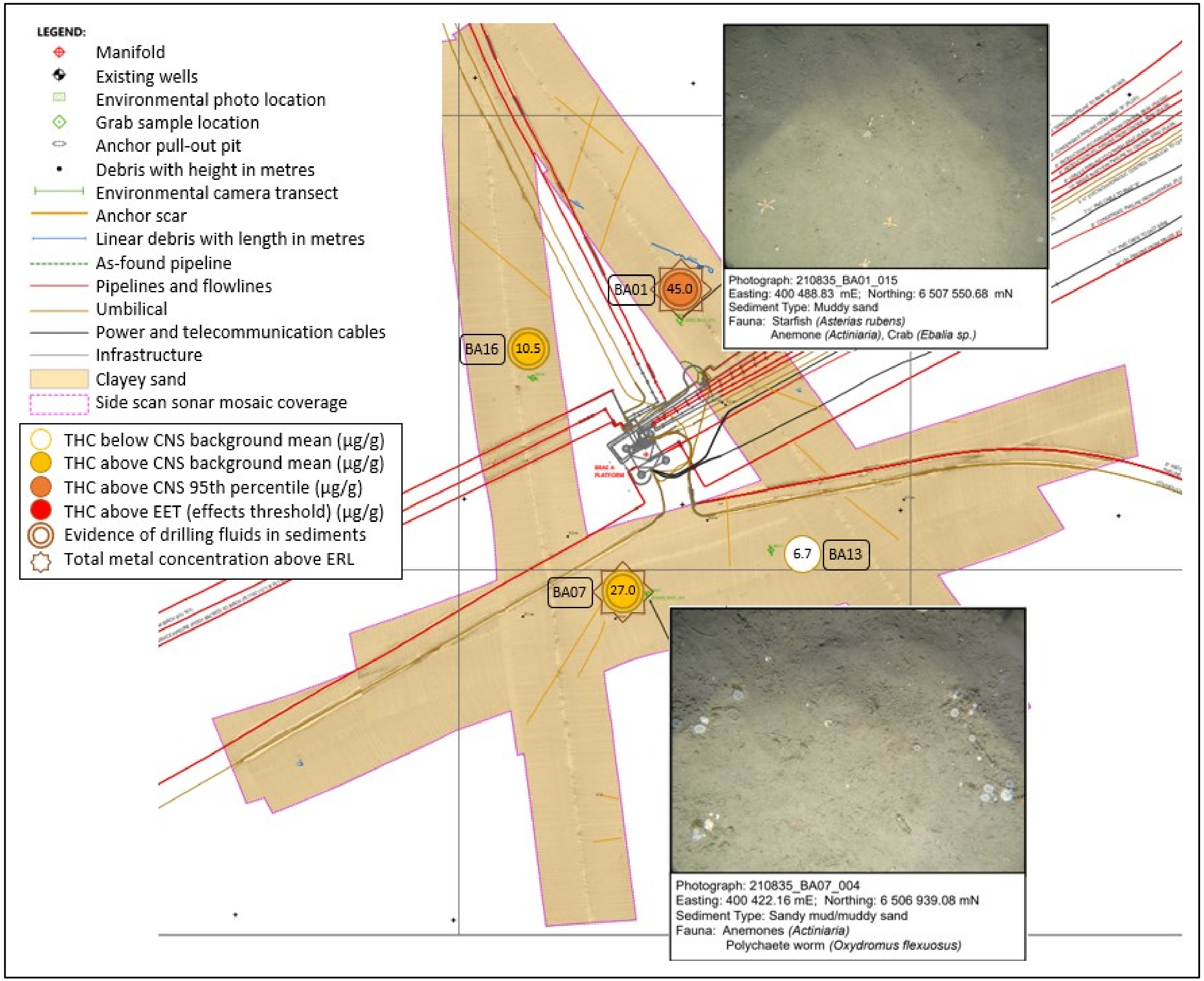


Figure 3-6: Brae A survey area summary of pre-decommissioning survey results (amended from Fugro, 2022a)



3.3.3 Historic Drill Cuttings

There was evidence of historic drill cuttings at both the Birch Manifold and Sycamore Main Manifold locations (Fugro 2022a).

Two areas of higher reflectivity were identified on the side scan sonar data, one to the south east of the Birch Manifold and the second to the east of the Sycamore Main Manifold location (Figure 3-4 and Figure 3-5). Samples collected within these locations (B-S1 – 100m south of the Birch Manifold, and S-NE1 – 100m north east of the Sycamore Main Manifold) contained elevated gravel content which was also identified from the video data and attributed to the presence of rock chippings associated with drill cuttings deposition (Fugro 2022a). These stations were classified as the European Nature Information System (EUNIS) habitat 'industrial waste' (J6.5). The potential volume of cuttings material was estimated from geophysical survey data as *ca*. 464m^3 in the Birch field, and *ca*. 684m^3 in the Sycamore field (Fugro 2022a), while the spatial extent appears to be limited to within 250m distance from the manifolds.

THC exceeded the OSPAR 50mg/kg ecological effects threshold (EET) at S-NE1 (326mg/kg THC) and to a lesser extent at B-S1 (65.1mg/kg THC). Concentrations of chromium, copper, mercury and lead were all above the effects range low (ERL) threshold at S-NE1, and levels of mercury exceeded the ERL threshold at B-S1, indicating that contaminants are present in the sediments at levels posing a risk to the environment. An assessment based on the OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles was undertaken for the Birch and Sycamore Main drill cuttings piles as part of decommissioning planning. The screening assessment indicates that both of the Birch and Sycamore Main drill cuttings pile fall below the OSPAR 2006/5 thresholds for rate of oil loss and persistence over area of seabed contaminated, such that the piles may be left *in situ* to degrade naturally (Hartley Anderson 2023).

Analysis of infauna showed evidence of modified macrofaunal communities at B-S1 and S-NE1 which showed significant differences in the community structure from other stations within the fields.

The macrofaunal community recorded at B-S1 had the lowest numbers of taxa and individuals compared to other stations within the Birch field and very low numbers of background polychaete species which are considered intolerant of hydrocarbons (Fugro 2022a).

While S-NE1 comprised the largest number of taxa and a high diversity when compared to other stations from the Sycamore Main survey area, this station also contained low numbers of the hydrocarbon tolerant species and primary coloniser *Thyasira sarsii* which is often found in very high numbers associated with hydrocarbon contamination.

Results from the 2022 habitat survey indicated that the OSPAR (2010) habitat 'sea pens and burrowing megafauna communities' is present throughout the Trees fields survey area, and while the sea pen *Pennatula phosphorea* occurs in 'frequent' abundance across the majority of the sampling stations within the Trees fields, this species was absent from both B-S1 and S-NE1 which are located within the historic drill cuttings (Sections 3.5 and 3.9.1).

3.4 Plankton

Plankton can be divided into phytoplankton (plants) and zooplankton (animals). The community found in the waters around the Trees area is typical of most of the central and northern North Sea, despite local variations. Plankton acts as an important link between the biological and physical components of the ecosystem. Members of the plankton are key producers and primary consumers in marine ecosystems and so population changes will have impacts on organisms at higher trophic levels, with environmental and economic consequences (BEIS 2022).

The inflowing of warm, oceanic waters is thought to be a factor promoting stratification (Drinkwater *et al.* 2003) resulting in a relatively strong seasonal cycle in the plankton community in the region. The phytoplankton seasonal cycle is bimodal, with peaks of abundance dominated by diatoms and dinoflagellates, occurring in spring and autumn respectively. The blooms decline as nutrients become depleted, while short day lengths during winter limit primary production in the region. The phytoplankton bloom will support an increase in the zooplankton biomass which will in turn support organisms at higher trophic levels. Phytoplankton that is not consumed by zooplankton during a bloom will sink to the seabed, providing a nutrient source for the benthic community.

The phytoplankton community in the central/northern North Sea is dominated by dinoflagellates of the genus *Tripos* (*T. fusus*, *T. furca* and *T. lineatus*), with diatoms such as *Thalassiosira* spp. and *Chaetoceros* spp. also abundant.

Zooplankton communities are dominated in terms of biomass and productivity by copepods, mainly Calanus species (*Calanus finmarchicus* and *C. helgolandicus*) which are an important food source for commercial fish species. Other important groups include *Paracalanus* spp., *Pseudocalanus* spp. and smaller taxa such as *Acartia* spp., *Evadne* spp. and *Oithona* spp.. Copepod abundance reaches a peak in May following the phytoplankton bloom and remains high throughout the summer, followed by a sharp decline between September and November.

The larger zooplankton, known as megaplankton, includes euphausiids (krill), thaliacea (salps and doliolids), siphonophores and medusae (jellyfish). The gelatinous taxa are poorly sampled as their bodies disintegrate on contact with the Continuous Plankton Recorder (CPR) although they are known to be more abundant in late summer and autumn (Witt *et al*. 2007, Pikesley *et al*. 2014).

Meroplanktonic (temporary plankton) larval stages of benthic organisms and fish may also form a large proportion of the zooplankton biomass at certain times of the year, particularly late summer. Important components of the meroplankton include the larvae of echinoderms (sea urchins and starfish), decapod crustaceans (crabs and lobsters) and fish. In winter, the zooplankton population is much reduced in biomass.

3.5 Habitat and Benthic Communities

In regional-scale classifications of North Sea benthos, Künitzer *et al*. (1992) indicated that benthic infaunal communities in waters north of the 70m depth contour, were typified by finer sediments and the indicator species *Spiophanes kroyeri*, *Prionospio cirrifera* and *Myriochele* spp. (polychaetes). Similarly, Reiss *et al.* (2010) identified a northern and central North Sea infaunal assemblage in water depths of 96m (range 40-185m) characterised by *Myriochele* spp., *Amphiura filiformis* (echinoderm), *Spiophanes* spp. and *Paramphinome jeffreysii* (polychaete).

Analysis of grab samples from the 2022 Trees fields survey indicate that macrofaunal community structure and abundances across the Trees and Brae A fields were generally typical of the wider CNS. *Paramphinome jeffreysii* was the most abundant taxon across the Trees fields, with the polychaete *Galathowenia* the most abundant taxon in community at the Brae A stations. *P. jeffreysii* is considered typical of the survey area and is known to inhabit muddy and sandy sediments, such as those recorded in the Trees fields survey area (George & Hartmann-Schröder 1985). *Galathowenia* is also considered typical of the survey area and is known to occur in greatest density in sandy sediments (Nilsen and Holthe 1985, Parapar 2003) which were more common within the Brae A survey area.

The macrofaunal community observed within the pre-decommissioning survey (Fugro 2022c) was described as relatively diverse, as was previously reported in both the Brae A and Trees fields survey areas (Gardline 2009, Fugro 2015, Fugro 2022b,c). Despite elevated levels of hydrocarbons being identified at some stations, moderate to high diversity was observed across all of the sites in the current survey. The stations at Birch (B-S1) and Sycamore Main (S-NE1) survey sites which exhibited a modified macrofaunal community associated with the presence of drill cuttings were discussed in Section 3.3.3. While other stations with elevated THC levels (e.g. B-W1) contained low numbers of taxa and individuals, some stations with relatively low THC levels (e.g. B-S4, SS-S1, SS-S2, L-W1) also exhibited lower numbers of taxa and individuals. It is unclear why these stations with relatively low hydrocarbon contents have reduced numbers of taxa and individuals compared to other stations but sampling and natural variability are likely explanations.

The community of the Trees fields survey areas was relatively consistent and comprised of the polychaetes *Paramphinome jeffreysii*, *Galathowenia* sp, *Levinsenia gracilis* and *Eclysippe vanelli* and the molluscs *Adontorhina similis*, *Papillicardium minimum* and *Abra nitida*, all of which are common for this part of the CNS and comparable to the previous surveys in the area.

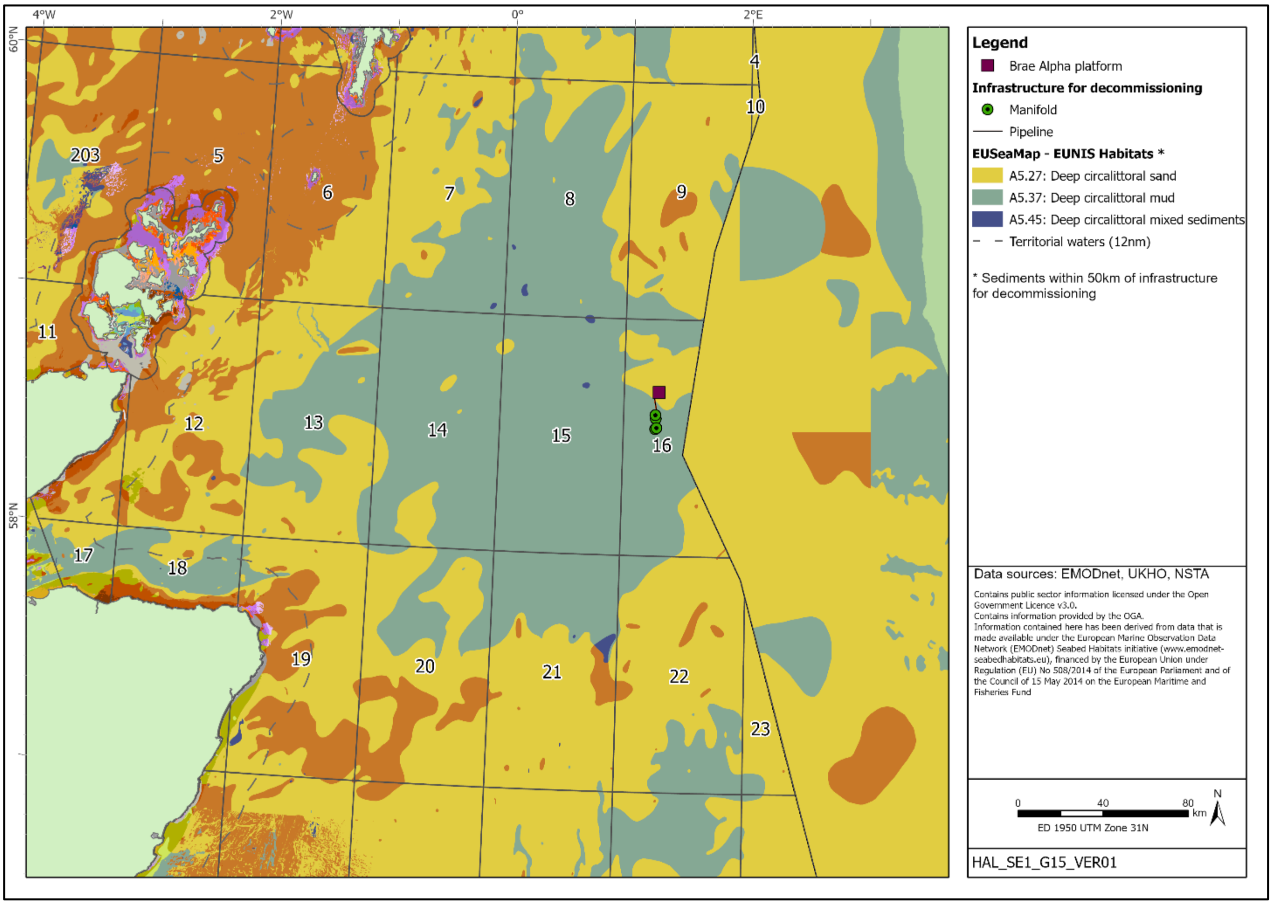
3.5.1 Habitats

In Fugro (2022a and 2022c) the grab sampling from the Trees fields stations were assigned the EUNIS classification of 'deep circalittoral mud' (A5.37), with the exception of stations B-S1 and S-NE1 which were the EUNIS classification 'Industrial waste' (J6.5) (Section 3.3.3).

Broad habitat and biotope classification was based on seabed photographic data, particle size analysis and macrofaunal composition and was consistent with the European Marine Observation and Data Network seabed habitats map (EMODnet 2022) (Figure 3-7). Seabed sediments within the Trees fields were classified as 'mud and sandy muds' with sediment samples comprising >30.6% fines content. The macrofaunal community across the area was dominated by annelids and due to the clear dominance of *Paramphinome jeffreysii* in the macrofaunal community the EUNIS classification was further refined to the biotope '*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud' (A5.376).

The biotope complex within the Brae A survey area was classified as 'deep circalittoral sand' (A5.27) with sediments being classified as 'muddy sand' and comprising <16.1% fines content (Fugro 2022a). Whilst benthic epifauna was generally sparse, the most frequently observed taxa included anemones (Metridioidea), starfish (Asteroidea including *Asterias rubens* and *Astropecten irregularis*) and hermit crabs (Paguridae).

Figure 3-7: Predicted seabed habitats within the Trees area



From the survey (Fugro 2022a), several sensitive habitats/species were identified across the Trees fields.

3.5.2 OSPAR 'sea pen and burrowing megafauna communities' Habitat

Video and still photographic data across the survey areas were analysed using the MNCR (Marine Nature Conservation Review) SACFOR (superabundant, abundant, common, frequent, occasional and rare) abundance scale to determine whether the OSPAR threatened and/or declining habitat 'sea pen and burrowing megafauna communities' habitat was present. The sea pen *Pennatula phosphorea* was recorded as 'frequent' at the majority of Trees fields survey stations (except L-S2, B-S1, S-NE1 where this species was not recorded), burrows (>15cm) were present at all stations and classified as 'abundant' at the majority of stations and other burrows (3-15cm) were classified as 'abundant' throughout all survey stations (Table 3-2 and Table 3-3). Consequently, the OSPAR designated 'sea pen and burrowing megafauna communities' habitat is considered likely to be present throughout the Trees fields survey area.

Sea pens and *Nephrops* burrows was less prevalent within the Brae A survey area, which may be attributed to the sandier sediment compared to the Trees areas.

3.5.3 OSPAR Species *Arctica islandica*

The ocean quahog *(Arctica islandica*) is known to occur within 'subtidal sands and gravels' and 'Offshore deep-sea muds' and *A. islandica* is listed as an OSPAR threatened and /or declining species. One live adult *A. islandica* specimen was recovered within a grab sample in the Larch Wye survey area (LW-NE1) and there were possible *A. islandica* siphons identified during seabed video and photography analysis at two Larch Wye stations (LW-NE1 and LW-SE1). Whole shells and shell fragments of *A. islandica* were identified at each grab station within the Larch Wye survey area. Juvenile *A. islandica* specimens were recovered within grab samples from all survey areas.

3.5.4 Other Sensitive Habitats

The majority of the sediments within the survey areas were classified as the EUNIS biotope complex 'deep circalittoral mud' (A5.37), which falls within the broad Priority Marine Feature (PMF) habitats 'burrowed mud' and 'offshore deep-sea muds', as well as the United Kingdom Biodiversity Action Plan (UKBAP) Priority Habitat 'mud habitats in deepwater'. Stations at Brae A were classified as the EUNIS biotope complex 'deep circalittoral sand' (A5.27), which falls within the broad PMF habitat 'offshore subtidal sands and gravels'.

These sediment types are widely distributed in the CNS (EMODnet 2022) and are likely to have been represented elsewhere within the Scottish marine protected area (MPA) network, including the Norwegian Boundary Sediment Plain Nature Conservation Marine Protected Area (NCMPA) and Central Fladen NCMPA (JNCC 2021a, 2021b).

Table 3-2: SACFOR assessment for sea pens and burrowing megafauna for Brae A, Larch Wye, Larch and Birch Fields

Station	*Pennatula phosphorea*	*Virgularia* sp.	Mounds	*Nephrops* Burrows (>15cm)	Burrows (3cm to 15cm)
Repeat BA01	Absent	Absent	Absent	Absent	Common
Repeat BA07	Absent	Absent	Absent	Absent	Abundant
Repeat BA13	Absent	Absent	Absent	Frequent	Abundant
Repeat BA16	Frequent	Absent	Absent	Absent	Abundant
LW-NE1	Frequent	Occasional	Absent	Abundant	Abundant
LW-SE1	Frequent	Absent	Absent	Abundant	Abundant
LW-SW1	Frequent	Absent	Absent	Common	Abundant
LW-NW1	Common	Absent	Absent	Abundant	Abundant
L-N1	Frequent	Absent	Absent	Abundant	Abundant
L-S1	Occasional	Absent	Absent	Abundant	Abundant
L-S2	Absent	Absent	Absent	Abundant	Abundant
L-S3	Frequent	Absent	Absent	Abundant	Abundant
L-S4	Frequent	Occasional	Absent	Abundant	Abundant
L-E1	Frequent	Occasional	Absent	Abundant	Abundant
L-W1	Frequent	Absent	Absent	Common	Abundant
B-S1	Absent	Absent	Absent	Abundant	Abundant
B-S2a	Frequent	Absent	Absent	Abundant	Abundant
B-S3	Frequent	Common	Absent	Abundant	Abundant
B-S4	Occasional	Common	Absent	Abundant	Abundant
B-E1	Frequent	Absent	Absent	Abundant	Abundant
B-W1	Frequent	Absent	Absent	Common	Abundant
B-N1	Frequent	Absent	Absent	Common	Abundant

Table 3-3: SACFOR assessment for sea pens and burrowing megafauna for Sycamore Main and Sycamore Satellite fields

Station	*Pennatula phosphorea*	*Virgularia* sp.	Mounds	*Nephrops* Burrows (>15cm)	Burrows (3cm to 15cm)
S-N1	Common	Frequent	Absent	Abundant	Abundant
S-S1	Frequent	Absent	Absent	Abundant	Abundant
S-S2	Frequent	Frequent	Absent	Abundant	Abundant
S-S3	Frequent	Common	Absent	Abundant	Abundant
S-E1	Frequent	Common	Absent	Abundant	Abundant
S-W1	Frequent	Common	Absent	Abundant	Abundant
S-NE1	Absent	Absent	Absent	Abundant	Abundant
ENV1	Frequent	Absent	Absent	Common	Abundant
ENV2	Frequent	Frequent	Absent	Abundant	Abundant
ENV3	Frequent	Common	Absent	Abundant	Abundant
SS-N1	Frequent	Common	Absent	Abundant	Abundant
SS-N2	Frequent	Common	Absent	Abundant	Abundant
SS-S1	Frequent	Frequent	Absent	Abundant	Abundant
SS-S2	Frequent	Frequent	Absent	Abundant	Abundant
SS-S3	Frequent	Frequent	Absent	Abundant	Abundant
SS-E1	Frequent	Occasional	Absent	Abundant	Abundant
SS-W1	Frequent	Common	Absent	Abundant	Abundant

3.6 Fish and Shellfish

Callaway *et al*. (2002) analysed catches from surveys conducted using 2m beam trawls and otter trawls to establish epibenthic and fish communities throughout the North Sea, including sampling at sites in depths of greater than 100m, in the wider Trees area. Between 100m and 200m depth, Norway pout (*Trisopterus esmarkii*) was the dominant species in the demersal community, with the hagfish (*Myxine glutinosa*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), plaice (*Pleuronectes platessa*), grey gurnard (*Eutrigla gurnardus*) and lemon sole (*Microstomus kitt*) also present. Pelagic species found in the area included herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and sprat (*Sprattus sprattus*). Many of these species are abundant in the deeper waters of the central and northern North Sea; species diversity within the fish community is not as great here as in the southern North Sea (Callaway *et al.* 2002).

Shellfish that may be found in the area include various crustaceans, the Norway lobster *Nephrops norvegicus*, the deep-water shrimp (*Pandalus borealis*) and a variety of cephalopod species. Cephalopods are short-lived, fast growing molluscs and are important elements in marine food webs. Among the most frequently recorded species in the central and northern North Sea are: the long-finned squids *Alloteuthis subulata* and *Loligo forbesii*, the short finned squids *Todarodes sagittatus* and *Onychoteuthis banksii*, various bobtail squids and the octopus *Eledone cirrhosa* (BEIS 2022).

Seabed photographs from the Trees fields survey show the presence of flatfish, hagfish, gurnard, gadoid species and *Nephrops* (Fugro 2022a).

Blocks 16/12a and 16/07 lie within ICES rectangle 46F1. This rectangle overlaps with reported spawning areas of five species (cod, mackerel, *Nephrops*, Norway pout, saithe) (González-Irusta *et al*. 2016 describes the ICES rectangles as containing 'rare' cod spawning areas) (Table 3-4) and nursery grounds for these (except saithe) and a further nine species (Coull *et al* 1998, Ellis *et al*. 2012). These features are dynamic and likely to show some degree of spatial and temporal variability (Coull *et al*. 1998) and whilst grounds are reported within the rectangle, these may not extend over the entire rectangle (e.g. Figure 3-8 and Figure 3-9 – as the infrastructure is relatively close to 45F1, this is shown in these figures for context).

Table 3-4: Fish and shellfish spawning and nursery periods for ICES rectangle 46F1

Species	J	F	M	A	M	J	J	A	S	O	N	D
Anglerfish[1]	N	N	N	N	N	N	N	N	N	N	N	N
Blue whiting[1]	N	N	N	N	N	N	N	N	N	N	N	N
Cod[1]	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Haddock	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
Herring[1]	N	N	N	N	N	N	N	N	N	N	N	N
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel[1]	N	N	N	N	S*N	S*N	S*N	SN	N	N	N	N
Nephrops	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Norway pout[1,2]	SN	SN	SN	SN	N	N	N	N	N	N	N	N
Saithe[1]	S*	S*	S	S								
Sandeel[1]	N	N	N	N	N	N	N	N	N	N	N	N
Spotted ray	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog[1]	N	N	N	N	N	N	N	N	N	N	N	N
Whiting[1]	N	N	N	N	N	N	N	N	N	N	N	N

Notes: [1]Priority Marine Features in Scottish waters (NatureScot website), [2]High concentration spawning (per Coull et al 1998). N = Nursery, S = Spawning SN = Spawning and Nursery. Sources: Coull et al (1998), Ellis et al. (2012)

Figure 3-8: Fish and shellfish spawning grounds

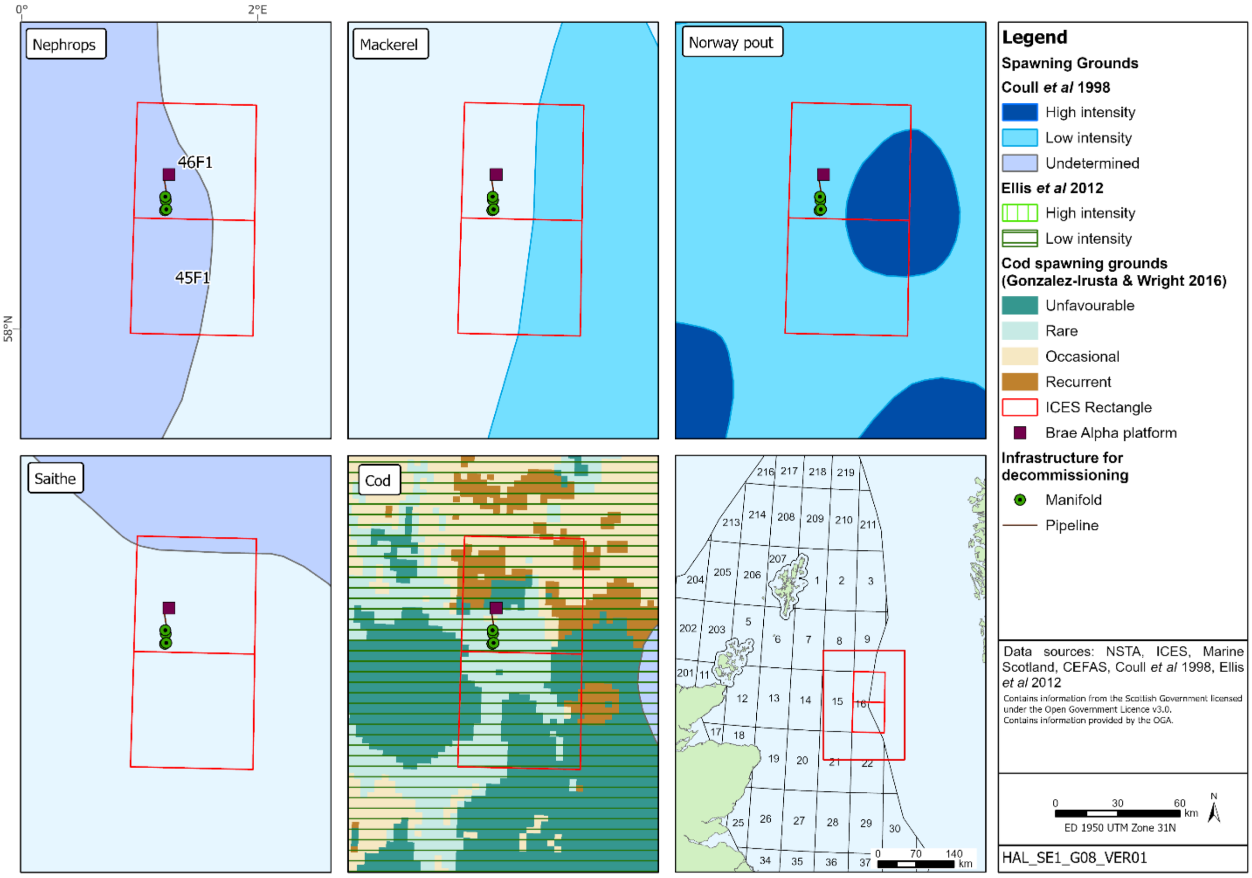
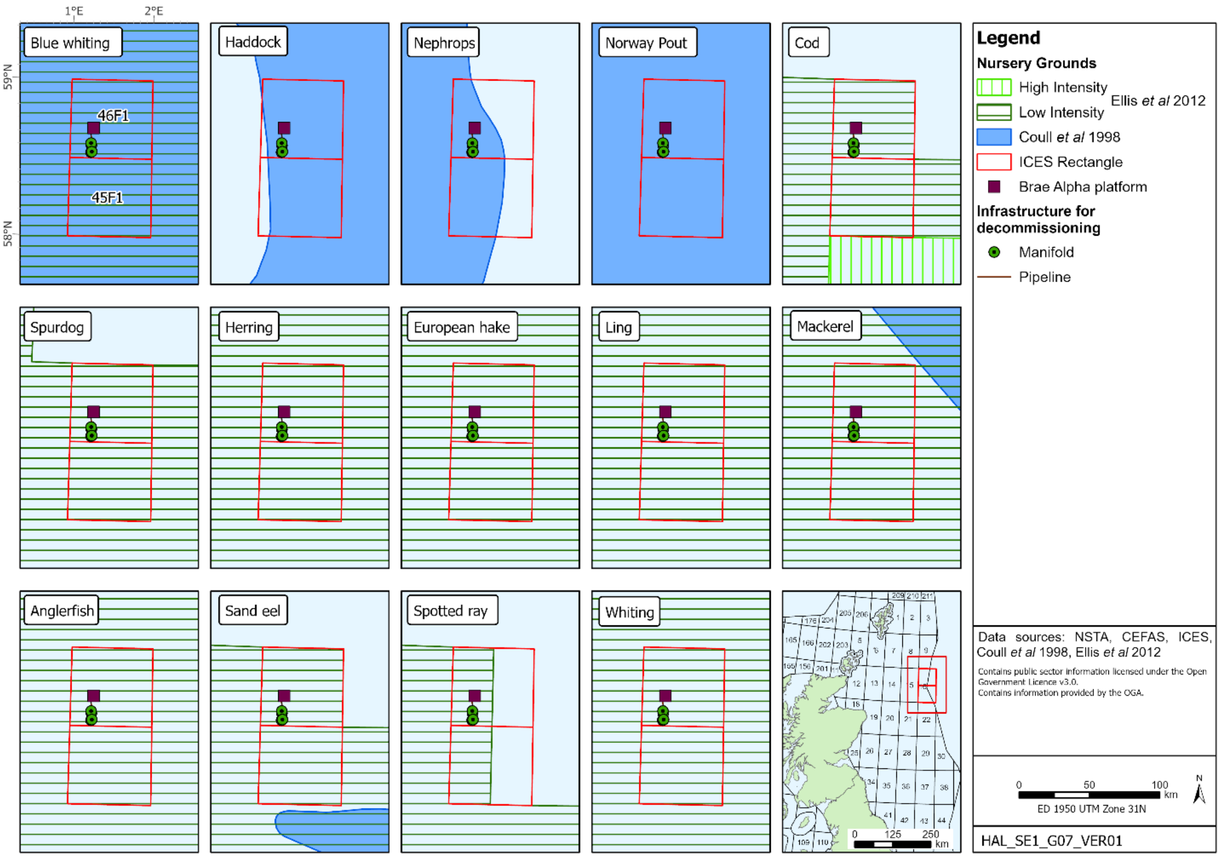


Figure 3-9: Fish and shellfish nursery grounds



All of the species with reported spawning areas over the rectangle, with the exception of *Nephrops*, are Priority Marine Features[4] (PMFs), and their spawning period may coincide with the Trees fields decommissioning activities.

Mackerel are pelagic spawners, are widely distributed in Scottish waters (Tyler-Walters *et al*. 2016) and are fast growing. North Sea mackerel overwinter in deep water to the east and north of Shetland, before migrating south to spawn between May and August (Coull *et al.* 1998, Ellis & Heessen 2015). Eggs are shed in large batches (a 200g female may produce 211,000 eggs per batch) (van Damme & Thorsen 2014) and can be found in the CNS at depths to 60 m below the surface, but the majority are found in the upper mixed layer above 26m (Coombs *et al.*1981). Following spawning, North Sea mackerel will mix with immigrant western stock mackerel in the northern North Sea feeding grounds, before returning to over-wintering sites (Lockwood 1988).

Cod and Norway pout are also broadcast pelagic spawners, both releasing eggs into the water column. Cod show a preference to spawn in waters with temperatures between 5-7ºC and high salinities, over coarse sand with a low tidal flow (González-Irusta & Wright 2015) and spawning is thought to be more widespread than suggested by Coull *et al*. 1998 (Ellis *et al*. 2012). Norway pout are generally found in waters of 80-200m over sandy and muddy substrates, but also occur in waters of up to 450m depth in the Norwegian Deep. The majority of the fish spawn for the first time when they are in their second year, but some may do so when they are one year old (Raitt & Mason 1968). During June and July, the pelagic 0-groups (fish within the first year of their lives), are thought to migrate vertically within the water column, spending most of the daylight hours close to the seabed, and moving in to midwater at night (Bailey 1975).

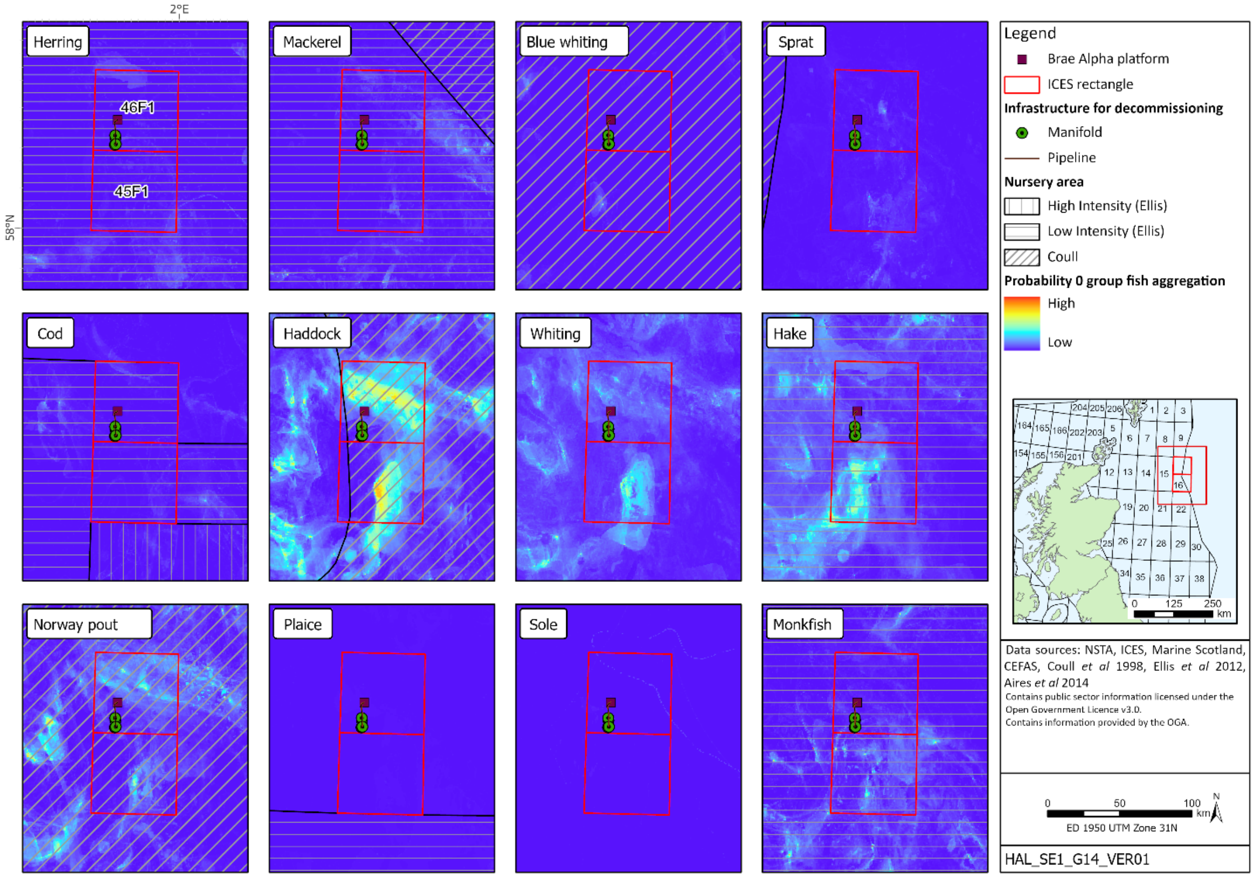
Saithe are also pelagic spawners and are most abundant at depths of between 125-200m around

[4] NatureScot and the Joint Nature Conservation Committee (JNCC), along with Marine Scotland, developed a list of Priority Marine Features in Scotland to help focus future research, planning and conservation https://www.nature.scot/professional-advice/protected-areas-and-species/priority-marine-features-scotlands-seas

north-east Atlantic coastlines, usually entering coastal waters in spring and migrating back to deeper sea in winter (Hislop *et al*. 2015). Young saithe migrate into coastal waters of the north of Scotland, Orkney and Shetland, where they remain for 3-4 years, before recruiting to stocks in the northern North Sea (Newton 1984). Abundances are greatest in the deeper waters north of the 100m contour (Hislop *et al*. 2015). Saithe spend more time moving freely through the water column and less time on the bottom than other gadoid species (Scott and Scott 1988), and these movements up and down the water column are variable with regard to season and time of day (Armannsson *et al*. 2007).

Aires *et al*. (2014) identified areas of significant probability of large aggregations of 0-group fish (fish within the first year of their lives) of juvenile haddock, Norway pout, and to a lesser extent whiting, hake and monkfish in the wider area (Figure 3-10).

Figure 3-10: Nursery and juvenile aggregation areas in the region



3.7 Birds

At an annual scale, the offshore CNS, including the Trees area, may be considered to be of moderate importance for seabirds in the context of the North Sea as a whole. This is related to the distance from breeding colonies, and the availability of prey. Seabird distribution and abundance varies throughout the year with offshore areas, in general, containing peak numbers of birds during late summer/early autumn, following the breeding season and through winter.

The most numerous species will include northern fulmar (*Fulmaris glacialis*), northern gannet (*Morus bassanus*), herring gull (*Larus argentatus*), black-legged kittiwake (*Rissa tridactyla*), common guillemot (*Uria aalge*), razorbill (*Alca torda*) and Atlantic puffin (*Fratercula arctica*) (Tasker & Pienkowski 1987, Skov *et al*. 1995, Furness 2015). Other species present include Arctic skua (*Stercorarius parasiticus*) and great skua (*Stercorarius skua*), lesser black-backed gull (*Larus* *fuscus*) and great black-backed gull (*Larus marinus*) (Batty 2008).

From January to March, northern fulmar is present in most offshore waters, with spring migration in January in most years. Herring gull, black-legged kittiwake, common guillemot and razorbill are widespread throughout the area at this time, and are among species starting to return to breeding colonies through February and March (Skov *et al*. 1995, Tasker & Pienkowski 1987).

During the breeding season (early spring/summer), the numbers of birds in offshore areas are typically low, as most birds are concentrated around colonies. Information on bird foraging ranges during the breeding season (reviews in Thaxter *et al*. 2012 and subsequently updated by Woodward *et al*. 2019) identifies species with mean maximum foraging ranges of *ca*. 209km (the approximate distance of the Trees fields from the nearest mainland coastline), which are features of Special Protection Areas (SPA) (either as qualifying interests or as part of an assemblage) present along the north east of Scotland coastline include storm petrel, northern fulmar, northern gannet and great skua (Woodward *et al*. 2019).

While the mean maximum foraging distances for these birds are large and suggest the potential for birds from many distant colony SPAs to be present in the Trees area, seabird density declines with distance from the colony with density-dependent competition, coastal morphology and habitat preferences (Wakefield *et al.* 2017). For example, oceanographic features at which seabirds preferentially forage including shelf-edge fronts, upwelling and tidal-mixing fronts, offshore banks and internal waves, regions of stratification, and topographically complex coastal areas subject to strong tidal flow (Cox *et al.* 2018), resulting in highly non-uniform distributions.

June is typically the peak of the breeding season, at which time numbers of birds offshore is low. As the breeding season comes to an end (*ca*. July), adult and juvenile birds start to disperse from colonies. In early autumn, rafts of moulting auks (common guillemot and razorbill) can be found widely dispersed in many areas of the North Sea, particularly off the eastern coast of Scotland and northern England. Atlantic puffins, which do not moult until spring, can be found concentrated around the Buchan Front, *ca*. 60-100km off the Aberdeenshire coast during this time. Young northern gannets start to leave and are flightless for a short period with areas close to colonies. Fledglings ringed on sea below a colony on Noss moved on average 60km/day during the first 10-16 days; there is also a northern gannet colony at Troup Head on the Scottish east coast (Wanless & Okill 1994, Furness 2015, Lane *et al*. 2021).

From autumn and into winter (September-December) seabirds are widely dispersed offshore, with the continuation of the southwards shift in numbers (e.g. common guillemot and razorbill) seen in early September. Large concentrations of razorbill can be found off the Moray Firth and east of the Forth and Tay, with these areas also important for Atlantic puffins (Skov *et al*. 1995). Great skuas become widespread in the North Sea as they leave their breeding sites in the Northern Isles and move south. At this time, winter visitors become more common, with the arrival of gulls (e.g. herring and great black-backed gulls) in offshore waters from Norway, to areas of the North Sea including the Fladen Ground, while little auk arrive into the (northern) and CNS from their Arctic breeding grounds (Furness 2015).

3.7.1 Seabird Vulnerability to Pollution

The vulnerability of seabird species to oil pollution at sea is dependent on a number of factors and varies considerably throughout the year. An initial vulnerability index assessed the vulnerability of bird species to surface pollution using four factors: amount of time spent on the water; total biogeographical population; reliance on the marine environment; and potential rate of population recovery (Williams *et al.* 1994, JNCC 1999)

A new Seabird Oil Sensitivity Index (SOSI) has been subsequently developed based on the previous index (Williams *et al.* 1994) and method refining according to Certain *et al.* (2015) using seabird survey data collected from 1995-2015 from a variety of survey techniques (boat-based, visual aerial and digital video aerial). The SOSI is presented as a series of monthly UKCS block gridded maps, with each block containing a score on a scale of low to extremely high; these scores indicate where the highest seabird sensitivities might lie, if there were to be a pollution incident.

The majority of the Trees fields infrastructure is located in block 16/12a, with pipelines tying back to the Brae A installation in block 16/07 and seabird sensitivity in all or parts of these blocks is low for those months with data (Table 3-5 and Figure 3-11). Data availability is highlighted by Webb *et al*. (2016) as a wider issue for the index which requires extended data coverage to be improved. JNCC devised guidance to help reduce coverage gaps (JNCC 2017).

For the relevant blocks, using data from adjacent months/blocks has been sufficient to populate further months for blocks 16/12a and 16/07, which are marked red and highlighted yellow in Table 3-5 and data for adjacent block has been used to populate May for Block 16/07, marked purple and highlighted yellow. For the remaining months (November and December, blocks 16/12a and 16/07), coverage gaps for these have been denoted by ‘N’ and highlighted yellow.

Table 3-5: Seabird oil sensitivity in and around the Trees area

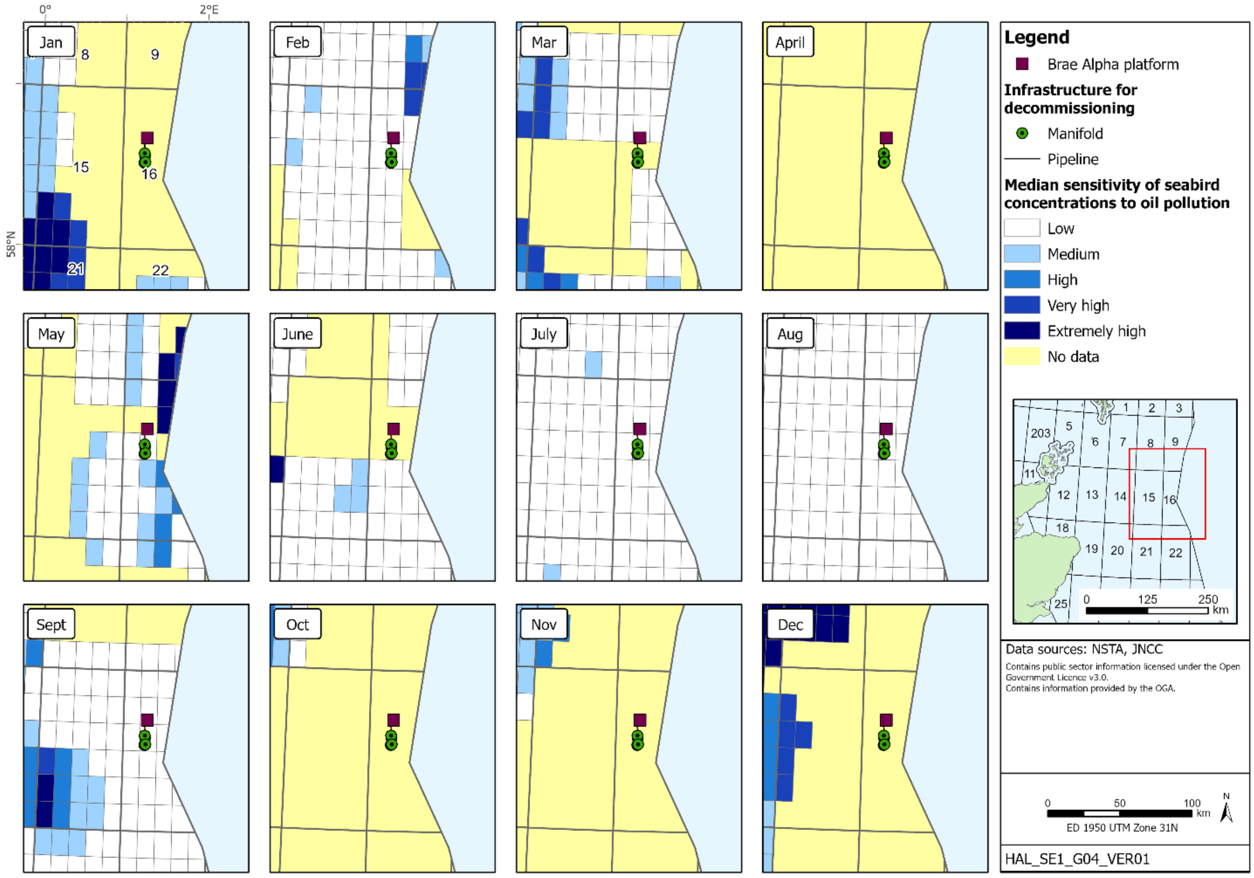
Block	J	F	M	A	M	J	J	A	S	O	N	D
16/06	5	5	5	5	N	5	5	5	5	5	N	N
16/07	5	5	5	5	1	5	5	5	5	5	N	N
16/08	5	5	5	1	1	1	5	5	5	5	N	N
16/11	5	5	5	5	5	5	5	5	5	5	N	N
16/12	5	**5**	5	5	**5**	5	**5**	**5**	**5**	5	**N**	**N**
16/13	5	5	5	N	N	5	5	5	5	5	N	N
16/16	5	5	5	5	5	5	5	5	5	5	N	N
16/17	5	5	5	4	4	5	5	5	5	5	N	N
16/18	N	5	5	3	3	5	5	5	5	5	N	N

Notes: Colour coding as follows:

1 = Extremely high	2 = Very high	3 = High	4 = Medium	5 = Low	N = No coverage

Source: JNCC 2017

Figure 3-11: Monthly seabird oil sensitivity index scores for the Trees and surrounding area



3.8 Marine Mammals

The CNS has a moderate diversity and density of cetaceans, with a general trend of increasing diversity and abundance of cetaceans with increasing latitude (Reid *et al.* 2003).

Nineteen species of cetacean have been recorded in UK waters (Reid *et al*. 2003). Whilst seven of these can be considered regular visitors to waters around the Trees area, harbour porpoise (*Phocoena phocoena*), white-sided dolphin (*Lagenorhynchus acutus*), white-beaked dolphin (*Lagenorhynchus albirostris*), minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), Risso's dolphin (*Grampus griseus*), and bottlenose dolphin (*Tursiops truncatus*) (Reid *et al*. 2003), only three of these (harbour porpoise, white-beaked dolphin and minke whale) were recorded in the area from the SCANS-IV (small cetaceans in European Atlantic waters and the North Sea) survey. SCANS-IV provides the latest, published (Gilles *et al*. 2022) information on cetacean densities in the North Sea.

The Trees area lies within SCANS survey stratum 'NS-F' which covers offshore waters of the central and northern North Sea, either side of the UK-Norway median line. Estimated densities (animals per km^2) of surveyed species in this stratum were: 0.4393 for harbour porpoise, 0.3056 for white-beaked dolphin and 0.0271 for minke whale (Gilles *et al*. 2022). These observed densities in offshore waters of the CNS are relatively low for the species concerned, particularly compared to nearshore waters or, for the harbour porpoise, designated sites such as the Southern North Sea Special Area of Conservation (SAC).

Harbour porpoise are frequently sighted throughout the CNS and while these species can be present throughout the year, peak numbers are generally recorded in summer months from June to October[5]. White-beaked dolphin sightings in the northern and central North Sea are most frequent from June to September, and during summer months minke whales are widely distributed in these areas, particularly in the west. A summary of seasonal sightings of the seven considered regular visitors (from Reid *et al*. 2003) are shown in Table 3-6.

Table 3-6: Seasonal presence of cetaceans around the Trees area

Block	J	F	M	A	M	J	J	A	S	O	N	D
Harbour porpoise		3			2	1	1	1	2	2		
White-sided dolphin		2				2	2	2	2			
White-beaked dolphin						2		2				
Minke whale					3	3	2	3				
Killer whale	3	3	3								3	3
Risso's dolphin						3						
Bottlenose dolphin						3	3	3				

Notes: Information on seasonal abundance of cetaceans is limited, so this table should be regarded as indicative of general trends only. Colour coding as follows:

1 = High density	2 = Moderate density	3 = Low density

Source: Reid et al. (2003)

[5] Cetacean sightings generally peak in the summer months, but this also coincides with typically, increased survey effort and calmer sea conditions, in which animals may be more easily visible

Both grey (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are resident in UK waters and are widespread along the coastline of eastern Scotland. The east coast of Scotland, Orkney and Shetland support important breeding colonies and haul-out sites for both species, several of which receive international conservation designations; both species are also listed as priority marine features (PMFs).

Both species are chiefly inshore and nearshore species, and although the majority of seal activity takes place in coastal waters, foraging can, particularly by grey seals, take place further offshore in deeper waters.

Model-based assessments of the at-sea distribution of these around the UK and Ireland have been derived from satellite tagging data and haul-out count data, including several dozen seals tagged at colonies on the east coast of Scotland and Orkney (Jones *et al*. 2015, Russell *et al.* 2017, Carter *et al*. 2022).

While harbour seals primarily stay within 50km of the coastline, results have shown that grey seals use prominent corridors connected to their haul-out sites, to offshore area, up to 100km from the coast (Jones *et al*. 2015, Carter *et al*. 2022).

Models of marine usage (Carter *et al*. 2020, Carter *et al*. 2022) highlight the importance of Scottish territorial waters to both species. Off the northeast coast of Scotland, higher densities of grey seals radiate out from colonies and haul-outs north of Aberdeen, the inner Moray Firth and Orkney; for harbour seals, the majority of animals in water off north east Scotland occur within the inner Moray Firth and Orkney inshore waters. The Trees fields are more than 200km offshore and therefore the presence of harbour seals is unlikely; it is possible that grey seals may be present, but only in low numbers (Russell *et al*. 2017, Carter *et al*. 2022).

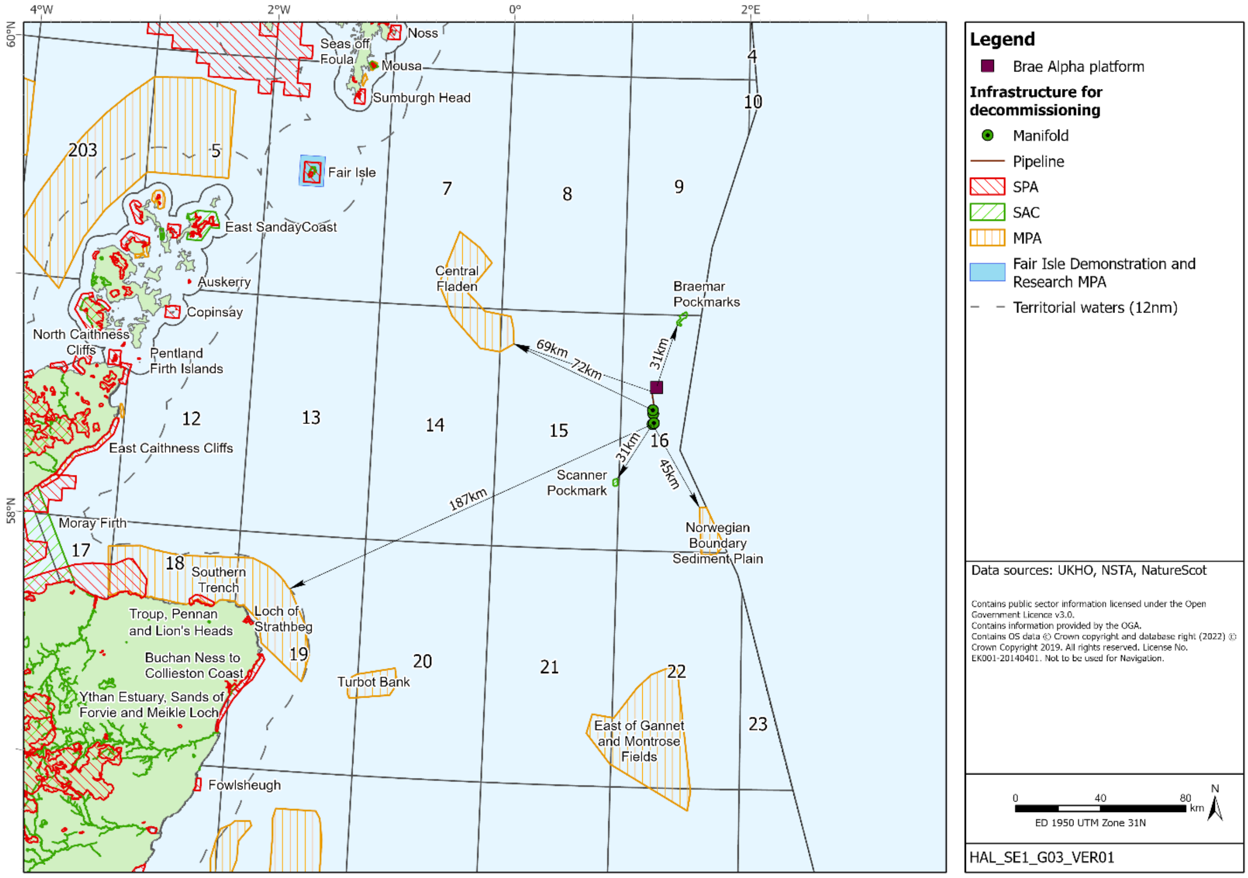
3.9 Conservation

The *Conservation of Habitats and Species Regulations 2017* (as amended) (the Habitats Regulations) and the *Conservation of Offshore Marine Habitats Species Regulations 2017* (as amended) (the Offshore Habitats Regulations) make provision for the designation of sites for the protection of habitats and species of international importance, Special Areas of Conservation (SACs) and the classification of sites for the protection of rare and vulnerable birds and for regularly occurring migratory species within the UK and internationally, Special Protection Areas (SPAs). The importance of the region is reflected in the number of SPAs and SACs designated, as well as the designation of NCMPAs under the *Marine (Scotland) Act 2010* (as amended) in Scottish territorial waters and by the *Marine and Coastal Access Act 2009* (as amended) in offshore waters.

The closest mainland coastline to the Trees fields is the north east coast of Scotland, while the closest SPA is that of Fair Isle which is *ca*. 190km to the north west; few of the species for which the site is designated would forage this distance during the breeding season, with the majority of the species expected to forage in coastal waters. The closest SACs are the Scanner Pockmark SAC and Braemar Pockmarks SAC, both *ca*. 31km from the Trees fields, and which are designated for the feature *Submarine structures made by leaking gases*.

The closest NCMPA is the Norwegian Boundary Sediment Plain (45km), designated for ocean quahog aggregations (including sands and gravels as their supporting habitat) and the Central Fladen (72km) designated for the habitat *Burrowed mud (sea pens and burrowing megafauna and tall sea pen components*) (Section 3.4) and the geomorphological feature *Sub-glacial tunnel valley representative of the Fladen Deeps Key Geodiversity Area* (JNCC website). The relevant sites and their distances to the Trees fields are shown in Figure 3-12.

Figure 3-12: Conservation sites in the wider Trees area



3.9.1 Sensitive Habitats and Species

The pre-decommissioning survey (Fugro 2022a) recorded sea pens and burrows in sufficient density to indicate the presence of the OSPAR listed threatened and/or declining habitat, *Sea pens and burrowing megafauna communities.* There was no clear pattern of spatial distribution of the two sea pen taxa across the survey areas and burrow types showed a consistently high occurrence throughout all stations in the Trees fields survey (Fugro 2022a) (see also Section 3.5).

The PMF broad habitats *Burrowed mud* and *Offshore deep-sea muds*, as well as the UKBAP Priority Habitat (JNCC 2019) *Mud habitats in deepwater* are also likely to be present within the survey area.

These habitats are widely distributed in the CNS and are represented within the UK MPA network, including the Norwegian Boundary Sediment Plain MPA and Central Fladen MPA, located more than 45km from the Trees fields.

One live adult ocean quahog (*Arctica islandica*) specimen was recovered within a grab sample at the Larch Wye survey area, with possible *A. islandica* siphons identified during seabed video and photography analysis at two Larch Wye stations. However, no further specimens were recovered and there was no further video or photographic evidence of adults or aggregations in the survey area.

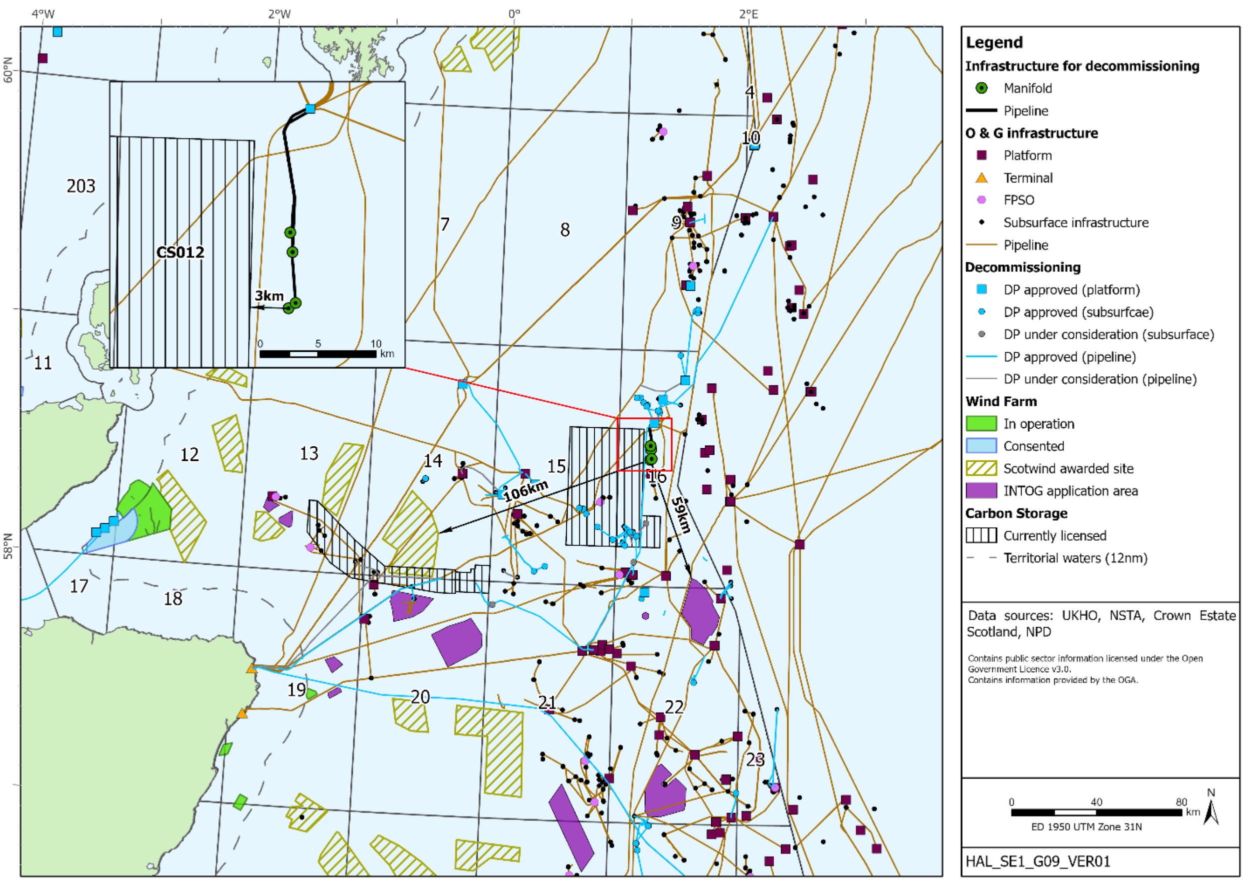
No other Annex I habitats, OSPAR threatened and/or declining species and habitats, or Scottish biodiversity list species and habitats (OSPAR 2008; JNCC 2019; NatureScot 2020) were observed within the survey areas.

3.10 Other Users

3.10.1 Offshore Energy

The Trees fields are located within an area of mature oil and gas production in the CNS, with numerous pipelines, platforms (Figure 3-13) and wells (platform and subsea) in the region. The closest surface infrastructure is the TAQA operated Brae A installation located *ca.* 13km away, to which the Trees fields are tied back. As this wider area is mature in terms of oil and gas development, there are a growing number of decommissioning projects in the region, including the Brae Bravo installation, which, along with Brae Charlie, makes up the three Brae installations in the region. There are also a growing number of offshore areas for renewable or other energy related development, including carbon dioxide transport and storage, however, there are no operational, under construction and consented wind farm developers/demonstrators in and around the Trees fields and wider area, the closest of these being the Cerulean Winds Innovation and Targeted Oil and Gas (INTOG[6]) leasing area, 59km away; the Trees area (Larch Wye) is close to (2km), and sections of the pipelines traverse through, the INTOG area of search and exclusion NE-d, however, none of the 13 projects offered exclusivity agreements are located within NE-d and it is unknown when, or if this area is to be offered again (area NE-d is not shown on Figure 3-13). The Trees fields are relatively close (*ca*. 3km) to CS012, an area awarded in the recent North Sea Transition Authority (NSTA) carbon storage licensing round.

Figure 3-13: Energy and other industries around the Trees area



[6] The INTOG leasing round from Crown Estate Scotland, is a process whereby developers can apply for the rights to build offshore wind farms specifically for the purpose of providing low carbon electricity to power oil and gas installations and help decarbonise the sector. It also provides an opportunity to enable small scale (less than 100MW) innovation projects, including alternative outputs such as hydrogen; https://www.crownestatescotland.com/resources/documents/intog-public-summary

3.10.2 Commercial Fisheries

The Trees fields infrastructure are located within ICES rectangle 46F1 and the landings (quantity and value) and fishing effort (days) for this rectangle over the period 2020 to 2022 are shown in Table 3-7 and Table 3-8 respectively (the Trees fields infrastructure are located close to the border of rectangle 45F1 and, the information relevant to that rectangle is also included). It should be noted, that the data presented includes the period of the COVID-19 pandemic, and catches may have been affected by related restrictions.

For ICES rectangle 46F1, for all three years, landings (weight) was dominated by demersal species, with shellfish dominating in terms of value in 2021 and 2022. In contrast, shellfish was the dominant catch (weight and value) in 45F1, for the whole period. In both rectangles, and throughout this period, pelagic catches have been consistently low.

Nephrops is the dominant shellfish species landed, with haddock, cod, monks/anglers, whiting and saithe accounting for the majority of the landings, although over a dozen other species are also landed.

Both rectangles account for less than 1% of the total UK landings indicating the area is of relatively low importance compared to other areas fished around the UK.

Table 3-7: Landings (quantity and value) by species type in ICES rectangles 46F1 and 45F1

Specie Type	2020		2021		2022	
	Liveweight (tonnes)	Value (£)	Liveweight (tonnes)	Value (£)	Liveweight (tonnes)	Value (£)
ICES Rectangle 46F1						
Demersal	874	1,345,455	505	876,235	466	715,191
Pelagic	0	60	-	-	0	75
Shellfish	191	459,090	365	1,187,633	384	1,968,250
Total	**1,065**	**1,804,605**	**870**	**2,063,868**	**851**	**2,683,516**
UK total	**525,685**	**642,630,058**	**538,310**	**686,074,365**	**481,398**	**684,497,956**
% of UK total	**0.2**	**0.3**	**0.2**	**0.3**	**0.2**	**0.4**
ICES Rectangle 45F1						
Demersal	364	511,061	671	1,142,617	714	1,094,748
Pelagic	1	674	0	3	0	135
Shellfish	367	904,715	948	3,069,327	844	4,009,086
Total	**732**	**1,416,450**	**1,619**	**4,211,947**	**1,558**	**5,103,969**
UK total	**525,685**	**642,630,058**	**538,310**	**686,074,365**	**481,398**	**684,497,956**
% of UK total	**0.1**	**0.2**	**0.3**	**0.6**	**0.3**	**0.7**

Notes: Landing by UK vessels into the UK ports and abroad and foreign vessels into UK. Total from summing all landings and all values from all relevant rectangles in that year and using annual total tab from official statistics spreadsheet. Source: Marine Scotland Data website

Logbooks submitted by fishermen allow an examination of the gears operated and seasonal patterns in fishing effort (Table 3-8). Over the period 2020 to 2022, fishing effort is low to moderate, accounting for less than 1% of the UK total (with exception in the neighbouring rectangle 45F1 in 2022), with highest numbers typically in spring and summer months, although in 2021 and 2022, higher numbers has also been seen towards the latter part of the year.

Table 3-8: Number of days fished per month (all gears) in ICES rectangles 46F1 and 45F1

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total	UK Total	% of UK Total
ICES Rectangle 46F1															
2020	14	8	32	12	7	23	49	65	14	34	90	11	358	103,842	0.3
2021	7	20	37	9	6	D	50	194	20	60	25	D	437	105,642	0.4
2022	5	9	13	20	6	165	91	65	72	41	D	D	487	94,467	0.5
ICES Rectangle 45F1															
2020	D	D	208	50	D	10	17	19	9	111	9	D	446	103,842	0.4
2021	4	126	110	111	D	-	221	43	D	121	230	D	972	105,642	0.9
2022	D	D	20	81	D	290	166	135	196	141	D	D	1,037	94,467	1

Notes: Monthly fishing effort by UK vessels >10m, days fished includes time travelling within rectangles; green = 0-50 days fished, yellow = 51-100, orange = 101-150, blue = 151-200, red = >200, D = disclosive and - = no data. Sources: Marine Scotland Data website

Figure 3-14 and Figure 3-15 illustrate the landings weight and value in 46F1 and surrounding ICES rectangles for 2018-2022 for each species type. It shows landings from the rectangle to be in general, lower in comparison.

Figure 3-14: Fisheries landings (weight) for ICES rectangle 46F1 and surrounding rectangles

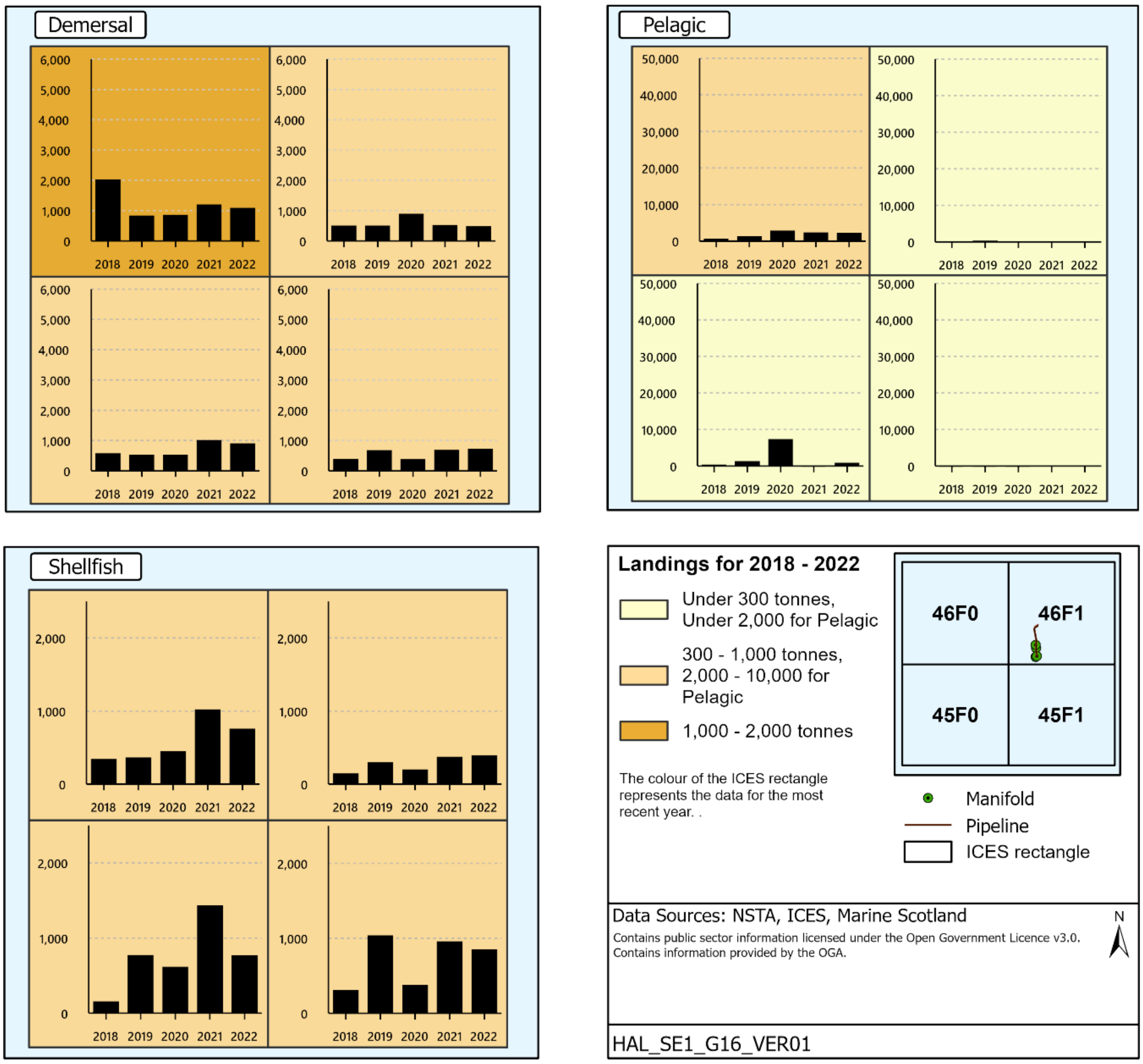
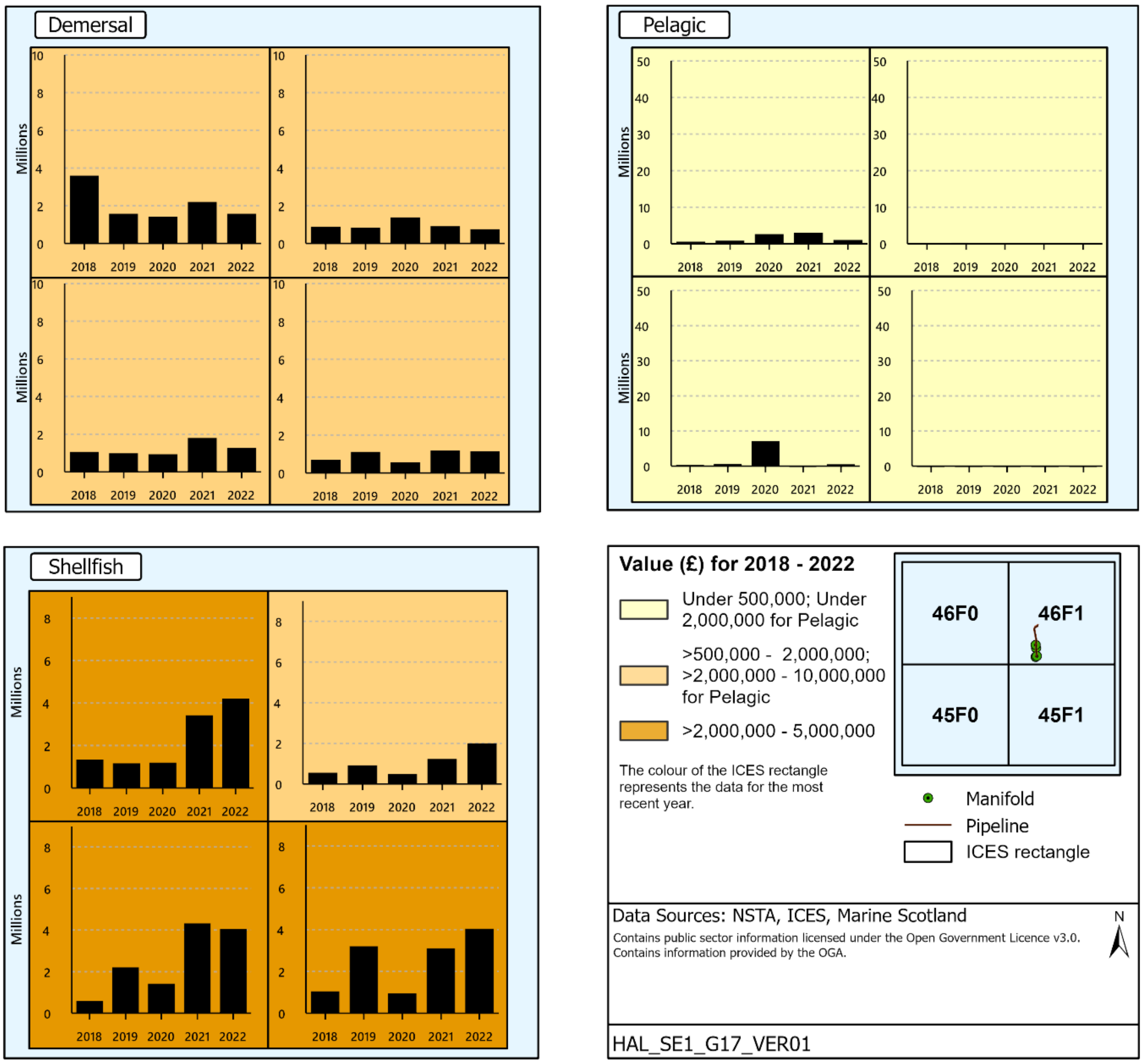


Figure 3-15: Fisheries landings (value) for ICES rectangle 46F1 and surrounding rectangles



Vessel Monitoring System (VMS) data show moderate levels of fishing effort in the Trees area for UK vessels (Figure 3-16); a closer examination of the fishing intensity (Figure 3-17 and Figure 3-18) further shows the most common gears used in the area are bottom trawl, typically targeting demersal fish species and *Nephrops*.

Figure 3-16: Fishing effort vessels landings (all gears combined)

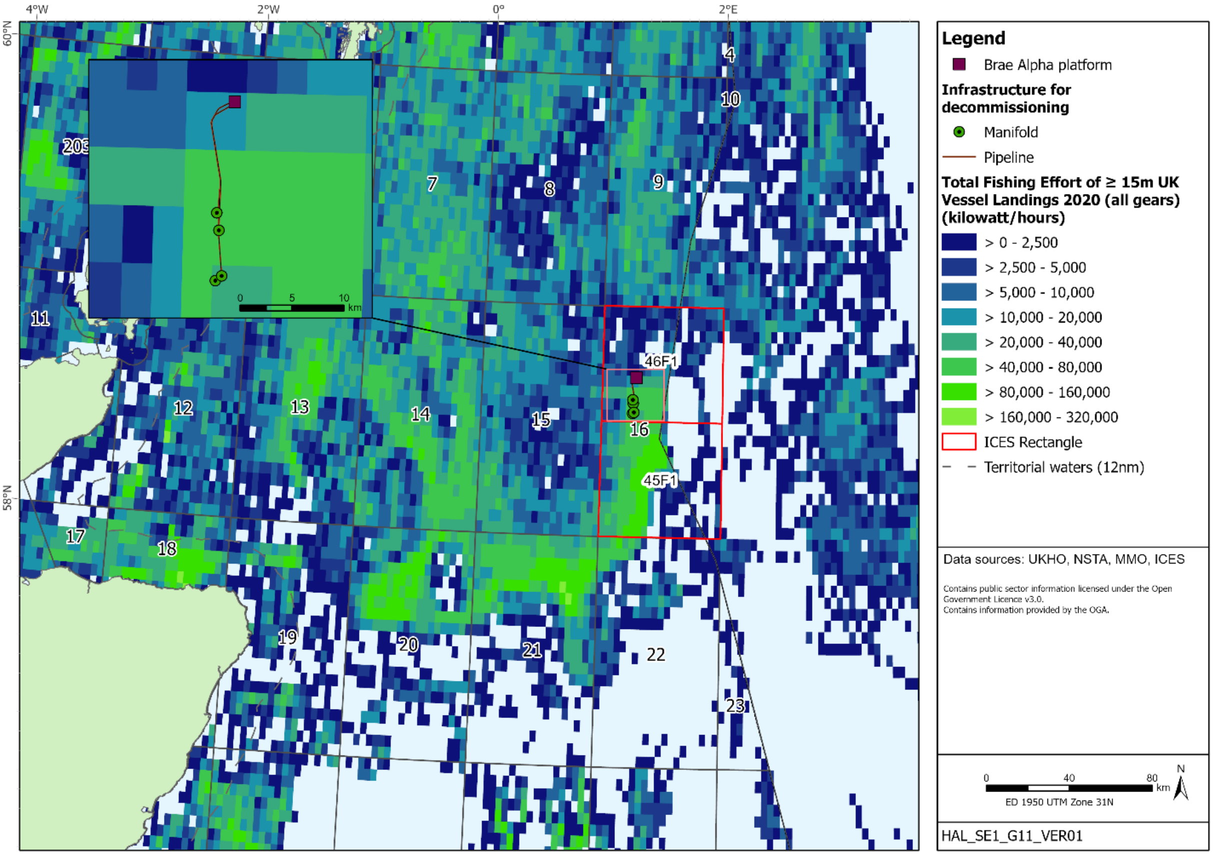


Figure 3-17: Fishing effort vessels landings (all gears split out)

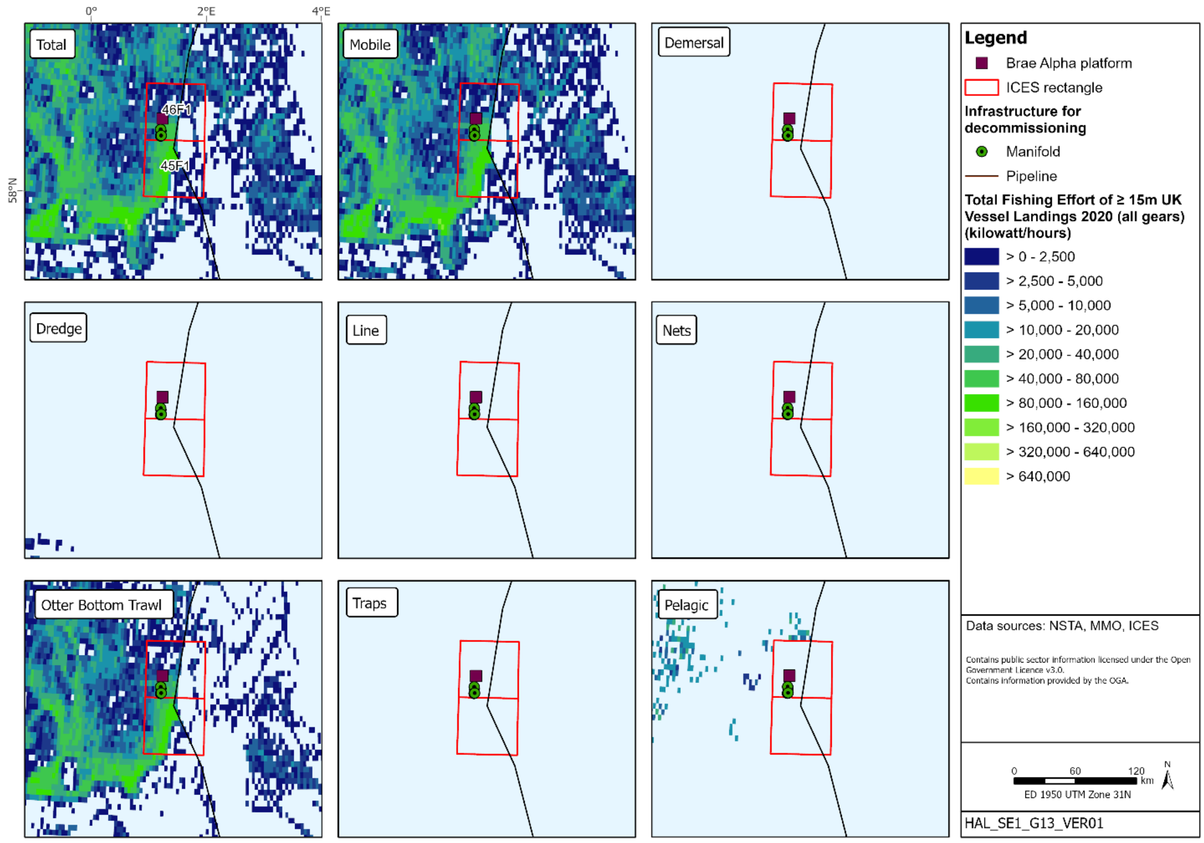
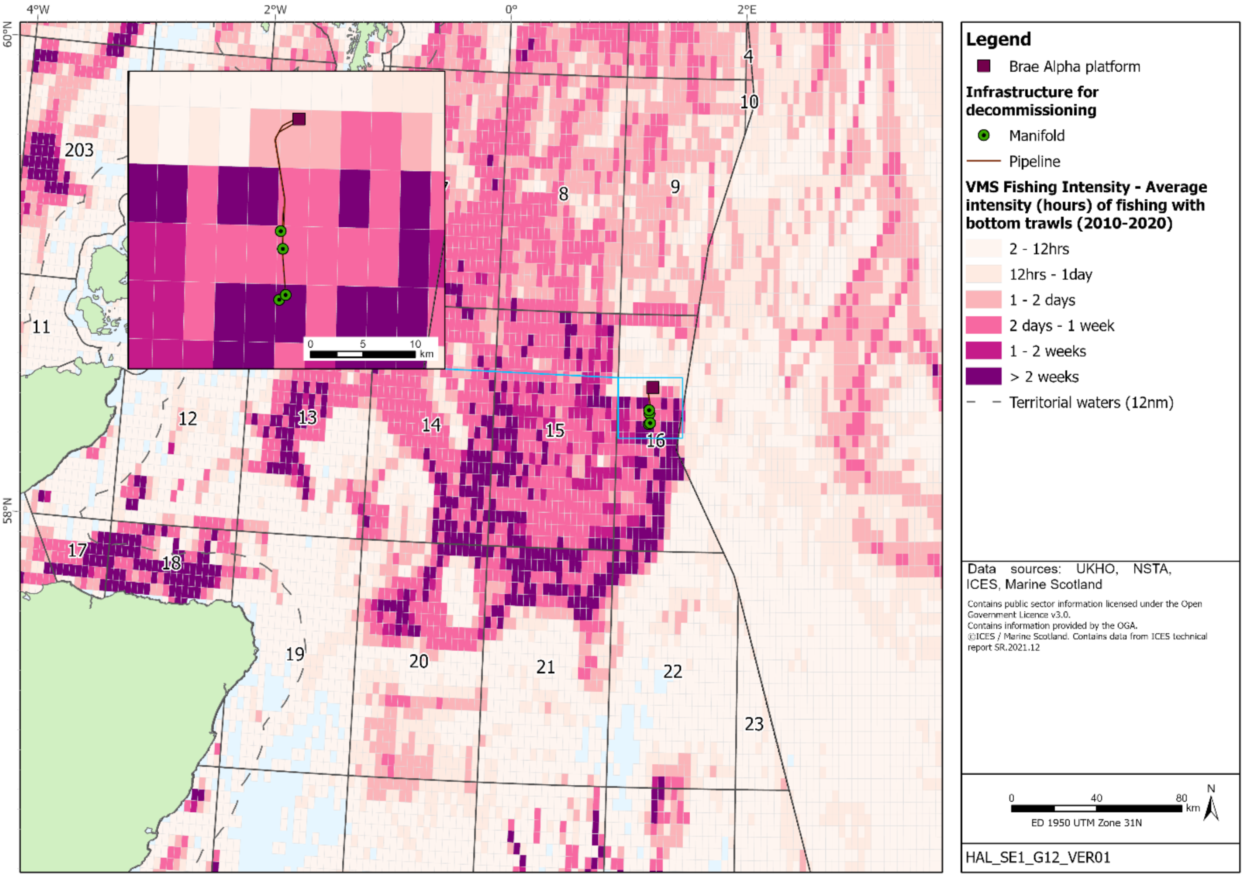


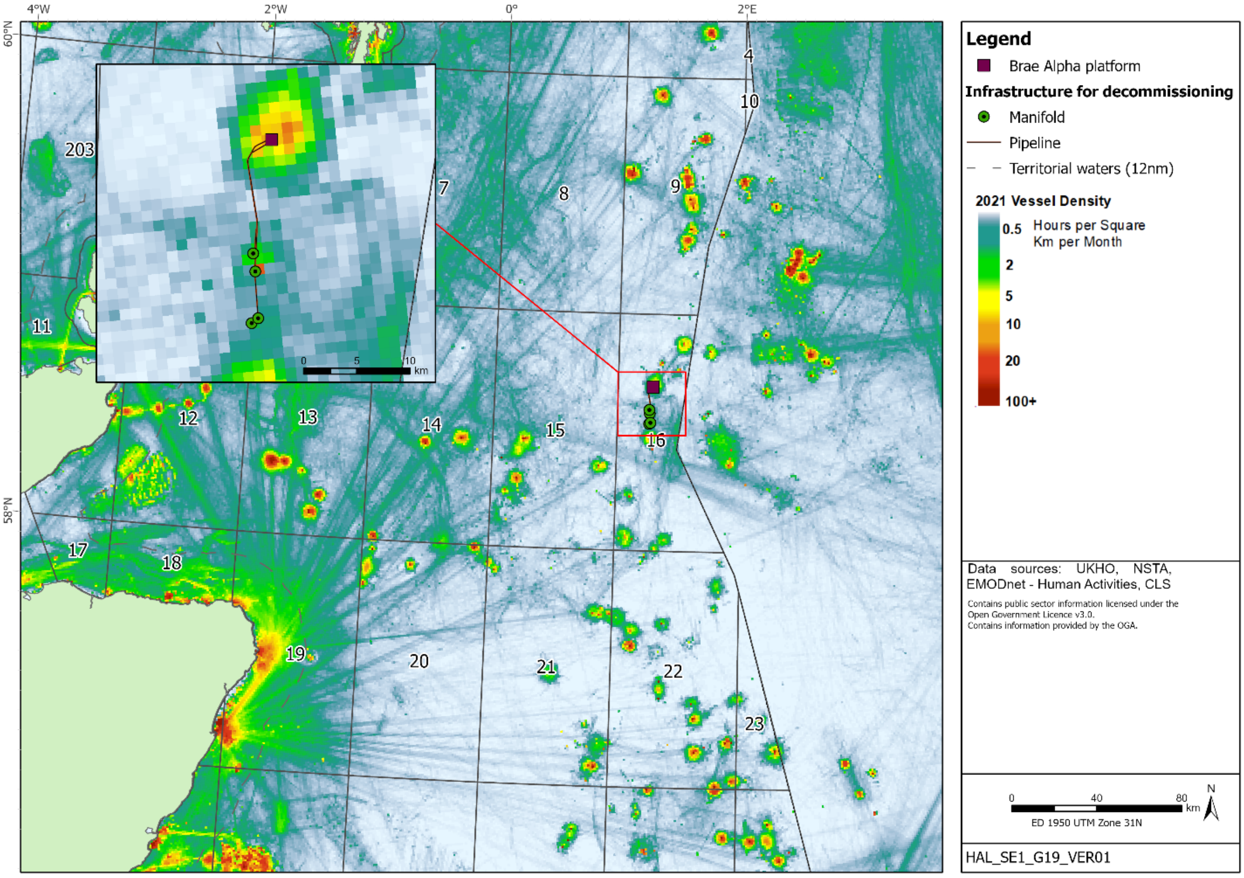
Figure 3-18: Fishing average intensity (bottom trawls) over the period 2010-2020



3.10.3 Shipping Traffic

Shipping density data (NSTA website[7]) shows block 16/12a as having moderate, and block 16/07 having low levels of shipping; vessel density around the Trees area is shown in Figure 3-19. Typical vessels in the area are likely to be oil and gas supply and support vessels, the routes of the majority of which are expected to originate from service ports in Peterhead and Aberdeen.

Figure 3-19: Vessel density around the Trees fields and the wider North Sea area



A review of a vessel traffic survey will be carried out and will support the environmental permit applications for the decommissioning activities; these will be completed and submitted to the regulator at a future date and prior to commencement of offshore activities.

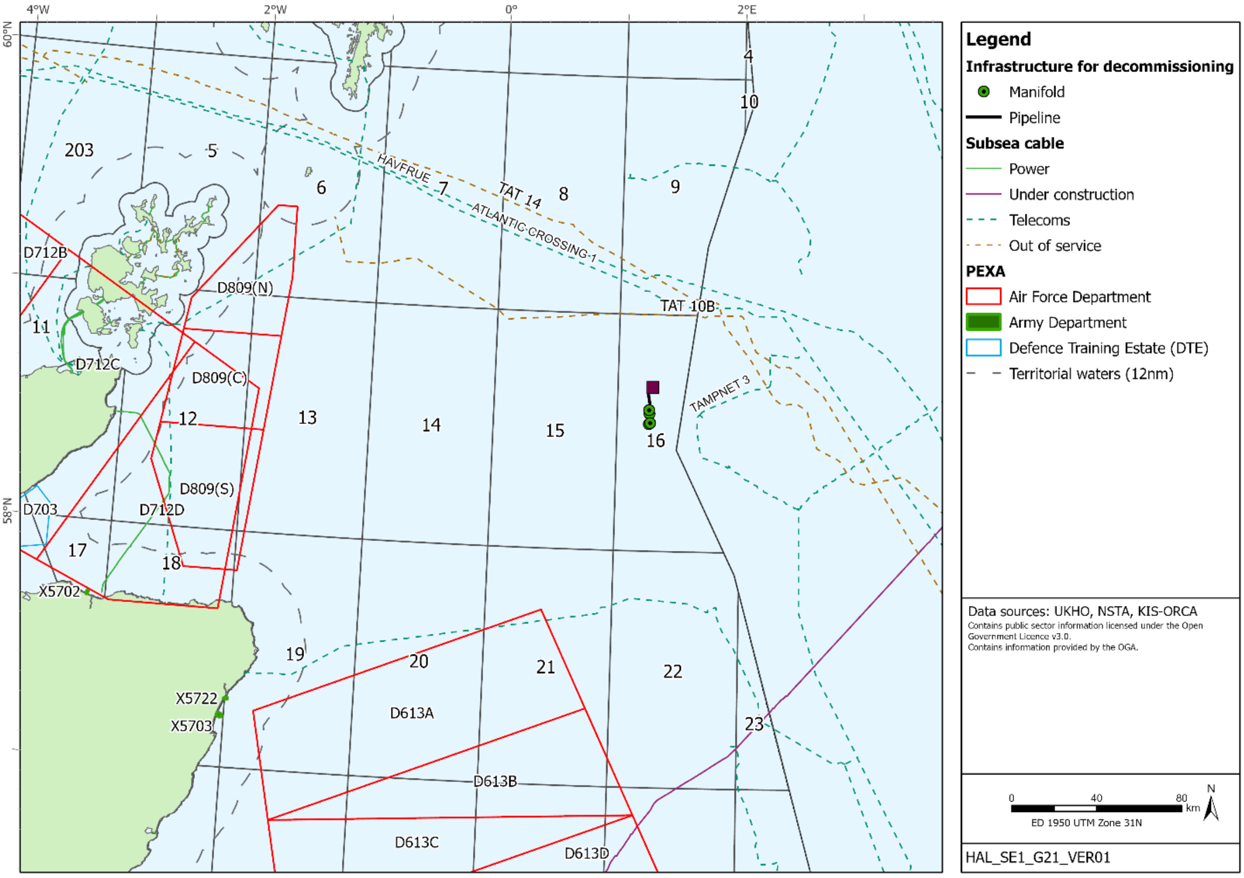
3.10.4 Telecommunication Cables, Military Areas and Wrecks

There are no telecommunication cables, military areas or designated wrecks in the Trees area (Figure 3-20). The closest service cable to the Trees fields is the Tampnet 3 cable, *ca.* 22km from the Sycamore Manifold and the closest military area is the D613A practice area, *ca*. 100km from the Trees area.

There are no known wrecks within the immediate vicinity of the Trees area (NMPi 2018, UKHO website).

[7] NSTA licensing round information: https://www.nstauthority.co.uk/media/1419/29r_shipping_density_table.pdf

Figure 3-20: Cables and MoD areas around the Trees area



4 ENVIRONMENTAL IMPACT SCOPING

The activities associated with the decommissioning of the Trees fields have the potential to affect the environment in a number of different ways, such as physical disturbance to the seabed or other users, generation of underwater sound, discharges to sea and atmospheric emissions.

Spirit Energy have a defined process for environmental management throughout the project lifecycle which provides a framework for environmental impact assessment of the project from the planning phases to execution (Spirit Energy 2018). This process ensures that environmental impacts associated with the project activities are identified, assessed and appropriately managed to minimise the impact to as low as reasonably practicable (ALARP) through design.

4.1 Method

Spirit Energy held an Environmental Impact Identification (ENVID) workshop (the workshop) to identify project activity / environmental interactions (known as environmental aspects) and to assess the potential scale of these impacts.

In line with OPRED Decommissioning Guidance Notes (BEIS 2018), the ENVID and this EA assess the impacts associated with planned offshore activities associated with the recommended decommissioning option. Consequently, this EA does not consider activities such as onshore waste management, unplanned / accidental events such as spills from vessels, or activities associated with other options considered within the comparative assessment for pipeline decommissioning.

The description of the environmental baseline including specific environmental sensitivities, and an appropriately detailed description of the project activities, form the basis of the environmental assessment. During the workshop, decommissioning activities were systematically considered by a multidisciplinary team (including representation from the project manager, discipline engineer, environmental advisor and environmental consultants) for their potential interactions with the environment in the context of legislative and policy requirements.

Impacts were assessed assuming that standard industry control measures would be in place. As described in the Spirit Energy environmental management framework, the scale of the environmental impact is a function of its estimated extent and the duration (recovery time), which are combined in the Spirit Energy impact assessment matrix to indicate the severity of the impact (Table 4-1 and Table 4-2).

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Table 4-1: Criteria for the identification of potential significance of environmental effects from the Trees fields decommissioning activities

Impact Significance Matrix			Benefit	Duration of Harmful Effect				
				Within 1 month	Within 1 year	<3 years	>3 years or >2 growing seasons	>20 years
				1	2	3	4	5
Extent of Harmful Effect to Habitats and Species	5	Large area of habitat and/or large number or proportion of population or species impacted	P	Minor	Moderate	Significance	Major	Catastrophic
	4	Moderate area of habitat and/or moderate number or proportion of population or species impacted	P	Negligible	Minor	Moderate	Significance	Major
	3	Small area of habitat impacted and/or small number or proportion of population or species impacted	P	Negligible	Minor	Minor	Moderate	Significance
	2	Change in within scope of existing variability (or acceptable mixing zone) but potentially detectable or all within the site boundary / 500m safety zone (78.5 hectares)	P	Negligible	Negligible	Minor	Minor	Moderate
	1	Effects are unlikely to be noticed or detectable.	P	Negligible	Negligible	Negligible	Negligible	Negligible

P	Positive – positive or beneficial impact	Medium	Impact is tolerable but to be managed to ‘as low as reasonably practicable’
Low	Impact broadly acceptable and considered ‘as low as reasonably practicable’	High	Impact intolerable without control and mitigation measures required to be reduce impacts to ‘as low as reasonably practicable’

Table 4-2: Impact significance severity scale and environmental consequences

Significance of Impact	Significance Severity Scale	Consequence
P	Positive	Positive or beneficial impact
L	Negligible	Negligible environmental impact
M	Minor	Minor environmental impact on site or to lower value environment with short term natural recovery
M	Moderate	Moderate environmental impact in neighbouring area. Longer term natural recovery or minor remediation intervention
H	Significant	Significant environmental impact on local area. Long term natural recovery or moderate remediation intervention
H	Major	Major environmental impact to regional or high value environment requiring protracted remediation
H	Catastrophic	Catastrophic environmental impact which is widespread or affects a highly sensitive valuable environment requiring long term remediation.

Table 4-3: Significance of potential environmental effects from the Trees fields DP

Trees Decommissioning Activity	**Atmospheric Emissions**	**Discharge to Sea**	**Seabed Disturbance**	**Physical Presence**	**Underwater Sound**	**Resource Use**
Vessel transits						
Vessel working on Trees fields location						
Removal and recovery of manifolds, , crossover bundle assembly, Larch Wye-piece assembly, Larch T-piece, spools (not in drill cuttings location)						
Removal of mattresses, grout bags.						
Remediation of 37m of PL1527 to protect a shallow trenched (<0.6m depth) section of pipeline (trenching / dredging using mass flow excavation, or addition of rock cover).						
Remediation of 37m of PL1527 to protect a shallow trenched (<0.6m depth) section of pipeline (cut and remove).						
Disturbance of historic drill cuttings during removal of the spools and jumpers at Birch and Sycamore Main.						
Remediation of cut pipeline ends within the trench using deposited rock or trenching via mass flow excavator.						
Cutting pipelines and spools - shears or diamond wire.						
Discharges of seawater and hydraulic fluid from cut ends of trenched pipelines and umbilicals.						
Discharges from surface laid spools, pipeline and umbilical sections during recovery.						
Trenched pipelines and umbilicals decommissioned *in situ*						
Seabed clearance surveys and over-trawl trials to demonstrate clear seabed, disturbance to cuttings piles.						
Removal of 500m safety zones.				P		
Release of residual hydrocarbons and chemicals remaining in trenched pipelines and umbilical's following degradation[1].						
Disturbance of cuttings piles and contaminated sediments by fishing gear once safety zones are removed.						

Notes: [1].Pipelines will degrade over time (months/years); the expected timeline for this has not been calculated/estimated as part of this assessment.

5 CONSIDERATION OF ENVIRONMENTAL EFFECTS

5.1 Potential Effects Considered Minor

Table 5-1 lists those sources of effects (aspects) identified during the ENVID workshop (Section 4) that were considered minor, and which were not, as a result, assessed further in the appraisal.

Table 5-1: Environmental effects considered minor

Environmental Effect	Consideration
Planned Vessel Usage and Subsea Decommissioning	
Physical presence	Potential disruption to fishing and shipping activities from the presence of project vessels. Impacts from vessel transits to site will be temporary as vessels move through an area within hours. Vessels working in the fields will largely be located within the existing 500m safety zones and would not pose additional disturbance to fishing or shipping activities while in the zone. Some short duration activities (days) are required out with the 500m safety zones to remediate pipeline sections, these are of relatively short duration. Operations are within an area of existing oil and gas associated shipping movements and decommissioning will represent a small increment to existing traffic, and the duration of vessels working on site and transiting will be minimised through project execution schedules. The timing and nature of the work will be communicated to other users through the Kingfisher Bulletins issued prior to activities commencing. Significant environmental effects are not considered likely.
Underwater sound	Noise sources from the proposed activities include vessel noise (including over-trawl survey vessel), noise from cutting of infrastructure (end of pipelines and piles), and depositing rock. Potential, temporary, disturbance to marine mammals from sound sources. Vessel noise sources are non-pulsed and continuous in nature. Transiting vessels will have very short term impacts within a specific area, vessels within the Trees fields will be working within localised areas (i.e. pipeline ends) for relatively short durations. Duration of vessels working on site and transiting will be minimised through project execution schedules Cuts to separate pipelines and spools will be limited in number, short in duration (less than one hour per cut), and phased between fields and cutting piles below the seabed will be short in duration (less than an hour per pile, max 23 piles spread over 3 locations) and staggered in over time due to the different locations of the structures. Sound generated by diamond wire cutting may not be discernible above the background vessel sounds (Pangerc *et al*. 2016). Sound generated from cutting will add generally to the overall ambient noise in the wider Trees area and may result in some temporary influence on the behaviour of individual marine mammals in the vicinity of operations. Installation of deposited rock is likely to produce underwater sound, however, measurements of depositing rock from a subsea rock installation vessel found no evidence that the installation of deposited rock contributed to the sound level above that of the vessel (Nedwell and Edwards 2004) Duration of vessels working on site and transiting will be minimised through project execution schedules and planning an efficient cutting regime will minimise cutting duration. Any impacts associated with underwater noise will be short term, localised, and in the context of existing levels of shipping activity in the region. Any impact generated as a result of decommissioning activities, will cease once decommissioning activity in the area is complete. Significant environmental effects are not considered likely.

Environmental Effect	Consideration
Discharges to sea	Discharges will be associated with pipeline cleaning and flushing, and any re-suspension of cuttings. Discharges from pipeline cleaning and flushing will be relatively small, with chemicals used selected for best environmental performance where technically feasible to do so. Flushing will be back to the Brae Alpha and discharged through process systems on the installation; chemical use and discharge quantities for cleaning (i.e. gels) are typically small, (e.g. a few hundred kgs) and chemical types are well used within the industry and generally Gold banded chemicals. Flushes are then continued with seawater, with pipelines typically left filled with seawater. The cuttings piles present at the Trees well locations are such that the rate and persistence are below the OSPAR thresholds and no other discharges have contaminated the cuttings piles, therefore, no further action is necessary and the cuttings may be left *in situ* to degrade naturally (OSPAR 2006). Removal of the Birch manifold and jumpers at the Sycamore Satellite wells are likely to result in small quantities of drill cuttings being resuspended into the water column, exposing pelagic and benthos fauna to increased toxicity and potential smothering, although this latter impact is expected to be localised; currents at the Trees area are not particularly strong limiting natural dispersion of cuttings piles, for example compared to the southern North Sea, where currents are stronger and natural dispersion occurring over a wider area, . Any dissolved organics will be rapidly diluted and disperse within the water column. Discharges will contribute to local water quality changes and associated interactions with water column biota. Discharges will be small, and considering the offshore location, local waves / current action and water depth, discharges are expected to be readily diluted and dispersed. Disturbance of drill cuttings will be minimised where possible through execution planning and engineering. Vessels will meet MARPOL requirements and will adhere to sewage, waste and ballast water management plans. The project will adhere to Spirit Energy's Marine Assurance Standard to verify all vessel contractors meet regulatory requirements. Significant environmental effects are not considered likely.
Resource use	Use of diesel fuel and the leaving of material *in situ* such that it will not be subject to f re-use/recycling, are the main sources of resource use from the Trees fields decommissioning activities. Trees fields decommissioning is a relatively short campaign (*ca*. 2-3 months, with short duration ongoing survey activities), with a small number of vessels such that project fuel consumption will not influence the global fuel supply. Duration of vessels working on site and transiting will be minimised through project execution schedules. The majority of the pipelines and umbilicals will be decommissioned *in situ*, and as such the steel associated with these lines will not be available for recycling and future use and will be an unavailable resource. However, the quantity of material estimated to be decommissioned *in situ* is relatively small at 8,133 tonnes and considered negligible in terms of an unavailable resource. Significant environmental effects are not considered likely.
Waste production	Materials returned to shore for processing and landfill will be processed at approved facilities. Relatively small quantities of materials will be returned to shore and the majority of material (*ca*. 90% steel) will be readily recyclable. The project will adhere to the Waste Framework Directive and Spirit Energy's Marine Assurance Standard. Spirit Energy will ensure the selected port and decommissioning yard will have the appropriate environmental and operational licenses and consents to receive and process the material. Significant environmental effects are not considered likely.
Material Decommissioned *In Situ*	
Physical presence (removal of 500m safety zones)	Beneficial impact - potentially increasing the area available to fisheries.
Discharges to sea	The production and gas lift pipelines will be flushed and cleaned using inhibited seawater to an

Environmental Effect	Consideration
	agreed acceptable cleanliness level (leaving only residual chemical/hydrocarbon in the pipeline) and left with seawater. At initial disconnect when the pipelines are left open to sea and over time as the pipelines degrade, the seawater will discharge to the marine environment. This will result in a small volume of residual chemical and hydrocarbon being discharged to sea (this will be the chemical and hydrocarbon contained within the seawater, the maximum volume of which will be based on the length and diameter of the pipelines and assuming an oil in water content of the line). Oil in water (OIW) concentrations after cleaning and flushing are typically less than 10mg/l, however, when detailed assessments for this are submitted, a higher concentration is normally assessed to represent worst case. Sampling as part of the cleaning and flushing programme will provide a more accurate OIW concentration for chemical permit assessment. This discharge will occur over a long period of time, as the pipelines degrade and once complete, no other discharge will be associated with the pipelines. The hydraulic and chemical cores from the umbilical will not be flushed and an initial discharge will occur at disconnect with the cores fully discharging over a prolonged period of time as the umbilical degrades. Although this discharge will be 100%, these cores are typically small diameter (the Trees field cores are of various (outer) diameters, e.g. 9mm, 15mm, 19mm) and the volume discharged will be in the order of 8.5m^3 and will just be that present in the lines (based on length and diameter of the cores multiplied by number of used cores), with no further discharge associated with the cores. Typically the chemicals present have discharges associated with them during operational life, and additional discharges from these cores are unlikely to represent a significant increase in this discharge. During normal operational life, hydraulic fluids may not be discharged (i.e. where used in a closed loop system), however, in many cases, discharges can be included in operational chemical permits for discharges associated with valve actuation. Although the discharge associated with the decommissioning of the Trees fields will be larger (overall) than that typically included in an annual chemical permit, this will occur over a prolonged period of time as the umbilical degrades and once discharged, there will be no further discharge of hydraulic fluid associated with these umbilicals. Oceanic HW443ND is an OCNS D product (one category above E, the most preferred ONCS category, and as a D category chemical, under chemical permit conditions, does not typically require additional justification, this applicable to OCNS C, B and A). In addition, Oceanic HW433ND does not contain any components identified for substitution or any other warning labels, indicating the discharge of this chemical would not result in a significant impact on the marine environment. All of these discharges will be risk assessed as part of the environmental (chemical) permits required. Discharges will contribute to local water quality changes and associated interactions with water column biota. However, discharges will be relatively small (the maximum discharges will just be those present in pipeline and umbilical core volumes), are expected to be readily diluted and dispersed and once completed, no further discharges will be associated with these pipelines and umbilicals. The cuttings piles present at the Trees well locations are such that the rate and persistence are below the thresholds (OSPAR 2006) and no other discharges have contaminated the cuttings piles, therefore, no further action is necessary and the cuttings may be left *in situ* to degrade naturally (OSPAR 2006). Recovery of the sediment following the deposition of material is dependent on a number of factors, including depth of deposition (the cuttings piles at Trees are relatively small), rates of biodegradation of organic chemicals in the sediment, the resuspension and re-distribution of material through currents and wave action (Trees are not located in a particularly high energy area, i.e. compared to the southern North Sea) and time for recolonization of biota. As fishing activity may resume over the cuttings pile locations (after removal of the 500m safety zones from where it was excluded), there is the potential for trawling to result in the re-distribution of cuttings, and the release of contaminants into the water column. This activity will result in the release of contaminants but will also aerate the cuttings, allowing additional aerobic degradation.

Environmental Effect	Consideration
	Potential impacts include uptake of contaminants in the plankton and benthos and bioaccumulation of contaminants in fish that consume these. Such effects are expected to be localised and short term (i.e. fish are likely to metabolise oils quickly and unlikely to be significantly affected in the medium to long term (OSPAR 2019). Studies have found that, using heavy monkfish trawls on a cutting pile in the Moray Firth did distribute cuttings, but not at a level or rate that would *pose serious wider contamination or toxicological threats to the marine environment* (OSPAR 2009), with the act of spreading encouraging aeration of material and enhancing degradation. Fishing gear was typically found to re-suspend the equivalent of 1mm depth of seabed sediment, while the contaminant content of the top layer of a cuttings pile (~100mm) is expected to be low, having already been subject to natural weathering and biodegradation (anaerobic degradation may take place down to ~20-50cm over time, with contaminants in the deeper parts of the pile remaining unchanged). The Trees cuttings piles have been *in situ* since the mid 1990s (Birch) and early 2000s (Sycamore) therefore some natural degradation will have occurred. Significant environmental effects are not considered likely.

5.2 Potential Effects Considered Further

Table 5-2 lists those sources of effect (aspects) and interactions identified during the ENVID workshop (Section 4) that were considered to have the potential to cause significant effect and were, as a result, assessed further in the appraisal (Section 6).

Table 5-2: Environmental effects considered further

Environmental Effect	Potential Source of Environmental Impact (Project Activity)	Section
Seabed disturbance[1]	• Removal of subsea infrastructure and moving aside/removal of protective material • Trenching/backfilling of cut pipeline ends • New deposited rock	6.1
Atmospheric emissions[1]	• Vessel power generation	6.2

Notes: [1].Potential cumulative impacts from seabed disturbance and atmospheric emissions, as a result of decommissioning activities have been addressed in Section 6.4, Table 6-6 (see Table 5-3 below).

Two environmental aspects were assessed for the potential to result in any in-combination or cumulative impacts from both within the Trees fields decommissioning project activities and together with activities from other existing, current or reasonably foreseeable projects (including other oil and gas activities and activities associated with other industries e.g. windfarm, commercial fisheries) (Table 5-3).

Table 5-3: Transboundary and cumulative impacts

Impact Type	Environmental Aspects with the Potential for Transboundary or Cumulative Impacts	Section
Transboundary impacts	• Atmospheric emissions and seabed disturbance	6.3
Cumulative impacts	• Physical presence, seabed disturbance, atmospheric emissions, noise	6.4

6 POTENTIAL ENVIRONMENTAL IMPACTS

6.1 Seabed Disturbance

6.1.1 Sources of Potential Impacts

Decommissioning of the Trees fields infrastructure will require intervention at or near the seabed which may result in short-term disturbance to background seabed sediments and, in some cases, to contaminated drill cuttings. Short-term environmental impacts associated with seabed disturbance during decommissioning activities which include:

- Potential excavation using a mass flow excavator to allow access for cutting equipment to cut the pipeline ends within the trench.
- Cutting pipelines and spools within the pipeline trench transition – by shears or diamond wire.
- Removal and recovery of Larch Wye, Larch and Sycamore Satellite pipeline spools, SW1 wellhead, Birch crossover bundle assembly; Larch Wye-piece assemblies; and Larch T-piece.
- Removal of concrete mattresses and grout bags.
- Remediation of 37m of PL1527 to protect a shallow trenched (less than 0.6m depth) section of pipeline, by one of the following methods:
    - trenching / dredging using mass flow excavation, or
    - covering with rock,
    - cut and remove with pipeline ends protected by additional rock.

In addition, the decommissioning activities may lead to some longer-term impacts associated with addition of protective rock cover, for example, at the cut pipeline ends, or on the 37m section of PL1527.

Other potential longer term impacts may arise from disturbance of contaminated seabed:

- Potential disturbance of historic drill cuttings (e.g. from removal of the mattresses, spool pieces and jumpers at Birch and Sycamore Main).

6.1.2 Quantification of Seabed Disturbance

Short-term Impacts from Seabed Disturbance

The removal of Larch and Sycamore Satellite pipeline spools, Birch crossover bundle assembly; Birch manifold; Larch Wye assembly; Larch Manifold, and exposed stabilisation materials will result in limited seabed disturbance, the majority of which will be within the existing physical footprint of the original equipment. The base case is that all mattresses and grout bags, which are not covered by rock cover or are within pipeline trenches, will be removed.

The pipeline / umbilical ends will be cut at a depth of at least 0.6m below the seabed within the trench transition to allow removal of the spool pieces. Localised excavation using a mass flow excavator may be required to allow access for the shears or diamond wire cutting equipment to cut the pipeline ends. Remedial trenching by mass flow excavation will also be required for a 37m section of PL1527, to deepen the existing trench to ≥0.6m below the seabed. Mass flow excavation is proven technology where a flow of water is directed at the seabed to displace the sediment. In both instances, disturbance would be highly localised, and it has been assumed that there would be an area of disturbance out to a perimeter of 0.5m around all items removed and 5m around the 37m section of PL1527 requiring remedial trenching.

Structures which are secured to the seabed with structural piles will be released by internally cutting each pile at 3m below the seabed. If any difficulties are encountered to achieve this, then Spirit Energy will consult OPRED.

Following removal of the subsea infrastructure, and informed by the post-decommissioning survey, any items of debris located on the seabed will be removed using a Remotely Operated Vehicle (ROV) and grab. The removal of such items will represent a minor increment to seabed disturbance generated during decommissioning.

The principal sources of temporary seabed disturbance, with corresponding maximum area estimates, are itemised in Table 6-1, Table 6-2, Table 6-3, Table 6-4 (summarised in Table 6-5), and Table 6-6, where the total estimated area of seabed disturbance is calculated to be 0.013km^2 for removal activities, and 4.09km^2 for the potential use of over-trawl trials to confirm a safe seabed. To put this into context, a standard UKCS licence block covers *ca.* 200km^2. The area impacted is therefore considered small.

Permanent Impacts from Seabed Deposits

Deposited rock may be required to mitigate snagging risks to fishing activities for (Table 6-7):

- the cut pipeline / umbilical ends within the trench to ensure they remain buried. Up to 50 tonnes of rock would be required in each of 14 locations, this could create a footprint of *ca*. 1,050m^2;
- protection of a 37m section of PL1527 which lies within a shallow trench (less than 0.6m depth) in the event that deeper excavation of the trench fails. It is estimated that 250 tonnes of rock would be required, within the trench boundaries, this cover would create a footprint of *ca*. 250m^2 (50m x 5m).

The scale of permanent impacts resulting from deposited rock to protect cut ends of pipelines, and to protect the 37m length section of PL1527 that is trenched to less than 0.6m depth below seabed, are itemised in Table 6-7. The total area of hard rock substrate is calculated as 0.0013km^2.

Longer Term Impacts from Contaminated Drill Cuttings Disturbance

The Birch wells are located within the perimeter of the Birch drill cuttings piles (Figure 6-2). Limited mass flow excavation will be required to expose the lifting loops on the mattresses (which could be buried) which cover the spools and jumpers connecting the Birch wells and manifold. Disturbance associated with the Birch drill cuttings is expected to arise from cutting and removing the spools to the manifold and removal of the overlaying mattresses. This disturbance is expected to be relatively small and is conservatively estimated to encompass the complete footprint of the items to be recovered out to a perimeter of 0.5m and to a depth of 0.25m. The estimated volume of the total historic drill cuttings at Birch is *ca*. 464m^3, and the estimated volume of disturbance to the drill cuttings associated with removal of the spools, jumpers and mattresses at Birch is 163m^3 (Table 6-2).

The Sycamore wells SW1 (formerly SP1), SP2, and SW2 are located at the edge of the Sycamore drill cuttings pile (Figure 6-2). Disturbance of the Sycamore drill cuttings is expected to arise from cutting and removing the spools, jumpers and mattresses connecting the wellheads to the Sycamore Main Manifold, and from removing the SW1 wellhead. Limited mass flow excavation will be required to expose the lifting loops on the mattresses (which could be buried) which cover the spools and jumpers. This disturbance is expected to be relatively small and is conservatively estimated to encompass the complete footprint of the items to be recovered out to a perimeter of 0.5m and to a depth of 0.25m. The estimated volume of the total historic drill cuttings at the Sycamore Main location is *ca*. 684m^3, and the estimated volume of disturbance to the drill cuttings associated with removal of the spools, jumpers and mattresses at Sycamore Main is 478m^3 (Table 6-4).

The long-term impacts of disturbed drill cuttings during recovery of subsea infrastructure are calculated in Table 6-1, Table 6-2 and Table 6-4 (summarised in Table 6-5). The total area of seabed impacted by disturbed drill cuttings is calculated as 0.0055km^2, the total volume of cuttings disturbed from activities at Brae A, Birch Manifold and Sycamore Main Manifold is conservatively calculated as 1,380m^3.

Unplanned Activities and Events

During all lifting activities, there is the potential for infrastructure, tools and equipment to be accidentally dropped because of procedural failure, or mechanical failure of lifting apparatus. The degree of disturbance would be primarily related to the size of the dropped object and its 'footprint'.

Decommissioning of Infrastructure *In Situ*

The *in situ* decommissioning of pipeline rock cover can be considered to cause permanent disturbance to the seabed. The degree of disturbance will be related to the footprint of the rock cover and the burial status.

Table 6-1: Short-term seabed disturbance from decommissioning activities associated with infrastructure at Brae A

Field	Infrastructure to be removed or remediated	Assumptions and relation to drill cuttings pile	Number	Dimensions per item including perimeter	Estimated footprint area disturbed (m^2)	Estimated disturbance volume (m^3)
Brae A	Pipeline ends, spools and mattresses at Brae A (PL1161, PL1162, PL1163 & PL1164)	Within Brae A cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the largest mattress width (3m), the combined length of material to be removed (504m), with a disturbance perimeter (0.5m) (i.e. 4m x 505m). Requires MFE – disturbance depth 0.25m.	4 cut ends	4m x 505m	2,020*	505*
	Pipeline end and spools at Brae A (PL1531)	Within cuttings pile footprint. The area of disturbance is based on complete mattresses coverage: the largest mattress width (2m), the combined length of material to be removed (189m), with a disturbance perimeter (0.5m), (i.e. 3m x 190m). Includes disturbance for mattresses / grout bags. Requires MFE – disturbance depth 0.25m.	1 cut end	3m x 190m	570*	143*
	Crossover Bundle at Brae A	Within Brae A cuttings pile footprint. Disturbance assessed out to 0.5m perimeter (included within 'Dimensions per item column'). Requires MFE – disturbance depth 0.25m.	1	38.5m x 9m	347*	91*
	Anode skids at Brae A		2	2m x 2.4m x 2no.	9.6*	
	SSIV protection structure at Brae A		1	2m x 2.7m	5.4*	
				Total	**2,952***	**739***

* Denotes area and volume of disturbance within Brae A drill cuttings pile.
Note: At the time of writing the Trees Decommissioning EA, the timing for decommissioning the pipeline crossings within the Brae A 500m safety zone were under discussion with Brae Group, which includes TAQA and Spirit Energy.

Table 6-2: Short-term seabed disturbance from decommissioning activities associated with infrastructure in the Birch Field location

Field	Infrastructure to be removed or remediated	Assumptions and relation to drill cuttings pile	Number	Dimensions per item including perimeter	Estimated footprint area disturbed (m^2)	Estimated disturbance volume (m^3)
Birch	Birch Manifold	Not within Birch cuttings pile footprint. Disturbance assessed out to 1m perimeter. Requires MFE – disturbance depth 0.25m	1	22m x 18m	396	99
	Pipeline ends and spools at Birch manifold (PL1161, PL1162, PL1163, PL1164)	Not within Birch cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the largest mattress width (3m), the combined length of material to be removed (474m), with a disturbance perimeter (0.5m), (i.e. 4m x 475m). Includes disturbance for mattresses / grout bags. Requires MFE – disturbance depth 0.25m.	4 cut ends	4m x 475m	1,900	475
	Spools / jumpers from Birch Manifold to Birch wells.	Within Birch cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the overall width (20m) and the combined length of material to be removed (30m) with a disturbance perimeter (0.5m) (i.e. 21m x 31m). Includes disturbance for mattresses / grout bags. Requires MFE – disturbance depth 0.25m.	Combined	31 x 21m	651*	163*
	Spools / jumpers between Birch manifold and Sycamore Main Towhead	Not within Birch cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the overall width (6m) and the combined length of material to be removed (100m) with a disturbance perimeter (0.5m) (i.e.101m x 7m).Includes disturbance for mattresses / grout bags. Requires MFE – disturbance depth 0.25m.	Combined	101m x 7m	707	177
	Mattresses	Disturbance footprint is included within pipeline ends and spools/ jumpers footprint, and is not double counted here.	182	Various	Included above	-
	Grout bags		2,100	*ca.* 0.5m^2	Included above	-
	Concrete protection covers	Disturbance assessed out to 0.5m perimeter. Various sizes, see DP.	8	45m (combined length) x 7m width	368	-
				Total	**4,022**	**914**

* Denotes area and volume of disturbance within Birch drill cuttings material.

Table 6-3: Short-term seabed disturbance from decommissioning activities associated with infrastructure in the Larch Field location

Field	Infrastructure to be removed or remediated	Assumptions and relation to drill cuttings pile	Number	Dimensions per item including perimeter	Estimated footprint area disturbed (m^2)	Estimated disturbance volume (m^3)
Larch	Larch gas lift Manifold	No drill cuttings pile at Larch. Disturbance assessed out to 1m perimeter. Requires MFE – disturbance depth 0.25m.	1	14m x 13.5m	189	47
	Larch Wye-piece (original)	Disturbance assessed out to 0.5m perimeter. Requires MFE – disturbance depth 0.25m.	1	9.4m x 7.5m	70.5	32
	Larch Wye-piece extension spool		1	5.5m x 4m	22	
	Larch Wye-piece (new)		1	7.5m x 4.8m	36	
	Pipeline ends and spools at Larch Wye and Tee (PL1527, PL1528, PL1529, PL1530, PL1531)	The area of disturbance is based on complete mattress coverage: the largest mattress width (3m), the combined length of material to be removed (664m), with a disturbance perimeter (0.5m), (i.e. 4m x 665m). Requires MFE – disturbance depth 0.25m.	7 cut ends	4m x 665m	2,660	665
	Pipeline ends and spoolpieces / jumpers - Larch manifold and pipelines to the Larch wells (PL1527, PL1528, PL1529, PL1530, PL1531)	The area of disturbance is based on complete mattress coverage: the largest mattress width (3m), the combined length of material to be removed (1190m), with a disturbance perimeter (0.5m), (i.e. 4m x 1191m). Requires MFE – disturbance depth 0.25m.	5 cut ends	4m x 1,191m	4,764	1,191
	Mattresses	Disturbance footprint is included within pipeline ends and spools/ jumpers footprint, and not double counted here.	298	Various	Included above	-
	Grout bags		2,700	*ca.* $0.5m^2$	Included above	-
	Concrete protection covers	Disturbance assessed out to 0.5m perimeter.	10	57m (combined length) x 8m width	456	-
	Remediation of 37m of Larch PL1527	Remediation option: MFE. Disturbance assessed out to 5m perimeter. Requires MFE – disturbance depth of 1m.	1	47m x 10m	470	470
				Total	**8,668**	**2,405**

Table 6-4: Short-term seabed disturbance from decommissioning activities associated with infrastructure in the Sycamore Fields

Field	Infrastructure to be removed or remediated	Assumptions and relation to drill cuttings pile	Number	Dimensions per item including perimeter	Estimated footprint area disturbed (m^2)	Estimated disturbance volume (m^3)
Sycamore	Spoolpieces / jumpers (SW1 (formerly SP1), SP2, and SW2 wells to Sycamore Main Manifold).	Within cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the overall width (20m) and the combined length of material to be removed (90m) with a disturbance perimeter (0.5m) (i.e. 91m x 21m). Requires MFE – disturbance depth 0.25m.	Combined	91m x 21m	1,911*	478*
	Spoolpieces / jumpers (SP3 well to Sycamore Satellite Manifold).	Not within cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the overall width (10m) and the combined length of material to be removed (60m) with a disturbance perimeter (0.5m) (i.e. 11m x 61m). Requires MFE – disturbance depth 0.25m	Combined	61m x 11m	671	168
	Spoolpieces / jumpers (Sycamore Satellite Towhead to Sycamore Main Manifold).	Not within cuttings pile footprint. The area of disturbance is based on complete mattress coverage: the overall width (6m) and the combined length of material to be removed (60m) with a disturbance perimeter (0.5m) (i.e. 7m x 61m). Requires MFE – disturbance depth 0.25m	Combined	7m x 61m	427	107
	Mattresses	Disturbance footprint is included within pipeline ends and spools/ jumpers footprint, and is not double counted here.	88	Various	Included above	-
	Grout bags		500	*ca.* 0.5m^2	Included above	-
				Total	**3,009**	**753**

* Denotes area and volume of disturbance within Sycamore Main drill cuttings material.

Table 6-5: Summary of short-term seabed disturbance from decommissioning activities associated with the Birch, Larch and Sycamore Fields

Field	Not within drill cuttings - Estimated footprint area disturbed (m^2)	Within drill cuttings - Estimated footprint area disturbed (m^2)	Not within drill cuttings - Estimated disturbance volume (m^3)	Within drill cuttings - Estimated disturbance volume (m^3)
Brae A Field location	-	2,952m^2 (0.003km^2)	-	739
Birch Field location	3,400m^2 (0.0034km^2)	651m^2 (0.00065km^2)	751	163
Larch Field location	8,668m^2 (0.0087km^2)	-	2,405	-
Sycamore Field location	1,100m^2 (0.0011km^2)	1,911m^2 (0.002km^2)	275	478
Total	13,137m^2 (0.013km^2)	5,514m^2 (0.0055km^2)	3,431	1,380

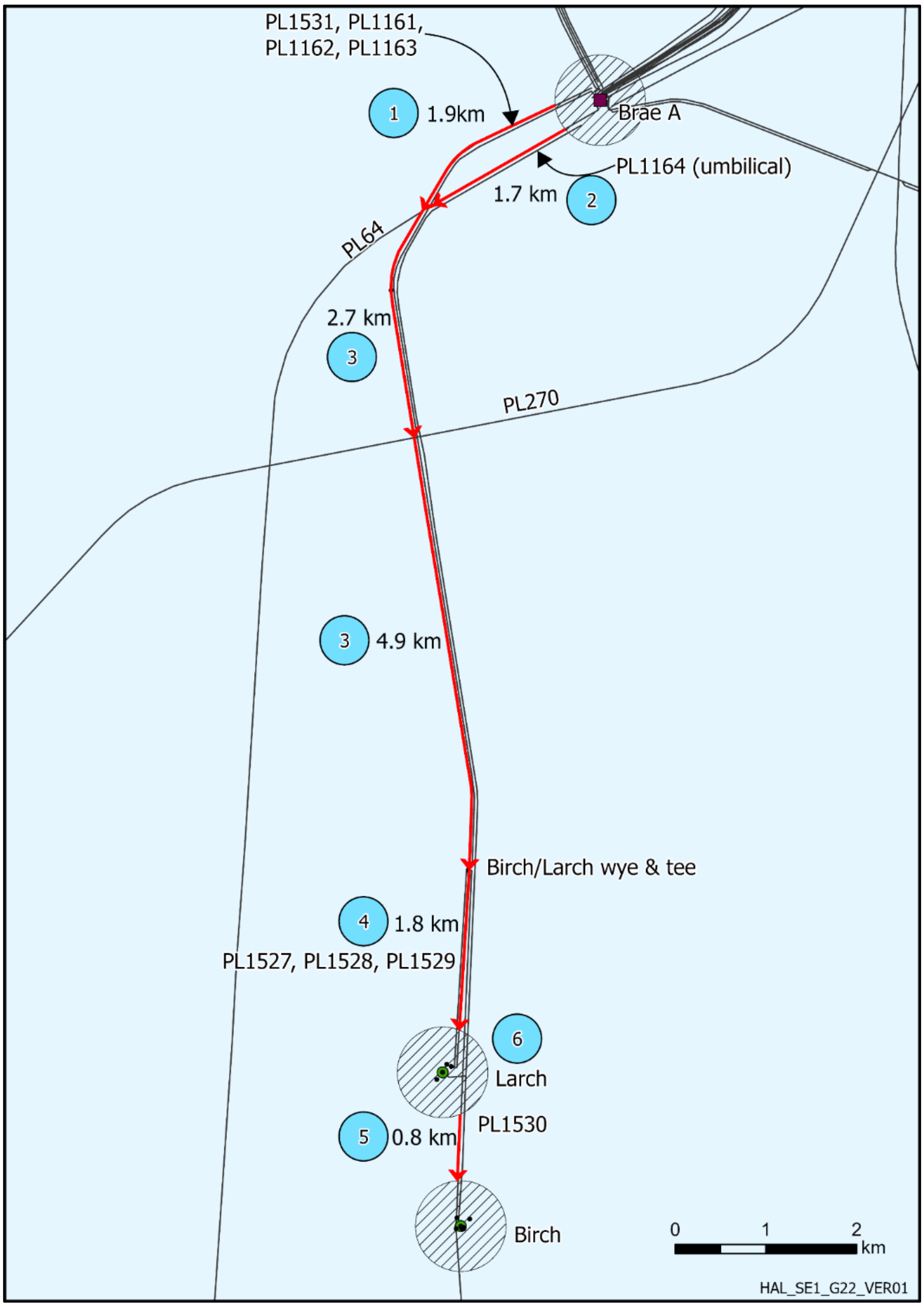
Table 6-6: Over-trawl areas associated with Trees fields decommissioning

Section (Figure 6-1)	Pipelines included within section	Length of section (km)	Max. width of pipeline spread (m)	Max width of over-trawl area including 50m each side of the pipeline (m)	Area of over-trawl for each section (km^2)
1	PL1531, PL1161, PL1162, PL1163 (Brae A 500m zone to Forties PL64 crossing)	1.9	80	180	0.342
2	PL1164 (Brae A 500m zone to Forties PL64 crossing)	1.7	Single pipeline	100	0.17
3	PL1531, PL1161, PL1162, PL1163, PL1164 (Forties PL64 crossing to Miller PL720 crossing (2.7km) / Miller PL720 crossing to Birch/Larch Wye-piece (4.9km))	2.7 + 4.9	80	180	1.368
4	PL1527, PL1528, PL1529, PL1531, PL1161, PL1162, PL1163, PL1164 (Birch/Larch Wye-piece to Larch 500m zone)	1.8	130	230	0.414
5	PL1161, PL1162, PL1163, PL1164 (Larch 500m zone to Birch 500m zone)	0.8	40	140	0.112
6	Larch 500m zone	-	-	-	1
				Total	3.406
				Total including 20% contingency	4.09

Table 6-7: Permanent impacts from seabed deposits during Trees fields decommissioning

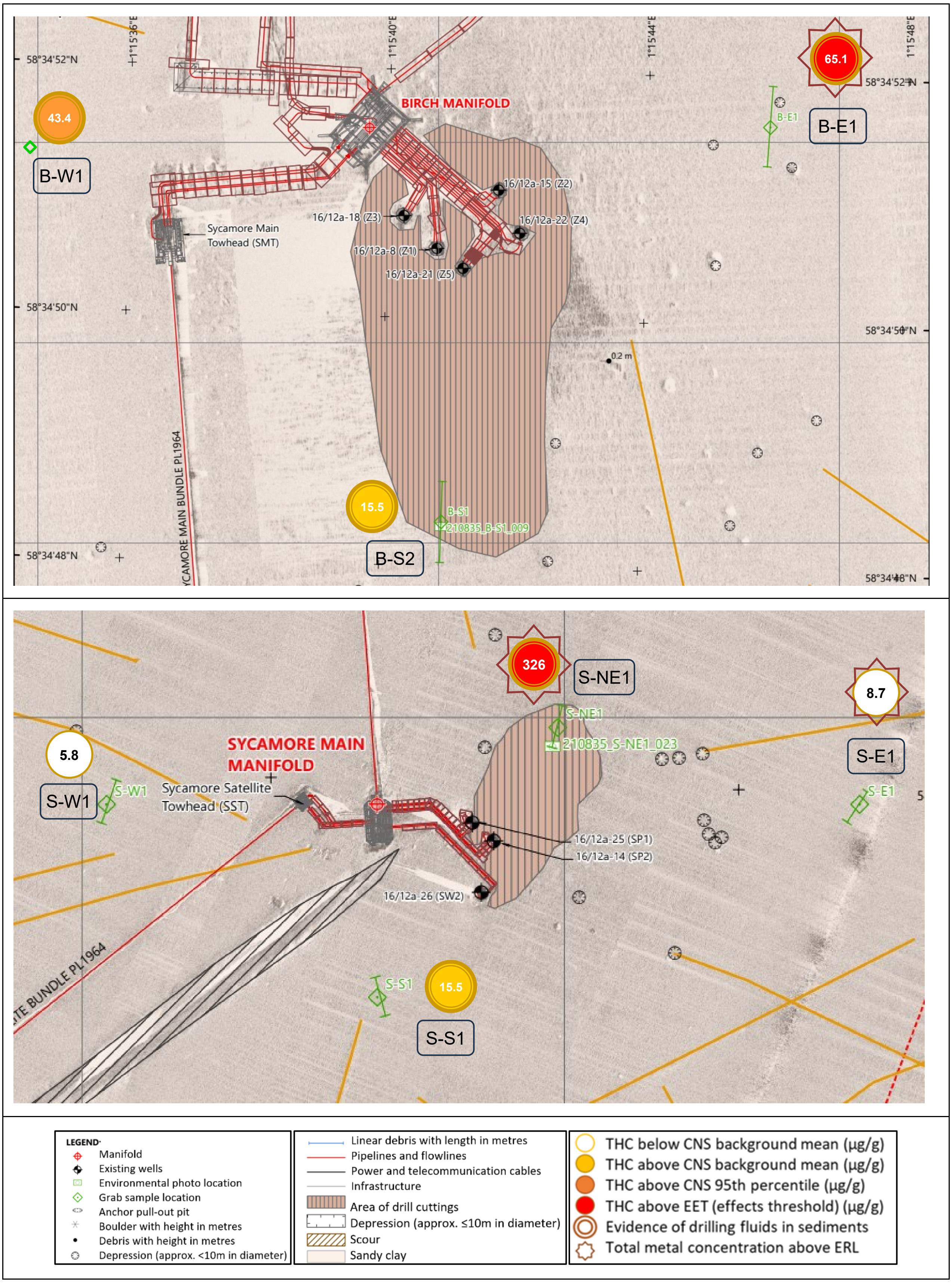
Activity	Details and Assumptions	Estimated Footprint Area Disturbed (km^2) (numbers rounded)
Installation of deposited rock on the cut pipeline / umbilical ends within the trench to ensure they remain buried.	Up to 50 tonnes of rock would be required in 14 locations to cover 21 pipeline / umbilical ends. Where the lines are piggybacked or within the same trench then that is considered as a single rock placement location. - Brae Alpha, 4 locations (5 pipeline ends) - Birch manifold, 2 locations (4 pipeline ends) - Larch 8 locations (12 pipeline ends) Each location will require an estimated area of $75m^2$ (15m length x 5m width). Disturbance area = 14 x 75 = $1,050m^2$	0.00105
Installation of deposited rock to provide protection of a 37m section of PL1527 which lies within a shallow trench (<0.6m depth), in the event that deeper excavation of the trench fails. Or cut and recover the 37m pipeline section with installation of deposited rock on the two cut ends.	250 tonnes of rock would be required to remediate the shallow section of pipeline, within the trench boundaries. This would cover an estimated area of $250m^2$ (50m length x 5m width). The option to cut and recover the pipeline with installation of rock on each pipeline end would cover require 50 tonnes of rock each on two locations covering an estimated area of $75m^2$ each (total $150m^2$). The worst case option of 250 tonnes of rock covering $250m^2$ has been assessed here.	0.00025
	Total	**0.0013**

Figure 6-1: Illustration of sections of pipeline and Larch 500m zone included in over-trawl assessment detailed in Table 6-6



Note: The Brae and Birch 500m safety zones are not included in the over-trawl assessment as Brae A and the Sycamore bundles and their towheads (towheads are within the Birch 500m zone) will be subject to separate decommissioning programmes.

Figure 6-2: Schematic of the manifolds, mattresses, pipelines, wells and drill cuttings at the Birch and Sycamore Main drill centres



6.1.3 Impacts on Sensitive Receptors

Impacts of Seabed Disturbance

Seabed disturbance will result in direct physical effects on benthic communities which may include mortality as a result of physical trauma from mass excavation and over-trawl assessment, smothering from resettlement of excavated and trawled sediments and change of habitat type from addition of rock cover. Disturbance during decommissioning activities would be limited to the benthic fauna present in the seabed sediment where excavation is required, fauna colonising the hard surfaces of the protective material to be lifted, and the soft sediment fauna present in locations where protective rock cover is required.

The response of benthic macrofauna to physical disturbance has been well characterised, with increases in abundance of small opportunistic fauna and decreases in larger more specialised fauna (e.g. Eagle & Rees 1973, Newell *et al*. 1998, van Dalfsen *et al*. 2000, Dernie *et al*. 2003). The duration of effects on benthic community structure are related to individual species' biology and to successional development of community structure. The majority of seabed species recorded from the CNS are known or believed to have relatively short lifespans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid population recovery, typically between 1 to 5 years (Jennings & Kaiser 1998), such that any effect will be temporary.

The infauna of the Trees fields is characterised by a range of small, short lived species, which have a widespread distribution and are characteristic of the muddy / sandy sediments. Seabed imagery and grab samples from the pre-decommissioning survey, indicated that epifauna and mobile epifauna fauna were relatively sparse, but there was evidence that burrowing megafauna were abundant throughout the Trees fields and the sea pen *Pennatula phosphorea* was frequently observed, such that the OSPAR threatened and/or declining habitat 'sea pen and burrowing megafauna communities' is considered to be present throughout the survey areas.

Excavation activities will be required within the trench transition areas and would be focussed on the sediment within the base of the trench. Excavation will lead to direct mortality of a number of individuals within the disturbed area. While rock will be deposited over the cut pipeline ends in the trench transition, it is expected that the remainder of the disturbed sediment would be quickly recolonised by benthic fauna typical of the area via larval settlement and migration of animals from adjacent undisturbed sediments (Dernie *et al*. 2003).

Resuspension and resettlement of sediment associated with mass flow excavation activities is expected to occur within a few metres from the excavation site. The majority of sediment would resettle close to the site and form only a thin veneer of sediment, that would be comparable to the natural burial of fauna from sediment movement due to subsea currents, settling beyond the first few metres. The majority of species within the OSPAR habitat are burrowing megafauna living within the sediment and are likely to have high resilience to limited sedimentation levels (up to 5cm depth) with the ability to restore their burrow entrances within hours to days, and lower tolerance to smothering by depths of 30cm of sediment (Marine Scotland 2022). An increase in suspended sediment may affect the feeding efficiency of suspension feeders such as the sea pens, although *P. phosphorea* and *Virgularia* spp. are able to withdraw into the sediment and appear to be able to recover from smothering by producing an increased amount of mucus to aid sediment removal (Marine Scotland 2022).

P. phosphorea spawns annually and its fecundity is high (Edwards & Moore 2008), information on the reproduction of *Virgularia* spp is sparse but based on its wide distribution and abundance is considered likely to be similarly fecund. Gates & Jones (2012) suggest that re-establishment of pennatulids is likely to take in excess of five years due to their slow growth rate (based on the Arctic species *Halipteris willemoesi*).

Relevant information on the recovery of benthic habitats to smothering mainly comes from studies of dredge disposal areas (Newell *et al*. 1998). Recovery following disposal occurs through a mixture of vertical migration of buried fauna, together with sideways migration into the area from the edges, and settlement of new larvae from the plankton. Defaunated sediments will be rapidly recolonised; Harvey *et al.* (1998) suggest that it may take more than two years for a community to return to a closer resemblance of its original state (although if long lived species were present this could be much longer).

There was evidence of the OSPAR threatened and/or declining species ocean quahog (*Arctica islandica*) from the pre-decommissioning survey, with juvenile specimens recovered within grab samples throughout the Trees fields, a live adult recovered in the Larch Wye area and possible *A. islandica* siphons identified in seabed photography at two Larch Wye stations. *A. islandica* has low resilience to physical disturbance and its inhalant siphon has low tolerance to high levels of sedimentation (Tillin *et al*. 2010), suggesting that individuals within the area of excavation and areas of high sediment resettlement may experience high levels of mortality, although undamaged individuals may have some ability to rebury or return to the sediment water interface. As a long-lived species with a very slow growth rate, which exhibits irregular recruitment and low juvenile survival, recovery may be very slow in areas where population numbers of *A. islandica* have become depleted (OSPAR 2009). Individuals within the wider area experiencing low levels of sediment resettlement (≤5cm sediment depth) are unlikely to be impacted (Tillin *et al*. 2010).

In areas of predominantly muddy / sandy sediments, the introduction of hard substrate (deposits of protective material including rock), might facilitate biological colonisation, including by non-indigenous species, by allowing species with short lived larvae to spread to areas, using these 'stepping stones' where previously they were effectively excluded. A concern of introducing hard substrate to a seabed area where currently there is little, is that this could result in changing the seabed from one type to another, adversely affecting species with habitat preferences. The impact will be limited to approximately a worst case estimate of 0.0013km^2 of seabed. The areas of rock cover would be unsuitable habitat for the OSPAR habitat 'Sea pen and burrowing megafauna communities' and the OSPAR species ocean quahog to recolonise and would result in a permanent loss of habitat. While the rock cover would prevent recovery of the existing habitats and species only a very small proportion of the available habitat would be affected, and it is expected that the rock would be colonised by epifaunal assemblages naturally present within the area. Such organisms would include tubeworm, barnacles, hydroids, tunicates and bryozoans, which are commonly found on submerged rocky outcrops, boulders and offshore structures rather than on sediment. The seabed feature that will result from the rock cover may provide habitats for crevice-dwelling fish and crustaceans and may attract fish to the site (Lissner *et al*. 1991).

Overall, the worst case seabed disturbance from Trees fields decommissioning activities is expected to impact a small area of habitat (0.013km^2, with an additional 0.0055km^2 which are within previously contaminated drill cuttings and are discussed in Section 0 below) and small number of species / individuals within the localised area, with most species showing recovery within the short (<1 year) to medium term (<3 years), with some small areas of permanent disturbance associated with the deposited rock. The overall significance of impact to the benthic community is moderate, and activities will be managed to as low as reasonably practicable levels.

Impacts of Drill Cuttings Disturbance

Decommissioning activities are likely to interact with the historic drill cuttings adjacent to the Birch and Sycamore Main infrastructure. Removal of the infrastructure (i.e. spools, jumpers and overlaying mattresses) is expected to be limited to disturbance of surface material from mass flow excavation to expose the lifting loops on the mattresses. While the estimated proportion of cuttings material that could be disturbed is *ca*. 35% of the cuttings pile at Birch and *ca*. 70% of the cuttings pile at Sycamore, the estimated quantity of cuttings that could potentially be disturbed at each location is relatively small (463m^3 and 684m^3 respectively) in comparison to the range of cuttings piles present on the UKCS (average ~6,610m^3, and often exceeding 10,000m^3 for those associated with platform wells, OSPAR 2019, ERT 2009). The quantities of cuttings disturbed are based on conservative estimates and assumptions, and the cuttings piles were screened and found to be below OSPAR thresholds such that the piles may be left *in situ* to degrade naturally. It is expected that any disturbed material would resettle within the immediate area and largely within the existing footprint of contaminated sediment given the density of the cuttings material and low seabed currents in the region. Disturbance of the drill cuttings material may result in a small spread of contaminated material beyond the existing footprint, however, given the relatively small quantities it is not expected to pose significant toxicological threats to the marine environment .

Depending on the degree of weathering since the original discharges, the resettlement of sediments contaminated with historic drilling muds could be toxic to benthic organisms. As a result, recolonisation is generally characterised by the appearance of opportunistic species which are hydrocarbon and/or sulphide tolerant. Total hydrocarbon levels of 326 mg/l were recorded at S-NE1 in the drill cuttings affected area at Sycamore Main (Figure 6-2). These levels exceeded the ecological effects threshold (EET) (50mg/l) and macrofaunal analysis showed a subtly different macrofaunal community to adjacent stations, where THC levels were below the 95^{th} percentile for the Central North Sea, with low densities of the sulphide tolerant bivalve *Thyasira sarsii*, although typical primary opportunistic species such as the polychaete *Capitella* were not present. Total hydrocarbon levels at Birch exceeded the EET (50mg/l) at B-E1 (65.1mg/kg) which is to the northeast of the cuttings pile, while sediments at the southern tip of pile were below the EET and CNS 95^{th} percentile, but exceeded the CNS mean at B-S1 (15.5mg/kg) (Figure 6-2). Sediments at B-W1 to the west of the pile (43.5mg/kg) exceeded the CNS 95^{th} percentile but were below the EET. Generally these levels indicate the presence of contaminated sediments associated with the pile but also suggest that levels within surrounding sediments are reducing through natural processes. Recolonisation of any contaminated sediments disturbed during Trees fields decommissioning activities can be expected to occur rapidly. Based on the results of single well surveys (Cranmer 1988, Hartley Anderson 2005) biodegradation of contaminants within the surface layer of the disturbed and background sediments would be expected to reduce contaminants to background levels over the following 10-20 years.

The disturbance of contaminated drill cuttings is expected to be limited to relatively small volumes of material that will resettle within the immediate vicinity and existing contamination footprint near the Birch and Sycamore wells. Biodegradation of contaminants within the surface layer of the disturbed and background sediments would be expected to reduce contaminants to background levels over the following 10-20 years. The overall significance of impact to the benthic community is considered to be moderate, but this will be limited to a small area of seabed, largely within an existing contamination footprint. Decommissioning activities and the resulting impacts will be managed to as low as reasonably practicable levels.

6.1.4 Operational Controls and Mitigation

Spirit Energy manage environmental impacts arising from their operations through their fully integrated business management system, which ensures that environmental requirements are embedded into all of their business practices and that environmental impacts are managed to ALARP. In the context of the Trees fields decommissioning:

- Spirit Energy’s contractor selection process takes into consideration a prospective contractors ability (including resources and experience) to undertake work in an environmentally sound manner, with interfaces detailing responsibilities, including environmental responsibilities, and regular HS&E meetings, as required.
- Seabed disturbance arising during removal of concrete mattresses and grout bags will be minimised by optimising work procedures, any baskets, equipment, items to be recovered will be laid (if required) within a 5m corridor of the original infrastructure or pipeline location.
- Applications will be made to deposit rock, the quantity of rock will be engineered to achieve an appropriate profile to avoid snagging risks and to minimise the quantity of rock and area covered. Rock will be installed using a fall pipe vessel to control the distribution of rock.
- Disturbance to the seabed for trench remediation will be minimised through an engineered solution, selection of fit-for-purpose equipment (e.g. mass flow excavator will have an appropriate pump capacity and suction head size) and management of activities.

- Spirit Energy will optimise the area that requires an over-trawl assessment to verify a safe seabed within the 500m safety zone located at Larch and along a 100m wide corridor (50m either side) of all flowlines and umbilicals. In consultation with all relevant governmental and non-governmental stakeholder, where possible preference will be given to non-intrusive methods such as multibeam sonar or side scan sonar.

6.1.5 Conclusion

Seabed disturbance resulting from activities to decommission the Trees fields will result in both temporary and permanent impacts.

Temporary impacts will arise from removal of the spools, jumpers, subsea structures, stabilisation materials and remedial trenching to protect a shallow trenched section of pipeline. These activities will result in direct physical effects to benthic communities including mortality from physical trauma, smothering from excavation, resuspension and deposition of sediments. Resettlement of excavated sediment is likely to occur outside the trench as a thin veneer of sediment. Impacts will be limited to a relatively small area, and within the immediate area of the Trees infrastructure, which has been subject to historical disturbance. Faunal communities are expected to recover by larval settlement and migration of animals from adjacent undisturbed sediments.

A small area of permanently deposited rock will be required to protect the cut pipeline ends and may be required to mitigate against snagging risk to demersal trawl fisheries along the exposed section of pipeline PL1527 (if remedial trenching is unsuccessful). Deposited rock will result in the introduction of a hard substrate in a predominantly soft substrate area. While the rock cover would prevent recovery of the existing habitats and species only a very small proportion of the available habitat would be affected, and it is expected that the rock would be colonised by epifaunal assemblages naturally present within the area.

Removal of infrastructure likely to interact with the historic drill cuttings adjacent to this, could result in resuspension of contaminated material (*ca.* 1,380m^3 cuttings material), however, this is expected to resettle within the existing 'effect footprint'. Recolonisation of contaminated sediments are likely to occur rapidly with biodegradation of contaminants occurring over the medium term (10-20 years).

The total estimated area of temporary physical disturbance to the seabed is considered to be relatively small in the wider context of the CNS (0.0182km^2 not including over-trawl trials; of which 0.013km^2 is out with cuttings pile footprint, and 0.0055km^2 is within the cuttings pile footprint), with a very small area of permanent disturbance (0.0013km^2) arising from deposition of rock. In view of the potential effects described and recovery potential of the seabed, significant effects from physical disturbance are not expected.

6.2 Atmospheric Emissions

6.2.1 Sources of Potential Impacts

The ENVID workshop did not identify atmospheric emissions as a source of significant effect from the decommissioning activities. However, to align with the current BEIS guidance (BEIS 2018), an emissions impact assessment was conducted as part of the EA. The sources of emissions arising from the Trees fields decommissioning programme are from the combustion of diesel by vessels for power generation

Emissions of relevant gas species and their associated Global Warming Potential (GWP) have been estimated for vessel activities using standard industry conversion factors (after DECC 2008), the most recent GWP metrics (Forster *et al*. 2021), and a range of assumptions relating to vessel type and timings (Table 6-8), with the outputs shown in Table 6-9.

The result is a value in tonnes (te) of CO_2 equivalent (CO_2 eq.) based on the radiative forcing effect of each greenhouse gas (GHG) species relative to CO_2 and the atmospheric residence time of each gas, amongst other factors. The GWP factor therefore changes depending on the 'time horizon' considered (IPCC 2001, 2007, 2021, Myhre *et al*. 2013; Shine 2009, Allen *et al*. 2016 and Cain *et al*. 2019).

For the purposes of this assessment, a 100 year time horizon has been used, in line with its adoption by the United Nations Framework Convention on Climate Change (Myhre *et al*. 2013), and nationally for the calculation of CO_2eq. emissions (Shine 2009).

Table 6-8: Estimated vessel time on location and fuel consumption

Vessel Type	Days on Location	Fuel Consumption (te/day)	Total Fuel Consumption (te)
Construction vessel[1]	67	12	804
Heavy lift vessel	3	19	57
Rock placement vessel	10	11	110
Survey vessel (post-decommissioning)[2]	10	4	40
Survey vessel (legacy monitoring)[2]	54	4	216

Notes: [1]construction vessel used for flushing and cleaning and also subsea infrastructure removal, [2] A Post-decommissioning survey will be undertaken upon completion of the decommissioning activities, and the legacy monitoring will be the ongoing survey of the material decommissioned in situ; the frequency of these shown are indicative only as frequency will be agreed with OPRED.

Based on their estimated fuel consumption, atmospheric emissions have been estimated (Table 6-9).

Table 6-9: Estimated atmospheric emissions from Trees fields decommissioning

Vessel	Gas and associated emission factors[1]						
	CO_2 (3.2)	N_2O (0.00022)	CH_4 (0.00018)	NOx (0.0594)	SO_2 (0.004)	CO (0.0157)	NMVOC (0.002)
Construction vessel	2,573	0.2	0.1	48	3	13	2
Heavy lift vessel	182	0.01	0.01	3	0.2	0.9	0.1
Rock placement vessel	352	0.02	0.02	7	0.4	2	0.2
Survey vessel (post-decommissioning)	128	0.01	0.01	2	0.2	0.6	0.1
Survey vessel (legacy monitoring)	691	0.05	0.04	13	0.9	3	0.4
Total Mass (te)	3,926	0.3	0.2	73	5	20	3
GWP Factor[2]	1	273[2a]	29.8[2b]				
Total GWP (teCO2eq)	3,926	82	6				
Overall GWP($teCO_2eq$) at 100-years = 4,014							

Notes/Sources: [1]DECC (2008), [2]Forster et al. (2021) [2a]±130, [2b]±11 (Forster et al 2021)

The decommissioning activities, as described in this EA, are estimated to result in emissions of *ca.* 4,014teCO_2eq.

6.2.2 Trees Fields Decommissioning Estimated Emissions in Context

In 2021, carbon dioxide (CO_2) emissions in the UK were provisionally estimated to be 341.5 million tonnes (Mt), an increase of 6.3% from 2020, while the total UK emissions of the basket of seven greenhouse gases covered by the Kyoto Protocol, were provisionally estimated to be 424.5 million tonnes carbon dioxide equivalent (MtCO_2eq), an increase of 4.7% from 2020; it should be noted however, that due to the restrictions across the UK during 2020 and 2021 due to the COVID-19 pandemic, this had a significant impact on greenhouse gas emissions in the UK over this period

(BEIS 2022).

Compared to 2019, the most recent pre COVID-19 pandemic year, 2021 CO_2 emissions are down 5.0% and total greenhouse gas emissions are down 5.2%. Total greenhouse gas emissions were 47.3% lower than they were in 1990 (BEIS 2022). The increase seen in 2021 is primarily due to the increase in the use of road transport, as there was a further easing of COVID-19 pandemic related restrictions, along with increases in emissions from power stations and the residential sector (BEIS 2022).

Therefore, taking 2019 as the base year (pre COVID-19 pandemic), UK total emissions of greenhouse gases were *ca*. 454.8 million tonnes (Mte) CO_2eq; CO_2 being the most dominant of these, accounting for *ca*. 81% of the emissions (365.1 Mte) (BEIS 2021). From available information from Offshore Energies UK, *ca*. 14.63 MtCO_2eq was attributable to installations in the UKCS in 2018 (OGUK 2019).

The emissions from Trees fields decommissioning activities, in the context of UK GHG emissions, would represent an increment of 0.0009% on those emitted from all UK sources in 2019, or 0.03% of those from installations on the UKCS in 2018 (OGUK 2019). These emissions are therefore considered to be very small in the context of emissions associated with the UK oil and gas industry, and will make a small one-off contribution to global atmospheric GHGs and their related effects, compared to the annual emissions generated from operating the Trees fields.

6.2.3 Operational Controls and Mitigation

As part of their standard project management planning, Spirit Energy aims to minimise vessel time in the field as far as practicable and, where possible, will make use of vessel synergies and aggregate work scopes. The above estimates are based on representative vessels presently in operation, with timings and related emissions representing a probable worst case. As part of their contractor selection process, Spirit Energy will consider the selection of contractors, for example, with modern and fuel efficient vessels where available, while satisfying other selection criteria. Emissions are also reduced by following relevant industry best practices and minimising fuel consumption where possible. These actions, along with the development of decommissioning key performance indicators, align with expectations contained within the Stewardship Expectation 11 and the Decommissioning Strategy.

It is considered that there is limited scope for additional mitigation measures to reduce the residual effect on atmospheric GHG loading, or any local effects on air quality. However, these air quality effects are naturally mitigated through the area being far offshore (more than 200km) which is considered to be a highly dispersive environment and the relatively short duration of activities.

6.2.4 Conclusions

Trees fields decommissioning activities will lead to emissions of gases which contribute both to localised and short-term increases in atmospheric pollutants, and to global atmospheric GHG concentrations. These effects are considered to be negligible in the context of wider UK emissions, and following decommissioning activities there will be no further emissions associated with the fields. Overall effects are considered to be negligible severity and consequently were assessed as of low significance.

6.3 Transboundary Impacts

Although the Trees fields are relatively close to the UK/Norwegian median line (14km east), the decommissioning activities have a limited likelihood of transboundary effects. Atmospheric emissions from the activities are unlikely to be detectable or to significantly affect Norwegian national waters, air quality and seabed disturbance is localised to the Trees fields.

As part of the permitting and consenting process for the decommissioning activities, accidental events and a major environmental incident assessment will be carried out, which will take into consideration the potential for transboundary impacts.

6.4 Cumulative Impacts

Current guidance (BEIS 2018) requires the environmental assessment supporting the proposed decommissioning activities to consider any in-combination and cumulative effects arising from these activities in the context of all other activities taking place in the area, where relevant to do so.

The Trees fields environmental assessment has considered the decommissioning activities in the context of other existing, consented or reasonably foreseeable planned activities in the area and determined whether they are likely to result in any significant cumulative impacts; Table 6-10 summarises the consideration of these.

Table 6-10: Potential cumulative effects from the proposed Trees fields decommissioning activities

Effect	Consideration
Physical presence	The existing oil and gas developments in the area are mature, with no, known planned installation of new oil and gas infrastructure, the construction of which would coincide with Trees fields decommissioning activities. Vessels carrying out decommissioning activities will be predominately located within existing 500m safety zones, resulting in no, or very little incremental loss in fishing access; transit to and from locations and presence on locations will represent a small increment in existing vessel traffic in the area. Decommissioning activities will ultimately result in a removal of existing safety zones, re-opening up areas for fishing activity. Other restrictions are present in the area (around Brae A, B etc) with these localised to the area around the installations; there are no other significant access restrictions to navigation in the area. The schedule for the Trees fields decommissioning activities may coincide with other decommissioning/development activities in the area, if this is the case, vessel synergies will be explored to minimize vessel presence.
Seabed disturbance	Seabed disturbance from decommissioning activities will be incremental with that resulting from other similar activities within the vicinity. The Tree fields tie into Brae A, part of the Brae complex, some of which is currently undergoing decommissioning; Brae B topsides have been removed for decommissioning, however, at time of writing, cessation of production for Brae A has not been approved. Decommissioning activities in the wider area include decommissioning of the Balmoral field (block 16/12a), which have already commenced and are scheduled for completion in 2027. The majority of the spatial disturbance for the Trees fields decommissioning is temporally and spatially limited (i.e. at wells locations, and at exposed ends of pipelines locations), with the majority of the activities separated from the Brae complex, with the only footprint overlap being the tie-in at Brae A. The total area affected by Trees fields decommissioning activities, is a relatively small proportion of the benthic habitat in the area and the majority of disturbance is expected to be temporary. Although fishing effort/intensity is moderate in comparison to other areas, it is likely to represent the principal source of seabed disturbance in and around the Trees fields and wider area. Bottom trawl is the most used gear type in the region, with trawl scars likely to be extensive in some areas. The contribution of Trees fields decommissioning activities is considered to be low and not significant.
Discharges	Removal of the Birch manifold and jumpers at the Sycamore Satellite wells are likely to result in small quantities of drill cuttings being resuspended into the water column, temporarily exposing pelagic and benthic biota to increased toxicity level. Any dissolved organics will be rapidly diluted and disperse within the water column. The size of the cuttings piles present are such that the oil loss rate and persistence are below the thresholds (OSPAR 2006) and no other discharges have contaminated the cuttings piles, therefore, no further action is necessary and the cuttings may be left *in situ* to degrade naturally (OSPAR 2006). Recovery of the sediment following the deposition of material is dependent on a number of factors, including depth of deposition (the cuttings piles at Trees are relatively small), rates of biodegradation of organic chemicals in the sediment, the resuspension and re-distribution of material through currents (Trees are not located in a particularly high energy area, i.e. compared to the southern North Sea and as such re-distribution is expected to be localised to around the existing footprint of the cuttings) and

Effect	Consideration
	time for recolonization of biota. Resumption of fishing activity after removal of the 500m zones, can also result in the re-distribution of cuttings, and the release of contaminants contained within the cuttings pile into the water column. This activity will result in the release of contaminants but will also aerate the cuttings pile, allowing additional degradation; however, these impacts, which will include smothering (benthos) and uptake of contaminants in the plankton and benthos and bioaccumulation of contaminants in fish that consume these are expected to be localised (to the benthos in the area of re-distribution) and short term (fish are likely to metabolise oils quickly and unlikely to be significantly affected in the medium to long term (OSPAR 2019). Studies have found that, using heavy monkfish trawls on a cutting pile in the Moray Firth, did distribute cuttings, but not at a level or rate that would *pose serious wider contamination or toxicological threats to the marine environment* (OSPAR 2009), with the act of spreading encouraging aeration of material and enhancing degradation. Fishing gear was typically found to re-suspend the equivalent of 1mm depth of seabed sediment, while the contaminant content of the top layer of a cuttings pile (~100mm) is expected to be low, having already been subject to natural weathering and biodegradation (anaerobic degradation may take place down to ~20-50cm over time, with contaminants in the deeper parts of the pile remaining unchanged). The Trees cuttings piles have been *in situ* since the mid 1990s (Birch) and early 2000s (Sycamore) therefore some natural degradation will have occurred. Given the (relatively small) scale of the piles, that these are localised to the well areas with no other significant cuttings piles in close proximity, the small spatial and temporal extent of the impacts expected (as seen from studies, OPSAR 2009, 2019), cumulative impacts are not expected.
Atmospheric emissions	No significant cumulative effects, in view of scale of inputs (vessels on location to carry out activities, then only short duration post-decommissioning surveys), and very high available dispersion. No ongoing operational emissions associated with the fields. Greenhouse gas emissions will be cumulative in a global context, although the contribution associated with the decommissioning activities at the Trees fields is minor.
Noise	The primary source of underwater noise from the decommissioning activities will be vessel noise and noise from the cutting of piles, and, this will be incremental to other, similar oilfield noise sources in the immediate and wider areas (e.g. standby vessels, supply vessels). However, the increment associated with the short term decommissioning activities of the Trees fields, will be small relative to vessel traffic levels in adjacent areas (standby and supply vessel activity at the Brae A and other producing installations in the area) or significant spatial or temporal effects (i.e. additive to on-going or previous and subsequent disturbance by seismic and other activities). The Trees fields are distant to the nearest renewable energy area, although close to (~3km) an area offered as part of the carbon storage licensing round, however, with the exception of possible surveys, noise producing activities associated with carbon storage are not expected to overlap with decommissioning activities at the Trees fields.

7 ISSUE MANAGEMENT AND OVERALL CONCLUSIONS

The decommissioning activities will be conducted in accordance with Spirit Energy's Health, Safety, Environment and Security (HSES) policy and environmental management system (EMS); the EMS is certified to the Environmental Management System ISO 14001:2015 Standard.

A number of contractors will be involved in the detailed planning and execution of the decommissioning activities and Spirit Energy has established contractor selection and management procedures which include evaluation of HS&E aspects and environmental management and compliance. Table 7-1 below presents a summary of commitments and actions identified through the assessment process. All project impacts were assessed to be within tolerable levels and managed to as low as reasonably practicable (ALARP) by implementation of standard industry practices and through Spirit Energy environmental management and project control procedures, consequently project specific mitigation measures were not required to manage the impacts of the Trees fields decommissioning programme.

Note the table below does not include legal requirements, e.g. obtaining and complying with approved permits and consents, and the conditions contained therein (e.g. notice to mariners, vessel lighting), including the pipeline works authorisation (PWA) and those required under PETS, the required oil spill response documents and the compliance with all relevant waste regulations applicable to material being returned to shore.

Table 7-1: Trees fields project commitments and actions identified during the environmental appraisal

Commitments and Actions
Overall Project
Lesson learned from previous decommissioning scopes will be reviewed and implemented; ensure indicators and targets for the Trees fields decommissioning project are consistent with Spirit Energy policy and established for the main decommissioning activities, monitor and review performance against indicators and targets, ensuring remedial action is instigated where necessary. Existing processes will be used for contractor management to assure and manage environmental impacts and risks; Spirit Energy's management of change process will be followed should changes in scope be required. Conduct a post project review to assess accuracy of EA assessment in the context of actual impacts.
Vessels and Atmospheric Emissions
The vessels' work programme will be optimised to minimise vessel use; vessel synergies and work scopes aggregated where possible; vessels will be managed in accordance with Spirit Energy's Marine Assurance Standard. Spirit Energy will also develop decommissioning emissions key performance indicators.
Seabed Disturbance
All activities resulting in seabed disturbance will be planned, managed and implemented in such a way as to minimise disturbance as far as practicable; where remediation of exposed ends is required, the use of excavated material will be used where possible, with rock deposits minimised as far as practicable, the use of non-invasive post-decommissioning survey method will also be considered.
Waste Production and Disposal
Waste production will be minimised as far as practicable and managed through a waste management plan; re-use and recycle applied as far as practicable, and the selected receiving port and waste handling facility will be able to demonstrate a proven disposal track record and waste stream management throughout the process.

7.1 Overall Conclusions

The overall conclusion of the environmental appraisal of the decommissioning of the Trees fields are:

- No significant environmental or adverse effects on benthic habitats or faunal communities in the area are expected from the estimated seabed disturbance as a result of decommissioning operations.
- No significant environmental or adverse effects are expected from estimated atmospheric emissions as a result of decommissioning operations.
- No significant environmental, or adverse effects on other users of the sea are expected from the planned activities associated with the decommissioning operations.
    - Some Trees fields infrastructure is to be decommissioned *in situ*, however, this will be monitored on a basis to be agreed with OPRED to ensure this does not become a hazard for other users and periodic reviews will be conducted by Spirit Energy of new and emerging technologies for safe removal
- No impacts on conservation interests are expected; the Trees fields are not located within, or close to, a designated area.
- No specific, additional controls are considered necessary for activities beyond application of regulatory requirements, established Spirit Energy management processes, operational controls and following industry guidelines and best practice where applicable.
- A range of environmental management commitments and actions have been identified and will be carried forward through the detailed planning and execution phase of the decommissioning project to further avoid, or minimise adverse environmental impacts, as far as technically feasible.

8 BIBLIOGRAPHY

Aires C, González-Irusta JM & Watret R (2014). Updating fisheries sensitivity maps in British waters. *Scottish Marine and Freshwater Science Report* Vol 5 No 10, 93pp.

Allen MR, Fuglestvedt JS, Shine KP, Reisinger A, Pierrehumbert RT & Forster PM (2016). New use of global warming potentials to compare cumulative and short-lived climate pollutants. Nature Climate Change 6: 773-776

Armannsson H, Jonsson S, Neilson JD & Marteinsdottir G (2007). Distribution and migration of saithe (*Pollcahius virens*) around Iceland inferred from mark-recapture studies. *ICES Journal of Marine Science*, 64; 1006–1016, https://doi.org/10.1093/icesjms/fsm076

Bailey RS (1975). Observations on diel behaviour patterns of North Sea gadoids in the pelagic phase. *Journal of the Marine Biological Association of the United Kingdom*.55.133-142

Batty A (2008). Seabird and marine mammal survey: FRV Scotia, 5-29th August 2008. Report for Cork Ecology, produced as part of the UK DECC SEA programme.

BEIS (2018). Guidance Notes. Decommissioning of Offshore Oil and Gas Installations and Pipelines. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760560/Decom_Guidance_Notes_November_2018.pdf

BEIS (2020). 2019 UK greenhouse gas emissions

BEIS (2021). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide. July 2021, Revision 03 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005109/The_Offshore_Oil_and_Gas_Exploration__Production__Unloading_and_Storage__Environmental_Impact_Assessment__Regulations_2020_-_A_Guide__July_2021.pdf

BEIS (2022). 2021 UK greenhouse gas emissions, provisional figures, https://data.gov.uk/dataset/9a1e58e5-d1b6-457d-a414-335ca546d52c/provisional-uk-greenhouse-gas-emissions-national-statistics

BERR (2008). Review of cabling techniques and environmental impacts applicable to the offshore wind farm industry. Technical report, 159pp.

Cain M, Lynch J, Allen MR, Fuglestvedt JS, Frame DJ & Macey AH (2019). Improved calculation of warming-equivalent emissions for short-lived climate pollutants. Climate and Atmospheric Science 2: https://doi.org/10.1038/s41612-019-0086-4

Callaway R, Alsvag J, de Boois I, Cotter J, Ford A, Hinz H, Jennings S, Kroncke I, Lancaster J, Piet G, Prince P & Ehrich S (2002). Diversity and community structure of epibenthic invertebrates and fish in the North Sea. *ICES Journal of Marine Science* 59: 1199-1214.

Carter MID, Boehme L, Duck CD, Grecian WJ, Hastie GD, McConnell BJ, Miller DL, Morris CD, Moss SEW, Thompson D, Thompson PM & Russell DJF (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Sea Mammal Research Unit, University of St Andrews, Report to BEIS, OESEA-16-76/OESEA-17-78, 74pp.

Carter MID, Boehme L, Cronin MA, Duck CD, Grecian WJ, Hastie GD, Jessopp M, Matthiopoulos J, McConnell BJ, Miller DL, Morris CD, Moss SEW, Thompson D, Thompson PM & Russell DJF (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. *Frontiers in Marine Science* 9: 875869. https://doi.org/10.3389/fmars.2022.875869

Certain G, Jørgensen LL, Christel I, Planque B and Bretagnolle V (2015). Mapping the vulnerability of animal community to pressure in marine systems: disentangling pressure types and integrating their impact from the individual to the community level. ICES Journal of Marine Science, 72: 1470–1482

Coombs SH, Pipe RK & Mitchell CE (1981). The vertical distribution of eggs and larvae of blue whiting (*Micromesistius poutassou*) and mackerel, (*Scomber scombrus*) in the Eastern North Atlantic and North Sea. Rapports et Proces-Verbaux desReunions du Conseil International pour l'Exploration de la Mer.178. 188-195

Coull KA, Johnstone R & Rogers SI (1998). Fisheries Sensitivity Maps in British Waters. Report to United Kingdom Offshore Operators Association, Aberdeen, 58pp. http://www.cefas.co.uk/Publications/fsmaps/sensi_maps.pdf

Cox SL, Embling CB, Hosegood PJ, Votier SC & Ingram SN (2018). Oceanographic drivers of marine mammal and seabird habitat-use across shelf-seas: A guide to key features and recommendations for future research and conservation management. *Estuarine, Coastal and Shelf Science* 212: 294-310

Cranmer GJ (1988). Environmental survey of the benthic sediments around three exploration well sites. 1987. Aberdeen University Marine Studies Ltd Report 88/02 prepared for UKOOA

DECC (2008). EEMS Atmospheric Emissions Calculations. Issue 1.810a, Oil & Gas UK and the Department of Energy and Climate Change, 53pp.

DECC (2016). Offshore Energy Strategic Environmental Assessment 3, Environmental Report. Department of Energy and Climate Change, UK, 613pp. plus appendices.

Dernie KM, Kaiser MJ, Warwick RM (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*. 72(6):1043-1056.

Drinkwater KF, Belgrano A, Borja A, Conversi A, Edwards M, Greene CH, Ottersen G, Pershing AJ & Walker H (2003). The response of marine ecosystems to climate variability associated with the North Atlantic Oscillation. In: JW Hurrell, Y Kushnir, G Ottersen & M Visbeck Eds. The North Atlantic Oscillation: Climate significance and environmental impact. *Geophysical Monograph Series*. 134:211-234.

Eagle RA & Rees EIS (1973). Indicator Species – A Case for Caution. Marine Pollution Bulletin 4: 25.

Edwards DCB & Moore CG (2008). Reproduction in the sea pen *Pennatula phosphorea* (Anthozoa: Pennatulacea) from the west coast of Scotland. *Marine Biology* 155: 303–314

Ellis JR, Milligan SP, Readdy L, Taylor N & Brown MJ (2012). Spawning and nursery grounds of selected fish species in UK waters. Cefas Science Series: Technical Report 147: 60pp. For graphics: CEFAS spawning/nursery Ellis et al. 2012 - http://data.cefas.co.uk/#/View/153

ERT (2009). Data review for an industry wide response to cuttings pile management. Final report no ERT1987, 61pp.

European Marine Observation Data Network [EMODnet] (2022). Seabed habitats project. http://www.emodnet-seabedhabitats.eu

Forster PT, Storelvmo K, Armour W, Collins JL, Dufresne D, Frame DJ, Lunt T, Mauritsen MD, Palmer M, Watanabe M, Wild H & Zhang (2021). The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In: Masson-Delmotte VP, Zhai A, Pirani SL, Connors C, Péan S, Berger N, Caud Y, Chen L, Goldfarb MI, Gomis M, Huang K, Leitzell E, Lonnoy JBR, Matthews TK, Maycock T, Waterfield O, Yelekçi R Yu and Zhou B (eds.). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 132pp.

Fugro (2015). Pre-decommissioning Environmental Survey, UKCS Block 16/7a (Fugro report No. J/4/20/2805). Fugro EMU Limited

Fugro (2022a). Trees Pre-decommissioning Environmental Survey, UKCS Blocks 16/07a and 16/12a. Geophysical Results and Habitat Assessment Report (Fugro report no. 220056V1.3). Spirit Energy.

Fugro (2022b). Trees Pre-decommissioning Environmental Survey, UKCS Blocks 16/07a and 16/12a. Environmental Field Report (Fugro report no. 210835-R-001 01). Spirit Energy.

Fugro (2022c). Trees Pre-decommissioning Environmental Survey, UKCS Blocks 16/07a and 16/12a. Environmental Baseline Survey (Fugro report no. 220056V2.01). Spirit Energy.

Furness RW (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Gardline (2009). Rig Site and Environmental Survey, Survey Report, UKCS Block 16/12a. Report No. 8226. Venture North Sea Oil Limited

Gates AR & Jones DOB (2012). Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380m depth in the Norwegian Sea). PLoS One 7(10): e44114.

George JD & Hartmann-Schröder G (1985). Polychaetes: British Amphinomida, Spintherida and Eunicida. Synopses of the British Fauna (New Series), 32, pp. 1-221.

Gilles A, Authier M, Ramirez-Martinez NC, Araújo H, Blanchard A, Carlström J, Eira C, Dorémus G, Fernández- Maldonado C, Geelhoed SCV, Kyhn L, Laran S, Nachtsheim D, Panigada S, Pigeault R, Sequeira M, Sveegaard S, Taylor NL, Owen K, Saavedra C, Vázquez-Bonales JA, Unger B, Hammond PS (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pp. https://tinyurl.com/3ynt6swa

González-Irusta JM & Wright PJ (2015). Spawning grounds of Atlantic cod (*Gadus morhua*) in the North Sea. *ICES Journal of Marine Science* 73: 304-315.

Hammond PS, Lacey C, Gilles A, Viquerat S, Börjesso P, Herr H, Macleod K, Ridoux V, Santos MB, Scheidat M, Teilmann J, Vingada J, Øien N (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. SCANS 40pp.

Hartley Anderson (2005). 2004 Single Well Survey. Report to the Government/Industry Offshore Environmental Monitoring Committee by Hartley Anderson Limited in association with ERT (Scotland) Ltd and Identichaet.

Hartley Anderson (2023). Trees Fields Decommissioning Drill Cuttings Screening Assessment 040423. Hartley Anderson Reference: J-PDI-492. April 2023.

Harvey M, Gauthier D & Munro J (1998). Temporal changes in the composition and abundance of the macrobenthic invertebrate communities at dredged material disposal sites in the Anseà Beaufils, Baie des Chaleurs, Eastern Canada. *Marine Pollution Bulletin* 36:41–55.

Heessen HJL, Daan H & Ellis JR (2015). Fish Atlas of the Celtic Sea, North Sea and Baltic Sea. Wageningen Academic Publishers, the Netherlands, 572pp.

Hislop J, Bergsat OA, Jakobsen T, Sparholt H, Blasdale T, Wright P, Kloppmann M, Hillgruber N & Heessen H (2015). Codfishes (Gadidae). In: HJL Heessen, H Daan & JR Ellis (2015). Fish Atlas of the Celtic Sea, North Sea and Baltic Sea. Wageningen Academic Publishers, the Netherlands, pp.186-236

IoP (2000). Guidelines for the Calculation of Estimates of Energy use and Gaseous Emissions in the Decommissioning of offshore structures, The Institute of Petroleum, February 2000 ISBN 0 8593 255 3.

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). In: JT Houghton, Y Ding, DJ Griggs, M Noguer, PJ van der Linden and D Xiaosu (Eds.). Cambridge University Press, UK pp 944.

IPCC (2007). Climate Change 2007: The physical science basis. In: S Solomon, D Qin, M Manning, Z Chen, M Marquis, KB Averyt, M Tignor & HL Miller Eds. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996pp.

IPCC (2021). Climate Change 2021: The Physical Science Basis. Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. 41pp.

Jennings S & Kaiser MJ (1998). The Effects of Fishing on Marine Ecosystems. *Advances in Marine Biology* 34: 201–352.

JNCC (2019). Annex I habitats list. https://sac.jncc.gov.uk/habitat/

JNCC (1999). Seabird vulnerability in UK waters: block specific vulnerability. Joint Nature Conservation Committee, Aberdeen, 66pp

JNCC (2017). Using the Seabird Oil Sensitivity Index to inform contingency planning (updated guidance to reduce data coverage gaps) http://jncc.defra.gov.uk/PDF/Using%20the%20SOSI%20to%20inform%20contingency%20planning%202017.pdf

JNCC (2021a). Norwegian Boundary Sediment Plain MPA. https://jncc.gov.uk/our-work/norwegian-boundary-sediment-plain-mpa/

JNCC (2021b). Central Fladen MPA. https://jncc.gov.uk/our-work/central-fladen-mpa/

Jones EL, McConnell BJ, Smout S, Hammond PS, Duck CD, Morris CD, Thompson D, Russel DJF, Vincent C, Cronin M, Sharples RJ & Matthiopoulos J (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Marine Ecology Progress Series* 534: 235-249.

Künitzer A, Basford D, Craeymeersch JA, Dewarumez JM, Dörjes J, Duineveld GCA, Eleftheriou A, Heip C, Herman P, Kingston P, Niermann U, Rachor E, Rumohr H & de Wilde PAJ (1992). The benthic infauna of the North Sea: species distribution and assemblages. *ICES Journal of Marine Science* 49: 127-143.

Lane JV, Pollock CJ, Jeavons R, Sheddan M, Furness RW, Hamer KC (2021). Post fledging movements, mortality and migration of juvenile northern gannets. *Marine Ecological Progress Series* 671, 207–218. https://doi.org/10.3354/meps13804

Lissner AL, Taghon GL, Diener DR, Schroeter SC, Dixon JD (1991). Recolonisation of deep-water hard substrate communities: potential impacts from oil and gas development. *Ecological Applications* 1:258-267.

Lockwood SJ (1988). The mackerel: its biology, assessment and the management of a fishery. Fishing News Books, Farnham, Surrey, UK, 181p

Marine Scotland Data website https://data.marine.gov.scot/dataset/2021-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices

Marine Scotland (2022). Feature Activity Sensitivity Tool (FEAST): Feature - burrowed mud – all sensitivities. Accessed 29-08-2022 https://www.marine.scotland.gov.uk/feast/FeatureReport.aspx#0

Myhre G, Shindell D, Bréon F-M, Collins W, Fuglestvedt J, Huang J, Koch D, Lamarque J-F, Lee D, Mendoza B, Nakajima T, Robock A, Stephens G, TTakemura T & Zhang H (2013). Anthropogenic and Natural Radiative Forcing. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V & Midgley PM (Eds.) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 659-740.

NatureScot. (2020). Scottish Biodiversity List. https://www.nature.scot/scottish-biodiversity-list

Nedwell JR & Edwards B (2004). A review of measurements of underwater man-made noise carried out by Subacoustech Ltd, 1993–2003. Report for Chevron Texaco Ltd., TotalFinaElf Exploration UK PLC, DSTL, Department of Trade and Industry, and Shell UK Exploration. ISBN Number: 534R0109.

Newell RC, Seiderer LJ & Hitchcock DR (1998). The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. *Oceanography and Marine Biology: An Annual Review* 36: 127-178.

Newton AW (1984). Scottish tagging experiments in the North Sea and in division VIa. ICES CM 1984 G:67: 4.

Nilsen R & Holthe T (1985). Arctic and Scandinavian Oweniidae (Polychaeta) with a description of Myriochele fragilis sp.n., and comments on the phylogeny of the family. Sarsia. 70(1), pp. 17-32

NMPi (2018). National Marine Plan Interactive. Available at http://www.gov.scot/Topics/marine/seamanagement/nmpihome

North Sea Task Force [NSTF] (1993). North Sea quality status report 1993. North Sea Task Force (OSPARCOM and ICEA). Olsen and Olsen

OGA (2021). Decommissioning Strategy https://www.nstauthority.co.uk/media/7538/decommissioning-strategy-may-2021.pdf

OGUK (2019). Environment Report 2019. Oil & Gas UK, 62pp

OSPAR (2008). OSPAR List of threatened and/or declining species and habitats. Reference Number: 2008-06. http://www.ospar.org/workareas/ bdc/species-habitats/list-of-threatened-declining-species-habitats.

OSPAR (2006). Harmonised reporting format to compile environmental monitoring data and information related to offshore oil and gas activities. OSPAR 2006-07, OIC 06/7/1-E.

OSPAR (2009). OSPAR Background document for ocean quahog *Arctica islandica*. Biodiversity series.

OSPAR (2010) Background document for sea pens and burrowing megafauna. OSPAR Commission biodiversity series Publication Number: 481/2010.

OSPAR (2019). Assessment of the disturbance of drilling cuttings during decommissioning. https://oap-cloudfront.ospar.org/media/filer_public/55/76/557644a6-a67f-44c8-802d-564041f07bc6/p00745_disturbance_drill_cuttings_decommissioning.pdf

Pangerc T, Robinson S, Theobald P & Galley L (2016). Underwater sound measurement data during diamond wire cutting: first description of radiated noise. *Proceedings of Meetings on Acoustics* 27: 040012.

Parapar J (2003). Two new species of Myriochele (Polychaeta: Oweniidae) from the Bransfield Strait, Antarctica. Antarctic Science, 15(02), pp. 219-226

PDi Ltd. (2021). Trees Pipeline Burial Profiles, October 2021. 2715-PDI-PE-TN-002 Rev. C1

Pikesley SK, Godley BJ, Ranger S, Richardson PB & Witt MJ (2014). Cnidaria in UK coastal waters: description of spatio-temporal patterns and inter-annual variability. *Journal of the Marine Biological Association of the United Kingdom* 94: 1401-1408.

Raitt DFS & Mason J (1968). The distribution of Norway pout in the North Sea and adjacent waters. *Marine Research*, 4. 19 pp

Reid JB, Evans PGH & Northridge SP (2003). Atlas of Cetacean distribution in north-west European waters, JNCC, Peterborough, ISBN 1 86107 550 2.

Reiss H, Degraer S, Duineveld GCA, Kröncke I, Aldridge J, Craeymeersch JA, Eggleton JD, Hillewaert H, Lavaleye MSS, Moll A, Pohlmann T, Rachor E, Robertson M, Vanden Berghe E, van Hoey G & Rees HL (2010). Spatial patterns of infauna, epifauna and demersal fish communities in the North Sea. *ICES Journal of Marine Science* 67: 278-293.

Russell DJF, Jones EL & Morris CD (2017). Updated seal usage maps: the estimated at-sea distribution of grey and harbour seals. *Scottish Marine and Freshwater Science* Vol 8 No 25, 25pp.

Scott WB & Scott MG (1988). Atlantic fishes of Canada. *Canadian Bulletin of Fisheries and Aquatic Sciences*, 219: 286 – 288.

Scottish Government (2015). Scotland's National Marine Plan: A single Framework for Managing our Seas. A report published by The Scottish Government, 144pp.

Shine KP (2009). The global warming potential – the need for an interdisciplinary retrial. Climatic Change 96: 467-472.

Skov H, Durinck J, Leopold MF & Tasker ML (1995). Important bird areas for seabirds in the North Sea, including the Channel and the Kattegat. Birdlife International.

Spirit Energy (2018) Guidance for Environmental Management in Capital Projects. CEU-HSEQ-GEN-GUI-0026

Spirit Energy (2022). Trees Pipeline & Bundle Decommissioning Comparative Assessment.

Tasker ML & Pienkowski MW (1987). Vulnerable concentrations of birds in the North Sea. Nature Conservancy Council

Thaxter CB, Lascelles B, Sugar K, Cook ASCP, Roos S, Bolton M, Langston RHW & Burton NHK (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation* 156: 53-61.

Tillin HM, Hull SC & Tyler-Walters H (2010). Development of a sensitivity matrix (pressures-MCZ/MPA features). Report to the Department of the Environment, Food and Rural Affairs from ABPmer, Southampton and the Marine Life Information Network (MarLIN) Plymouth: Marine Biological Association of the UK., Defra Contract no. MB0102 Task 3A, Report no. 22., London, 145 pp.

Tyler-Walters H, James B, Carruthers M (eds.), Wilding C, Durkin O, Lacey C, Philpott E, Adams L, Chaniotis PD, Wilkes PTV, Seeley R, Neilly M, Dargie J & Crawford-Avis OT (2016). Descriptions of Scottish Priority Marine Features (PMFs). Scottish natural Heritage Commissioned Report No. 406

UKHO (2012). North Coast of Scotland Pilot: North and north-east coasts of Scotland from Cape Wrath to Rattray Head and including Caledonian Canal, Orkney Islands, Shetland Islands, and Føroyar (Faroe Islands). 8th edition. The Hydrographer of the Navy, UK, 322pp

Van Dalfsen JA, Essink K, Toxvig Madsen H, Birklund J, Romero J & Manzanera M (2000). Differential response of macrozoobenthos to marine sand extraction in the North Sea and the western Mediterranean. *ICES Journal of Marine Science* 57:1439-1445.

Van Damme CJG & Thorsen A (2014). Mackerel historic fecundity and atresia data from the mackerel egg survey. Working document for the mackerel benchmark at the WKPELA, 6pp

Wakefield ED, Own E, Baer J, Carroll MJ, Daunt F, Dodd SG, Green JA, Guilford T, Mavor RA, Miller PI, Newell MA, Newton SF, Robertson GS, Shoji A, Soanes LM, Votier SC, Wanless S & Bolton M (2017). Breeding density, fine-scale tracking and large-scale modelling reveal the regional distribution of four seabird species. *Ecological Applications* 27: 2074-2091.

Wanless S & Okill JD (1994). Body measurements and flight performance of adult and juvenile gannets *morus bassanus*. *Ringing & Migration*, 15: 101-103

Williams JM, Tasker ML, Carter IC & Webb A (1995). A method of assessing seabird vulnerability to surface pollutants. Ibis 137: S147 – S152.

Witt MJ, Broderick AC, Johns DJ, Martin C, Penrose R, Hoogmoed MS & Godley BJ (2007). Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. *Marine Ecology Progress Series* 337: 231-244.

Woodward I, Thaxter CB, Owen E & Cook ASCP (2019). Desk-based revision of seabird foraging ranges used for HRA screening. Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate. BTO Research Report No. 724, 139pp.