MARATHON BRAE

Brae Alpha, Brae Bravo, Central Brae, West Brae and Sedgwick Combined Decommissioning Programmes Environmental Statement: Main Report

June 2017 Consultation Draft

Marathon Oil

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www.marathonoil.com/braedecom

StakeholderBraeDecom@MarathonOil.com

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Approvals

	Name	Date
Prepared by	Peter Bruce Ramboll Environ	June 2017
Reviewed by	Felicity Arthur Ramboll Environ	June 2017
Approved by	Louisa Dunn Advanced Environmental Professional	June 2017

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Contents

Figures

Tables

Terms and Abbreviations

AE	Accidental Event
APE	Alkylphenol Ethoxylates
BAT	Best Available Technique
BEIS	Department of Business Energy and Industrial Strategy (UK Government)
BEP	Best Environmental Practice
CA	Comparative Assessment
CITES	Convention on International Trade of Endangered Species of wild fauna and flora
CO_2	Carbon Dioxide
DP	Decommissioning Programme
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ES	Environmental Statement
ERL	Effects Range Low - value is the lower tenth percentile of the data set.
ERM	Effects Range Median
EUNIS	European Nature Information System
EWC	European Waste Code
FPV	Fall Pipe Vessel
ICES	International Council for the Exploration of the Sea
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LOI	Loss on Ignition
MDAC	Methane-Derived Authigenic Carbonates
MMO	Marine Mammal Observer
NEBA	Net Environmental Benefits Analysis
OPEP	Oil Pollution Emergency Plan
OSPAR	"OS" for Oslo and "PAR" for Paris Convention
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
PCB	Polychlorinated Biphenyls
PMF	Priority Marine Feature
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SD	Seabed disturbance
SEL	Sound Exposure Level

SEPA	Scottish Environment Protection Agency
SFF	Scottish Fishermen's Federation
SNH	Scottish Natural Heritage
SPL	Sound Peak Level
SR	Scoping Report
ROV	Remote Operated Vehicle
TBT	Tributyltin
THC	Total Hydrocarbon Concentration
TTS	Temporary Threshold Shift
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UN	Underwater Noise

Executive Summary

Marathon Oil U.K. LLC (Marathon Oil) is seeking approval of the Combined Decommissioning Programmes (DPs) [1] for the Brae Alpha and Brae Bravo platforms, along with Central Brae subsea installation, West Brae subsea installation, Sedgwick subsea installation and all associated pipelines, flowlines, umbilicals and power management system cables (the installations).

This non-statutory Environmental Statement (ES) is submitted to the Department of Business Energy and Industrial Strategy (BEIS) by Marathon Oil as part of the Decommissioning Programme (DP), under the Petroleum Act 1998, as amended by the Energy Act 2008.

The environmental assessment process has considered the potential for significant environmental effects as a result of interactions between the proposed decommissioning activities and sensitive environmental receptors. The potential activity/receptor interactions were considered for the following categories:

- effects on designated sites/ species disturbance;
- seabed disturbance effects (marine benthos, natural seabed sediment and drill cuttings pile);
- noise effects (fish, marine mammals, seabirds);
- water quality effects (water quality, plankton, fish, shellfish, marine mammals);
- socio-economic and other effects (commercial fisheries, shipping/navigation, recreation);
- atmospheric emission effects (energy use, climate change, air quality);
- accidental events (risk to water quality and supported marine life).

Following the scoping stage the key issues identified for further detailed assessment are:

- Seabed disturbance effects –considering the potential effects on both soft sediment and hard substrate benthic communities as a result of jacket/sub-structure removal, removal of the subsea installations, pipelines, flowlines, umbilicals and cables.
- Underwater noise effects – considering the potential effects of cutting activities on marine mammals.
- Cumulative and transboundary effects.

The assessment of environmental effects is presented under the following subheadings, consistent with the DP:

- Surface facilities – topsides;
- Jacket/sub-structures and subsea installations;
- Decommissioning pipelines;
- Decommissioning stabilisation features; and
- Decommissioning drill cuttings piles.

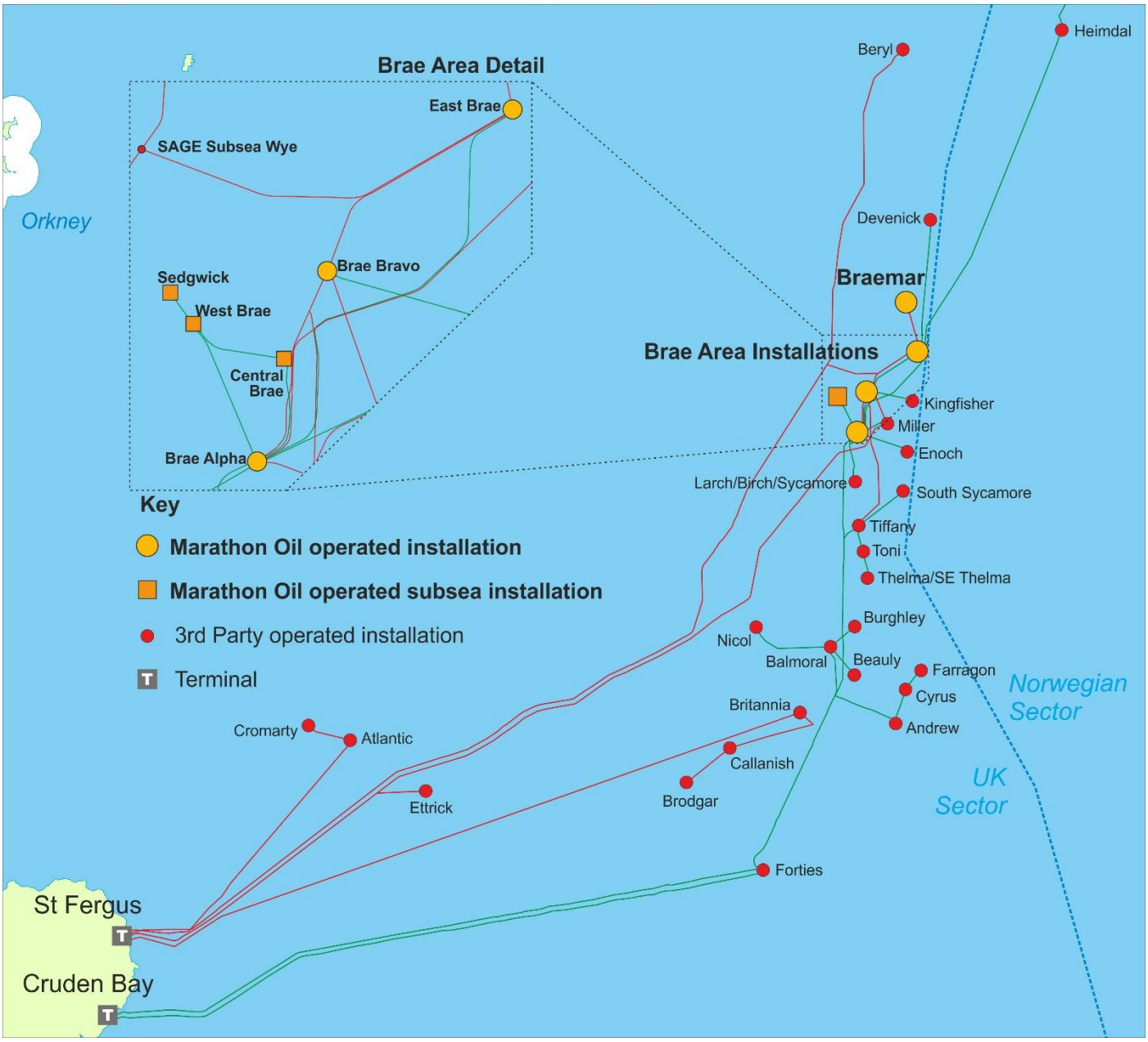
The environmental assessment has not identified any significant residual environmental effects, however Marathon Oil has set out a schedule of environmental management commitments in Section 6 of this document to further reduce the potential for environmental effects.

1. Introduction

Marathon Oil U.K. LLC (Marathon Oil) is seeking approval of the Combined Decommissioning Programmes (DPs) for the Brae Alpha and Brae Bravo platforms, along with Central Brae subsea installation, West Brae subsea installation, Sedgwick subsea installation and all associated pipelines, flowlines, umbilicals and power management system cables (the installations). The installations are located approximately 270 kilometres (km) north-east of Aberdeen, as illustrated in Figure 1.1.

This Environmental Statement (ES) reports on the non-statutory Environmental Impact Assessment (EIA) process which has been completed and provides an assessment of the potential for significant environmental effects as a result of the decommissioning activities associated with the proposed DP. The assessment of environmental effects and management of the EIA process has been undertaken by a team of experienced environmental specialists. The ES has been prepared by Ramboll Environ UK Ltd.

Figure 1.1: Location of Installations



1.1 Document Interface

In order to provide a streamlined suite of documents to support the DP application, this ES should be read alongside the other DP documents. The DP provides the description of the proposed decommissioning activities and has been used as the key reference for the purpose of identifying the potential for significant environmental effects. Table 1.1 illustrates the interface between the DP and ES.

Table 1.1: Decommissioning Programme Document Interface

Decommissioning Programme Contents [1]		Environmental Statement Content [this document]
1 Executive Summary		DP provides contextual information for ES.
2 Description of Items to be Decommissioned		DP provides a description of the scope of the decommissioning programme and was used for the purpose of describing the main physical characteristics of the items to be decommissioned.
3 Removal and Disposal Methods		DP provides a description of the proposed decommissioning activities. This was used as the basis of scoping and assessing potential interaction with environmental receptors. DP provides a description of the comparative assessment process used to assess decommissioning options. ES Section 5: Summary of Environmental Effects provides an assessment of environmental effects for each item listed under section 3 of the DP.
4 Environmental Impact Assessment		ES provides the basis of the summary of environmental impact assessment in the DP.
5 Interested Party Consultations		ES provides further details of scoping consultation carried out as part of the EIA Process in Technical Appendix 2.1: Scoping Consultation Responses.
6 Programme Management		DP provides input to ES on the overall programme of decommissioning activities.
7 Supporting Documents		n/a
8. Partner Letter(s) of Support		n/a

2. EIA Process and Methodology

2.1 Requirement for EIA

The requirement for EIA for the decommissioning of offshore oil and gas installations is not explicitly required under existing UK legislation. However the primary guidance on decommissioning offshore installations: *Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998* (DECC, 2011 [2]) states that an ES should be submitted with the DP.

The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999 (S.I. 1999/360 [3]), as amended (S.I. 2007/933 [4]) (the EIA regulations) require an EIA for certain offshore developments. The guidance associated with these regulations advises that this EIA should consider the environmental effects associated with the decommissioning of the installations.

2.1.1 Content of the ES

The information normally required in an ES is set out in Schedule 4 of the EIA Regulations [4]. In addition, guidance is provided by BEIS [2] on the suggested content of an ES for decommissioning of Oil and Gas infrastructure. Table 2.1 presents a summary of these requirements and indicates where the information is provided in this ES.

Table 2.1: Content of the ES

	Required Information	Section of ES
Required by EIA Regulations		
A	A description of the project comprising information on the site, design and size of the project, the seabed use requirements, a description of the main characteristics of the project, and an estimate by type and quantity of the expected residues and emissions.	The DP document provides: • a description of the main characteristics of the installations identified as falling within the scope of the DP. This ES document provides: • a summary of the estimated type and quantity of residues and emissions associated with the DP (ES Section 4: Scope of EIA).
B	A description of the measures envisaged to avoid, reduce and, if possible remedy significant adverse effects on the environment.	ES Section 6: Schedule of Environmental Management Controls provides a summary of the committed mitigation measures included within the DP to avoid, or reduce environmental effects.
C	The data required to identify and assess the main effects which the project is likely to have on the environment and where relevant to the particular characteristics of the project or the environmental features likely to be affected.	The ES document provides a summary of the environmental effects as follows: ES Section 3: Environmental Baseline provides a summary of the environmental baseline, to identify sensitive receptors. ES Section 4: Scope of EIA provides a summary of the aspects of the environment likely to be significantly affected, and those aspects that could be scoped out of the

Table 2.1: Content of the ES

	Required Information	Section of ES
		detailed assessment based on overarching principles. ES Section 5: Summary of Environmental Effects provides a description of the potential for effects for each of the main activity/receptor interactions identified during the scoping work under the following sub-headings: • Seabed Disturbance Effects • Underwater Noise Effects • Accidental Events • Cumulative and Transboundary Effects
D	An outline of the main alternatives (if any) studied by the undertaker and an indication of the main reasons for his choice, taking into account the environmental effects.	The DP document provides a description of the Comparative Assessment (CA) process followed by Marathon Oil. The CA process considered environmental effects, alongside safety, technical, societal and cost factors in coming to a decision on the preferred solution.
E	A non-technical summary of the information provided under the above headings.	A Non-Technical Summary is provided in the executive summary of this ES.
F	An indication of any difficulties (technical difficulties or lack of know-how) encountered by the undertaker in compiling the required information.	The technical appendices supporting Section 5: Summary of Environmental Effects outline the limitations and assumptions made in making the environmental assessment.
	Suggested Content – Guidance Notes [2]	
G	All potential impacts on the marine environment including exposure of biota to contaminants; other biological impacts arising from physical effects; conflicts with the conservation of species and their habitats.	ES Section 4: Scope of EIA provides a summary of the aspects of the environment potentially significantly affected, and those aspects that could be scoped out of the detailed assessment based on overarching principles. Section 4 is supported by Technical Appendix 4.1: Scoping Rationale, which provides the basis for scoping decisions made in relation to the exposure of biota to contaminants. Physical effects and underwater noise effects on marine mammals are covered in Section 5: Summary of Environmental Effects. Section 6: Schedule of Environmental Management Controls includes reference to

Table 2.1: Content of the ES

	Required Information	Section of ES
		measures proposed to avoid disturbance to the drill cuttings piles and the potential to mobilise contaminants.
H	All potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and impacts on the soil.	Impacts associated with emissions to the atmosphere have been scoped out. ES Section 4: Scope of EIA provides a summary of the rationale for scoping out further consideration of emissions to the atmosphere.
I	Consumption of natural resources and energy associated with reuse and recycling.	ES Section 4: Scope of EIA provides detail on the objectives for waste and materials management and on energy use associated with decommissioning. The DP provides information on potential waste streams and recycling targets associated with the project. There are no other significant natural resource uses associated with the proposed decommissioning activities.
J	Interference with other legitimate users of the sea and consequential impacts on the physical environment.	The DP provides information on the proposed post-decommissioning safety zone to be established around the remaining jacket/sub-structure footings, from which other vessels, including commercial fishing vessels will be excluded. The area of sea affected by these safety zones is considered negligible in the context of the wider North Sea available for commercial fishing activities. No further information is provided in the ES.
K	Potential impacts on amenities, the activities of communities and on future uses of the environment.	The scope of the EIA is focussed on offshore decommissioning activities. No potentially significant effects on amenities, communities or the future uses of the environment have been identified. Onshore activities would be completed at appropriately licensed and permitted sites, and therefore any environmental effects would be managed in accordance with legislation and regulations relevant to those sites. No further information is provided in the ES.

2.1.2 Structure of the Environmental Statement

This ES contains the environmental information required by the EIA Regulations and comprises the following sections:

- Environmental Statement: Main Report, comprising:
  - Table of Contents;
  - Terms and Abbreviations;
  - Non-Technical Executive Summary;
  - Section 1: Introduction;
  - Section 2: EIA Process and Methodology;
  - Section 3: Environmental Baseline;
  - Section 4: Scope of EIA;
  - Section 5: Summary of Environmental Effects;
  - Section 6: Schedule of Environmental Management Controls.
- Environmental Statement: Technical Appendices, comprising:
  - Technical Appendix 2.1: Scoping Consultation Register;
  - Technical Appendix 3.1: Brae Area Environmental Baseline: Seabed Sediment Chemical Baseline Data;
  - Technical Appendix 3.2: Brae Area Environmental Baseline: Fisheries;
  - Technical Appendix 4.1: Scoping Rationale;
  - Technical Appendix 4.2: Accidental Events;
  - Technical Appendix 5.1: Underwater Noise Impact Assessment;
  - Technical Appendix 5.2: Seabed Disturbance Effects.

2.2 EIA Process

2.2.1 Scoping and Consultation

An iterative scoping process reported within an EIA scoping report was used as the basis for consultation with stakeholders on the proposed scope of the EIA. The scoping report was submitted to DECC, JNCC, Marine Scotland and SEPA in February 2016[1]. The EIA Scoping Report sets out a description of the emerging parameters of the proposed DP. The scoping report also identifies the potential for environmental impacts across a wide range of features of the receiving environment and the key environmental effects to be considered further as part of the EIA.

The EIA has been scoped by means of a multi stage scoping process. The aim of the multi stage process was to agree a focused and proportionate EIA and ES, targeted to the specific requirements of the proposed Brae Area decommissioning activities. The scoping report identified potential activity/receptor interactions and provided further information to further characterise the potential for environmental effect. The scope of the EIA proposed was developed to address those activity/receptor interactions deemed to have medium or high potential to result in significant environmental effects at the scoping stage.

[1] *Available to download at URL: http://www.marathonoil.com/braedecom*

2.2.1.1 Scoping Responses

The responses received following the scoping consultation were generally in support of the proposed scope of the EIA. A summary of the key points raised by stakeholders in response to the EIA Scoping Report is provided in Technical Appendix 2.1: Scoping Consultation Register.

2.2.1.2 Final Scope of Assessment

As described in the Scoping Report, there is the potential for the Comparative Assessment (CA) process to rule out some potential activity/receptor interactions. Prior to the scoping consultation, consideration was given to a wide range of potential activities under consideration as part of the CA process (e.g. full and partial removal of jacket/sub-structures). The CA concluded that, subject to derogation approval, partial removal of the jacket/sub-structures with footings left in place would be the preferred option. This allowed the scope of EIA to focus only on those activities associated with the partial removal of the jacket/sub-structure and scope out activities solely associated with full removal of the jacket/sub-structure.

Further details on the final scope of the EIA are provided in ES Section 4: Scope of EIA and supported by Technical Appendix 4.1: Scoping Rationale.

2.3 Assessment Methodology

The EIA Regulations require 'a description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development.'

In this ES, the term 'effects' has been used to mean changes to environmental receptors resulting from the proposed decommissioning activities, following the approach in the wording of the EIA Regulations. A distinction is made between the 'impact,' defined as the action being taken, and the 'effect,' defined as the change resulting from that action. These terms and the meanings quoted above are used throughout this assessment.

Assessment criteria are required to evaluate environmental effects. Significance is generally determined through a combination of the sensitivity of a receptor to an effect and the magnitude of the change. This process and key definitions of 'Significance,' 'Sensitivity,' and 'Magnitude' are summarised below:

- identification of baseline conditions within the Brae Area and its surrounding environment, including the sensitivity of receptors which may be affected by changes in the baseline conditions;
- consideration of the magnitude of potential changes to the environmental baseline;
- assessment of the significance of effect taking into account sensitivity of receptors and magnitude of effect;
- identification of appropriate mitigation measures if required; and
- assessment of significance of residual effects taking account of any mitigation measures.

Where appropriate, alternative approaches to the generic approach described here are detailed in the relevant technical assessment.

2.3.1 Baseline Characterisation

The purpose of the EIA is to predict how environmental conditions may change as a result of the activities set out within the DP. This requires that the current environmental conditions (prior to

decommissioning commencing) are established. This is referred to as the baseline and has been established through a combination of desk-based research, site survey and empirical studies and projections. Together, these have been used to describe the current character of the Brae Area and the value and vulnerability of key environmental resources and receptors present, against which any changes or effects resulting from the proposed DP can be identified, understood and assessed.

The baseline for this EIA has been taken as the 'current' operating conditions of the Brae Area and its immediate surroundings. Further information is provided in Section 3: Environmental Baseline.

2.3.2 Consideration of Alternatives

The EIA Regulations require that the Applicant provides an outline of any alternatives studied and to provide an indication of the reasons for selecting the preferred alternative, taking into account environmental effects.

The DP document provides a summary of the CA process completed in determining the proposed decommissioning options. The CA process considered potential environmental effects alongside technical, safety and societal factors. In addition, a detailed appraisal of the environmental effects associated with different management options for the drill cuttings piles was undertaken. This appraisal used an Ecosystem Service valuation and Net Environmental Benefits Analysis approach to assess the optimum solution for managing the drill cuttings piles, comparing the potential loss and gain of ecosystem service value associated with each management option, where ecosystem services are defined as the direct and indirect contributions of ecosystems to human wellbeing and are generally described in four categories of provisioning (e.g. food and fisheries), regulating (e.g. climate, air), cultural (e.g. recreational use) and supporting services (e.g. nutrient cycling).

2.3.3 Impact Assessment

2.3.3.1 Nature, Type and Reversibility of Effect

Unless specified elsewhere, the definitions set out in Table 2.2 are applied with regard to the nature, type and reversibility of effects.

Table 2.2: Nature, Type and Reversibility

Category	Description	Detail
Nature	Adverse	• an effect that is considered to represent an adverse (negative) change from the baseline or to introduce a new, undesirable factor.
	Beneficial	• an effect that is considered to represent an improvement to the baseline or to introduce a new, desirable/ beneficial factor.
Type	Direct	• effects that result from a direct interaction between a planned project activity and the receiving environment (e.g. the loss or disturbance of a habitat during subsea installation removal).
	Indirect or secondary	• effects that result indirectly from other direct effects/decommissioning activities as a result of pathway, (e.g. the disturbance of drill cuttings piles where there is a direct effect on water quality and indirect effect on ecological receptors e.g. fish or marine mammals).
	Cumulative or in-combination	• the potential for individual activity/receptor interactions associated with each of the decommissioning activities set out

Table 2.2: Nature, Type and Reversibility		
Category	**Description**	**Detail**
		within the DP to combine with each other and have a significant cumulative effect will be considered where there is the potential for the activity/receptor interaction to be either spatially or temporally concurrent; • the potential for cumulative effects to result from the addition or combination of activities to decommission East Brae and Braemar, with the activities proposed to decommission Brae Alpha, Brae Bravo and other area wide subsea installations, and vice versa; • the potential for cumulative effects associated with the addition or combination of the Marathon Oil Brae Area decommissioning activities, with other known proposed DPs submitted to BEIS by other operators, where it is considered likely that there would be a spatial or temporal overlap.
Reversibility	Reversible/temporary	• effects on resources/receptors that cease to be evident, either immediately or following an acceptable period of time, after termination of a project activity (e.g., turbidity levels in the water column will return to normal levels shortly after the removal works in an area are finalised).
	Irreversible/permanent	• effects on resources/receptors that are evident following termination of a project activity and that remain for an extended period of time. Effects that cannot be reversed by implementation of mitigation measures.

2.3.3.2 Sensitivity/Importance of Receptors

The sensitivity of the baseline conditions is defined according to the relative importance of existing environmental features within or in the vicinity of the site, or by the sensitivity of receptors which would potentially be affected by the proposed DP.

Criteria for the determination of sensitivity (e.g. high, medium, or low) or of importance (e.g. international, national, regional or authority area) are established based on prescribed guidance, legislation, and/or expert judgement. The sensitivity ratings consider a variety of factors including value (e.g. conservation status, legal protection, socioeconomic value) and adaptability, tolerance and recoverability following exposure to an impact.

Table 2.3 sets out a set of generic criteria used to determine the sensitivity of the receptors. Further detail and examples of the criteria used for each environmental receptor are provided where relevant in the Technical Appendices supporting Section 5: Summary of Environmental Effects.

Table 2.3: Sensitivity/Importance	
Category	**Description**
Low	• A receptor that is not important to the functions/services of the wider ecosystem/socioeconomy or that is important but resistant to change (in the context of project activities) and will naturally or rapidly revert to pre-impact status once activities cease.

Medium	• A receptor that is important to the functions/services of the wider ecosystem/socioeconomy. It may not be resistant to change, but it can be actively restored to pre-impact status or will revert naturally over time.
High	• A receptor that is critical to ecosystem/socioeconomy functions/services, not resistant to change and cannot be restored to pre-impact status. May be the subject of international/national designation/legal protection.

2.3.3.3 Magnitude of Change

The magnitude of change to environmental baseline conditions is identified through detailed consideration of the proposed DP, taking due cognisance of the following factors:

- the intensity of the impact;
- the geographic extent of impact; and
- the duration of impact.

Table 2.4 sets out generic criteria used to determine and characterise the anticipated magnitude of change. Further detail and examples of the criteria used for each environmental receptor are provided where relevant in the Technical Appendices supporting Section 5: Summary of Environmental Effects.

Table 2.4: Magnitude of Change

Intensity	
None	• No effect on the receptor within the affected area.
Small	• Small effect on individuals/species within the affected area, but overall the functionality of the receptor remains unaffected.
Medium	• Partial effects on individuals/species within the affected area. Overall, the functionality of the receptor will be partially lost within the affected area.
Large	• Partial effects on individuals/species within the affected area. Overall, the functionality of the receptor will be partially or completely lost within and outside the affected area.
Geographic extent of impact	
Local	• Effects are restricted to the area where the activity is undertaken (within 10 km).
Regional	• Effects are outside the immediate vicinity of the project area (local impacts), and more than 10 km outside project area.
National	• Effects will be restricted to the UKCS sector.
Transboundary	• Effects will be experienced outside of the UKCS sector.
Duration of impact	
Short term	• Effects throughout the project activity and up to one year after.
Medium term	• Effects that continue over an extended period, between one and 10 years after the project activity.
Long term	• Effects that continue over an extended period, more than ten years after the project activity.

In the case of accidental events a risk based approach is used to characterise the effect, including consideration of the likelihood of effect occurrence.

2.3.3.4 Mitigation

Mitigation is defined here as measures identified through the consideration of alternatives, physical design, project management or operation to prevent, reduce and where possible offset any significant adverse effects on the environment. Some of the measures described as mitigation measures within the assessment sections comprise measures that do not relate to likely significant adverse effects, but have been included within the project assumptions or mitigation measures to further reduce the level of effects of the proposed development or implement best practice.

Mitigation has been considered as an integral part of the overall DP, including 'embedded' mitigation (e.g. undertaking a comparative assessment to identify the most appropriate decommissioning methodology) rather than relying solely on additional measures to prevent or reduce significant environmental effects.

In all cases, it is anticipated that the mitigation measures presented in Section 6: Schedule of Environmental Management Controls will be revisited to consider their relevance at the point of preparing an ES to support future marine licence applications.

2.3.3.5 Assessment of Residual Effects

The assessment of residual environmental effects identifies the likely significant effects associated with the DP following the implementation of committed mitigation measures. Significance relies on accepted thresholds and criteria where available, or, for situations in which such are not available, expert knowledge and judgments.

Within this ES, significance has been evaluated with reference to defined standards, accepted/published criteria and legislation, where available. Where it has not been possible to quantify potential impacts and residual effects, qualitative assessments have been carried out, based on expert knowledge and judgement. Where uncertainty exists, it has been noted in the relevant assessment discussion and a conservative approach adopted so that the significance will not be under-estimated.

The scale of the predicted residual effect has then been classified according to the following semantic scale:

- **None/Negligible** – no or imperceptible effect;
- **Minor** - slight, very short or highly localised effect;
- **Moderate** - limited effect (by magnitude, duration, reversibility, value and sensitivity of receptor) which may be considered significant; and
- **Major** - considerable effect (by magnitude, duration, reversibility, value and sensitivity of receptor) which may be more than of a local significance).

The significance of each effect is then identified based on the matrix and categories described in Table 2.5. The specific criteria applied for each technical assessment are included within the technical appendices supporting Section 5: Summary of Environmental Effects.

Table 2.5: Assessment Matrix

		Sensitivity of the Receptor		
		Low	**Medium**	**High**
Magnitude	None	None/Negligible	Minor	Moderate
	Small	Minor	Moderate	Moderate
	Medium	Moderate	Moderate	Major
	Large	Moderate	Major	Major

The significance grading is then tested/qualified through expert judgement based on consideration of probability and level of certainty of the impact occurring, and use of judgement as to whether mitigation is required. Moderate and Major effects are considered significant.

2.3.3.6 Cumulative and Transboundary Effects

The potential for cumulative and transboundary effects are considered in ES Section 5: Summary of Environmental Effects. This considers the potential effects of each of the decommissioning activities in respect to potentially significant effects which may extend across the Norwegian boundary line, where their occurrence has the potential to result in environmental and/or socio-economic impacts.

2.3.4 Assumptions and Limitations

A number of assumptions have been made during preparation of the ES, which are set out below:

- baseline conditions have been established from a variety of sources, including historical data, but due to the dynamic nature of certain aspects of the environment, conditions at the Brae Area may change;
- the assessments contained within Section 5 and associated Technical Appendices are based on the current or emerging legislative and policy framework;
- it is assumed that information received from third parties is accurate, complete and up to date;
- the assessments contained within Section 4, Section 5 and associated Technical Appendices are based upon the project description provided in the DP and take account of the reasonable 'worst environmental case' option considered as part of the comparative assessment process for the various decommissioning activities; and
- the assessments contained within Section 4, Section 5 and associated Technical Appendices are based on the assumption that mitigation measures proposed would be secured through regulatory regimes (e.g. by licence condition).

Assumptions specific to certain environmental aspects are discussed where relevant within the ES.

3. Environmental Baseline

3.1 Introduction

This section sets out data relating to the existing baseline characteristics of the Brae Area, as it relates to the Brae Alpha and Brae Bravo platforms and associated field infrastructure (pipelines and subsea structures).

3.2 Overview

For the purposes of this report the environmental baseline has been taken to be a representation of the characteristics currently existing within the Brae Area. The following sections include a summary of the likely physical, chemical, biological, and socioeconomic baseline characteristics of the Brae Area. This characterisation is based primarily on published data sources, supplemented by a review of Brae Area specific survey data over the time period since commencement of exploration (1981 to 2015).

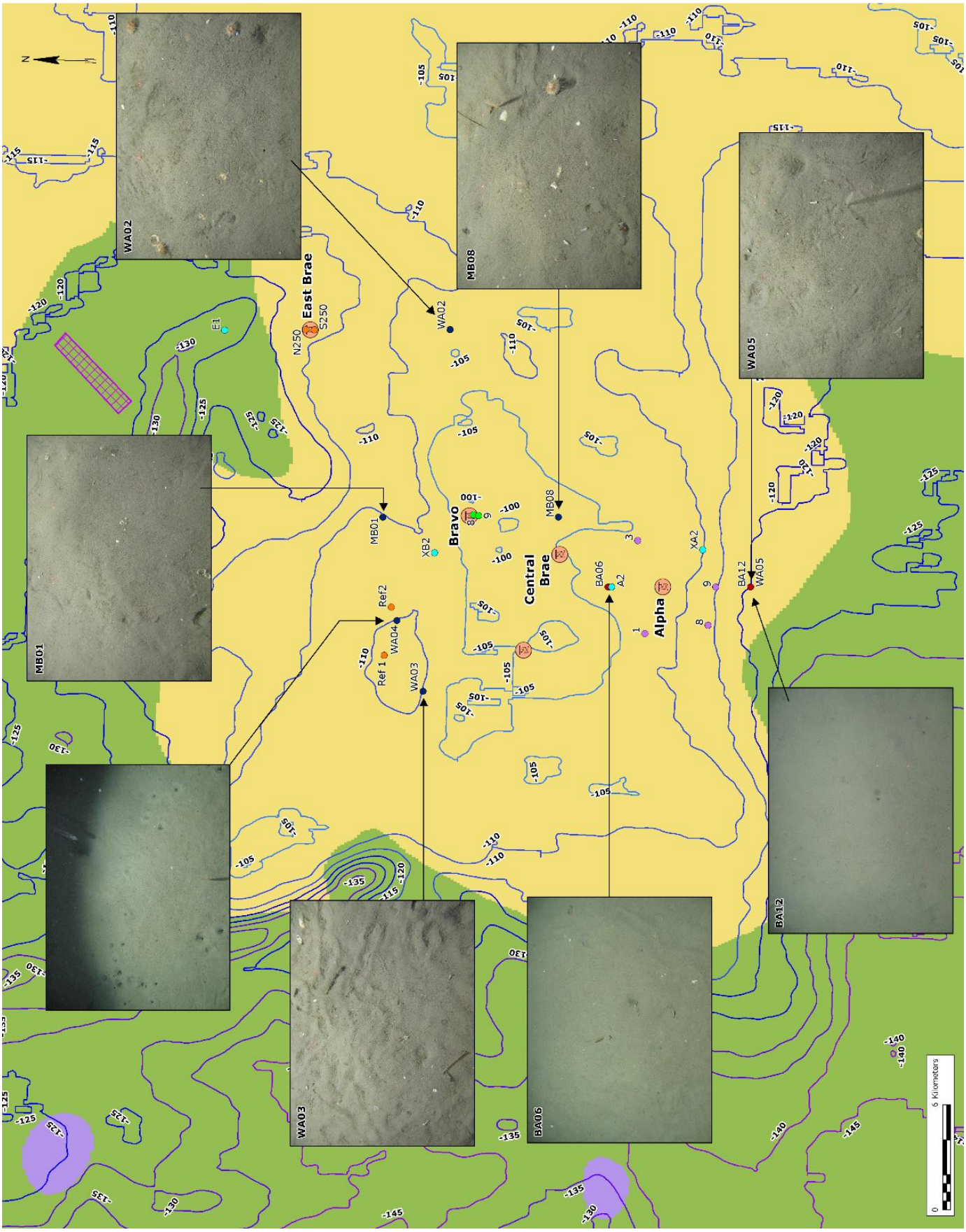
3.3 Hydrography

Water depth in the Brae Area ranges from approximately 90 to 116 m (NCS, 2013 [5]) (Figure 3.1). The East Shetland Atlantic Inflow is the dominant current in the region, with the Fair Isle current dominating the local hydrography around the Brae Area. The current flows south through the Fair Isle channel before circulating in the north and central North Sea. Seabed currents in the Brae Area are generally less than 0.43 m/s (Natural Environment Research Council, 1998 [6]).

Non-tidal currents in the Brae Area are dependent on meteorological conditions and are therefore irregular in nature but generally have an easterly set. The northern North Sea experiences the highest 50 year extreme maximum wave height in the North Sea of 30 - 32 m with a corresponding wave period of 18-19 seconds (OSPAR Commission, 2000 [7]). However, the annual mean wave height (average height of the highest 1/3 of waves) for the Brae Area is much lower, in the range from 2.10 – 2.70 m (Baxter *et al.,* 2011 [8]).

During the summer, the temperature and nutrient content of the central and northern North Sea is determined by the formation of a thermal stratification (thermocline) at approximately 30 - 50 m depth. This results in reduced vertical mixing, lowering the temperature and nutrient concentrations at depth. Increased wave strength and frequency in autumn, caused by stronger winds, increases vertical mixing in the water column and breaks down the thermocline (ICES, 1998 [9]).

Figure 3.1: Natural Seabed Sediments and Baseline Sample Locations



3.4 Geology and Seabed Sediments

3.4.1 Geology and Sediment Physical Characteristics - Regional Characterisation

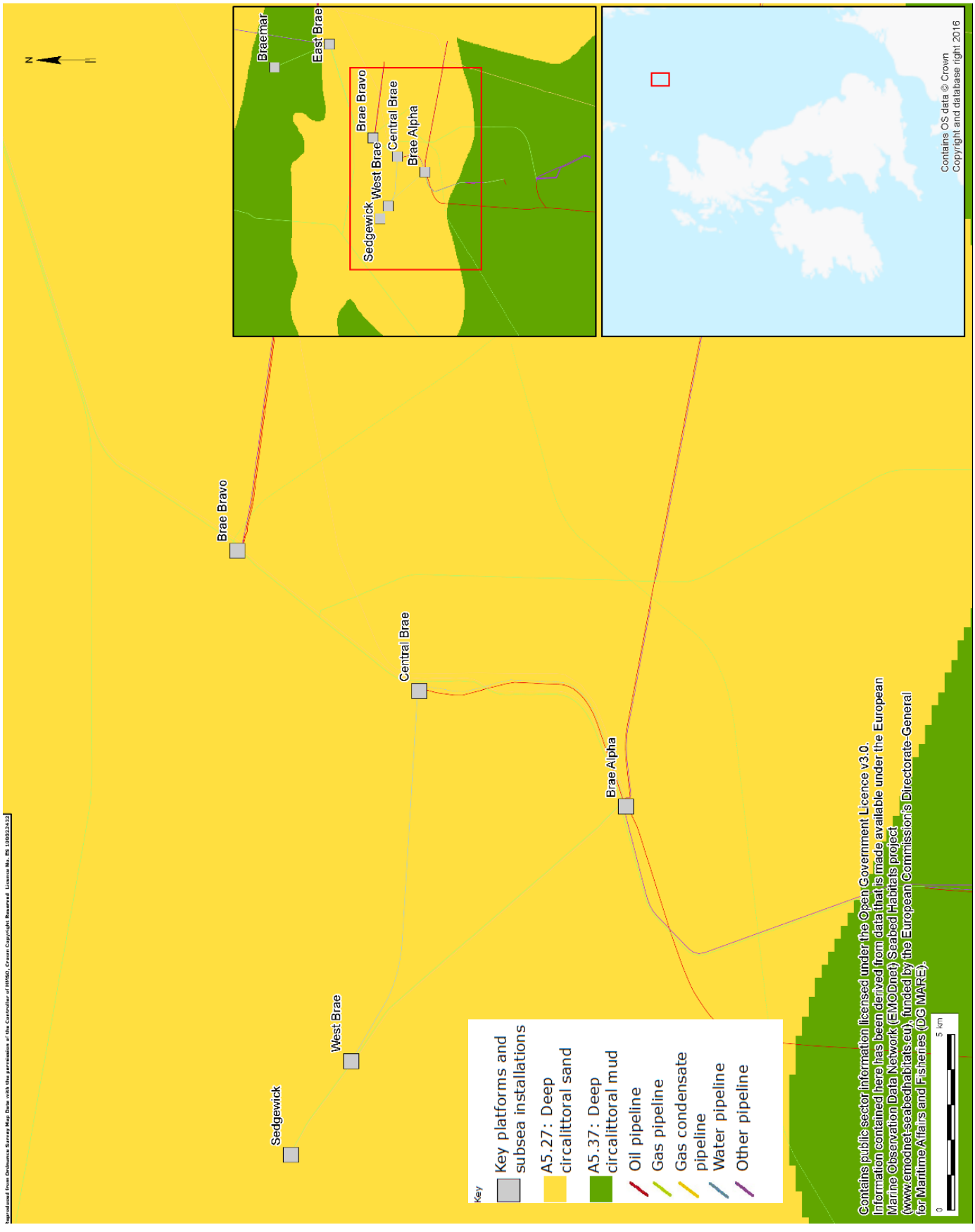
The Brae reservoirs largely consist of Eocene Balder Formation and Upper Sele Formation Sandstones that were deposited in northwest to southeast trending submarine channels across the area. From the seabed down, Quaternary deposits comprise well-layered soft clays of the Witch Ground Formation, structureless sandy clays of the Swatchway Foundation, Coal Pit Formation and Fisher Formation. The boundary between the Coal Pit and Fisher formations is estimated to be between 20 m and 45 m below the seabed (Marathon Oil, 2009 [10]). The relatively thick Quaternary deposits are overlain with thinner Holocene deposits (Marathon Oil, 2009). In the study area, these deposits are largely made up of sand and mud (Figure 3.1 and Figure 3.2).

The seabed in the Brae Area is relatively flat, with depths averaging between 90 m and 116 m. In the central and northern North Sea, the spreads of soft muds are locally characterised by small depressions or 'pockmarks', seabed pockmarks are shallow seabed depressions likely caused by the venting of fluid gases including methane into the water column (Gafeira, J. and Long, D. 2015 [11]; Hartley, 2005 [12]). The Braemar Pockmarks to the north of the Brae Area, lie in the region of the Braemar infrastructure and outside the study area for the Brae Alpha, Brae Bravo and associated infrastructure ES. They are designated as Annex 1 habitats under the Conservation of Habitats and Species Regulations 2010 (Habitats Regulations, S.I. 2010/420) and have been protected as part of the Braemar Pockmarks Special Area for Conservation (SAC). The pockmarks identified in the vicinity of the Braemar infrastructure range in size from a diameter of 5 m to 10 m and a maximum depth of 0.5 m, to larger less frequent pockmarks with a diameter of 50 m to 130 m and a maximum depth of approximately 5 m (Hartley, 2005 [12]). No methane derived autogenic carbonates (MDACs), which comprise of a carbonate cement formed by the anaerobic oxidation of vented methane by microbes and formed of carbonate cement, were encountered during the pre-decommissioning surveys.

Parts of the Brae Area have been mapped as deep circalittoral mud. To the south, seabed sediments in the Brae Area comprise very fine to medium sands (ranging from well-sorted to very poorly sorted). Six sampling stations were located in the wider area' (i.e. the samples taken 5 km to 20 km from platforms or subsea installations) as part of the 2013 monitoring programme for Brae Bravo (locations up to 17 km away from Brae Bravo). The samples from the wider area ranged from coarse silt (17.8 km northeast of Brae Bravo) to very fine sand (7 km to 8 km west and south of the Brae Bravo) and reflect the habitat described above.

A summary of sediment characteristics is presented in Technical Appendix 3.1: Brae Area Seabed Sediment Data.

Figure 3.2: Seabed Sediments



3.4.2 Brae Alpha

Sediments were sampled at 16 locations within approximately 100 m of the platform centre to characterise the drill cuttings pile sediments (Figure 3.3). In addition, a further 17 sampling stations were analysed to characterise the area within approximately 2,500 m around the Brae Alpha platform (Figure 3.4).

Figure 3.3: Brae Alpha Drill Cuttings Pile Sample Locations

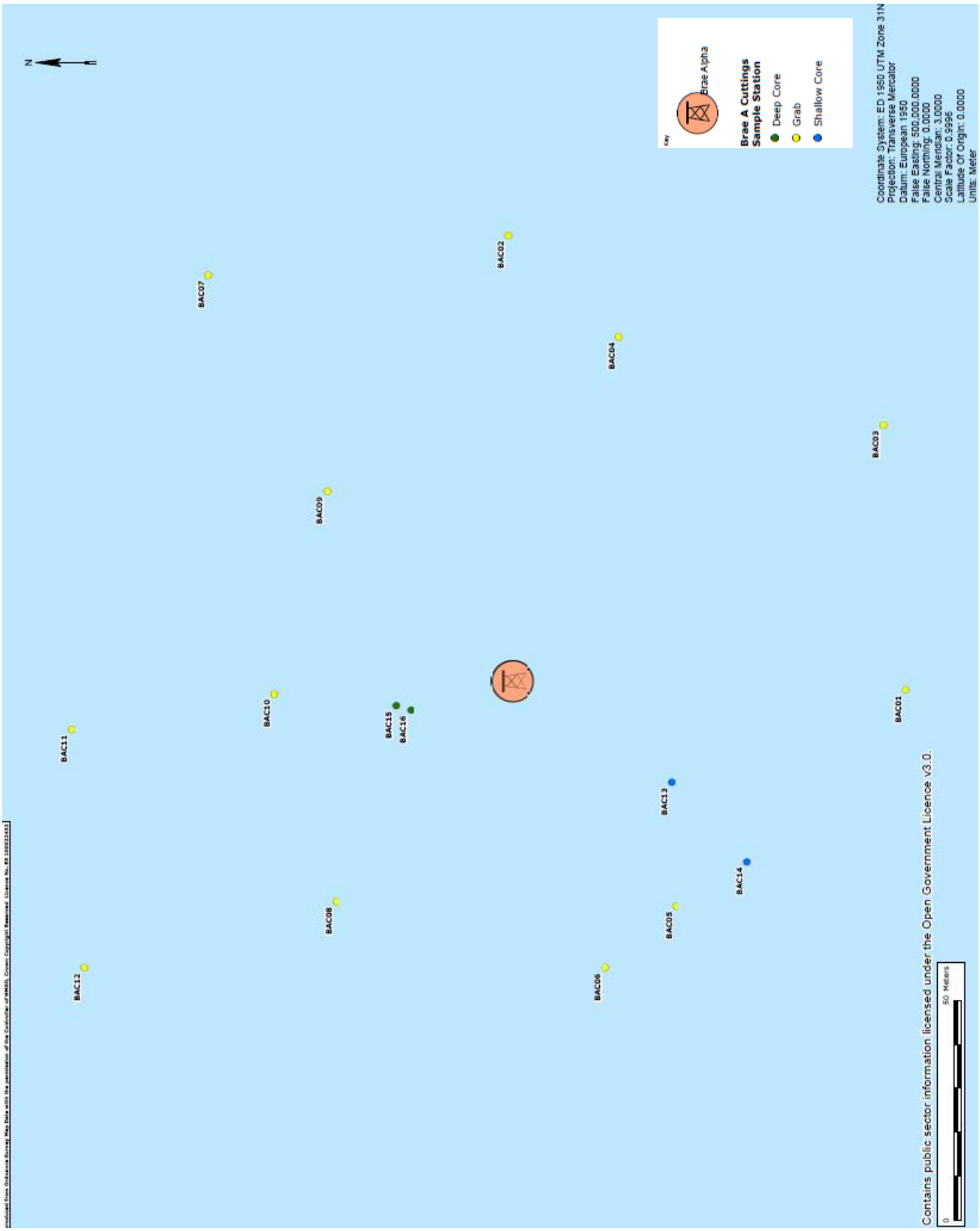
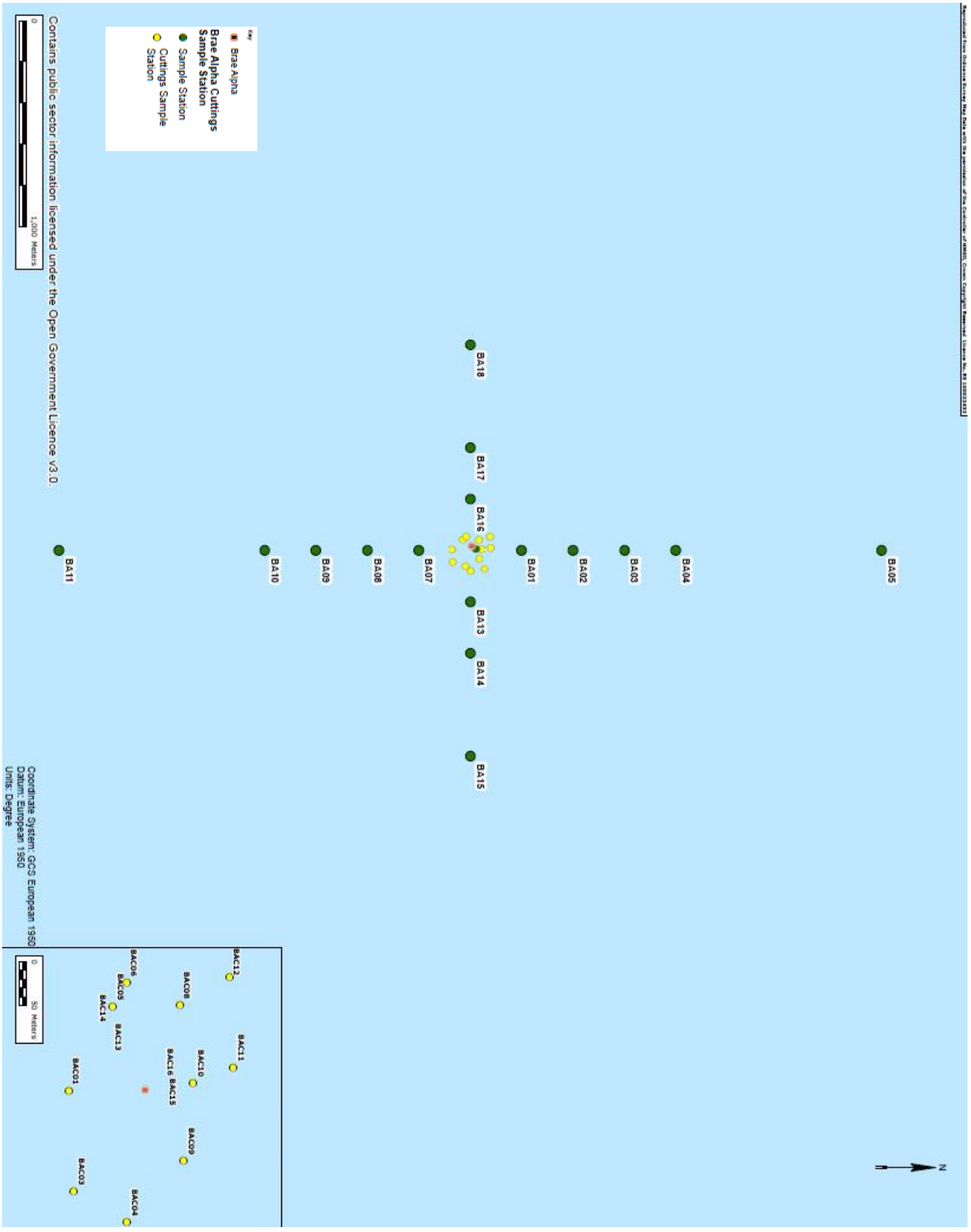


Figure 3.4: Brae Alpha Sediment Sample Locations



Seabed sediments collected from around the Brae Alpha were classified as fine and very fine sands (Wentworth scale). The mean particle diameter values ranged from 67 µm to 171 µm (mean 122 µm) - this is similar to previous surveys undertaken in 2000 and 2005/6, though it is noted that differing sampling methodologies mean the results are not directly comparable. Silt/clay content has increased during the monitoring period; from a mean of 0.53% in 1981 to a mean of 16.0% in 2015 (changes in analytical techniques since monitoring began may mean that the difference is presently over estimated). The majority of samples from 250 m to 5,000 m from the platform centre indicated very poor to poor sorting of sediments. In 2015, the organic matter content of the sediments ranged from 0.88% to 2.46% (mean 1.46%) and total organic carbon levels for these samples ranged from 0.28% to 0.48% (mean 0.35%).

The drill cuttings pile sediments at Brae Alpha cover an area of approximately 130 m by 115 m in elliptical plan view. The drill cuttings pile is centred below the platform within the jacket/sub-structure legs, and extends beyond the northern legs to a distance of approximately 65 m (Figure 3.5 and Figure 3.6). The cuttings pile has a maximum height of 11.5 m above the surrounding seabed. A total volume of 28,000 m^3 of deposited material has been estimated.

Fourteen of the samples showed that sediments are formed of coarse silt to medium sand (mean particle diameter range of 26 µm to 429 µm with a mean of 162 µm). The silt/clay content ranged from 7.5% to 55.2% (mean of 28.3%), indicating finer sediment than the surrounding area. The total organic carbon ranged from 0.25% to 3.41% (mean of 1.51%), which is also higher than the surrounding sediments. An increase in sediment fines is typically observed in cuttings piles due to the deposition of drilling muds. A relative increase in larger sediment particles was also observed in the cuttings, this is likely to be a result of rock chippings, gravel, etc. from the drilled wells being deposited along with the mud. Two additional core samples through the cuttings pile also indicate fine sediments (coarse silt and very fine sand) that are extremely poorly sorted.

Figure 3.5: Brae Alpha Drill Cuttings Pile

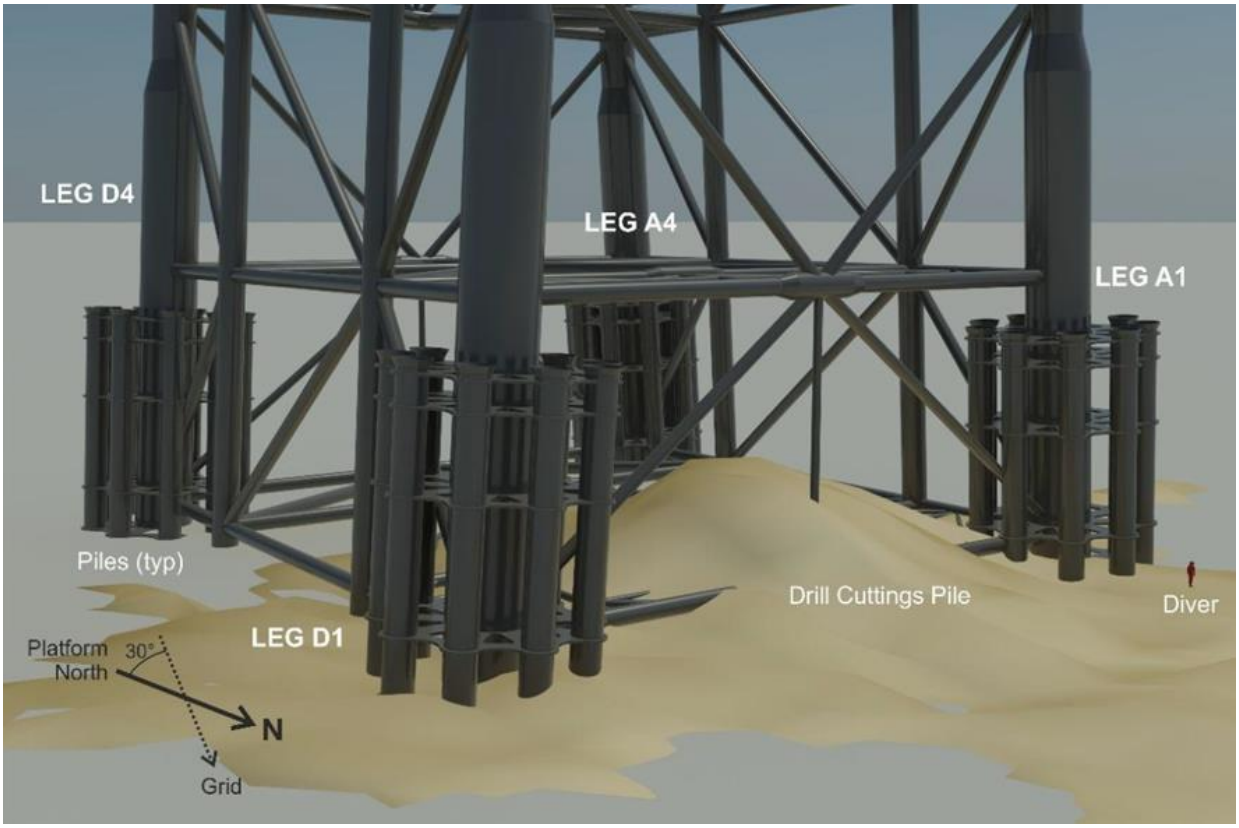
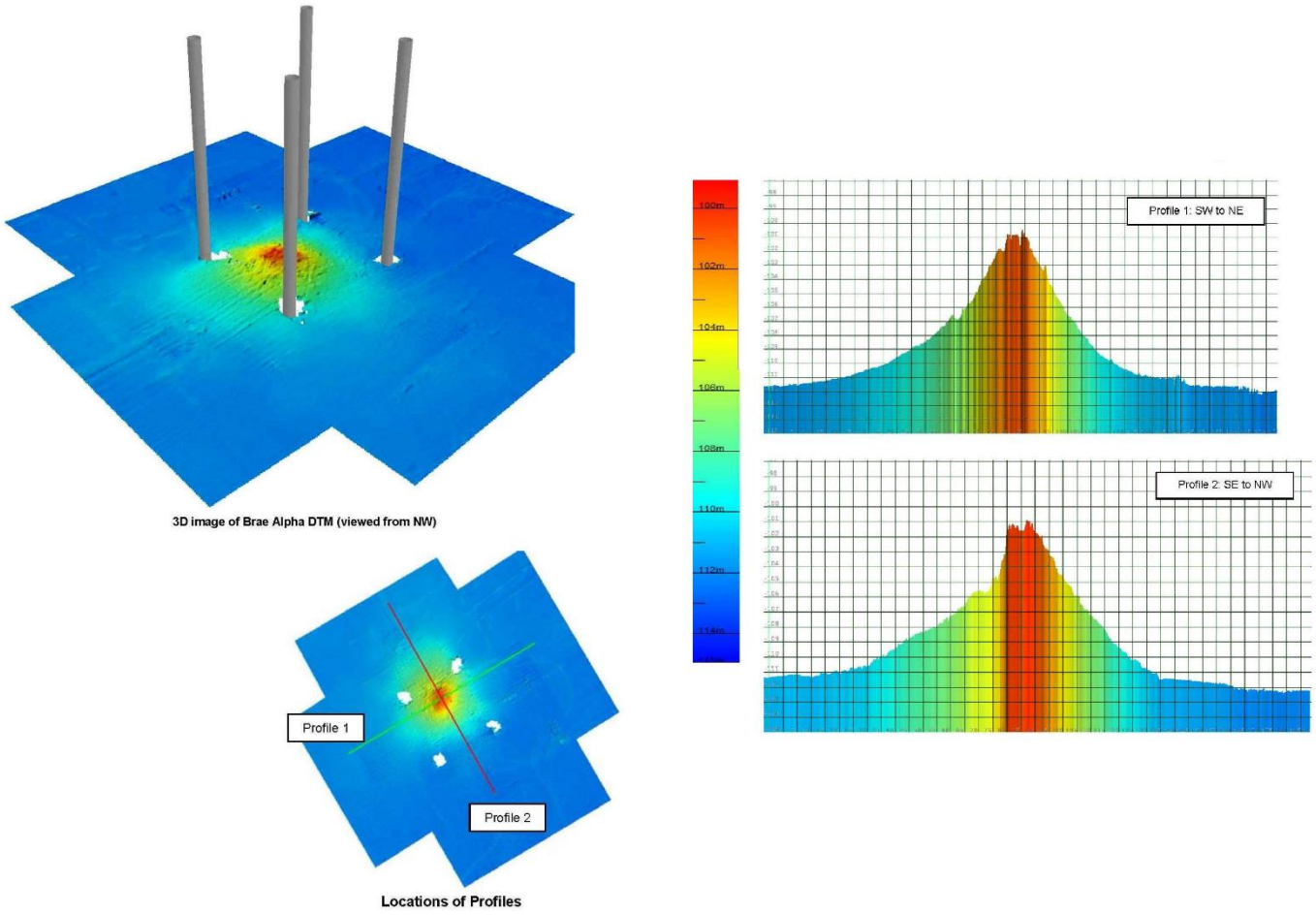


Figure 3.6: Brae Alpha Drill Cuttings Pile (section/topography)



3.4.3 Brae Bravo

Fifteen samples were taken from within 150 m of the Brae Bravo Platform to characterise the drill cutting pile sediments (Figure 3.7).

Seabed sediments were also analysed from 14 sampling stations around the Brae Bravo platform during the September 2013 environmental monitoring survey from approximately 500 m to 5,000 m from the platform centre (Figure 3.8). Seabed sediments collected from around the Brae Bravo were classified as fine sands, apart from one sample taken 500 m east of the platform, which was medium sands (Wentworth scale).

The mean particle diameter values across all samples ranged from 43 µm to 245 µm (mean 164 µm). Silt/clay content has increased during the monitoring period to a mean of 12.8% in 2013 (changes in analytical techniques since monitoring began may mean that the difference has been narrower). The majority of samples indicated very poor to moderate sorting of sediments. In 2013, the organic matter content of the sediments ranged from 0.07% to 3.00% (mean 1.30%) and total organic carbon levels for these samples ranged from <0.4% to 0.57%.

The drill cuttings pile at Brae Bravo covers an area of approximately 140 m by 90 m, centred mid-way between the northern sub-structure legs and extending beyond the legs to approximately 80 m (Figure 3.9 and Figure 3.10). The drill cuttings pile has a maximum height of 8 m above the surrounding seabed. A total volume of 22,500 m^3 of deposited material has been estimated.

The drill cuttings piles sediments ranged from very fine sand to medium sand (very poorly sorted to poorly sorted). The average particle diameters ranged from 69 µm to 324 µm (mean of 140 µm). As with the Brae Alpha drill cuttings pile, the silt/clay content was higher than the surrounding area, ranging from 7.7% to 46.2% (mean of 25.6%). Organic and carbon content was also higher.

Figure 3.7: Brae Bravo Drill Cuttings Pile Sampling Locations

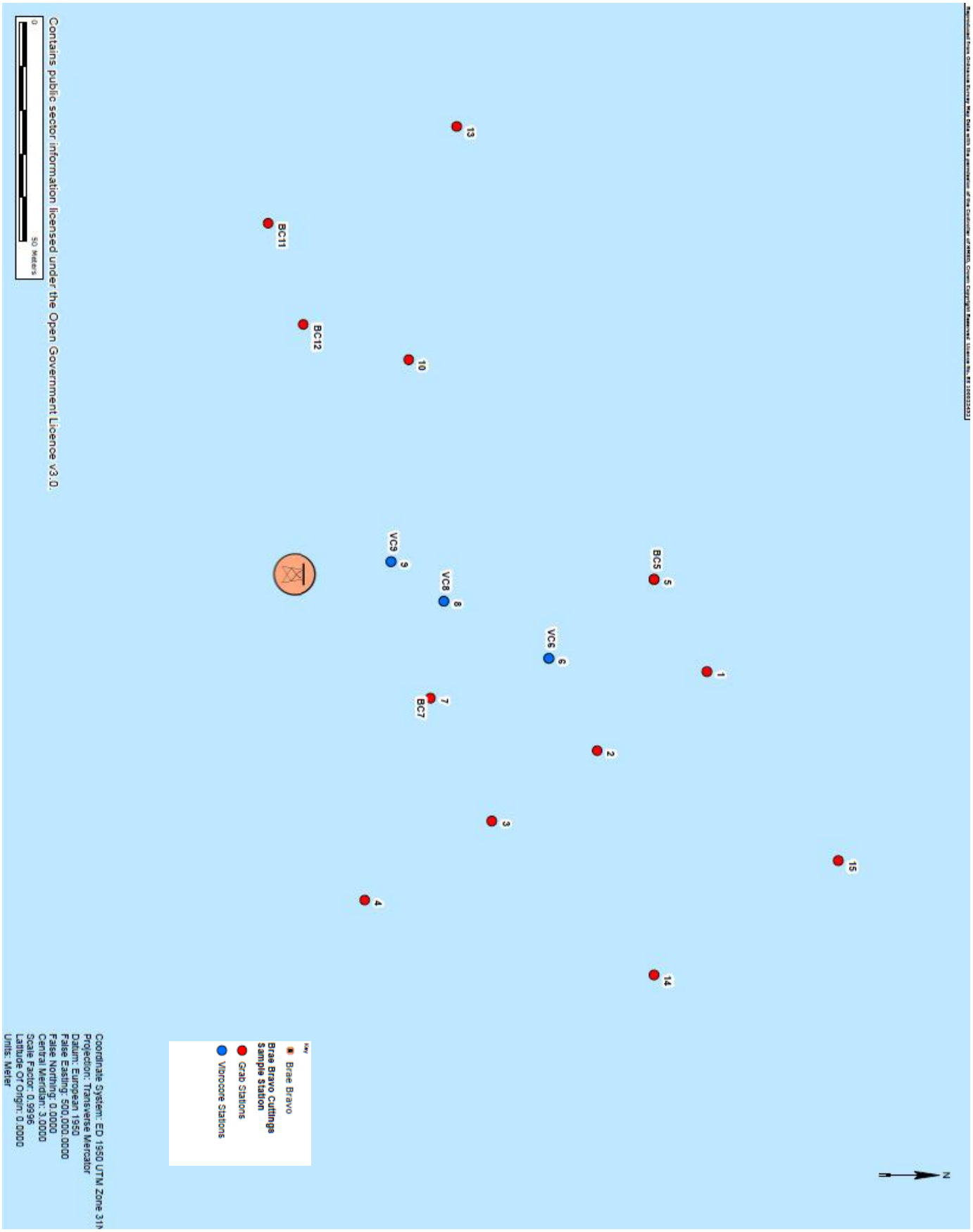


Figure 3.8: Brae Bravo Sediment Sample Locations

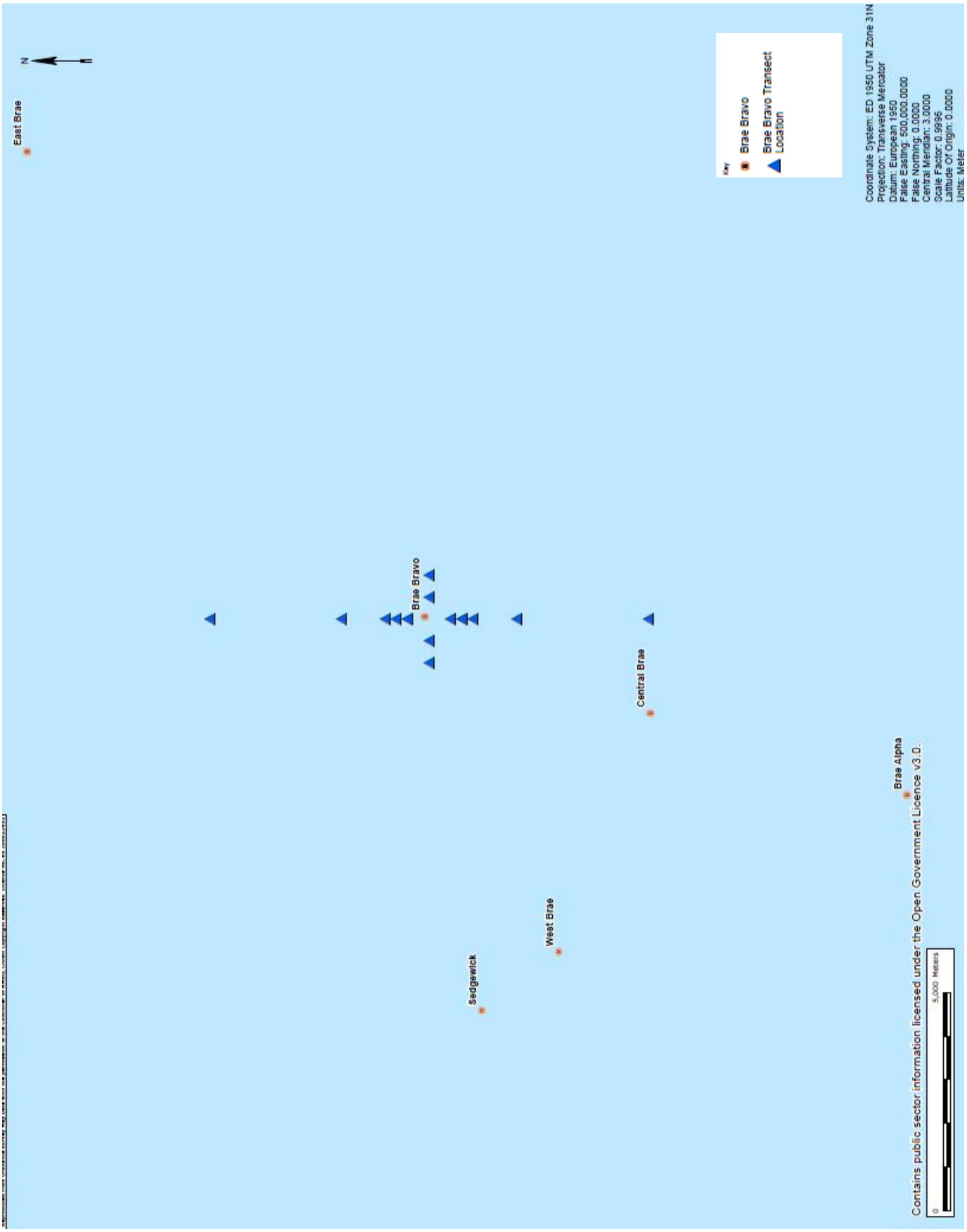


Figure 3.9: Brae Bravo Drill Cuttings Pile

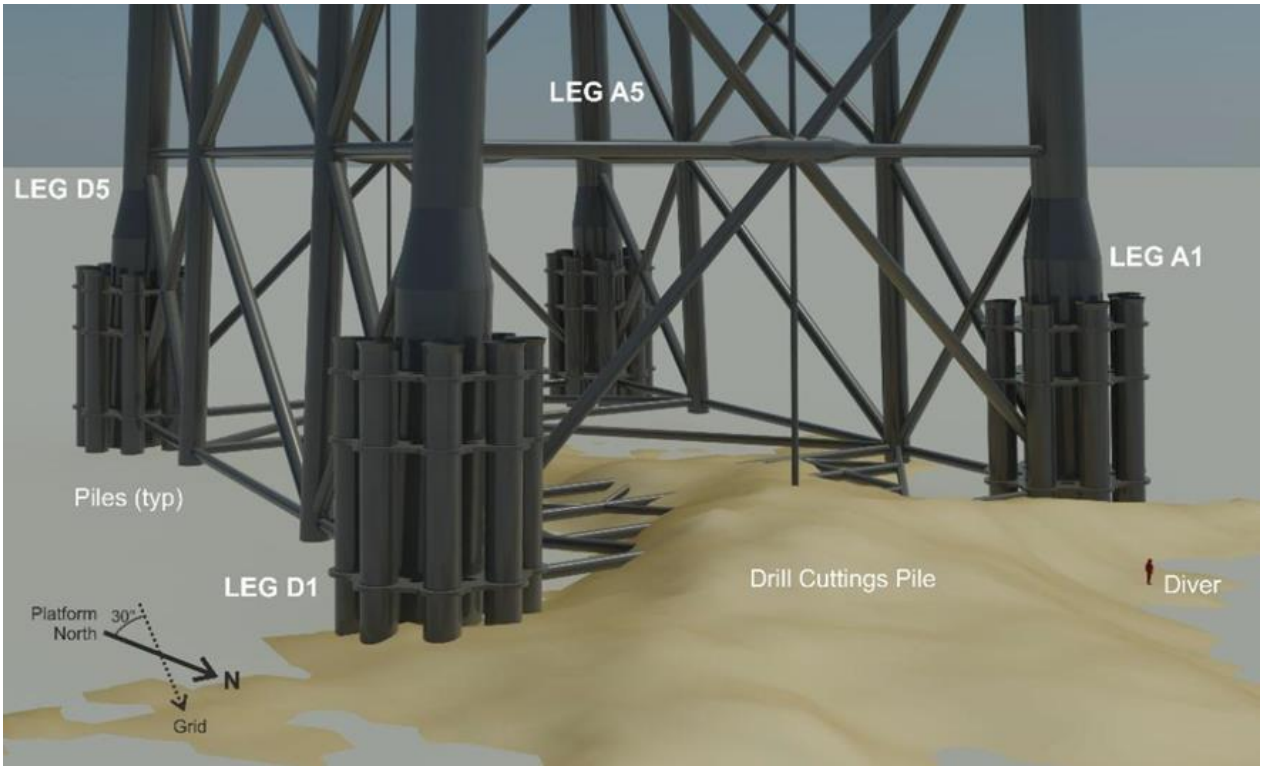
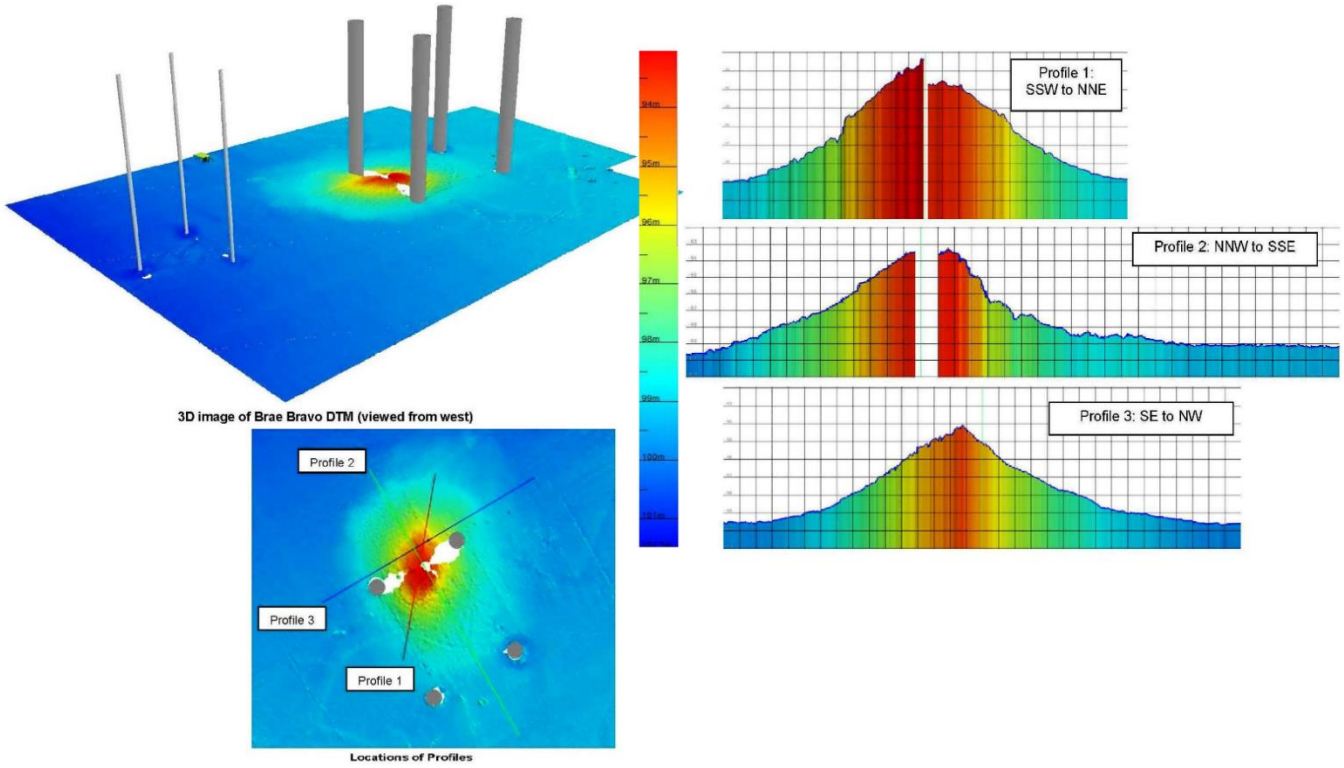


Figure 3.10: Brae Bravo Drill Cuttings Pile (section/topography)



3.4.4 West Brae (Including Sedgwick), Central Brae and All Associated Pipelines and Subsea Structure Decommissioning Activities

Sediment sampling was undertaken at the West Brae subsea manifold in March 2015, the sample locations ranged from 250 m to 2,000 m from the manifold. No drill cuttings pile is present at West Brae. The mean diameter of the sediments collected from 12 sample locations was 145 µm, which is comparable to other structure locations. The average silt content was 9.93%.

Sampling was also undertaken at the Central Brae subsea template. The 15 sample locations ranged from 250 m to 5,000 m from the manifold. There is no drill cuttings pile at Central Brae. The mean diameter of the sediments collected from 12 sample locations was 165 µm, which is comparable to other structure locations. The average silt content was 9.48%. This indicates that the sediments between West Brae and Central Brae are fairly consistent. Samples were not taken at Sedgwick but the wider area samples indicate that silt/clay content is slightly higher (12.1%) north of Sedgwick.

3.5 Sediment Quality

3.5.1 Regional Characterisation

A review of the chemical baseline environment, including data associated with the drill cuttings piles was carried out for the Brae Area. This included survey work from the period 1981 to 2015. The review considered a range of both carbon based (organic) contaminants such as hydrocarbons; and non-carbon based (inorganic) contaminants such as metals. The review considered how concentrations of these contaminants varied both according to:

- depth within the drill cuttings pile;
- distance from the platform; and
- the time period.

The review identified a consistent trend across the Brae Area, with contamination decreasing to below screening criteria levels beyond approximately 250 m from each platform installation.

The central and northern North Sea area has been extensively explored for oil and gas and there are many oil and gas fields in production. These activities have resulted in drilling discharges from exploration and development wells, produced water discharges, accidental oil spills and various other minor discharges. There are no other significant industrial sources of contaminants in the area, although seabed surveys have noted various localised inputs of hydrocarbons, presumed to originate from shipping. Various persistent contaminants found at low concentrations in offshore marine sediments, including metals, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs) and pesticides, are thought to originate from riverine inputs and atmospheric deposition, though these inputs have fallen since 1990 (OSPAR, 2010 [13]).

The Brae Area is surrounded by other developed oil, gas and condensate fields (e.g. Crawford, Miller, Gudrun, Sleipner, Tiffany, Toni, Thelma). Each installation has the potential to have an area of sediment contamination associated with the use of oil-based drilling muds. It is considered likely that a similar trend to that identified at the Brae Area, with contamination decreasing with increasing distance from installations, will be repeated across the wider region. On this basis, wide scale contamination of sediments is unlikely.

Chemical background conditions in the Brae Area were extracted from various Brae Area studies, taking a subset of sampling stations considered to be indicative of background conditions due to their distance from the drill cuttings piles. For Total Hydrocarbon (THC), there is a marked decrease in THC with increasing distance from each platform. Data shows that the majority of samples recovered from distances equal to or exceeding 500 m from the platform were below the OSPAR Recommendation 2006/5 level of 50 µg/g. PAHs illustrate a similar pattern to THCs, with little or no discernible presence beyond 250 m from the drill cuttings piles. Tributyltin (TBT), PCBs and Alkylphenol Ethoxylates (APEs) were measured only within core samples from the drill cuttings piles themselves; therefore relationships to concentrations in the surrounding area cannot be determined.

Sediment samples were collected to characterise the background chemical baseline within the wider Brae Area (covering approximately 600 km^2). Sample stations were located away from installations. Total hydrocarbon concentrations ranged from 1.7 µg/g to 3.6 µg/g, which provides an indication of sediment chemistry in the areas unaffected by oil and gas activity.

3.5.2 Brae Area Sediments

Monitoring undertaken by Marathon Oil indicates that sediments in the Brae Area have a low organic and carbonate content. Metal contents are within the range of natural background concentrations.

Immediately adjacent to and under the Brae Area platforms, mounds of previously discharged drill muds and cuttings exist. The drill cuttings piles have the potential to contain contaminants of concern (defined as those chemicals that could be present with potential toxicity to the surrounding marine environment). Contaminants of concern include Hydrocarbons, PCBs, Alkylphenols and APEs, TBT and Metals.

Although the absolute concentrations of contaminants varies between the platforms and drill cuttings piles, the overall pattern of distribution is similar at both Brae Alpha and Brae Bravo. The following observations can be made:

- PCB concentrations are generally low and comparable to background concentrations from other areas of the North Sea [14];
- APE and octylphenol concentrations are generally low and comparable to background concentrations from other areas of the North Sea; however, nonylphenol concentrations are higher than background, above the average value reported elsewhere [14]. The source of this contamination is potentially associated with early drilling fluids used; and
- TBT concentrations are typically within the same range as reported elsewhere [14], with the exception of occasional outliers. As no source of TBT has been reported by Marathon Oil, these concentrations are considered representative of regional background.

As with the organic contaminants, there is a marked decrease in the concentration of metals with increasing distance from the centre of the drill cuttings piles.

Consideration has been given to the potential for ecotoxilogical effects associated with the drill cuttings piles in their current condition. The assessment confirms the limited bioaccessibility and bioavailability of contamination in drill cuttings piles. Left undisturbed, there is unlikely to be an exposure pathway to benthic organisms since drill cuttings piles are covered with clean sediment or biological or mineral debris (e.g. shells from molluscs previously attached to the jacket/sub-structure), and benthic organisms do not come into contact with contaminants deep in a drill cuttings pile.

Leaching rates from undisturbed drill cuttings pile samples were investigated during the UKOOA drill cuttings initiative and were found to be below the detection limit (UKOOA, 2005 [16]).

3.5.3 Brae Alpha

Core samples from Brae Alpha drill cuttings pile exceeded Effects Range Low (ERLs) in a majority of samples for PAHs, nonylphenol, TBT, arsenic, barium, copper and zinc (Technical Appendix 3.1). Cadmium exceeded the ERL in a minority of samples (<20%) and chromium exceeded only at depth. This indicates that the sediments are likely to cause rare adverse effects to benthic organisms (i.e. have been shown to cause adverse effects in approximately 10% of studies (dependant on the specific contaminant)). There were no exceedances beyond 250 m of the platform except mercury, which exceeded in all samples. Mercury, nickel and zinc also exceeded the Effects Range Median (ERMs) within core samples, indicating that they are likely to cause occasional adverse effects to organisms if ingested (i.e. approximately 50% of available Brae Area specific studies show adverse effects at the ERM concentrations exceeded).

Surveys of the Brae Alpha drill cuttings pile and surrounding area in 2015 concluded that THC levels were significantly lower than previously recorded in 1983, 1985 and 1989. Also metal concentrations were

evenly spread throughout the survey area, but particularly elevated concentrations were located at two stations (BA01 and BA07 – see Figure 3.4 for location) both located 250 m from the platform centre, although on opposite sides of the platform.

3.5.4 Brae Bravo

Core samples from Brae Bravo exceeded ERLs in a majority of samples for PAHs, nonylphenol, arsenic, barium, copper, mercury, nickel and zinc (Technical Appendix 3.1). A minority of samples in both the shallow and deep cores also exceeded screening criteria for octylphenol and TBT. The same contaminants also exceeded ERLs in grab samples surrounding the drill cutting pile. There were no exceedances beyond 250 m of the platform except for barium and mercury (although these exceeded in all samples). Mercury, nickel and zinc also exceeded the ERMs in some core samples from within the pile.

Surveys of the Brae Bravo drill cutting pile and surrounding area (up to 5 km distance) in 2015 and concluded that THC levels were substantially elevated in comparison to historical survey data and background data for the North Sea (UKOOA, 2001 [15]), but were comparable to other drill cuttings piles in the North Sea.

Contaminant analysis of sediments at West Brae indicates that THCs were mostly below 25 µg/g, apart from a single sample which had a substantially higher THC of 201 µg/g – this station was 250 south of West Brae. The THCs at Central Brae were assessed to be lower, ranging from 2.8 µg/g to 41.3 µg/g. The concentrations at West Brae and Central Brae were generally comparable to those observed at Brae Alpha (greater than those observed at Brae Bravo). At West Brae metal concentrations exceeded ERLs for arsenic, copper and nickel. The concentrations of copper also exceeded ERMs. At Central Brae, there were exceedances of ERLs for nickel, copper and barium. This indicates that adverse effects to organisms may frequently occur when exposed to these sediments.

3.6 Marine Benthos and Seabed Habitats

Benthos are the organisms that live on, or associated with, or in seabed sediments. This section describes the marine benthos and seabed habitats.

3.6.1 Regional Characterisation

The seabed of the Brae Area is made up of soft sediments dominated by deep circalittoral sands with fine sands or non-cohesive muddy sands (EUNIS classification A5.27, JNCC SS.SMu.OMu) (Figure 3.2), supporting a diverse range of polychaetes and bivalves including maldanid polychaetes (*Maldan sarsi* and *Terebellidae spp.*), amphipods including *Harpinia anternnaris* as well as bivalves and echinoderms including *Amphiura filiformis*. Also recorded as dominant within the Brae Area are deep circalittoral muds (EUNIS classification A5.37, JNCC SS.SMu.Omu) which are described as mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50 m to 70 m depth. A variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira spp.*, echinoderms and foraminifera (EUNIS, 2007[18]).

The long lived bivalve (>100 years), *Arctica islandica*, was identified in low abundances across the survey area (mainly juvenile specimens). This bivalve is a Priority Marine Feature (PMF) due to its low or limited mobility, and OSPAR Annex V listed due to the decline/threatened status elsewhere within the North Sea (the German Exclusive Economic Zone (EEZ)). Within the UK its status is not rare/scarce. The species is known for its slow growth rate and long lifespan and occurs throughout the UK waters (>30 m). The

central and northern North Sea (Fladen Grounds) is dominated by juveniles, with an average density of 28,600 individuals per 100 m (Witbaard and Bergman, 2003 [19]).

Marine growth is common on structures in the central and northern North Sea (Fladen Grounds). Site-specific estimates of marine grown are provided in the sections below. Typically, marine growth comprises soft bodied organisms including kelps *Laminaria spp*, plumose anemone *Metridium senile*, soft corals e.g. *Alcyonium digitatum* and hydroids (Oil and Gas UK, 2011 [20]). Hard bodied organisms including blue mussels *Mytilus edulis*, barnacles *Balanus crenatus* and *B. hameri* and solitary tube worms *Pomatoceros triqutere*, *Hydroides norvegica* and *Serpula vermicularis* are also found. The cold water coral *Lophelia pertusa*, protected under European Habitat Directive and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has also been reported on northern North Sea sub-structures, although no evidence has so far been found of its presence on any of the Brae sub-structures.

3.6.2 Brae Alpha

With the exception of two survey locations (250 m north and south of the platform respectively (station BA01 and station BA07)), typical North Sea (Fladen Grounds) benthic communities were identified across the Brae survey area. The sample data confirms that the Brae Alpha area is largely dominated by the polychaetes *Paramphinome jeffreysii, Galathowenia oculata, Tharyx killariensis, Pholoe assimilis* and the bivalve molluscs *Adontorhina similis* and *Axinulus croulinensis*. The taxa identified across the survey area are broadly similar to those encountered previously in this area of the North Sea (Eleftheriou and Basford, 1989 [21]; Kunitzer et al., 1992 [22]; Oil and Gas UK, 2011 [20]).

Polychaete annelids have frequently been found to account for approximately 50% of the species encountered around the Brae Alpha platform. The polychaete *P. jeffreysii* accounted for 52% of the polychaetes identified and 41% of the total individuals found. The long-lived bivalve mollusc *Arctica islandica* was rarely encountered and accounted for 0.34% of all taxa (equal to 54 individuals, 53 of which were noted as juvenile).

Sampling stations BA01 and BA07, although dominated by *P. jeffreysii,* also contained large numbers of the secondary coloniser *Chaetozone setosa* and low numbers of the hydrocarbon tolerant bivalve, *Thyasira sari.* These two stations were also noted to have the highest relative abundance of the carnivorous polychaetes *Pholoe assimilis* and *Glycera lapidum*. The survey findings indicate that near-field habitats at these two sampling stations, each approximately 250 m distant from the platform centre, are in a transition from the severely disturbed community observed in 1989 to the current status.

The general biotopes around the Brae Alpha platform are considered to be variations on SS.SMU.OMu.PjefThyAfil, *(Paramphinome jeffreysii, Thyasira spp*. and *Amphiura filiformis* in offshore circalittoral sandy mud). This habitat is listed as a priority marine feature (PMF) and a priority habitat under the UK biodiversity action plan (UK BAP). However, these mud habitats occur widely across this part of the North Sea.

3.6.3 Brae Bravo

The benthic community identified within Brae Bravo survey area was also typical of the central and northern North Sea (Fladen Grounds), being largely dominated by the polychaetes (such as *Paramphinome jeffreysii, Spiophanes bombyx, Galathowenia oculata, Tharyx killariensis and Pholoe assi*milis) (Kunitzer et al., 1992 [22]; Eleftheriou and Basford, 1989 [21]; Oil and Gas UK, 2011 [20]).

P. jeffreysii accounted for 68% of the polychaetes identified and 55% of the total individuals found in samples. *Arctica islandica* accounted for 0.01% of all taxa (equal to three individuals).

A weak negative correlation (95.0%) between the distance from the platform and evenness (lack of species dominance), and a stronger negative correlation (99.0%) between individuals and mean diameter was identified in the data collected by Marathon Oil. Positive correlations between individuals, silt/clay and total organic matter by ignition (LOI) were also found. The habitat around the Brae Bravo platform is considered to be SS.SMU.CSaMu (offshore circa-littoral sandy mud).

The predominant biotope identified across the drill cuttings pile is broadly similar to SS.SMU.OMu.CapThy (opportunistic species *Capitella sp* and *Thyasira spp* in organically enriched offshore circalittoral mud and sandy mud) (Connor et al., 2004 [23]). The polychaete *P. jeffreysii* is considered to be hydrocarbon tolerant scavenger (Hiscock et al., 2005 [24]) and often found in high numbers in areas of contamination. Video footage also shows the presence of sulphide oxidising bacteria *Beggiatoa sp.* at stations to the north of the Brae field (north of the study area). This filamentous bacteria has been reported previous on cuttings piles throughout the North Sea and is considered indicative of a sulphide rich area (UKOOA, 2001 [20]).

The average number of taxa recorded from the drill cuttings pile were greatly reduced in relation to the wider area sampling locations; but due to the high numbers and dominance of the polychaetes (*Capitella sp* and *P. jeffreysii*), the average numbers of individuals recorded were greater in the drill cuttings pile than observed for the wider area (i.e. areas 5 km to 20 km from platforms or manifolds).

3.6.4 West Brae (Including Sedgwick), Central Brae and all Associated Pipelines and Subsea Structures

As with the other areas of the Brae Area described above, the seabed at West Brae, Central Brae and associated structures is dominated by polychaete species. The polychaete *P. jeffreysii* was the most commonly found species. For West Brae, *P. jeffreysii* accounted for >50% of all polychaetes and 41% of all individuals; and at Central Brae it accounted for >60% of all polychaetes and 48% of all individuals.

The bivalve mollusc *A. islandica* accounted for 0.32% of all individuals at West Brae (35 individuals, 29 of which were noted as juvenile), and was less abundant at Central Brae, accounting for 0.17% of all taxa (15 individuals, 11 of which were noted as juvenile).

Overall the benthos at the subsea installations is characteristic of the wider North Sea (Fladen Grounds) deep circalittoral sands with fine sands or non-cohesive muddy sands (EUNIS classification A5.27, JNCC SS.SMu.OMu).

3.6.5 Jacket/Sub-Structures

The marine life assemblage present on the platforms of the Brae Area was evaluated based on a review of selected available remotely operated vehicle (ROV) footage provided by Marathon Oil. It should be noted that the ROV footage was not designed or collected for the specific purpose of determining the biological communities on the platform sub-structure and thus the footage has been used to determine likely presence or absence of core species/groups making up the marine growth[2] assemblage.

Marathon Oil estimates that the marine growth on the sub-structures for Brae Alpha and Brae Bravo is as set out within Table 3.1 below.

[2] *Opportunistic colonists of the artificial habitats provided by man-made structures offshore*

Table 3.1: Estimated Total Marine-Growth of the Jacket/Sub-Structures	
Brae Alpha	Brae Bravo
1396 Tonnes	1547 Tonnes

Oil and Gas UK (2011)[20] reports patterns of depth zonation of typical species which may be anticipated on a North Sea jacket/sub-structure. The report describes the organisms that make up marine growth as 'Opportunistic colonists of the artificial habitats provided by man-made structures offshore.'

Typically, marine growth on North Sea jackets comprises soft bodied organisms including kelps *Laminaria spp*, plumose anemone *Metridium senile*, soft corals e.g. *Alcyonium digitatum* and hydroids, and also hard bodied organisms including blue mussels *Mytilus edulis*, barnacles *Balanus crenatus* and *B. hameri* and solitary tube worms *Pomatoceros triqutere, Hydroides norvegica* and *Serpula vermicularis*.

No evidence of cold water coral *Lophelia pertusa* has been found of its presence on any of the Brae jacket/sub-structures.

3.7 Water Quality

Water quality in the Brae Area is considered to be generally consistent with the wider northern North Sea area. An assessment of the potential for contaminants from the drill cuttings piles at Brae Alpha and Brae Bravo to leach into the water environment was carried out through the collection of samples acquired during the pre-decommissioning cuttings pile characterisation surveys commissioned by Marathon Oil. Ten samples from each pile were subject to laboratory leaching tests with samples analysed for THC, 2-6 ring PAHs and APEs. The THC results were screened against OSPAR threshold values. The laboratory testing indicated that, if leached, THC and PAH are unlikely to adversely affect water quality. While the laboratory tests indicated the potential for APEs to have a negative impact on water quality, it is noted that laboratory leaching test results are likely to overestimate leaching rates due to the exaggerated exposure of the sediment to water and the aggressive nature of the tests. Leaching rates from undisturbed drill cuttings pile samples were investigated during the UKOOA drill cuttings initiative and were found to be below the detection limit (UKOOA, 2005 [16]).

Levels of anthropogenic radionuclides in seawater in the Brae Area and surrounding region are low compared to the naturally occurring radionuclides. Concentrations of trace metals in the seawater of the region are also expected to be low.

Nutrient levels (including nitrate and phosphate levels) in the Brae Area and surrounding region vary seasonally, primarily influenced by the inflow of Atlantic water, stratification and utilisation by phytoplankton. Nutrient levels decrease in spring with reduced water inflow and the start of phytoplankton blooms (Department for Energy and Climate Change, 2001 [17]). The salinity in the central and northern North Sea is fairly constant, rising slightly in the summer.

3.8 Plankton

The plankton composition within the Brae Area is expected to reflect the composition found in this area of the North Sea. The Atlantic inflow to this region introduces extra nutrients allowing the area to sustain higher primary production by plankton than further south in the North Sea. Physical factors, such as

stratification, have a dominant role in the composition of plankton communities in the central and northern North Sea.

Zooplankton biomass follows a seasonal variation in primary productivity (caused by changes in phytoplankton), with a peak in May followed by a sharp decline in the winter; the rate of population response in zooplankton is much slower than phytoplankton, which allows algal populations to bloom. As a result of the slower response, much of the phytoplanktonic production within the central and northern North Sea is thought to sink to the seabed rather than being consumed by zooplankton, providing a major source of carbon and energy to support the offshore marine ecosystem.

Phytoplankton is dominated by copepods, mainly Calanus species (*C. finmarchicus* and *C. helgolandicus*), though larger zooplankton such as krill (*euphausiids*), salps and doliolids (*thaliacea*) and jellyfish (*siphonophores* and *medusae*) can also reach large densities and provide a primary food source for fish and whales.

3.9 Fish, Shellfish and Cephalopods

Several fish species are known to be present in the wider vicinity of the Brae Area and use the area for spawning and/or nursery grounds; these include the Norway pout (*Tisopterus esmarkii*), Nephrops, mackerel (*Scomber scombrus*), haddock (*Melanogrammus aeglefinus*) and blue whiting (*Merlangus merlangus*) (CEFAS, 2001 [25]; DTI, 2001 [26]; Coull *et al.,*1998 [27]). Spawning grounds extend over large areas of the North Sea, with eggs often developing on the seabed or in the water column, making them vulnerable to pollutants and disturbance.

Nephrops spend most of their lives in one area and do not migrate from their burrows (DTI, 2001 [26]). This species spawns in the sediments characteristic of the seabed around the Brae platforms and is one of the main species targeted by the fishing industry in the area (refer to section 3.6 for further details). A number of fish species known to be present within marine waters are protected under UK or international legislation, though few of these have distributions that extend into the offshore waters of the northern and central North Sea. During times of high zooplankton abundance the following protected elasmobranch species may occur in small numbers: basking shark (*Cetorhinus maximus*), tope (*Galeorhinus galeus*) and porbeagle (*Lamna nasus*). The common skate (*Raja batis*) and the Angel Shark (*Squatina californica*) can also be found at low densities.

3.10 Marine Mammals

The marine mammals in the Brae Area include pinnipeds and cetaceans. Pinnipeds include the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*). The cetaceans most commonly recorded in the Brae Area are the harbour porpoise (*Phocoena phocoena*), though Atlantic white-sided dolphin (*L. actus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutorostrata*) and long-finned pilot whale (*Globicephala melas*) are also known to occur in this part of the North Sea (IUCN, 2016 [28]).

Additional data relating to marine mammals in the Brae Area are provided in Technical Appendix 5.1: Underwater Noise Impact Assessment.

3.11 Seabirds

Seabirds are present in the central and northern North Sea throughout the year, though densities in the Brae Area tend to be lower due to the distance from coastal colonies (Stone *et al.,* 1995 [29]).

Seabird densities in the Brae Area are at their lowest in late spring/early summer when many birds are at their coastal colonies nesting and foraging distances out to sea are reduced (see Table 3.2). Species and birds remaining in the offshore areas during late spring/early summer are often dominated by immature birds or non-breeders. At the end of the breeding season, the diversity and density of seabirds offshore increases as breeding birds leave their colonies and disperse into the North Sea. Birds and their chicks are particularly vulnerable to surface pollutants when they are gathering for breeding season and when they undergo a moult of primary feathers, which leaves them flightless (i.e. Guillemots are most sensitive in July during their moult).

Table 3.2: Seabirds Likely to be Present in the Brae Area

Species	Months Present in the North Sea
Fulmar (Fulmarus glacialis)	All year
Gannet (Morus bassanus)	May - February
Common gull (*Larus canus*)	July – February
Herring gull (Larus argentatus)	July – April
Great black-backed gull (*Larus marinus*)	November – February
Kittiwake (Rissa tridactyla)	All year
Guillemot (*Uria aalge*)	All year
Little auk (*Alle alle*)	November – February
Puffin (Fratercula arctica)	April - September

Source: Stone *et al*, 1995 [29]

3.12 Designations

Seabed pockmarks supporting benthic communities rare to the North Sea are known to exist in the Brae Area, though none have been identified in close proximity to Brae Alpha, Brae Bravo or associated infrastructure. The Braemar Pockmarks, which are designated as a Special Area for Conservation (SAC), are located approximately 32 km to the north east of Brae Alpha and 20 km north east of Brae Bravo. This SAC has been described as 'a series of crater-like depressions on the sea floor', reflecting the Annex I habitat 'Submarine structures made by leaking gases.' Braemar pockmarks SAC has a global assessment grade of A, i.e. excellent conservation value (JNCC, 2012 [30]), with a specific benthic assemblage associated with the carbon structures.

The occurrence of seabed pockmarks indicates potential gas or fluid release, causing suspension and winnowing of sediments and carbon structures. Pockmarks are recognised as potentially providing sheltered habitats for a variety of marine organisms, as well as being active gas seeps which may be of ecological significance due to:

- Potential utilisation of methane and its by-product, hydrogen sulphide, by chemosynthesisers; and
- Formation of hard substrate suitable for colonisation by certain benthic organisms.

3.13 Ecosystem Services

Ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing. Galparsoro et al.(2014 [31]) describes the first assessment of ecosystem services provided by benthic habitats at an Atlantic European scale and concluded that benthic habitats provide a diverse range of ecosystem services. In general terms the highest provision of services were identified from habitats close to coastline in shallow waters. Galparsoro *et al.* (2014 [31]) concluded the primary identified ecosystem service contribution identified for A5.37 'Deep circalittoral mud' was considered to be in 'food provision' with secondary services being provided relating to 'nutrient provision', 'reproduction' and 'biodiversity.'

In addition to the ecosystem services provided by the wider Brae Area, some of the elements of infrastructure which form part of the current installations provide a level of ecosystem service. In general, habitats with hard bottom characteristics have a greater value than soft bottom habitats, and high-relief hard bottom is considered more valuable than low-relief hard bottom (Gala *et al.,* 2008 [32]). The biotic community of platforms can provide a steady rain of shells and organic matter, along with naturally deposited sediments. A shell hash layer can form a cap-like cover effectively sealing off much of the drill cuttings from the surrounding environment. It has also been demonstrated that hard bottom encrusting layers on the drill cuttings piles provide rare and valuable hard bottom habitat that supports a local community of rockfish, crabs, starfish, sea cucumbers and other marine life. Similar hard bottom habitat is also present within the Brae Area, associated with rock cover of pipelines.

3.14 Cultural Heritage

No designated wreck sites or known marine archaeological features are located within the Brae Area.

3.15 Other Sea Users

The North Sea has been extensively explored for oil and gas, with many production fields currently in operation. Infrastructure comprises platforms, pipelines, drilling templates, drill cuttings piles and other associated infrastructure.

There are no military uses known in the vicinity of the Brae Area. The Atlantic Crossing Telecommunication cable is charted to the north of the Brae Area.

In respect of recreation and tourism, activities in the offshore North Sea are limited to occasional yachts in passage.

In terms of shipping activity, the Brae Area is used by a range of commercial vessels, including fishing vessels, cargo vessels, tankers and oil and gas related vessels. A study commissioned by Marathon Oil found that 60% of the vessels recorded within 10 nm of the Brae Area platforms during a six month survey period in 2015 were classified as 'other.' This 60% accounts mainly for oil and gas vessels, including in-field vessels. Other notable types include 17% fishing vessels, 10% cargo vessels and 8% tankers. A collision risk analysis found that greater than 98% of the collision risk was associated with in-field vessels, with a return period of 53 years. As such, the risk to 'other sea users' (i.e. non oil and gas vessels) is low.

3.15.1 Commercial Fisheries

The North Sea is an important fishing ground, with Peterhead the main landing port for the vessels operating in the Brae Area. The principal target commercial species comprise the following:

- Pelagic species such as herring (*Clupea harengus*), mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*);
- Demersal species such as cod (*Gadus morhua*), haddock (M*elanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and saithe (P*ollachius virens*); and
- Shellfish such as Nephrops *(Nephrops norvegicus*).

Spawning and nursery grounds for various commercially important species are located in the vicinity of the Brae Area, including: cod, haddock, Norway pout, saithe, nephrops and mackerel.

For the purposes of establishing the baseline importance of the Brae Area for commercial fishing, the relevant study area has been defined as the International Council for the Exploration of the Sea (ICES) Rectangle 46F1. ICES Rectangle 46F1 is roughly equivalent to a 12 nautical mile (nm) buffer surrounding the three platforms. A 12 nm radius was agreed through consultation with the Scottish Fishermen's Federation (SFF) as reasonable to make an assessment of socioeconomic impact of the oil field. The catch by landings (quantity and value) for ICES rectangle (46F1) and the catch per unit effort from the ICES rectangle (46F1), along with figure showing location of the ICES rectangles and levels of fishing activity are provided in Technical Appendix 3.2.

Commercial fishing is currently excluded within 500 m of the platforms due to operational safety zones. Beyond this area, the following fisheries operate in the 46F1 rectangle. The 46F1 rectangle is considered of some local importance, with approximately 40% of the demersal and 65% of the pelagic fleets from Fraserburgh and Peterhead fishing within ICES rectangle 46F1 in the last five years. In the baseline (current) situation, around 73% of the study area is used for fishing, with other areas excluded due to a combination of safety zone/ snagging risk and unsuitable habitat. The area accounts for approximately 0.2% of landings (by value) of the Scottish fishing industry.

Commercial fishing in the vicinity of the Brae Area is dominated by demersal and shellfish fisheries, with fishing effort peaking during the spring and autumn. The pelagic fishery peaks for herring in May to September and for mackerel in August to February.

The gear types used for fishing in the Brae Area are trawlers and seine nets which were found to account for 100 % of fishing effort in terms of fishing days from 2009 – 2013 (within ICES rectangle 46F1). The shellfish (Nephrops) fishery is the most productive in terms of landings value and the pelagic fishery is the most productive in terms of tonnage.

3.16 Operational Emissions

The baseline for this EIA has been taken as the 'current' operating conditions of the Brae Area and its immediate surroundings. Therefore the baseline is considered to include current operational emissions to air and sea.

3.16.1 Emissions to Air

Carbon dioxide (CO_2) is the largest atmospheric emission from the Brae Area. The existing production operations at Brae Alpha and Brae Bravo result in CO_2 produced by the combustion of fuel (diesel) use and fuel gas use in turbines and engines, and also from process gas flaring and venting. The annual average emissions from the last five years at Brae Alpha are 288,869 tonnes of CO_2, with 269,095 tonnes of CO_2 emissions from Brae Bravo, as summarised in Table 3.3.

Table 3.3: Annual Average Tonnes of CO_2 Emitted 2012 -2015 at Brae Alpha and Brae Bravo

Year	Diesel in Engines	Diesel in Turbines	Fuel Gas	Flaring	Venting	Total
Brae Alpha						
Average	118	4,668	164,168	119,185	731	288,869
Brae Bravo						
Average	1,306	7,955	245,471	43,819	545	269,095

3.16.2 Emissions to Sea

3.16.2.1 Produced Water Discharges

The discharge of produced water in the UK is regulated by the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

The Brae Area operates well below the legislative 30 mg/l monthly average limit for concentration of oil in produced water discharged. The average oil in water concentration for the Brae Area in 2016 was 13 mg/l. In total, 1,942,280 m3 of produced water and 26.2 tonnes of permitted oil was discharged in 2016.

3.16.2.2 Chemical Discharges

The use and discharge of chemicals in the UK is regulated under the Offshore Chemical Regulations 2002 (as amended) and enforces a number of OSPAR requirements.

The volume of production chemical discharges in the Brae Area was 2,243 tonnes in 2016. The vast majority of chemicals used and discharged in the Brae Area (98%) fall within Offshore Chemical Notification Scheme (OCNS) categories Gold and E which are least hazardous to the environment. 2% of the total quantity of chemicals discharged from the Brae Area during 2016 carried substitution warnings.

3.16.2.3 Oil and Chemical Spills

During 2016 there was one unplanned release of oil (diesel) totalling 0.00043 tonnes and one unplanned release of chemicals (water based hydraulic fluid HW443ND) totalling 0.585 tonnes in the Brae Area.

4. Scope of EIA

4.1 Scope of EIA and Overarching Principles

The final scope of the EIA and the content of this ES was determined following the conclusion of the CA process. The selection of the partial removal of jacket/sub-structures as the preferred option (subject to approval) removes the consideration of the potential for significant environmental effects associated with full jacket/sub-structure removal and drill cutting piles disturbance from the scope of the EIA.

Table 4.1 provides an outline of the activity/receptor interactions considered through the scoping process. The table identifies the potential for significant effects. Those activity/receptor interactions which are considered to be 'low', 'negligible', or 'no impact/positive' are not considered likely to give rise to significant impact and have been scoped out from further detailed consideration within this ES.

Potential activities that were considered to be 'medium or high' during the scoping stage are considered to be activities that have the potential to cause significant adverse effects, or where there is currently uncertainty over the potential for significant effects which warrants further detailed assessment, or where it is considered that bespoke mitigation beyond best practice/generic mitigation may be required.

Table 4.1: Scoping Activity/Receptor Interaction

Decommissioning Activity	Designated Sites/ Species Disturbance Effects	Seabed Disturbance Effects (marine benthos, natural seabed sediment and drill cuttings pile)	Noise Effects (fish, marine mammals, seabirds)	Water Quality Effects (water quality, plankton, fish, shellfish, marine mammals)	Socio-economic and Other Effects (commercial fisheries, shipping/navigation, recreation)	Atmospheric Emission Effects (energy use, climate change, air quality)	Accidental Events (risk to water quality and supported marine life)
Transportation of Materials							
Topsides Preparation							
Subsea Installations Removal							
Topsides Removal							
Drill Cuttings Piles (Remove/Relocate)	Scoped out of EIA						
Drill Cuttings Piles (left in place)							
Steel jacket/sub-structure – Full Removal	Scoped out of EIA						
Steel jacket/sub-structure – Partial Removal							
Subsea Installations (manifolds, wellheads, mattresses) – Removal							
Subsea Installations (Central Brae Template)							
Pipelines/Cables/Flowlines/Umbilicals – full or partial removal							
Pipelines/Cables/Flowlines/Umbilicals – left in place							
LEGEND:	HIGH		MEDIUM		LOW		NEGLIGIBLE

The rationale for the EIA scoping (illustrated by Table 4.1) relies on a number of key overarching principles (described further in Technical Appendix 4.1: Scoping Rationale), identified through the course of researching the environmental baseline and the consideration of likely effects at the scoping stage for the following topics:

4.1.1 Energy Use and Emissions

Emissions to air, with global warming potential (GWP), are anticipated as a result of all decommissioning activities involving vessel use. The emissions include (but are not limited to) carbon dioxide (CO_2) associated with vessel fuel energy use and the emissions from the recycling of materials brought to shore. A secondary effect from the emissions associated with processing new materials to replace those left in place. In addition nitrogen oxide (NO_x) emissions from vessel use can result indirectly in an increase in ozone (0_3) and nitrous oxide (N_20), with GWP.

Given the meteorological conditions, emissions would be likely disperse rapidly. All vessels are required to comply with MARPOL 73/78 Annex VI on air pollution; plant is required to comply with relevant air pollution regulations (The Offshore Combustion Installations (Prevention and Control of Pollution) (Amendment) Regulations 2007).

Calculations completed to support the Brae Alpha jacket/sub-structure CA process identified the following emissions associated with partial removal using a heavy lift vessel:

- Total emissions, including emissions from vessel energy use and from new material processing, material recycling (including consideration of the replacement of materials left at sea) : 64,000 tonnes CO_2

For context, the existing production operations at Brae Alpha result in emissions with GWP, in the form of fuel gas use, flaring, venting and diesel use. The annual average platform emissions from the last five years at Brae Alpha were 288,869 tonnes of CO_2 (excluding standby vessels, supply vessels and transportation of personnel by helicopter). As such, the potential emissions of 65,049 tonnes CO_2 associated with the jacket/sub-structure decommissioning (a one off event) would represent a reduction in emissions relative to the normal annual operational emissions associated with operating the Brae Area platforms and infrastructure. Comparing the decommissioning activity air emissions to the operational emissions, or the emissions associated with the UKCS oil and gas industry as a whole, the potential for significant environmental effect on air quality or climate change is negligible. Air emissions are therefore not assessed in further detail.

No significant emissions to sea during decommissioning are anticipated. All flushing and cleaning activities, which may result in discharges to sea of chemicals and oil in water, will be delivered under the terms of Marathon Oil's existing permits under The Offshore Chemicals Regulations 2002 (as amended) and The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended). Chemical use during well plug and abandonment campaigns is outside the scope of the DP and this environmental assessment. Placed in the context of operational discharges to sea, decommissioning emissions to sea are considered to be negligible and are therefore not assessed in further detail.

4.1.2 Accidental Events

Hydrocarbon leaks or spills could occur from a range of different sources. Residual hydrocarbons and chemicals left following cleaning work would be present only in very small quantities, such that they would not pose a significant risk to the environment. The main potential source of contamination identified is diesel associated with vessels. In the event of a spill, the lighter fraction hydrocarbons (e.g. diesel fuel) would be expected to disperse rapidly in the immediate environment. In addition, chemical

spills would be likely to pose a negligible risk of significant environmental effect due to the combination of small quantities, rapid dispersion, the dynamic nature of the environment, dilution of the chemicals and the depth of water. The residual risk of environment effects from accidental oil spills would be reduced through the implementation of the preventive measures outlined in Section 6: Schedule of Environmental Management Controls. Further details on the assessment of accidental events is provided in Technical Appendix 4.2: Accidental Events.

Taking account of biological and chemical parameters or socioeconomic receptors (e.g. commercial fishing vessels), there are no significant long term residual risks attached to the potential for dropped objects on the basis that all objects would be recovered to shore. There would be no risk for shipping or fishing activities during lift activities, on the basis that an exclusion zone would remain in place during the decommissioning activities, preventing any interaction with general vessel movements or fishing vessels. Objects dropped during lifting operations would potentially impact upon the benthic communities within the drop zone, however the benthic fauna present would be likely to recover rapidly (within 1 year) following any disturbance. On this basis, and taking account of the small extent of any impact, the impact of dropped objects on benthic communities, including the drill cuttings piles is considered to be minor and not significant.

Risks during the decommissioning work would be managed to be as low as reasonable practicable (ALARP) with all reasonable care taken to avoid dropped objects. This will principally be achieved through risk assessment and the development of work method statements setting out the proposed decommissioning methodology and control measures.

4.1.3 Socioeconomic Effects (Other Sea Users)

The DP includes a proposed post-decommissioning safety zone around the jacket/sub-structure footings and drill cuttings piles. All wellheads and subsea structures outside the post-decommissioning safety zone would be removed from the Brae Area as part of the proposed DP. This safety zone would maintain fishing restrictions in the Brae Area; however overall the remaining restriction to fishing activity is considered to be negligible. The average annual economic value of fish landings from ICES rectangle 46F1 is approximately £1,000,000 (2013). The current safety zones for all three Brae Area platforms represent less than 0.05% of the total area provided by the ICES rectangle 46F1.

Where pipelines/cables/ flowlines/umbilicals are proposed to be left in place, they would either be trenched, suitably rock covered or within a post-decommissioning safety zone, so there would be no interaction with commercial fishery interests.

4.1.3.1 Post-Decommissioning Debris Clearance, Verification and Safety Zones

A post-decommissioning site survey will be carried out within a 500 m radius of installation sites and within 200 m of pipelines and umbilicals. Oilfield related seabed debris will be recovered for onshore recycling or disposal. Following implementation of the recovery plan, Marathon Oil will engage an independent organisation to conduct trawl sweeps (location and extent to be defined in consultation with relevant parties, including the fishing industry) to provide verification that the seabed is clear of debris.

It is proposed that post-decommissioning safety zones will be established around the jacket/sub-structure footings, subject to consultation with authorities and stakeholders. The purpose of these post-decommissioning safety zones is to mitigate the risk of fishing vessels inadvertently snagging their nets

on the jacket/sub-structure footings. The post-decommissioning safety zones will be recorded on the FishSAFE system and on Admiralty Charts to provide a warning to all mariners of the presence of subsea obstructions. The current safety zones at Central Brae, West Brae and Sedgwick will be removed once the equipment has been decommissioned. Applications for post-decommissioning safety zones will be made to the Health and Safety Executive (HSE).

Overall, it is considered that there is no potential for significant socio-economic effect associated with commercial fisheries interests.

4.1.4 Waste and Residues

For the purpose of the EIA process it has been assumed that removal and/or management of wastes will follow the Materials Management Strategy (MMS) to be developed for the decommissioning project, which will adhere to relevant policy and legislation as set out within the Brae Area Decommissioning Waste Management Guidance Document [46]. The principal, overarching objectives being;

- protection of the environment and achievement of compliance with environmental and waste legislation and industry standards to satisfy Marathon Oil's Duty of Care with respect to wastes including (but not limited to) the principles of the waste hierarchy as established by the European Waste Framework Directive (implemented at national level by country specific regulations and regulated in Scotland by SEPA);
- stakeholder expectation (e.g. customer/client/regulatory authority) in relation to continual improvement in environmental and sustainability management, this includes meeting project targets and objectives with respect to waste management; and
- delivery of a safe, resource efficient decommissioning process, achieving waste reduction, improved business efficiency and cost savings.

Marathon Oil's intent is to maximise the reuse and recycling of materials that are returned to shore, and minimise the quantity of material sent to landfill. The majority of material will be returned to shore in the period from 2020 - 2031. It is not possible to predict the state of the re-use and recycling market at that time, however the provisional targets for reuse and recycling are set within the DP (see Table 3.14 in the DP).

Table 2.7 and Table 2.8 in the DP [1] provides an approximate materials inventory for the installations and pipelines respectively. Appendix 3 in the DP [1] provides an additional breakdown. A focused review of the inventories of materials will be conducted during the detailed engineering phase of the decommissioning programmes. The level of detail developed will be appropriate to the chosen removal method, local regulatory requirements and conditions of the receiving facility. Due consideration will also be made as to whether materials will become waste e.g. those that are destined for direct reuse will not enter the waste stream and therefore will not be included in the waste inventory. Materials that are included in the waste inventory will be assigned the appropriate European Waste Code (EWC).

Due to the scale of the project, it is recognised that there will be large quantities of material returned to shore. Marathon Oil will undertake sufficient consultations with all relevant regulatory authorities and waste management contractors to ensure that appropriate licenced waste management facilities are available.

5. Summary of Environmental Effects

5.1 Introduction

This section provides a summary of the potentially significant effects associated with the proposed decommissioning activities.

5.1.1 Issues Remaining Following Scoping

Following the scoping stage the key issues identified for further detailed assessment are:

- Seabed disturbance effects –considering the potential effects on both soft sediment and hard substrate benthic communities as a result of jacket/sub-structure removal, removal of the subsea installations, flowlines/umbilicals and pipelines/cables.
- Underwater noise effects – considering the potential effects of cutting activities on marine mammals.
- Cumulative and Transboundary effects.

The assessment of environmental effects is presented under the following subheadings, consistent with the DP:

- Surface facilities – topsides;
- Jacket/sub-structures and subsea installations;
- Decommissioning pipelines;
- Decommissioning stabilisation features; and
- Decommissioning drill cuttings piles.

5.2 Surface Facilities – Topsides

No potentially significant environmental effects were identified at the scoping stage (see Table 4.1) associated with the removal of the Brae Alpha and Brae Bravo platform topside modules.

5.3 Jacket/sub-structures and Subsea Installations

This section provides a summary of the environmental effects associated with the partial removal of the Brae Alpha and Brae Bravo jacket/sub-structures, the full removal of the Brae Bravo flare stack, and removal of the Central Brae template and the West Brae manifold. There are no separate wellhead protection structures on subsea well installations[3].

5.3.1 Underwater Noise

Underwater noise associated with decommissioning activities was considered at the scoping stage. The potential for significant effects was identified associated with:

- Cutting activities required for the partial removal of the Brae Alpha and Brae Bravo jacket/sub-structures;
- Cutting activities during the full removal of the Brae Bravo flare jacket/sub-structure; and

[3] *All wellhead protection structures are integral to the xmas tree and therefore would be removed as part of the well plug and abandonment campaigns.*

- Potential explosive detonations associated with the full removal of the Central Brae template structure.

Since the scoping stage, further comparative analysis of the potential removal options for the Central Brae template structure has identified options for full removal which do not require the use of explosives. As a result, the potential for significant effects associated with explosive detonations has been scoped out the assessment.

The duration of the cutting activities would vary depending on the technical option selected. For the partial removal of the Brae Alpha jacket/sub-structure using a Heavy Lift Vessel (HLV) to recover the jacket/sub-structure in sections, the removal activities are anticipated to include cutting operations expected to last 38-42 days. For the partial removal of the Brae Bravo jacket/sub-structure, the cutting operations would be expected to last from 28-32 days. This would represent a worst case. The assumptions made regarding the sound source levels are presented in Technical Appendix 5.1: Underwater Noise Impact Assessment.

A detailed assessment of potential effects on marine mammals has been undertaken, considering the likely noise propagation from the identified noise sources. Underwater noise associated with vessel movements and other ancillary activities is not considered further on the basis that the noise associated with these activities is unlikely to exceed thresholds that would cause injury.

5.3.1.1 Receptors

The marine mammals commonly sighted in the Brae Area are harbour porpoise and seals (grey and harbour seal). Other species may be encountered, but as they are rare, the focus of the impact assessment is on seals and harbour porpoise.

5.3.1.2 Jet Cutting

For the purposes of this assessment it is assumed that jet cutting would be undertaken at Brae Alpha for a period of up to 42 days, and at Brae Bravo for a period of up to 32 days. The noise effects associated with jet cutting are considered to provide a reasonable basis for assessment purposes and potential noise from other cutting techniques would fall within the parameters used for the noise assessment here.

The calculated distances and areas using threshold values for Permanent Threshold Shift (PTS – permanent injury e.g. loss of hearing), Temporary Threshold Shift (TTS – temporary injury) and behavioural response are presented in Table 5.1. The distances and areas to the thresholds are presented for SPL (sound peak level) and SEL (sound exposure level). The two hour cumulative is considered a realistic worst case scenario and is used in the impact assessment.

Table 5.1: Distance and Area to Thresholds for PTS, TTS and Behavioural Response - Jet Cutting

Distance (m) and area (km^2) where threshold is exceeded for jet cutting threshold (2 h)

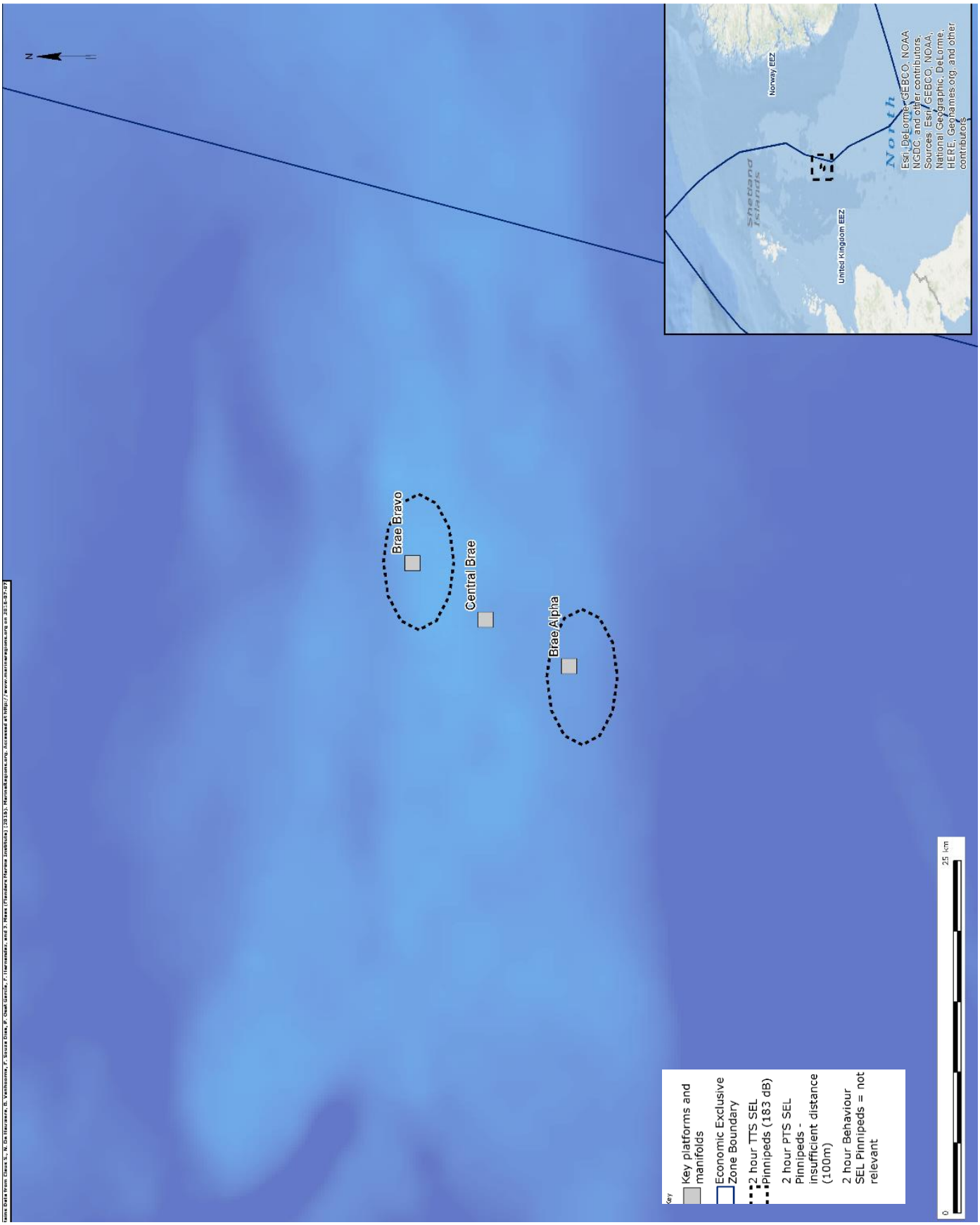
	PTS		TTS		Behavioural response	
	SPL	SEL	SPL	SEL	SPL	SEL
Seals	0 m	100 m	0 m	2,500 m	0 m	n/a
	0 km^2	0.03 km^2	0 km^2	19.6 km^2	0 km^2	n/a
Harbour porpoise	0 m	0 m	0 m	0 m	0 m	n/a
	0 km^2	0 km^2	0 km^2	0 km^2	0 km^2	n/a

5.3.1.3 Impacts on Seals

The Brae Area is not a key habitat for seals, as seals use haul-out sites for mating and moulting. However, as seals are widely dispersed for foraging, they may be present in the Brae Area.

The distances to thresholds for PTS, TTS and behavioural impact are illustrated in Figure 5.1.

Figure 5.1: Distance to Noise Threshold for Seals (Pinnipeds)



Seals may exhibit injury at close distance to jet cutting (up to 100 m from the cutting activity). Since the impact of PTS is irreversible with a long-term duration, the impact to individuals is assessed to be large.

As the extent of the impact is highly localised, the number of individuals potentially affected by PTS would be negligible.

Both grey and harbour seal populations in the Brae Area have been assessed by the IUCN as least concern, and the European population is stable. Based on this, it is assessed that the magnitude of PTS from jet cutting is negligible.

As the sensitivity to PTS is high, and the magnitude is none/negligible, the overall effect of PTS is thus assessed to be minor and not significant.

At larger distances (up to 2,500 m) exposed individuals are likely to experience a temporary low-frequency hearing loss (TTS), lasting from minutes to a maximum of one day. The duration of jet cutting is temporary, and due to the distance where TTS may occur, the magnitude of TTS is considered small. The overall significance of TTS is assessed to be minor.

Behavioural impact ranges are 0 m, and no behavioural impacts are foreseen. Disturbances are likely to be of similar magnitude as disturbance from passing merchant vessels, which are very abundant in the North Sea.

The duration of jet-cutting is temporary and the scale is local. As the sensitivity to behaviour is medium, and the magnitude is none/negligible, **the overall effect of behavioural impact is thus assessed to be minor and not significant.**

5.3.1.4 Impacts on Harbour Porpoise

The Brae Area is not a key habitat for harbour porpoises, though harbour porpoises may be present in the Brae Area. The density of harbour porpoise in the Brae Area is 0.3 animals/km^2.

The distances to thresholds for PTS, TTS and behavioural impact are shown to be zero in Table 5.1 for harbour porpoise, indicating that the thresholds are not exceeded. The magnitude of impact is thus negligible.

The duration of jet-cutting is temporary and the scale is local. Although the sensitivity of harbour porpoise is medium - high, the magnitude is negligible, **therefore the overall effect of behavioural impact is assessed to be minor and not significant.**

5.3.1.5 Summary of Impact

The assessment of impacts has been performed in accordance with the methodology presented in Technical Appendix 5.1: Underwater Noise Impact Assessment. A summary of the impact assessment is provided in Table 5.2.

Table 5.2: Summary of Potential Impacts at Brae Alpha, Brae Bravo and Area-wide Infrastructure

Species	Sensitivity	Magnitude	Overall Effect
Jet cutting – Brae Alpha and Brae Bravo			
Injury or PTS Grey seal and harbour seal	High	No or negligible	Minor
TTS Grey seal and harbour seal	Medium	No or negligible	Minor
Behavioural impact Grey seal and harbour seal	Medium	No or negligible	Minor
Injury or PTS Harbour porpoise	High	No or negligible	Minor
TTS Harbour porpoise	Medium	No or negligible	Minor
Behavioural impact Harbour porpoise	Medium	No or negligible	Minor

5.3.1.6 Indirect Effects

There are no potential indirect effects associated with underwater noise and marine mammals. The assessment also considered the potential for secondary effects on other receptors, e.g. fish, which are also vulnerable to underwater noise. Avoidance reactions from almost all fish species are likely to occur in close proximity to the area, however the fish population is also likely return after the cessation of decommissioning activities.

5.3.2 Seabed Disturbance

The key issues assessed as part of the EIA include the potential disturbance to natural seabed sediments, benthic communities and drill cuttings pile sediments during partial sub-structure removal, removal of the Brae Bravo flare stack sub-structure, and the removal of area wide subsea installations.

Based on the comparative assessment process, Marathon Oil has proposed, subject to approval, that the jacket/sub-structure would be removed to a point above the top of the jacket/sub-structure footings as described in the DP [1]. The footings and drill cuttings pile would be left in place. Therefore the effect of removal or re-distribution of the drill cuttings piles beneath Brae Alpha and Brae Bravo by dredging has been subsequently scoped out of this assessment.

The benthic community present (SS.SMU.OMu.Cap*Thy - Capitella sp* and *Thyasira spp* in organically enriched offshore circalittoral mud and sandy mud) is of low importance and considered likely to recover within less than a year of disturbance, therefore the overall sensitivity of the community is low.

The OSPAR and Priority Marine Feature (PMF) listed *Arctica islandica* may be present in very low densities under and around the platform sub-structure. Macrofaunal grab samples indicated that juvenile forms of the OSPAR and PMF listed *Arctica islandica* may be present in densities up to seven individuals per 0.1 m^2 (no adults present). This is less than the regional estimate of 28.6 individuals per 0.1 m^2 (Witbaard and Bergman, 2003[19]). The species is not sensitive to increased suspended sediment but has 'moderate' sensitivity to smothering, physical disturbance and displacement (Sabatini and Pizzola, 2008 [33]). Overall, the receptor habitats and species are considered to have medium sensitivity.

This section considers:

- the potential sediment disturbance effects at the platform sub-structure only;
- the effects resulting from removal of the Brae Bravo flare stack sub-structure (which will require different methods); and
- physical effects to benthic communities as a result of sub-structure cutting/removal, such as damage or injury.

5.3.2.1 Disturbance to Natural Seabed Sediments and Drill Cuttings Pile Sediments During Platform Sub-Structure Removal (Without Footings)

Decommissioning activities at the platform sub-structure which may result in seabed disturbance have been identified as: preparation works (including marine growth removal); and jacket/sub-structure cutting and lifting.

Significant disturbance of the underlying drill cuttings pile may cause leaching of hydrocarbon contaminants into the water column along with the suspension of particle bound contaminants that may impact on the local benthic fauna through assimilation into the gut of suspension feeders (Breuer et al., 2004 [35]). However, decommissioning activities have been defined to avoid disturbance to the drill cuttings piles where ever possible. Any initial disturbance caused by cutting activities to separate the jacket/sub-structure from its footings would not require significant intrusion into the cuttings pile or seabed sediment (such as would be required for complete platform sub-structure removal). Consequently the effects to water quality are considered to be negligible.

The spatial extent of seabed disturbance resulting from works at the sub-structure locations (cutting, rock and mattress placement) would be highly localised as it would occur in the immediate vicinity of the platform sub-structure. Initial disturbance to the drill cuttings piles caused by cutting will be minimised as footings would be well above the greatest elevation of the cuttings piles from the seabed.

Any disturbance caused by anchoring would be close to the seabed and would avoid direct anchor placement in immediate proximity to the cuttings piles.

Consequently no significant intrusion into the cuttings pile or seabed sediment is anticipated (such as would be required for complete sub-structure removal). The resultant seabed change and sediment plumes are therefore anticipated to be localised in extent, negligible duration, minor frequency, and the magnitude of the effect is negligible.

It is anticipated that recovery of the benthic ecosystem from sediment disturbance (plumes, turbidity, contaminant releases) will occur once the decommissioning works are complete, due to the chemical tolerance of the species present and the small severity of the predicted change compared to baseline conditions. Overall, **the temporary and adverse impact is assessed to be minor and not significant.**

5.3.2.2 Disturbance to Seabed During Removal of Flare Stack Sub-Structure at Brae Bravo

The flare stack and bridge associated with Brae Bravo will be removed in its entirety using a lift vessel. The flare tower is approximately 200 m northwest of the Brae Bravo platform. The footings of the flare tower sub-structure will be removed to -3 m below the seabed, and therefore cause intrusion below the seabed surface. For the purposes of this assessment it has been assumed that sediment will be excavated/dredged from beneath the flare stack, to give access to the footings prior to removal. Sediment will be redeposited on the adjacent seabed. This section considers the effect to seabed habitats and geology as a result of the intrusion during sub-structure pile removal.

Seabed samples collected from representative locations indicate the surface sediments are likely to comprise fine sand. The nearest grab sample locations which are not within the drill cuttings pile indicate that THC concentrations are likely to be approximately 2.2 µg/g to 2.8 µg/g, well below the Marine Scotland Action Level 1 for THC (100 ppm (i.e. mg/kg or µg/g). This is also true in relation to metal concentrations. Therefore, the severity of the effect of contaminant disturbance is considered to be negligible.

The removal will consequently cause mixing of the 3 m depth sediments and is likely to cause sediment to be lifted into the water column, creating a localised sediment plume[4].

Whilst the volume of sediment to be removed has not been confirmed at this stage, nor has a range of variable parameters such as potential discharge points from dredging, or height of discharge point above seabed, it is noted that the fine characteristic of the sand would contribute to a slower settling velocity than would be expected for coarse materials. Sediments subsequently lifted through the water column as a direct result of footings removal are considered likely to flocculate or remain aggregated as they are lifted from seabed level, and consequently may settle faster than a source such as a discharge (e.g. from dredge discharge as a result of sediment excavation/dredging as discussed above).

It is considered that the seabed disturbance will mainly cause suspension of sediments in the lower parts of the water column and significant concentrations will settle out in the order of hours. The direct disturbance of the seabed will affect the epibenthic community at seabed level. Remediation work will be required to infill the void space left behind following the removal of the flare stack footings. This would be likely to be achieved using a combination of recycled mattresses and rock cover. Effects associated with this remediation work would be very localised and as such are considered to be negligible and not significant.

The effect will be localised to the sub-structure area, and as described previously, will have negligible severity and medium spatial extent. The duration is considered to be negligible, with the habitat being returned to soft sediment once the works are complete, and the frequency is considered to be negligible as the seabed lift is likely to be completed as one campaign of three lifts. The overall magnitude of the effect is assessed to be small. **Therefore, the temporary adverse impact is assessed to be minor and not significant.**

[4] *Based on the assumption of spherical quartz grains at 20º, uniform density, no flocculation or wave influences the settling velocity of fine sand would be 0.01-0.03 m/s (Gibbs et al. 1971) [34], meaning that if sediment is lifted 5m above the seabed (for example), it will take and estimated 2-9 min to settle. Whereas the settling velocity of coarse sand is 0.08 to 0.15 m/s (Gibbs et al. 1971), so would take 30 sec to 1 min to settle through a 5 m distance. Mean spring peak tidal flows are approximately 0.26 m/s in the Brae Area – so fine sand may travel laterally 130 m in 9 mins (also assuming no wave influences, flocculation, etc.).*

5.3.2.3 Localised Disturbance to Seabed and Marine Growth During Removal of Area Wide Subsea Installations Affecting Benthic Communities and Natural Seabed Sediments

This section considers the direct physical disturbance impacts to benthic communities as a result of the subsea installations structure cutting and removal. Removal of the subsea installations may cause effects related to the direct disturbance of the surface sediments as well as the removal of hard substrate and the associated marine growth prior to lifting.

The dominant growth on the structures is plumose anemone *Metridium senile*, which makes up 30% to 80% of growth identified below 10 m water depths in the majority of cases (identified through remotely operated vehicle (ROV) video footage). This species is assessed as having low sensitivity to abrasion and physical disturbance that is equivalent to a scallop dredge landing or being dragged across the organism, which may be experienced during water jetting (Hiscock and Wilson, 2007 [24]). The water jetting will cause the organisms to fall to the seafloor; the species has low sensitivity to changes in biological zone, but sensitivity to substratum loss is moderate (Hiscock and Wilson, 2007 [24]). It is likely that plumose anemone will fall to the seabed, where a small proportion of individuals may survive as they require hard surfaces on which to anchor to enable feeding.

Near the top of the jacket/sub-structures (0 m to 10 m depths), the assemblage comprises species such as common mussel *Mytilus edulis*, which ranges from 10% to 70% cover dependant on location. Macro algae were also abundant at 5 m to 10 m depths on the majority of sub-structure legs at Brae Alpha and Brae Bravo – i.e. on three to four of the legs, dependant on the depth of the observation). These species have low sensitivity to abrasion and physical disturbance (De-Bastos and Tyler-Waters, 2008 [36]; Budd, 2008 [37]). Common mussel is primarily an intertidal species and needs to maintain attachment to hard structures to feed, it is therefore unlikely to survive on fine seabed sediments if displaced, and there may not be sufficient photosynthetically active radiation (light available for plants to survive) at the seabed for macro algae. Other organisms present on the platform sub-structure include starfish, deadman's finger *Alyconium digitatum*, copepods, fanworms (*Serpulidae*) and rarely sponges (*Profifera*); these are considered to have similar or greater sensitives and it is assumed that they will not survive jet washing due to direct damage or increased predation risk.

The organisms that are not removed from the structure prior to lifting shall undergo disturbance and permanent desiccation as they are brought to the surface and taken ashore for disposal. Part of the sub-structure would be retained meaning that the entire community would not be lost. Assuming that a third of the structure will be retained and that the assemblage is distributed evenly, an estimated 1,942 Te of benthic organisms will be lost during cut and disposal of Brae Alpha and Brae Bravo sub-structures in total (i.e. two thirds of the total assemblage). The higher biological zones that are dominated by common mussel are unlikely to be represented in the zone of the structure to be retained. Although the effect covers a relatively small extent, the severity of the effect is considered to be medium (loss of representation against the baseline conditions), including approximately 1,942 Te of benthic fauna, with a permanent duration but negligible frequency. Overall the magnitude of the adverse effect is assessed to be small. The adaption and recoverability of most of the species affected is low. No species of legislative importance were identified on the sub-structure, therefore the species are considered to have negligible value. Therefore the sensitivity of the receptor is low.

The full removal of other subsea installations would cause mobilisation and mixing of sediments and is likely to cause sediment to be lifted into the water column, creating a sediment plume. While the sediment plume would be likely to vary according to prevailing currents and the particle size of the

sediments, impacts are considered likely to be limited predominantly to and area within 100 m of the installation to be removed. It is considered that the seabed disturbance will mainly cause suspension of sediments in the lower parts of the water column and significant concentrations will settle out in the order of hours. The direct disturbance of the seabed would affect the epibenthic community at seabed level. The effect will be localised to the installation area, and as described previously, will have negligible severity and local spatial extent. The duration is considered to be short-term, with the habitat being returned mainly to soft sediment once the works are complete, and the benthic communities recovering within one year of completion. Remediation work would be required to infill the void space left behind following the removal of installations. Effects associated with this remediation work would be local to the immediate footprint of the rock covered area and as such are considered to be negligible and not significant.

The overall permanent disturbance and removal impacts at the subsea installations i.e. Central Brae template, West Brae manifold and other wellhead protection structures is assessed to be minor and not significant.

5.4 Decommissioning Pipelines

The pipeline comparative assessment considered a range of options for decommissioning pipelines, summarised in the DP [1].

5.4.1 Underwater Noise

During pipeline decommissioning, underwater noise would be limited to predominately vessel based sources. Typical source noise levels for localised cutting (e.g. hydraulic shears), trenching (e.g. mass flow excavation or water jetting) and rock placement using a fall pipe vessel were considered. A review of relevant literature confirms that dynamic positioning of the vessels (a system of sensors and thrusters used on vessels to allow it to maintain a position without the use of an anchor spread) associated with the works would result in the highest underwater noise levels, with an upper value of 197 dB re 1 uPa at 1 m. Dynamic positioning noise from vessels would occur for the majority of the works periods, during pipeline decommissioning, therefore it is assumed that its noise level would dominate over any other underwater activities.

Acoustic energy from dynamic positioning would be concentrated in a relatively low acoustic frequency range, between 50 Hz and 3 kHz. Predictions for the distance beyond which limits for TTS and PTS would not be exceeded have been made using simplified noise modelling principles assuming 15 times logarithmic distance propagation, without taking into account the bathymetry and sea bottom geo-acoustic properties. The distances beyond which the adopted limits for cumulative underwater noise level would not be exceeded are shown in Table 5.3.

Table 5.3: Summary of Potential Underwater Noise Impacts During Pipeline Decommissioning

Group of animal species	Distance to threshold levels	
	TTS	PTS
Low frequency cetaceans	1450 m	70 m
Medium frequency cetaceans	10 m	<10 m
High frequency cetaceans	175 m	<10 m
Pinnipeds	550 m	25 m

Table 5.3: Summary of Potential Underwater Noise Impacts During Pipeline Decommissioning

Group of animal species	Distance to threshold levels	
	TTS	PTS
Fish with swim bladder	<10 m	<10 m

The calculations set out in Table 5.3 are made on a very conservative set of parameters; however they demonstrate that the potential for injury would be localised. The detailed noise assessment, set out in **Technical Appendix 5.1: Underwater Noise Impact Assessment** confirms that low frequency cetaceans may be encountered, but are rare within the Brae Area.

The marine mammals commonly sighted in the Brae Area are harbour porpoise and seals (grey and harbour seal), and permanent injury would only occur within <10 and <25 m respectively for these species. **Given the local scale of the effects, the overall effect is considered to be negligible and not significant.**

5.4.2 Seabed Disturbance

The trenching of pipelines in place is considered for the purposes of this environmental assessment. This would result in high amounts of seabed disturbance as surface silt is mobilised into the lower water column, however this would be expected to settle quickly due to the short distance to the seabed. It is estimated that installation and removal of linear infrastructure affects a 10 m – 15 m width if ploughed into the seabed (Cordes et al., 2016 [41], OSPAR, 2009 [38]), with indirect effects over a wider 100 m area (Cordes et al., 2016 [41]). The quantity of marine growth on the pipeline and/or rock mattressing that will be removed or smothered as a result of burial is not known, but is likely to comprise species observed at the base of the sub-structure, such as the plumose anemone *Metridium senile*. The trenching of pipelines allows for seabed habitats to return to soft sediment but causes temporary disturbance effects during the burial, such as increased turbidity, sediment mixing and smothering.

The magnitude of the effect of contaminant resuspension is considered to be negligible based on the following considerations:

- The sediments in the wider Brae Area contained contaminants that are below ERLs, which indicates that they would rarely cause adverse effects to benthic organisms if ingested.

The sediment in the wider Brae Area is made up of very coarse silt to fine sand with mean diameters from 43 µm to 155 µm. Contaminants readily adsorb to fine sediments, particularly organic contaminants such as PAHs , THCs and PCBs, which have low solubility in water and 'preferentially' adsorb to sediments. The ratio of the contaminant that will leave sediment and enter the dissolved phase, and become more bioavailable, is referred to as the partition coefficient. Partition coefficients are typically four or five orders of magnitude lower than predicted increases in suspended sediments (ABPmer, 2009 [39]) and would be less so for finer sediments. This means that the majority of contaminants remain adsorbed to sediment particles when re-suspended in water, with only a small proportion becoming aqueous [40]. This further highlights the negligible magnitude and implies a small spatial extent and duration based on the anticipated dilution and dispersion.

The pipelines are unlikely to support species of importance, although it is acknowledged that the substrate may allow a local increase in biological production associated with a hard substrate habitat when compared to surrounding soft sediment habitats. The habitat is considered to be of negligible importance. The magnitude of the effect is considered to be small due to the relatively localised extent covered in proportion to the habitats available in the wider area. Equally, the seabed disturbance caused by removals or trenching is of small scale (i.e. direct effects within 15 m and indirect effects within 50 m to 100 m of the pipeline (Cordes et al., 2016 [41])) and is likely to have a short duration and negligible frequency in any one area due to the 'rolling' movement along the cable/pipe routes, and therefore predicted to have a small effect magnitude. Overall, the adverse impacts of safeguarding pipelines/cables/flowlines/umbilicals is assessed to be minor and not significant.

5.5 Decommissioning Stabilisation Features

The scope of the DP includes for reusing mattress protection to stabilise cut-ends of pipelines/umbilicals/flowlines/cables no more than 250 m from the derogated jacket/sub-structure footings within the post-decommissioning safety zone or for profiling the seabed as part of the seabed remediation at Central Brae and West Brae. Any surplus mattresses would be recovered and returned to shore in accordance with the Brae Area materials management strategy.

Mattresses to be reused from elsewhere within the Brae Area in a post-decommissioning safety zone would not be placed directly over drill cuttings pile sediments, thereby avoiding the potential to disturb and mobilise entombed contaminants.

The seabed disturbance caused by mattress removals or movement for reuse is of small scale and is likely to have a short duration and negligible frequency in any one area and is therefore predicted to have a small effect magnitude.

5.6 Decommissioning Drill Cuttings Piles

5.6.1 OSPAR 2006/5 – Screening for Contamination Thresholds

OSPAR Recommendation 2006/5 [45] on a Management Regime for Offshore Cuttings Piles sets out criteria for the identification of a best practice management regime for offshore drill cuttings piles to reduce the impacts of pollution by oil and other substances within the piles to a level that is not considered significant. The Recommendation comprises a two stage process: Stage 1 (Screening) sets out criteria thresholds against which the level of pollution from an existing drill cuttings pile may be measured to determine whether the level of pollution could be considered significant. The thresholds comprise:

- Rate of oil loss to the water column: 10 tonnes/year; and/or
- Persistence over the area of seabed contaminated: 500 km^2/year.

The Recommendation states that "persistence should be assessed on the basis of the area of the seabed where the concentration of oil remains above 50 mg/kg and the duration that this contamination level remains." This criterion is equivalent to 50 $\mu g\ g^{-1}$.

The Recommendation goes on to state that "Where both the rate and persistence are below the thresholds set out above and no other discharges have contaminated the cuttings pile, no further action is necessary and the cuttings pile may be left in place to degrade naturally."

Only if results of the Stage 1 screening analysis indicate that either of these thresholds are likely to be exceeded is there a requirement for a Stage 2 assessment to determine the Best Available Technique (BAT) and/or Best Environmental Practice (BEP) for the drill cuttings pile.

Marathon Oil completed a Stage 1 screening assessment in 2008 in line with OSPAR recommendation 2006/5 based on data available at that time and utilising the assessment methodology set out within UKOOA (2000a and 2000b), including the development of a long-term model (LTM) to predict the fate and persistence of the drill cuttings piles based on physical stability and diagenetic processes. The Stage 1 screening assessment was updated and verified using samples gathered and analysed in 2015.

The rate of oil loss to the water column from each of the drill cuttings piles was less than 10% of the 10 tonnes/year threshold set out within OSPAR 2006/5 (OSPAR, 2006 [45]). The persistence of seabed contamination over time for all piles was less than 4% for Brae Alpha and less than 14% for Brae Bravo against the 500 km^2/year OSPAR threshold.

The key finding is that, even under the worst case scenarios assessed, **the estimated values are well below the thresholds set out within OSPAR 2006/5 (as described above) and may therefore be left in place to degrade naturally.**

5.6.2 Drill Cuttings Piles – Comparative Assessment of Decommissioning Options Using Net Environmental Benefits Analysis

Marathon Oil commissioned a detailed CA to consider options for the management of the drill cuttings piles beneath the Brae Alpha and Brae Bravo platforms to confirm the conclusions of the screening assessment. The CA used a Net Environmental Benefits Analysis methodology (incorporating Habitat Equivalency Analysis) to determine the preferred option for the management of the drill cuttings piles.

The CA of the decommissioning options follows the requirements set out in OSPAR recommendation 2006/5 [45], and considered:

- The technical and engineering aspects of the option, including re-use and recycling and the impacts associated with cleaning the cuttings pile while it is offshore.
- The timing of the decommissioning.
- Safety considerations associated with removal and disposal, taking into account methods for assessing health and safety at work.
- Impacts on the marine environment, including those arising from exposure of biota to contaminants associated with the cuttings pile, other biological impacts arising from physical effects, conflicts with the conservation of species, with the protection of their habitats, or with mariculture, and interference with other legitimate uses of the sea.
- Impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and effects on the soil.
- Consumption of natural resources and energy.
- Other consequences to the environment which may be expected to result from the options.
- Impacts on amenities, the activities of communities and on future uses of the environment.
- Economic aspects.

This CA process confirmed that the preferred option is to leave the drill cuttings piles in place undisturbed.

In addition, consideration has been given to the potential for ecotoxilogical effects associated with the drill cuttings piles. The assessment confirms the limited bioaccessibility and bioavailability of contamination in drill cuttings piles. There is unlikely to be an exposure pathway to benthic organisms where the contaminants have previously leached. This is because drill cuttings piles are covered with clean sediment or biological or mineral debris (e.g. shells from molluscs previously attached to the jacket/sub-structure), preventing benthic organisms from coming into contact with contaminants deep in the drill cuttings piles. An adverse biological effect can only occur where an exposure pathway exists. On this basis, no significant effects associated with the decommissioning of the drill cuttings piles have been identified.

5.7 Cumulative and Transboundary Effects

The EIA has given consideration to effects which may arise as a result of interaction with the following additional activities:

- The potential for individual activity/receptor interactions associated with each of the decommissioning activities for Brae Alpha, Brae Bravo and associated field infrastructure to combine with each other where they are either spatially of temporally concurrent;
- The potential for activities associated with the decommissioning of Brae Alpha, Brae Bravo and associated field infrastructure to combine with similar concurrent activities associated with the decommissioning of East Brae and Braemar; and
- The potential for activities associated with the decommissioning of the Brae Area infrastructure to combine with other known proposed Decommissioning Programmes submitted to BEIS by other operators, where it is considered likely that there would be a spatial or temporal overlap.

Whilst the Brae Area lies in proximity to a number of third party pieces of infrastructure which are likely to be decommissioned in the future, only one of these: BP's Miller platform is currently subject to a publicly available Decommissioning Programme. Consequently, for the purposes of this assessment it has been assumed that the decommissioning of other adjacent infrastructure will be temporally separate from the decommissioning of Brae Area infrastructure covered by this ES.

In addition, the EIA considers the potential effects of the DP in respect of any implications for the territory of another country. In this case, the section considers the potential for impacts to extend across the Norwegian Exclusive Economic Zone (EEZ) boundary line (13 km to the east of the Brae Bravo platform) where their occurrence has the potential to result in environmental and/or social-economic effects across the international border.

5.7.1 Seabed Disturbance

During scoping, it was identified that potential for cumulative effects on the seabed may exist associated with the introduction of further rock cover protection along retained pipelines/umbilicals/flowlines/cables. The addition of new rock into a previously soft sediment habitat could be expected to bring localised change both to physical seabed profile and to the biological composition of the seabed.

The direct disturbance to the seabed of additional rock cover would be an adverse smothering effect on the epibenthic community at seabed level. While the trenching of pipelines in place would cause temporary disturbance effects during the burial (such as increased turbidity, sediment mixing and smothering), the seabed habitats would be expected to recover to a condition close to the current condition following the completion of the work. Additional rock cover would however result in a permanent habitat change local to the rock cover. The additional adverse effect of this habitat change in

combination with other decommissioning activities is not considered to be significant on the basis that, overall, very small areas (in the context of the surrounding benthic habitat area) of benthic habitat would be lost, to an extent unlikely to affect the functioning of the ecosystem and unlikely to be noticeable against background variability.

In addition, consideration has been given to the potential for the introduction of additional hard substrate to act in combination as 'stepping stones' for alien species brought in as larvae by ballast waters (Wilhelmsson et al., 2010 [42]). The introduction of non-native species may impair the ecosystem equilibrium, as artificial structures are reported to be more suitable for non-native species than natural reefs by changing the competitive interactions (Wilhelmsson et al., 2010 [42]). However, the likelihood of non-native species establishing and dominating on rock protection within the Brae Area is reduced by the existing presence of man-made hard substrate in the region that already supports established epibenthic communities. In light of this, the vulnerability of the existing biotopes to colonisation of alien species is considered negligible.

There is the potential for cumulative beneficial effects where localised rock placement may introduce localised new hard substrate habitat resulting in localised benthic habitat enhancement. The complexity of habitat which may be supported by rock placement is difficult to quantify at this stage due to potential variations in size, length, water depth, surface texture, rugosity (form of wrinkles), lacunarity (size and distribution of holes) and angularity of the rock placement. These characteristics are of crucial importance in determining which animals, or size of animals can exploit the habitat offered. Even when considered cumulatively across the Brae Area the magnitude of habitat enhancement resulting from the introduction of artificial structures is considered to be small. The cumulative effect of the provision of additional benthic habitat through artificial reefs is assessed to be minor and not significant and this assessment carries a medium uncertainty.

Localised rock placement and habitat change may also facilitate an increase in connectivity within and beyond the Brae Area between these new harder substrate habitats.

Evidence from available fish survey data including a 2 year survey programme of fish populations beneath the adjacent Miller platform (Fujii, 2015 [43]; Fujii, 2016 [44]) indicates strong seasonal patterns and variations in body size composition of fish which have been observed to exploit the shelter and hard substrate biological community provided by the Miller jacket/sub-structure. This in turn suggests that individuals observed are likely to be part of interconnected subpopulations that migrate between areas of habitat with few species appearing to remain in the location of a single platform for their entire life history.

The Brae Alpha, Brae Bravo and associated infrastructure to be left in place, when considered in combination with the infrastructure left in place at East Brae and Braemar, as well as the footings of the adjacent BP Miller platform may serve as interconnecting 'stepping stones' for these subpopulations forming a potential network of artificial reefs, in which the aggregate habitat value and associated productivity of the network is greater than that of the individual pieces of infrastructure.

Although reef habitat is not consistent with the pre-development natural environment, it is nonetheless considered to the potential to enhance the diversity and productivity of the existing habitats. Based on current knowledge and published literature, it is not possible to predict whether the potential beneficial effects of introducing new hard substrate habitat outweigh the adverse effects of smothering existing habitats, and or introducing alien material. On this basis, while there is a potential beneficial effect, the overall effect for biological communities is assessed to be neutral and not significant. All rock placement

resulting in physical alteration to the seabed will be subject to 'overtrawlability' testing, therefore no significant cumulative effect on other sea users (fisheries activity) is anticipated.

Overall the magnitude of the adverse cumulative effects have been assessed as negligible. The assemblages associated with the existing biotopes at risk are not considered to be of importance and are predicted to accommodate the change and potentially increase in extent, therefore the sensitivity is assessed to be negligible. Overall the adverse impact is assessed to be negligible and not significant.

5.7.2 Underwater Noise

As any effects on marine mammals would be temporary and limited to the period of jet cutting operation, no significant cumulative effect is anticipated. The predicted impact range of underwater noise associated with jet cutting extends to 1- 2 km from the noise source. In the event of simultaneous jet cutting at other installations (either East Brae, or other third party installations), this would be expected to lie outwith this range of impact, therefore no significant cumulative effects are foreseen.

The North Sea, including around the Brae Area, is heavily trafficked, with constant vessel movements associated with a range of activities contributing to the ambient noise environment. Noise from decommissioning vessel movements will continue to contribute to this ambient noise throughout the decommissioning process. Underwater noise from vessel movements is not considered to give rise to any additional cumulative significant effects considering the potential for temporary or permanent injury to marine mammals.

At the time of writing, it has been assumed that jacket/sub-structure cutting associated with the BP Miller platform would have occurred prior to the decommissioning of Brae Alpha or Brae Bravo jackets. It is not known whether any blasting will be undertaken during decommissioning of other nearby infrastructure however it has been assumed that these activities will not occur simultaneously with Brae Alpha or Bravo activities.

The potential remains for cumulative effect from repeat disturbance of marine mammals from different sources and projects to lead to potential effects on population capacity. While there is currently insufficient information on the programming of other third party decommissioning activities to provide a meaningful cumulative effects assessment, it is proposed that further consideration would be given to the potential for cumulative effects associated with the addition or combination of the Marathon Oil Brae Area decommissioning activities, with other known proposed DPs at the point of marine licensing.

It is considered that the potential for cumulative effects as a result of interactions in combination with other DPs would be adequately mitigated through communication and management between operators and the relevant regulatory authorities.

5.7.3 Accidental Events

In order for cumulative effects to occur from an accidental event then more than one accidental event would have to occur either at the same time, or in sufficiently short succession such that the effects from the initial event had not ceased by the time effects from subsequent events occurred. In this context the events could either all be associated with Brae Area decommissioning activities (e.g. multiple spills at the same time) or could be partially from the Brae Area and partially from a different source such as another oil and gas field nearby. There is also the potential for cumulative effects to marine ecology to occur as a result of repeated exposure to hydrocarbon or chemical contamination in the water column.

5.7.4 Transboundary Effects

No significant transboundary effect on seabed or supported habitat is anticipated. Transboundary effects are limited to potential underwater noise effects and combined accidental events.

5.7.4.1 Underwater Noise

Brae Alpha, Brae Bravo and associated infrastructure are situated within the UKCS. The UK/Norwegian boundary line lies approximately 13 km from Brae Bravo.

The underwater noise from jet cutting is predicted to extend only approximately 1-2 km from source, and is not expected to have adverse transboundary impacts.

5.7.4.2 Accidental Events

Given the prevailing wind and current regime in the area it is likely that any spills would move towards (and in some cases enter) the Norwegian sector. However, the extent to which any spill would penetrate into the Norwegian sector is dependent upon a number of factors such as the volume and type of spill. Inventories would be very small, therefore whilst some of the diesel spill modelling results performed for the operational phase Oil Pollution Emergency Plans (OPEPs) do indicate that diesel could enter the Norwegian sector it does not reach the shoreline. The only spill scenarios modelled where a hydrocarbon reaches a Norwegian shoreline are major crude spills of the type that would only occur during the operational phase and not during decommissioning. No significant cumulative or transboundary effects associated with accidental events are predicted.

No significant cumulative or transboundary effects associated with accidental events are predicted.

6. Schedule of Environmental Management Controls

6.1 Introduction

One of the main aims of the decommissioning planning process was to 'design out' potential for environmental effects as far as possible. To this end, no significant residual environmental effects have been identified through the EIA process. This section provides a summary of the key 'mitigation by design' embedded in the proposed Decommissioning Programme. In addition, the purpose of this section is to summarise the committed environmental management measures proposed in each of the technical sections to avoid or reduce predicted environmental effects.

The scope of the EIA was determined with reference to committed mitigation measures set out in a scoping stage schedule of mitigation. These scoping stage mitigation measures have been carried forward into this schedule of environmental management measures, set out in Table 6.1.

The reference numbers given to each proposed mitigation/management measure in Table 6.1 will be used going forward to ensure that each measure is carried forward for implementation.

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
Brae Alpha and Brae Bravo Platform Decommissioning			
Transportation of materials to and from, and within, the Brae Area	SR: 001	**Atmospheric Emissions**: Movement of decommissioning vessels to, from and within the Brae Area will result in gaseous emissions to the atmosphere particularly relating to CO_2 emissions as a primary greenhouse gas, and also NOx and particulates.	A comparative assessment process has been completed and is documented within the DP to ensure that energy use and atmospheric emissions are as low as reasonably practicable. Marathon Oil will seek to optimise the vessels required to perform each task, taking account of the need to minimize energy use as far as possible. All vessels will comply with MARPOL 73/78 Annex VI on air pollution; plant will comply with relevant air pollution regulations (The Offshore Combustion Installations (Pollution Prevention and Control) Regulations 2013).
	AE: 001	**Accidental Events/Water Quality:** Unplanned release of hydrocarbons (e.g. shipping diesel) from decommissioning vessel activity have potential to affect water quality with secondary effects on marine biology interests.	Ensure that all vessels working on the decommissioning of the Brae Area infrastructure will operate to SMPEPs (Shipboard Marine Pollution Emergency Plans).
Topside Preparation	SR:002	**Accidental Events/Water Quality**: Unplanned release of hydrocarbons, hazardous materials or cleaning materials during topside preparation for decommissioning have potential to affect water quality with secondary effects on marine ecosystems.	Topside preparation (including activities required to ensure hydrocarbons and chemicals have been removed, all processing plant has been shut down and isolated from the reservoir and all conductors, casings, tubings and other well equipment has been removed), will be delivered under the terms of Marathon Oil's existing operating licences and discharge consents.

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
			As such all activities will be subject to spill management measures as set out within Marathon Oil's operational Oil Pollution Emergency Plan (OPEP).
	AE:001	**Accidental Events/Water Quality:** Unplanned release of hydrocarbons (e.g. shipping diesel) from decommissioning vessel activity have potential to affect water quality with secondary effects on marine biology interests.	Ensure that all vessels working on the decommissioning of the Brae Area infrastructure will operate to SMPEPs
	SR: 003	**Underwater Noise:** Topside preparation has the potential for vessel activity to generate underwater noise which in turn may affect noise sensitive species including seabirds, fish and marine mammals.	Vessels required to support topside preparation are not expected to be substantially different to those associated with the current operations of the platforms (see Topside Removal for consideration of HLV activity). All equipment including vessels required to facilitate topside preparation will be maintained and operated to manufacturers' specifications. The number of vessels travelling or on standby in the Brae Area at any one time will be kept to a minimum. Vessels may hold station using either dynamic positioning or using an appropriate anchor spread (see SR: 004 under Topside Removal). When using dynamic positioning, vessels will hold station for the minimum time required to achieve their task objective.
Topside Removal	SR: 004	**Underwater Noise**: Topside removal and potential for vessel activity to affect noise sensitive species including seabirds, fish and marine mammals.	All equipment will be maintained to manufacturers' specifications.

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
			Number of vessels travelling or on standby in the Brae Area at any one time will be kept to a minimum.
	SR: 005	**Seabed Disturbance**: Anchoring of vessels associated with topside removal has the potential to cause localised disturbance to seabed and suspension of sediment.	Site survey data will be used to ensure suitable anchor locations are selected and avoid known areas of contamination associated with drill cuttings.
Platform jacket/sub-structure removal	SD: 001	**Seabed Disturbance**: Disturbance to seabed during removal of jacket/sub-structure, risers, pipelines, flowlines, umbilicals, power cables and other subsea installations, with resultant potential effects on benthic communities, natural seabed sediments and cuttings pile sediments. Disturbance may also occur during preparation for the footings to be left in place.	Platform jacket/sub-structure and associated risers etc. removal at Brae Alpha and Brae Bravo will be cut at the top of the footings. This would also be at sufficient height to avoid disturbance of the drill cuttings piles. Footings and associated drill cuttings piles will be left in place and undisturbed as far as is reasonably practicable. All infrastructure identified to lie within, or be overlain by drill cuttings materials will be left in place. Cutting and lifting operations associated with the removal of subsea infrastructure will be controlled by ROV to ensure accuracy in all activities and therefore minimize the potential for seabed sediment disturbance.
	UN: 001	**Underwater Noise**: Jet cutting associated with the cutting and removal of the risers, pipelines, flowlines, umbilicals, power cables and other subsea installations at Brae Alpha and Brae Bravo has the potential to cause disturbance to marine mammals in the area.	See UN: 002 for details of noise mitigation.

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
Drill cuttings piles left in place	AE: 002	**Accidental Events**: Dropped Objects. Physical objects dropped during decommissioning activities at Brae Alpha and Brae Bravo, if of sufficient size, could cause disturbance to underlying cuttings piles, resulting in disturbance to established benthic communities and/or mobilization of drill cutting contaminants to the water column.	Working method statements for decommissioning activities taking place above or in the vicinity of drill cuttings piles, including provision measures to prevent dropped objects will be agreed in advance by Marathon Oil, prior to work commencing.
Steel jacket/sub-structure – footings left in place	SR: 007	**Commercial Fisheries**: Derogated footings and infrastructure left within proximity to the jacket/sub-structure footings presenting a long term hazard to demersal fisheries.	Subject to derogation approval the presence of the footings would be marked on relevant Admiralty charts and communicated to other sea users through the normal communication channels (for example, FishSAFE). It is proposed that a post-decommissioning safety zone would be established around derogated jacket/sub-structure footings.
	UN:002	**Underwater Noise**: Jet cutting associated with the cutting and removal of the steel jacket/sub-structures at Brae Alpha and Brae Bravo has the potential to cause disturbance to marine mammals in the area.	No specific guidance exists in relation to minimising risk of injury to marine mammals from jet cutting. The requirement for mitigation would be reconsidered following further detailed engineering design and selection of the final removal solution. Typical measures to be considered and agreed with the appropriate statutory consultees may include: • A mitigation zone describing the area in which a marine mammal could be exposed to sound that could cause injury would be established around the jet cutting site for the duration of this activity;

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
			• Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM) operatives would be provided for the duration of the jet cutting activities at Brae Alpha and Brae Bravo; • Cutting activity would not be commenced if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual or acoustic detection; and • Soft start of jet cutting activities should be implemented.
Wider Subsea Installations Decommissioning			
Subsea Installations including West Brae and Sedgwick (drill templates, wellheads, mattresses) removal	SD: 004	**Seabed Disturbance**: Localised disturbance to seabed may occur during removal of subsea installations including at West Brae and Sedgwick.	Cutting and lifting operations associated with the removal of subsea infrastructure would be controlled by ROV to ensure accuracy in all activities, therefore minimising the potential for seabed disturbance.
Pipelines/Cables/ flowlines/Umbilicals – full or partial removal	SR: 008	**Accidental Events/Water Quality:** pipelines and flowlines will be flushed and cleaned prior to decommissioning activities, which may result in the release of hydrocarbons or cleaning fluids to the natural environment/water column.	All flushing and cleaning activities will be delivered under the terms of Marathon Oil's existing operating licences and discharge consents. As such all activities will be subject to spill management measures as set out within Marathon Oil's operational OPEP.
	SD: 005	**Seabed Disturbance**: Mattresses currently protecting surface laid pipelines etc. may be reused within the post-decommissioning safety zones defined around Brae Alpha and Brae Bravo	The reuse of mattresses within the post-decommissioning safety zones surrounding Brae Alpha and Brae Bravo footings would not be allowed to disturb the identified drill cuttings piles. Mattresses may also be reused to reprofile the

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
		footings, resulting in potential disturbance to seabed and benthic habitats within these areas.	seabed as part of the Central Brae seabed remediation work.
Pipelines/Cables/ flowlines/umbilicals – left in place	SD: 006	**Seabed Disturbance**: Pipelines/cables/flowlines/umbilicals, where left in place will be protected through additional rock placement resulting in the introduction of additional hard surfaces with potential for local alterations to benthic habitat characteristics.	The extent of additional rock-placement will be minimised where ever possible.
General Mitigations: Brae Area			
General, All Vessels	GN: 001	**Atmospheric Emissions**: Movement of decommissioning vessels to, from and within the Brae Area will result in gaseous emissions to the atmosphere particularly relating to CO_2 emissions as a primary greenhouse gas, and also NOx and particulates.	A comparative assessment process has been completed and is documented in the DP to ensure that energy use and atmospheric emissions are as low as reasonably practicable. All vessels will comply with MARPOL 73/78 Annex VI on air pollution; plant will comply with relevant air pollution regulations (The Offshore Combustion Installations (Pollution Prevention and Control) Regulations 2013.).
	GN: 002	**Accidental Events (dropped objects)/Water Quality/Seabed disturbance/Commercial Fisheries**: Decommissioning activities may result in unidentified debris being left on the seabed, potentially resulting in long term physical and/or biological effects on seabed, and/or fisheries hazards through net snagging etc.	A seabed survey will be undertaken to identify debris within a 500m radius of the Brae Alpha and Brae Bravo platforms and a 200m wide corridor along each pipeline. All items of oil and gas development or production related debris will be categorized, in consultation with the UK Government (BEIS) and a management and recovery plan will be agreed.

Table 6.1: Schedule of Environmental Management Controls

Decommissioning Activity	ES Mitigation Ref	Environmental Receptor Interaction	Mitigation Commitment
			Following completion of the recovery plan verification of seabed clearance by an independent organisation will be carried out.
	GN: 003	**Accidental Events/Water Quality/Seabed disturbance**: Long term deterioration of infrastructure decommissioned in place, may result in collapse of overlying rock placement and or slow release of aluminium from deteriorating protection anodes etc. to the water column.	All facilities left in place will be monitored following a programme to be agreed with BEIS.

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www.marathonoil.com/braedecom

StakeholderBraeDecom@MarathonOil.com