# Technical Note

## Review of rock and other protective material use in offshore oil and gas operations in the UK Continental Shelf.

December 2021

**Acknowledgements**

The document has been prepared by Genesis Oil and Gas Consultants (Genesis) with input from the Department for Business, Energy and Industrial Strategy (BEIS) and the Centre for Environment Fisheries and Aquaculture Science (CEFRAS).



Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk **[replace with team email address if available]**

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# Abbreviations

| Abbreviations | Definitions |
|---|---|
| ' | Minute (coordinates) |
| " | Second (coordinates) |
| < | Less than |
| > | More than |
| ° | Degrees |
| °C | Degrees centigrade |
| BEIS | Department for Business, Energy & Industrial Strategy |
| CNS | Central North Sea |
| DECC | The Department for Energy and Climate Change |
| DF | Dilution Factor |
| DREAM | Dose-related Risk and Effects Assessment Model |
| E | East |
| ED | European Datum |
| g | Gram |
| kg | Kilogram |
| m | Metre |
| m3 yr-1 | Metre cubed per year |
| min | Minute (time) |
| N | North |
| n | Sample size |
| NNS | Northern North Sea |

| Abbreviations | Definitions |
|---|---|
| NOS | Naturally Occurring Substance |
| PBT | Persistent, Bio-accumulative and Toxic |
| PEC | Predicted Environmental Concentration |
| PNEC | Predicted No Effect Concentration |
| ppm | Parts per million |
| PW | Produced Water |
| RBA | Risk Based Approach |
| s | Second (time) |
| SNS | Southern North Sea |
| UK | United Kingdom |
| UTM | Universal Transverse Mercator |
| WET | Whole Effluent Testing |
| yr | Year |

# Introduction

## Background.

Deposits of protection materials may be used during offshore oil and gas exploration, development, production and decommissioning activities. Specific examples include the use of rock placement at pipeline crossings and the use of concrete mattresses or grout/sand bags for pipeline/infrastructure stabilisation, and the use of rock placement for stability and scour protection around the base of jack-up rig legs.

Prior to depositing protection material on the seabed, the proposed deposit must usually be approved and consented by both the Oil and Gas Authority (OGA) and by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

In the OPRED deposit application, a worst-case estimate of the quantity and spatial impact of the deposit is made; to inform the supporting Environmental Impact Assessment (EIA) for the proposed operations. An assessment of the in-combination and cumulative impacts of a project with other existing, consented or planned activities in the development area is also required, with supporting information on the type, estimated or actual quantity of material placed to be provided.

Following the completion of the operations, the operator is also required to submit a return confirming the deposit location, the quantity of material deposited, and the area of seabed impacted. The quantity of material deposited is typically much less than the worst-case estimate given in the EIA/deposit application, and in some cases the need for the placement will not arise. To assess the current status of deposits made on the United Kingdom Continental Shelf (UKCS), OPRED asked Genesis to compile and analyse the offshore oil and gas industry deposit returns data, providing a report on the location, volume and extent of the protection material used. The objectives and scope, and the methodology of the study are outlined in more detail in Objectives and Scope, Data Sources and Methodology.

## Objectives and Scope.

The objectives of the project are to:

- Collate and review the worst-case estimates of material placed on the UKCS over a period of five years (2011 – 2016) based on the permit applications and returns information provided to OPRED by oil and gas operators on the UKCS
- Collate and review operator returns data to compare estimates made in the application and reported deposits.
- Carry out data analysis and reporting by broad geographic areas:

  - West of Shetland (WoS)
  - Northern North Sea (NNS) and Central North Sea (CNS) combined;
  - Southern North Sea (SNS);
  - Irish Sea; and
  - The Fladen Grounds.
- Carry out data analysis and report on the quantity of material placed in protected sites designated for seabed features and the area of seabed covered.
- Draw possible conclusions relating to any patterns evidenced by the data.

In order to carry out the scope of work, a number of data manipulation, import, editing and analysis tasks have been undertaken using Microsoft Excel and Esri's ArcGIS Geographic Information System (GIS) software (See Methodology Section).

# Defining the Geographic Areas for Analysis.

As previously discussed, a series of broad geographic areas and protected areas have been identified to facilitate the quantitative analysis of the spatial impact (footprint) of seabed deposits on the UKCS. To enable analysis within ArcGIS to be carried out, spatial datasets have been sourced which can be used to define the geographic boundaries of these areas. The areas identified for the analysis are discussed below while the spatial datasets used are described further in Additional Geographic Data.

## Broad Geographic Areas

The UKCS is the area of seabed and subsoil beyond the territorial sea over which the UK exercises sovereign rights of exploration and exploitation of natural resources. The exact limits of the UKCS are set out under the Continental Shelf Act 1964. The baseline from which seaward boundaries are measured is usually the low water mark around the UK coast. These may be straight lines across the mouths of bays and all rocks, reefs etc. that are above the sea at low water but submerged at other times extend the baseline if they are within 12 nautical miles (nm) of the mainland or an island. The UK territorial sea is the sea extending 12 nm from the baseline, as defined by the Territorial Sea Act 1987.

The Petroleum Licensing (Applications) Regulations 2015 define the landward and seaward areas available for oil and gas exploration and production licences. Except for certain defined areas, the line dividing landward areas from seaward areas is taken as the low water line along the coast of the mainland of Great Britain and Northern Ireland, the Isle of Wight, Anglesey and Holy Island, therefore seaward licences (under which offshore oil and gas activities take place) may be granted within territorial waters as well as on the UKCS, beyond 12 nm.

The Oil and Gas Authority (OGA) provide a dataset depicting the major geological basins of the UKCS (see Table 2). The geographical boundaries of the basin data extend from the landward/seaward dividing line to the furthest offshore boundary of the UKCS, encompassing

the areas for which deposit consents are issued. The basin polygons were merged to define the broad geographic areas of the UKCS for the analysis. These are shown in Table 1.

**Table 1: Major Geological Basins used to Define the Broad Geographic Areas**

| Geographic area | Geological basins merged |
|---|---|
| WoS | North of 62N; Rockall; West of Shetland. |
| NNS | Northern North Sea; East Shetland Platform Area; Fair Isle. |
| CNS | Moray Firth; Forth Approaches; Central North Sea; Mid North Sea High Area. |
| SNS | Southern North Sea |
| Irish Sea | Irish Sea; Cardigan Bay. |

### The Fladen Grounds

In addition, the Fladen Grounds (located in the NNS to the northeast of Scotland) were selected as a particular area of interest for investigation. This area provides an important habitat for sea pens and is also characterised by burrows made by crustaceans such as mud shrimp and the Norway lobster (Nephrops). Burrowed mud is an important marine habitat that supports a rich community of animals and is considered by OSPAR to be a Threatened or Declining habitat across the North-east Atlantic (JNCC, 2018). The Fladen Grounds are also the single biggest area of suitable mud supporting a Nephrops population in the North Sea (Scottish Government, 2015) and is therefore an area of importance to the Scottish fishing industry. The area of impact on the Fladen Grounds has been analysed in addition to the whole NNS due to its particularly sensitive habitat and importance to the Nephrops fishery.

Broad-scale seabed habitat data, classified using the European Union Nature Information System (EUNIS) classification is available for the North Sea, depicting modelled boundaries of different habitat types. An area classified as ‘Deep circalittoral mud’ (EUNIS A5.37) has been extracted from this dataset to represent the approximate boundary of the Fladen Grounds. For context, all benthic broad habitats have also been mapped against the deposit data and the area of impact on the different habitat types calculated

## Protected Areas

On the UKCS and in coastal and marine areas of the UK, a network of Marine Protected Areas (MPAs) is in place to aid the protection of vulnerable and endangered species and habitats. These sites include:

- Special Protection Areas (SPAs);
- Special Areas of Conservation (SACs);

- Nature Conservation Marine Protected Areas (NCMPAs) (Scotland); and
- Marine Conservation Zones (MCZs) (England and Wales).

For the analysis, protected areas were selected for investigation where they have been designated for the protection of seabed features (which could be impacted by seabed deposits).

Boundary data which maps the spatial extent of the protected areas is available from the Statutory Nature Conservation Bodies (SNCBs) (see Table 3). Table 2 below lists the protected areas selected for the analysis which have been impacted by seabed deposits (based on the 2011 – 2016 data, see Sections Area of Impact within Protected Areas and Area affected within Protected Areas). The primary qualifying features of the sites are also described.

SPAs have been included within the GIS database (as part of the MPA network) but have not been used in the analysis performed as they are primarily designated to protect rare and vulnerable birds and regularly occurring migratory species. They are not designated for the protection of seabed features which could be impacted by seabed deposits.

The Southern North Sea (SNS) SAC is designated for harbour porpoise and not seabed features. However, the site is characterised by sandy, coarse sediments which cover much of the site and these physical characteristics are thought to be preferred by harbour porpoise, likely due to availability of prey (JNCC, 2019). In the following data analysis, the impact of deposits in the SNS SAC has been analysed separately, as the primary reason for designation is not seabed features, however, deposits may still have an indirect impact on harbour porpoise protected by this site (through the potential changes/disturbance of their prey habitat), hence the inclusion of this particular SAC.

Within the SNS, there are several other SACs which are designated for their seabed features. These include the Dogger Bank SAC, the North Norfolk Sandbanks and Saturn Reef SAC, and the Haisborough, Hammond and Winterton SAC which are important for sublittoral and offshore sandbank features and reefs. The inner banks of the North Norfolk Sandbanks feature mobile sandwaves and are thought to be slowly elongating in a north-easterly direction (Cooper et al., 2008). The banks support communities of invertebrates which are typical of the sandy sediments of the SNS. The SNS is a dynamic environment, and the features and habitats of these protected sites are of particular interest with regard to the use of protection material.

The Central Fladen Nature Conservation Marine Protected Area (NCMPA) falls within the Fladen Grounds (as previously defined). The impacts on this site have been analysed separately to the Fladen Grounds habitat as it forms part of the MPA network along with the other protected areas under consideration

**Table 2: Protected areas used in the analysis and their primary qualifying features**

| Destination | Name | Primary qualifying feature |
|---|---|---|
| SAC | Southern North Sea(1) | Harbour porpoise (*Phocoena phocoena*). |
| SAC | Dogger Bank | Sandbanks which are slightly covered by sea water all the time. |
| SAC | Haisborough, Hammond and Winterton | Reefs; Sandbanks which are slightly covered by sea water all the time. |
| NCMPA | Central Fladen | Burrowed mud |
| NCMPA | East of Gannet and Montrose Fields | Ocean quahog (*Arctica islandica*) aggregations (including their supporting habitat, sands and gravels); Offshore deep sea muds. |
| NCMPA | Faroe-Shetland Sponge Belt | Deep sea sponge aggregations; Offshore subtidal sands and gravels; Ocean quahog (*Arctica islandica*) aggregations; Continental slope. |
| NCMPA | Norwegian Boundary Sediment Plain | Ocean quahog (*Arctica islandica*) aggregations (including their supporting habitat, sands and gravels). |
| MCZ | Fulmar | Subtidal mixed sediments; Subtidal sand; Subtidal mud; Ocean quahog (*Arctica islandica*). |
| MCZ | Holderness Offshore | North Sea Glacial Tunnel valleys; Ocean quahog (*Arctica islandica*); Subtidal coarse sediment; Subtidal mixed sediments; Subtidal sand. |
| MCZ | Markham's Triangle | Subtidal coarse sediment; Subtidal mixed sediments; Subtidal mud; Subtidal sand. |
| MCZ | Swallow Sand | Subtidal coarse sediment; Subtidal sand; North Sea glacial tunnel valleys (Swallow Hole). |
| MCZ | West of Walney | Subtidal sand; Subtidal mud; Sea-pen and burrowing megafauna communities. |

Notes:

1. The impacts within the SNS SAC have been analysed separately to the other protected areas. As discussed in this Section, the site is not designated for its seabed features, however, the physical characteristics of the seabed are considered important to harbour porpoise.

# Data Sources

## Background.

The data provided by OPRED covers the period 2011 – 2016. Prior to 2013, applications for environmental permits were made via a Petroleum Operations Notice No. 15 (PON15). For example, the PON15C was used to 'seek a direction that an Environmental Statement (ES) is not required for a proposed pipeline'. In 2013, the Portal Environmental Tracking System (PETS) replaced the PON15 applications with a system consisting of a Master Application Template (MAT) for different activities (e.g. Pipeline Operations – PLA), supplemented by various associated Subsidiary Application Templates (SATs) relating to specific regulatory approvals (e.g. EIA Direction for Deposits - DEP). The data provided by OPRED is outlined in 'OPRED Deposits Data' while 'Additional Geographic Data' describes the additional geographic data used to carry out the data analysis in the GIS.

## Data Sources.

### OPRED Deposits Data

The raw data provided by OPRED was in Microsoft Excel format, recorded manually or as an export from the Environmental and Emissions Monitoring System (EEMS), as follows:

- Deposits spreadsheet with five tabs:
    - 2011 – 2013 PON15C pipeline deposits (pre-PETS).
    - 2013 - 2016 PLA pipeline operations deposits following PETS roll-out. The information in this spreadsheet should tally with the report run from EEMS (see below).
    - 2013 - 2016 DRA (drilling), WIA (well intervention) and PRA (production) operations deposits following PETS roll-out. The information in this spreadsheet should tally with the report run from EEMS (see below).
    - Marine Licence 2011 - 2013 Deposits associated with Marine Licence applications pre-PETS.
    - Marine Licence 2013 - 2016 Deposits associated with Marine Licence applications following PETS roll-out.
- Four separate 'EIA Direction Deposit' EEMS returns spreadsheets for 2013, 2014, 2015 & 2016. The returns were introduced through EEMS following PETS roll-out in 2013.

## Additional Geographic Data

A number of additional geographic datasets were added to the Geodatabase and GIS to provide geographic and environmental context for the deposits data and for use within the spatial analysis carried out. The datasets and source of the data are listed in Table 3 below.

**Table 3: Additional Geographic Data used in the Spatial Analysis**

| Data | Description | Source |
|---|---|---|
| Bathymetry | Water depths (in metres). | EMODnet (https://www.emodnet-bathymetry.eu/) |
| Coastline | UK/European coastline. | OGA National Data Repository (NDR) (https://ndr.ogauthority.co.uk) |
| Median Line | International median lines. | |
| Quadrants | Oil and gas quadrants (one degree of latitude by one degree of longitude). | |
| Blocks | Oil and gas licence blocks (30 blocks per quadrant). | |
| Hydrocarbon Fields | Boundaries of oil, gas and condensate fields on the UKCS. | |
| Surface Infrastructure | Location of oil and gas surface infrastructure on the UKCS. | |
| Subsurface Infrastructure | Location of oil and gas subsurface infrastructure on the UKCS. | |
| Pipelines | Location of oil and gas pipelines, umbilical's and cables on the UKCS. | |
| SACs | Boundaries of UK marine/offshore SACs. | Joint Nature Conservation Committee (JNCC) (http://archive.jncc.gov.uk/ProtectedSites/SACselection/gis_data/terms_conditions.asp) |
| SPAs | Boundaries of UK marine/offshore SPAs. | |

| | | |
|---|---|---|
| MCZs | Boundaries of MCZs (England and Wales). | Natural England (https://naturalengland-defra.opendata.arcgis.com/) |
| NCMPAs | Boundaries of NCMPAs (Scotland). | Scottish Natural Heritage (SNH) (https://gateway.snh.gov.uk/natural-spaces/index.jsp) |
| pSPA | Boundaries of potential SPAs (UK). | Natural England (https://naturalengland-defra.opendata.arcgis.com/) and SNH (https://gateway.snh.gov.uk/natural-spaces/index.jsp) |
| pNCMPA | Boundaries of possible NCMPAs (Scotland). | SNH (https://gateway.snh.gov.uk/natural-spaces/index.jsp) |
| Seabed Habitats (1)" | Broad-scale seabed habitat map for Europe classified using the European Union Nature Information System (EUNIS) classification system. | EMODnet (https://www.emodnet-seabedhabitats.eu/) |
| Defined Sea Areas (OGA Basins) (2) | OGA Geological major boundaries. | OGA Open Data (https://data-ogauthority.opendata.arcgis.com/) |

Notes:

1. An area classified as 'Deep circalittoral mud' (EUNIS A5.37) has been extracted from this dataset to represent the boundary of the Fladen Grounds.
2. 2. Major geological areas were merged to create a dataset depicting the broad geographic areas required for the analysis.

# Methodology

Analysis of the data has been undertaken using Microsoft Excel and Esri's ArcGIS software. GIS allows geographic data to be mapped and analysed based on location, deriving patterns and relationships between different geographic features. The following sections summarise the workflow used.

## Data Manipulation, Import and Editing.

The datasets provided in applications to deposit rock and other protection materials and in the EEMS returns record the geographic coordinates (latitude and longitude) of the deposit location in degrees, minutes and seconds (DMS). The location is given either as a single point (spot location), or as start and finish locations along a pipeline route (where the deposit may be placed anywhere between the two locations provided). The geographic coordinate information allows the data points to be plotted on a map in the GIS, enabling spatial relationships with other geographic features to be analysed and any patterns determined.

To allow for the successful import of the data into GIS, the original Excel spreadsheets required some formatting, editing and data cleansing to make the data usable and as accurate as possible. The following sections describe the data import and editing process.

### Pre-PETS Data Import

For data recorded pre-PETS, coordinates (latitude and longitude) have been stored in a single column in Excel and were not easily input to GIS in this format. In addition, the coordinate system/datum used (e.g. WGS 84 or ED50) is not specified. For the 2011 – 2013 tab in the Deposits Spreadsheet, all the data was reformatted in a new spreadsheet to create individual item lines for each deposit location on each application. Separate columns were created for the start and end locations (latitude and longitude) and the coordinates formatted, separating values using Degrees (D), Minutes (M) and Seconds (S) columns to match the EEMS returns data format (see EEMS Returns Data Import). The coordinate values were then calculated in decimal degrees, deriving separate columns for latitude and longitude. This data was then added to ArcGIS, importing the Excel file as an XY Event Theme[1] . As the original data did not specify the coordinate system used, WGS 84 was assumed as this is usually the default option for input.

The pre-PETS data also recorded both the estimated and actual area of impact of the deposit in text format and a mixture of units (e.g. m² or km²)[2] . To aid in the analysis, new attribute

[1] A point feature layer created in ArcGIS based on X and Y coordinates. The layer created is temporary until exported to a GIS data format.

[2] Note: the estimated and actual area of impact is not available for every record. This is discussed further in 'Data Analysis Results'

columns were added to the data with all areas of impact (estimated and actual) converted to m² in a number format.

Three different Event Theme layers were created to map the data in ArcGIS:

- Start Location points;
- End Location points; and
- Spot Location points.

At present, only the 2011 – 2013 PON15 data has been imported to GIS as the Marine Licence data records (Marine Licence 2011 – 2013) do not contain coordinate information.

## EEMS Returns Data Import

For the EEMS returns data, the operation start and end location coordinates are specified in separate columns for latitude and longitude (with coordinate system (WGS 84 or ED50), where known) and values separated using D, M, S columns. Using the data tools in Excel, the same process as described in 'Pre-PETS Data Import' was used to restructure the latitude and longitude values into separate columns for Degrees, Minutes and Seconds and to then calculate the coordinate values in decimal degrees, deriving separate columns for latitude and longitude.

Nine different Event Theme layers were created to map the data. As for the pre-PETS data, this was for the start and end location points, as well as spot locations, imported using the different co-ordinate systems (WGS 84 and ED50). Where the coordinate system was unknown it was assumed to be WGS 84.

The EEMS returns data records the actual area of impact in m2 and in a number format suitable for analysis calculations.

All EEMS returns data for 2013 – 2016 has been imported to GIS.

## Data Editing

Mapping the data as Event Themes in ArcGIS allowed for the high-level identification of any obvious data location errors where the wrong coordinate information had been entered (e.g. data points falling inland or outside of the UKCS and not associated with UKCS oil and gas infrastructure, or where the longitude value had been designated as west rather than east). Where erroneous data were identified, these were marked-up and corrected in the Excel spreadsheets where possible. Corrections and adjustments were made based on an examination of the other attributes of the data points (e.g. pipeline references, operator, asset and field information) to help determine the most likely correct geographic location of the data.

**Figure 1**below shows example data points from 2014 which originally plotted in the wrong geographic location (central Norway), circled in red. Using other attribute data (shown in the GIS pop-up window in the figure), the pipeline numbers that the data points were associated

with were identified and this indicated that the longitude value that had been entered for the data points (10° west) should have been 1° west instead. Other coordinate values for the data points at this location were assumed to be correct.

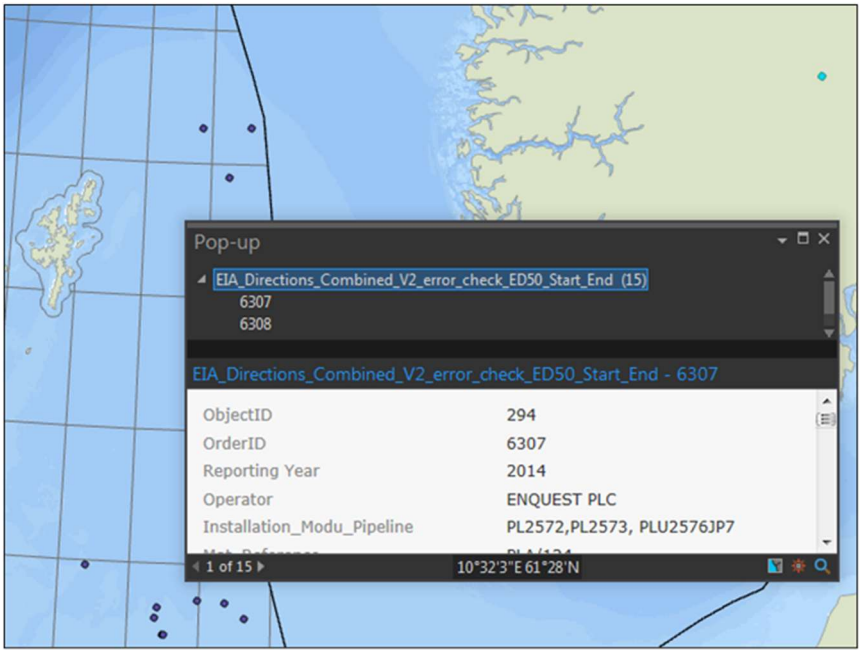


**Figure 1: Identification of Erroneous Data using Data Mapped as an Event Theme in ArcGIS Pro**

Having identified the obvious errors and corrected them where possible, the data were re-imported.

# Export to GIS Database and Further Processing.

Following import of the edited data to the GIS as an Event Theme, the layers can then be exported to a native GIS data format for easier storage, manipulation and analysis. In this case, the data has been exported to Esri File Geodatabase point feature layers. The process of data export and further data processing carried out is summarised in the following sections.

## Data Export

The Event Theme data layers created for the 2011 – 2013 data and the 2013 – 2016 data were exported to the Geodatabase as individual point feature layers using the coordinate systems of the original data (ED50 and WGS 84). Using the data management tools available in ArcGIS, the data layers were then re-projected to use the projected co-ordinated system ED50 UTM Zone 31N (which is used to map data in the northern hemisphere between 0° and 6° east). This coordinate system covers the majority of the data which is located in the eastern area of the UKCS (although some, e.g. West of Shetland and Irish Sea fall within UTM Zone 30N, between 0° and 6° west). Using one coordinate system for all of the data ensures that the data points all map in the correct location in relation to one another and other geographic features,

ensuring the accuracy of the spatial analysis undertaken. Attribute fields within the data layer record the original datum/co-ordinate system used as well as the original co-ordinate values recorded for the deposit.

## Merging Data

Once the data were imported to the Geodatabase as separate point feature layers and re-projected to the same co-ordinate system, it was possible to use ArcGIS to merge the separate layers together to create two point data layers; one for the 2011 – 2013 data and the other for the 2013 – 2016 data. An attribute field in the datasets called 'GIS_Reference' records whether the data point is a single data point (spot location for a deposit) or the start or end location for a deposit (e.g. along a pipeline route).

## Creating Multipoint Data Layers

For both data layers (2011 – 2013 and 2013 – 2016), the start and end locations for a deposit were initially saved as an individual record within the data layer which meant that the area of impact for one deposit was recorded twice (for the start and end locations). To overcome this, the data management tools in ArcGIS were used to convert these single point records to multipoint records so that the start and end points for a deposit form only one data record each in the Geodatabase. This ensures that impact area calculations performed as part of the spatial analysis were more accurate.

## Removing Duplicate Records

A number of duplicate records were identified and removed to prevent records being counted twice in the analysis.

## Displaying the Layers in ArcGIS

The final two output data layers are:

- EIA Deposits 2011 to 2013; and
- EIA Deposits 2013 to 2016.

To display the data in ArcGIS, the data layers have been symbolised using the 'GIS_Reference' attribute, with different coloured symbols representing single (spot) point locations and multipoints representing the start and end location of a deposit (between points).

Several maps have been generated from ArcGIS to illustrate the location of the deposits on the UKCS:

- **Figure 2** and **Figure 3** show the location of the data points for the respective reporting periods, in relation to the defined sea areas, the Fladen Grounds and Protected Areas.
- **Figure 4** and **Figure 5** show the location of the data points for the respective reporting periods, in relation to oil and gas infrastructure (surface infrastructure and;

- pipelines/cables. Note: Features which have been decommissioned and removed or are no longer in-service are also shown).
- Figure 6 shows the location of the data points for all years (2011 – 2016) in relation to modelled broad benthic habitat types using the MSFD classification.

It should be noted that some data points for deposits are not located on the UKCS, for example those shown for deposits on the Scotland to Ireland interconnector (southwest Scotland to the east coast of Ireland) (2011 - 2013) and the Balgzand to Bacton pipeline (Netherlands to east coast of England) (2013 - 2016). These data points show the start and/or end of the pipeline along which deposits have been made but are not deposits made outside the UKCS limits.

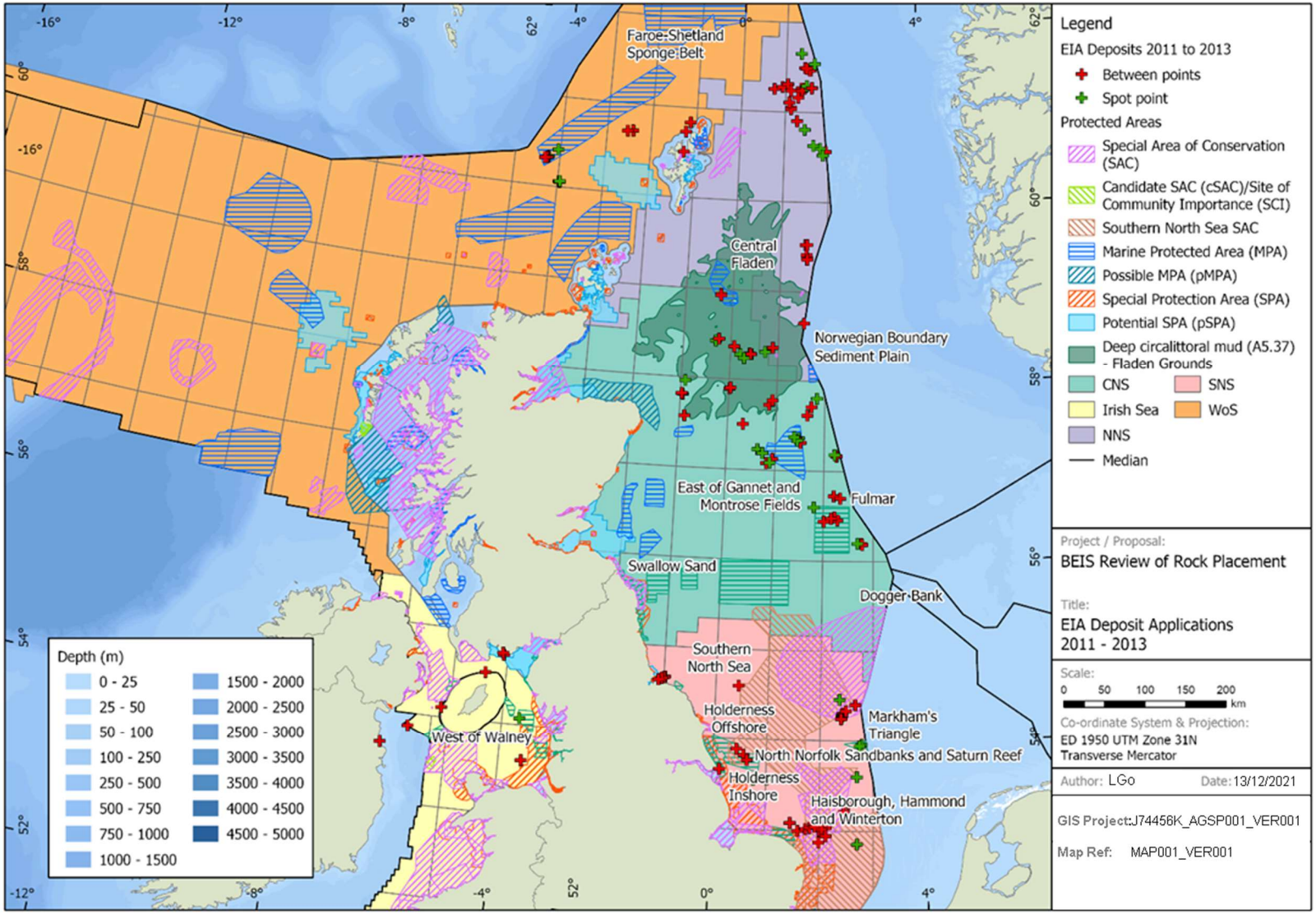


**Figure 2: Location of Deposits on the UKCS 2011 – 2013 (where co-ordinates provided) in relation to Conservation Sites.**

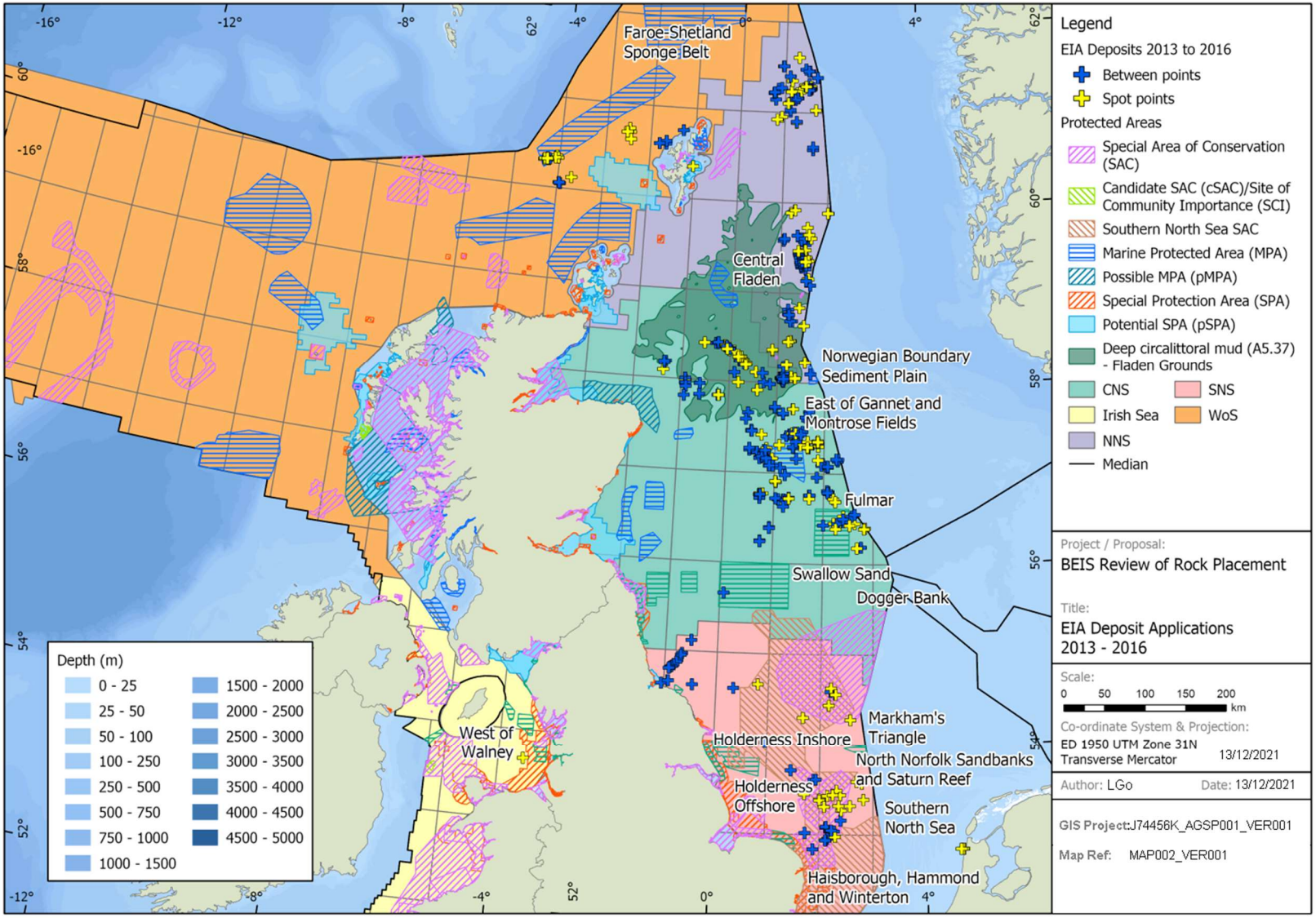


**Figure 3: Location of Deposits on the UKCS 2013 – 2016 (where co-ordinates provided) in relation to Conservation Sites**

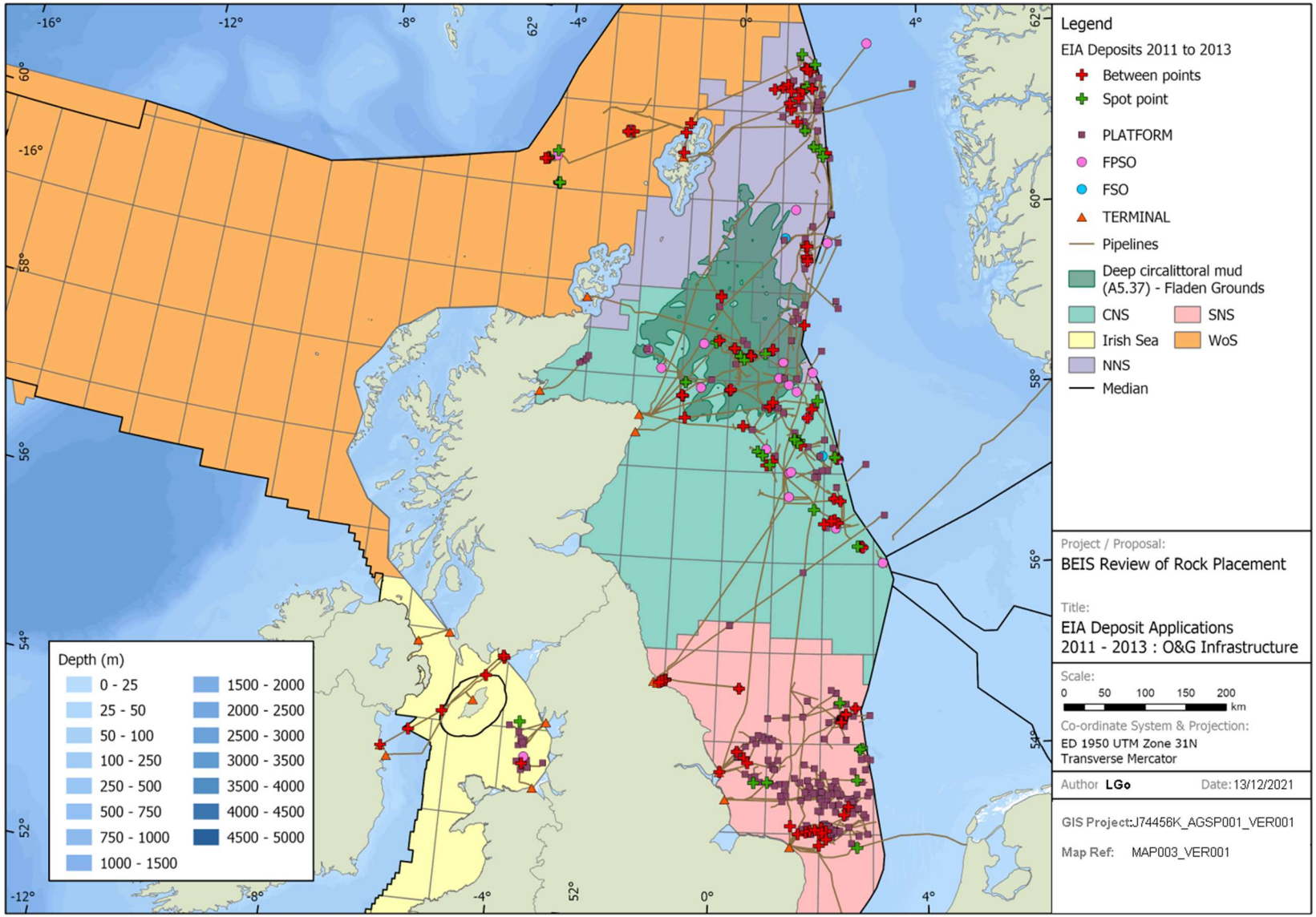


**Figure 4: Location of Deposits on the UKCS 2011 – 2013 (where co-ordinates provided) in relation to Oil & Gas Infrastructure.**

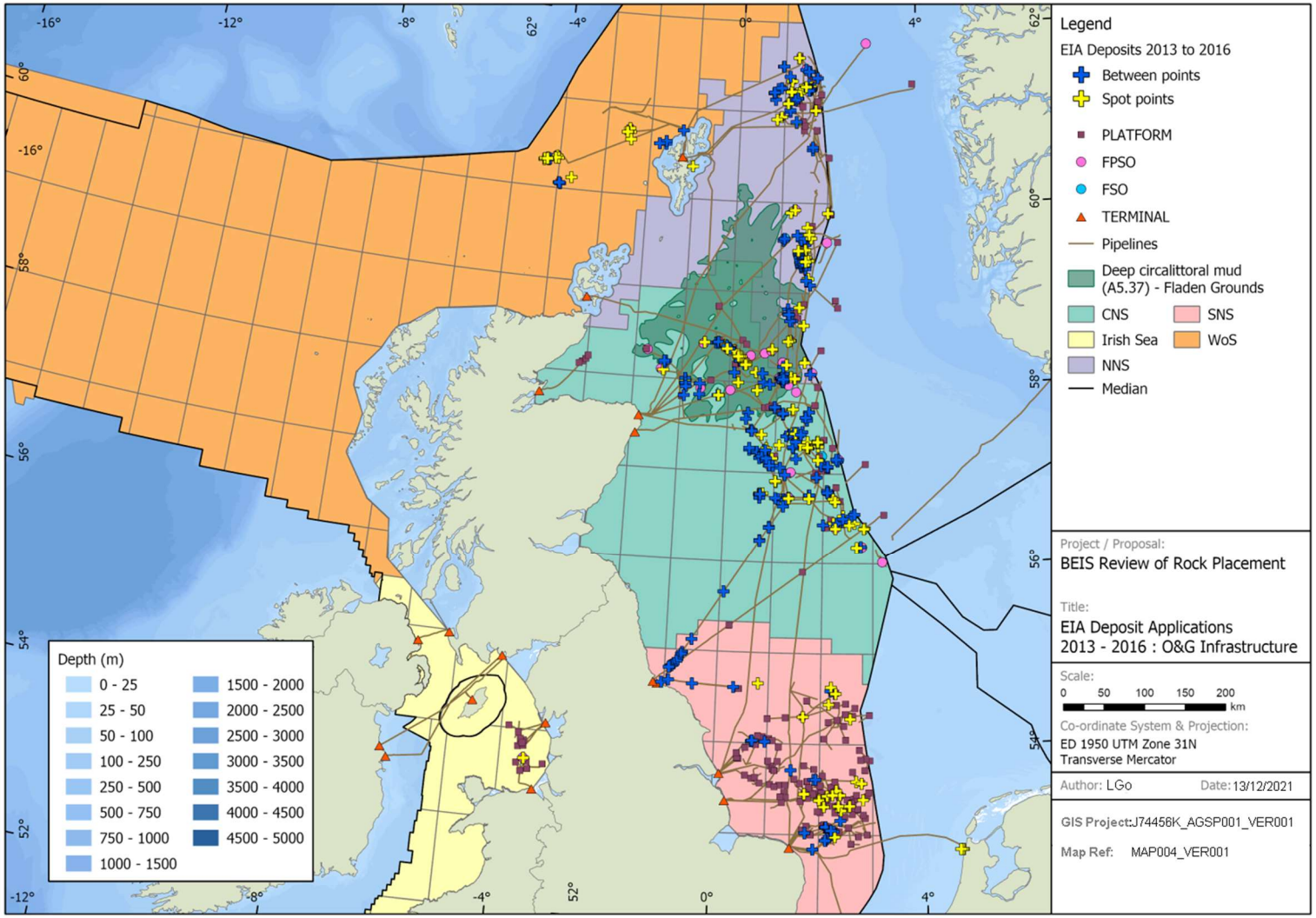


**Figure 5: Location of Deposits on the UKCS 2013 – 2016 (where co-ordinates provided) in relation to Oil & Gas Infrastructure.**

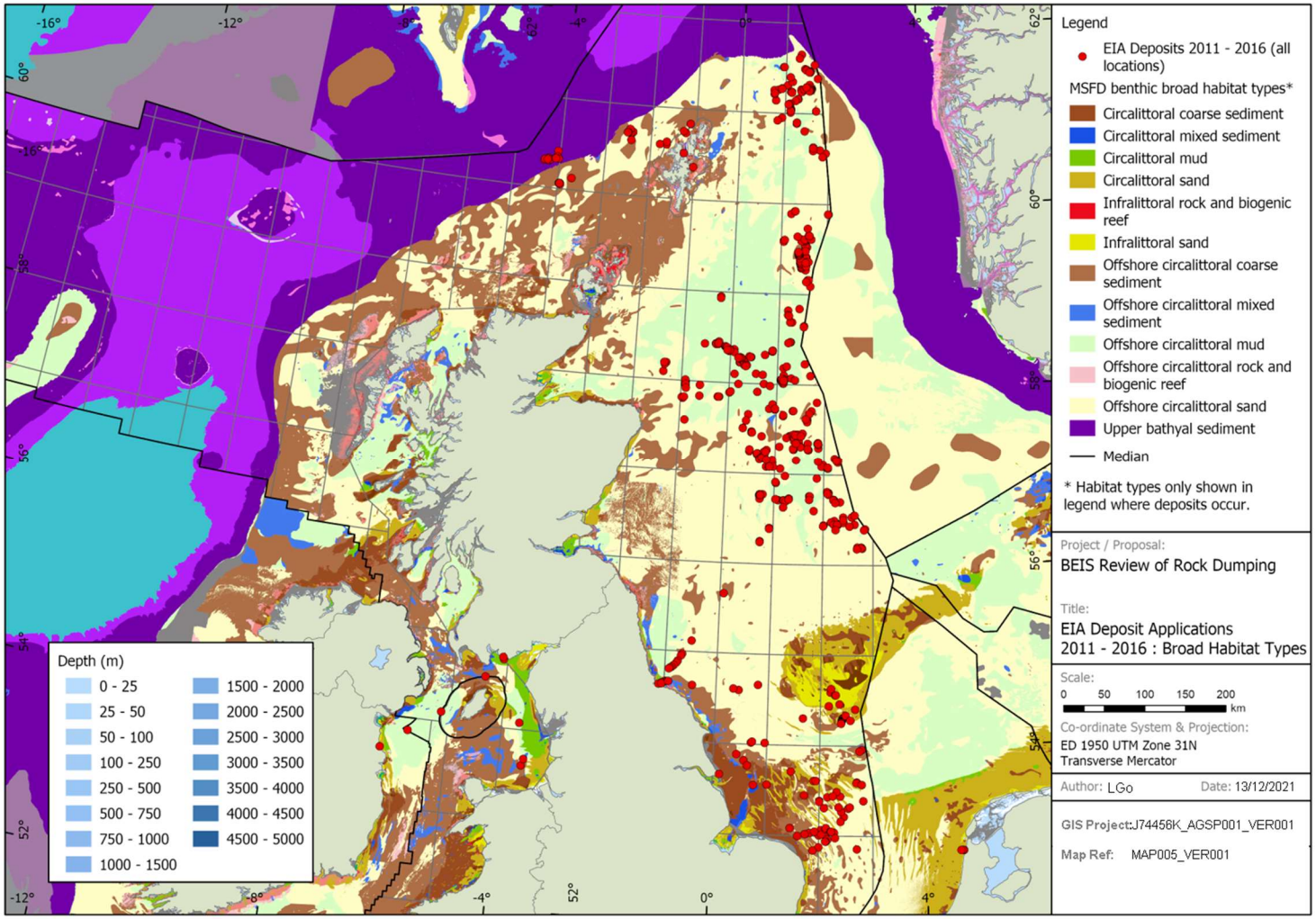


**Figure 6: Location of Deposits on the UKCS 2011 – 2016 (where co-ordinates provided) in relation to MSFD Benthic Broad Habitats**

## Additional Attributes

To satisfy the Objectives and Scope of the project (see Objectives and Scope section), a spatial analysis of the data was required to understand the location, type and extent of the deposits in relation to other geographical features such as seabed type, protected areas and the geographic area. To facilitate the analysis, a number of additional attributes were added to the Geodatabase; these are described in Table 4.

**Table 4: Description of Additional Attributes Added to the Geodatabase.**

| Attribute name | Description |
|---|---|
| Site_Name (1) | The name of the protected area/site that the deposit is located within (if applicable) |
| Site_Code (1) | The site code for the protected area/site that the deposit is located within (if applicable) |
| Site_Status (1) | The status of the protected area (e.g. designated, potential etc.) |
| Site_Type (2) | The type of site: SAC,SPA; NCMPA; MCZ. |
| In_SNS_SAC (3) | Based on the GIS information, is the deposit located within the SNS SAC (Yes and [other designation type]/Null). |
| GIS_In_Protected_Area | Based on the GIS information, is the deposit located within a protected area (Yes/No)? |
| GIS_In_Protected_Area_not_SNS (4) | Based on the GIS information, is the deposit located within a protected area which is not the SNS SAC (Yes/No)? |
| Defined_Sea | Which broad geographic area is the deposit located within WoS; NNS and CNS; SNS; Irish Sea? |
| In_Fladen (5) | Based on the GIS information, is the deposit located within the Fladen Grounds? |

Notes:

1. These attributes are taken from the GIS data supplied by the Statutory Nature Conservation Bodies (SNCBs) and are used to identify the protected area.
2. SPAs are also included within the Geodatabase but have not been used in the analysis.
3. The SNS SAC is designated for harbour porpoise and not seabed features. However, the site is characterised by sandy, coarse sediments which cover much of the site. These physical characteristics are thought to be preferred by harbour porpoise, likely due to availability of prey (JNCC, 2019).
4. This attribute allows the deposits in the SNS protected area to be separated from the other protected sites which are designated strictly for seabed features/habitats.

5. The Fladen Grounds is a large area of mud in the NNS and is an important habitat for sea pens and is also characterised by burrows made by crustaceans such as mud shrimp and the Norway lobster (*Nephrops*). The Fladen Grounds is also an important Nephrops fishery.

## Spatial Analysis

One of the fundamental capabilities of GIS is the ability to overlay geographic data, superimposing multiple datasets to determine the relationships between them. The new data layers for the deposit locations were overlaid on the protected areas, defined sea areas (OGA basins) and EUNIS seabed habitat (including the Fladen Grounds) data layers and deposit data records selected based upon whether they fall within one of those features. The new attribute fields (listed in Table 4) were then populated for the selected records using a number of different Field Calculations in ArcGIS.

Figure 7 shows an example of selecting the deposit data records that are located within the deep circalittoral mud habitat constituting the Fladen Grounds. The ‘In_Fladen’ attribute field has been populated with ‘Yes’ for the selected (highlighted) records and ‘No’ for those records that are not selected.

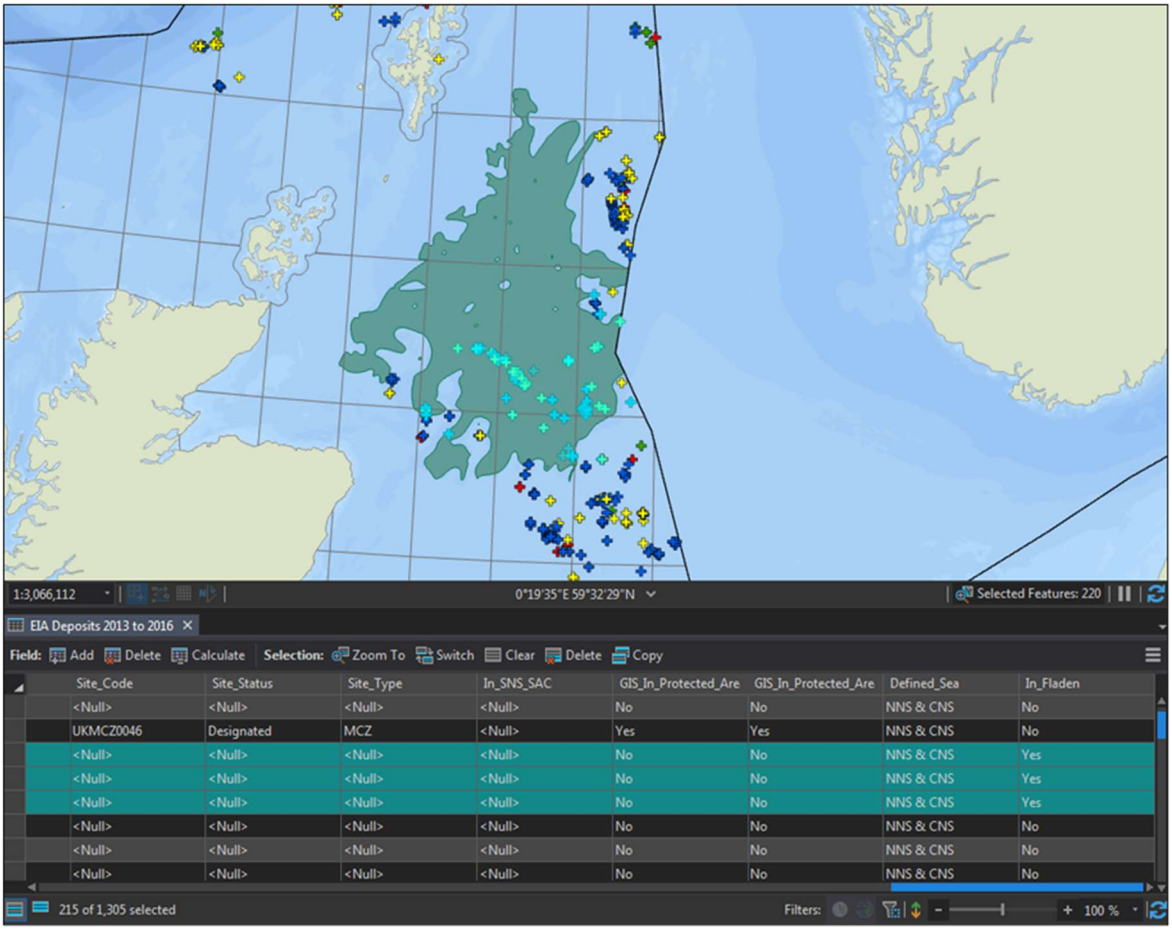


**Figure 7: Example Overlay Analysis Selecting all Deposits Within the Fladen Grounds.**

Following completion of the overlay analysis and population of the attribute fields, the data tables containing all records from the two deposits data sets were exported to Excel to allow further analysis and graphing of the data. The results are presented in ‘Data Analysis Results’

# Data Analysis Results

The data output from the GIS has been analysed in Excel and a number of charts developed to show the results. These show the total area impacted by seabed deposits based on the original data provided from the pre-PETS returns (2011 – 2013) and the EEMS returns (2013 – 2016), where coordinate information was available, and the area of impact reported. It should be noted that all of the area calculations are based on area of impact reported (for all years). A number of the data records, particularly for the pre-PETS data do not have information on the final area of impact, therefore the data presented here should not be regarded as complete. For the EEMS returns data (2013 – 2016), the deposit type/material used for the deposit has been recorded and this has been used in the analysis. Similar data for 2011 – 2013 is not as easily distinguished and has therefore not been reported. Data issues and gaps are considered further in Data Issues and Gaps.

## Analysis Results for all Data (2011-2016).

The following sections describe the results of an analysis of the combined data sets for the pre-PETS returns and the EEMS returns data. Analysis Results for EEMS Return Data (2013-2016) describes the results of the analysis of the EEMS returns data only, which includes a breakdown of deposits by the type of material used.

### Deposits for UKCS by Year

Based on the data available, Figure 8 shows the total area impacted by seabed deposits on the UKCS by reporting year for the period 2011 – 2016. The data suggests a significant increase in deposits made and subsequent area impacted in 2015 (compared to the other years), however, as previously noted the data available is incomplete (particularly for the period 2011 – 2013) and therefore it is not possible to determine whether this is an accurate representation of activity. The following sections provide a further analysis of the data based on geographical region, protected areas and sediment type.

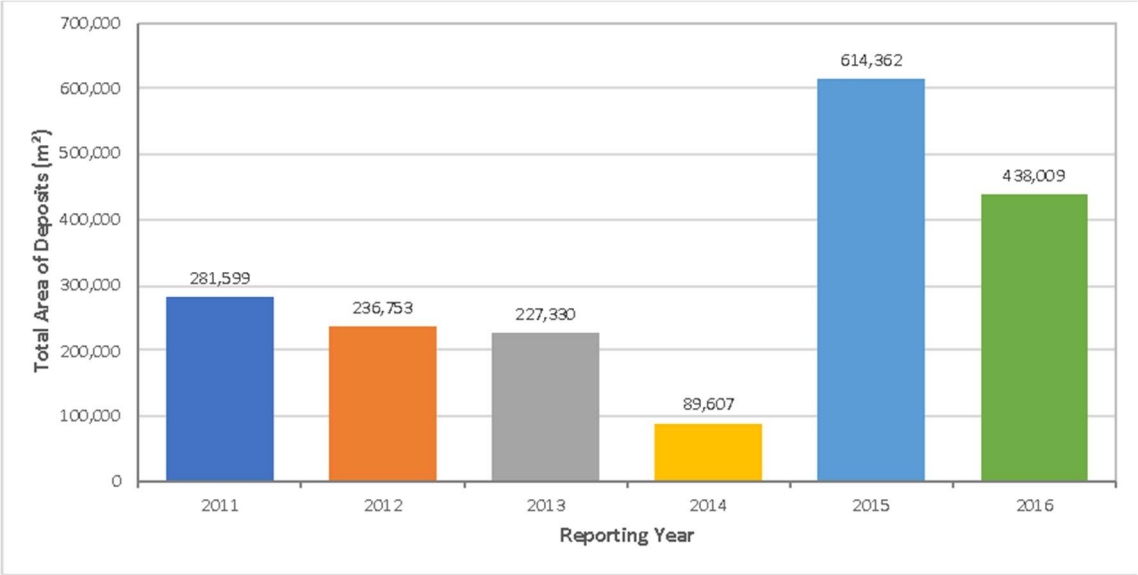


**Figure 8: Total Area Impacted by Seabed Deposits on the UKCS (2011-2016)**

## Deposits for UKCS and by Defined Sea within Protected Areas

Table 5 and Figure 9 below show the total area impacted by seabed deposits on the UKCS (2011 – 2016) by defined sea area (using the OGA Basins data - Table 3) and the area of impact within a protected area (in this analysis the SNS SAC is not included as it is not designated for the protection of seabed features (see Protected Areas).

**Table 5: Total Area Impacted by Seabed Deposits on the UKCS (2011 – 2016); by Defined Sea Area and Protected Area.**

| Defined sea | Defined sea area (m²) | Total area impacted by deposits (m²) (1) | Area of impact as percentage of total defined sea area (%) | Total area of deposits within protected sites (m²) (1,2) | Total area of deposits outside protected sites (m²) (1,2) | Percentage of deposits within protected area (%) (2) |
|---|---|---|---|---|---|---|
| Irish Sea | 57,368,835,551 | 93,010 | 0.00016 | 90,479 | 2,531 | 97.28 |
| NNS & CNS | 180,565,238,749 | 957,250 | 0.00053 | 50,701 | 906,548 | 5.30 |
| SNS | 69,669,508,041 | 711,658 | 0.00102 | 327,530 | 384,128 | 46.02 |
| WoS | 450,634,649,646 | 100,794 | 0.00002 | 1,668 | 99,126 | 1.65 |
| N/A (3) | | 3,951 | | | 3,951 | |
| All UKCS | 855,955,418,569 (4) | 1,866,663 | 0.00022 | 470,378 | 1,396,285 | 25.2 |

Notes:

1. Based on the data available. Not all returns include a final area of impact.
2. Protected sites include SACs (excluding SNS), NCMPAs and MCZs designated for seabed features (see Section 1.3.2).
3. Data point falls outside the boundary of a defined sea area based on the OGA basins GIS data, however, it is included in the total comparisons.
4. 4. Includes the area of the Southern Channel basin (97,717,186,582 m2) where there are no deposit records.

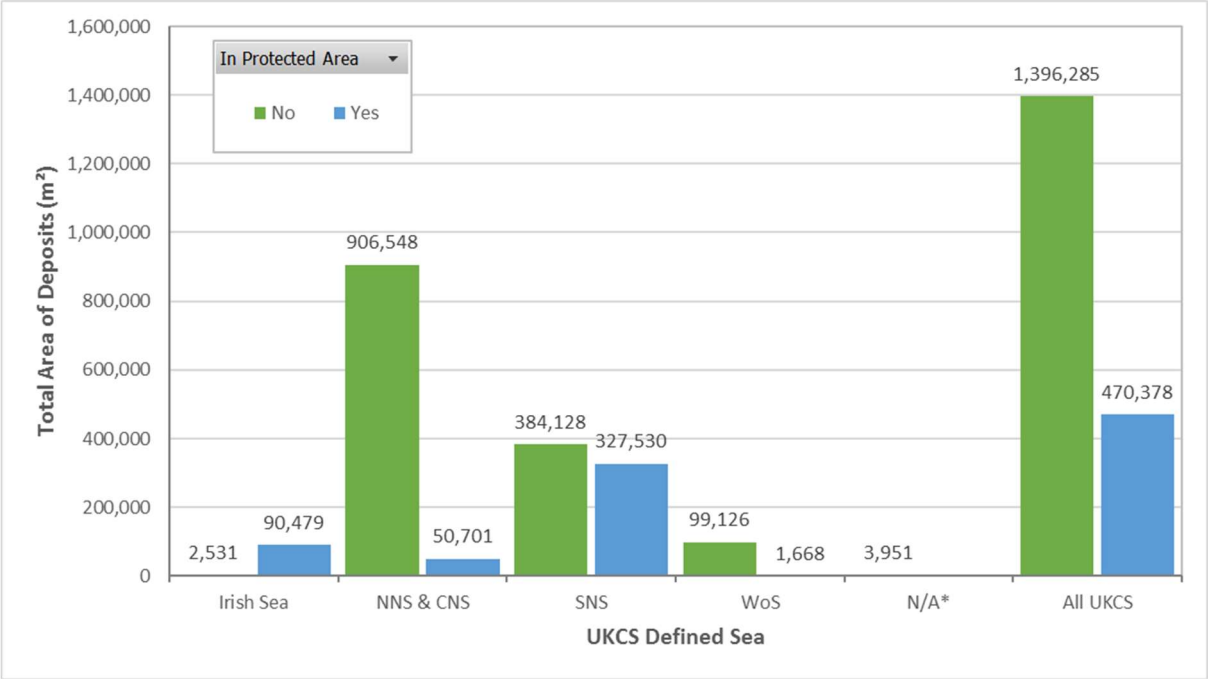


**Figure 9: Total Area Impacted by Seabed Deposits on the UKCS (2011 – 2016); by Defined Sea Area and Protected Area.**

From the data available, the total area of seabed impacted by deposits between 2011 and 2016 is 1,866,663 m2 which is 0.00022% of the total UKCS. Of this area, 470,378 m2 is within areas currently designated for the protection of seabed habitats and associated species, which is 25.2% of the total area of impact. The area impacted outside designated areas is 1,396,285 m2.

Of the defined sea areas, the Irish Sea shows the smallest total area of impact from deposited material (93,010 m2), but nearly all of the deposits were within areas designated for conservation (97.28%). On closer inspection of the data, it can be seen that this can be attributed to a single deposit located in the West of Walney MCZ (Hydrocarbon Resources, PON15C/383/0, 2012). As this is a large area of impact for a single deposit (compared to the rest of the UKCS), it is possible that this is an error in the data which requires further investigation.

Based on the data available, it can be seen that the largest total area of impact of deposited material is for the combined area of the NNS and CNS area at 957,250 m2, which is 0.00053% of the defined sea area. This area forms the largest geographical sea area for mature oil and gas activities on the UKCS. Although there are several large designated areas within the NNS and CNS (including Swallow Sand MCZ, Fulmar MCZ

and the East of Gannet and Montrose Fields NCMPA), which are all impacted by oil and gas infrastructure, the total area of the designated sites is small compared to the wider geographical area of the CNS and NNS, and the total area of protected sites impacted by deposits is therefore only 5.3% of the total impacted area.

The SNS has the highest percentage of the total basin area on the UKCS impacted by deposits at 0.00102% (711,658 m2), which can be attributed to its smaller total geographical area but relatively high number of oil and gas installations. This is also the second largest total area impacted after the NNS and CNS.

Large areas of the SNS are designated for the protection of seabed features as SACs and MCZs. The largest of these sites are the Dogger Bank SAC and the North Norfolk Sandbanks and Saturn Reef SAC. Smaller sites are found closer to the coast. Given the large number of sites in this geographical area as well as the relatively high number of oil and gas installations, it is not surprising that almost half of the total area impacted by seabed deposits (327,530 m2 or 46.02%) is within existing designated areas.

The defined geographical area for WoS is very large compared to the other sea areas of the UKCS. There are also fewer oil and gas developments in this area compared to the mature regions of the NNS, CNS and SNS and the area impacted by seabed deposits is therefore also much smaller (100,794 m2) which is a very small percentage of the total sea area (0.00002%). The Faroe-Shetland Sponge-Belt NCMPA is the only designated site impacted by deposits (1,668 m2 or 1.65% of total deposits). Further investigation of the data confirms that 85,708 m2 of the total area impacted outside the protected area is related to one deposit consent (BP, DEP/179/9/1, 2015). As with the Irish Sea deposit discussed earlier, this may also be an error requiring further investigation.

## Area of Impact within Protected Areas

Table 6 and Figure 9 show the total area of impact of deposits on the seabed for 2011 – 2016 for each individual protected area.

**Table 6: Total Area Impacted by Seabed Deposits on the UKCS within Protected Areas (2011 – 2016).**

| Protected area | Total area of designated site (m2) | Total area impacted by deposits (m2) | Area of impact as a percentage of designated site (%) |
|---|---|---|---|
| Central Fladen NCMPA | 924,889,864 | 29 | 0.000003 |
| Dogger Bank SAC | 12,337,180,118 | 64,763 | 0.000525 |
| East of Gannet and Montrose Fields NCMPA | 1,840,414,420 | 33,344 | 0.001812 |
| Faroe-Shetland Sponge Belt NCMPA | 5,270,862,801 | 1,668 | 0.000032 |
| Fulmar MCZ | 2,437,257,282 | 17,228 | 0.000707 |
| Haisborough, Hammond and Winterton SAC | 1,468,698,947 | 44,299 | 0.003016 |
| Holderness Offshore MCZ | 1,176,000,296 | 6,500 | 0.000553 |
| Markham's Triangle MCZ | 200,107,579 | 163,700 | 0.081806 |
| North Norfolk Sandbanks and Saturn Reef SAC | 3,609,157,647 | 48,268 | 0.001337 |
| Norwegian Boundary Sediment Plain NCMPA | 163,807,674 | 100 | 0.000061 |
| Swallow Sand MCZ | 4,746,416,351 | 0.0002 | 0.000000 |
| West of Walney MCZ | 387,884,084 | 90,479 | 0.023326 |
| **Total** | **34,562,677,063** | **470,378** | **0.001361** |

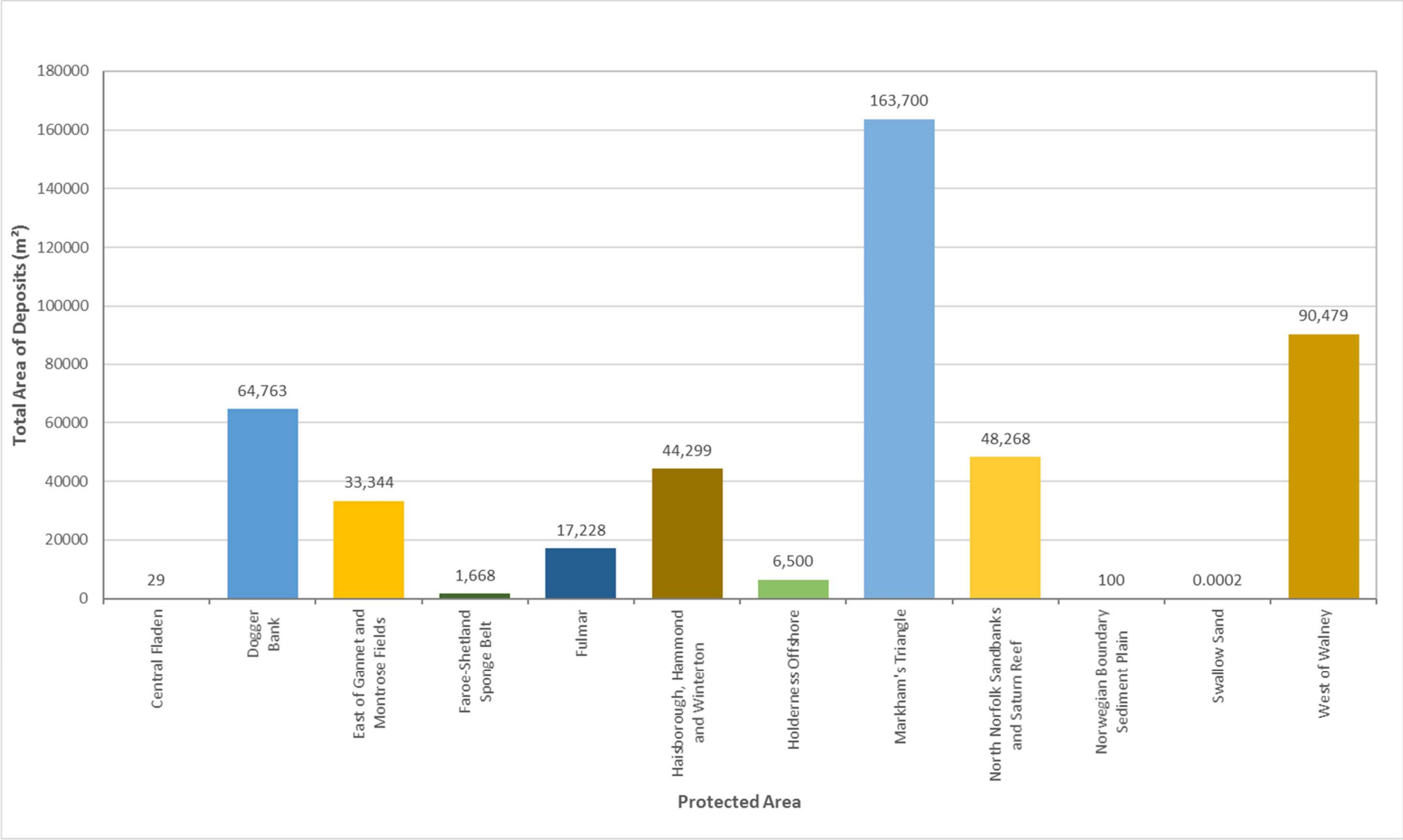


**Figure 10: Total Area of Impact by Seabed Deposits on the UKCS within Protected Areas (2011 – 2016).**

The data indicates that the protected areas with the greatest percentage of area impacted are:

- Markham's Triangle MCZ (0.08%); and
- West of Walney MCZ (0.02%).

Both of these sites have either a single individual deposit consent with an estimated large area of impact, which could be a data error (Hydrocarbon Resources, PON15C/383/0, West of Walney), or deposits with duplicate values for the area of impact which may be skewing the data (Centrica, PON15C/412/0, PON15C/412/7 and PON15C/412/9, Markham's Triangle). These require further investigation.

Other protected areas which display relatively large areas of impact from seabed deposits include; the Haisborough, Hammond and Winterton SAC, the East of Gannet and Montrose Fields NCMPA, and the North Norfolk Sandbanks and Saturn Reef SAC. The Dogger Bank SAC has a larger total area of impact from seabed deposits than these three sites, however, due to its larger size, the percentage area of impact is smaller.

The total area of impact by deposits on the seabed within protected areas (excluding the SNS SAC is 470,378 m² which is 0.001349% of the total area of the protected areas where deposits have been made.

## Deposits in the Southern North Sea SAC

Figure 11below shows the total area of impact by seabed deposits within the SNS SAC. The data has been grouped to show the area impacted by deposits which only fall within the SNS SAC, and the area of impact by deposits which are in the SNS SAC and other overlapping protected areas (other SACs and MCZs). The total area of impact within the SNS SAC is 195,369 m², which is 0.00053% of the area of the SNS SAC (36,942,100,161 m²). The majority of this (136,036 m²) also falls within other SACs and MCZs designated primarily for their seabed features while 59,333 m² is solely within the SNS SAC (equating to 0.0002% of the area of the SNS SAC).

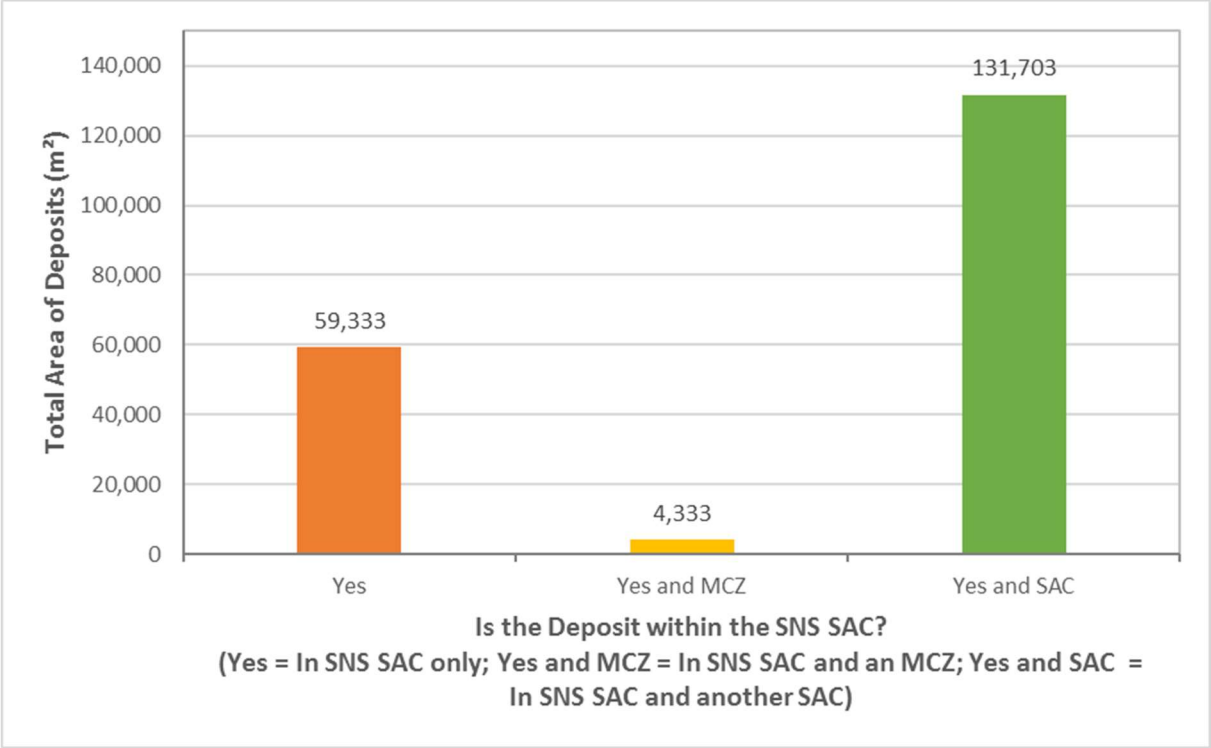


**Figure 11: Total Area Impacted by Seabed Deposits in the SNS SAC (2011 - 2016).**

## Deposits in the Fladen Grounds

The total area of the Fladen Grounds (based on an area classified as 'Deep circalittoral mud' (EUNIS A5.37) (see Table 3 is 29,614,321,401 m². The total area of seabed impacted by deposits within the Fladen Grounds (324,300 m2), representing 0.001% of the total area, is shown in Figure 12, compared to the total area of seabed impacted on the remainder of the UKCS (1,563,360 m²). 17% of the area impacted by seabed deposits on the UKCS (2011 – 2016) is within the Fladen Grounds.

The Central Fladen NCMPA is located within the Fladen Grounds (see **Figure 2** and F**Figure 3**). As discussed in 'Area of Impact within Protected Areas', the area impacted by seabed deposits within the Central Fladen protected area is 29 m².

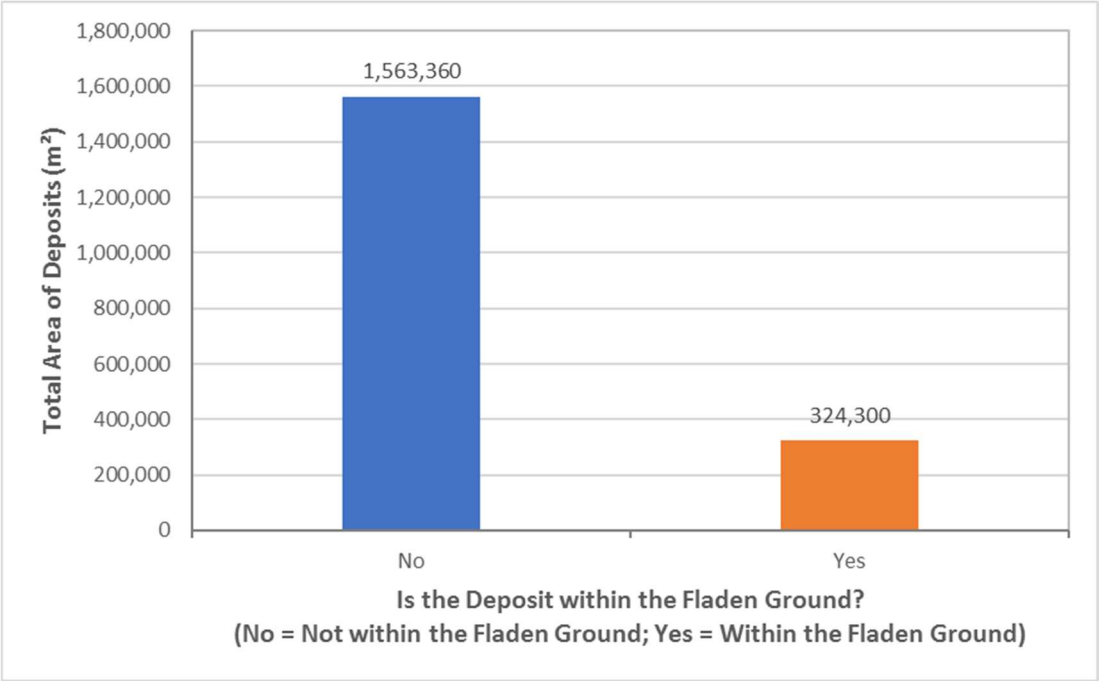


**Figure 12: Total Area Impacted by Seabed Deposits in the Fladen Grounds (2011 - 2016).**

## Deposits in Relation to Benthic Broad Habitat Types on the Wider UKCS

To put the impact of deposits in the Fladen Grounds into a wider context of the impact from deposits to different seabed habitats across the UKCS, further analysis was carried out to determine which benthic broad habitat type each deposit record occurs within (see Figure 6). The results of this analysis are shown in Table 7 and Figure 13. The EUNIS classification 'Deep circalittoral mud', used to define the area of the Fladen Grounds is classified as 'Offshore circalittoral mud' under the MSFD classification. From the results it can be seen that a total area of 460,540 m² of habitat classified as offshore circalittoral mud is impacted by seabed deposits on the UKCS. Of this area, 324,300 m² is within the Fladen Grounds. The largest area of impact from seabed deposits is to the offshore circalittoral sand and offshore circalittoral mud habitat types. These are the predominant benthic broad habitat types within the NNS, CNS and SNS, where the majority of the deposits have been made. A more varied range of habitat types are impacted in the SNS, associated with the subtidal sandbanks and reefs found there.

**Table 7: Total Area Impacted by Seabed Deposits by Benthic Broad Habitat Type and UKCS Broad Geographic Area.**

| EUNIS Broad Habitat | Area of benthic broad habitat type impacted by seabed deposits within each broad geographic area (m2) | | | | | Total area impacted (m2) (benthic broad habitat type) |
|---|---|---|---|---|---|---|
| | WoS | NNS & CNS | SNS | Irish Sea | NA | |
| Circalittoral coarse sediment | | | 91,757 | | | 91,757 |
| Circalittoral mud | | | 3,253 | | | 3,253 |
| Circalittoral sand | | | 19,861 | | 3,933 | 23,794 |
| Infralittoral rock and biogenic reef | | | 17,279 | | | 17,279 |
| Infralittoral sand | | | 37,730 | | | 37,730 |
| Offshore circalittoral coarse sediment | 83,345 | 20,753 | 97,328 | | | 201,426 |
| Offshore circalittoral mixed sediment | | | | 3 | | 3 |
| Offshore circalittoral mud | | 368,670 | 1,388 | 90,482 | | 460,540 |
| Offshore circalittoral rock and biogenic reef | | | 336 | | | 336 |
| Offshore circalittoral sand | 15,781 | 567,809 | 463,723 | 2,525 | | 1,049,838 |
| Upper bathyal sediment | 1,668 | 18 | | | | 1,686 |
| **Total area impacted (m2) (broad geographic area)** | **100,794** | **957,250** | **732,655** | **93,010** | **3,933** | **1,887,642** |

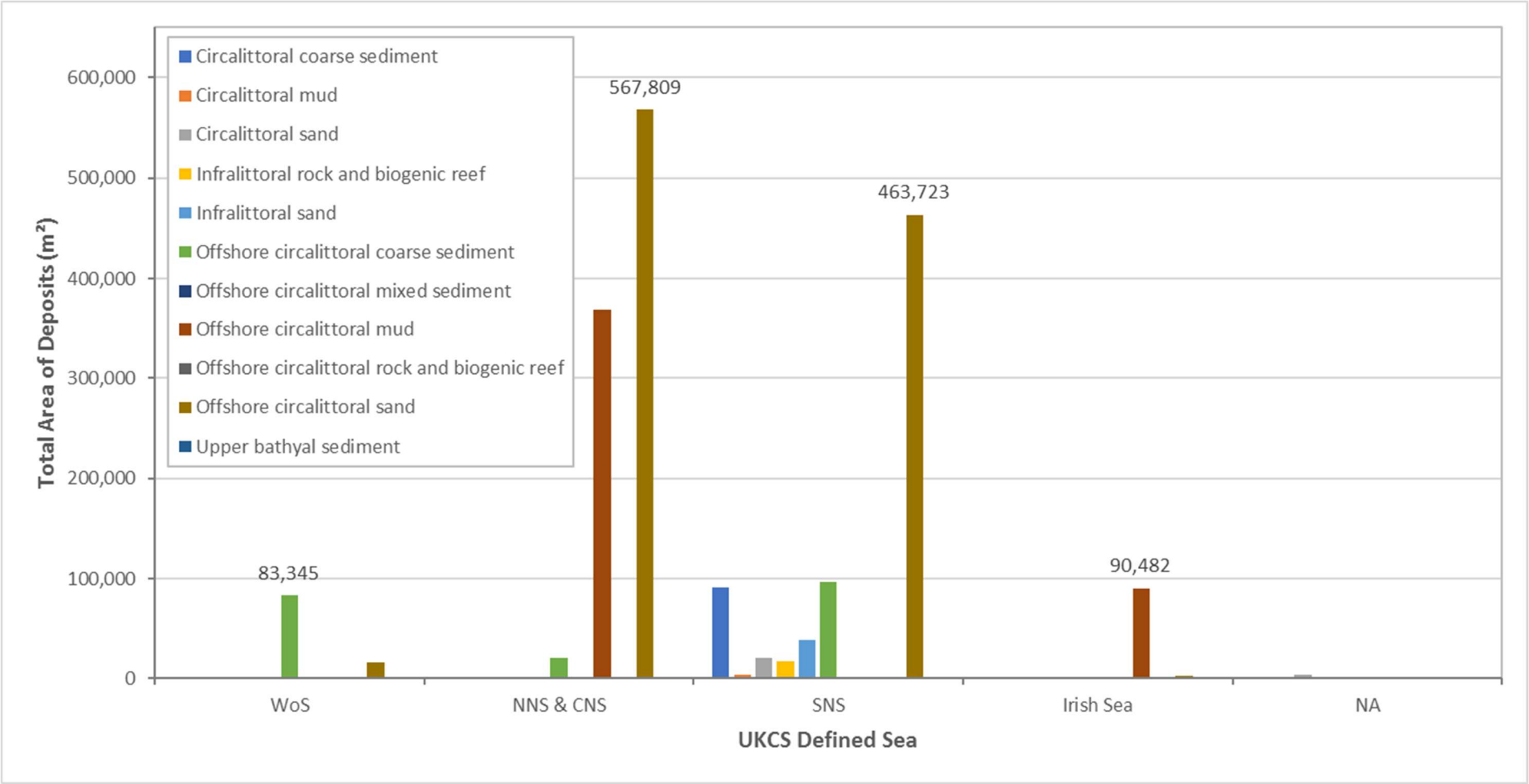


**Figure 13: Total Area Impacted by Seabed Deposits by Benthic Broad Habitat Type and UKCS Broad Geographic Area.**

# Analysis Results for EEMS Return Data (2013-2016).

The following sections describe the results of an analysis of the EEMS returns data sets only, which includes a breakdown of deposits by the type of material used. The classification of material is as follows:

- Clean inert rock;
- Gravel;
- Hessian bags containing grout;
- Hessian bags containing sand;
- Mattresses;
- Sand; and
- Other (not specified).

The type of material used is an important factor when considering the potential environmental impact of the deposit (i.e. introducing hard substrate to a sandy/muddy environment) and for possible removal or abandonment during decommissioning activities.

## Deposits for the UKCS and by Defined Sea

Table 8 and Figure 14: Total Area Impacted by Deposits on the UKCS (2013 – 2016); by Defined Sea Area and Type of Material Used. below show the total area of seabed impacted by deposits on the UKCS (2013 – 2016) by defined sea area (using the OGA Basins data - Table 3) and grouped by the type of protection material used.

**Table 8: Total Area Impacted by Deposits on the UKCS (2013 – 2016); by Defined Sea Area and Type of Material Used.**

| Defined Sea | Type of material used and total area of impact (m²) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Clean inert rock | Gravel | Hessian bags containing grout | Hessian bags containing sand | Mattresses | Other (not Specified) | Sand | Total |
| Irish Sea | | | | | | 2,500 | | 2,500 |
| NNS & CNS | 677,270 | 59,158 | 37,255 | 455 | 92,695 | 27,197 | 343 | 894,373 |
| SNS | 130,925 | 8,207 | 264 | | 4,830 | 1,869 | | 146,095 |
| WoS | 83,920 | | 1,046 | 288 | 8,667 | 1,141 | | 95,062 |
| **Total** | **892,115** | **67,365** | **38,565** | **743** | **106,192** | **32,707** | **343** | **1,138,030** |

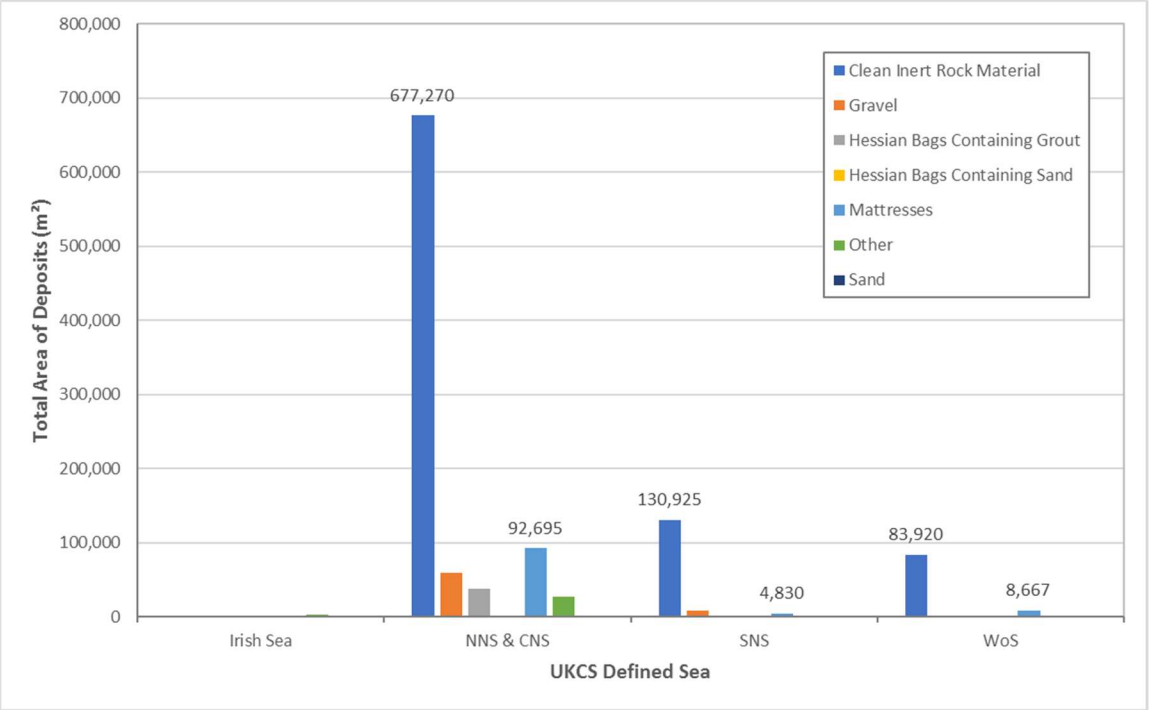


**Figure 14: Total Area Impacted by Deposits on the UKCS (2013 – 2016); by Defined Sea Area and Type of Material Used.**

As described earlier in 'Deposits for UKCS and by Defined Sea within Protected Areas', the largest total area of impact is in the NNS and CNS area, followed by the SNS (the mature areas of oil and gas activity on the UKCS). In both regions, clean inert rock material shows the largest total area of impact, followed by mattresses and then gravel (NNS and CNS). Clean inert rock is also the predominant protection material used WoS, although with a smaller total area of impact than in the other two sea regions.

## Area affected within Protected Areas

Table 9 and Figure 15 show the total area of impact by seabed deposits for 2013 – 2016 for each individual protected area, grouped by the type of material used.

**Table 9: Total Area Impacted by Seabed Deposits on the UKCS (2013 – 2016); within Protected Areas and by Type of Material Used**

| Protected Area | Type of material used and total area of impact (m²) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Clean Inert Rock | Gravel | Hessian Bags Containing grout | Hessian bags containing sand | Mattresses | Other (not specified) | Sand |
| Dogger Bank | 56,706 | 4,904 | 147 | | 3,006 | | 64,763 |
| East of Gannet and Montrose Fields | 19,845 | 75 | 777 | | 11,794 | 250 | 32,741 |
| Faroe-Shetland Sponge Belt | 160 | | 90 | 8 | 321 | 1,089 | 1,668 |
| Fulmar | 10,210 | | 275 | 20 | 6,003 | 144 | 16,652 |
| Haisborough, Hammond and Winterton | 6,909 | | | | | | 6,909 |
| North Norfolk Sandbanks and Saturn Reef | 42,670 | 3,303 | | | 592 | 528 | 47,093 |
| Norwegian Boundary Sediment Plain | | | | 100 | | | 100 |
| Swallow Sand | 0.0002 | | | | | | |
| **Total** | **136,500** | **8,282** | **1,289** | **128** | **21,716** | **2,011** | **169,926** |

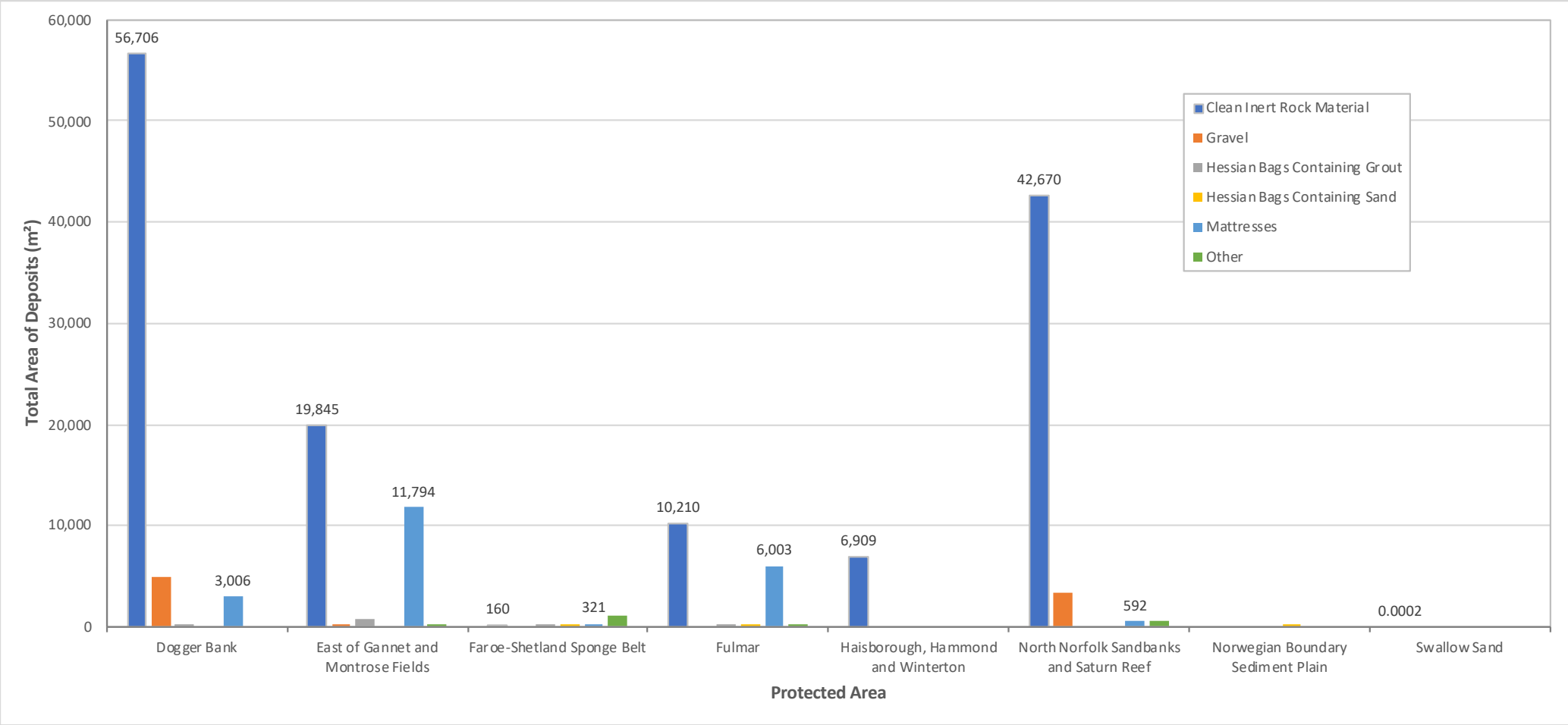


**Figure 15: Total Area of Impact by Seabed Deposits on the UKCS (2013 – 2016) within Protected Areas and by Type of Material Used.**

The data indicates that the protected areas with the greatest area impacted by seabed deposits in the reporting period 2013 – 2016 are;

- Dogger Bank SAC;
- North Norfolk Sandbanks and Saturn Reef SAC;
- East of Gannet and Montrose Fields NCMPA; and
- Fulmar MCZ.

The predominant type of protection material used in all of these sites (with the largest seabed impact) is clean inert rock, followed by mattresses in the East of Gannet and Montrose Fields NCMPA and Fulmar MCZ, and gravel in the Dogger Bank SAC.

## Deposits in the Southern North Sea SAC

Figure 16 below shows the total area of seabed impacted by deposits within the SNS SAC for the reporting period 2013 – 2016. The data has been grouped to show the area impacted by deposits which only fall within the SNS SAC, and the area of impact by deposits which are in the SNS SAC and other overlapping SACs. The data indicates that the predominant deposit material used (having the largest impact) is clean inert rock, followed by gravel and mattresses. The chart shows that the majority of the rock, gravel and mattress within the SAC is also located within other SACs that have been designated primarily for their seabed features (see 'Area affected within Protected Areas').

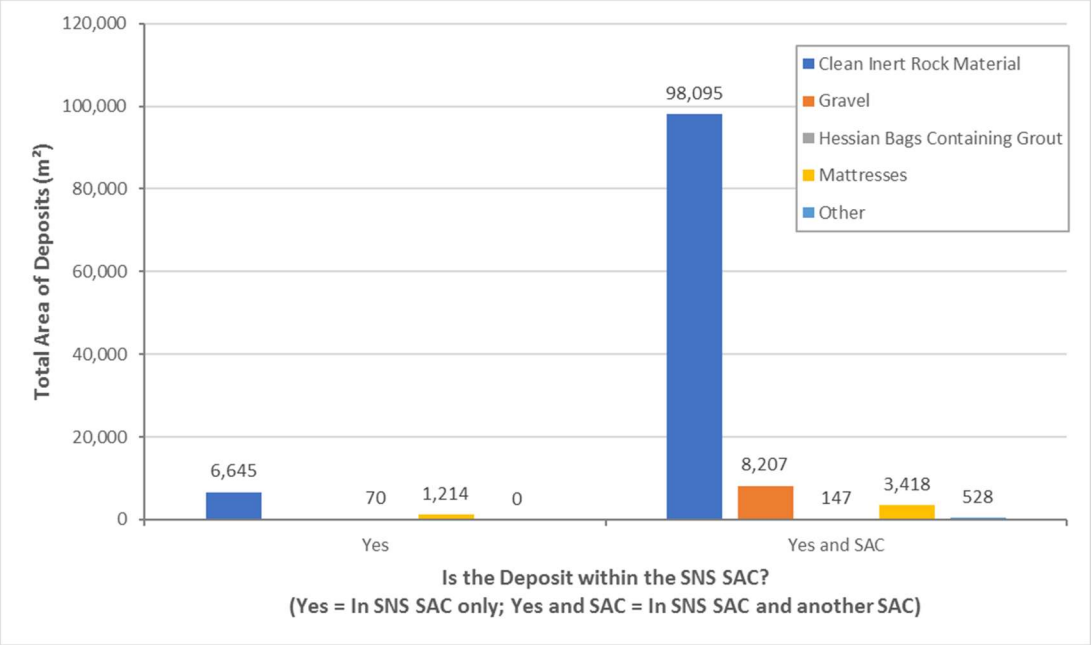


**Figure 16: Total Area of Impact by Seabed Deposits in the SNS SAC (2013 - 2016) and by Type of Material Used.**

### Deposits in the Fladen Grounds

Figure 17 below shows the total area impacted by seabed deposits in the Fladen Grounds compared to the remainder of the UKCS for the reporting period 2013 – 2016. The data indicates that the predominant deposit material used (having the largest impact) is clean inert rock, followed by hessian bags containing grout and mattresses.

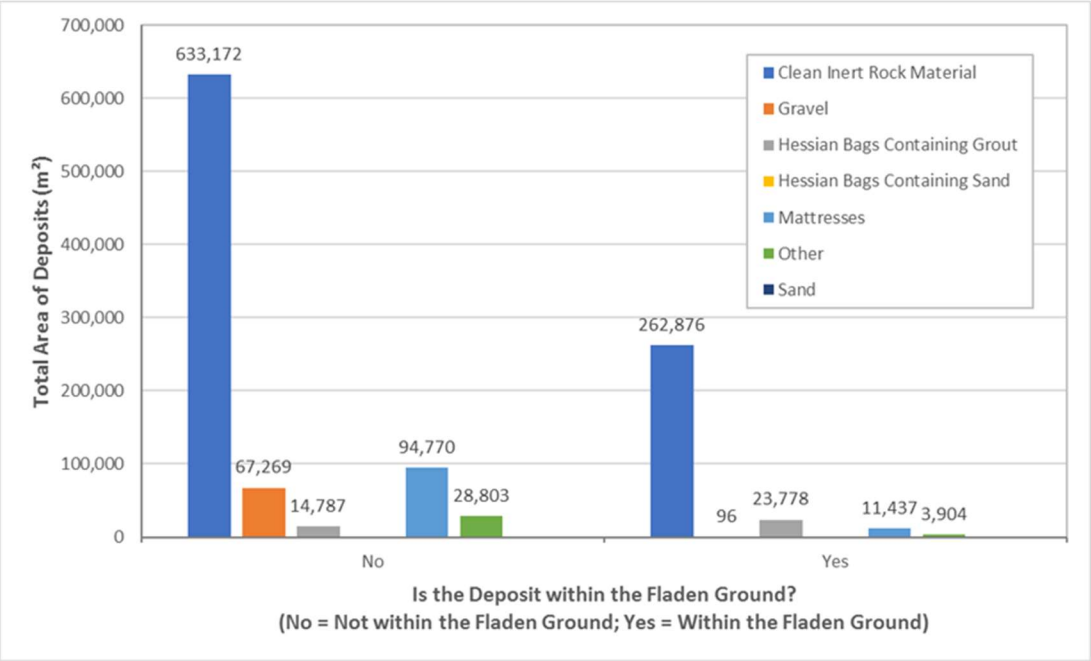


**Figure 17: Total Area Impacted by Seabed Deposits in the Fladen Grounds (2013 - 2016) and by Type of Material Used.**

# Data Issues and Gaps

There are several data quality issues and gaps associated with the data provided for use in this analysis. It is important to note these when interpreting the results that are presented.

- The 2011 – 2013 data format in Excel is not easily reformatted for input to GIS as for example, deposit location coordinates are grouped in one spreadsheet cell and need to be separated out to individual rows and columns for use in GIS.
- As described in ‘Data Editing’ a number of errors were discovered in the location coordinates, meaning that deposits were initially mapped in the wrong location. Other minor errors (from e.g. typographical errors) may not have been identified, and where deposits have potentially been mapped in the wrong location, the spatial overlay analysis will also contain subsequent errors.
- In the 2011 – 2013 data, not all deposit records have been provided with location coordinates and have not been mapped. These records are therefore not included in any of the spatial analyses carried out, or area of impact calculations made. Several coordinates were also found to be truncated and could not be mapped.

- As described in Pre-PETS Data Import' the Marine Licence data do not include coordinate information, therefore this data has not been mapped or included in the analysis.
- For some of the records in the 2011 – 2013 dataset, the area impacted (estimated or actual) was not recorded, or the Excel spreadsheet references other documentation. These data records could not be included in the area of impact calculations. Additionally, not all records for 2011 - 2013 included an estimated area of impact (although the actual area of impact was recorded). As an estimate is not provided in the EEMS returns data for 2013 – 2016 either, a comparison between the estimated and actual area of impact could not be made for any of the years considered. As noted in 'Data Analysis Results', a number of individual deposit records also displayed a relatively large area of impact or duplicate areas of impact. These may be data input errors which would have likely skewed some of the results.
- The EEMS returns data for 2013 – 2016 provides a standardised classification of the nature (type) of the material used for the deposit. The 2011 – 2013 data does not include this classification and therefore an analysis of the deposits made by type of material could not be made for these years.
- For deposits recorded as 'between points', there is no way of determining where a deposit was located between the start and end coordinates. Where a deposits' start location is within a protected area and the end location is outside the protected area, the area of impact could be completely within the protected area or completely outside its boundary. The analysis cannot determine where this might be the case and the deposits were therefore assumed to be within the protected area.
- The fate of the deposit has not been analysed. As some deposits may only be temporary and could have subsequently been removed, the total area of impact presented could be less than estimated.

# Conclusions

Based on the data provided and the analysis undertaken and taking into account the data issues and gaps identified in Section 5.0, the following conclusions have been made.

- For the years 2011 to 2016, the total area of seabed impacted by deposited material was greatest in 2015 (614,362 m²).
- The total area of seabed impacted by deposits between 2011 and 2016 was 1,866,663 m2 which is 0.00022% of the total UKCS. Of this area, 470,378 m² is within areas currently designated for the protection of seabed habitats and associated species, which is 25.2% of the total area of impact. The area impacted outside designated areas is 1,392,334 m².
- The largest total area of deposited material is for the NNS and CNS area at 957,250 m², which is 0.00053% of that defined sea area. Of the total area impacted by deposits, 50,701 m2 (5.3%) is within protected areas compared to 906,548 m² outside protected areas.
- The SNS has the greatest percentage of the total area impacted by deposits on the UKCS, 711,658 m² or 0.00102% of the total area, which may be attributed to its smaller total geographical area and relatively high number of oil and gas installations. The mobile nature of the seabed sediments in this area of shallower water means that the requirement for stabilisation/protection material around oil and gas infrastructure is greater than other less dynamic environments. Almost half of the total area impacted by seabed deposits (327,530 m² or 46.02%) is located within existing designated areas.
- Markham's Triangle MCZ and West of Walney MCZ all show a relatively large percentage total area of impact from seabed deposits. This may be due to their relatively small area compared to some of the larger designated sites and also possible data errors in the deposits recorded. Other protected areas which display relatively large areas of impact from seabed deposits include; the Haisborough, Hammond and Winterton SAC, the East of Gannet and Montrose Fields NCMPA, and the North Norfolk Sandbanks and Saturn Reef SAC. The Dogger Bank SAC has a larger total area of impact from seabed deposits than those three sites, but because of the site's larger size the percentage area of impact is smaller (0.0005%).
- For 2011 – 2016, the total area of seabed impacts within the SNS SAC is 195,369 m², which is 0.00053% of the total area of the SNS SAC.
- For 2011 – 2016, the total area of seabed impacts in the Fladen Grounds is 324,300 m2, compared to the total area of seabed impacted on the remainder of the UKCS (1,563,360 m²). 17% of the area impacted by seabed deposits on the UKCS is within the Fladen Grounds.
- Based on an analysis of the 2013 – 2016 data, the predominant protection material deposited on the UKCS seabed with the largest total area of impact is clean inert rock.

The largest total area of impact is in the NNS and CNS area, followed by the SNS area (the mature areas of oil and gas activity on the UKCS). The Dogger Bank SAC, the East of Gannet and Montrose Fields NCMPA and the North Norfolk Sandbanks and Saturn Reef SAC all have a relatively large total area impacted by this material (although the total percentage area of the sites impacted by seabed deposits within the protected areas is small).

- For the 2013 – 2016 data, the largest area of impact within the Fladen Grounds and the SNS SAC is related to the deposit of clean inert rock.

# Future Work

The spatial analysis presented in this report has been undertaken using Esri's modern mapping software, ArcGIS Pro. The charts created in Microsoft Excel can also be produced using the ArcGIS Pro software and linked to the data presented in the map interface. Interacting with the mapping system (switching different layers on and off, zooming in on areas of interest) changes the data displayed in the charts, helping the user to interact with the data and to identify trends and patterns. In addition, the data points for the deposit records can be interrogated using the GIS 'identify' tool, allowing the user to quickly access information for a deposit based on its location, in context with other features on interest (e.g. protected areas and oil and gas infrastructure). Developing and maintaining the GIS database of deposit records will help to monitor and assess the cumulative impact of seabed deposits in the future.

In addition to oil and gas data, information on deposits from other industrial activities for e.g. telecommunications and windfarm cables are required, particularly from cumulative impact assessment perspective (The Crown Estate, 2020).

It is possible to provide wider access to the deposits data in a web-based interactive environment such as ArcGIS and Microsoft PowerBI, without the requirement for access to a desktop GIS.

This report has highlighted a number of data gaps, errors and inconsistencies in the deposit data that is currently available for the UKCS. In order to make the most of the capabilities of the GIS software and interactive tools, and to allow a more consistent and accurate analysis of the potential impacts of rock placement on the seabed, the way data is collected and stored could be improved. The structure of the EEMS returns data post implementation of PETS, provides the greatest consistency and is most easily imported into GIS. A method of automating coordinate string conversion to decimal degree (latitude and longitude) would further facilitate the import workflow. Tools to help operators more accurately describe the location and extent of the deposit could be developed (e.g. locating on an interactive map or import of GIS Shapefiles). This would help improve the accuracy of the overlay analysis to determine the footprint of material within an area (e.g. a protected area).

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