Hornsea Project Four

Clarification Note on Marine Sediment Contaminants

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Revision Summary

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Acronyms

Term	Definition
CAL1	Cefas Action Level 1
CAL2	Cefas Action Level 2
DCO	Development Consent Order
EQSs	Environmental Quality Standards
ISQG	Interim Sediment Quality Guidelines
MMO	Marine Management Organisation
PAH	Polyaromatic hydrocarbons
PCB	Polychlorinated byphenyls
PEL	Probable Effect Levels
TEL	Threshold Effect Levels
TBT	Tributyltin

1 Introduction

1.1 Aim of this clarification note

1.1.1.1 Orsted Hornsea Project Four Limited (hereafter the Applicant) has submitted a Development Consent Order (DCO) application to the Planning Inspectorate (PINS), supported by a range of plans and documents including an Environmental Statement (ES) which set out the results of the Environmental Impact Assessment (EIA) on the Hornsea Project Four Offshore Wind Farm (hereafter Hornsea Four) and its associated infrastructure.

1.1.1.2 This clarification note has been prepared to provide a detailed response to the Relevant Representations made by the Marine Management Organisation (MMO) (RR-020) and Natural England (RR-029). This note aims to provide sufficient information to provide confidence for these parties that the potential for the release of contaminants in the marine environment has been adequately considered in the Applicant's DCO Application.

1.1.1.3 This note has sought to collate information from the following DCO Application documents:

- **Volume A2, Chapter 2: Benthic and Intertidal Ecology (APP-014)**;
- **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068)**;
- **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes (APP-013)**;
- **Volume A4, Annex 4.4: Dredging and Disposal (Site Characterisation) (APP-042)**; and
- **Volume A5, Annex 2.2: Water Framework Directive Assessment (APP-069)**.

1.1.1.4 The collated information is intended to provide the MMO and Natural England with sufficient information to provide comfort that sediment bound contaminants are not a matter for concern in relation to the construction, operation and decommissioning of Hornsea Four.

1.2 Key points raised

1.2.1.1 **Table 1** provides the key Relevant Representations made in relation to the potential impacts arising from sediment bound contaminants.

Table 1: Relevant Representations with regards to sediment contamination.

Interest Party	Relevant Representation	Section in this note where the concerns are addressed
MMO	**3.3.4:** The dredge and disposal site characterisation report correctly highlights that dredging may lead to sediment plumes, which could create indirect effects on other receptors as a result of increased suspended sediment concentration, deposition and potential release of contaminants (noting these will be discussed in the relevant chapters for individual receptors). The report also highlights that the material to be dredged is predominantly coarse sand, and therefore the likelihood of persistent plumes is low. The MMO believes that this is an accurate conclusion.	This is welcomed by the Applicant and is not addressed further in this clarification note but has been included for completeness.
MMO	**3.3.8:** The ES concludes that potential impacts related to dredging and disposal operations are negligible. The MMO agrees with this conclusion, based on the information provided, which suggests that material is likely to be comprised mostly of coarse sand with low levels of observed contamination.	This is welcomed by the Applicant and is not addressed further in this clarification note but has been included for completeness.
MMO	**3.4.25:** The MMO previously raised the potential issue of obtaining contaminant samples from a Hamon grab as this gear mixes the sediment. The MMO is not aware of any studies being undertaken to compare the results of using this gear type compared with those obtained using the standard gear type (Day grab) used for this purpose, nor know of the consequences of using this gear type on the concentrations of the contaminants. It would be beneficial to compare results with any other data nearby that has been collected using the correct gear, to provide confidence in the results.	A 0.1 m^2 Mini-Hamon grab was used to collect the physio-chemical data due to the course nature of the sediment in the survey area, i.e., the sediment was too coarse to obtain success day grab samples. Sediments with a finer particle size, such as clays and muds, can act as adsorption surfaces for contaminants that may be released into the water column if the sediment is disturbed (Cefas, 2001). Sediments with larger particle sizes (e.g. sands) are not typically associated with elevated concentrations of anthropogenic contaminants. Hydrocarbons in particular are closely linked to the spatial distribution of sediment types. The concentrations of metals in sediments are generally higher in the coastal zone and around estuaries, decreasing offshore, indicating that river input and run-off from land are significant sources. As presented in Appendix A of **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068)**, Results of the chemical analyses revealed that hydrocarbon concentrations across the majority of the Hornsea Four survey area were within the expected UKOOA (2001) background concentrations. Some elevation in total hydrocarbon (THC) concentrations was noted nearby existing infrastructure which was expected. Gas chromatography traces were typical of background levels of hydrocarbon inputs in areas of historical oil and gas exploration

Interest Party	Relevant Representation	Section in this note where the concerns are addressed
		such as the North Sea (McDougall, 2000). Therefore, it is the Applicant's position that the surveys were sufficient for the purposes of characterisation for the purposes of EIA.
Natural England	Certain impacts assessed for the project alone are not considered in the cumulative assessment, as they are assessed as 'not significant' on a project alone basis. Natural England believe these should be carried forward to the CEA or the Applicant needs to provide further detail to justify the exclusion of these potential cumulative impacts (Construction phase: - Direct and indirect seabed disturbances leading to the release of sediment contaminants… It should also be noted that the CEA may need to be updated following adjustments to the 'project alone' assessments.	See Section 4.3 of this clarification note.
Natural England	**Section 2.7.1.15:** Of the metals, arsenic at several stations across both the array and ECC exceeded the ISQG (TEL) and CEFAS Action Level 1 (AL1). At ECC Station ECC_14, arsenic also exceeded the ISQG PEL and this is not stated within the ES (para 2.7.1.16). Neither the ES or technical report explores the potential source for the regionally elevated arsenic and it would be useful to understand (for example from existing literature or previous surveys) whether this is considered to be natural (e.g. associated with sediment mineralogy, underlying geology) or anthropogenic in origin.	See Section 3 of this clarification note which provides collates all contaminants information and provides regional context.
Natural England	**Section 2.7.1.18:** The ES does not provide an assessment as to whether there was any evidence the above elevated contaminants were having an adverse effect on the baseline benthic community composition and structure, particularly within the ECC. This is touched upon within the array survey report, however comparisons in the technical report mainly focus on the link between the variation in physical sediment properties. Natural England recommends this aspect is clarified by the Applicant. This will help to further inform whether the contaminants would be a cause for concern (or not) due to sediment disturbance and re-suspension impacts from construction activities, or if removed for sediment disposal.	See Sections 4.2 and 4.3 of this clarification note for a full justification as to why the level of contamination and the implications of the proposed works will not be significant in EIA terms.
Natural England	Detailed comments – Volume A2.2 Benthic and intertidal ecology: Point 12 **Section 2.11.1.39 – 2.11.1.41:** Sediment contamination has been discussed in point 1 of this table, and those comments are also relevant to this section of the impact assessment (2.11.1.39 onwards). More discussion of toxicity thresholds is required to	Further discussion regarding the potential toxicity of thresholds is provided in Section 4 of this clarification note. Concentrations of all metals and PAHs recorded within the project specific surveys have been presented against the Cefas Action Levels (where available) and provided

Interest Party	Relevant Representation	Section in this note where the concerns are addressed
	help fully assess the impact these contaminated sediments might have to the faunal community. THC concentrations are compared to regional UKOOA, 2001 background data. It is also as important to compare these to the aforementioned SEI thresholds (UKOOA, 2001, 2005) and Kingston, 1992 for impacts to fauna community as a result of sediment disturbance. For PAHs, while comparison to OSPAR BACs, is useful to assess if concentrations are typical of background levels, it is thresholds such as the ISQG TEL and PEL that will provide confidence in the potential toxicity of PAH concentrations along with comparison to CEFAS Action Level 1. We also note that the statement that "As concentrations are higher than CEFAS AL 1 at all stations along the ECC" is incorrect. CEFAS AL 1 was exceeded at 7 of the ECC stations and the Canadian ISQG TEL at 15 of the ECC stations. Natural England recommends the Applicant provides evaluation of these additional thresholds as part of the determination of the magnitude of impact.	against the Interim Sediment Quality Guidelines (ISQG) TEL and PEL thresholds in Section 3 of this note for the purposes of clarification. An assessment of the impact of the potential release of contaminated sediments is provided in Section 4 of this clarification note. It should be noted that this has been informed by several documents with the Applicant's DCO Application.
Natural England	Detailed comments – Volume A2.2 Benthic and intertidal ecology: Point 13 **Section 2.11.1.43:** There is little evidence provided of the impact of direct and indirect seabed disturbances leading to the release of sediment contaminants (BIE-C-6) but the magnitude is concluded to be negligible which rules out the need to consider sensitivity. Addressing point 13 above will improve evidence of the impact. Natural England would encourage the ExA to seek advice from Cefas on possible impacts and significant of disturbing contaminated sediments as they have more expertise in his area.	The Applicant disagrees with this statement and numerous documents (as outlined in Section 4 of this note) consider the impact of sediment contaminants as part of the Applicant's ES. Please see the MMO (and Cefas') Relevant Representations which have not raised concerns in this matter. In addition, the Environment Agency have not raised concerns in relation to marine water quality or potential impacts under the Water Framework Directive arising from Hornsea Four. An assessment of the impact of the potential release of contaminated sediments is provided in Sections 4.2 and 4.3 of this note. It should be noted that this has been informed by several documents with the Applicant's DCO Application.
Natural England	Detailed comments – Volume A2.2 Benthic and intertidal ecology: Point 15 **Section 2.12.1.7:** Natural England advise that the following two impacts should not have been excluded from the CEA based on Hornsea 4 alone not leading to significant	See Section 4.3 of this clarification note provides a collation of evidence to justify the Applicant's position presented that no significant effects (in EIA terms) would arise from the disturbance of sediment bound contaminants.

Interest Party	Relevant Representation	Section in this note where the concerns are addressed
	impacts. These two impacts have been assessed as 'non significant' rather than 'negligible' where the methodology states they could be excluded from the CEA. Natural England believe a CEA should be carried out for these two impacts (appreciating it will probably conclude 'not significant'),or provide further detail to justify the exclusion of these potential cumulative impacts • Construction phase: - Direct and indirect seabed disturbances leading to the release of sediment contaminants: the potential significance of the impact from Hornsea 4 alone has been assessed as not significant.	
Natural England	Detailed comments – Volume A5.2.1 Benthic and intertidal ecology technical report: Point 20 **Section 5.4.2.7:** The number of stations where the CEFAS AL1 threshold was exceeded does not match the results tabulated within the Appendix D for the ECC benthic survey. Further consideration of the source and therefore the level of potential concern for the elevated As concentrations is not fully explored and this is highlighted in comments to the ES point 2. Natural England suggest using available literature to explore the regional trend for As.	Concentrations of all metals and PAHs recorded within the project specific surveys have been presented against the Cefas Action Levels (where available) and provided against the ISQG TEL and PEL thresholds in **Section 3** of this note for the purposes of clarification. Further information regarding the potential sources of contaminants is provided in **Section 3**.
Natural England	Detailed comments – Volume A4.4.4: Dredging and Disposal (Site Characterisation): Point 31 **Section 6.2.2.2 and 6.2.3.2:** As in point 1 & 13 above, high levels of contaminants have been found in some sediment samples as described in the 'benthic and intertidal ecology' chapter and 'Technical report'. Should evidence arise that the dredging and disposal of these sediments could have environmental impacts due to the high contaminant levels they contain, Natural England wants to see measures in place to minimising this effect.	As presented in **Sections 4.2** and **4.3** of this clarification note, it is the Applicant's position that significant environmental impacts (in EIA terms) will not occur. This is supported by the information provided in **Volume A4, Annex 4.4: Dredging and Disposal (Site Characterisation) (APP-042)**.

2 Relevant thresholds

2.1.1 Cefas Action Levels

2.1.1.1 The Cefas Action Levels are used as part of a 'weight of evidence' approach to assessing the suitability of material for disposal at sea but are not themselves statutory standards. There are no Environmental Quality Standards (EQSs) for *in situ* sediments in the UK. In the absence of any defined EQSs, data from the surveys is analysed relative to the Cefas Action Levels for the disposal of dredged material. This may be used to provide evidence for decision makers about the disposal of dredged material, they are not however statutory. The Cefas Action Levels are presented in **Table 2**. These levels were used in this assessment to determine whether further assessment is required rather than a pass/ fail criterion.

2.1.1.2 For dredging projects, contaminants below the Cefas Action Level 1 (CAL1) are not considered to be of concern and are approved for disposal at sea. Contaminant levels above Cefas Action Level 2 (CAL2) are not considered suitable for disposal at sea without further consideration. It is noted that Hornsea Four is not a proposed dredging scheme but, given the project proposal to dredge, drill and dispose of seabed material within the Hornsea Four Order Limits, and in keeping with common practice, contaminants were contextualised against the Cefas Action Levels to provide an indicative risk to the environment.

2.1.1.3 There is currently no guidance or procedure in place regarding the handling of sediments which fall between CAL1 and CAL2 or the lines of evidence that should be considered to evaluate these samples (Cefas, 2015). Furthermore, the High Level Review of Current UK Action Level Guidance (Cefas, 2015) states:

"Suitability for disposal of sediments between CAL1 and CAL2 is determined through expert judgement based on evaluation of a number of lines of evidence including historical information, disposal site characteristics and physical characteristics of the material."

2.1.1.4 The Applicant has provided a detailed characterisation of the disposal site characteristics and physical characteristics of the material being disposed of in **Volume A4, Annex 4.4: Dredging and Disposal (Site Characterisation) (APP-042)**. In addition, historical information and potential sources of contaminants were discussed in **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068)**.

Table 2: Cefas Action Levels.

Contaminant/ Compound	Action Level 1	Action Level 2
	mg/kg Dry Weight	mg/kg Dry Weight
Arsenic	20	100
Mercury	0.3	3
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Lead	50	500
Zinc	130	800
Orgotins; TBT DBT MBT	0.1	1
PCB's, sum of ICES 7	0.01	none

Contaminant/ Compound	Action Level 1	Action Level 2
	mg/kg Dry Weight	mg/kg Dry Weight
PCB's, sum of 25 congeners	0.02	0.2
*DDT	*0.001	N/A
*Dieldrin	*0.005	N/A

*as set in 1994

2.1.2 Canadian Marine Sediment Quality Guidelines

2.1.2.1 In addition to the Cefas Action Levels, the Canadian sediment quality guidelines have been utilised to provide further context, and for contaminants such as polycyclic aromatic hydrocarbons (PAHs) that are not captured within the Cefas Action Levels. The Canadian Sediment quality guidelines were developed by the Canadian Council of Ministers of the Environment as broadly protective tools to support the functioning of healthy aquatic ecosystems. They are based on field research programmes that have demonstrated associations between chemicals and biological effects by establishing cause and effect relationships in particular organisms. Comparison of measured concentrations of various contaminants within the sediments with these guideline values provided a basic indication on the degree of contamination and likely impact on ecology.

2.1.2.2 The guidelines consist of Threshold Effect Levels (TELs) (also known as interim sediment quality guidelines) and Probable Effect Levels (PELs). The TELs and PELs are used to identify the following three ranges of chemical concentrations with regard to biological effects:

- Below the TEL - the minimal effect range within which adverse effects rarely occur;
- Between the TEL and PEL - the possible effect range within which adverse effects occasionally occur; and
- Above the PEL - the probable effect range within which adverse effects frequently occur.

2.1.2.3 Table 3 presents the guidelines for the TELs and PELS. Where Cefas Action Levels are not available for a substance then TELS and PELS have been utilised to characterise the baseline environment.

Table 3: Canadian Marine Sediment Quality Guidelines.

Substance	Units	TEL	PEL
Metals			
Arsenic	mg/kg	7.24	41.6
Cadmium	mg/kg	0.7	4.2
Chromium	mg/kg	52.3	160
Copper	mg/kg	18.7	108
Lead	mg/kg	30.2	112
Mercury	mg/kg	0.13	0.7
Zinc	mg/kg	124	271
Polychlorinated byphenyls (PCB)			
PCBs: total PCBs	mg/kg	21.5	189
Polyaromatic hydrocarbons (PAH)			
Acenaphthene	µg/kg	6.71	88.9
Acenaphthylene	µg/kg	5.87	128
Anthracene	µg/kg	46.9	245
Benz(a)anthracene	µg/kg	74.8	693
Benzo(a)pyrene	µg/kg	88.8	763
Chrysene	µg/kg	108	846
Dibenz(a,h)anthracene	µg/kg	6.22	135
Fluoranthene	µg/kg	113	1,494
Fluorene	µg/kg	21.2	144
2-Methylnaphthalene	µg/kg	20.2	201
Naphthalene	µg/kg	34.6	391
Phenanthrene	µg/kg	86.7	544
Pyrene	µg/kg	153	1,398

3 Sediment Quality Baseline

3.1.1.1 This section has collated information from the following sources with the Applicant's DCO Application:

- Appendix A of **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068)**; and
- Appendix D of **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068).**

3.1.1.2 Within **Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report (APP-068)**, specifically Figure 1.1 of Appendix A and Figure D.1 of Appendix D, the locations of the project specific sampling locations are presented, which are discussed in more detail below.

3.1.2 Metals

3.1.2.1 Further details of the chemical analysis undertaken for Hornsea Four are provided in these Appendices. **Table 4** presents the metal contaminants in the context of the Cefas Action Levels. As denoted by the yellow shading, both arsenic and organotins are between CAL1 and CAL2 within the array. Approximately 27% of samples (seven samples) in the ECC are above between CAL1 and CAL2 for arsenic and organotins within the ECC (**Table 4**). One sample in the ECC (ECC_24) exceeded CAL1 for nickel. Two sample (ECC_21 and ECC_23) exceeded CAL2 for organotins. The following metals do not exceed CAL1 in any of the samples:

- Mercury;
- Cadmium;
- Chromium;
- Copper;
- Lead; and
- Zinc.

3.1.2.2 In addition, the metals have been provided in the context of the ISQGs in **Table 5**. Approximately 41% and 58% of samples are between TEL and PEL for arsenic in the array and ECC respectively. There is one exceedance of PEL for arsenic in the ECC (ECC_14). The values for TEL and PEL are more precautionary than CAL1 and CAL2 for arsenic. In addition, two samples are between TEL and PEL for lead in the ECC. The following metals do not exceed TEL in any of the samples:

- Mercury;
- Cadmium;
- Chromium;
- Copper; and
- Zinc.

3.1.2.3 Natural sources of arsenic in the marine environment include (but are not limited to) remobilisation and erosion of arsenic-rich rocks (Research Council of Norway, 2012), which vary naturally according to local geology; anthropogenic sources include mining and smelting (Research Council of Norway, 2012), as well as the burning of fossil fuels (ICES, 2004). Due to the high natural occurrence of this metal, it is often difficult to precisely discern

between natural and anthropogenic sources of this metal (OSPAR, 2005). The arsenic concentrations (Table 4) were within the range reported for the southern North Sea: < 0.5 mg kg^{-1} to 135 mg kg^{-1} of dry weight arsenic (Whalley *et al.*, 1999). When considered within this context, the recorded data are considered typical for the region and not of particular note in terms of contamination.

3.1.2.4 Organotins including Tributyltin (TBT) has been used historically on ship hulls and other marine structures to prevent biofouling growth of aquatic organisms (Bryan *et al*, 1986). The use of TBT was prohibited in 1987, but has remained persistent within the marine environment with associated effects on ecology (such as imposex gastropods). Concentrations are typically highest in or near marinas and areas of higher shipping densities.

3.1.2.5 Lead typically enters the marine environment from the atmosphere via rainfall. However, oil and gas activities may result in elevated concentrations. The range in the North Sea is 0.02-0.1 µg l^{-1} (Cefas, 2001).

Table 4: Project specific metal contaminants data in the context of the Cefas Action Levels.

Location	Station	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Orgotins; TBT DBT MBT
CAL1 (mg/kg Dry Weight)		20	0.3	0.4	40	40	20	50	130	0.1
CAL1 (mg/kg Dry Weight)		100	3	5	400	400	200	500	800	1
Array	ENV1	5.9	0.02	0.05	5.8	5.9	2.9	3.8	11.3	<0.5
Array	ENV2	21	0.01	0.11	8.7	7.2	7.9	6.3	21	<0.5
Array	ENV4	4.4	0.01	0.06	8.1	7.1	4.2	5.1	15.1	<0.5
Array	ENV5	15.8	0.01	0.06	6.3	5.6	3.6	5.4	21.7	<0.5
Array	ENV6	10.9	0.01	0.06	6.9	6.1	3.5	5.1	16.8	<0.5
Array	ENV8	4.3	0.05	0.05	7.7	5.7	4	5.2	16.9	0.5
Array	ENV9	5.3	0.04	0.08	8.9	6.5	5.2	5.8	20.9	0.5
Array	ENV10	4.2	0.03	0.07	7.9	7.2	4	5.7	18.5	0.5
Array	ENV11	5	0.02	0.05	7.8	5.9	3.5	4.7	15.7	0.5
Array	ENV14	4.2	0.03	0.08	7.3	6.2	3.8	5.2	15.2	<0.5
Array	ENV15	7.2	0.03	0.07	9.5	6.2	4.1	7.2	19.5	<0.5
Array	ENV16	31.8	0.03	0.06	10	7.3	6	12.2	22.4	<0.5
Array	ENV17	24.2	0.05	0.05	13.5	6.5	8	10.8	24.8	0.6
Array	ENV18	13.7	0.02	0.06	6.4	6.2	5.2	6.8	23.1	<0.5
Array	ENV19	6.8	0.03	0.08	9.1	7.2	4.6	7.4	22.1	0.5
Array	ENV20	4.9	0.01	0.06	6.1	6.9	3.1	4.1	13.7	<0.5
Array	ENV21	7.5	0.02	0.05	10	6.2	4.3	7.6	17.7	<0.5
Array	ENV22	15.3	0.02	0.06	9.7	6.2	4.3	9.6	22.4	<0.5
Array	ENV23	6.1	0.02	<0.04	6.6	5	3.3	3.7	10.8	<0.5
Array	ENV24	20	<0.01	0.09	9.1	10.8	6.5	8.5	22.1	0.5
Array	ENV25	18.5	0.02	0.09	7.1	7.4	4.9	8	18.3	<0.5
ECC	ECC_01	5.6	<0.015	<0.04	6.9	5	3.8	5.1	17.9	<0.5

Location	Station	Arsenic	Mercury	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Orgotins; TBT DBT MBT
ECC	ECC_02	8.9	<0.015	<0.04	8.1	4.6	4.3	5.7	23.3	<0.5
ECC	ECC_03	4.2	<0.015	<0.04	7.1	5.6	3.7	5.5	22.6	<0.5
ECC	ECC_04	3.7	<0.015	<0.04	6.8	5.3	3.8	5.6	22.3	<0.5
ECC	ECC_05	4.9	<0.015	<0.04	8.1	6	4.6	6.9	21.1	<0.5
ECC	ECC_06	5.4	0.06	0.05	8.8	6.2	4.9	7.9	19.7	<0.5
ECC	ECC_07	4.6	<0.015	0.04	7	5.4	3.9	7.1	36.7	<0.5
ECC	ECC_08	5.4	<0.015	0.06	7.9	7	4.6	7.8	33.8	<0.5
ECC	ECC_09	7.8	<0.015	<0.04	9.7	6.3	5.3	8.3	25.9	<0.5
ECC	ECC_10	6.4	<0.015	<0.04	8.6	5.5	4.6	8.6	22.3	<0.5
ECC	ECC_11	5.3	<0.015	0.07	6.7	6	3.8	7	22.9	<0.5
ECC	ECC_12	9.4	<0.015	<0.04	7.2	4.8	3.9	7.6	16.4	<0.5
ECC	ECC_13	6	0.03	0.05	8	6.7	4.2	7.7	19.9	<0.5
ECC	ECC_14	48.7	<0.015	0.13	10.3	5.6	9.4	20.7	32.7	<0.5
ECC	ECC_15	18.7	<0.015	0.06	9.6	4.8	4.9	15.7	29.2	<0.5
ECC	ECC_16	20.2	<0.015	<0.04	9.5	5.5	6.1	18.8	31.6	<0.5
ECC	ECC_17	37	<0.015	0.04	12	5.6	7.5	35.6	35.2	<0.5
ECC	ECC_18	38	<0.015	0.08	14.4	7.2	10.8	25.3	43.8	0.5
ECC	ECC_19	24	0.03	0.13	17	11.5	13.3	41.9	68.2	1
ECC	ECC_20	23.3	0.02	<0.04	13.2	8.9	12.8	19	48.8	1
ECC	ECC_21	15.8	0.03	0.06	20.1	15.7	20.1	24.3	63	1.9
ECC	ECC_23	23.3	<0.015	0.06	6.9	6.6	9.6	9.2	34.5	1.1
ECC	ECC_24	17.2	<0.015	<0.04	8.5	6.6	7.5	17.7	43.6	1
ECC	ECC_25	15.4	0.04	<0.04	7.5	7.2	7.3	20.5	37.3	1
ECC	ECC_26	12.7	0.05	<0.04	7.2	6.7	6.5	18.7	38.6	0.9
ECC	ECC_27	14.1	0.1	<0.04	7.8	6.6	6.6	16.9	35.8	0.9

Below CAL1
Above CAL1 but below CAL2
Above CAL2

Table 5: Project specific metal contaminants data in the context of the ISQGs.

Location	Station	Arsenic	Mercury	Cadmium	Chromium	Copper	Lead	Zinc
ISQG TEL		7.24	0.13	0.7	52.3	18.7	30.2	124
ISQG PEL		41.6	0.7	4.2	160	108	112	271
Array	ENV1	5.9	0.02	0.05	5.8	5.9	3.8	11.3
Array	ENV2	21	0.01	0.11	8.7	7.2	6.3	21
Array	ENV4	4.4	0.01	0.06	8.1	7.1	5.1	15.1
Array	ENV5	15.8	0.01	0.06	6.3	5.6	5.4	21.7
Array	ENV6	10.9	0.01	0.06	6.9	6.1	5.1	16.8
Array	ENV8	4.3	0.05	0.05	7.7	5.7	5.2	16.9
Array	ENV9	5.3	0.04	0.08	8.9	6.5	5.8	20.9
Array	ENV10	4.2	0.03	0.07	7.9	7.2	5.7	18.5
Array	ENV11	5	0.02	0.05	7.8	5.9	4.7	15.7
Array	ENV14	4.2	0.03	0.08	7.3	6.2	5.2	15.2
Array	ENV15	7.2	0.03	0.07	9.5	6.2	7.2	19.5
Array	ENV16	31.8	0.03	0.06	10	7.3	12.2	22.4
Array	ENV17	24.2	0.05	0.05	13.5	6.5	10.8	24.8
Array	ENV18	13.7	0.02	0.06	6.4	6.2	6.8	23.1
Array	ENV19	6.8	0.03	0.08	9.1	7.2	7.4	22.1
Array	ENV20	4.9	0.01	0.06	6.1	6.9	4.1	13.7
Array	ENV21	7.5	0.02	0.05	10	6.2	7.6	17.7
Array	ENV22	15.3	0.02	0.06	9.7	6.2	9.6	22.4
Array	ENV23	6.1	0.02	<0.04	6.6	5	3.7	10.8
Array	ENV24	20	<0.01	0.09	9.1	10.8	8.5	22.1
Array	ENV25	18.5	0.02	0.09	7.1	7.4	8	18.3
ECC	ECC_01	5.6	<0.015	<0.04	6.9	5	5.1	17.9
ECC	ECC_02	8.9	<0.015	<0.04	8.1	4.6	5.7	23.3
ECC	ECC_03	4.2	<0.015	<0.04	7.1	5.6	5.5	22.6
ECC	ECC_04	3.7	<0.015	<0.04	6.8	5.3	5.6	22.3
ECC	ECC_05	4.9	<0.015	<0.04	8.1	6	6.9	21.1
ECC	ECC_06	5.4	0.06	0.05	8.8	6.2	7.9	19.7
ECC	ECC_07	4.6	<0.015	0.04	7	5.4	7.1	36.7
ECC	ECC_08	5.4	<0.015	0.06	7.9	7	7.8	33.8
ECC	ECC_09	7.8	<0.015	<0.04	9.7	6.3	8.3	25.9
ECC	ECC_10	6.4	<0.015	<0.04	8.6	5.5	8.6	22.3
ECC	ECC_11	5.3	<0.015	0.07	6.7	6	7	22.9
ECC	ECC_12	9.4	<0.015	<0.04	7.2	4.8	7.6	16.4
ECC	ECC_13	6	0.03	0.05	8	6.7	7.7	19.9
ECC	ECC_14	48.7	<0.015	0.13	10.3	5.6	20.7	32.7
ECC	ECC_15	18.7	<0.015	0.06	9.6	4.8	15.7	29.2
ECC	ECC_16	20.2	<0.015	<0.04	9.5	5.5	18.8	31.6
ECC	ECC_17	37	<0.015	0.04	12	5.6	35.6	35.2
ECC	ECC_18	38	<0.015	0.08	14.4	7.2	25.3	43.8

Location	Station	Arsenic	Mercury	Cadmium	Chromium	Copper	Lead	Zinc
ECC	ECC_19	24	0.03	0.13	17	11.5	41.9	68.2
ECC	ECC_20	23.3	0.02	<0.04	13.2	8.9	19	48.8
ECC	ECC_21	15.8	0.03	0.06	20.1	15.7	24.3	63
ECC	ECC_23	23.3	<0.015	0.06	6.9	6.6	9.2	34.5
ECC	ECC_24	17.2	<0.015	<0.04	8.5	6.6	17.7	43.6
ECC	ECC_25	15.4	0.04	<0.04	7.5	7.2	20.5	37.3
ECC	ECC_26	12.7	0.05	<0.04	7.2	6.7	18.7	38.6
ECC	ECC_27	14.1	0.1	<0.04	7.8	6.6	16.9	35.8

Below TEL
Above TEL but below PEL
Above PEL

3.1.3 Polycyclic aromatic hydrocarbons

3.1.3.1 It should be noted that there are no Cefas Action Levels of PAHs (see Section 1). There are no exceedances of the TEL threshold for any of the PAHs within the array (Table 6). There are three sites (ECC_19 to ECC_21) along the ECC where numerous PAHs are recorded between TEL and PEL (Table 6).

3.1.3.2 As noted in paragraph 2.1.7.10 of Volume A2, Chapter 2: Benthic and Intertidal Ecology (APP-014), Gas Chromatography traces across the array area were generally indicative of background levels of hydrocarbons in areas of historic oil and gas exploration and suggested a mixture of petrogenic and pyrogenic sources.

Table 6: Project specific PAHS contaminants data in the context of the ISQGs.

Location	Station	Polyaromatic hydrocarbons (PAH) (ug/ kg)											
		Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene
ISQG TEL		6.71	5.87	46.9	74.8	88.8	108	6.22	113	21.2	34.6	86.7	153
ISQG PEL		88.9	128	245	693	763	846	135	1,494	144	391	544	1,398
Array	ENV1	<1	<1	<1	<1	<1	1	<1	2	<1	<1	1	1
Array	ENV2	<1	<1	<1	1	1	3	<1	3	<1	<1	3	2
Array	ENV4	<1	<1	<1	2	2	3	<1	5	<1	2	5	4
Array	ENV5	<1	<1	<1	1	1	2	<1	4	<1	<1	2	2
Array	ENV6	<1	<1	<1	<1	<1	2	<1	2	<1	<1	2	2
Array	ENV8	<1	<1	<1	1	2	2	<1	3	<1	1	2	2
Array	ENV9	<1	<1	<1	2	3	3	<1	5	<1	2	4	4
Array	ENV10	<1	<1	<1	3	3	4	<1	5	<1	2	4	4
Array	ENV11	<1	<1	<1	1	2	2	<1	3	<1	<1	2	2
Array	ENV14	<1	<1	<1	<1	1	1	<1	2	<1	<1	2	2
Array	ENV15	<1	<1	<1	3	3	4	1	5	<1	2	4	4
Array	ENV16	<1	<1	<1	2	3	4	1	5	<1	2	5	4
Array	ENV17	<1	<1	1	4	5	6	2	8	1	5	8	6
Array	ENV18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Array	ENV19	<1	<1	<1	2	3	4	1	5	<1	2	5	4
Array	ENV20	<1	<1	<1	<1	<1	1	<1	1	<1	<1	1	1
Array	ENV21	<1	<1	<1	2	2	3	<1	4	<1	2	3	3
Array	ENV22	<1	<1	<1	1	2	2	<1	3	<1	1	2	2
Array	ENV23	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Array	ENV24	<1	<1	<1	1	1	2	<1	2	<1	1	6	2
Array	ENV25	<1	<1	<1	<1	<1	1	<1	1	<1	<1	2	1
ECC	ECC_01	<1	<1	<1	1.86	2.24	3.35	<1	3.99	<1	2.16	5.98	<1
ECC	ECC_02	<1	<1	<1	<1	<1	1.66	<1	2.38	<1	<1	2.19	<1
ECC	ECC_03	<1	<1	<1	1.36	1.72	2.24	<1	3.04	<1	1.42	2.68	<1
ECC	ECC_04	<1	<1	<1	1.35	1.78	2.25	<1	2.95	<1	<1	3.27	<1
ECC	ECC_05	<1	<1	<1	1.35	1.63	2.26	<1	3.08	<1	<1	2.56	<1
ECC	ECC_06	<1	<1	<1	1.6	2.06	2.75	<1	3.75	<1	1.68	3.64	<1
ECC	ECC_07	<1	<1	<1	2.45	2.7	3.97	<1	5.46	<1	2.18	4.67	<1
ECC	ECC_08	<1	<1	<1	3.58	4	5.8	1.32	7.89	<1	3.47	7.46	1.77
ECC	ECC_09	<1	<1	<1	2.69	2.87	4.59	<1	5.94	<1	3.3	8.09	<1
ECC	ECC_10	<1	<1	<1	3.12	3	4.93	<1	6.83	<1	2.77	8.06	<1
ECC	ECC_11	<1	<1	<1	2.02	2.22	3.33	<1	4.33	<1	1.41	4.59	<1
ECC	ECC_12	<1	<1	<1	2.16	2.23	3.45	<1	4.53	<1	1.94	5.08	<1

Location	Station	Polyaromatic hydrocarbons (PAH) (ug/ kg)											
		Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Naphthalene	Phenanthrene	Pyrene
ECC	ECC_13	<1	<1	<1	1.51	1.81	2.38	<1	3.42	<1	1.64	2.75	<1
ECC	ECC_14	<1	<1	<1	1.08	<1	1.85	<1	2.66	<1	<1	1.61	<1
ECC	ECC_15	<1	<1	<1	3.31	2.99	5.2	<1	7.92	<1	2.84	9.25	<1
ECC	ECC_16	<1	<1	<1	2.02	2.17	3.65	<1	4.23	<1	3.45	6.42	<1
ECC	ECC_17	<1	<1	<1	3.42	3.33	5.25	<1	6.22	1.3	5.95	10.2	<1
ECC	ECC_18	1.92	3.52	6	18.2	17.6	25.1	3.58	29.1	6.12	26.2	58.5	4.2
ECC	ECC_19	5.06	10.3	15	49.1	46.5	58.3	9.65	82.4	18.5	75.6	93.1	11.1
ECC	ECC_20	6.75	17.7	30.3	93	81.7	117	14.3	157	29.1	114	258	19.2
ECC	ECC_21	7.11	15.6	24	73.1	67.1	88.3	13.3	118	29.2	123	149	15.4
ECC	ECC_22	<1	<1	1.66	4.63	4.14	6.46	<1	8.45	1.57	8.73	12	<1
ECC	ECC_23	<1	<1	<1	3.85	3.34	7.55	<1	9.25	<1	3.97	6.39	1.35
ECC	ECC_24	<1	<1	1.44	4.4	4.28	7.15	<1	8.81	1.47	5.7	9.91	1.37
ECC	ECC_25	<1	<1	<1	3.3	3.12	6.18	<1	7.01	<1	4.39	7.65	<1
ECC	ECC_26	<1	<1	3.5	8.66	8.3	11.4	1.52	15.9	<1	5.01	8.73	2.58

Below detection limit
Below TEL
Between TEL and PEL
Above PEL

4 Release of sediment bound contaminants

4.1 Introduction

4.1.1.1 This section has collated information for numerous documents provided in the Applicant's DCO Application to provide assurance that significant effects (in EIA terms) will not result from the disturbance of contaminated sediments as a result of Hornsea Four alone or cumulatively. It is the Applicant's position that the findings of the assessments in the Applicant remain valid and proportionate to the degree of risk. In addition, that no further measures are required.

4.1.1.2 As noted in Section 6.2 of **Volume A4, Annex 4.4: Dredging and Disposal (Site Characterisation) (APP-042)** and **Section 0**, the chemical composition of the material being disturbed and disposed of and concluded that the sediment was considered to be at background levels for the region. As such this Section only considers contaminates either above CAL1 or the ISQG TEL, namely:

- Arsenic;
- Lead;
- Organotins; and

- PAHs.

4.2 Project alone

4.2.1.1 A precautionary assessment of the release of EQSD substances was presented in Section 7.2 of **Volume A5, Annex 2.2: Water Framework Directive Assessment (APP-069)**. This assessment, whilst assessing changes in water quality in the designated waterbodies also is explicable to the remainder of the ECC and array. The WFD assessment stated that activities which disturb the seabed have the potential to remobilise contaminants bound in the sediment back into the water environment. Following disturbance as a result of construction activities, the majority of resuspended sediments are expected to be deposited in the immediate vicinity of the works.

4.2.1.2 Project specific modelling was undertaken to understand the SSC plume dynamics including lateral and vertical dilution as well as temporal nature of the plumes. The key findings of the modelling are presented in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes (APP-013)** and are summarised in **Table 7**. The results from the project specific modelling can be used to infer the number and rate of dilutions which would be achieved by any released contaminants as a result of the proposed activities. The release of contaminants, such as arsenic and Polycyclic Aromatic Hydrocarbons (PAHs), are likely to be rapidly dispersed with the tide and/ or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects is not expected. The levels of contaminants within the length of the offshore ECC are all comparable to the wider regional background and not considered to be of a low quality that may result in a significant effect-receptor pathway if made bioavailable.

4.2.1.3 In addition, under normal circumstances, very small concentrations of contaminants enter to the dissolved phase, with the vast majority adhering to the sediment particles when temporarily entering suspension in the water column. Partition coefficients may be applied to estimate the concentration of the contaminants entering the dissolves phase which typically result in a reduction of several orders of magnitude than the concentrations associated with suspended sediments.

4.2.1.4 Therefore, for these reasons the findings of the benthic ecology assessment remains valid. The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. The magnitude is therefore, considered to be **negligible**. Irrespective of the sensitivity of the receptor, the significance of the impact is **not significant** as defined in the assessment of significance matrix and is therefore not considered further in this assessment.

Table 7: Temporary increases in SSC and sediment deposition as a result of construction activities at Hornsea Four.

Construction Impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
Sandwave clearance	Nearshore ECC / cable crossing	10 km (springs) and 6 km (neaps)/ 14 km (springs) and 6 km (neaps)	• SSCs within sediment plumes associated with overspill can be in the order of hundreds of mg/l in the vicinity of the dredger, reducing to tens of mg/l with distance, but also quickly dissipating in time after release; • The deposition of fine sediment under low flow conditions is predicted to be less than 2 mm from overspill; • Dredge spoil disposal plume concentrations remain less than 10 mg/l for all locations 2 km beyond the point of release and are not detectable after about 20 hours; and • The depth of spoil deposition (for all sediments) is typically very small (around 0.1 mm) but reaches 5.9 cm for the spring tide in a confined area and 10 cm for a neap release. These depths of deposition cover a very small area and are due to coarser grained sediments (gravels).
Offshore trenching for cables	Offshore ECC	4 km along the axis of the tide	• Within 5 m of trenching very high plume concentrations are expected. SSC could be millions of mg/l. This is only expected to occur while the CFE is active; • At 2 km from the source, the silt content will be approximately 100 mg/l during the trenching period and will fully dissipate and will fully dissipate after around 65 hours; and • The maximum depth of deposition is 0.1 m to 0.12 m within the cable crossing area and 0.13 m to 0.14 m within the inshore cable route. The maximum settlement depth reduces exponentially in range from the trench reaching 0.12 m at 50 m and 0.06 m at 100 m, for a 6 m^2 trench.

4.3 Cumulative effects assessment

4.3.1.1 As presented in Section 4.2, the levels of contaminants within the Hornsea Four Order Limits are all comparable to the wider regional background and not considered to be of a low quality that may result in a significant effect if made bioavailable. The vast majority of contaminants will adhere to the sediment particles when temporarily entering suspension in the water column.

4.3.1.2 Rapid dispersion and high dilution of contaminants will occur. Therefore, in the unlikely event that sediment plumes from two projects overlap the concentrations of released contaminants, whilst additive, will not be discernible from background levels. Therefore, the

of the cumulative impact on benthic ecology is therefore **negligible**. Irrespective of the sensitivity of the receptors, the significance of the cumulative impact **not significant** as defined in the assessment of significance matrix. Therefore, this assessment was not presented in the Applicant's EIA.

5 Conclusions

5.1.1.1 This clarification note has been prepared to provide a detailed response to the Relevant Representations made by the MMO and Natural England. This note aims to provide sufficient information to provide confidence for the regulators that the potential for the release of contaminants in the marine environment has been adequately considered in the Applicant's DCO Application.

5.1.1.2 This note has sought to collate information from the relevant DCO Application documents to provide a summary of the information presented within. The collated information is intended to provide the MMO and Natural England with sufficient information to provide sufficient comfort that sediment bound contaminants are not a matter for concern.

5.1.1.3 It is the Applicant's position that the findings of the assessments in the Applicant remain valid and proportionate to the degree of risk. In addition, that no further measures are required.

6 References

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