TR483 SYNTHESIS OF EVIDENCE FOR SZC WATER FRAMEWORK DIRECTIVE (WFD) AND HABITATS REGULATIONS ASSESSMENT (HRA) MARINE ASSESSMENTS VERSION 6

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1	08/03/2019	Holly Buckley	Senior Marine Ecologist	Chris Jenkins	Energy Portfolio Director	Brian Robinson	Director
2	22/03/2019	Holly Buckley	Senior Marine Ecologist	Chris Jenkins	Energy Portfolio Director	Brian Robinson	Director
3	28/03/2019	Holly Buckley	Senior Marine Ecologist	Chris Jenkins	Energy Portfolio Director	Brian Robinson	Director
4	16/08/2019	M. Breckels S. Wallbridge	Marine Ecology Lead / Senior Scientist Coastal Processes			Brian Robinson	Director
5	17/04/2020	M. Breckels H. Buckley	Marine Ecology Lead/ Senior Marine Ecologist			Not Submitted	Not Submitted
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Revision	Purpose	Amendment	By	Date
1.00	Submission to EDFE	Submission to EDFE (WFD section only)	Holly Buckley	08/03/2019
2.00	Submission to EDFE	Submission to EDFE with HRA section	Holly Buckley	22/03/2019
3.00	Submission to EDFE	Submission to EDFE with updated HRA section (incorporating updated HRA screening report)	Holly Buckley	28/03/2019
4.00	Submission to EDFE	Submission to EDFE with updated results for underwater noise assessments, dredge plume modelling, coastal processes, and water quality.	Mark Breckels and Steven Wallbridge	16/08/2019
5.00	Update content for DCO.	Submission to EDFE with updates to hydrazine commissioning discharges, syntheses and areas of overlap with concentrated bird foraging activity included.	Mark Breckels and Holly Buckley	Not submitted.
6.00	Update content post DCO submission.	Additional new evidence and assessments following stakeholder comments.	Holly Buckley	15/12/2020

Synthesis of evidence for SZC Water Framework Directive (WFD) and Habitats Regulations Assessment (HRA) marine assessments Version 6

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Holly Buckley

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	Version	Author	Date
Draft	0.01	Holly Buckley	01/02/2019
Internal QC	0.02	Chris Jenkins	06/02/2019
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Incorporation of HRA evidence	1.01	Holly Buckley	15/03/2019
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Revision – incorporating modelling and assessment updates	4.01	Mark Breckels & Holly Buckley	17/04/2020
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Revision – incorporating assessment updates following Supplementary Fish Package.	5.01	Holly Buckley	04/12/2020
Internal QC	5.02	Mark Breckels	15/12/2020
Executive QC & Final Draft	5.03	Brian Robinson	15/12/2020
Submission to EDFE	6.00		15/12/2020

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Executive summary

This synthesis of evidence is intended to provide detail on the potential impacts of the construction, commissioning, and operational activities of the proposed Sizewell C New Nuclear Build (SZC NNB). It provides the evidence base, and acts as a signpost for the relevant technical reports, for the marine elements of the Water Framework Directive (WFD) assessment and Habitats Regulation Assessment (HRA) for the proposed development. In the case of decommissioning of the proposed development, it is necessary to obtain prior consent from the Office for Nuclear Regulation (ONR) and undertake a separate EIA at the time of submission. A further assessment of decommissioning will be made based on the available technology, methods of decommissioning, and baseline environmental conditions at the time, following a process of consultation. Decommissioning is beyond the scope of this report.

This report incorporates all the latest marine evidence up to 4 December 2020. The report does not provide evidence for the changes to the marine freight options including the enhanced permanent BLF or temporary BLF plans.

Potential effects identified that relate to the WFD marine assessment are summarised as follows:

Sizewell C construction

- Localised hydrological changes in water depth as a result of scour around permanent infrastructure (e.g., cooling water infrastructure, nearshore outfalls and the beach landing facility (BLF)) and as a result of dredging that is undertaken to enable navigational access and berthing of vessels at the BLF.
- A change in substrate where the overlying sediment has been removed and scoured down to different sedimentary material or rock, or where scour protection is used, which introduces hard substrate.
- Changes in wave energy and bed shear stress when the BLF is in use (as a result of the dredged / reprofiled seabed).
- Localised effects on obligate benthic suspension feeders from increases in suspended sediment concentration (SSC) during dredging and disposal activities.
- Areas above the relevant environmental quality standard (EQS) for chromium and zinc during dewatering of the main development site (MDS).
- Nutrient enrichment and un-ionised ammonia from construction discharges.
- Discharges of tunnelling chemicals, which may be used during tunnelling for the cooling water infrastructure (including tunnel boring machine (TBM) chemicals and the drilling mud bentonite).

Sizewell C Commissioning

- Commissioning discharges during cold flush testing would be discharged from the combined drainage outfall (CDO), within the WFD waterbody, including hydrazine, which is assessed.

Sizewell C Operation

- Localised changes in water depth as a result of scour around permanent infrastructure [e.g., cooling water intakes and outfalls, beach landing facility (BLF)) and as a result of dredging that is undertaken to enable navigational access and berthing of vessels at the BLF.
- A change in substrate where the overlying sediment has been removed and scoured down to different sedimentary material or rock, or where scour protection is used, which introduces hard substrate.
- Localised changes in wave energy and bed shear stress due to bed reprofiling when the BLF is in use.
- Localised reductions in phytoplankton productivity from entrainment and operational discharges.
- Localised effects on obligate benthic suspension feeders from increases in suspended sediment concentration (SSC) during dredging activities associated with occasional usage of the BLF.
- Areas above the relevant environmental quality standards from cooling water discharges including temperature, total residual oxidants (TRO), bromoform and hydrazine.
- Potential thermal barriers to fish migration in the mouth of the Blyth and Alde-Ore estuaries.

Potential effects identified that relate to the HRA marine assessments are summarised as follows:

Sizewell C Construction

- Localised temporary displacement of acoustically sensitive fish species and marine mammals as a result of increases in underwater noise during piling and dredging activities.
- Direct habitat loss/change from dredging, drilling and piling activities.
- Areas above the relevant EQS for chromium and zinc during dewatering of the MDS.
- Nutrient enrichment and un-ionised ammonia from construction discharges.
- Discharges of tunnelling chemicals, which may be used during tunnelling for the cooling water infrastructure (including TBM chemicals and the drilling mud bentonite).

Sizewell C Commissioning

- Commissioning discharges during cold flush testing would be discharged from the CDO, within the WFD waterbody, including hydrazine, which is assessed.
- The potential for overlap with foraging ranges of designated species and/or potential to cause prey avoidance is considered.

Sizewell C Operation

- Areas above the relevant EQS from cooling water discharges including temperature, TRO, bromoform and hydrazine.
- Localised displacement of fish as a prey species due to the thermal and chemical plumes.

- Mortality of fish populations (as prey species for designated features) due to impingement in the context of natural variability and stock sizes.
- Direct habitat loss/change from occasional dredging activities associated with the BLF.
- Under a future baseline scenario - disruption to sand and shingle transport following exposure of the hard coastal defence feature that may require intervention (bypassing, beach recycling or beach recharge) to prevent or minimise any disruption. The potential for impacts on SAC designated annual vegetation of drift lines habitat are considered.
- Consideration of potential for impacts from the HCDF following cessation of mitigation (intervention).

Version History

V1 dated 08/03/2019

Collated evidence from technical reports listed in Section 1.1 for WFD marine assessment only.

V2 dated 22/03/2019

Collated evidence from technical reports listed in Section 1.1 for WFD and HRA marine assessments.

V3 dated 28/03/2019

Incorporation of updated HRA LSE screening report (see Appendix A).

V4 dated 16/08/2019

Incorporation of updated results for underwater noise assessments, dredge plume modelling, coastal processes, and water quality assessments. Version 4 of this report of 16/08/2019 formed the basis for the DCO submission.

V5 dated 17/04/2020 (not submitted)

Updated for final DCO evidence including Synthesis for Environmental Impact Assessment (MSR1 - BEEMS Technical Report TR311 ED. 4) and Sizewell Marine Water and Sediment Quality Synthesis (BEEMS Technical Report TR306 Edition 5) and Sizewell - Discharges H1 type assessment supporting data report. (BEEMS Technical Report TR193. Edition 5).

Specific changes included incorporation of updates to hydrazine commissioning discharges and updated areas of overlap with bird foraging activity.

Version 5 was not submitted due to ongoing stakeholder consultation particularly in relation to fish receptors.

V6 dated 15/12/2020

Version 6 of this report has been updated following stakeholder consultation, Marine Technical Forum (MTF) meetings and initial responses to Relevant Representations provided on the 30th September 2020.

It provides additional evidence based on a series of supplementary reports to support the evidence base for assessments:

1. Impingement predictions for Sizewell C have been revised following the DCO Application based on meetings and written comments from statutory stakeholders. Notable changes to BEEMS Technical Report TR406.v7 include updated Sizewell B impingement predictions using a bootstrapping approach, akin to the methods employed at Hinkley Point C, with an additional step to account for periods when sampling was not possible due to station outages and a new local effects assessment. An update to expected performance of the Low Velocity Side Entry (LVSE) head has also been applied. The updated evidence has in some cases resulted in changes to absolute impingement predictions, however in terms of numbers and biomass, the scales of effects have not altered, and the conclusions remain unchanged.
2. A series of new Scientific Position Papers provides the evidence base that underpins edits to TR406.v7, these include:
    - SPP100 - Estimates of European populations of twaite shad and cucumber smelt of relevance to Sizewell. Shad and smelt population numbers were updated after further analyses but these changes made no significant difference to the conclusions in TR406.
    - SPP101 - Implications of tidal elevation and temperature on smelt, *Osmerus eperlanus*, impingement at Sizewell (see Section 3.4.1.6 and 4.4.3.1 for evidence updates).
    - SPP102 - Use of Spawning Production Foregone EAVs for impingement assessment. This report demonstrates that the use of the Spawning Production Foregone (SPF) EAV does not enhance the quality or reliability of the Sizewell C fish abstraction assessment.
    - SPP103 - Consideration of potential effects on selected fish stocks at Sizewell (see Section 3.4.2.4 and 4.8.1.1 for evidence updates).
    - SPP104 - Worst case glass eel entrainment assessment for Sizewell C. Overall conclusion unchanged that entrainment in SZC would have a negligible effect on the sustainability of local eel populations.
    - SPP108 - Sensitivity of the Alde Ore Transitional Fish Classification Index (TFCI) to changes in smelt, *Osmerus eperlanus*, abundance (see Section 3.4.2.4 for evidence updates).
3. TR520 (updated version of existing report) - Sizewell C Water quality effects of the fish recovery and return system. Small numerical changes to discharge source terms. No changes to the previously reached conclusions of no adverse effects of the Fish Recovery and Return (FRR) discharge on local receptors.

1 Background

EDF Energy proposes to construct and operate a new nuclear power station (new nuclear build, or NNB) immediately to the north of the existing Sizewell B station on the Suffolk coast. Under the Planning Act 2008, this development, as with other nationally-significant infrastructure projects, requires a Development Consent Order (including, in the case of conservation areas, a Habitats Regulations Assessment) to be granted by the UK Government's Planning Inspectorate. The marine aspects of the development will also require regulatory permits for, amongst other activities, cooling water discharges and activities that disturb the seabed. Decisions on permissions will be taken based on an Environmental Impact Assessment (EIA) encompassing the key ecological features of the site and including all marine activities associated with the development.

The EU Water Framework Directive was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The WFD relates to improving and protecting the chemical and ecological status of surface waters throughout a river basin catchment from rivers, lakes and groundwaters through to estuaries (transitional) and coastal waters to one nautical mile out to sea (three nautical miles in Scotland). The requirements of the Directive need to be considered at all stages of the river and coastal planning and development process. To meet the requirements of the WFD, the competent authority (the Environment Agency) has set Environmental Objectives for each water body. A default objective in all water bodies is to achieve 'good' status and prevent deterioration in either the 'Ecological Status' (for natural water bodies) or the 'Ecological Potential' (for heavily modified or artificial water bodies). For surface waters, there are two separate classifications for water bodies; ecological and chemical. For a water body to be in overall 'good' status, both ecological and chemical status must be at least 'good'.

The ecological status of a surface water body is assessed according to:

a. the condition of relevant biological quality elements, for example fish, benthic invertebrates, phytoplankton and other aquatic flora dependent upon the water body type;
b. the condition of supporting physico-chemical elements, for example temperature, pH, oxygenation, salinity and concentrations of nutrients;
c. the concentrations of specific pollutants; and,
d. the condition of the hydromorphological quality elements, including morphological condition, hydrological regime and tidal regime (coastal waters only).

Chemical status is assessed by compliance with environmental standards for the priority chemicals that are listed in the EC Environmental Quality Standards Directive (2008/105/EC) as amended by Directive 2013/39/EU (implemented by the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015), which increased the list of priority chemicals to 45. Chemical status is recorded as 'good' or 'fail'. The chemical status classification for the water body is determined by the worst scoring chemical.

The EU Birds and Habitats Directives (EC Directive on the Conservation of Wild Birds (2009/147/EC) and EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) were transposed into law in England and Wales by the Conservation of Habitats and Species Regulations 2017 and The Offshore Marine Conservation Regulations 2017. The competent authority must carry out an appropriate assessment (AA) as part of a Habitat Regulations assessment (HRA) if a plan/project is likely to have a likely significant effect on a European Marine Site (EMS) alone or in-combination. HRAs must consider potential effects upon:

a. ornithological interests – designated species populations of SPAs, possible SPAs (pSPAs) if appropriate and Ramsar sites, including rare and vulnerable birds (as listed on Annex I of the Birds Directive), regularly occurring migratory species and species forming designated assemblages (including impacts on those species that are designated as a feature of a SPA/Ramsar, and that may be affected outside of the boundaries of designated sites);
b. SACs and candidate SACs (SACs), if appropriate, (as listed in Annex I of the Habitats Directive);
c. SAC designated species populations (as listed in Annex II of the Habitats Directive);
d. habitats and species populations of Ramsar sites not covered under SPA and SAC designations; and,
e. supporting species and habitats in those cases where there are potential impacts upon designated features through indirect effects (e.g. prey species).

This synthesis of evidence is intended to provide detail on the potential impacts from activities during the construction, commissioning, and operational phases of the proposed Sizewell C New Nuclear Build (SZC). It is intended to provide the evidence base allowing technical assessments to be made for the marine elements of the Water Framework Directive (WFD) assessment and Habitats Regulation Assessment (HRA) for the proposed development. The report also signposts the key Technical Reports for assessment purposes.

The evidence base presented here does not include the Sizewell C decommissioning. Details of the decommissioning engineering works are not presently defined and will be subject to a separate environmental assessment at that time. Impacts from the decommissioning phase considered herein are limited to the presence of the hard coastal defence feature (HCDF), which will remain in place throughout the site lifetime as the only point of contact between the main development site and the future marine environment.

The marine components of the development site include:

1. Coastal Defence Features.

2. Beach Landing Facility (BLF).

3. Cooling Water Infrastructure including Intakes and Outfall headworks.

4. Fish Recovery and Return (FRR) systems.

5. Combined Drainage Outfall (CDO).

The components of the Main Development Site that could impact designated nature conservation sites under The Conservation of Habitats and Species Regulations (2017) or designated waterbodies under The Water Environment (Water Framework Directive) England and Wales Regulations (2017) are as follows:

During construction and commissioning

- Changes in water turbidity (cloudiness) and quality (contaminant mobilisation) due to the re-suspension of marine sediments into the water column during the construction of the cooling water intake and outfall vertical shafts and head structures, the FRR systems, the CDO, and the BLF.
- Localised changes in water depth will occur as a result of dredging that is undertaken to enable berthing and access of vessels at the BLF.

- Heavy plant movements associated with the construction of the BLF and the soft coastal defences could cause localised compaction. Access routes across the beach berm could result in berm lowering and potential sites for overtopping during storm events if temporary plastic-track roadways are not installed.
- Discharges to surface waters that enter the marine environment that include surface water drainage containing suspended sediment, contaminants and treated sewage effluent (from the CDO). All such discharges would have an appropriate level of treatment before discharge to the marine environment.
- Potential changes to marine water quality because of chemicals that are used in the commissioning.

During operation

- Discharge of treated sewage effluent to sea would occur via the Main Development Site cooling water system.
- The elevated temperature of the cooling water effluent would alter the thermal regime near the discharge point.
- Potential changes may occur to marine water quality because of process chemicals that will be used in the operation of the Main Development Site and that are discharged in the cooling water effluent.
- The occasional need to access the BLF to receive deliveries of Abnormal Indivisible Loads (AILs) by sea during the operational life of the power station would require dredging resulting in localised changes in water turbidity (cloudiness) and quality (contaminant mobilisation) due to the re-suspension of marine sediments into the water column.
- Localised changes in water depth will occur as a result of scour around permanent (e.g. cooling water, BLF) infrastructure. A change in substrate could occur where the overlying sediment has been removed and scoured down to different sedimentary material or rock, or where scour protection is used, which introduces hard substrate.
- The BLF including dredge channel, when in use, would cause localised changes in wave energy.

Some of the potential effects of the Main Development Site on designated nature conservation sites and designated waterbodies are dependent upon the engineering designs of specific coastal infrastructure and Marine Licence requirements.

1.1 Feeder Reports

The synthesis of evidence for SZC WFD and HRA marine assessments is primarily based on information gathered by Cefas under the BEEMS marine evidence programme (the BEEMS Technical Reports, or ‘feeder reports’). For this synthesis, the key BEEMS reports forming the main basis of the assessments are the marine water and sediment quality synthesis, the coastal geomorphology and hydrodynamics synthesis, ecological characterisations and selected modelling reports. These, in turn, reference earlier BEEMS Technical Reports containing detailed methods and data analyses from the BEEMS surveys, experiments and modelling.

The main feeder reports are as follows with the primary reference documents in bold:

- **Sizewell Coastal Geomorphology and Hydrodynamics: Synthesis for Environmental Impact Assessment (MSR1 – Edition 4). BEEMS Technical Report TR311 ED. 4.**

- **Sizewell Marine Water and Sediment Quality Synthesis. BEEMS Technical Report TR306 Edition 5.**
- **Sizewell - Discharges H1 type assessment supporting data report. BEEMS Technical Report TR193. Edition 5.**
- Underwater noise effects assessment at Sizewell C. BEEMS Technical Report TR312. Edition 2 (version 5).
- Modelling of sediment dispersion of dredge material from Sizewell C construction and operation. BEEMS Technical Report TR480 (version 3).
- Sizewell phytoplankton status under the Water Framework Directive (WFD). BEEMS Technical Report TR476.
- Sizewell characterisation report – phytoplankton. BEEMS Technical Report TR346. Edition 2 (version 4).
- Sizewell benthic ecology characterisation. BEEMS Technical Report TR348 (version 3).
- Sizewell characterisation report – fish. BEEMS Technical Report TR345 (version 4).
- Sizewell marine mammal characterisation. BEEMS Technical Report TR324 (version 4).
- Sizewell Entrainment Predictions. BEEMS Technical Report TR318 (version 6).
- Sizewell C – Impingement predictions based upon specific cooling water system design. BEEMS Technical Report TR406 (version 7).
- Sizewell C – Sizewell C offshore acoustic *Sabellaria spinulosa* survey: August 2019. BEEMS Technical Report TR512.

2 Description of the marine components of the proposed Sizewell C development

This section details the development's marine components - the beach landing facility (BLF), coastal defence feature(s), cooling water system, and associated activities for their construction and operation. The marine components illustrated in Figure 1.

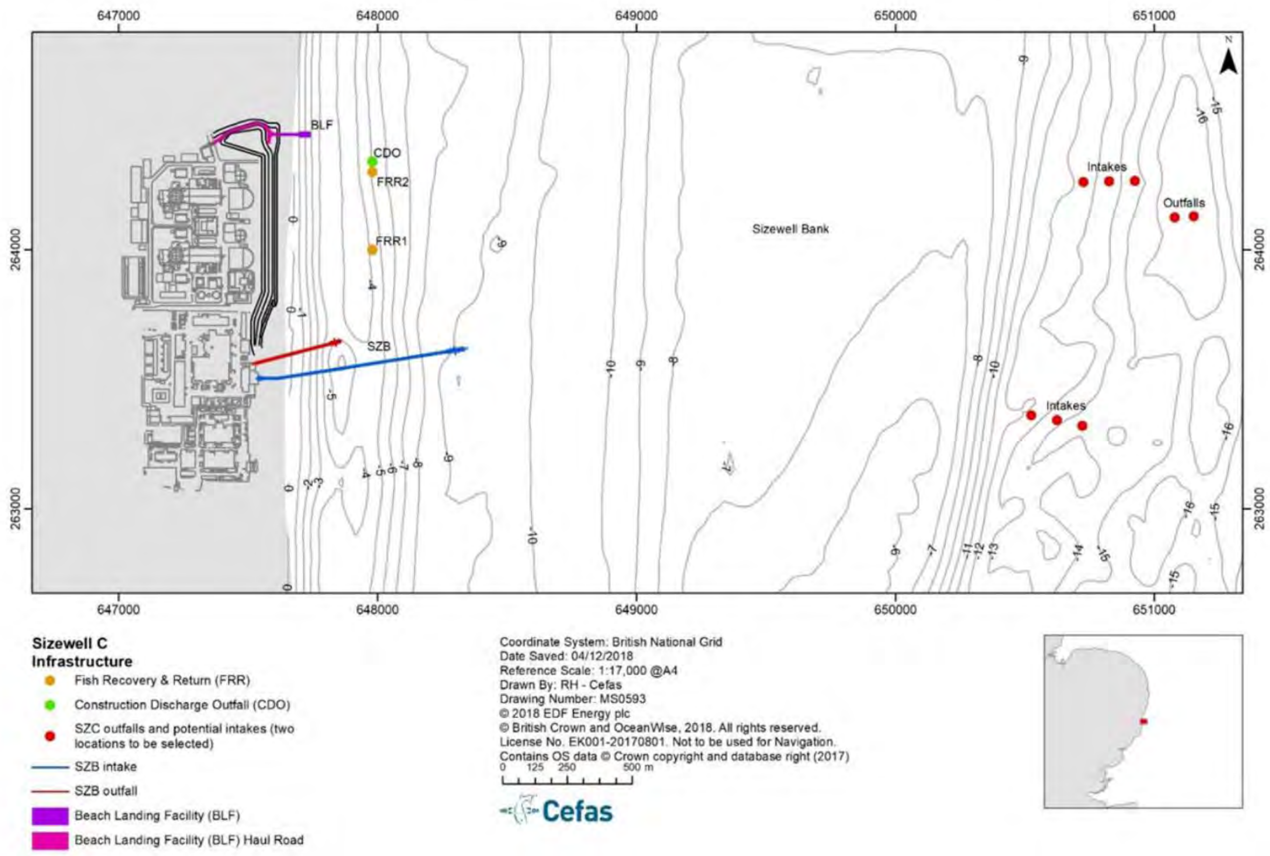

Figure 1: Schematic of development locations in the marine environment overlaid on bathymetry, blue indicates intake tunnels, red indicates outfall. Intake and outfall tunnels would be subterranean.

2.1 Beach Landing Facility (BLF)

The BLF would be used to receive large deliveries (including AILs) to Sizewell C by barge. On approach the barge would be assisted by tugs, and moor at the end of the BLF at high water: as the water level drops, the barge would ground. Deliveries would then be transported to site along the BLF access road. The BLF would be used throughout the construction phase and would facilitate occasional AIL deliveries during the operational life of the station, approximately every 5-10 years.

The BLF would consist of a piled platform, ramp, fenders and mooring dolphins. The final four pile pairs are within the marine environment below MHWS (Figure 2) - one pair is close to the low tide mark, and three pairs are seaward of low tide. Therefore, two fenders would be piled at the end of the BLF and two mooring dolphins would be positioned at approximately 66 m and 128 m from MHWS. For assessment purposes piles are assumed to be approximately 1 m in diameter and the fender/dolphin piles would be 1.5 m in diameter. A total of 12 piles would be installed within the marine environment below MHWS with the deepest pile located in a water depth of approximately -3 m ODN.

The landward sections of the BLF jetty would be constructed by a terrestrial piling machine operating from land or the BLF jetty itself using a cantilever approach. The marine piling would be undertaken using the cantilever method or a walking jack-up barge or similar (e.g., WaveWalker). Dolphins would be installed from a standard or walking jack-up barge (BEEMS Technical Report TR311 Ed. 4).

2.1.1 Piling

Impact piling is the anticipated method for installing the 12 marine piles. Indicative piling specifications are:

- Maximum hammer energy of 90 kJ.
- Strike rate of 46 strikes per minute.
- Each pile would require approximately 1,500 hammer blows to install (lasting 33 minutes).
- A maximum of 5 piles would be installed in each 24-hour period (the timeframe for cumulative noise assessments).

It is envisaged that a 20-minute soft start/ ramp up would be implemented where technically feasible, resulting in a total piling time of approximately 50 minutes per pile.

Underwater noise modelling was undertaken to determine the potential effects of pilling on marine mammals and fish species at Sizewell (BEEMS Technical Report TR312 Ed. 5). Assessments modelled the indicative piling specifications provided and incorporated an additional 200kJ hammer energy option, with the same total number of hammer blows to represent a precautionary scenario and to envelope potential engineering options.

Piling activities will conform to best environmental practice in accordance with JNCC guidelines (JNCC, 2010) to mitigate effects on marine mammals. A Marine Mammal Mitigation Protocol (MMMP) has been prepared to be submitted as part of the DCO application (BEEMS Technical Report TR509).

2.1.2 Dredging

To accommodate the safe passage of barges and accompanying tugs to the BLF, a navigational channel and grounding area would be required in the nearshore zone occupied by the two longshore bars.

Plough dredging would be used to create a planar surface for the barges to come aground. Plough dredging agitates the sediment, which is then transported away by the tide, the sediment is not removed.

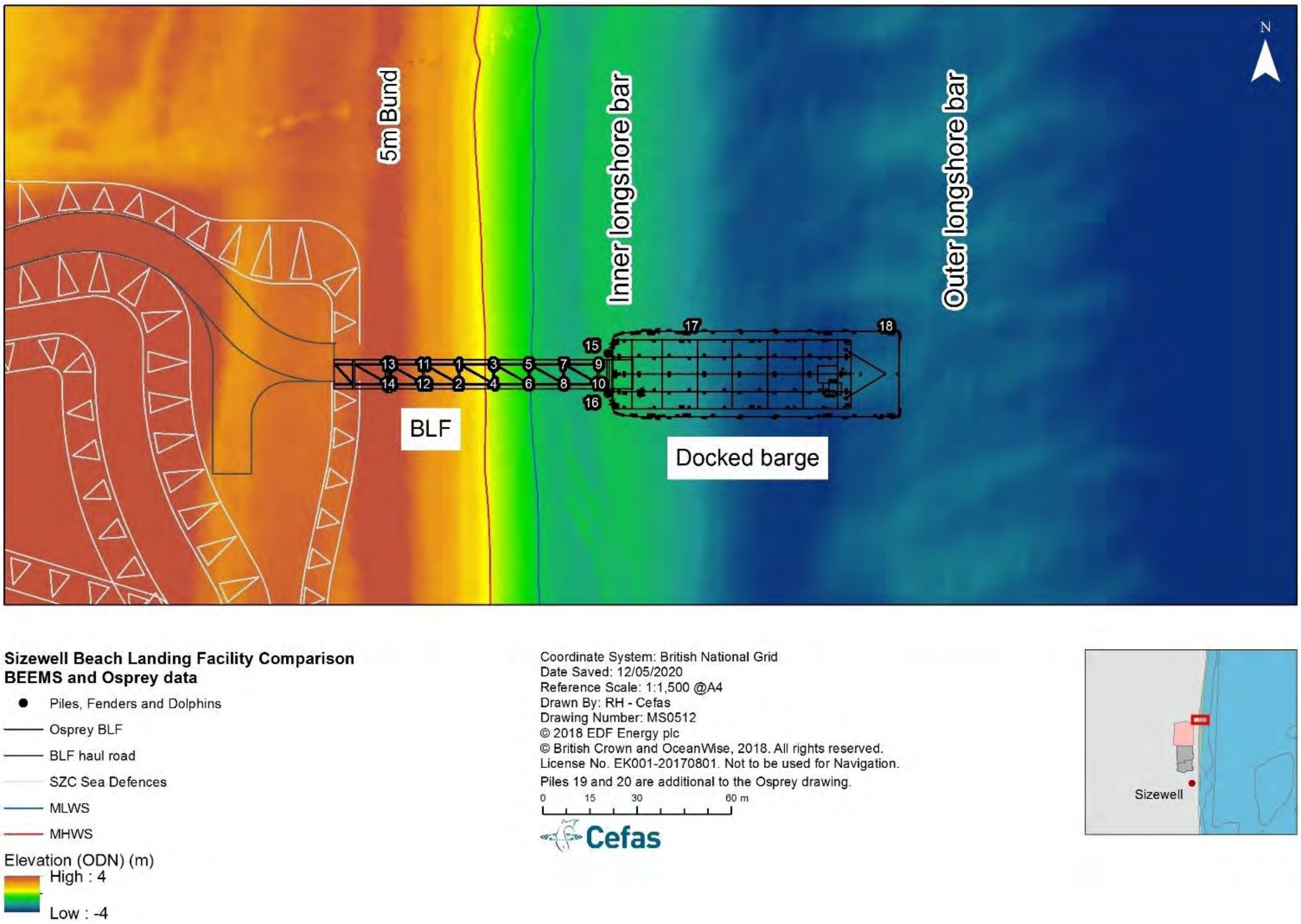

Figure 2: The Beach Landing Facility (BLF) showing the position of the piles, fenders (points 15 and 16) and dolphins (points 17 and 18) relative to the longshore bars and MHWS.

2.2 Cooling water infrastructure

2.2.1 Cooling Water Infrastructure: Construction

Offshore cooling water infrastructure consists of two subterranean intake tunnels and heads and one outfall tunnel and head. Tunnels would be excavated by tunnel boring machines (TBMs) from land. The TBM heads would be left at the end of each tunnel run, approximately 30 m under the seabed.

2.2.1.1 Tunnelling spoil and chemical discharges

The specific TBM method to be used during construction of the cooling water tunnels is dependent on the underlying geology and is still to be confirmed. The potential for 'frac-out' of tunnelling materials poses minimal risks to the overlying marine environment and is not considered further as the excavated pressure would be similar to ambient conditions. The potential for contamination in the wastewater is considered.

Based on current understanding of the underlying geology a TBM slurry method is the most likely scenario for tunnelling. Spoil from the cutting face would be transported to a temporary stockpile for onward management. During the transport and processing of spoil material, groundwater (arising from galleries dug out to allow access to the tunnels) and potentially residual TBM chemicals would be produced in wastewater that would be transported landward and treated appropriately. To encompass worst-case water quality scenarios, assessments assume discharges of wastewater from the CDO.

Water Quality modelling accounted for a tunnelling wastewater discharge rate of 34.4 l/s and a discharge of 8.8 mg/l bentonite (a clay mineral regularly used in construction and offshore drilling operations which may be applied at the cutter face; bentonite is included on the OSPAR list of PLONOR substances which '***p***ose ***l***ittle ***o***r ***n***o ***r***isk to the environment'). The predicted concentration of bentonite in suspension would be orders of magnitude lower than baseline SSC with 95th percentile concentrations of 10 µg/l restricted to sea surface areas of <11 ha and mean concentrations of 10 µg/l to less than 1.5 ha (BEEMS Technical Report TR193 Ed. 5). In the tidally dominated environment characterised by high resuspension rates, the potential for sedimentation of fine materials to cause ecological effects during normal tunnelling processes is negligible. No further assessment is made.

To envelope alternative tunnelling methods, assessments considered the use of indicative ground conditioning TBM chemicals. Ground conditioning chemicals may be used at the cutter head to optimise TBM efficiency and include anti-clogging agents, anti-wear components and soil-conditioning compounds. The exact chemical constituents of the ground conditioning chemicals are dependent upon the ground conditions encountered on site and therefore cannot be precisely specified in advance of drilling trials by the tunnelling contractor. Whilst a slurry method is the most likely tunnelling option, representative chemicals from those applied for Hinkley Point C assessments are considered to most accurately envelope potential tunnelling options at this stage. These include the anti- clogging agent BASF Rheosoil 143 and the soil conditioning additive CLB F5 M.

2.2.1.2 Cooling water headworks

Each tunnel would terminate in two concrete headworks. The optimal location of the outfall heads was investigated using the validated Sizewell GETM model in consultation with the Environment Agency to ensure compliance with Environment Agency guidelines to reduce environmental impacts of the thermal plume and minimise recirculation of heated water at the Sizewell B intakes.

Embedded mitigation measures implemented into the design of the intake and outfall headworks include:

- The intakes and outfalls of the cooling water infrastructure would be located approximately 3 km offshore, east of the Sizewell-Dunwich Bank, thereby allowing greater dilution of cooling water discharges and reducing potential intersections with the shore.
- The intakes would be fitted with low-velocity side-entry (LVSE) headworks designed to minimise water velocities across the face.
- The long axis of the intakes would be positioned parallel to the current in a north-south orientation. Intake slits would be positioned on the side of the headworks perpendicular to the tidal flow. This reduces both vertical currents, which fish are susceptible to, and reduces the probability of fish being forced into the intakes by tidal currents.

- Coarse bar screens at the intakes would prevent seals and marine debris from entering the cooling water system.
- The outfall headworks are designed to funnel thermally buoyant discharges away from the seabed thereby minimising effects on benthic receptors.
- The offshore location of the CW intakes of the proposed development relative to the FRR systems means the potential for re-impingement of fish is negligible.

Prior to the installation of the headworks small scale capital dredging would take place to remove surficial sediments to the underlying bedrock. Dredging is anticipated to be by cutter suction dredger with local disposal.

Following dredging, the bedrock would undergo ground preparation and a gravel bed would be installed below the proposed headwork, which would be lowered into position. Depending on the ground conditions and geotechnical calculations, seismic qualification may be required and would be achieved through the installation of piles. Piles would be installed by drilling, rather than percussive methods, to reduce the levels of underwater noise.

Vertical connection shafts would be drilled with the headwork in-situ to connect the headworks to the subterranean cooling water tunnels. Drilling would occur through the centre of the headworks, within the dredge footprint.

After the headworks are installed and scour protection placed in-situ (where required), soft-sediment would be back-filled.

2.2.2 Cooling Water Infrastructure: Operation

During operation, the SZC intakes would abstract seawater at a rate of 131.8 m^3/s (two x 65. 9m^3/s for each intake tunnel) during standard operating procedures. A maximum of 8.6 % of the total cooling water flow would supply the essential and auxiliary cooling water systems and the remaining 91.4 % (120 m^3/s) would supply the main cooling water systems.

The thermal uplift of the 11.8 m^3/s that supplies the essential and auxiliary cooling water systems is 6.6 °C. In the absence of full details on the design of the SZC cooling water system, thermal modelling assumed 125 m^3/s would be discharged at 11.6 °C thermal uplift (BEEMS Technical Report TR302). This is within 1.4 % of the predicted total heat flux in the cooling water discharge of 131.8 m^3/s at a net thermal uplift of 11.15 °C and the modelling is, therefore, of sufficient accuracy for assessment purposes.

An additional scenario was assessed during normal operation of Sizewell B and maintenance of Sizewell C, whereby two of the four pumps are not operating but the two EPR Units remain running at full power. Such circumstances are unlikely but would result in approximately half the cooling water abstraction rate with the same level of thermal energy applied. Therefore, excess temperatures could potentially rise from 11.6 °C to 23.2 °C (BEEMS Technical Report TR302). Modelling has demonstrated that a warmer thermal plume loses heat faster to the atmosphere, resulting in less heat being mixed down into the water column. Under this scenario, the total areas in exceedance of thermal standards are lower than during standard operating procedures, therefore assessments consider normal operating scenarios as the worst-case (BEEMS Technical Report TR306 Ed. 5).

Abstracted water for the main cooling water system would arrive at the forebay at the end of each intake tunnel before being passed through four drum screens to remove fish and larger organisms, which would be returned to the receiving waters via the fish recovery and return (FRR) systems. Essential and auxiliary cooling water would pass through band screens or drum screens.

Chlorination would be applied to achieve protection of critical plant (essential cooling water systems for the nuclear island and the turbine hall, and the condensers). To reduce the annual duration of chlorinated discharges, seasonal chlorination would be applied. The seasonal chlorination strategy for the proposed development involves chlorination during the period of the year when water temperatures exceed 10ºC. However, spot-chlorination may be required to protect critical plant outside these periods.

Chlorination would be applied after the drum screens to prevent exposure of impinged biota. Chlorination would be applied at a dose level to produce a total residual oxidant (TRO) concentration of 0.2 mg/l after the drum screens. The TRO discharge concentration from the CW systems at the outfall would be 0.15 mg/l. To represent the worst-case scenario water quality modelling considers the impacts of 0.15 mg/l TRO released at the outfalls at a maximum discharge of 132 m^3/s

By 2030, predicted water temperatures at the Sizewell C intakes would exceed 10 ºC from the beginning of May until the start of December (BEEMS Technical Report TR306 Ed. 5). The potential exists for future climate change to extend the period of the year seawater temperatures exceed 10 ºC, and by proxy, the seasonal duration of chlorination. Shifts in plankton phenology have been observed in the North Sea. Since the 1960s, peaks in dinoflagellates have occurred 23 days earlier, diatoms 22 days earlier, copepods 10 days earlier, and other holozooplankton groups 10 days earlier (Richardson, 2008). Whilst the duration of the growing season is likely to extend in the future, temperature driven changes in phenology would be moderated by day length and solar elevation thus restricting the total growth period. In the coastal waters at Sizewell, high levels of turbidity in the winter and early spring limit biological production (BEEMS Technical Report TR346) and increases in the duration of annual chlorination is likely to be in the order of weeks at most.

Chemicals, including hydrazine, are added to the secondary circuit to prevent corrosion and to control pH. The non-recyclable blowdown from the Steam Generator Blowdown System is sent to the nuclear island waste monitoring and discharge System for monitoring and discharge on a batch basis in admixture with stream B (the nuclear island waste monitoring and discharge system tanks). If necessary, mitigation may be implemented at this stage to treat hydrazine to an acceptable level prior to discharge.

The admixture of stream B and C would be discharged to the outfall pond prior to release to the Greater Sizewell Bay via the common Outfall Tunnel. Additional inputs at the discharge pit including sanitary waste, groundwater and surface run-off, and daily hydrazine discharges. Discharges into the cooling water flow allows dilution prior to mixing in the receiving waters allowing a level of mitigation. The lowest volume of water abstracted under normal operating conditions would be 116 m^3/s. Water quality assessments for discharged contaminants are based on this discharge rate as it represents the worst-case dilution scenario for standard operation of the power station (BEEMS Technical Report TR306 Ed. 5).

2.2.2.1 Refuelling and maintenance outages

During the 60-year operational life, each reactor unit would undergo refuelling and maintenance shutdowns (otherwise known as 'outages') at approximately 18-month intervals. The duration of these outages would vary according to the maintenance and inspections required but would typically be up to two months.

2.3 Fish Recovery and Return (FRR)

2.3.1 FRR: Construction

Two fish recovery and return (FRR) systems would be constructed, one for each reactor. The small diameter FRR tunnels (approximately 0.65 m internal diameter) would be drilled beneath the seabed with arisings transported to landward for disposal.

Prior to installation of the FRR outfall headworks, overlying soft sediment in the shallow subtidal (<6 m) would be removed by dredging probably using a cutter suction dredger with spoil disposed locally within a licensed disposal site. The FRR outfall headwork is assumed to comprise a concrete block approximately 3 m long, 4.5 m high, and 3 m wide buried 2 m into the sediment.

The northerly position of the two FRRs is designed to be in alignment with the forebays of each reactor, minimising the required tunnel length and hence the time taken for fish to be returned to the marine environment. The optimal easterly position is determined by several interacting factors, including:

- The depth of the water at the point of discharge. Water depths must be sufficient at all stages of the tide to reduce predation by surface feeding birds.
- Avoidance of mobile geomorphic features. The two nearshore bars at Sizewell are important to sand transport and move naturally within a 'positional envelope' in response to the prevailing wave climate. The FRRs (and CDO) have been positioned on the seaward flank of the positional envelope of the outer longshore bar, where bed level fluctuations are less, due to lower rates of transport. This is to avoid burial of the system as the bar periodically moves downward. This location also minimises the effects of the structures on geomorphology to localised scour only.
- Minimising transit time of impinged biota.
- Avoiding the Sizewell B (SZB) discharge plume. The SZB outfall is positioned 150 m offshore (from mean water level on the beach face). A short FRR tunnel would, therefore, release fish into the SZB TRO plume on the ebb tide. The SZB cooling water discharge is chlorinated throughout the year.
- Minimising the risk of fish re-impingement into SZB. The SZB intake is 600 m offshore and there is a risk that, on the flood tide, some of the fish discharged from the FRR outfall could be re-abstracted at the SZB intake.

The proposed position for the FRR outfalls is approximately 475 m from the forebays on the seaward flank of the outer longshore bar in water depths of 5.5 -6 m below ODN (based on 2014 bathymetry). Transit along the 475 m tunnel to the FRR outfalls would take approximately 13 minutes at a discharge rate of 0.3 m^3/s (BEEMS Technical Report TR333).

The exact position of the headworks will depend on constructability, with the Works Plan allowing a 25 m radius for deviation for all headworks. Indicative positions of the FRR headworks for assessment purposes are assumed to be:

- FRR 1 head: Easting 647980, Northing 264000 -5.6m ODN.
- FRR 2 head: Easting 647980, Northing 264300 -6.0m ODN.

2.3.2 FRR: Operation

Abstracted water would be transported along the intake tunnels to the station forebays where rotating drum screens would impinge larger biota, including fish and crustaceans. Impinged biota would be washed off the drum screens and returned to the GSB via the fish recovery and return (FRR) systems.

Transit along the 475 m tunnel to the FRR outfalls would take approximately 13 minutes for a passive object at a discharge at a rate of 0.3 m^3/s.

The proposed drum screen mesh size for Sizewell C is 10 mm allowing a direct comparison with the current mesh size employed at Sizewell B. In the best practice guide for screening for intakes and outfalls Turnpenny and O'Keeffe (2005) recommend *"mesh size should be as small as is practical, and of no more than 6 mm aperture"*. However, Turnpenny *et al.,* (2010) acknowledge that at coastal sites a 6 mm mesh may lead to the risk of ctenophore blockage during Summer months. Sizewell B experiences large numbers of ctenophores at certain times of the year and these more readily distort under drum screen conditions and squeeze through a 10mm mesh screen. A 10 mm screen is considered appropriate for Sizewell C.

The use of a dedicated FRR for each EPR™ avoids the need for a complex junction system with associated increase in transit times. Elevations and tidal heights allow direct discharge without the need for an Archimedes screw (necessary in the Hinkley Point C design), thus minimising the 'handling' of impinged fish and crustaceans.

The specific design details of the FRR system would largely replicate the Hinkley Point C FRR design, taking into consideration the design best practice guidance, and comply with Marine Licence conditions, including:

- The pressure of the wash water jets to remove fish.
- The geometry of the fish collection hoppers.
- Flushing rates, and.
- Optimising return lines and gullies by smoothing and grouting to reduce damage and avoiding sharp bends.

Hydraulic assessments have determined that an Archimedes screw would not be required The FRR wash water would not be chlorinated. Therefore, impinged biota would not be subjected to chlorination.

2.4 Combined Drainage Outfall (CDO)

2.4.1 Construction and construction phase function of the combined drainage outfall

The combined drainage outfall (CDO) would be constructed early in the construction phase and act as the site discharge outfall. Drilling the tunnel is anticipated to take two months with directional drilling. Prior to CDO completion, station effluents would be reused where possible or tankered offsite for managed disposal.

As required, the CDO would discharge tertiary treated sewage, dewatered groundwater, surface run-off, tunnelling wastewater, and commissioning discharges. Discharges would be treated with oil separators to minimise potential hydrocarbon contamination from mobile or fixed plant operations and a silt-buster or similar technology to reduce sediment loading.

A Water Discharge Activity (WDA) Environmental Permit assessment will be required prior to any discharges.

The exact position of the CDO headwork will depend on constructability. For assessment purposes the CDO headwork is assumed to be located at 647980 E, 264340 N on the seaward flank of the outer longshore bar, approximately 400 m from the HCDF, in water depths of approximately -6 m ODN (based on 2014 bathymetry). The location limits the potential for discharges to interact with the coastline. The CDO tunnel would be drilled beneath the seabed with arisings transported to landward for disposal. The tunnels would be connected to a concrete outfall structure anticipated to be of similar dimensions to the FRR headworks.

Prior to installation of the CDO outfall headwork, overlying soft sediment in the shallow subtidal (<6m) would be removed by dredging via a Cutter Suction dredger with spoil disposed locally within a licensed disposal site with local disposal.

To enable the plausible worst-case volume and contaminant concentrations to be considered for permitting and for assessment in the ES the following cases have been considered:

- **Case A** is associated with the dewatering phase of the cut-off wall for the main development site. Initial dewatering is anticipated to remove 300,000 m^3 of groundwater at rate of 124 l/s. Dewatering is anticipated to last 28 days and represents the worst-case for metals contamination. For the remainder of the construction period groundwater dewatering is estimated to occur at a nominal rate of 15 l/s to remove rainwater and seepage through the cut-off wall.
- **Case D** is based on the expected number of personnel on site during the construction phase and represents the typical worst-case scenario for sewage discharges, nutrient inputs and un-ionised ammonia. Sewage discharge rates are anticipated to be 13.3 l/s throughout much of the construction period. The biochemical oxygen demand (BOD) from these discharges is expected to be of negligible significance to the dissolved oxygen (DO) concentration and DO levels are anticipated to remain within WFD ‘high’ status during the construction phase (BEEMS Technical Report TR306 Ed. 5).
- **Case D1** represents an extreme case of sewage discharge, it is likely to be highly transitory with a maximum sewage only discharge rate of 30 l/s. Groundwater from main site with inputs from tunnelling are also included.
- **Case E** waste from the TBM soil conditioning chemicals, if present, is likely to make the largest contribution during Case E. This assumes consecutive TBM machines operating with the potential for two sources of ground conditioning chemicals (6 l/s) to be discharged in a total estimated volume of 34.3 l/s although recovery systems mean some chemical inputs are likely to be minimised.

2.4.2 Commissioning function of the combined drainage outfall

The CDO would act as a discharge point during part of the commissioning phase of the proposed development. Commissioning of the reactors is proposed to take place in two stages;

- cold flush testing, and;
- hot functional testing.

The commissioning process for each unit would last for about 24 months. A 12-month gap is anticipated between the completion of the two reactor units. Cold flush testing mainly involves cleansing and flushing the various plant systems with demineralised water to remove surface deposits and residual debris from the installation. Waste streams during cold flush testing of Unit 1 would be directed to a storage tank with controlled discharge via the CDO. The discharge routing for Unit 2 has yet to be confirmed. A Rochdale envelope approach was therefore applied to represent the worst-case scenario for commissioning discharges, whereby treatment tanks for both units were assumed to discharge to the CDO. This represents a highly precautionary assessment. A second assessment assumes the case whereby cold flush testing discharges from Unit 2 are released via the CDO, whilst Unit 1 is operational. This represents a potential worst-case scenario for fish and other biota discharged from the FRR associated with Unit 1, approximately 340 m south of the CDO.

Cold flush testing discharges would include small quantities of conditioning chemicals including:

- hydrazine;
- ammonia;
- phosphate; and
- ethanolamine.

Detailed modelling and assessments have been completed to determine the fate of commissioning discharges of hydrazine.

Nutrient discharges, including DIN and phosphate are considered as part of the wider construction nutrient release scenarios. Water quality assessments indicated that ethanolamine passed initial dilution assessments and never exceeds assessment thresholds whilst un-ionised ammonia does not exceed EQS beyond 25 m from the point of discharge (BEEMS Technical Report TR193 Ed. 5). Un-ionised ammonia discharges during commissioning are lower than the worst-case construction discharges, which are assessed.

Hot flush testing takes place before fuelling the reactor once the cooling water infrastructure is operational. The effluent produced during hot functional testing would be diluted within the cooling water system before being discharged via the outfall tunnel.

2.4.3 Operational function of the combined drainage outfall

There is no operational function anticipated for the CDO.

3 Evidence for WFD marine assessment

3.1 WFD Scoping

In the Sizewell C Water Framework Directive Stage 2 Scoping Assessment the Transitional and Coastal (TraC) waterbodies listed in Table 1 and shown in Figure 3, were scoped in for potential effects from the construction and operation of the marine components of the Sizewell C development.

Table 1: Sizewell C WFD Compliance Assessment: TraC waterbodies that have been scoped in.

Name of Water Body	Water body ID	Hydro morphological Designation	Reasons for Designation as HMWB	Current Overall Status	Proposed Status
Coastal					

Suffolk	GB650503520002	HMWB (highly modified water body)	Coastal Protection Flood Protection	Moderate potential	GEP (good ecological potential) by 2027
Walberswick Marshes	GB610050076000	HMWB	Flood Protection	Good potential [1]	Remain at GEP
Transitional					
Blyth (S)	GB510503503700	HMWB	Coastal Protection Flood Protection	Moderate potential	GEP by 2027
Alde & Ore	GB520503503800	HMWB	Flood Protection	Moderate potential	GEP by 2027

The following information from the Suffolk operational catchments has been taken from the Environment Agency catchment data explorer:

Suffolk Coastal[2] - The Suffolk coastal operational catchment includes the natural surface water catchments of the rivers: Lothingland, Easton Broad, Wang, Blyth, Leiston Beck & Minsmere Old River, Fromus, Hundred and Alde & Ore, Butley, Tang, and Black Ditch. The catchment is mainly rural with numerous small towns and villages scattered throughout the area. It is one of the driest parts of the country, with local rainfall typically only two-thirds of the national average. The importance of this coastal catchment for biodiversity is recognised by its many wildlife designations including Ramsar sites, SPAs, SACs, NNR and SSSIs.

Suffolk TraC[3] - There are five estuaries along the Suffolk coast (the Stour, Orwell, Deben, Alde/Ore and Blyth) with extensive wildlife-rich intertidal areas of mudflat and salt marsh the importance of which is recognised by their designation as sites of European/National importance. In places, old river mouths have become enclosed by sand and shingle bars, creating large areas of freshwater marshland, much of which is managed as nature reserves. Reclaimed estuarine intertidal areas bounded by river walls are now important agricultural areas. The shoreline consists of predominantly shingle beaches as well as important geomorphological features including shingle structures, such as Orford Ness.

The status of each waterbodies classifying elements along with information on sensitive habitats is found in the WFD waterbody summary table below (Table 2).

It is noted that since the DCO Application the 2019 WFD waterbody classifications have been released. The overall waterbody classifications in Table 1 remain consistent and this does not affect the evidence provided herein.

[1] This classification is based on expert judgement, as no biological data were available at the time of assessment, see Environment Agency (2011).
[2] https://environment.data.gov.uk/catchment-planning/OperationalCatchment/3427/Summary (date accessed 17/06/2020)
[3] https://environment.data.gov.uk/catchment-planning/OperationalCatchment/3428/Summary (date accessed 17/06/2020)

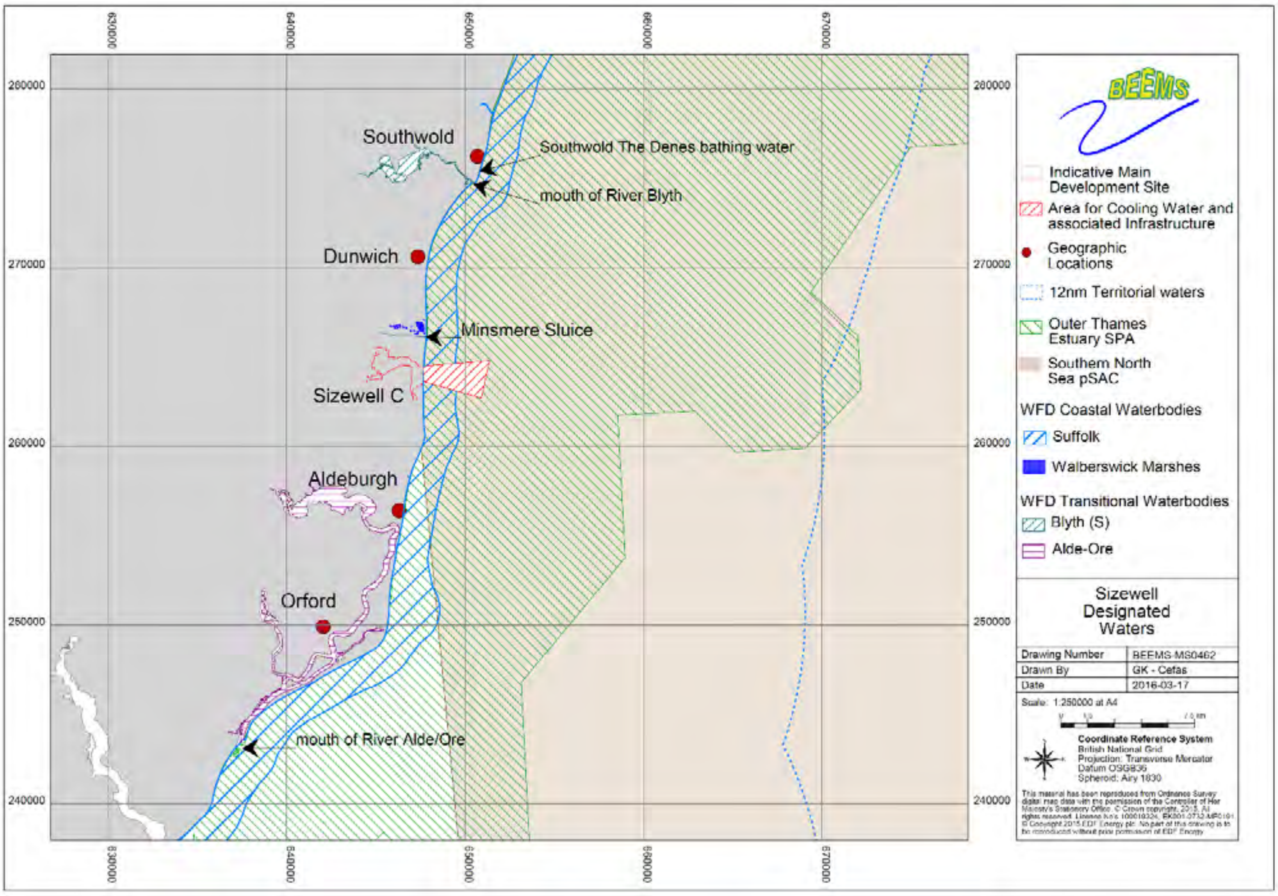

Figure 3: The location of the Sizewell site on the Suffolk coast indicating the boundary and extent of the Suffolk, Walberswick Marshes coastal waterbodies and associated transitional waterbodies.

Water body summary table					Current water body status			Target water body status		Hydromorphology					Biology: higher sensitivity habitats (source: Natural England marine evidence database)			Biology: lower sensitivity habitats (source: Natural England marine evidence database)				Biology: bivalve mollusc production areas	Water quality: phytoplankton and harmful algae	
WFD water body name	**WFD water body ID**	**River basin district name**	**Water body type**	**Water body total area (ha)**	**Overall water body status**	**Ecological status**	**Chemical status**	**Target water body status**	**Deadline (year)**	**Hydro-morphology status**	**Is the water body heavily modified (HMWB)?**	**Use (reason for HMWB designation): coastal protection**	**Use: flood protection**	**Use: navigation, ports and harbours**	**Mussel beds, including blue and horse mussel (ha)**	**Polychaete reef (ha)**	**Saltmarsh (ha)**	**Cobbles, gravel and shingle (ha)**	**Intertidal soft sediment (ha)**	**Rocky shore (ha)**	**Subtidal soft sediments (ha)**	**Bivalve mollusc production area name**	**WFD phyto-plankton classification**	**History of harmful algae**
Alde & Ore	GB520503503800	Anglian	Estuarine	1086.81	Moderate	Moderate	Good	Moderate	2015	Supports Good	Yes	No	Yes	No	1.38	-	390.82	219.22	817.54	0.29	320.56	Butley	-	Yes
Blyth (S)	GB510503503700	Anglian	Estuarine	260.60	Moderate	Moderate	Good	Moderate	2015	Supports Good	Yes	Yes	Yes	No	-	-	93.02	-	200.46	-	-	-	-	Not Monitored
Suffolk	GB650503520002	Anglian	Coastal	14653.27	Moderate	Moderate	Good	Moderate	2015	Not assessed	Yes	Yes	Yes	No	-	11.57	197.49	1929.57	816.46	1.78	10568.96	-	Good	Not Monitored
Walberswick Marshes	GB610050076000	Anglian	Coastal	25.66	Good	Good	Good	Good	2015	Not assessed	Yes	No	Yes	No	-	-	-	-	-	-	-	-	-	Not Monitored

Table 2: WFD waterbody summary table (EA, 2017[4]).

4 https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters (date accessed 18/06/2020).

3.2 Potential effects on hydromorphological elements

Of the four waterbodies identified in the Sizewell C Water Framework Directive Stage 2 Scoping Assessment (Suffolk, Walberswick Marshes, Blyth(S) and Alde & Ore waterbodies), only the Suffolk waterbody was scoped in for potential effects on the hydromorphological elements of the waterbody during Sizewell C construction and operation. The Water Framework Directive defines the hydromorphological elements as:

- water depth;
- the structure and substrate of the sea floor and sediment transport;
- the structure and substrate of the intertidal zone;
- the direction of dominant water currents; and
- the degree of wave exposure of the waterbody.

3.2.1 Water depth

Localised changes in water depth will occur as a result of scour around permanent (e.g., cooling water, BLF) infrastructure and as result of dredging that is undertaken to enable berthing and access of vessels at the BLF. As the infrastructure footprint is small, there are no predicted broadscale effects from changes in water depth due to raised seabed structures (<5 m above the seafloor).

3.2.1.1 Scour

Once constructed, the seabed surrounding the BLF piles, fenders, and dolphin piles will scour. For estimating a conservative area of maximum potential habitat change, scour predictions were based on the modelled peak tidal current during a storm surge event, where the bases of all piles were submerged. The total area impacted, including the footprint of the structures themselves, was predicted to be 852 m^2 (considered a conservative estimate of habitat change, being over four times the area calculated for 'normal' wave and tidal conditions: 186 m^2). For perspective, this would be equivalent to a 10 by 10 m square box per pile pair (four pile pairs in the marine environment) for the conservative scenario (BEEMS Technical Report TR311 Ed. 4).

Cooling water infrastructure would be located beyond the Sizewell-Dunwich Bank approximately 3 km offshore and therefore outside the WFD waterbody. The scour pits for the FRR and CDO would be broadly elliptical due to reversing tidal currents, with a 7.2 m extent from each side of the structure along the tidal axis (north – south) and a 4.1 m extent across the tide (east – west). The area of changed habitat (including the 9 m^2 footprint of the structure itself) would be 170 m^2 (0.0170 ha) per structure and 510 m^2 (0.051 ha) for the three structures. The amount of sediment displaced due to the formation of the predicted scour pits would be 109 m^3 per structure and 328 m^3 for the three structures (excluding the volume of the structures themselves).. Secondary or edge scour, would be likely to form around the perimeter of the scour protection, as observed at the SZB intake heads, and therefore, were scour protection to be installed over the entire projected footprint, the secondary scour would mean that the total area influenced by the presence of the structure would be larger than if no scour protection was installed (BEEMS Technical Report TR311 Ed. 4).

3.2.1.2 Dredging

A navigation channel would need to be dredged to provide access to the Beach Landing Facility (BLF), which would be used for delivery of AILs, rock armour and other marine freight. Additional dredging would be required to create a planar surface for the barge to rest flat on the seabed (a grounding pocket). The total dredge volume for the BLF is 4,600 m^3. The proposed plough dredge method does not extract material; however, banking of redistributed sediments may occur in the local vicinity causing burial of surficial sediments. Figure 4 shows the required dredge profile, in red, compared to the current (2017) bathymetric profile in front of the BLF. The outer bar would be clipped to a height of -3.5 m ODN to allow clearance of the tugs over the outer bar. Figure 5 shows the area over which the dredging would be required. The total area dredged is 9,068 m^2, or 0.91 ha. The total area includes the width of the barge to rest centred in front of the BLF plus the length of the tugboat to work tangentially to the barge to provide clearance for safe working. As sediment mobility in nearshore zones is high, and the navigation channel narrow, the channel is expected to infill and so the depth change for the BLF is temporary (BEEMS Technical Report TR311 Ed. 4). A precautionary stance based on the predicted infilling rates assumes a single annual capital dredge event followed by monthly maintenance dredges of the berthing pocket and outer bar, equating to a combined 10 % of the initial capital dredge volume (BEEMS Technical Report TR487).

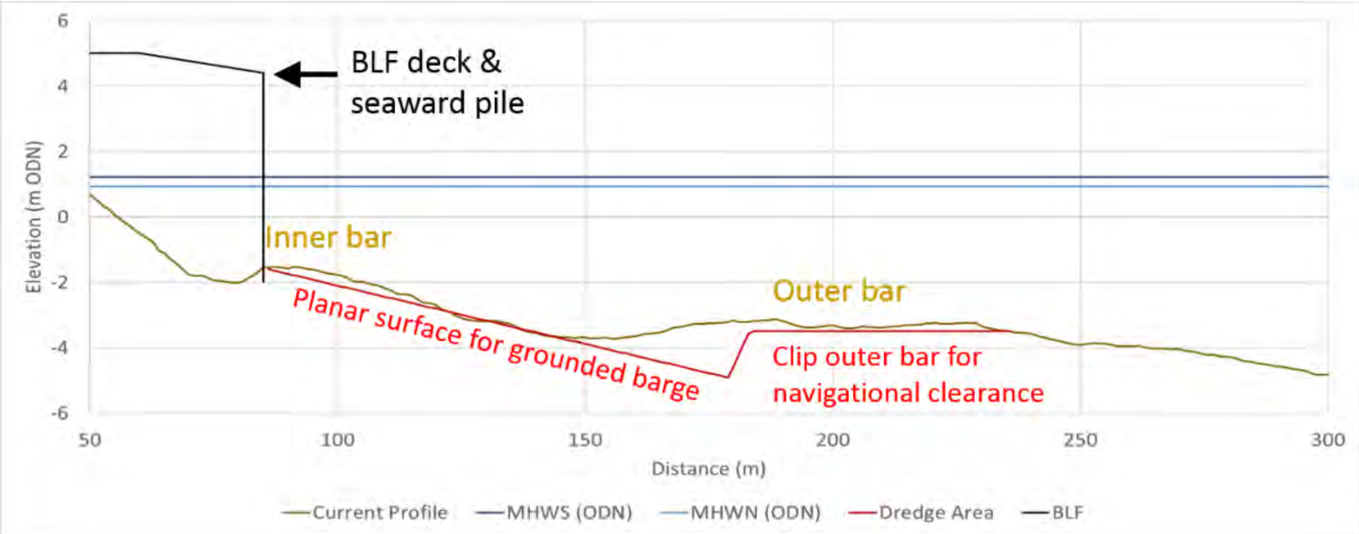

Figure 4: Desired dredge profile (red) required for a North Sea barge to dock at the BLF (black), compared to the current (2017) bathymetry (brown). Mean High Water Spring and Neap are shown in blue (BEEMS Technical Report TR481).

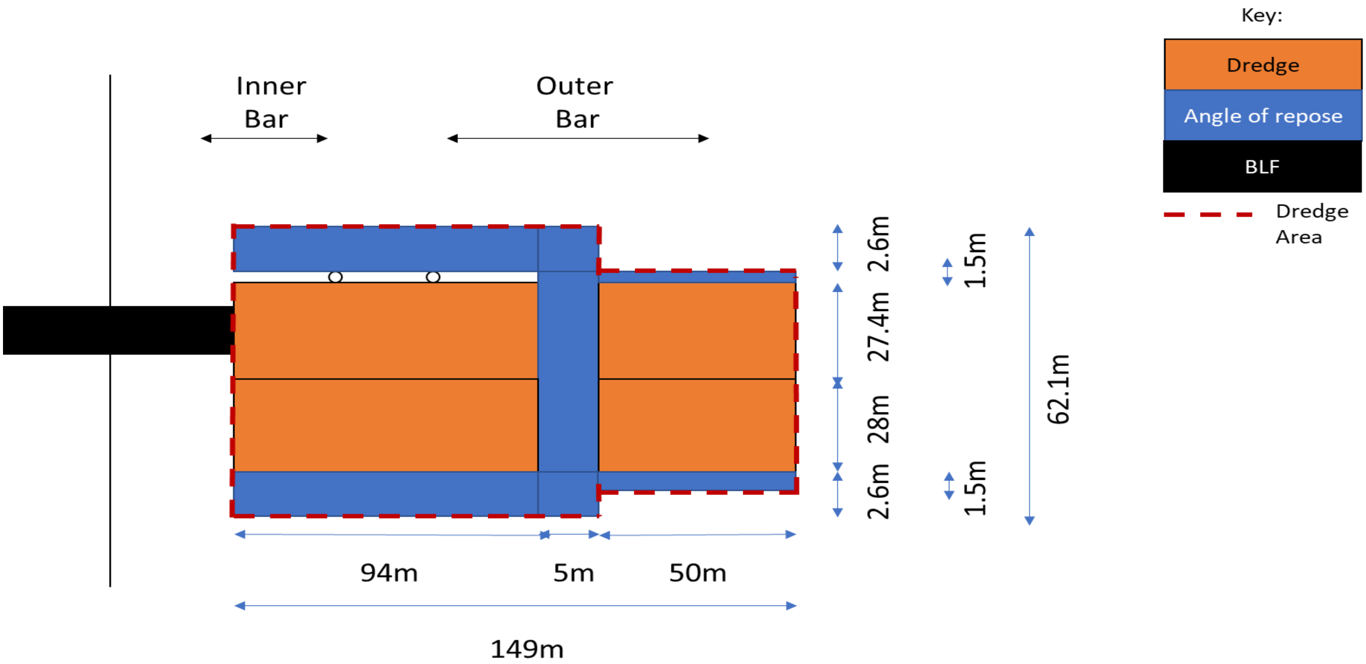

Figure 5: Dredge area required for the BLF approach. Dredge area includes barge grounding and clearance for tugboat safe working (BEEMS Technical Report TR481).

3.2.2 The structure and substrate of the sea floor and sediment transport

A change in substrate could occur where the over lying sediment has been removed and scoured down to different sedimentary material or rock, or where scour protection is used, which introduces hard substrate. Where scour protection is used there will be a change in substrate from sand to rock (concrete). Section 3.2.1 details the predicted scour and scour protection.

The only component of the proposed development that could affect sediment transport is the Coastal Defence Feature. Until depleted by the normal processes of shoreline erosion, the SCDF will feed sediment into the system, though this does not represent a change in any of the natural processes presently operating. Material changes to physical processes will only occur due to the HCDF, if exposed during a future baseline scenario, as detailed in Section 4.3.2.1.

3.2.3 The structure and substrate of the intertidal zone

The intertidal zone at Sizewell is occupied by a narrow beach face that is typically 20 m wide and comprised of a mixture of sand and gravel-sized sediments. The main impact on the intertidal zone will be heavy plant movements associated with the construction of the BLF and the soft coastal defences (total length approximately 1km). Localised but largely superficial effects will result (e.g., compaction), but the substrate itself would not be changed.

Access routes across the beach berm could result in berm lowering and potential sites for overtopping during storms if temporary plastic-track roadways are not installed. Such impacts are above MHWS and are not considered further as part of the marine assessments.

3.2.4 The direction of the dominant water currents

3.2.4.1 BLF

The low density of piles (spacing is 11.2 m cross-shore and 6.3 m alongshore) means that the BLF is transmissive to water movement, and the local effect on current flow and wave energy transmission is expected to be minimal. Modelling shows that when the BLF is not in use (structure only) the two end-piles combined with the fender piles slightly interrupts the shore parallel tidal flow, with a small decrease in the currents in the lee of the piles up to a maximum distance of 45 m (Figure 6). Closer to shore the effects lessen, due to the lower current speeds in shallower water. For the BLF combined with the dredged berthing pocket, whilst the magnitude of change[5] is smaller than for the structure alone (Figure 6 and Figure 7), the spatial extent affected is larger (355 m compared to 60 m) (BEEMS Technical Report TR311 Ed. 4).

[5] Calculations based on worst-case ebb tidal conditions. If required, calculations based on the flood-tide can be provided and these will be presented in a future updated BLF report.

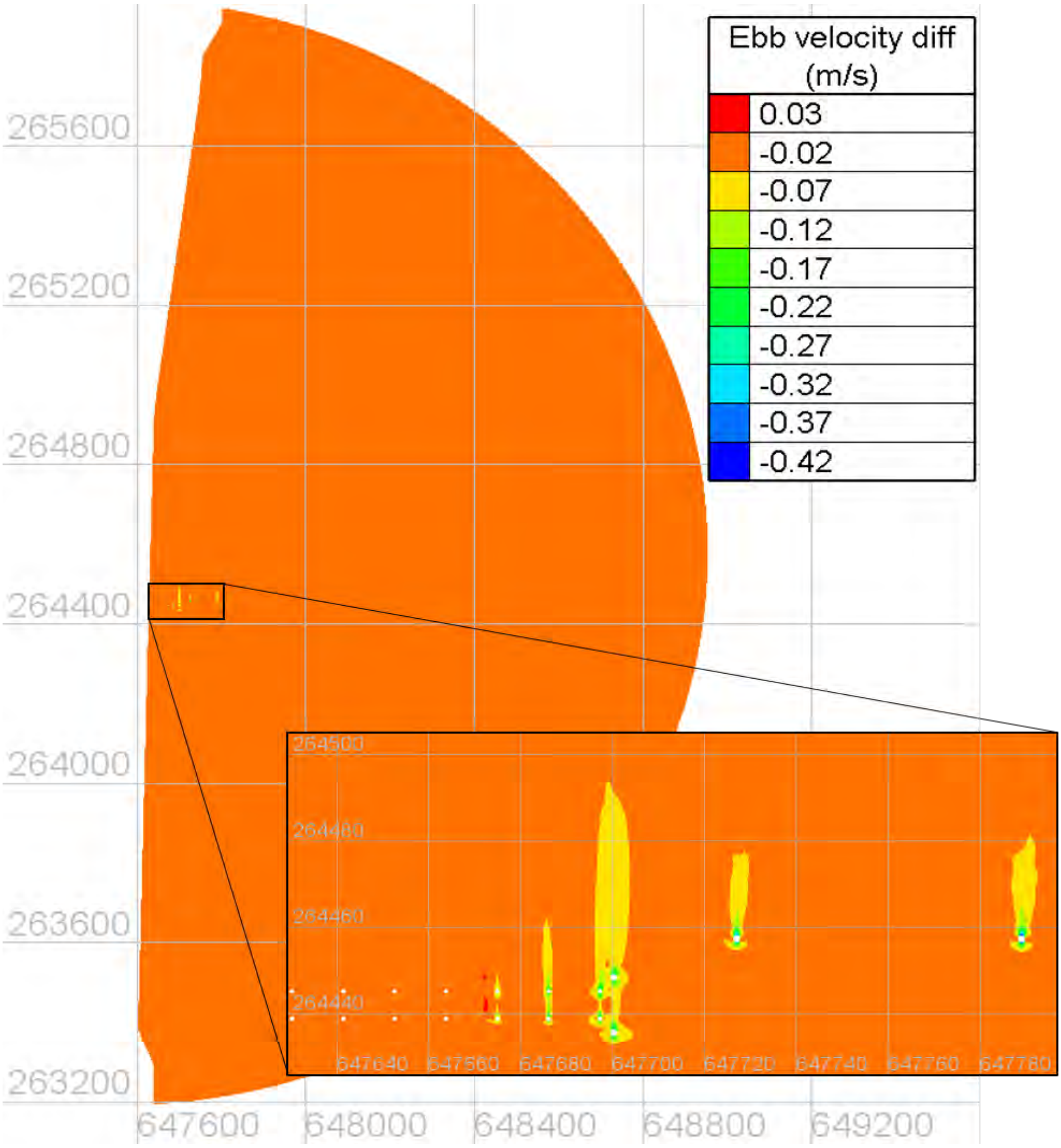

Figure 6: Difference in Peak Ebb velocity from background due to the presence of the BLF not in use (BEEMS Technical Report TR481).

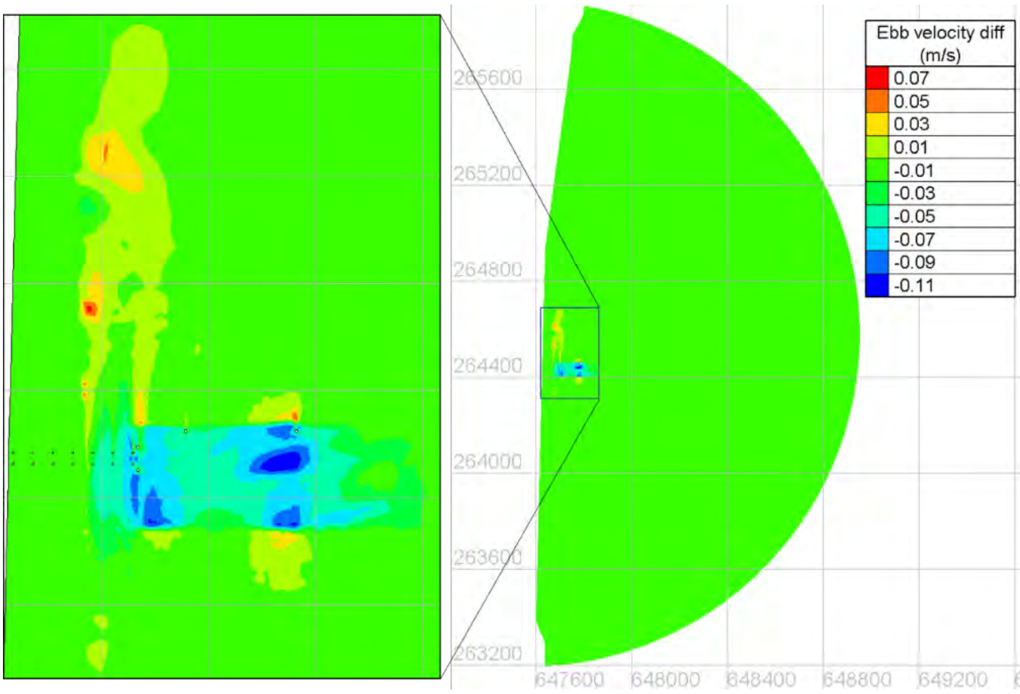

Figure 7: Peak Ebb velocity difference: BLF-dredge – BLF (BEEMS Technical Report TR481).

3.2.5 Effect of changes in wave exposure and bed shear stress on the water body

Figure 8 shows the observed changes in wave energy, due to the BLF when it is not in use, are small, with a maximum increase of 20 % and a maximum decrease of 17 %, over a very small area. The area of seabed where the change in wave energy is greater than or less than five percent (±5 %) corresponds to approximately 1,130 m^2 (or 0.1 ha) over a 65 m frontage. The total longshore impact was slightly larger at approximately 115 m. Most changes are to the north of the structure due to the ebb tidal conditions[6] and the south-easterly waves being considered (BEEMS Technical Report TR311 Ed. 4).

The peak increase in wave energy when the BLF is in use is approximately 150 %, although this is for a very small area of around 500 m^2 (see Figure 9). The peak decrease in wave energy is 52 % and is observed around the first mooring dolphin. The area of seabed where the change in wave energy is greater than or less than five percent (±5 %) corresponds to about 18,800 m^2 (or 1.88 ha) over a 400 m frontage. These results show that the combined structure and dredged pocket (BLF in use) would have a greater impact on wave energy, both in spatial extent and magnitude, than the structure alone (no dredging) (see Figure 8) (BEEMS Technical Report TR311 Ed. 4).

To encompass the full extent of potential change resulting from the BLF on wave energy changes and bed shear stress, consideration of the tide flowing in both directions and the two primary wave directions is required. The total extent of change for the BLF in use was determined by taking the spatial union of

[6] Calculations based on worst-case ebb tidal conditions. If required, calculations based on the flood-tide can be provided and these will be presented in a future updated BLF report.

the 5 % change in bed shear stress for all combinations of ebb currents, flood currents, NE waves and SE waves. The total area of change in bed shear stress greater than 5 percent (± 5 %) is 34,095 m^2 (BEEMS Technical Report TR311 Ed. 4).

Whilst these changes do extend to the SAC/SPA frontage the magnitude of effects is very small (Figure 10). Patches of altered bed shear stress are sufficiently small in magnitude and scale that they are not expected to cause detectable change to the shoreline.

No effects are predicted on the shoreline, the 'annual vegetation of drift lines' habitat (Minsmere to Walberswick Heaths and Marshes SAC) or the potential nesting sites for little tern (*Sterna albifrons*) (Minsmere to Walberswick SPA). The BLF piles are transmissive and not expected to block sediment transport, however localised scour is predicted (BEEMS Technical Report TR311 Ed. 4).

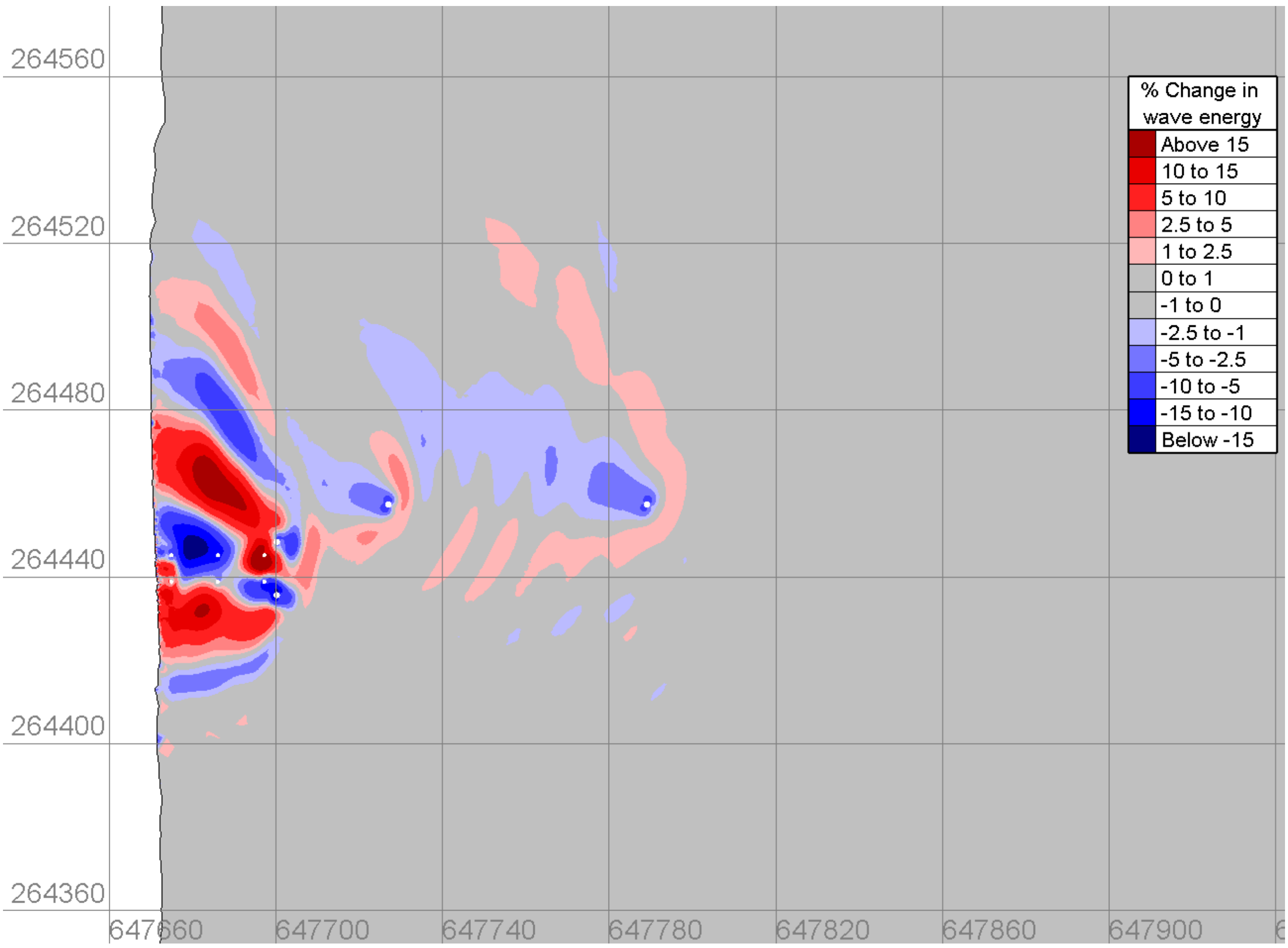

Figure 8: Percentage change in wave energy from background due to the presence of the BLF not in use (BEEMS Technical Report TR481).

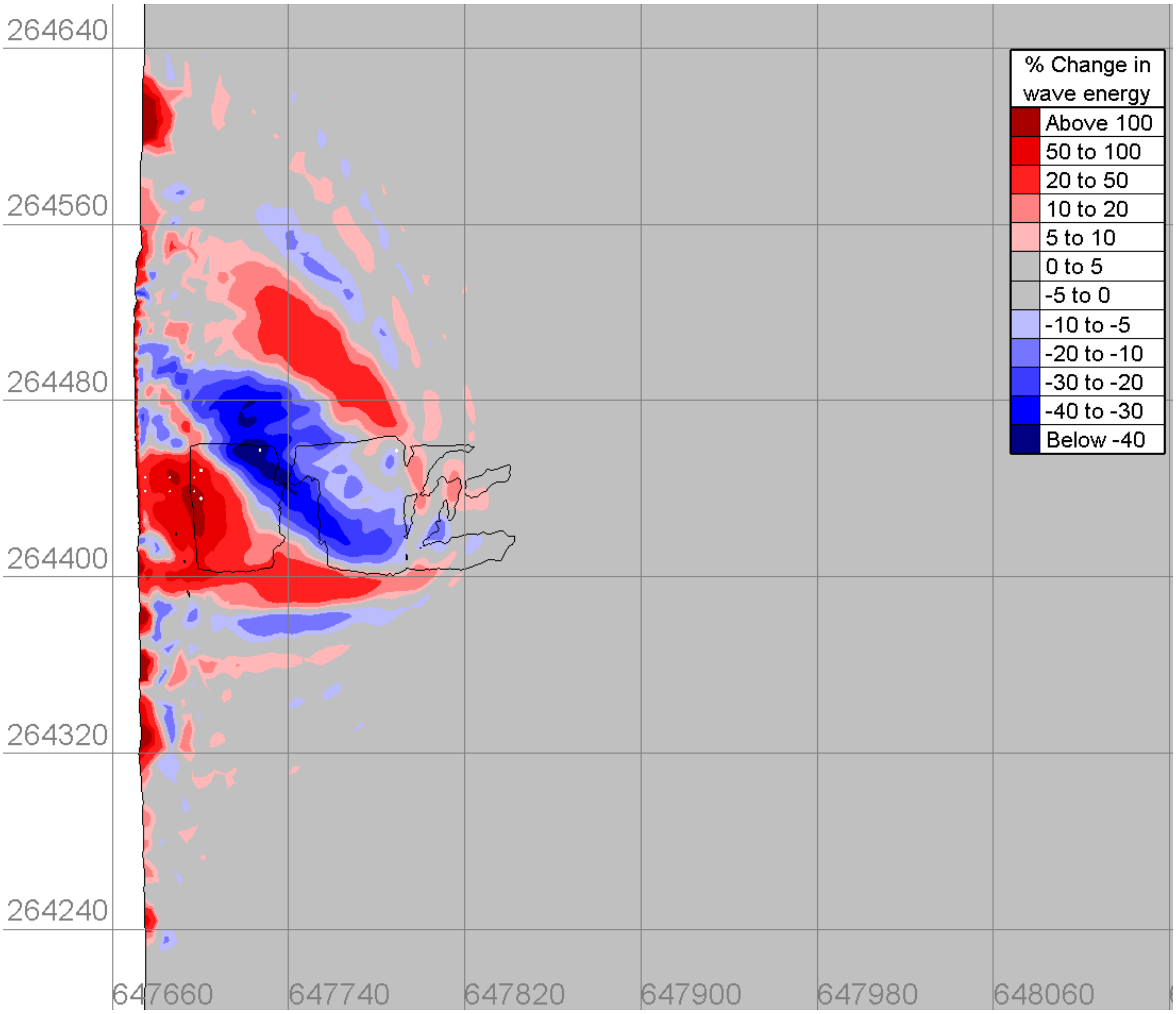

Figure 9: Percentage change in wave energy due to the BLF in use compared to not in use. The black isoline corresponds to change in bathymetry due to dredging (BEEMS Technical Report TR481).

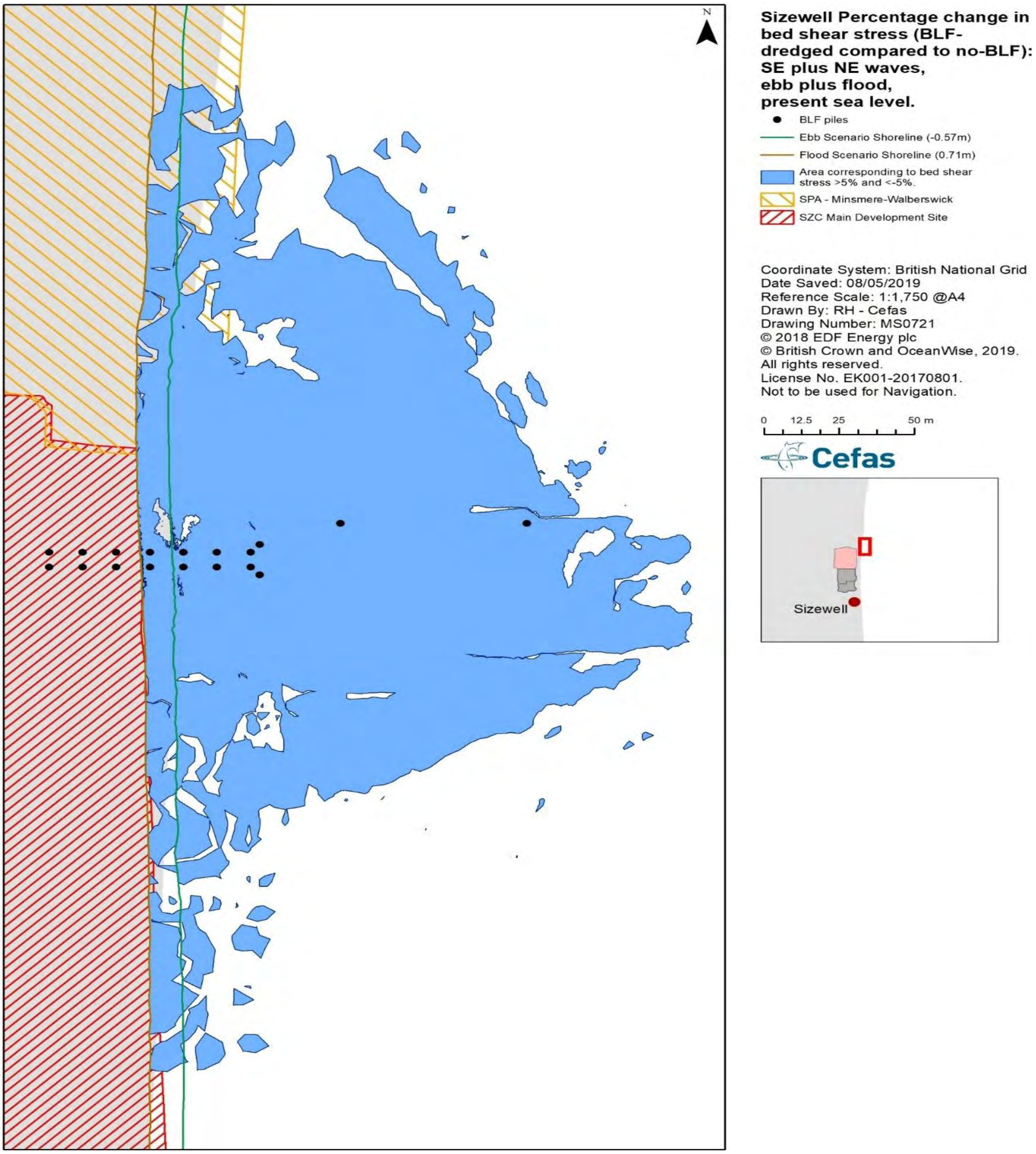

Figure 10: The total area corresponding to a magnitude of change in bed sheer stress of greater than ± 5 % for the BLF in use compared to no BLF, for both wave and tidal current directions.

3.3 Potential effects on chemical elements

Chemical status is assessed by compliance with environmental standards for the priority chemicals that are listed in the EC Environmental Quality Standards Directive (2008/105/EC) as amended by Directive 2013/39/EU (implemented by the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015) which increased the list of priority chemicals to 45. Chemical status is recorded as 'good' or 'fail'.

The chemical status classification for the water body is determined by the worst scoring chemical. All four of the waterbodies identified in the Sizewell C Water Framework Directive Stage 2 Scoping Assessment (Suffolk, Walberswick Marshes, Blyth(S) and Alde & Ore waterbodies) are classed as having ‘good’ chemical status.

This section reviews the development activities with the potential to impact chemical status and considers specific pollutants associated with the proposed development in the construction, commissioning and operational phases.

3.3.1 Construction discharges and activities

During the construction phase the installation of infrastructure in the marine environment and vessel traffic represents a potential pathway for contamination. Contamination could result from:

- Resuspension of sediment bound contaminants, for example heavy metals and hydrocarbons, during dredging, drilling and pilling activities.
- Accidental chemical release from vessels.
- Chemicals leaching from coatings on marine infrastructure.

In addition, a number of discharges would occur during the construction phase. Construction discharges would be directed via the CDO and include:

- Surface water drainage.
- Effluent from the treatment of sewage and from potable supply (black and grey water) by the on-site treatment works.
- Water pumped from both groundwater and excavations during construction dewatering activities.
- Wash water from cleaning concrete production equipment.
- Wastewater from horizontal cooling water system tunnelling operations (during construction).

Detailed assessments of construction discharges are provided in the H1-style assessment (BEEMS Technical Report TR193 Ed. 5) and the Water Quality Synthesis (BEEMS Technical Report TR306 Ed. 5).

3.3.1.1 Potential effects of chemical release from sediment resuspension

Except for the construction of the coastal protection features, all the construction activities listed in Section 2 present a risk of remobilising any contaminants present in the local seabed sediments through dredging, drilling and piling activities.

The marine sediment quality off Sizewell was characterised in terms of contamination in BEEMS Technical report TR305. The report concluded that due to the sandy nature of the material and levels of contamination below Cefas AL2 found in the marine sediment at Sizewell, there is a low risk of release of contaminants to the water column. The proposed seabed disturbance activities associated with the construction and operational phases of Sizewell C are, therefore, considered unlikely to cause any chemical release effects to the water and sediment quality of the local area due to sediment composition and low level of contaminants (BEEMS Technical Report TR305). A disposal site characterisation report has been prepared in BEEMS Technical Report TR508 and includes:

- The need for a new disposal site.
- The characteristics of the material to be disposed.
- The disposal site characteristics.
- The assessment of potential impacts.

3.3.1.2 Potential for effects from accidental chemical release from vessel movements

The potential for chemical and oil spills during vessel movements, whilst recognised, would be managed by compliance with IMO regulations and the Government Pollution Prevention Guidelines. Therefore, no chemical release effects to the water and sediment quality of the local area are expected as compliance with established regulations minimises the risk of release events.

3.3.1.3 Potential for harmful effects of chemicals leaching from marine structures and coatings

Any chemicals used in marine construction will be selected from the list of notified chemicals assessed for use by the offshore oil and gas industry under the Offshore Chemicals (Amendment) Regulations 2011. Any coatings or treatments must be suitable for use in the marine environment in accordance with best environmental practice (Guidance for Pollution Prevention). Therefore, no chemical release effects from marine structures to the water and sediment quality of the local area are expected.

3.3.1.4 Metals

The volume of water that would need to be discharged during the initial dewatering phase will be around 300,000 m^3 based on the hydraulic properties of the materials within the cut-off wall around the main construction site (BEEMS Technical Report TR306 ED. 5 Ed. 5). Exploratory boreholes across the site showed different levels of contamination with dissolved metals and dissolved inorganic nitrogen (DIN) (Table 3). No other contaminants were detected (Atkins, 2016). Table 3 shows that there are no contaminants on the list of priority chemicals that are above the environmental quality standard (EQS).

There are specific requirements for the minimisation of the annual loads of the priority hazardous substances cadmium and mercury. Taking account of all groundwater discharge sources for the construction site the criteria not to exceed 5 kg and 1 kg, for cumulative loads of both cadmium and mercury, respectively. Annual loads are not exceeded over the three-year period of discharges (BEEMS Technical Report TR306 Ed. 5).

Table 3: Metal concentration range measured in SZC construction site and relevant EQS values and marine background concentrations (BEEMS Technical Report TR306 Ed. 5).

Substance	WFD priority substance	Mean dissolved concentration µg/l	95% dissolved concentration µg/l	Saltwater EQS AA µg/l	Saltwater EQS MAC µg/l	Marine Background concentration µg/l
Arsenic		3.55	11.5	25	-	1.07
Cadmium	✓	0.10	0.18	0.2	1.5	0.05
Chromium		6.39	18.45	0.6	32	0.57
Copper		1.87	4.25	3.76	-	2.15
Lead	✓	1.07	1.07[1]	1.3	14	-
Zinc		7.34	17.5	6.8[2]		15.12
Mercury	✓	0.013	0.023	-	0.07	0.02
Iron		395	1500	1000	-	50
DIN		3.55	5636	980[3]	-	426

1. The limited number of values above detection limits leads to a mean value higher than the 95 percentile which represents a value below detection limit therefore the higher mean value is used here, 2. Zinc toxicity may be reduced by elevated organic carbon levels and the EQS may be adjusted to take account of this but here the most conservative value is applied, 3. 99 % (70 µmol) converted to N standard for period 1st November – 28th February for dissolved inorganic nitrogen for Good status. Appendix B BEEMS TR306. Based on unpublished guidance more specific DIN value may be derived based on site average SPM 55mg/l however the value is used for initial screening, but a more thorough investigation is undertaken using modelling.

Annual load limits for the priority hazardous substances cadmium and mercury of 5 kg and 1 kg cumulative loads are not exceeded.

In the dewatering phase two groundwater metals, zinc and chromium failed initial EQS screening and GETM modelling was undertaken to determine the mixing rates and spatial extent of the impacts.

The mean background concentration of zinc in the environment is 15.12 µg/l whilst the EQS is 6.8 µg/l as an annual average. Since the background levels are in exceedance of the EQS, zinc discharges could not be assessed under standard procedures. Modelling predicted the point at which zinc concentrations would be indiscernible from background based on analytical detection limits of 0.4 µg/l. Therefore, the threshold value for zinc was set at 15.52 µg/l. Thus, the amount of change relative to baseline is approximately 2.5 %. Modelling demonstrated that zinc concentrations would only be discernible above background over a mean sea surface area of 0.11 ha. At the seabed, zinc concentrations are not predicted to exceed background concentrations.

Chromium has a mean EQS concentration of 0.6 µg/l and a 95 % EQS concentration of 32 µg/l. Chromium background concentration of 0.4-0.57 µg/l are reported for the site. As a precautionary measure the higher background concentration was applied to give a mean EQS threshold of 0.03 µg/l. Thus, the amount of change relative to baseline is approximately 5 %. A sea surface area of 0.34 ha exceeded the mean EQS, at the seabed chromium did not exceed EQS concentrations. The 95th percentile concentration (32 µg/l) was not exceeded (BEEMS Technical Report TR193 Ed. 5).

The dewatering phase is a short-term activity (28 days). Areas impacted extend over a very limited spatial area and the amount of change is small relative to the baseline conditions and no significant effects are predicted on ecological receptors.

3.3.1.5 Unionised ammonia

Ammoniacal nitrogen exists in both ionised and unionised form in the combined groundwater and sewage discharges from the construction site with the ratio of each determined by pH, temperature and salinity. Unionised ammonia is generally considered more toxic and has an annual average EQS of 21 µg/l. A mixing figure was used to determine the ratio of unionised to ionised ammonia as the groundwater and sewage mix with seawater (BEEMS Technical Report TR193 Ed. 5).

Treated sewage discharges from the CDO have the potential to exert toxicological effects on receptors should ammonia levels exceed EQS values.

The worst-case un-ionised ammonia discharge would occur in the unlikely event of a sewage only discharge. In this situation dilution modelling predicts exceedance of EQS concentrations up to 6.3 m from the point of discharge. EQS exceedance is within 4 m of the discharge for all other construction scenarios (BEEMS Technical Report TR193 Ed. 5). The limited spatial extend means significant effects are not predicted.

3.3.1.6 Tunnelling chemicals

The offshore cooling water infrastructure consists of two subterranean intake tunnels and one outfall tunnel. Tunnels would be excavated by tunnel boring machines (TBMs) from landward. Spoil from the cutting face of the TBMs would be removed by a screw conveyor, then transported by conveyor belt to the landward muck bay for licenced disposal. Groundwater would be generated from digging the galleries allowing access to the tunnels. During the transport of spoil material, groundwater and TBM chemicals can leach from the conveyor belts and fall to the tunnel floor. Wastewater on the tunnel floor would be discharged via the CDO. Discharges would be treated with a silt-buster or similar technology to minimise sediment inputs. Groundwater discharges are not considered to represent an environmental risk during the tunnelling phase (BEEMS Technical Report TR306 Ed. 5).

Chemicals used at the cutter face have the potential to persist in the leachate and are assessed further. This section considers assessments undertaken in relation to tunnelling chemicals, which are associated with three broad functions:

- fuelling and lubrication of the TBM;
- sealing the tunnel walls against water/soil ingress; and
- ground conditioning.

Fuel and lubricants would be subject to management protocols and oil/chemical spills will be contained by appropriate treatment and disposal. Sealants and greases are impervious to water and will remain associated with the tunnel walls or be removed with the spoil.

Ground conditioning chemicals are used at the cutter head to optimise TBM efficiency and include anti-clogging agents, anti-wear components and soil-conditioning compounds. The exact chemical constituents of the ground conditioning chemicals are dependent upon the ground conditions encountered on site and therefore cannot be precisely specified in advance of drilling trials by the tunnelling contractor. In order to enable the discharge to be assessed, wastewater parameters and representative chemicals are taken from those applied for Hinkley Point C assessments to envelope potential drilling options.

The underlying geology at Sizewell differs from Hinkley Point and a bentonite slurry tunnelling method is anticipated at Sizewell. Bentonite is a clay mineral regularly used in construction and offshore drilling operations. Bentonite is included on the OSPAR list of PLONOR substances (pose little or no risk to the environment). However, due to the potential for releasing fine material into the receiving waters an assessment was undertaken.

The concentration of bentonite in suspension is orders of magnitude lower than baseline SSC at the site with 95th percentile concentrations of 10 µg/l restricted to sea surface areas of approximately 11 ha (BEEMS Technical Report TR306 Ed. 5). In the tidally dominated environment characterised by high resuspension rates, the potential for sedimentation of fine materials to cause ecological effects during normal tunnelling processes is negligible. No further assessment is made.

In the case surfactant compounds are required (as at Hinkley Point), assessments consider the anti-clogging agent BASF Rheosoil 143 and the soil conditioning additive CLB F5 M as representative compounds. The active substances with the lowest Predicted No Effect Concentrations (PNEC) were applied for assessment purposes.

For the soil conditioning chemical discharges, the total Rheosoil plume areas at the EQS (40 µgl^{-1} as a mean and 95th percentile) were calculated. There is no exceedance at the bed and only very limited areas of exceedance at the surface 1.01 ha (5.83 as a 95th percentile) for a mean assessment. There was no exceedance of the EQS for CLB F5 M at the seabed and the area at the surface exceeding the EQS were relatively small with 3.14 ha exceeding the EQS for a mean assessment (25 ha as a 95th percentile) (BEEMS Technical Report TR193 Ed. 5).

Tunnelling is predicted to be a medium-term impact lasting several years in total. The use of TBM surfactants in the tunnelling process remains to be confirmed and assessments present a precautionary approach enveloping worst-case representative chemicals. Effects on ecological receptors are therefore predicted to be minimal.

3.3.2 Commissioning discharges

The CDO would act as a discharge point during part of the commissioning phase of the proposed development. Commissioning of the reactors is proposed to take place in two stages;

- cold flush testing; and
- hot functional testing.

The complete commissioning process for each unit would last for about 24 months and a 12-month gap is anticipated between the completion of the two reactor units. Cold flush testing mainly involves cleansing and flushing the various plant systems with demineralised water to remove surface deposits and residual debris from the installation. Cold-flush commissioning discharges from Unit 1 and Unit 2 are unlikely to overlap but a Rochdale Envelope approach was applied to represent the worst-case scenario whereby cold flush commissioning discharges for both Units from the CDO occurred simultaneously. This represents a highly precautionary assessment. A second (most likely) assessment assumes cold-flush testing discharges from Unit 2 are released via the CDO, whilst Unit 1 is operational. This represents a potential worst-case scenario for fish and other biota discharged from the FRR associated with Unit 1, approximately 340 m south of the CDO.

Cold flush testing discharges would include small quantities of conditioning chemicals including:

- hydrazine;
- ammonia;
- phosphate; and
- ethanolamine.

Modelling indicated that ethanolamine discharges never exceed the applied predicted no effect concentration (PNEC: 160µg/l) at the surface or seabed as a mean concentration or as a 95th percentile (BEEMS Technical Report TR306 Ed. 5). Ethanolamine is therefore not considered further.

Modelling results from GETM show there is no plume in exceedance of the EQS for the un-ionised ammonia. In the direct vicinity of the outfall (<5 m) the un-ionised ammonia of the discharge will exceed the EQS. But this behaviour is smaller than the model grid cell size (25 m). By the time the discharge has got to the boundary of the initial grid cell, mixing will have reduced the plume such that the EQS is not exceeded. Comparisons against previous nearfield modelling using CORMIX suggest a 16.8-fold dilution is achieved within approximately 10 m. Therefore, the GETM model was unlikely to produce a plume. The maximum concentration at the surface and seabed is 50 µg/l and 1.39 µg/, respectively. While this can be considered as a potential underestimate of the concentrations at the immediate point of discharge, however, it demonstrates that exceedance of EQS would be highly spatially restricted (BEEMS Technical Report TR193 Ed. 5).

Nutrient discharges, including phosphate and DIN are considered as part of the wider construction nutrient release scenarios (Section 3.4.1).

Hydrazine is considered in more detail below.

Hot flush testing takes place before fuelling the reactor once the cooling water infrastructure is operational. The effluent produced during hot flush testing would be diluted within the cooling water system before being discharged via the outfall tunnel.

3.3.2.1 Hydrazine

Hydrazine (N_2H_4) is an ammonia-derived compound with strong anti-oxidant properties, regularly used as a corrosion inhibitor in cooling water circuits of nuclear power stations. There is no established EQS for hydrazine and so a chronic PNEC (Predicted No-Effect Concentration) of 0.4 ng/l has been calculated for long term discharges (calculated as the mean of the concentration values) and an acute PNEC of 4 ng/l for short term discharges (represented by the 95th percentile).

During the commissioning phase, hydrazine would be used during cold-flush testing of the reactor units. Based on the Rochdale envelope approach, modelling took the precautionary position of both reactors being commissioned simultaneously with hydrazine discharged into the receiving waters via the CDO[7]. The model results predict the concentrations are higher at the surface than at the bottom, showing the stratification of the hydrazine plume caused by the difference in salinity with respect to the environment.

[7] Under the scenario that the second EPR is commissioned once the first is operational, hydrazine would be discharged via the cooling water flow. This scenario represents similar discharge conditions to those calculated during the operational phase (BEEMS Technical Report TR193 Ed. 5).

At the sea surface, the chronic PNEC of 0.4 ng/l, which is evaluated using the monthly mean model results, is exceeded in 30.5 ha, representing 0.208 % of the Suffolk coastal water body based on a release concentration of 15 µg/l. The acute PNEC of 4 ng/l, which is evaluated using the 95th percentile of the model results, is exceeded in 12.9 ha, representing 0.088 % Suffolk coastal Water body. Table 4 provides a summary of the areas of exceedance in the WFD water body.

Canadian Federal Water Quality Guidelines for hydrazine indicate concentrations below 200 ng/l have a 'low probability of adverse effects for marine life' (Environment Canada, 2013). The area of the hydrazine plume with a concentration greater than 200 ng/l is limited to the immediate vicinity around the CDO 0.34 ha as a 95th percentile (18.5 ha as a 100th percentile).

Further details can be found in BEEMS Technical Reports TR193 Ed. 5.

Table 4: Areas of PNEC exceedance for hydrazine discharges during commissioning.

Release Concentration	PNEC		WFD (Suffolk coastal waters 14653.59 ha)	
			surface	seabed
15 µg/l	Chronic 0.4 ng/l (as a mean concentration)	ha	30.5	2.92
		% of designated area	0.208	0.020
	Acute 4 ng/l (as a 95th percentile)	ha	12.9	2.92
		% of designated area	0.088	0.020

Once Unit 1 is operational, commissioning discharges from Unit 2, discharged via the CDO have the potential to intersect fish returned from the southern (Unit 1) FRR, approximately 340 m south of the CDO. Model results show that at the southern FRR, the hydrazine plume exceeds the acute PNEC at the surface and seabed. At a release concentration of 15 µg/l, the transitory peak concentration at the surface is predicted to be 176.4 ng/l. The average concentration of the plume at the surface above the PNEC (only including the times above the PNEC) is 15 ng/l. Whilst the plume regularly exceeds the acute PNEC, the duration of the exceedance is short, with concentrations exceeding the acute PNEC for no longer than 3.25 hours at a time. The total time above the acute PNEC represents 5.1 % of the modelled month and concentration never exceeds 200 ng/l (BEEMS Technical Report TR494). Given the limited sensitivity of fish to hydrazine, whereby lethal responses occur at concentrations orders of magnitude higher than the peak concentrations predicted at the southern FRR and the transitory nature of the plume, fish exposure to toxicological concentrations is minimal.

3.3.3 Operational discharges

Expected discharges to local marine waters from SZC during the operation may be broadly characterised as:

- Surface drainage from across the developed site;
- Sanitary wastewater from on-site purification plants;
- Effluent from demineralisation plant;

- Thermal elevation of the cooling water (see physico-chemical elements section 3.4.1)
- Chemicals discharged during the operation of the two units including hydrazine; and
- Chlorinated discharges.

The Sizewell C chemical discharges are evaluated in the H1 screening assessment BEEMS Technical Report TR193 Ed. 5 and thermal discharges in BEEMS Technical Report TR306 Ed. 5.

None of the expected discharges contain any contaminants on the WFD list of priority chemicals. The offshore location of the outfalls means that cooling water discharges rarely interact with the WFD water body with the exception of thermal discharges. Thermal discharges will be considered in further detail relative to the WFD assessment criteria.

3.3.3.1 Chlorinated discharges: Total Residual Oxidants (TRO)

Chlorination of the power station cooling water system would be required to avoid bio-fouling. The total residual oxidants (TRO) resulting from the combination of chorine and organic material in the water were modelled using an empirical demand/decay formulation derived from experiments with Sizewell seawater and coupled into the GETM Sizewell model based on a release of 0.15 mg/l. The TRO plumes from Sizewell C and Sizewell B are spatially distinct at ecologically relevant concentrations and follow a long narrow trajectory parallel to the coast (BEEMS Technical Report TR306 Ed. 5).

The EQS for TROs is10 µg/l as a 95th percentile. **Model outputs show that there is no intersection between the Sizewell C TRO plume (above the EQS) and the WFD Suffolk waterbody** (Figure 11).

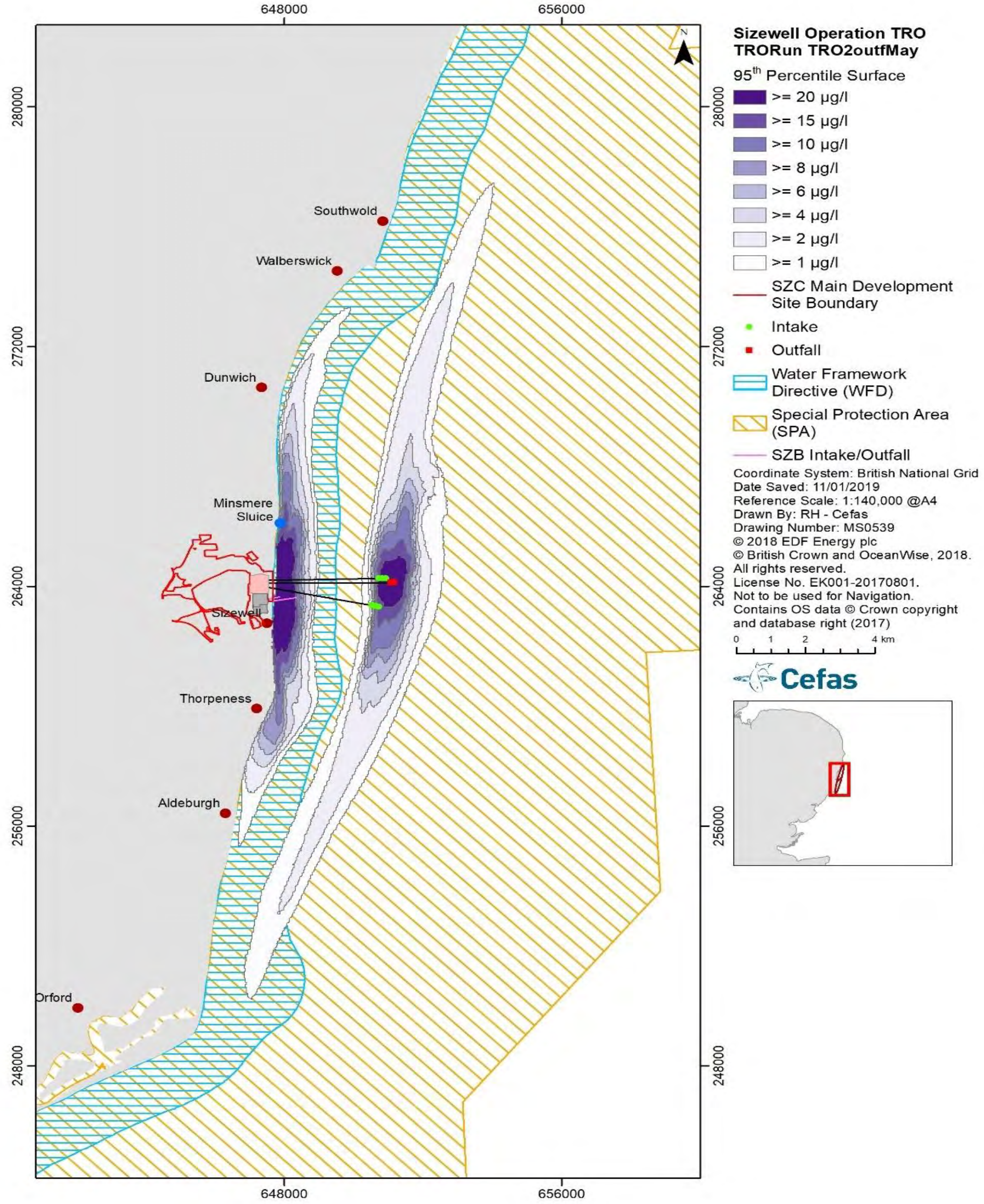

Figure 11: SZB + SZC modelling: 95th percentile of the TRO concentration at the surface (µg/l).

3.3.3.2 Chlorinated discharges: Chlorinated-by-products (CBPs) (Bromoform)

Depending on the water chemistry an array of chlorination by-products (CBPs) can be formed in addition to TROs. Seawater is rich in bromide, which reacts with chlorination compounds to produce CBPs. The most abundant CBP in discharges from coastal power stations, and the only product detected in the waters off Sizewell is bromoform. EQS concentrations for bromoform do not exist and a PNEC of 5 µg/l as a 95th percentile is applied as the recommended standard.

Like the TRO plume, the bromoform plume is a long, narrow feature parallel to the coast. The SZB plume is always within the channel inshore of the Sizewell-Dunwich Bank and does not overlap with the SZC plume that is outside the Bank (BEEMS Technical Report TR306 Ed. 5).

Results of bromoform modelling show that there is no intersection between the Sizewell C bromoform plume (above the PNEC) and the WFD Suffolk waterbody (Figure 12).

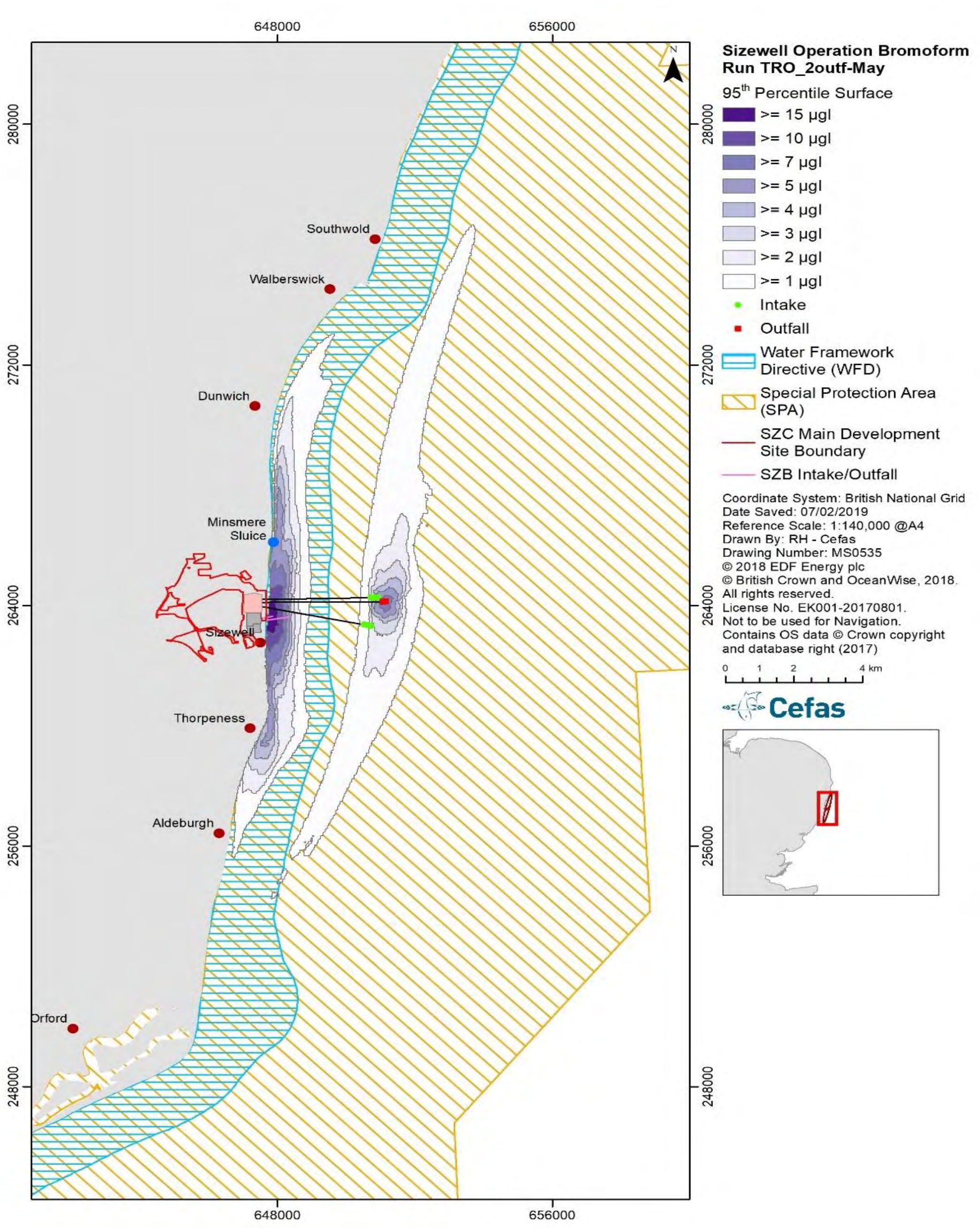

Figure 12: 95th percentile of the Bromoform concentration at the surface for chlorination from SZB and SZC (run Brom_2outf_May). Black line delineates the PNEC of 5 µg/l.

3.3.3.3 Hydrazine

During the operational phase daily hydrazine discharges result in a plume with a narrow trajectory parallel to the shore beyond the Sizewell-Dunwich Bank. **The results of operational hydrazine modelling show that there is no intersection between the Sizewell C hydrazine plume and the WFD Suffolk waterbody** (BEEMS Technical Report TR306 Ed. 5). Figure 13 shows the predicted surface plume resulting from a daily hydrazine discharge from Sizewell C.

The worst-case daily hydrazine production would be after wet lay-up of steam generators. However, hydrazine discharges would be treated until the hydrazine concentration falls below a level that is acceptable for a batch discharge. Wet lay-up is not expected in a normal refuelling outage. In the case of Sizewell B, wet lay-up first occurred ~15 years after first operation.

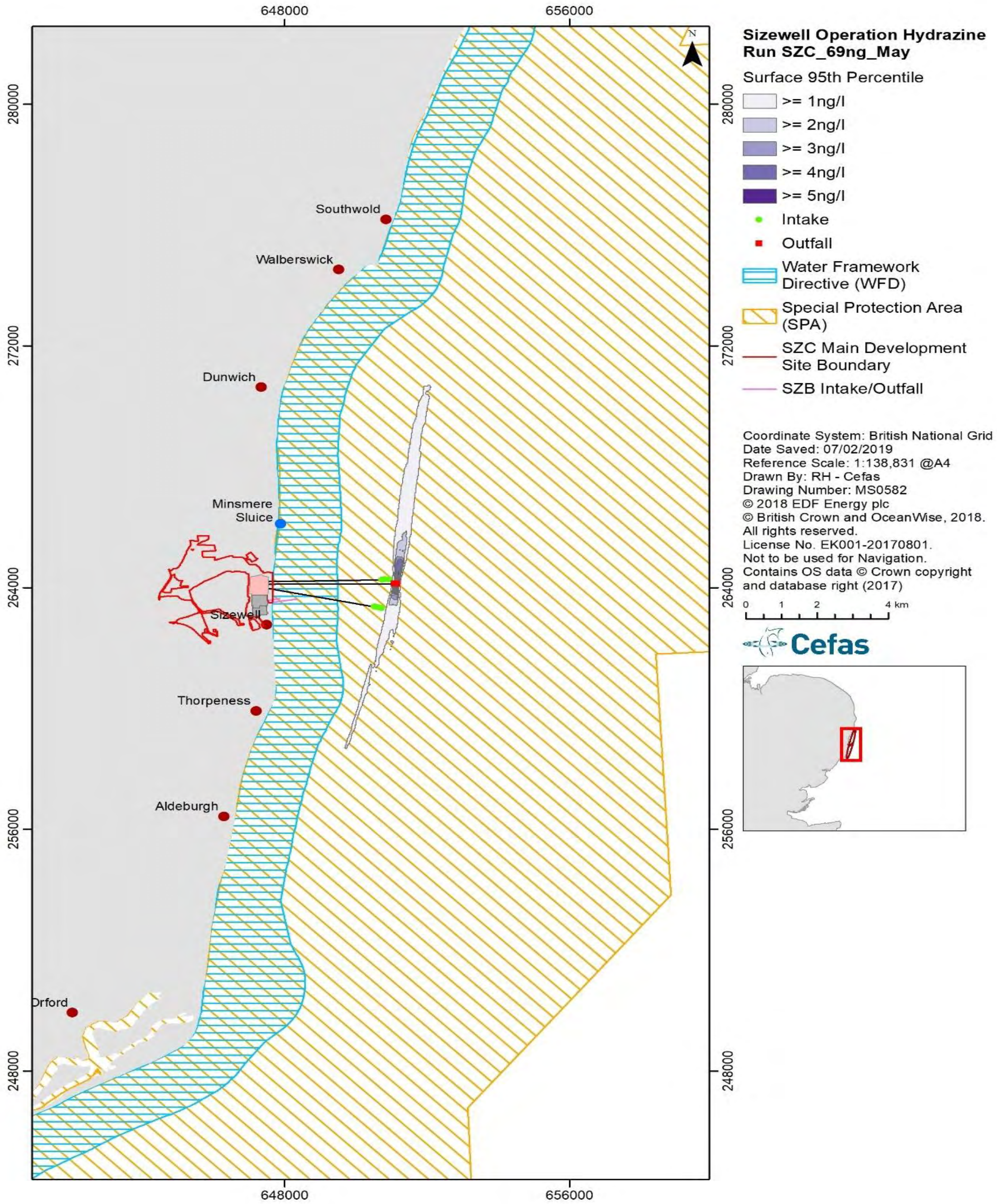

Figure 13: 95th percentile hydrazine concentration at the surface after release of 69 ng/l in pulses of 2.32 h from SZC (run Hydrazine_SZC_69ng_May).

3.4 Potential effects on ecological elements

The ecological status of a surface water body is assessed according to:

- The condition of relevant biological elements, for example fish, benthic invertebrates, phytoplankton and other aquatic flora;
- The condition of supporting physico-chemical elements, for example temperature, pH, oxygenation, salinity and concentrations of nutrients;
- The concentrations of specific pollutants; and
- The condition of the hydromorphological quality elements, including morphological condition, hydrological regime and tidal regime (coastal waters only covered Section in 3.2).

Biological standards are values defined for measures of ecological quality, such as the abundance of different species or groups of species of phytoplankton, fish or invertebrates. They describe the boundaries for ecological quality ratios (EQRs) between 5 ecological status classes (high, good, moderate, poor and bad) used to classify waterbodies. Assessment tools have also been developed for each of the elements which use a number of parameters to assess status.

Three of the four waterbodies identified in the Sizewell C Water Framework Directive Stage 2 Scoping Assessment (Suffolk, Blyth(S) and Alde & Ore waterbodies) are classed has having 'moderate' ecological status and Walberswick Marshes is classed as having 'good ecological status.

3.4.1 Physico-chemical elements

3.4.1.1 Nutrient additions

3.4.1.1.1 Construction and commissioning

The combined loadings of nitrogen and phosphorus as described from the construction and commissioning inputs together with relevant inputs from SZB resulting from the use of conditioning chemicals and the discharge of treated sewage were assessed (BEEMS Technical Report TR193 Ed. 5). For much of the year light availability limits phytoplankton growth and the addition of relatively small quantities of nutrients has no effect. In the summer, nitrate is a limiting nutrient (when light is not limiting) and is consumed rapidly. However, the exchange with the wider environment is much greater than the maximum proposed discharges, during construction and commissioning combined, so that no change in phytoplankton growth beyond natural variability would be observed. A Combined Phytoplankton and Macroalgae model Box model (BEEMS Technical Report TR385) run over an annual cycle and incorporating nitrogen and phosphorus inputs showed an insignificant increase in carbon levels (phytoplankton biomass) of 0.13 % within the Greater Sizewell Bay. Overall carbon levels decrease by approximately 5 % due to entrainment mortality and the added nutrients has a very minor influence on this (BEEMS Technical Report TR193 Ed. 5).

3.4.1.1.2 Operation

During the operational phase, maximum daily loading for nitrogen therefore reach approximately 2% of the daily exchange for Sizewell Bay, but the average daily value assessed in BEEMS TR385 is low at 0.4 % (considered negligible as the nutrient exchange with the wider marine environment is much greater than the maximum proposed discharges). A re-evaluation of the combined inputs from the FRR taking account of the updated impingement assessment result in a value of 0.3% of the daily exchange for the daily average nitrogen input and a reduced value also for phosphorus (BEEMS Technical Report TR520).

3.4.1.2 Dissolved Oxygen

3.4.1.2.1 Construction

Monitoring of dissolved oxygen (DO) levels at Sizewell has shown levels range between 7 and 11mg/l. Minimum summer dissolved oxygen values were recorded in July 2015 (6.96 -7.04 mg/l) but remained well above the WFD threshold for 'high' (5.7 mg/l) (BEEMS Technical Report TR306 Ed. 5).

During the construction phase discharges from the CDO would result in the biochemical oxygen demand (BOD) falling to background within a few 10s of metres from the discharge head and would not be expected to deviate from the background BOD by more than 1.5 mg/l which would mean that DO levels would not be reduced by more than 0.5 mg/l. Therefore, DO is likely to remain at high status. The discharges of BOD during construction are therefore considered to be of negligible significance for dissolved oxygen modification (BEEMS Technical Report TR193 Ed. 5).

3.4.1.2.2 Operation

Decaying biomass from the FRRs would increase the BOD biochemical oxygen demand and has the potential to reduce dissolved oxygen levels. The waters off Sizewell are well mixed vertically facilitating reaeration at the surface and the rate of water exchange within the GSB would limit the extent and duration of any oxygen reduction.

Background dissolved oxygen concentrations conforms to 'high' status within the WFD waterbody and includes the influence of Sizewell B. The biological oxygen demand from biomass discharged from the FRRs is predicted to have a negligible effect on water quality.

3.4.1.3 Microbiology

Under bathing water regulations discharges containing faecal bacteria must be treated to ensure that the concentration of key indicator organisms will meet a designated standard for coastal and transitional waters for which Good status for Transitional and Coastal waters requires that the colony forming unit (cfu) counts for intestinal enterococci are ≤200 cfu/100 ml and for *Escherichia coli* are ≤500 cfu/100 ml.

3.4.1.3.1 Construction

During the construction phase secondary or tertiary (possibly UV) treated sewage would be released via the CDO. Following either sewage treatment at the distance from the CDO discharge point, at which enough dilution occurs to be below relevant microbiological standard levels, has been estimated using CORMIX.

CORMIX estimates show that the concentration of *Enterococci* is likely to exceed the bathing water standard only within 460 m for the maximum discharge with no tertiary treatment. With tertiary treatment, exceedance is limited to within less than 1 metre of the discharge. Treatment from the plant is sufficient to ensure that *E. coli* concentrations in discharged waters comply with bathing water standards within a maximum of 3.1 km from the discharge point (without UV treatment) and <1 m (with UV treatment).

The nearest designated bathing waters are Southwold the Denes (latitude 52.32º N, longitude 1.679º E) and Felixstowe North (latitude 51.96º N, longitude 1.355º E) and are approximately 10 km and 35 km distant, respectively. As the microbiological modelling assessment indicates a relatively small distance over which indicator organism numbers would exceed the good bathing water standard and the nearest designated bathing waters are approximately 10km distant, there is a negligible risk to bathing water quality (BEEMS Technical Report TR193 Ed. 5).

3.4.1.3.2 Operation

Microbiological input from sewage discharge during operation is indicated to be compliant with bathing water standards at the point of discharge based on secondary treatment and within system dilution (BEEMS Technical Report TR193 Ed. 5).

3.4.1.4 Thermal discharges

3.4.1.4.1 Operation

Thermal discharges would occur throughout the operational phase of the proposed development. The worst-case thermal impact would occur during the operation of Sizewell B and Sizewell C and is therefore the focus of assessments. Additional scenarios, including Sizewell C operating in isolation and a Sizewell C maintenance scenario have also been considered.

The thermal plume from both Sizewell B and Sizewell C was modelled using the validated Sizewell GETM an additional scenario with Sizewell C operating in isolation is also provided (BEEMS Technical Report TR306 Ed. 5).

The WFD standards for water quality apply for both absolute water temperatures and temperature uplift:

1. Annual 98th percentile of the absolute water temperature

T < 20˚C	=	High
20˚C < T ≤ 23˚C	=	Good
23˚C < T ≤ 28˚C	=	Moderate
T > 28˚C	=	Poor

2. Annual 98th percentile uplift in water temperature

Uplift ≤ 2˚C	=	High
2˚C < Uplift ≤ 3˚C	=	Good
Uplift > 3˚C	=	Moderate

Unlike chemical standards which normally have a clear evidence link to ecological effects, thermal standards are not always evidence based due to a lack of reliable data (BEEMS Scientific Advisory Report SAR008). In order to be protective of the most sensitive species, thermal standards have, therefore, been set on an indicative basis and, as such, they act as trigger values for further investigation of potential ecological effects.

BEEMS SAR008 reviews the available evidence on thermal effects and concludes:

> *"The available data confirms that adverse effects of CW outfalls are restricted to an area close to the plume, that temperature rises up to 3 °C appear to be tolerable, and that resulting temperatures of less than 27 °C have no clear deleterious impact on species in the receiving waters, but, in the longer term, changes in the local community may result as species with differing tolerances of elevated temperature show differing survival, growth and patterns of reproduction from those expressed under ambient conditions. Furthermore, populations that persist adjacent to a heated CW effluent will acclimate to those new local conditions and evolve in response to them"*

The SZC and SZB plumes are separate at high plume temperatures but at lower temperatures, the SZC plume acts to increase the size and temperature of the SZB plume at the surface and the seabed (BEEMS Technical Report TR301). This means that the thermal effects of SZC also contribute to a magnified Sizewell B plume (the Sizewell C plume is smaller and largely outside the 1nm offshore limit of the WFD water body). Figure 15 and Figure 14 illustrate the effect of the Sizewell C cooling water discharge on the Sizewell B thermal plume.

Table 6 shows the results of applying these standards to the predicted output from the SZB+SZC thermal plume modelling. At the request of the Environment Agency the area of exceedance has also been calculated using GETM absolute temperatures outputs, these values are presented in BEEMS Technical Report TR302 but should be treated with caution as GETM is known to overestimate absolute temperatures.

The area of the Suffolk waterbody exposed to temperatures >28 °C as a 98th percentile is negligible during the SZB+SZC run (0.11 ha). The area of the Suffolk waterbody exposed to temperatures >23 °C as a 98th percentile is 87.7 ha at the surface and 23.8 ha at the seabed for SZB and SZC combined. The SZC only run shows no areas of exceedance of the absolute temperature thresholds (Table 5). These areas represent a WFD classification of moderate.

Exceedance of the 3°C excess temperature standard occurs over a 1,550 ha at the seabed and 1,859 ha at the surface during the operation of SZC + SZB (Table 6). These areas represent a WFD classification of moderate.

Once Sizewell B is decommissioned, the Sizewell C plume results in no exceedance of the thermal uplift thresholds within the WFD waterbody.

The Sizewell B only thermal discharge plume is displayed in Figure 15.

The Sizewell B + Sizewell C thermal discharge plume is displayed in Figure 14.

The Sizewell C only thermal discharge plume is displayed in Figure 16.

Table 5: Area of the Suffolk coastal water body (14,653.59 ha) where the Water Framework Directive absolute temperature standards are exceeded. Values represent uplifts within the WFD water body, not absolute areas.

Model run	Position		**>23 °C (98th percentile)** Calculated from mean excess temperature >3.6 °C (WFD 'moderate' status)	**>28 °C (98th percentile)** Calculated from mean excess temperature >8.6 °C (WFD 'poor' status)
ReferenceV2 annual SZB	Surface	ha	43.77	0
		%	0.30	0
	Seabed	ha	8.63	0
		%	0.06	0
Conf12 annual SZB+SZC	Surface	ha	87.66	0.11
		%	0.60	<0.01
	Seabed	ha	23.81	0
		%	0.16	0
Conf12 annual SZC	Surface	ha	0	0
		%	0	0
	Seabed	ha	0	0
		%	0	0

Table 6: Area of the Suffolk coastal water body (14,653.59 ha) where the Water Framework Directive uplift temperature standards are exceeded. Values represent uplifts within the WFD water body, not absolute areas.

Model run	**Position**		**Excess temp. >2 but ≤ 3 °C (98th percentile)** WFD assessment ('good' status)	**Excess temp. >3 °C (98th percentile)** WFD assessment ('moderate' status)
ReferenceV2 annual SZB	Surface	ha	2,428	1,260
		%	16.6	8.6
	Seabed	ha	2,121	665
		%	14.5	4.5
Conf12 annual SZB+SZC	Surface	ha	4,123	1,859
		%	28.1	12.7
	Seabed	ha	3,758	1,550
		%	25.6	10.6
Conf12 annual SZC	Surface	ha	0	0
		%	0	0
	Seabed	ha	0	0
		%	0	0

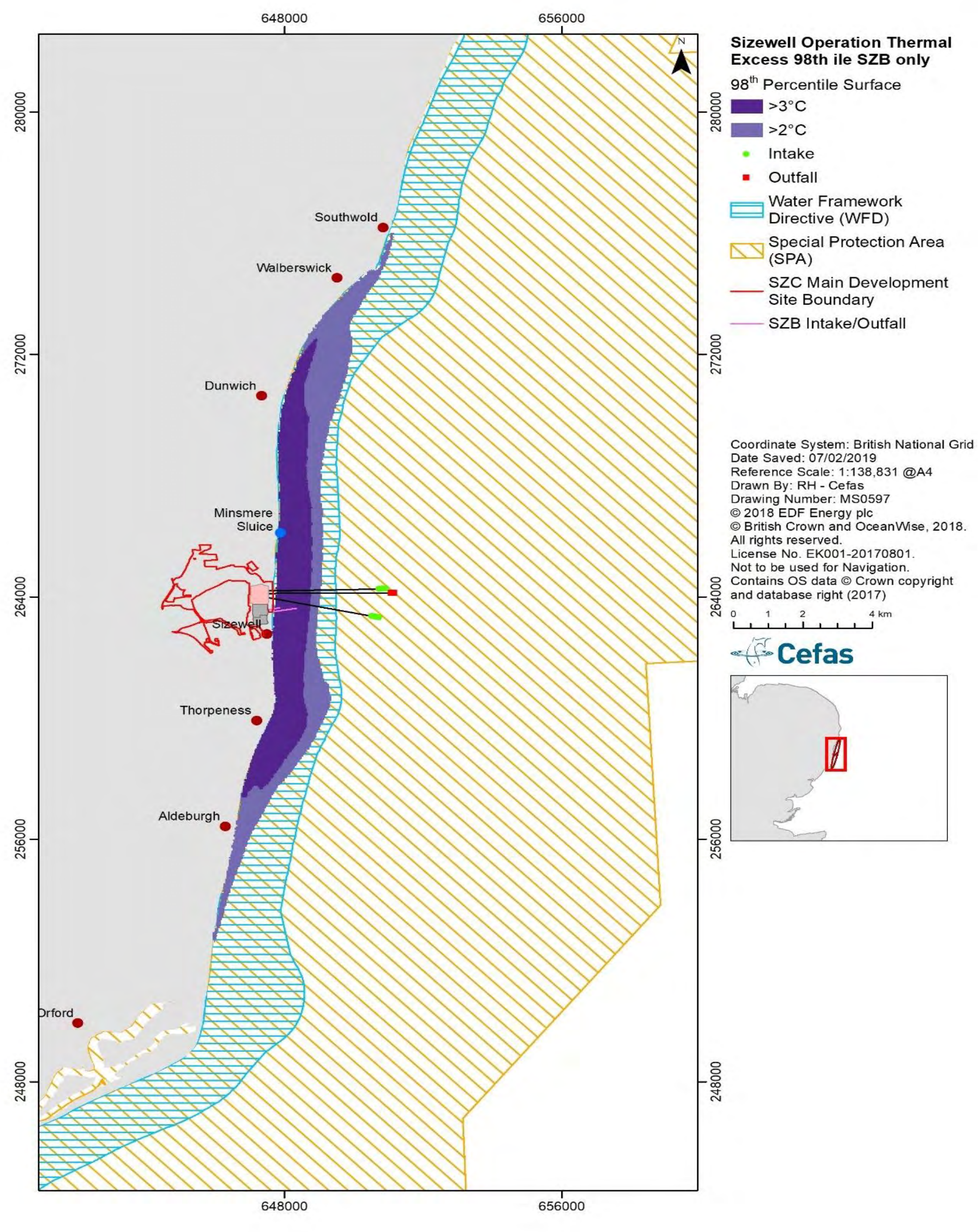

Figure 14: 98th percentile of surface excess water temperature showing >2 and >3 °C contours for run with only SZB operating.

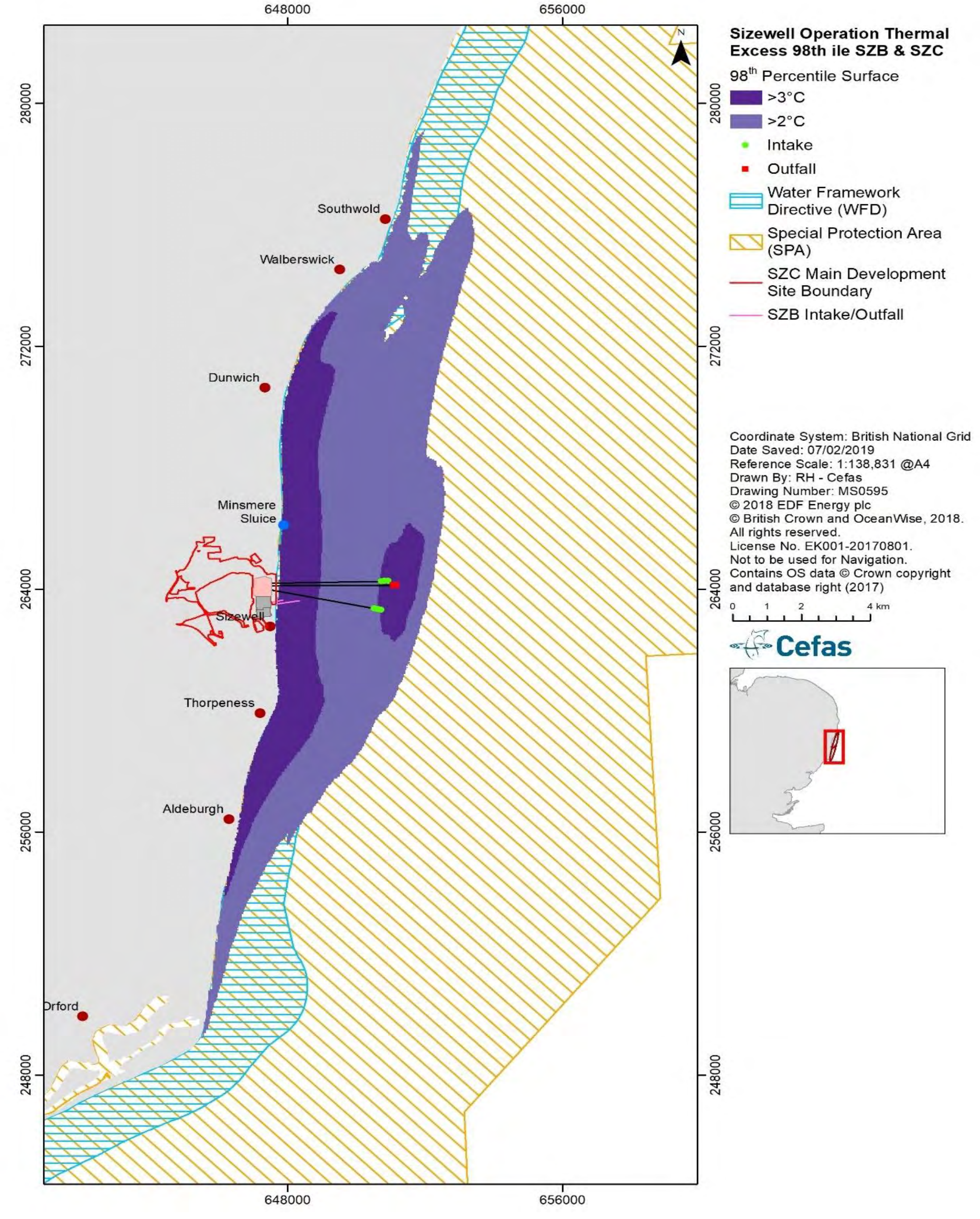

Figure 15: 98th percentile of excess surface water temperature showing >2 and >3 °C for run with SZB and SZC operating.

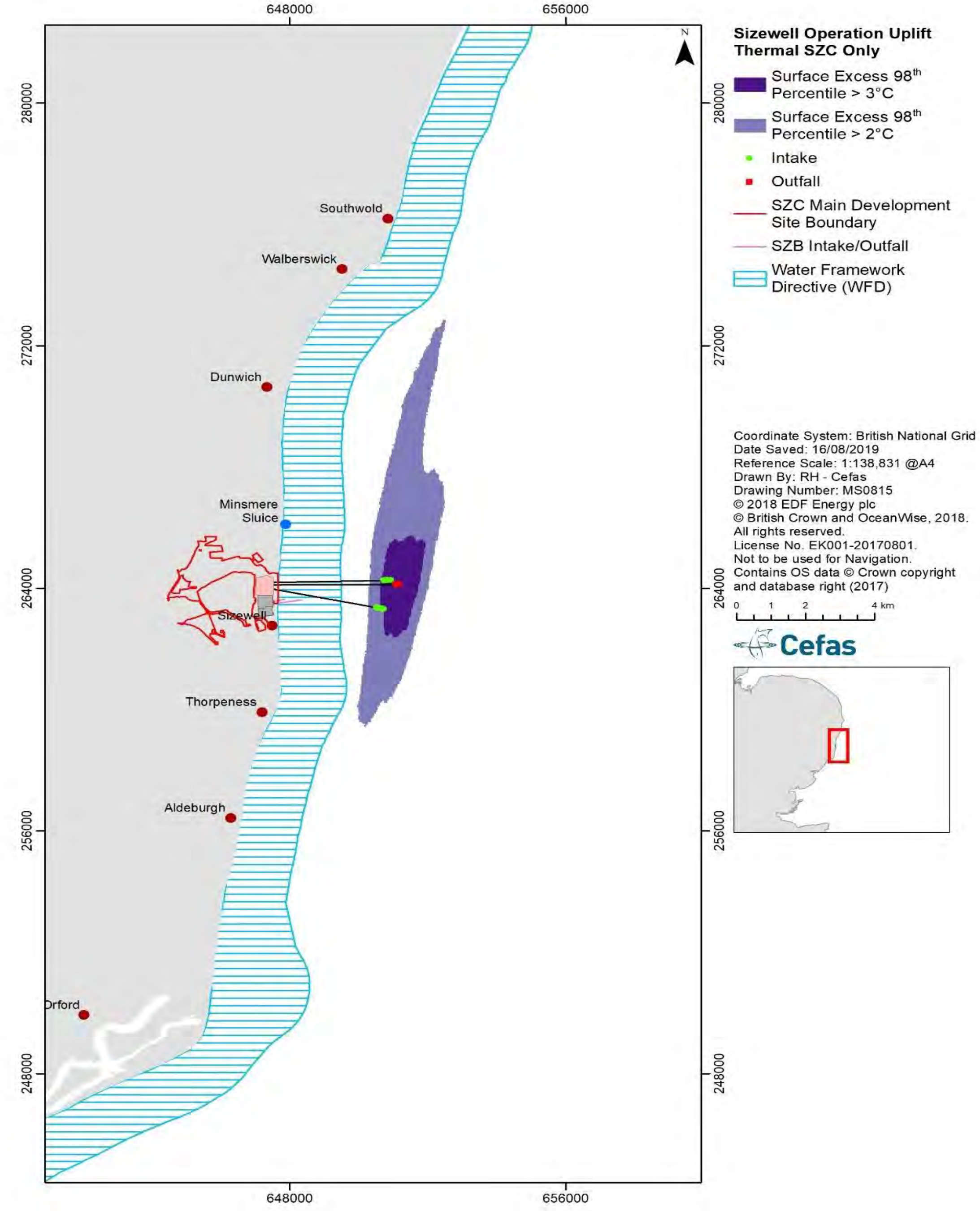

Figure 16: 98th percentile of surface excess water temperature showing >2 and >3 °C contours for run with only SZC operating.

3.4.1.5 Thermal discharges during a hypothetical maintenance scenario

A potential worst-case scenario was assessed during normal operation of Sizewell B and maintenance of Sizewell C, whereby two of the four pumps are not operating but the two EPR Units remain running at full power. Such circumstances are unlikely but would result in approximately half the cooling water abstraction rate with the same level of thermal energy applied. Therefore, excess temperatures could potentially rise from 11.6 °C to 23.2 °C.

Modelling has demonstrated that a warmer thermal plume loses heat faster to the atmosphere resulting in less heat being mixed down into the water column. In the direct vicinity of the outfall (<5 m) the temperature of the discharge will exceed an absolute temperature of 28 °C. But this behaviour is smaller than the model grid cell size (25 m). By the time the discharge has got to the boundary of the initial grid cell, mixing will have reduced the temperatures such that the 28 °C absolute is not exceeded. Area calculations of the 98th percentile, as predicted by the mean excess plus the observed 98th percentile background temperature (see BEEMS Technical Report TR302), show no exceedance of 28 °C (Table 7). However, as the mean surface temperature difference at the SZC outfall (+4.6 °C) that occurs with the maintenance run is higher than +3.6 °C with the normal run, then more heat will be lost to the atmosphere. This means that less heat is added to the overall water body and reduces the interaction with the SZB plume. As the SZB plume discharge is in shallow water (-5.1 m ODN compared to -16.8 m ODN at SZC outfall), it is there that the exceedance above 28 °C occurs (for the normal SZC + SZB run) and that reduction of the SZC contribution drops the combined SZB (plus SZC uplift) below 28 °C.

While this can be considered as a potential underestimate of the temperature at the immediate point of discharge, it demonstrates that exceedance of 28 °C thresholds would be highly spatially restricted.

The total area where absolute temperatures exceed 23 °C as a 98th percentile are lower than during the standard operating procedures (Table 7). As the areas of exceedance at the surface and bed are smaller during the maintenance run than the normal operating condition, impact assessments consider only the normal operating condition (Table 5; BEEMS Technical Report TR306 Ed. 5).

Table 7: Total areas where WFD absolute temperature standards are during the ‘maintenance scenario’. Values represent absolute areas and are not restricted to intersections with the WFD waterbody.

Model run	Position		98th percentile >23 °C. Calculated from mean excess temp.>3.6 °C	98th percentile >28 °C. Calculated from mean excess temp.>8.6 °C
Conf12_maint-May	Surface	ha	37.79	0
	Seabed	ha	5.38	0

3.4.1.6 Potential for fish avoidance of thermal plumes

Minimal evidence supports thermal avoidance of modest thermal uplifts causing avoidance behaviours and temperature increases of >2°C may not be a significant deterrent to the movement of a number of important species (BEEMS Technical Report TR302).

As a precautionary measure, existing thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25 % with a temperature uplift above 2 °C, for more than 5 % of the time (BEEMS Scientific Advisory Report SAR008). The thermal plume only intersects the mouth of the Alde-Ore at excess temperatures in the 0 °C to 1 °C range as a 98^{th} percentile and the standard for thermal barriers in estuarine waters is not, therefore, exceeded (BEEMS Technical Report TR302). The SZB+SZC thermal plume intersects the Blyth estuary at temperatures in the 2 °C to 3 °C range as a 98^{th} percentile and there is, therefore, a potential to exceed the estuarine thermal standard and to create an impact on the movement of migratory fish. The temperatures in the cross section across the estuary mouth was extracted from the GETM SZB+SZC model outputs. The thermal plume intersects over 25 % of the Blyth estuary cross section above 2 ºC for 3.5 % of the annual model simulation (307 hours per annum), less than the 5 % threshold.

There are no thermal standards to assess potential migration barriers for fish in coastal waters. However, if fish have to pass through a coastal plume on their migration route to or from an estuary there remains the possibility of the plume acting as a barrier to migration. In BEEMS Technical Report TR302 the results from available laboratory thermal preference experiments were used applying the same thermal standards to a 3 km corridor from the coastline. Modelling results shows that smelt, sea trout, glass eel and silver eel with avoidance thresholds of ≥3 °C would experience a barrier to migration (constituting 25 % of the coastal corridor) less than 5 % of the time during their migratory periods in the transect from the coast to the Sizewell C outfalls. Thermal barriers were also considered in relation to migratory lampreys. During a subset of the river lamprey migration period (from October to December), a 2 ºC uplift is predicted to occur over 25 % of the estuary mouth for 5.6 % of the time, however, thermal barriers are not predicted to last for more than 1 day. Given the high percentage of the transect that would be available for a Sizewell transit and the low likelihood that such a transit would actually take place, the Sizewell thermal plumes are not considered to present a barrier to migration for sea and river lampreys. It is concluded that the presence of thermal plumes off Sizewell would not present a barrier to migrating fish of conservation concern (BEEMS Technical Report TR302).

BEEMS Scientific Position Paper SPP101 considered the potential effects on smelt in the Alde-Ore transitional water body. Impingement monitoring at Sizewell B demonstrates that smelt did not avoid the area of the intakes when water temperatures reached their maximum (maximum annual temperature predicted to be 22.6°C). There was also no evidence that large fish are more likely to avoid the area of the intakes with increasing excess seabed temperatures up to 2.5°C (BEEMS Scientific Position Paper SPP101).

The potential for avoidance of thermal plumes is considered in the HRA assessment in relation to availability of fish as a prey resource for designated species.

3.4.1.7 Sensitivity of benthic invertebrates to thermal plumes

Benthic invertebrates are ectotherms. As their body temperature is externally regulated, they are subjected to the ambient thermal conditions, which affects their behaviour and physiology (Reiser *et al.*, 2016). The potential effects of cooling water discharges on benthic organisms fall under three categories (BEEMS Scientific Advisory Report SAR008):

- Chronic effects due to long-term increases in mean temperature on biological processes (growth, reproduction).
- Acute effects where absolute temperatures approach lethal levels.
- Stress caused by short-term fluctuations associated with the passage of thermal fronts.

As biological response to increases in temperature is species-specific, assessments consider the effect on survival and life history of the key benthic taxa identified in the benthic characterisation report for the GSB (BEEMS Technical Report TR348). Pelagic eggs and larvae of benthic invertebrates are considered as a separate sub-receptor of this pressure. Assessments draw on experimental and observational evidence relating to the acute and chronic response of organisms to temperature uplifts, as well as documented latitudinal and depth distributions of species. Regarding latitudinal distributions, a species was considered less sensitive to mean thermal uplifts if its range extends to low latitudes (i.e. warm waters) and more sensitive if its range is restricted to high latitudes (i.e. cold waters). Regarding depth distributions, a species is considered less sensitive to temperature fluctuations if it inhabits shallow waters (i.e. intertidal and shallow subtidal zones, where temperatures fluctuate daily) and more sensitive if it only inhabits deeper waters (where temperature is relatively stable).

The sensitivity of benthic invertebrates within the GSB to temperature changes due to cooling water discharges ranges from *Not Sensitive* to *Low* (Table 8). There is little evidence that acute effects are likely and the thermal plume area of exceedance against relevant standards at the seabed is relatively small (see section 3.4.1.4.1). However, some cold-water species, such as *Limecola balthica*, are predicted to incur chronic effects associated with reduced growth and/or reproduction over a limited spatial area, while species that prefer relatively warm water, such as *Crangon crangon*, may experience increases in physiological processes. Differences in species responses to the thermal plume may lead to minor changes in community composition, but such changes are unlikely to alter the functioning of benthic communities within the GSB.

The limited sensitivity of species to temperature changes associated with cooling water discharges and the likelihood of recruitment from source populations outside the zone of influence mean that effects of the thermal plume on benthic invertebrates are predicted to be minor.

Table 8: Sensitivity of key benthic invertebrate taxa and pelagic eggs and larvae to temperature change due to cooling water discharges from the CWS outfalls.

Key taxa	Evidence	Sensitivity
Abra alba (white furrow shell)	Distribution extends from Norway to the Mediterranean (Hayward and Ryland, 2011) and from the infralittoral zone to about 60m depth (BEEMS Technical Report TR348). The broad latitudinal range of the species suggests resistance to increases in mean temperature, while its presence in the intertidal zone implies resistance to temperature fluctuations. These suggestions are supported by the persistence of *Abra alba* populations in vicinity of two nuclear power stations (Penly and Graveline) on the French coast (Dreves *et al.*, 2010; Antajan *et al.*, 2013). The species has a short life span, rapid growth, long larval stage and can spawn multiple times within a year, which makes it an opportunistic taxon	*Not Sensitive*

Key taxa	Evidence	Sensitivity
	as well as a pioneer species capable of rapidly colonising muddy-sand substrate previously disrupted (Dauvin *et al.*, 1993).	
Ensis spp. (razor shell)	Distribution extends from Norway to the Mediterranean and west Africa, suggesting tolerance to increases in mean water temperature within the GSB. Moreover, *Ensis* spp. is a burrow-dweller (BEEMS Technical Report TR348) and can adapt its behaviour to temperature fluctuations, as observed during extreme cold events (Crisp, 1964). No mortality is expected due to cooling water discharges during the operation of the proposed development. Temperature is an important trigger for gametogenesis and spawning, with higher temperatures tending to extend the spawning period and cause a greater number of gametes to be released (Cardoso *et al.*, 2009; Cross *et al.*, 2014), as is observed in southern populations (Cross *et al.*, 2014). The effects of potential changes to spawning within the zone of influence are unclear; however, the widespread distribution of the species in the GSB and southern North Sea indicate that population-level effects are unlikely.	*Not sensitive*
Limecola balthica (Baltic tellin)	Distribution extends along the European coasts from the White Sea to Portugal, but has contracted at its southern limit due to warming (Jansen *et al.*, 2007). The species appears to be sensitive to warmer winter temperatures (Honkoop and Van Der Meer, 1998), which are associated with reduced fecundity , earlier and reduced recruitment (Honkoop *et al.*, 1998; Philippart *et al.*, 2003) and reduced condition (Honkoop and Beukema, 1997). Experiments showed that a 2.5 °C increase in winter temperatures led to fewer eggs being produced, while growth and survival were impaired at temperatures >20°C under laboratory conditions (de Wilde, 1975; Honkoop *et al.*, 1998). Chronic effects on individuals within the zone of influence are possible. However, the species has high fecundity (Caddy, 1967) and there is potential for recruitment from source populations outside the zone of influence. Indeed, *L. balthica* is a characteristic taxon within the fine muddy sands of the Suffolk coast (Barne *et al.*, 1998) and a small proportion of the local population would be exposed to the thermal plume.	*Low*
Mytilus edulis (common mussel)	Distribution extends from the Arctic to the Mediterranean, suggesting tolerance to increases in mean water temperature within the GSB. Few mussel beds are found along the Suffolk coast and most of the individuals found in the GSB are juveniles, possibly due to the limited availability of hard substrate for attachment (BEEMS Technical Report TR348). Experiments	*Not sensitive*

Key taxa	Evidence	Sensitivity
	show that elevated temperature does not affect the growth of the species, as it adapts its metabolic and feeding rate to temperature change (Widdows, 1976; Kittner and Riisgård, 2005). *Mytilus edulis* populations around Great Britain have a thermal tolerance limit of about 29°C (Read and Cumming, 1967; Almada-Villela *et al.*, 1982).	
Nucula nitidosa and *N. nucleus* (bivalve mollusc)	Direct evidence on the tolerance of this genus to elevated temperature is scarce. The distributions of *N. nitidosa* and *N. nucleus* extend from south Norway to Africa, suggesting tolerance to increases in mean water temperature within the GSB. On the other hand, both species are restricted to deeper subtidal areas of the GSB, suggesting lower tolerance to temperature fluctuations than would be implied if these species were found in intertidal or shallow subtidal areas. Indeed, a negative correlation between depth and thermal tolerance has been demonstrated for circalittoral bivalves (Wilson, 1981). As both species are common in the subtidal muddy sands of the Suffolk coastal region (Irving, 1998), individuals within the zone of influence constitute a small proportion of the local population. Both species also have high fecundity (Wilson, 1992). Therefore, if reproduction is inhibited by warming, recruitment could occur via source populations outside the zone of influence.	*Low*
Buccinum undatum (common whelk)	Widely distributed throughout the North Atlantic. An experiment on the thermal tolerance of the species shows adaptation to temperatures above those currently experienced in its natural environment (Smith *et al.*, 2013). Indeed, its abundance increased in an area under the influence of the thermal plume from a nuclear power station in Bradwell, with the species recorded very close to the outfall structure (Hawes *et al.*, 1975). However, the thermal tolerance observed during experiments comes at an energetic cost, with warming reducing the number of offspring (Smith *et al.*, 2013). Few *B. undatum* individuals were collected in the GSB during baseline surveys (BEEMS Technical Report TR348), although the gears used in the surveys were not selected to target this species. The species is, however, common in the southern North Sea. Therefore, a small proportion of the local population would be exposed to this pressure. Moreover, the mobility of the species would allow it to migrate in or out of the zone of influence according to its temperature preference.	*Not sensitive*
Cancer pagurus (brown crab)	Distribution extends from Norway to west Africa, suggesting tolerance to increases in mean water temperature within the GSB. The species is also found from intertidal to subtidal areas (90m depth), suggesting tolerance of temperature fluctuations and a	*Not sensitive*

Key taxa	Evidence	Sensitivity
	wide thermal range. These suggestions are reaffirmed by an experiment which found that the first signs of heat stress occurred at 31 °C for crabs collected in the North Sea near Hartlepool during summer and 23 °C for crabs collected during winter (Cuculescu *et al.*, 1998). Another experiment showed increased thermal tolerance of *C. pagurus* following heat-shock (1h exposure to lethal temperature) (Hopkin *et al.*, 2006). The species is highly mobile and undertakes migration between inshore and offshore areas on an annual basis (Nichols *et al.*, 1982). Heat stress could therefore be avoided by adult movement if physiological tolerance is exceeded.	
Homarus gammarus (European lobster)	Distribution extends from Norway to the Mediterranean, suggesting tolerance to increases in mean water temperature within the GSB. Elevated temperature tends to increase moult frequency and, therefore, enhance the growth of this species, as well as bringing forward spawning period (Lewis, 2002). A high mortality rate has been observed for juveniles kept in tanks at 28 °C (Richards, 1981); however, areas predicted to exceed 28 °C in the GSB are <1 ha at the seabed. Moreover, the high mobility of *H. gammarus* would allow it to avoid exposure to such temperatures and access alternative areas that are within its preferred temperature range. While this would lead to a small, very localised reduction in population density, it would likely also prevent any acute or chronic effects on the species.	*Not sensitive*
Crangon crangon (brown shrimp)	The population in the GSB is part of a larger interconnected southern North Sea population, extending from Spurn Head to Dungeness and including the Dutch and Belgian coasts (Henderson *et al.*, 1990). The species is adaptable to a wide range of environmental temperatures due to both physiological (i.e. seasonal plasticity in thermal preference) and behavioural (i.e. seasonal offshore migration) adaptations (Reiser *et al.*, 2014, 2016). The species may even benefit from warming inside the zone of influence, as higher recruitment has been observed under warmer mean temperatures from January through August (Henderson *et al.*, 2006). However, as a very small proportion of the population would be exposed to thermal uplifts, any effects on individuals would likely be undetectable at the population level.	*Not sensitive*
Pandalus montagui (pink shrimp)	Distribution extends from Greenland and Iceland to the British Isles. The species is common in the GSB and the wider North Sea (BEEMS Technical Report TR348), but as the GSB is close to the southern limit of the species it likely has a low tolerance to increases in temperature. The species is, however, highly mobile and has been observed moving to reach its preferred temperature range (Stevenson and Pierce, 1985). Therefore, behavioural	*Low*

Key taxa	Evidence	Sensitivity
	avoidance of exposure to lethal temperatures within the GSB is possible. This would lead to a very localised reduction in population density. It is unclear whether any individuals would suffer mortality as a result of temperature uplifts, but any such effect would likely be restricted to a very small proportion of the local population.	
Bathyporeia elegans (sand hopper, amphipod)	Distribution extends from Norway to west Africa and from the infralittoral zone to 40 m depth (Hayward and Ryland, 2011). These observations suggest a tolerance to increases in mean temperature within the GSB as well as temperature fluctuations. The growth rate of amphipods is regulated by temperature, with moulting frequency increasing in warmer water. Amphipods reach sexual maturity after a fixed number of moults and, therefore, an increase in temperature could hasten the onset of sexual maturity for individuals within the zone of influence of the thermal plume. The consequences of early recruitment on the population are unclear; however, no mortality is expected. *Bathyporeia elegans* is typical of sandbank habitats along the Suffolk coast, where it can occur in high abundances (d'Udekem d'Acoz, 2004; EMU, 2012). A small proportion of its local population would therefore be exposed to this pressure.	*Not sensitive*
Gammarus insensibilis (lagoon sand shrimp)	Distribution extends from England to the Mediterranean, with the Humber Estuary considered to be the northern limit of the species (Gates, 2006). *Gammarus insensibilis* is relatively common in waters to the south of the GSB, suggesting that it prefers relatively warm water. Moreover, the species primarily inhabits saline lagoons, including those near the GSB (Sibbet, 1999), where it experiences temperature and salinity fluctuations to which organisms adapt by changes in reproductive strategies (Gates, 2006). The thermal plume would not influence the saline lagoons, but individuals found offshore occur within the modelled footprint of the thermal plume (BEEMS Technical Report TR348). The latitudinal distribution and habitat preferences of this species suggest that it is likely to be tolerant of this pressure.	*Not sensitive*
Corophium volutator (mud shrimp)	Distribution extends from Norway to the Mediterranean and from the intertidal zone to the sublittoral fringe. These observations suggest a tolerance to increases in mean temperature within the GSB and temperature fluctuations. Indeed, an ability to tolerate chronic temperature uplift and survive temperatures up to 30-35 °C has been recorded (Meadows and Ruagh, 1981). No mortality is expected due to cooling water discharges within the GSB. Reproduction may be inhibited at higher temperatures, with greater breeding success observed at 15 °C than at 23 °C (Wilson and Parker, 1996). However, *C. volutator* is one of the most	*Not sensitive*

Key taxa	Evidence	Sensitivity
	abundant organisms on estuarine mudflats in Suffolk and has a great potential for recovery (Hughes, 1988). Therefore, any effects of temperature uplifts on reproductive output within the zone of influence would likely be undetectable at the population level.	
Nephtys hombergii (catworm)	Distribution extends from the Barents Sea to the Mediterranean, suggesting a tolerance to increases in mean temperature within the GSB. Moreover, *N. hombergii* is commonly found in the first few centimetres of surface sediment in the lower intertidal areas, suggesting a tolerance to extreme temperature fluctuations (Clay, 1967). Indeed, the species has been found to survive summer temperatures of 30-35 °C (Emery and Stevenson, 1957). The production of a spawning hormone does, however, appear to be initiated at low temperatures (Bentley and Pacey, 1992). Therefore, while no mortality is expected, an increase in winter temperature due to cooling water discharges in the GSB could reduce the fecundity of *N. hombergii* within the zone of influence (Olive *et al.*, 1985). The widespread distribution of the species in the GSB and southern North Sea indicate that a small proportion of its population would be exposed to this pressure. Moreover, recruitment within the zone of influence could occur via the pelagic larvae of this species sourced from outside the zone of influence.	*Not sensitive*
Notomastus spp. (bristleworm)	Distributed along most European coasts and is found in the shallow subtidal zone, where temperature can show large fluctuations. The taxon is found in lagoons in the Mediterranean where temperatures regularly exceed 30 °C (Giangrande and Fraschetti, 1993). Moreover, *Notomastus* spp. has high fecundity and is an opportunist, with the ability to rapidly increase in abundance if conditions become unfavourable to more competitive species (Giangrande and Fraschetti, 1993).	*Not sensitive*
Scalibregma inflatum (polychaete)	Direct evidence on the tolerance of this species to elevated temperature is scarce. However, its distribution extends from the Arctic to all European coasts, suggesting a tolerance to increases in mean temperature within the GSB. The species' ability to migrate vertically within its tube, which can extend to a depth of 13 cm below the sediment surface (Caradec *et al.*, 2004), is likely to confer a tolerance to temperature fluctuations. *Scalibregma inflatum* is a widespread and numerically dominant benthic invertebrate within the GSB and is widely distributed in the southern North Sea. It has high fecundity, as observed in numerous pronounced recruitment events during baseline surveys (BEEMS Technical Report TR348). Therefore, in addition to its apparent tolerance to cooling water discharges within the GSB, only a small proportion of the local population would be exposed	*Not sensitive*

Key taxa	Evidence	Sensitivity
	to the pressure, and any localised declines in population density would likely be followed by rapid recolonization sourced from outside the zone of influence.	
Spiophanes bombyx (bristleworm)	Direct evidence on the tolerance of this species to elevated temperature is scarce. It is found on most British coasts and has been recorded in the Mediterranean, suggesting a tolerance to increases in mean temperature within the GSB. It also inhabits sediments from the infralittoral down to 60 m depth, suggesting tolerance to temperature fluctuations and a wide thermal range. Additionally, *S. bombyx* is an opportunistic species with a short life span, high dispersal potential and high reproductive rates (Niermann *et al.*, 1990). It is often found during the early successional stages of variable, unstable habitats that and is quick to colonize following perturbation (Pearson and Rosenberg, 1977).	*Not sensitive*
Sabellaria spinulosa (Ross worm)	Distribution extends from Iceland to the Mediterranean and the Indian Ocean, suggesting a tolerance to increases in mean temperature within the GSB. The species is also found in the shallow subtidal zone, suggesting a possible tolerance to temperature fluctuations. Indeed, its life strategy allows it to tolerate environmental fluctuations by having a high rate of reproduction during favourable conditions (Wilson, 1970). There are currently no published laboratory studies on the thermal tolerance of *S. spinulosa*; however, the species has been identified as a warm water species and is more sensitive to extreme cooling events than warming events (Gibb *et al.*, 2014). It has been suggested that warming is likely to facilitate a northward expansion of its distribution, provided it can find suitable hard substrate (Cook and Harrison, 2001).	*Not sensitive*
Ophiura ophiura (brittlestar)	Distribution extends from Norway to the Mediterranean and from the lower intertidal to about 200 m. These observations suggest a tolerance to increases in mean temperature within the GSB and temperature fluctuations. Experiments on the species have shown that under chronic increases in temperature, the species up-regulates its metabolism, resulting in an increase in movement speed and arm regeneration (Wood *et al.*, 2010). The species tends to escape disturbance by moving horizontally rather than burying itself in the sediment (Boos *et al.*, 2010) and its high mobility should allow it to escape any thermal stress associated with cooling water discharges within the GSB. The species is common in the GSB and the wider North Sea (BEEMS Technical Report TR348). Therefore, potential behavioural responses to temperature uplifts would lead to a very localised reduction in	*Not sensitive*

Key taxa	Evidence	Sensitivity
	population density but likely have little effect at the broader population level.	
Planktonic eggs and larvae of benthic invertebrates	Benthic invertebrates in the GSB primarily have planktonic egg and larval development (BEEMS Technical Report TR348). Planktonic eggs and larvae would only be affected by the thermal plume as it mixes with the receiving waters and, thus, dilutes and cools (BEEMS Scientific Advisory Report SAR008, 2011). Most studies investigating the effects of cooling water on planktonic early life stages of invertebrates have focused on acute mortality during primary entrainment in the cooling water system rather than the implications in the receiving waters. Planktonic invertebrate eggs and larvae are unlikely to experience chronic effects in receiving waters, as the water masses they occupy would move away from the outfall causing heat losses. However, when the water masses are near the point of discharge, the absolute temperature could reach the upper tolerance limit of some sensitive species and, thus, induce acute effects, resulting in direct mortality and/or reducing their fitness. The spatial scale of the thermal plume coupled with hydrodynamic processes means that exposure to areas of thermal stress would be limited to a few hours each tide for a small proportion of populations. As benthic invertebrate eggs and larvae are produced in very high numbers by populations with broad spatial distributions, and incur high natural mortality (mainly through predation), it is expected that any deleterious effect of cooling water discharges would be highly localised and undetectable at the population level (BEEMS Scientific Advisory Report SAR008, 2011).	*Not sensitive*

3.4.2 Biological elements

3.4.2.1 Phytoplankton

The nearest EA WFD monitoring locations are approximately 29 km to the north and 12.5 km to the south of Sizewell B, therefore BEEMS data was used to compute the WFD phytoplankton status of coastal waters at Sizewell using the approach developed by the UK TAG as a cross check against the EA index for the wider waterbody area. BEEMS Technical Report TR476 determined the ecological potential of the phytoplankton community at two sites, a reference site 5.8 km north of the operating Sizewell B station and (SZ3), at the location of the Sizewell B intake (SZ140) (see Figure 17). These sites lie within the WFD Suffolk coastal water body, which has an overall ecological potential of ‘Moderate’ due to physico-chemical quality elements and the one-out-all-out principle of the WFD (see EA, 2016 and Table 9).

Phytoplankton status was assessed using data collected from March 2014 to December 2016 and the assessment tool developed by UK TAG. The phytoplankton tool combines metrics for chlorophyll *a* during the growing season (March to October, inclusive), elevated counts, and seasonal succession.

Averaging all three metrics gave an overall final score of 0.69 for SZ3, which equates to an assessment outcome of 'Good' status for the phytoplankton element. At the Sizewell B outfall site (SZ140), a score of 0.80 was achieved with an overall assessment on the lower threshold of 'High' status for the phytoplankton element. Overall confidence of class for good status was 99.9 % for SZ3 and for high status was 51.3 % for SZ140. Results are consistent with the assessment of the phytoplankton element carried out by the Environment Agency under the WFD between 2013 and 2016, which ranged between 0.71 and 0.74 with a classification of 'Good' status (BEEMS Technical Report TR476).

It is noted that since the DCO Application the 2019 WFD waterbody classifications have been released. The Suffolk coastal waterbody phytoplankton status remains 'Good' in 2019.

Table 9: Suffolk coastal waterbody classification (EA: https://environment.data.gov.uk/catchment-planning/WaterBody/GB650503520002, accessed on 22 January 2019).

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate
Supporting elements (Surface Water)	Good	Good	Good	Good
Biological quality elements	Good	Good	Good	Good
Phytoplankton	Good	Good	Good	Good
Physico-chemical quality elements	Moderate	Moderate	Moderate	Moderate
Dissolved Inorganic Nitrogen	Moderate	Moderate	Moderate	Moderate
Dissolved oxygen	High	High	High	High
Specific pollutants	High	High	-	-
Chemical	Good	Good	Good	Good

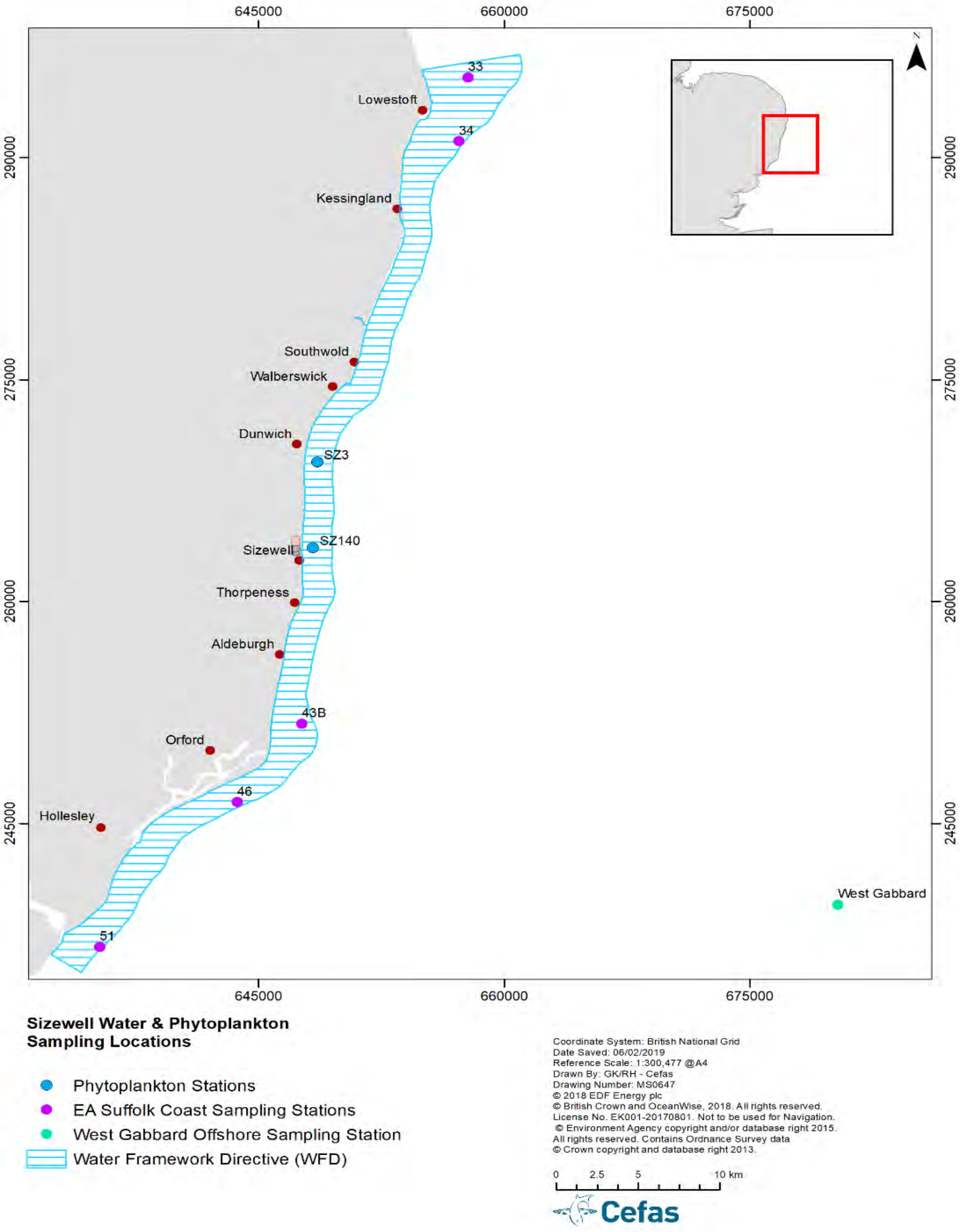

Figure 17: Location of Sizewell sampling sites.

Effects of dredging on phytoplankton

Dredging would occur during the construction phase and to a lesser extent during the operational phase (Section 4.4; Table 14). It is assumed that dredge spoil will be disposed of on-site via a pipe that transports the dredge material 500 m down drift (BEEMS Technical Report TR480). The primary impact of dredging activities would be the increase in suspended sediment in the water column, which would reduce light availability to photosynthetic phytoplankton. Biomass and primary productivity are particularly sensitive to variations in suspended sediment concentrations (Peterson and Festa, 1984). In estuarine systems attenuation of light due to suspended sediments limits the photic zone and controls productivity, which becomes repressed as suspended particulate matter increases from 10mg/l to 100 mg/l (Cloern, 1987). Phytoplankton exposed to increases in SSC may be susceptible to reductions in productivity. However, the plume is short lived and transitory (Section 4.4;

Table 15), therefore reductions in primary productivity and biomass are predicted to be minor relative to natural variation.

Effect of entrainment on phytoplankton

Entrainment effects at the population level have been assessed through modelling approaches. Phytoplankton mortality from Sizewell C acting cumulatively with Sizewell B is estimated to result in losses of approximately 5 % of gross annual productivity across the GSB and tidal excursion. Losses at this scale are within the bounds of natural variability and the population level effect of entrainment on the phytoplankton community would not be significant (BEEMS Technical Report TR385).

Combining the effects of entrainment mortality, increased nutrient discharges and the effects of the thermal plumes, the predicted local reduction in total phytoplankton production by SZB+SZC is about 6 % over the reference (no stations) condition (BEEMS Technical Report TR385).

3.4.2.2 Benthic Invertebrates

BEEMS data was used to compute the benthic infaunal status of coastal waters at Sizewell using the approach developed by the UK TAG. BEEMS Technical Report TR348 determined the ecological status of the benthic infaunal community in the coastal waters at Sizewell using the approach developed by UK TAG. Infaunal Quality Index (IQI) is a multi-metric index expressing the ecological health of benthic macroinvertebrate (infauna) assemblages. The metric encompasses a high amount of information on how macroinvertebrate assemblage changes within the marine environment as its calculation relies on selected metrics: taxa number, the AZTI Marine Biotic Index (AMBI, a measure of sensitivity to disturbance) and Simpson's evenness (a measure of the distribution of individuals across the different taxa). The IQI incorporates each metric as a ratio of the observed value to that expected under reference conditions (

Table 11). The index operates on a scale of zero to one: zero reflecting ecological quality under extreme anthropogenic disturbance and one representing ecological quality where anthropogenic disturbance is absent or negligible (Phillips *et al.,* 2014). The IQI is the recommended indicator to assess the ecological status of the macrobenthic invertebrate and infaunal assemblages of sediment habitats in UK coastal and transitional water bodies to support the requirements of the Water Framework Directive (WFD - 2000/60/EC).

According to the WFD Ecological Quality Ratios scale (EQRs), the results in Table 10 show that the Greater Sizewell Bay community is classified as a moderate to good status, a benthic community under moderate to slight disturbance (Phillips *et al.,* 2014).The coefficient of variation (CV) is a measure of relative natural variability for the benthic infaunal community for each quarter. Values are relatively high for the ecological indicators, about 15% for the IQI. The difference between IQI_{WFD} and IQI_{SZ} are as follows:

- IQI_{WFD}

Reference conditions in this report are based on a reference for UK marine muddy sands/sandy muds, 0.1 m^2 grab with 1 mm sieve mesh, recommended by the WFD (Phillips *et al*., 2014). Preliminary reference condition values for the IQI for coastal water, fine depositional sediments (sublittoral sand and mud) were established in 2004 and revised later in 2006 and in 2008 based on a combination of existing data and expert judgement to establish reference conditions (

Table 11).

- IQI_{SZ}

Phillips *et al*., (2014) recommend developing a model between the site specific IQI metrics and the associated environmental data to obtain reliable site-specific reference conditions. The data driving the biological assemblages have not been clearly identified so the site-specific reference condition have not been established. The site-specific calculations were therefore based on the calculation based on the IQI metrics for the sample with the highest AMBI value (

Table 11).

Table 10: Summary statistics on structural parameters and ecological indicators of diversity for each quarter of the year. Values are means ± standard deviation, CV is also provided. The significance of the difference between quarters was tested with a Kruskall-Wallis test (KW) and the results of the multiple comparison are shown by a colour code: highest values in green and lowest value in blue, no colour represents non- significant differences. SSSUB: shallow sublittoral data (calculated separately as sampled with a smaller van Veen grab). The difference between IQI_{WFD} and IQI_{SZ} are detailed above.

Survey quarter	Structure			Diversity			
	Richness	Abundance	Biomass	Shannon	Evenness	IQI_{WFD}	IQI_{SZ}
Q1	7.1 ± 0.7	401 ± 121	32.6 ± 29.2	1.3 ± 0.1	0.79 ± 0.03	0.72 ± 0.02	0.81 ± 0.02

	CV = 68%	CV = 197%	CV = 584%	CV = 44%	CV = 26%	CV = 10%	CV = 10%
Q2	8.0 ± 0.6 CV = 65%	1846 ± 495 CV = 233%	38.4 ± 11.1 CV = 251%	1.2 ± 0.1 CV = 56%	0.64 ± 0.03 CV = 44%	0.66 ± 0.02 CV = 14%	0.75 ± 0.02 CV = 14%
Q3	8.4 ± 0.7 CV = 63%	665 ± 200 CV = 224%	16.9 ± 4.7 CV = 208%	1.4 ± 0.1 CV = 47%	0.74 ± 0.03 CV = 30%	0.68 ± 0.02 CV = 15%	0.76 ± 0.02 CV = 14%
Q4	6.4 ± 0.6 CV = 66%	351 ± 119 CV = 234%	12.8 ± 5.5 CV = 297	1.2 ± 0.1 CV = 47%	0.79 ± 0.03 CV = 25%	0.69 ± 0.02 CV = 12%	0.77 ± 0.02 CV = 12%
KW test **(df = 3)**	X^2 = 23.262 P = 3.562^{-05}	X^2 = 43.483, P = 1.943^{-09}	X^2 = 30.518 P = 1.074^{-06}	X^2 = 14.441, P = 0.002362	X^2 = 48.976 P = 1.32^{-10}	X^2 = 15.177 P = 0.001671	X^2 = 14.5, P = 0.002298
Survey quarter	**Structure**			**Diversity**			
	Richness	**Abundance**	**Biomass**	**Shannon**	**Evenness**	**IQI_{WFD}**	**IQI_{SZ}**
Q3 **(SSUB)**	2.8 ± 0.6 CV = 71%	438 ± 210 CV = 155%	11.3 ± 7.5 CV = 213%	0.6 ± 0.2 CV = 94%	0.82 ± 0.09 CV = 28%	0.56 ± 0.07 CV = 27%	0.64 ± 0.08 CV = 26%

Table 11: IQI metric reference condition values from the Environmental Agency and from the Greater Sizewell Bay data. EA values (2004-2006) were established by United Kingdom and Republic of Ireland competent authorities combining expert judgement and existing data (Environmental Agency) whilst the GSB values were calculated from the sampling station with the highest AMBI value.

IQI parameters	**Environment Agency** **Phillips *et al.*, 2014**			**GSB** **monitoring data**
	Sand/Mud (2004)	**Sand/Mud (2006)**	**Sand/Mud (2008)**	**Max AMBI**
Taxa number	82	68	78.6	58
1-(AMBI/7)	1	0.96	0.96	1
Simpson’s evenness (1-λ′)	1	0.97	1.02	0.94

Effects of dredging on benthic invertebrates

Dredging would occur during the construction phase and to a lesser extent during the operational phase (Section 4.4; Table 14). It is assumed that dredge spoil will be disposed of on-site via a pipe that transports the dredge material 500m down drift (BEEMS Technical Report TR480). Increases in suspended sediments can affect benthic organisms by interfering with suspension-feeding (Briclej and Malouf 1984; Essink 1999; Tuttle-Raycraft *et al.,* 2017). Most of the taxa in the area predicted to be affected by changes in SSC are not suspension-feeders as adults (they are mainly deposit-feeders or predators) and are therefore unlikely to be impacted by this pressure during the adult life-stage. Three key taxa (the razor clam *Ensis* spp., common mussel *Mytilus edulis*, and ross worm *Sabellaria spinulosa*) are obligate suspension feeders and could therefore be vulnerable to elevated SSC. However, evidence suggests that these taxa are also insensitive to increases in SSC as they are often found in areas of high turbidity (Moore 1977; Hawkins and Bayne 1992; Gibb *et al*., 2014; Witbaard *et al*., 2015). Most benthic species in GSB have pelagic eggs and planktotrophic larvae and will therefore be vulnerable to any effects of elevated SSC. However, there is little evidence that elevated SSC negatively affects the eggs and larvae of benthos, with the limited available evidence suggesting a possible negative impact on bivalve larvae when the increase in SSC is substantial (500-1000 mg/l +) and prolonged (10-12 days +) but a positive effect when the increase in SSC is moderate (100-500 mg/l) (Wilber & Clarke 2001).

Direct habitat loss/change could occur from construction dredging (Section 4.4; Table 15), and piling activities associated with the BLF. The BLF piles could displace approximately 18 m^3 per pile (based on 1 m pile diameter). The total dredge volume for the BLF is 4,600 m^3 over an area of <1 ha. Sediment suspended by navigational dredging would be naturally dispersed within the GSB, while sediment extracted for the construction of other development components would be returned to the marine environment at local disposal sites presumed to be within the GSB. Therefore, a net removal of sediment from the GSB is not expected and changes in sediment characteristics are considered unlikely.

The FRR and CDO dredge volume is approximately 1,845 m^3 per outfall and the total habitat loss/change for all three structures represents less than 0.5 ha (Section 4.4; Table 15).

Potential for introduction of non-native species from ballast water

The potential for non-natives to be introduced from ballast water during site vessel activities, whilst recognised, would be managed by compliance with the IMO Ballast Water Management Convention (adopted in 2004). All ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. Therefore, no effects to the water and sediment quality of the local area from invasive non-native species are expected.

3.4.2.3 Brackish lagoons, Walberswick Marshes waterbody and RSPB Minsmere

A small brackish pond located between the seawall and the beach adjacent to Minsmere RSPB reserve to the north of the existing power stations (Figure 18) forms part of the Walberswick Marshes water body as defined by the Water Framework Directive**.** BEEMS Technical Report TR354 showed that the pond is isolated and adjacent to the coast with no direct connection to the Leiston Drain.

Automated salinity and water temperature monitoring was undertaken between 30th July 2014 and 5th May 2015 in order to assess whether there is connectivity between the pond and the adjacent marine environment either via overtopping during periods of elevated tidal levels or high wave conditions or via percolation through the dune system. This pond was selected because it was the closest pond to the sea and the only pond to lie outside of the flood protection that protects the RSPB Minsmere reserve. This pond was therefore the local waterbody most likely to exhibit marine connectivity.

No indication of overtopping was observed. The brackish nature of the pond water (6 to 25 psu) indicates that there is some limited seawater input into the pond. The measured changes in salinity indicate that saline water enters the pond slowly, mostly likely via slow diffusion through the dune system that lies between the pond and the coast.

Chemical plume modelling has shown that during operation TRO and hydrazine discharge plumes from SZC will not intersect with the Minsmere coast at concentrations above the EQS and PNEC, respectively. The risk to the Walberswick marshes waterbody from these discharges can, therefore, be discounted (BEEMS Technical Report TR354). During construction, discharges from SZC will occur inshore of the Sizewell –Dunwich Bank from the CDO. The physical and chemical inputs from construction discharges are predicted to have limited and localised influence in proximity to the discharge point with minimal potential to interact with the waterbody.

During commissioning, discharges of hydrazine would exceed PNEC levels (acute threshold 4ng/l as a 95th percentile), however interaction with the coastline does not occur at these levels (Section 3.3.2.1). Thus, the potential for percolation through the dune system is negligible, particularly when the rapid degradation rate of hydrazine is considered (38-minute half-life). As a precautionary measure a time series was modelled at the position of the Minsmere sluice to determine the potential for the maximum instantaneous plume to enter RSPB Minsmere.

The Minsmere sluice opens for half an hour after high tide, allowing saltwater to enter the coastal habitats associated with RSPB Minsmere. At Sizewell, the tide floods in a southerly direction. As the proposed development is south of the Minsmere sluice, discharges are only transported northward on an ebb tide, when water levels are lowering. During the month-long model run neither the acute nor chronic PNEC was exceeded. As such, the highest instantaneous concentration modelled at the sluice is highly unlikely to cause adverse effects (BEEMS Technical Report TR494).

Figure 18: The logger deployment location, approximately 50 m back from the dune crest (BEEMS Technical Report TR354).

3.4.2.4 Alde & Ore TFCI sensitivity to changes in fish abundance

Stakeholders have raised concerns relating to the potential for the proposed Sizewell C development to impact fish species of relevance to the Ade & Ore Transitional Fish Classification Index (TFCI). The primary concern is in relation to reductions in smelt. The status of the fish community in the Alde & Ore was classified as ‘Good’ in 2015 (EQR: 0.63) and ‘Good’ in 2016 (EQR: 0.61). During this period seine nets and beam trawls were the predominant sampling method but fyke nets were also deployed and used in the EQR calculation. No classification was produced in 2017 or 2018. The recently published 2019 results show the water body transitional fish status fell to ‘Moderate’ in 2019 (Environment Agency Catchment data Explorer, 2020). The 2019 EQR provided by the Environment Agency is 0.56 and was calculated using a combination of seine nets, beam trawls and fyke nets using data from 2013-2018.

BEEMS Scientific Position Paper SPP108 calculated the TFCI baseline Ecological Quality Ratio (EQR) by applying six years (2013-2018) Environment Agency fish monitoring data for the Alde & Ore water body. Sampling data from the period includes 75 seine nets, 34 beam trawls and 8 fyke nets (fykes sampled in 2013 and 2014 only). Seine samples returned 26 species and the highest catches, whilst beam trawls caught 21 species in total. Fyke nets only caught a single seabass and one ballan wrasse.

The Environment Agency algorithms used to derive EQR values now incorporate bootstrapping approaches. The bootstrapping method permutes samples from each gear type 1,000 times to determine the mean result and confidence intervals that are averaged between gears to calculate an overall EQR. By putting equal emphasis on all sample gears, the bootstrapping approach differs from the previously applied weighted mean approach and produces different results particularly when sample numbers and catch efficiency is low. It is noteworthy that if the 2019 EQR is calculated with fyke nets using the weighted mean approach, as in 2015 (0.63) and 2016 (0.61), the water body status is 'good' (EQR 0.63). Conversely if the 2016 data is recalculated using the same bootstrapping method applied in 2019, the status falls to 'moderate' with an EQR of just 0.50. The Alde & Ore water body classification using data from 2013-2018 without the use of fyke net data, results in an EQR of 0.69 representing 'good' status and a confidence of class for good status or above of 0.92.

BEEMS Scientific Position Paper SPP108 concluded that low sampling efficiency and statistical artefacts relating to the small fyke net sample size and poor catch rates caused the apparent deterioration of the water body classification to 'moderate' in 2019.

At the request of the Environment Agency, the sensitivity of the TFCI to smelt abundance, smelt numbers in samples were manipulated to four levels representing declines of 25%, 50%, a single smelt caught per annum (in seine samples), and total smelt absence. The sensitivity of the TFCI was also tested further through manipulated removals of thin-lipped mullet and Dover sole, as well as a scenario whereby smelt, thin-lipped mullet and sole were all simultaneously reduced by 50%. These manipulations were calculated with no fyke nets included.

1. The calculated Ecological Quality Ratio (EQR) was insensitive to manipulated reductions in smelt abundance of 25% and 50%.

2. Total absence of smelt reduced the EQR by 11% but 'good' status remained (when fyke net data is removed from the TFCI calculation).

3. The Environment Agency requested a scenario of total absence of both shad (1 individual caught between 2013-2018) and smelt along with 50% reductions in herring and bass. In this extreme scenario the EQR was reduced by 10.3%, however, 'good' status remains (TFCI calculated without the inclusion of fyke net data).

4. Total absence of thin-lipped grey mullet and Dover sole reduced the EQR by less than 4% in each case and 'good' status remained (TFCI calculated without the inclusion of fyke net data). The status also remained 'good' following the combined 50% reduction of smelt, Dover sole and thin-lipped grey mullet.

5. With the inclusion of fyke nets, the calculated TFCI did not change from 'moderate' status irrespective of the manipulated removal of fish described above.

Under all of the scenarios trested for fish manipulations, there was no deterioration of 'good' status when the TFCI was calculated without fyke net data. The report concluded that it is highly unlikely that the proposed development would cause a deterioration in the fish status of the Alde & Ore (BEEMS Scientific Position Paper SPP108).

The potential for the proposed development to affect smelt, and other migratory fish (e.g. Dover sole and grey mullet), in the Alde & Ore by means of thermal occlusion and impingement was investigated and it was concluded that:

1. There is no evidence for thermal occlusion either at the mouth of the Alde & Ore where temperatures are ≤1°C as a 98th percentile, or across a hypothetical corridor at the frontage of Sizewell C, 25km to the north of the estuary mouth.
2. Impingement from Sizewell C is predicted to have a negligible effect on regional smelt stocks (0.19% of the conservatively estimated ‘Anglian’ SSB) and would not result in significant local reductions in smelt abundance entering the estuary (BEEMS Scientific Position Paper SPP103).

Based on the evidence presented in BEEMS Scientific Position Paper SPP108 the Alde & Ore TFCI was tested against effects far in exceedance of those anticipated from the proposed development and in all cases the EQR remained within the boundaries of ‘good’ status (in the absence of fyke net samples), it is therefore considered highly unlikely that the proposed development would cause a deterioration in the fish status of the Alde & Ore.

3.4.3 Specific Pollutants

See Section 3.3 Potential Effects on Chemical Elements.

4 Evidence for HRA marine assessment

4.1 HRA Scoping

The proposed development has the potential to effect ecological sites designated as being of European of International Importance for nature conservation. Consequently, a Shadow Habitats Regulations Assessment (HRA) will be submitted to the Planning Inspectorate for Development Consent Order. The shadow HRA details the likely significant effects (LSE) on all European Sites and features within the ZoI of the proposed development.

The Sizewell C Habitat Regulations Assessment (HRA) Evidence Plan (EDF Energy, 2014) scoped LSE during the Construction and Operation phases of the Sizewell C development. These have been updated in the Sizewell C Stage 1 HRA Screening Report (EDF Energy, 2019b).

The conclusions of the LSE pertinent to marine elements are reproduced in Appendix A for the construction and operational phases. These tables were used to inform the relevant marine evidence base below. Figure 19 shows the location of the designated sites around Sizewell.

This section identifies the potential indirect effects on designated features, including effects on supporting habitat through changes is coastal processes, water quality or prey availability (mortality or avoidance).

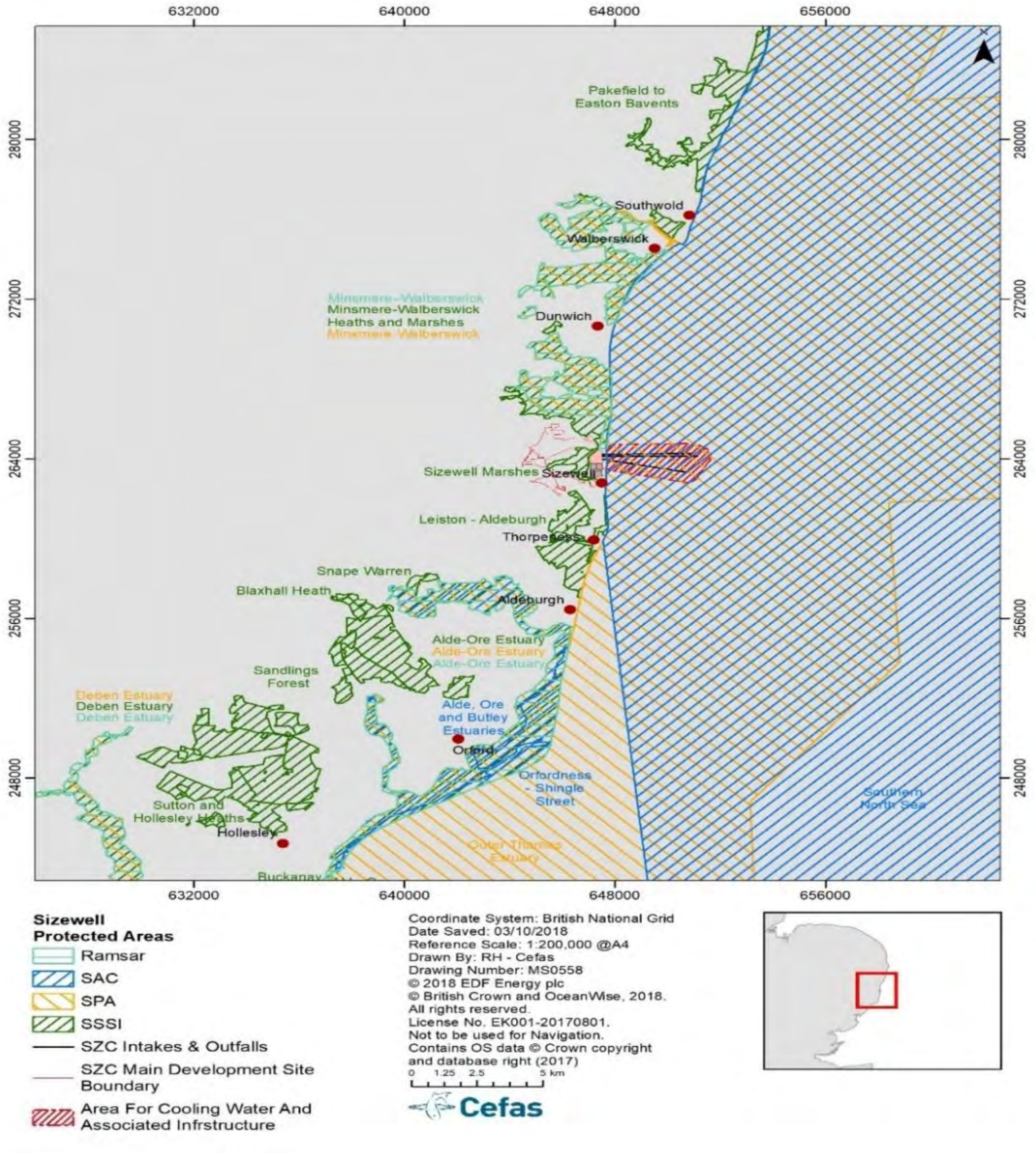

Figure 19: European and international designated sites in the Sizewell area.

4.2 Marine prey of designated species

BEEMS Technical Report TR431 identified for each designated SAC/SPA that has the potential to be impacted by the proposed development:

a. those species that have marine prey as an important component of their diet;
b. the marine foraging range of each designated species (where applicable); and
c. what their marine prey species are likely to be in the Sizewell area.

Table 12 details the relevant statutory designated sites and associated marine prey species. Appendix B and Figure 20 gives the SPA bird colony information and predicted foraging ranges.

Table 12: Relevant statutory designated sites for birds and marine mammals and associated marine prey species.

Statutory designated site	Description of site features	Description of associated marine prey species (prey species are based upon fish availabilities at Sizewell BEEMS Technical Report, TR345)
Minsmere to Walberswick SPA and Ramsar site (located adjacent to the north-east boundary of the Main Development Site)	Identified as a Ramsar site as it supports a diverse range of wetland bird species in nationally important numbers. The SPA supports breeding, wintering and passage bird populations of European importance, including breeding populations of marsh harrier (*Circus aeruginosus*), bittern (*Botaurus stellaris*), avocet (*Recurvirostra avosetta*) and little tern (*Sterna albifrons*).	Breeding and over wintering Bittern – eels (*Anguilla anguilla*). Eels form part of the diet of this species (particularly of juvenile bitterns). Bitterns do not forage at sea. Juvenile eels (glass eels/elvers) migrate from the marine environment into freshwater where they remain for many years (up to 20 years) until they are ready to return to the Sargasso Sea as adult silver eels. Breeding Little Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.
Sandlings SPA (located approximately 0.7km south of the Main Development Site)	Supports breeding populations of European importance of both nightjar (*Caprimulgus europaeus*) and woodlark (*Lullula arborea*).	No marine prey dependencies.

Statutory designated site	Description of site features	Description of associated marine prey species (prey species are based upon fish availabilities at Sizewell BEEMS Technical Report, TR345)
Alde-Ore Estuary SPA and Ramsar (located approximately 5.5km south of the Main Development Site)	Identified as a Ramsar site for its diverse and nationally important wetland bird species, and as a SPA because it supports bird populations of European importance, including breeding populations of avocet, little tern and sandwich tern (*Sterna sandvicensis)*, and over-wintering ruff (*Philomachus pugnax*). The site also supports important migratory populations of lesser black-backed gull (*Larus fuscus*) during the breeding season and redshank (*Tringa tetanus*) during the winter. The site also supports a seabird assemblage of international importance (including Little Tern, Sandwich Tern, Lesser black-backed gull, Black headed gull *Larus ridibundus* & Herring gull *Larus argentatus).*	Breeding Little Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy. Breeding Sandwich Tern (*Thalasseus sandvicensis*) (April to August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy. Breeding Lesser black-backed gull (April to August) - schooling pelagic fish and crustacea that are found near to the sea surface - sprat, herring, anchovy and swimming crabs together with the waste from fishing vessels.
Benacre to Easton Bavents SPA (located approximately 15km north of the Main Development Site)	The site qualifies by supporting the following species: Breeding and over wintering Bittern *Botaurus stellaris*, Breeding Little Tern *Sterna albifrons* and Breeding Marsh Harrier *Circus aeruginosus*. (Note: where available eels (*Anguilla anguilla*) form part of the diet of breeding and over wintering Bittern. There is no access for eels to migrate into this site from the marine environment and therefore there is no potential marine impact on Bitterns at this site).	Breeding Little Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.

Statutory designated site	Description of site features	Description of associated marine prey species (prey species are based upon fish availabilities at Sizewell BEEMS Technical Report, TR345)
Outer Thames Estuary SPA (includes the area of open sea adjacent to the eastern boundary of the Main Development Site)	The Outer Thames Estuary SPA qualifies by supporting populations of European importance of wintering Red-throated diver *Gavia stellata*, Breeding Little Tern *Sterna albifrons* and Breeding Common Tern *Sterna hirundo.*	Over wintering/passage Red-throated diver (September to March) – most commonly occurring benthopelagic species - sprat, herring, whiting and bass. Breeding Little Tern and Breeding Common Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.
Deben Estuary SPA	The site qualifies by supporting overwintering populations of avocet (*Recurvirostra avosetta*)	Avocet feed non-selectively on aquatic invertebrates such as insects, crustaceans, worms, some molluscs, fish and plant matter.
Deben Estuary Ramsar site	The Deben Estuary supports: a population of the mollusc *Vertigo angustior*; and an over-winter population of Dark-bellied brent goose, *Branta bernicla*	The dark bellied brent goose feeds on intertidal vegetation such as *Enteromorpha*, *Ulva*, *Zostera* and salt marsh vegetation in addition to terrestrial grasses and cereals.
Southern North Sea SAC (includes the area of open sea adjacent to the eastern boundary of the Main Development Site)	The Southern North Sea site is designated for the Annex II species harbour porpoise (*Phocoena phocoena*) for both winter and summer seasons.	Harbour porpoise feed on a wide variety of fish and generally focus on the most abundant local species. The predominant prey type appears to be demersal fish, although shoaling fish such as mackerel and herring are also taken (JNCC, 2017).
Humber Estuary SAC	The site is site is designated for the Annex II species Grey Seal	Grey seals are opportunistic foragers, eating a wide variety of prey types depending on location, season and the abundance of prey. Sandeel, cod, Dover sole, dab, flounder and plaice make up large components of the diet.

Statutory designated site	Description of site features	Description of associated marine prey species (prey species are based upon fish availabilities at Sizewell BEEMS Technical Report, TR345)
The Wash and North Norfolk Coast SAC	The site is site is designated for the Annex II species harbour Seal	Harbour seals are opportunistic foragers, consuming a wide variety of prey species, depending on the season and local availability. Whiting, Dover sole and gobies form a large component of the diet in the southern North Sea together with flounder, sprat and sandeel depending upon local availability.

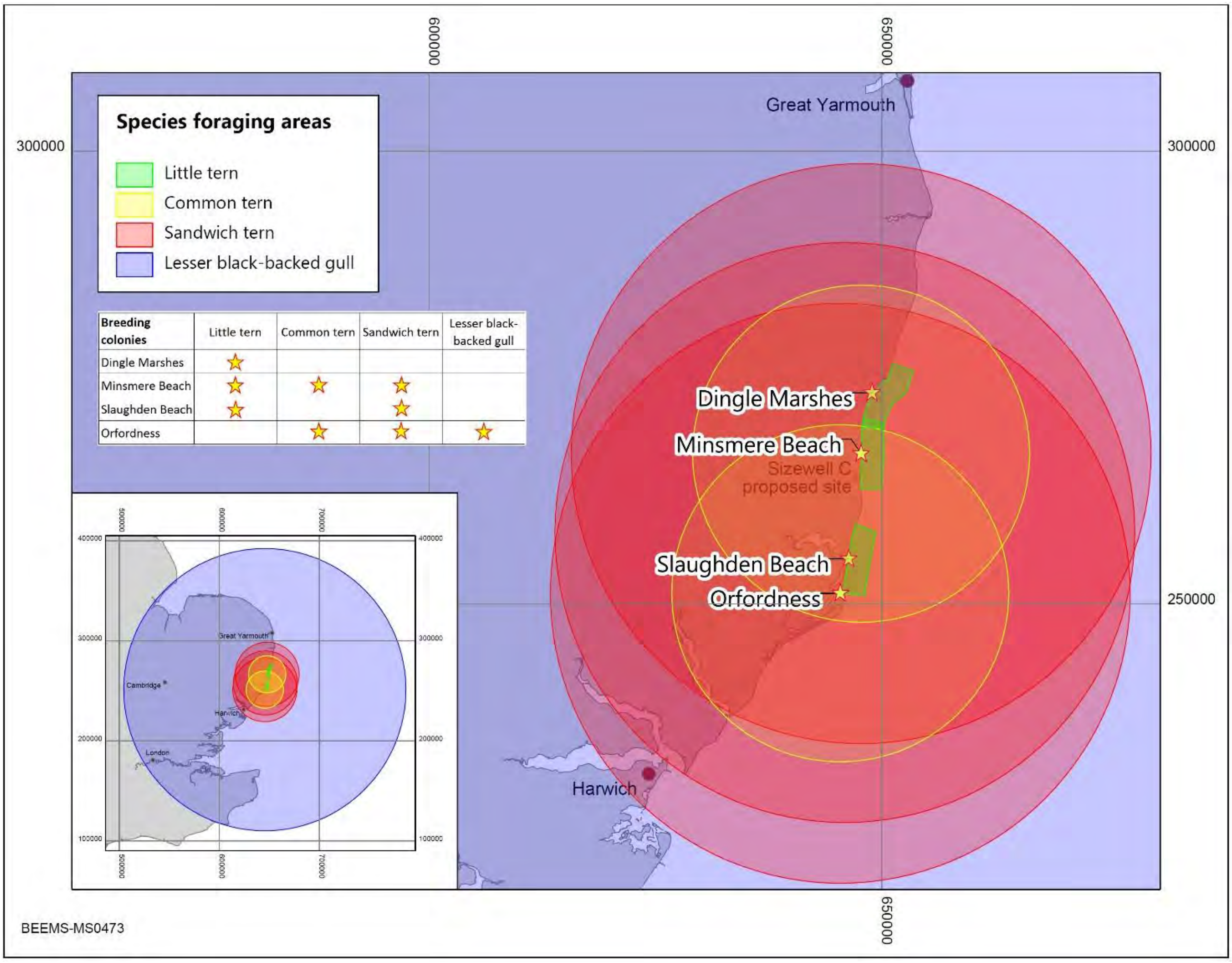

Figure 20: Map of the breeding colonies affected by SZC, with predicted foraging zones of the relevant bird species. Red throated divers are not represented as they are only present as overwintering birds and therefore do not have a foraging range around a breeding colony.

Predicted foraging ranges are equivalent to the maximum foraging ranges of each species (see Appendix B). Where impacts have the potential to effect designated species with restricted foraging ranges, for example around breeding colonies (i.e. little terns), the zone of influence of the impact is intersected with the predicted foraging range within the designated sites (see Figure 20; Table 13; Appendix B). Given that areas of concentrated foraging activity are likely to occur closer to the colony, the potential effect areas are also considered in relation to defined areas that are equivalent to the mean foraging range for the species (apart from little terns).

Table 13. Little tern colonies and predicted foraging areas.

Colony	Foraging Area (ha)
Dingle	1848.02
Minsmere	1808.38
Slaughden	1787.39

4.3 Potential for alteration of coastal processes/sediment transport

4.3.1 Construction

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for alteration of coastal processes/sediment transport from the construction phase of Sizewell C:

- Minsmere to Walberswick Heaths and Marshes SAC - Annual vegetation of drift lines and perennial vegetation of stony banks.
- Minsmere to Walberswick SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 1 (Mosaic of marine, freshwater, marshland and associated habitats), Ramsar criterion 2 (Supports 9 nationally scarce plants and at least 26 red data book invertebrates) and Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).

There are no significant potential effects arising from the construction phase of Sizewell C that could lead to alteration of coastal processes/sediment transport (BEEMS Technical Report TR311 Ed. 4):

- SCDF - The use of heavy vehicles would cause limited compaction of beach sediments, temporarily increasing their resistance to erosion. The effect on geomorphology would be localised on the SZC frontage and insignificant.
- BLF - As the effects of constructing the intertidal and subtidal sections of the BLF would be localised, superficial and short lived, it is expected to have no significant effect on the shoreline. Piling could result in a short and localised rise in amount of sediment in suspension, but the impact would be negligible and would not affect the shoreline or geomorphology. Whilst the bed level changes in the sub-tidal region off the end of the BLF are tidally dominated, the bed level changes and longshore shingle transport along the beach face is dominated by waves.
- Cooling water intakes and outfalls – Following dredging, the SSC plume quickly dissipates – the elevated concentrations decay to background levels within approximately four days on neap tides and two days on spring tides after the completion of disposal operations (BEEMS Technical Report TR508).
- FRR’s and CDO - Increases in SSC from dredging are short lived (of the order of days).

4.3.2 Operation

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for alteration of coastal processes/sediment transport from the operation phase of Sizewell C:

- Minsmere to Walberswick Heaths and Marshes SAC - Annual vegetation of drift lines and Perennial vegetation of stony banks.
- Minsmere to Walberswick SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 1 (Mosaic of marine, freshwater, marshland and associated habitats), Ramsar criterion 2 (Supports 9 nationally scarce plants and at least 26 red data book invertebrates) and Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).

4.3.2.1 Soft Coastal Defence Feature (SCDF) and Hard Coastal Defence Feature (HCDF)

The placement of the SCDF would alter the beach in two ways – it would change the profile landward of MHWS and increase the beach volume in that area. As a result of the larger back-beach volume, the rate of shoreline retreat would be slower and relatively small volumes of extra sediment would be episodically introduced into the coastal system during storms with high water levels. The SCDF is expected to last for several decades before it would be fully depleted due to the low rates of erosion on the Sizewell frontage (see

Figure 21). However, note that the retreat rates increase toward and beyond the north-east corner of the SZC frontage i.e., the Southern Barrier (with a maximum of -1.37 m/yr at northing 264498).

Without secondary mitigation, it is possible that beach recession could eventually lead to exposure of the HCDF, which could result in localised alternating patterns of erosion and accretion from blockage to gross transport during individual storms. That is, despite low net rates of shoreline change, the envelope of shoreline positions would be high due to localised starvation in the lee of the HCDF during storms. Reversal of the storm direction would see the return of the eroded sediments (BEEMS Technical Report TR420). However, with planned beach management activities (additional 'secondary' mitigation) (bypassing, beach recycling or beach recharge to maintain the beach, there would be no disruption to longshore sand and shingle transport and therefore it is unlikely that there will be a significant effect on the features of the relevant designated sites listed above. Such mitigation measures would not be required until several decades (approximately 2053 – 2087) into the future (BEEMS Technical Report TR311 Ed. 4) and would be activated based on triggers (determined from storm models) and future monitoring. The period over which additional mitigation measures are effective cannot be accurately predicted and it is possible that these measures cease to be effective if shoreline retreat on the northern flank of the SZC site and/or the southern flank of the SZA site is such that longshore connectivity cannot be maintained.

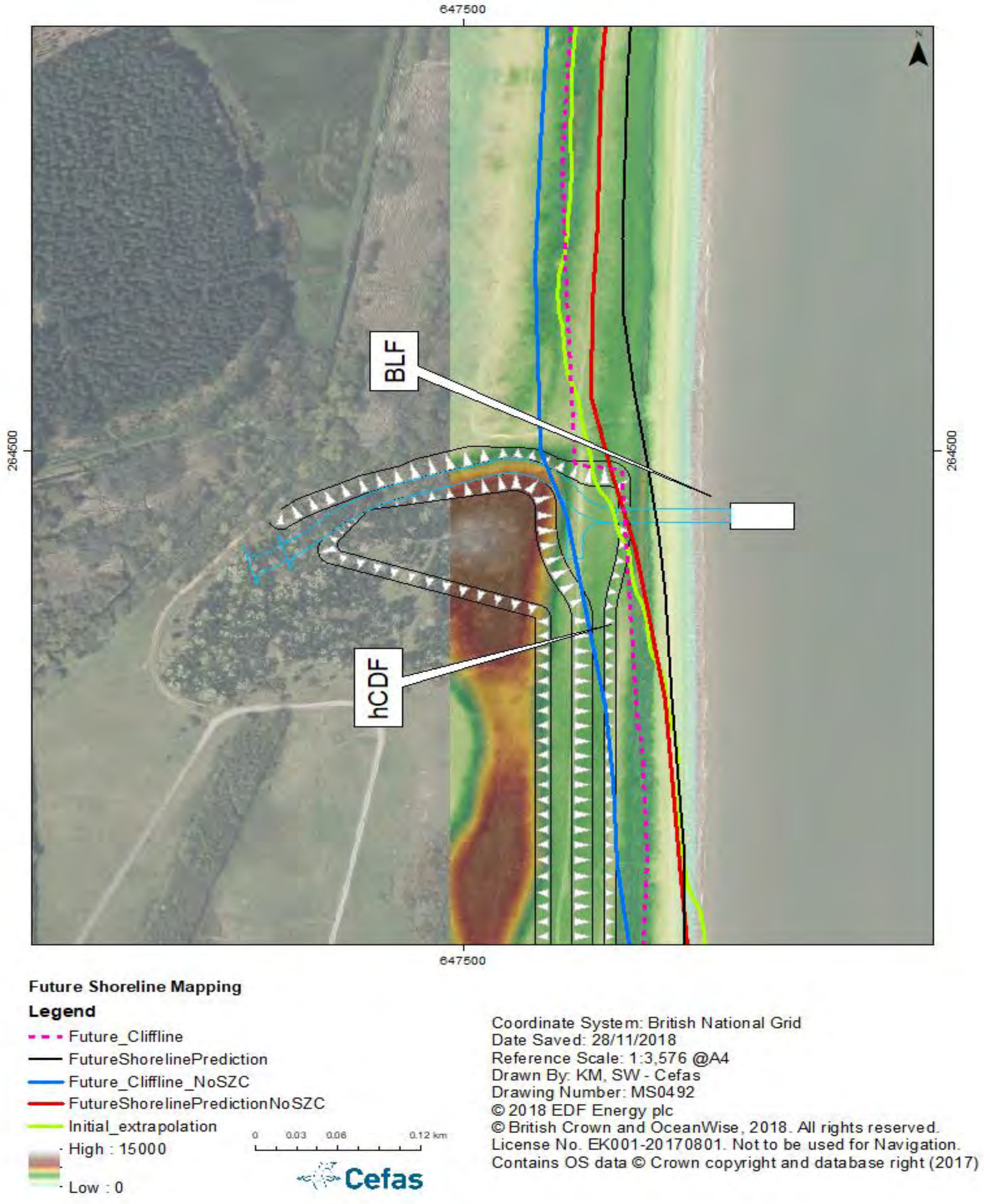

Figure 21: Projected shorelines and clifflines with and without Sizewell C, showing the expected constraining effect of the hCDF on the northern limit of the development site. The existing 'mound' of high ground at this location would have a similar bounding effect on the beach roll-back (BEEMS Technical Report TR403).

Beach maintenance activities conducted on the SZC frontage would continue for a period of time to maintain a continuous shingle beach. Beach management would avoid disruptions to longshore sediment transport and mean there would be no blockages to sediment transport and no negative effect on the SPA/SAC. Were beach recharge to be employed, the additional sediment in the system would increase sediment volumes and decrease erosion rates locally.

The beach maintenance / sediment management approaches would not have an adverse effect on designated supra-tidal shingle habitats (annual vegetated shingle and potential little tern nesting sites) as (BEEMS Technical Report TR311 Ed. 4):

- they would not cause erosion;
- they would cause some localised short-term beach accretion, limited in extent by the relatively small volumes being moved or introduced;
- sediment would not be extracted from statutory designated sites (in the cases of bypassing or beach recycling) unless accumulating sediments were a direct effect of SZC (mitigation or presence of the HCDF) and approval was given following demonstration that designated features would not be affected; and
- sediment would not be deposited on the supra-tidal beach within statutory designated sites unless approval was given following demonstration that designated features would not be affected.

Beach maintenance will cease by the end of decommissioning or earlier if the mitigation methods are not able to reasonably retain the HCDF shingle beach frontage. The exact timescale for cessation is unknown but long. It would begin after:

- **The terrestrial HCDF period (no marine impacts and no Additional Mitigation).** This period is expected to be until 2053 – 2087 and features coastal processes and parameters (other than sea level) similar to the present; and
- **The beach maintenance (Additional Mitigation) period.** The duration of this period cannot accurately be determined at this but would be expected to last for several years to decades. During this period beach maintenance activities would maintain the continuous shingle beach feature, which would allow sediment (shingle and sand) to flow around the HCDF and thereby prevent a sediment transport blockage.

Following cessation of beach maintenance, initial exposure of the HCDF could cause localised erosion of a few tens of metres on the SZC frontage (to the north of the HCDF), but this would be followed by shingle trapping as the NE corner of the HCDF protrudes into the longshore shingle transport pathway. The shingle beach may re-establish itself as a result of trapping on a permanent basis, or it may be intermittently exposed. Intermittent exposure would result is periods of disruption to longshore supply, followed by catch up as slugs of material are released from the accumulating shingle north of the HCDF (BEEMS Technical Report TR311 Ed. 4).

4.3.2.2 Beach Landing Facility (BLF)

The low density of piles (spacing is 11.2 m cross-shore and 6.3 m alongshore) means that the BLF is transmissive to water and sediment movement, and the local effect on current flow and wave energy transmission is expected to be minimal (BEEMS Technical Report TR311 Ed. 4). Modelling shows that the two terminal BLF deck piles and the fender piles (worst case) slightly interrupts the shore parallel tidal flow, with a small decrease in the currents in the lee of the piles up to a maximum distance of 4 5m. Closer to shore the effects lessen, due to the lower current speeds in shallower water (BEEMS Technical Report TR311 Ed. 4).

The scour depth around the BLF piles is likely to be as much as 1.5 m at the most offshore dolphin pile, and 0.7 m at the most landward pile pair located in the intertidal zone. The horizontal extent of scour around the piles ranged from 1.1 m for the most landward piles to 2.4 m for the most offshore dolphin pile (BEEMS Technical Report TR311 Ed. 4).

BEEMS Technical Report TR311 Ed. 4 states that despite the few regions of pronounced changes in bed shear stress as a result of the BLF dredged bathymetry, they are very small.

Therefore, it is unlikely that there will be a significant effect on the features of the relevant designated sites above.

4.3.2.3 Cooling water infrastructure and other nearshore outfalls

The presence of the intake and outfall heads would disrupt local hydrodynamic flow patterns, lowering the sedimentary seabed around the structures to form scour pits. Seabed depth would increase over the affected area (1,554 m^2 {0.2 ha} per intake structure and 1,552 m^2 {0.2 ha} per outfall structure) and sediment characteristics may be altered. There is also the potential for scour due to the continuous discharge of cooling water from the outfalls (1,013 m^2 {0.1 ha} per structure). However, such estimates are likely to be an overestimation, as they assume the discharge is at bed level, and that discharge comes from a single circular jet rather than two adjacent outlets (BEEMS Technical Report TR311 Ed. 4).

The scour pits for the FRR and CDO [170 m^2 (0.02 ha) per structure] would be broadly elliptical due to reversing tidal currents. The scour due to the discharge of water is conservatively estimated to be 0.76 m deep for the FRRs and 0.56 m deep for the CDO, which, being less than scour depth due to the structures themselves, is unlikely to have an influence on the seabed (BEEMS Technical Report TR311 Ed. 4). Therefore, it is unlikely that there will be a significant effect on the features of the relevant designated sites above.

Scour pit depth and extent was estimated for the cooling water intake and outfall head structures, assuming no scour protection is used (BEEMS Technical Report TR310 Ed. 2). For the four intakes, the area of changed habitat (including the 320 m^2 footprint of the structure itself) would be 1,554 m^2 (0.16 ha) per structure and 6,217 m^2 (0.62 ha) in total. For the two outfall heads, the area of changed habitat (including the 256 m^2 footprint of the structure itself) would be 1,552 m^2 (0.16 ha) per structure, or 3,105 m^2 (0.32 ha) for both (BEEMS Technical Report TR311 Ed. 4).

The scour pits for the FRR and CDO would be broadly elliptical due to reversing tidal currents, with a 7.2 m extent from each side of the structure along the tidal axis (north – south) and a 4.1 m extent across the tide (east – west). The area of changed habitat (including the 9 m^2 footprint of the structure itself) would be 207 m^2 (0.02 ha) per structure and 621 m^2 (0.06 ha) for the three structures. Secondary or edge scour, would be likely to form around the perimeter of the scour protection, as observed at the SZB intake heads, and therefore, were scour protection to be installed over the entire projected footprint, the secondary scour would mean that the total area influenced by the presence of the structure would be larger than if no scour protection was installed (BEEMS Technical Report TR311 Ed. 4).

The small spatial footprint of potential habitat change due to installation of infrastructure and associated scour in the offshore environment indicates that effects on the features of the designated sites (mediated through changes in prey availability due to habitat change) would be negligible.

Outcropping coralline crag material has been identified at the location of the southerly intakes. Evidence gathered during the 2019 survey confirmed the presence of *S. spinulosa* reef-like features on the offshore Coralline Crag (BEEMS Technical Report TR512). Whilst the area is not a designated site, *Sabellaria spinulosa* reefs are Annex I habitats and listed as habitats of conservation importance (HOCI) under Section 41 of the NERC Act (2006) and are considered in the EIA.

4.4 Potential Water quality effects – marine environment

4.4.1 Construction

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential marine water quality effects from the construction phase of Sizewell C:

- Alde-Ore Estuary RAMSAR - Ramsar criterion 2 (Nationally-scarce plant species and British Red Data Book invertebrates).
- Minsmere to Walberswick Heaths and Marshes SAC - Annual vegetation of drift lines and Perennial vegetation of stony banks.
- Minsmere to Walberswick SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 1 (Mosaic of marine, freshwater, marshland and associated habitats) and Ramsar criterion 2 (Supports 9 nationally scarce plants and at least 26 red data book invertebrates).
- Orford Ness to Shingle Street SAC - Coastal lagoons * Priority feature, Annual vegetation of drift lines and Perennial vegetation of stony banks.
- Outer Thames Estuary SPA - Supporting habitat to SPA designated interests, Wintering /passage Red-throated diver *Gavia stellata*, Breeding Little Tern *Sterna albifrons* and Breeding Common Tern *Sterna hirundo*.
- Southern North Sea SAC – Harbour porpoise (*Phocoena phocoena*).

4.4.1.1 Construction discharges

Section 3.3.1 details the construction discharges associated with the proposed development.

Annual load limits for the priority hazardous substances cadmium and mercury of 5 kg and 1 kg cumulative loads are not exceeded. Several metals are present in groundwater. Chromium and zinc fail screening and were modelled. The chromium plume is below EQS within 5.5 ha of the CDO at the sea surface. At the seabed, the EQS is no exceeded. Zinc concentrations would be indiscernible from background within 0.11ha from the CDO outfall. Therefore, it is unlikely that there will be a significant effect on the features of the relevant designated sites above.

Section 3.4.1 details the Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), ammonia and microbiology elements associated with the construction discharge. All of which are diluted to environmentally acceptable standards within metres of the discharge.

Tunnel boring machine (TBM) chemicals are predicted to exceed applied EQS concentrations but over limited spatial scales and do not intersect with the coastline. Therefore, it is unlikely that there will be a significant effect on the features of the relevant designated sites above.

4.4.1.2 Increases in Suspended Sediment Concentration (SSC)

BEEMS Technical Report TR508 contains information on the characteristics of the material to be disposed and an assessment of potential impacts. Increases in SSC from dredging activities has the potential to cause fish avoidance and thereby cause indirect effects on designated seabirds with marine foraging dependencies.

Ambient SSC at the site is highly variable. Satellite data for suspended particulate matter showed average mean SPM values at Sizewell during April to August of 31 mg/l (and average monthly maximum 80 mg/l) and during September to March 73 mg/l (and average monthly maximum 180 mg/l). Near-bed conditions are considerably more turbid, particularly beyond the Sizewell-Dunwich Bank. Two minilanders deployed between November 2018 and February 2019, at the proposed cooling water intake head locations showed mean SSC concentrations of 450-510mg/l at 1.4m above the bed. In both locations maximum SSC exceeded 2,000mg/l (BEEMS Technical Report TR306 Ed. 5).

Fish form an important component of the diet of designated species in the GSB (Table 12). To determine the potential for indirect effects on prey species a potential avoidance threshold was assumed. A threshold of 100 mg/l above baseline conditions has precautionarily be used to determine the spatial extent of the modelled SSC plumes. These thresholds are considered precautionary as fish are likely to be relatively tolerant to changes in SSC given the large range in ambient conditions.

Dredging and drilling activities would be required for a number of development components during the construction and operational phases of the proposed development. Full details of dredge activities are provided in BEEMS Technical Report TR480.

Beach Landing Facility: navigational dredging

To accommodate the safe passage of barges and accompanying tugs to the BLF, a navigational channel and grounding area would be required in the nearshore zone occupied by the two longshore bars. Plough dredging is the preferred option to create a planar surface for the barges to come aground. A 20 m wide navigational channel and grounding surface would be profiled within the shallow subtidal zone (<6 m water depth) using a plough dredger. Plough dredging agitates the sediment, which is then transported away by the tide. Dredging would be conducted over an area of 0.91 ha, to a depth greater than 0.5 m below the sediment surface. Initial capital dredging would last for 2.1 days in total if operations are continuous (; however, the duration would likely be longer due to operational constraints.

Deliveries would occur most frequently during the spring and summer months from 31st March to 31st October, the ‘campaign period’. However, deliveries may be required throughout the year. To ensure the BLF access channel is navigable monitoring would occur. It is anticipated that the full dredge area/volume would be reprofiled at least annually. The frequency of maintenance dredges would depend on ambient conditions of infilling.

Infilling rates suggest that small scale maintenance dredges (10% of the initial volume) would be required at approximately monthly intervals (BEEMS Technical Report TR311 Ed. 4). The frequency of maintenance dredging would depend on the specific tolerance of the barges to the substrate profile and seasonal infilling rates. Monitored during the campaign period would determine the necessity for dredging. Full dredge profiles are anticipated at least annually due to infilling during winter periods when BLF utilisation is anticipated to be reduced. Storm events could require full dredge volumes to be required.

During the operational phase, the BLF would facilitate occasional AIL deliveries, approximately every 5-10 years. During periods of operational utilisation of the BLF dredging activities as described would be required.

Installation of infrastructure headworks and connecting tunnels

Prior to installation of the CDO head, CWS intake and outfall headworks, and FRR outfall headworks, overlying soft sediment in the shallow subtidal (<6m) and relatively deep (>10 m) subtidal zones would be removed by dredging via a Cutter Suction dredger with spoil disposed locally within a licenced disposal site (

Table 15).

The CDO and FRR headworks are anticipated to be concrete structures buried to a depth of approximately 2 m within the sediment. The offshore CWS intake and outfall headworks would be installed into the bedrock and seismically qualified. Therefore, where necessary, overlying sediment would need to be removed. The precautionary dredge model scenarios estimate SSC plumes and sedimentation rates based on dredge profiles for overlying sediments of approximately 5-6 m depth.

Vertical connecting tunnels would be drilled to connect the headworks to the subterranean cooling water tunnels. Drilling would occur within the footprint of the dredge area and SSC plumes and sedimentation rates are negligible. Drilling is not assessed further.

Dredge areas, sediment plume characteristics and changes in sedimentation as a result of dredging and drilling activities are provided in

Table 15.

Table 14: Dredging and drilling activities associated with the proposed development (based on baseline information and engineering designs at the time of Sizewell C DCO submission).

Component	Dredge/drilling method and proposed disposal route	Dredge volume and surface area	Duration and frequency	Sediment characteristics modelled	Assessed further
BLF	Plough dredging, with sediment transported away by the tide.	4,600 m^3 9,068 m^2	Capital dredging expected to take 2.1 days per year. Maintenance dredging (10 % volume) expected monthly.	100 % fine to medium sand (63 µm-210 µm).	Yes
CDO	Cutter suction dredger with local disposal via a down tide pipe.	1,845 m^3 1,320 m^2	Single dredge event for the CDO head. Dredging expected to take 9.5 hours.	95 % fine to medium sand (63 µm-210 µm). 5 % fines (<63 µm).	Yes
CWS intakes	Cutter suction dredger with local disposal via a down tide pipe.	69,600 m^3 20,150 m^2	Single dredge event anticipated for each of the four CWS intake heads. Dredging expected to take 34 hours in total (8.5 hours per head).	75 % fine to medium sand (63 µm-210 µm). 20 % medium to coarse sand (210 µm-420 µm). 5 % fines (<63 µm).	Yes
	Drilling with arisings released at drill site.	3,016 m^3 201 m^2	Continuous drilling lasting 120 hours (30 hours per head).	50% of drill arisings expected to form spoil heap. 50% expected to be fines (<63µm).	No. SSC plume would be indiscernable above background conditions. Spoil heap would form within the dredge footprint. Wider sedimentation would be minimal.
CWS outfalls	Cutter suction dredger with local disposal via a down tide pipe.	23,500 m^3 7,442 m^2	Single dredge event anticipated for each of the two CWS outfall heads. Dredging expected to take 14 hours in total (7 hours per head).	60 % fine to medium sand (63 µm-210 µm). 10 % medium to coarse sand (210 µm-420 µm). 30 % fines (<63 µm).	Yes

	Drilling with arisings released at drill site.	1,908 m^3 127 m^2	Continuous drilling lasting 60 hours (30 hours per head).	Same as drilling for CWS intakes.	No. Same reasons as for drilling for CWS intakes.
FRR outfalls	Cutter suction dredger with local disposal via a down tide pipe.	3,690 m^3 2,640 m^2	Single dredge event for each of the two FRR outfall heads. Dredging expected to take 19 hours in total (9.5 hours per head).	Same as dredging for CDO.	Yes

Table 15: Substrate removal, SSC plumes and changes in sedimentation rates associated with dredging activities for the proposed development (based on baseline information and engineering designs at the time of Sizewell C DCO submission).

Component	Removal of substratum*			Changes in SSC (maximum instantaneous plume)			Siltation rate changes	
	Spatial extent	Amount of change	Duration and frequency	Spatial extent & amount of change		Persistence	Spatial extent & amount of change	Persistence
				Depth average	Surface water			
BLF – capital dredging	0.91 ha	>0.5 m	2.1 days x one event per campaign	188 ha (>50 mg/l) 83 ha (100 mg/l) 6 ha (1,000 mg/l)	248 ha (>50 mg/l) 108 ha (100 mg/l) 7 ha (1,000 mg/l)	Return to background concentrations within several days	6 ha (>20 mm) 3 ha (>50 mm) 1 ha (>300 mm)	0ha >50 mm after 15 days (3 ha remains >20 mm)
BLF – maintenance dredging	0.91 ha	>0.5 m	5 hours x twelve events per campaign	62 ha (>50 mg/l) 28 ha (100 mg/l) 1 ha (1,000 mg/l)	59 ha (>50 mg/l) 17 ha (100 mg/l) 1 ha (1,000 mg/l)	Return to background concentrations within several days	0 ha (>20 mm)	0 ha >10 mm after 15 days

CDO	0.13 ha	>0.5 m	<24 hours x one event	91 ha (>50 mg/l) 28 ha (100 mg/l) 1 ha (1,000 mg/l)	152 ha (>50 mg/l) 89 ha (100 mg/l) 1 ha (1,000 mg/l)	Return to background concentrations within several days	1 ha (>20 mm) 0 ha (>50 mm)	0 ha > 20 mm after 15 days
CWS intakes	2.02 ha total (four heads)	>0. 5m	<24 hours x four events	932 ha (>50 mg/l) 37 3ha (100 mg/l) 14 ha (1,000 mg/l)	553 ha (>50 mg/l) 291 ha (100 mg/l) 34 ha (1,000 mg/l)	Return to background concentrations within several days	106 ha (>2 0mm) 7 ha (>50 mm) 2 ha (>300 mm) per head	0 ha >5 mm after 15 days
CWS outfalls	0.74 ha total (two heads)	>0.5 m	<24 hours x two events	.....	.....	.....	40 ha (>20 mm) 4 ha (>50 mm) 1 ha (>300 mm) per head	….
FRR outfalls	0.26 ha total (two heads)	>0.5 m	<24 hours x two events	91 ha (>50 mg/l) 28 ha (100 mg/l) 1 ha (1,000 mg/l)	152 ha (>50 mg/l) 89 ha (100 mg/l) 1 ha (1,000 mg/l)	Return to background concentrations within several days	1 ha (>20 mm) 0 ha (>50 mm) per head	0 ha >20 mm after 15 days

Effects on marine designated species and associated marine prey

Harbour porpoise (Southern North Sea SAC) are well adapted to existence in turbid coastal waters (Perrin *et al*., 2002). A pool-based study on a captive harbour porpoise that was blindfolded showed it was able to forage, using echolocation to navigate, however, swim speed was reduced when blindfolded (Verfuß *et al*., 2009). The short duration of the dredging activities and the rapid decrease in SSC following cessation of activities suggest that impacts will be short-lived and not significant. There is potential for indirect effects on harbour porpoise prey species through potential avoidance of fish from the plume as assessed below or reductions in fitness. Dredging plumes are predicted to be transient and spatially limited. As such, reductions if prey availability leading to indirect effects is highly unlikely.

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies, the maximum areas of instantaneous plume intersection (defined as surface SSC above 100 mg/l) with bird predicted (maximum) foraging areas was calculated. The threshold was applied to represent potential prey avoidance or reduced foraging efficiency.

Results from the intersection of the SPA bird foraging areas with SSC plumes associated with dredging activities for the installation of the cooling water intakes (the largest offshore infrastructure) are presented in Table 16. The disposal point for intakes and outfalls are assumed to be the same location, therefore results apply to all structures with the intake being the most precautionary due to greater dredge volumes (Table 14). Results from the intersection of the SPA bird foraging areas with SSC plumes associated with dredging activities for the installation of the two FRRs and CDO outfalls (individually) are presented in Table 17.

Results from the intersection of the SPA bird foraging areas with SSC plumes associated with navigational dredging activities for the BLF is presented in Table 18. Maintenance dredging activities result in 1 % or less of the foraging areas being exposed to SSC at 100mg/l or above for all colonies of SPA designated birds.

Table 16: Maximum area of instantaneous plume intersection with bird predicted (maximum) foraging areas resulting from dredging of surficial sediments for cooling water intakes. Plume defined as surface SSC above100 mg/l.

Colony	**Spring tide**		**Neap Tides**	
	Area (Ha)	**% of predicted foraging area**	**Area (Ha)**	**% of predicted foraging area**
Little tern: Dingle colony	0	0	0	0
Little tern: Minsmere colony	0	0	0	0
Little tern Slaughden colony	124	7	68	4
Common tern: Minsmere colony	265	1	206	<1
Common tern: Orfordness colony	238	<1	291	<1
Sandwich tern	265	<1	291	<1
Lesser black-backed gull*	265	<1	291	<1

* Not identified in the HRA Screening report (EDF Energy, 2019b) but included for information

Table 17: Maximum area of instantaneous plume intersection with bird predicted (maximum) foraging areas resulting from dredging of surficial sediments for FRR1 outfall. Plume defined as surface SSC above100 mg/l.

Colony	**Spring tide**		**Neap Tides**	
	Area (Ha)	**% of predicted foraging area**	**Area (Ha)**	**% of predicted foraging area**
Little tern: Dingle colony	76	4	29	2
Little tern: Minsmere colony	10	1	31	2
Little tern Slaughden colony	32	2	21	1
Common tern: Minsmere colony	89	<1	54	<1
Common tern: Orfordness colony	38	<1	32	<1
Sandwich tern	89	<1	54	<1
Lesser black-backed gull*	89	<1	54	<1

* Not identified in the HRA Screening report (EDF Energy, 2019b) but included for information

Table 18: Maximum area of instantaneous plume intersection with bird predicted (maximum) foraging areas resulting from navigational dredging for the BLF. Plume defined as surface SSC above 100 mg/l.

Colony	Spring tide		Neap Tides	
	Area (Ha)	% of predicted foraging area	Area (Ha)	% of predicted foraging area
Little tern: Dingle colony	51	3	13	1
Little tern: Minsmere colony	98	6	44	3
Little tern Slaughden colony	14	1	14	1
Common tern: Minsmere colony	98	<1	48	<1
Common tern: Orfordness colony	97	<1	48	<1
Sandwich tern	108	<1	51	<1
Lesser black-backed gull*	108	<1	51	<1

* Not identified in the HRA Screening report (EDF Energy, 2019b) but included for information

The areas calculated represent the maximum instantaneous intersections with SSC of 100 mg/l or over. In the tidally dominant system, the plume is highly transient and return to background concentrations within a few days (BEEMS Technical Report TR480), therefore it is unlikely that there will be a significant effect on the features of the relevant designated sites.

Evidence gathered during the 2019 survey confirmed the presence of *S. spinulosa* reef-like features on the offshore Coralline Crag (BEEMS Technical Report TR512). Whilst the area is not a designated site, S. spinulosa reefs are Annex I habitats and listed as habitats of conservation importance (HOCI) under Section 41 of the NERC Act (2006) and are therefore considered in the EIA.

The Sizewell-Dunwich Bank is not an Annex I designated habitat; however,, the feature appears to have an important ecological role in the benthic communities of the Greater Sizewell Bay (BEEMS Technical Report TR348) and is therefore considered in the EIA.

4.4.2 Commissioning discharges

During cold flush testing discharges would include small quantities of conditioning chemicals including:

- hydrazine;
- ammonia;
- phosphate; and

- ethanolamine.

Only hydrazine exceeded applied EQS concentrations and was investigated further for potential for LSE on HRA features (see section 3.3.2).

4.4.2.1 Commissioning discharges of hydrazine

During the commissioning phase, hydrazine would be used during cold flush testing of the reactor units. The commissioning process for each reactor unit would last for about 24 months. A 12-month gap is anticipated between the completion of the two reactors. Cold flush testing mainly involves cleansing and flushing the various plant systems with demineralised water to remove surface deposits and residual debris from the installation. Waste streams during cold flush testing of Unit 1 are anticipated to be treated within a 750 m^3 storage tank before controlled discharge via the CDO. The discharge routing for Unit 2 has yet to be confirmed. A Rochdale envelope approach was therefore applied to represent the worst-case scenario for commissioning discharges, whereby treatment tanks for both Units (1,500 m^3) were assumed to discharge to the CDO. This represents a highly precautionary assessment. A second assessment assumes the case whereby cold flush testing discharges from Unit 2 are released via the CDO, whilst Unit 1 is operational. This represents a potential worst-case scenario for fish and other biota discharges from the FRR associated with Unit 1, approximately 340 m south of the CDO.

To assess the potential impact of the hydrazine discharges five environmental criteria were investigated:

1. The area of the plume above acute PNEC concentrations that intersects with the predicted foraging range of breeding little terns within the Minsmere to Walberswick SPA and Outer Thames Estuary SPA.

2. The likelihood for hydrazine to enter the Minsmere sluice thereby potentially effecting the Minsmere to Walberswick SPA and Ramsar site.

3. The potential for hydrazine to act as a chemical barrier effecting the migratory behavior of glass eels and yellow eels, life stages of the European eel (*Anguilla anguilla*).

4. The potential for hydrazine to intersect the Coralline Crag where potential *Sabellaria spinulosa* reef formations have been identified.

5. The potential for exposure of hydrazine to fish released once the Unit 1 Fish Recovery and Return (FRR) outfall is operational during commissioning of Unit 2.

Criteria 1 to 4 are based on the worst-case scenario of both treatment tanks discharging via the CDO, whilst criteria 5 assumes Unit 1 is operational, therefore, only commissioning discharges from Unit 2 are released via the CDO. Worst-case discharge concentrations and release scenarios are reported (30 µg/l hydrazine discharge concentration, 83.3 l/s discharge rate, 5-hour and 2.5-hour release for the combined and single Unit release, respectively). Further details are available in BEEMS Technical Report TR494.

1. Hydrazine intersection with breeding little tern foraging area

The worst-case hydrazine discharge results in an area exceeding the chronic PNEC (0.4 ng/l as an average of the month-long model simulation) over an area of 30.5 ha at the surface and 2.92 ha at the seabed, both representing <0.01 % of the Outer Thames Estuary SPA, respectively. The acute PNEC (4 ng/l as a 95th percentile of the month-long model simulation) is exceeded over an area of 12.9 ha at the surface and 2.92 ha at the seabed, which represents <0.01 % of the Outer Thames Estuary SPA, respectively. Assuming a highly precautionary scenario of fish avoidance from the areas above the acute PNEC, the loss of potential foraging habitat to red throated divers would be negligible.

The limited spatial extent of the hydrazine plume means that the Alde-Ore Estuary Ramsar site and the coastal lagoons within the Orford Ness to Shingle Street SAC are beyond the ZoI of the discharge.

In the Greater Sizewell Bay, three breeding colonies of little terns have been identified at Dingle, Minsmere and Slaughden. Model results show that only the foraging ranges of the Minsmere colony is intersected by the hydrazine plume. At a release concentration of 15 µg/l, the peak instantaneous area intersection of the hydrazine plume above acute PNEC concentrations during month-long model simulations was 2.56 % whilst the average was 0.12 %. The duration of the plume is short, with concentrations exceeding the acute PNEC for no longer than 3.5 hours (BEEMS Technical Report TR494).

The acute PNEC is considered highly precautionary when compared to the Canadian Federal Water Quality Guidelines for hydrazine of 200 ng/l for low likelihood of adverse effects for marine life. The area of discharged hydrazine with a concentration greater than 200 ng/l is limited to the immediate vicinity around the CDO (0.34 ha as a 95th percentile) and represents <0.02 % of the foraging area of little terns from the Minsmere colony (Table 13). At a release concentration of 15 µg/l, the maximum instantaneous intersection above 200 ng/l is 4.44 ha or 0.245 % with a mean intersection of 0.003 %. Therefore, a minimal area of the foraging range of designated little terns is predicted to be exposed to ecologically relevant concentrations based on precautionary commissioning discharge assessments (BEEMS Technical Report TR494).

2. *Likelihood for hydrazine discharges to enter the Minsmere Sluice*

A time series was modelled at the position of the Minsmere sluice to determine the potential for the maximum instantaneous plume to enter RSPB Minsmere and thereby potentially affect the Minsmere to Walberswick SPA and Ramsar site.

The Minsmere sluice opens for half an hour after high tide, allowing saltwater to enter the system. At Sizewell, the tide floods in a southerly direction. As the proposed development is south of the Minsmere sluice, discharges are only transported northward on an ebb tide, when water levels are lowering. Model results of the monthly discharge indicate maximum instantaneous hydrazine concentrations of 0.12 ng/l at the surface and 0.11 ng/l at the seabed occur at the location of the Minsmere Sluice. Neither the chronic nor acute PNEC are exceeded and, as the plume is only transported northward during a falling tide the potential for hydrazine to enter the sluice is low. As such, the very low concentration at the sluice and limited potential to enter the coastal habitats means adverse effects are highly unlikely (BEEMS Technical Report TR494).

3. *Hydrazine and chemical barrier to migratory eels*

The potential concern for hydrazine discharges during commissioning to effect to migratory eels has been raise. In the UK glass eels enter river systems from the sea in March and April whilst yellow eels migrate from the rivers back to sea in September to December. Commissioning discharges could coincide with the period of eel migration, as such the concentration of hydrazine at the Minsmere sluice (the closest entry point to freshwater from the CDO) was investigated. European eels (*Anguilla Anguilla*) are a Priority Species in Section 41 of the NERC Act 2006 and are included on the Oslo-Paris (OSPAR) Commission List of Threatened and/or Declining Species and Habitats.

Results show that the hydrazine discharge forms a long narrow shore parallel plume leaving a narrow corridor 270 m wide between the shoreline and the edge of acute PNEC concentration contour (4 ng/l as a 95th

percentile). The northern tip of the 95th percentile surface plume is approximately 1,235 m south of the east-west axis of the Minsmere sluice. This would allow eels to both migrate north-south along the coastline and enter/exit the Minsmere sluice travelling east-west into the North Sea unimpeded. At the sluice itself, the peak instantaneous concentration is 0.12 ng/l at the surface and 0.11 ng/l at the seabed.

Data on the toxicity of hydrazine to marine fish is not available, however, the most sensitive freshwater species have a 96-h LC_{50} of 610,000 ng/l. This acute toxic threshold is over 40-fold higher than the source concentration of the proposed CDO commissioning discharge and over 10^6 higher than the maximum instantaneous concentration at the sluice. Behavioural responses of freshwater bluegill (*Lepomis macrochirus*), have been observed at concentrations of 100,000 ng/l and above, over 800,000 times higher than the instantaneous maximum concentration at the sluice. Therefore, it is considered highly unlikely that commissioning discharges of hydrazine would affect eel migration given the low concentration and limited potential for exposure.

4. Hydrazine intersection with the Coralline Crag

A time series was modelled at the position of the Coralline Crag where *Sabellaria spinulosa* reef formations have been identified (BEEMS Technical Report TR348). The peak instantaneous concentration of hydrazine during the worst-case release scenario at the seabed was 0.05 ng/l, below the acute and chronic PNEC. The PNEC was never exceeded under all scenarios tested meaning *S. spinolosa* reefs would not be exposed to concentrations anticipated to cause adverse effects (BEEMS Technical Report TR494).

5. Exposure of biota discharged from the FRR to hydrazine

In the case cold flush testing discharges from Unit 2 are released via the CDO, whilst Unit 1 is operational, fish and other biota discharged from the Unit 1 FRR, approximately 340 m south of the CDO, may be exposed to hydrazine.

At a release concentration of 15 µg/l, the peak concentration at the surface is 176.38 ng/l. The average concentration of the plume at the surface above the PNEC (only including the times above the PNEC) is 15.03 ng/l (BEEMS Technical report TR494). The maximum concentration never exceeds the Canadian Standards (200 ng/l). Whilst the plume regularly exceeds the acute PNEC, the duration of the plume is short, with concentrations exceeding the acute PNEC for no longer than 3.25 hours. It is important to note that, for the 15 µg/l release concentration, the maximum plume duration above the acute PNEC does not correspond to the time of the peak concentration. The peak concentration of 176.38 ng/l would only last for 1 model output time step (i.e. 15 minutes). The total time above the acute PNEC represents only 5.1 % of the modelled month, for the 15 µg/l release concentration (BEEMS Technical Report TR494). The duration of the instantaneous plume above the PNEC is short, along with the total time during the month. Therefore, fish discharged from the FRR are predicted to have minimal exposure at ecologically relevant concentrations based on precautionary commissioning discharges (BEEMS Technical Report TR494).

4.4.3 Operation

The HRA Evidence Plan scoped in the following sites and features for having the potential marine water quality effects from the operation phase of Sizewell C:

- Alde-Ore and Butley Estuaries SAC – estuaries, mudflats and sandflats not covered by seawater at low tide and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*).

- Alde-Ore Estuary SPA - Supporting habitat to SPA designated interest, breeding little Tern *Sterna albifrons*, breeding sandwich tern *Sterna sandvicensis*, breeding lesser black-backed gull *Larus fuscus* and assemblage qualification: a seabird assemblage of international importance.
- Alde-Ore Estuary RAMSAR - Ramsar criterion 2 (Nationally-scarce plant species and British Red Data Book invertebrates), Ramsar criterion 3 (The site supports a notable assemblage of breeding and wintering wetland birds) and Ramsar criterion 6 (Species/populations occurring at levels of international importance).
- Benacre to Easton Bavents Lagoons SAC - Coastal lagoons * Priority feature.
- Benacre to Easton Bavents SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick Heaths and Marshes SAC - Annual vegetation of drift lines and perennial vegetation of stony banks.
- Minsmere to Walberswick SPA - Supporting habitat to SPA designated interests and breeding little tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 1 (mosaic of marine, freshwater, marshland and associated habitats) and Ramsar criterion 2 (Supports 9 nationally scarce plants and at least 26 red data book invertebrates).
- Orford Ness to Shingle Street SAC - Coastal lagoons * Priority feature and annual vegetation of drift lines.
- Outer Thames Estuary SPA - Supporting habitat to SPA designated interests, wintering /passage red-throated diver *Gavia stellata*, breeding little tern *Sterna albifrons* and breeding common tern *Sterna hirundo*.
- Southern North Sea SAC – Harbour porpoise (*Phocoena phocoena*).
- Humber Estuary SAC – Grey seal (*Halichoerus grypus*)
- The Wash and Norfolk Coast SAC - Harbour seal (*Phoca vitulina*).

4.4.3.1 Thermal discharge

Thermal discharges would occur throughout the operational phase of the proposed development. The worst-case thermal impact would occur during the operation of Sizewell B and Sizewell C and is therefore the focus of attention. Additional scenarios, including Sizewell C operating in isolation and a Sizewell C maintenance scenario have also been considered.

The thermal plume from both Sizewell B and Sizewell C was modelled using the validated Sizewell GETM in BEEMS Technical Report TR302. The results are summarised in the Water Quality Synthesis BEEMS Technical Report TR306 Ed. 5.

Unlike chemical standards which normally have a clear evidence link to ecological effects, the evidence base for thermal standards is limited by the availability of reliable data (BEEMS Scientific Advisory Report SAR008). In order to be protective of the most sensitive species, thermal standards have, therefore, been set on an indicative basis and, as such, they act as trigger values for further investigation of potential ecological effects.

BEEMS Scientific Advisory Report SAR008 reviewed the available evidence on thermal effects and concludes:

> *"The available data confirms that adverse effects of CW outfalls are restricted to an area close to the plume, that temperature rises up to 3 °C appear to be tolerable, and that resulting temperatures of less than 27 °C have no clear deleterious impact on species in the receiving waters, but, in the longer term, changes in the local community may result as species with differing tolerances of elevated temperature show differing survival, growth and patterns of reproduction from those expressed under ambient conditions. Furthermore, populations that persist adjacent to a heated CW effluent will acclimate to those new local conditions and evolve in response to them"*

Two threshold values are applied for SPA assessments:

1. Temperature uplift ≤2 ˚C as a Maximum Allowed Concentration (MAC) at the edge of the mixing zone.
2. 98th percentile of the absolute temperature ≤28 ˚C.

The uplift criteria is defined as a Maximum Allowed Concentration. In ecotoxicity studies MACs are normally defined as 95th or 98th percentiles but the SPA uplift threshold is specified as a 100th percentile i.e. a maximum temperature value. This metric is, therefore, very dependent on how the observations or model simulations are done and the time period considered. Using the Sizewell GETM model the maximum taken from instantaneous temperature fields, saved every hour over a one-year simulation, provides data on the area that exceeds 2 ˚C excess temperature for at least 1 hour per year i.e. for 1h in 8760 h per annum. At this temperature threshold, this metric is not considered to have any link to specific ecological effects, and it serves as a precautionary threshold to trigger further ecological investigation.

The absolute temperature standard for SPAs of ≤28 ˚C as a 98th percentile does have a robust evidence link as it is known than the upper lethal temperature for many benthic organisms is in the range 30-33 ˚C (BEEMS Scientific Advisory Report SAR008).

The SZC and SZB plumes are separate at high plume temperatures but at lower temperatures, the SZC plume acts to increase the size and temperature of the SZB plume at the surface and the seabed (BEEMS Technical Report TR301). This means that the thermal effects of SZC also contribute to a magnified Sizewell B plume. Figure 15 and Figure 14 illustrate the effect of the Sizewell C cooling water discharge on the Sizewell B thermal plume.

Thermal thresholds for SACs designated for estuarine or embayment habitat and/or salmonid species, also apply absolute temperature thresholds of 21.5 ᵒC as a 98th percentile (Wither *et al.* 2012). However, these criteria are not applicable as salmonids are not designated features of the EMS within the ZoI of the thermal plume and the Southern North Sea SAC, directly adjacent to the proposed development is designated for harbour porpoise. As such, SPA absolute temperature criteria are applied.

Effects on marine designated species

The areas of exceedance for the SPA thermal standards are shown in Table 19. The 2 ˚C uplift threshold in the Outer Thames Estuary SPA is exceeded over a total seabed area of 16,443 and a surface area of 22,455 ha for SZB and SZC.

The second criteria for SPAs is the 98th percentile of the absolute temperature (annual model run). The predicted areas where the plume temperatures exceed 28 ˚C are shown in Table 19 and are all below 1ha.

For red-throated diver, the area of exceedance of the habitat thermal standards (2 °C uplift as a 100th percentile) from SZC and SZB is less than 6 % of the Outer Thames Estuary SPA area (Table 19). This is considered in more detail below.

For harbour porpoise, the area of exceedance of the habitat thermal standards (2 °C uplift as a 100^{th} percentile) is 0.5 % of the Southern North Sea SAC area (Table 19). Harbour porpoise are highly mobile and are not predicted to be adversely affected by thermal discharges. The potential for loss of foraging area due to thermal discharges is considered in more detail below.

There is no intersection between the proposed development site and Humber Estuary SAC, designated for grey seals (*circa* 220 km to the north), or The Wash and North Norfolk Coast SAC designated for harbour seals (*circa* 120 km to the north), however, seals are known to transit past the site. Grey seals are wide ranging and can utilise different breeding and foraging grounds (Russell *et al*., 2017). Typical foraging trips are within 100 km from their haul-out sites, although trips of several hundred km have been recorded as well (SCOS, 2017). The typical foraging trips are usually between 40 to 50 km from the haul-out site (SCOS, 2017). The longest foraging trips have been recorded during tagging studies at the Wash where seals often foraged up to 120 km offshore (average 80 km) and occasionally travelled up to 220 km (Sharples *et al.,* 2012). It is therefore possible that seals from designated sites may transit past the area. The large foraging ranges of these species and the low site utilisation indicates that the potential for loss of foraging area due to thermal discharges would be negligible.

Table 19: Area of the Outer Thames Estuary SPA (392,400 ha) and Southern North Sea SAC (3,695,054 ha) where the SPA temperature standards are exceeded. Values represent intersections with designated sites, not absolute values.

Designated site	Model run	Position		Max excess temp. >2 °C (100^{th} percentile)	98^{th} percentile >28 °C. Calculated from mean excess temp. >8.6°C
Outer Thames Estuary SPA	SZB	Surface	ha	9,370	0
			%	2.39	0
		Seabed	ha	5,214	0
			%	1.33	0
Outer Thames Estuary SPA	SZB+SZC	Surface	ha	22,455	0.11
			%	5.72	<0.01
		Seabed	ha	16,443	0
			%	4.19	0
Outer Thames Estuary SPA	SZC	Surface	ha	16,775	0
			%	4.28	0
		Seabed	ha	12,244	0
			%	3.12	0
Southern North Sea SAC	SZB	Surface	ha	7,878	0
			%	0.21	0
		Seabed	ha	4,454	0

			%	0.12	0
Southern North Sea SAC	SZB+SZC	Surface	ha	18,457	0.11
			%	0.50	<0.01
		Seabed	ha	13,095	0
			%	0.35	0
Southern North Sea SAC	SZC	Surface	ha	15,245	0
			%	0.41	0
		Seabed	ha	11,426	0
			%	0.31	0

Effects on marine prey of designated species

It is known from laboratory thermal preference experiments that fish species can choose to avoid areas of high temperature and there is, therefore, a possibility that thermal plumes could act as barriers to migration in transitional waters or more generally that areas of thermal plumes may be avoided by fish.

The issue of potential thermal barriers is discussed in BEEMS Scientific Advisory Report SAR008:

> *"There is a regulatory concern as to how fish will behave when confronted with a step change or sharp gradient in temperature on meeting a thermal plume or far-field temperature rises caused by a thermal discharge.*
> *...*
>
> *"This is one of the most important regulatory aspects for consenting thermal discharges. In relation to European sites, WQTAG160 (WQTAG, 2006) takes a precautionary approach and assumes that fish will be reluctant to pass through thermal plumes. "*
> *…*
>
> *"Blockage by thermal plumes appears to be an intuitive rather than observed concept. The reasoning is that salmonids (the main migratory species of interest in past studies) are cold-water stenotherms and therefore avoid warm water. In fact, fish tracking studies carried out in rivers and estuaries in the United Kingdom and elsewhere in the world do not provide any clear evidence of thermal barriers, and where evidence suggests possible effects it has been confounded by other issues such as changes in – or absolute levels of – freshwater discharge and the levels of dissolved oxygen."*

Existing thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25 % with a temperature uplift above 2 °C, for more than 5 % of the time[8] (BEEMS Technical Report TR302). In the absence of specific data, this standard makes the precautionary assumption that fish will actively avoid areas of thermal uplift of more than 2 °C. In fact, for various species the measured avoidance thresholds from choice tank experiments are higher than 2 °C. Gray (1977) reported that juvenile chinook salmon (*Oncorhynchus tshawytscha*) tested under three discharge conditions (no plume, ambient plume and heated plume) avoided plume temperatures greater than 9-11 °C above ambient. However, studies have shown that temperature increases of >2 °C may not be a significant deterrent to the movement of a number of

[8] The potential for disruption to fish migration is considered in Section 3.4.1.6.

important species (BEEMS Technical Report TR302). Experimental studies have shown that salmonids and smelt will tolerate temperature increases of up to 4 °C above background (Wood and Turnpenny, 1994). Given the choice of a base temperature averaging 12.3 °C (9.5 °C in the case of eels), or water incrementally raised by 2–12 °C, only juvenile smelt and dace exhibited an avoidance reaction, initially observed at a ΔT of +4 °C and +8 °C, respectively, relative to the base temperature (BEEMS SAR008). These are choice chamber results which do not reflect real world behavioural imperatives which in practice may drive fish to ignore these ‘thresholds’. There was also no evidence that large smelt are more likely to avoid the area of the intakes with increasing excess seabed temperatures up to 2.5°C (BEEMS Scientific Position Paper SPP101).

The relevance to the designated features at Sizewell is that if avian prey species avoid areas of the thermal plume this may reduce the feeding opportunities for HRA designated marine birds. To calculate the potential loss of foraging areas the plume size above certain thresholds is intersected with the foraging areas of each species of interest to calculate the potential lost foraging area. There are no regulatory standards or guidelines for such calculations.

One way to undertake this calculation could be to intersect a precautionary annual 98th percentile area of plume uplift with each foraging area. However, this is not appropriate because the designated birds are only present at certain times of the year at Sizewell and using annual statistics is, therefore, incorrect (thermal uplift plume sizes vary with the time of the year due to different amounts of seasonal mixing BEEMS Technical Report TR302).

Alternatively, the 98th percentile uplift plume area could be intersected with the relevant foraging area during the time period when the designated birds are present at Sizewell (these plume areas are shown in Appendix C). However, 98th percentile areas are statistical constructions not the instantaneous plume sizes that the fish will encounter. To calculate thermal uplift areas that may cause fish avoidance the instantaneous plume size has therefore been calculated at hourly intervals for the relevant period of the year for each bird species of interest and these have been intersected with the relevant foraging areas (predicted/maximum or mean, see section (see section 4.2 and Appendix B).

For the relevant SPA designated bird species with marine prey (breeding little tern, sandwich tern, common tern; and over-wintering red-throated diver) instantaneous plume intersect size for a 2 ˚C and 3 ˚C uplift has been modelled for the relevant period of the year:

- May to August for little tern (colonies combined) (
-
- Figure 22).
- May to August for common tern (
- Figure 24).
- April to August for sandwich tern (Figure 23) and lesser black-backed gull (Figure 25).
- September to March for red-throated diver (Figure 26).

The instantaneous plume intersect size for a 2˚C and 3˚C uplift modelled for the individual little tern predicted foraging areas are shown in Appendix D and presented in Table 20.

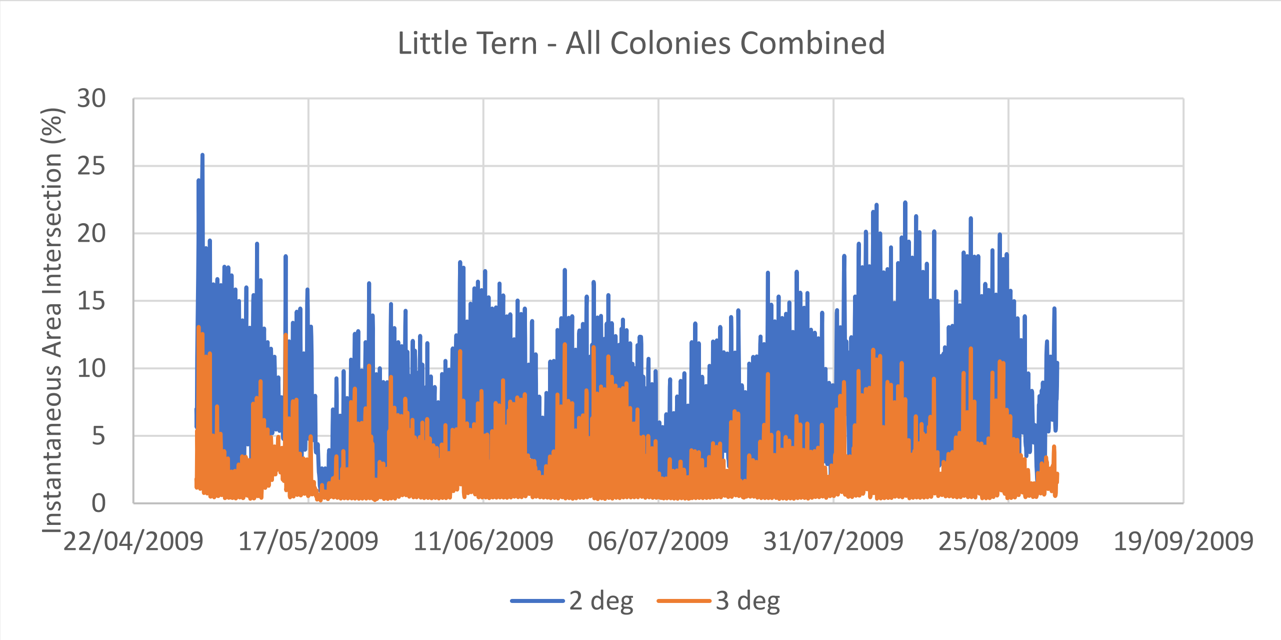

Figure 22: Instantaneous area intersection of the 2 ˚C and 3˚C thermal uplift with the breeding little tern foraging area during May to August.

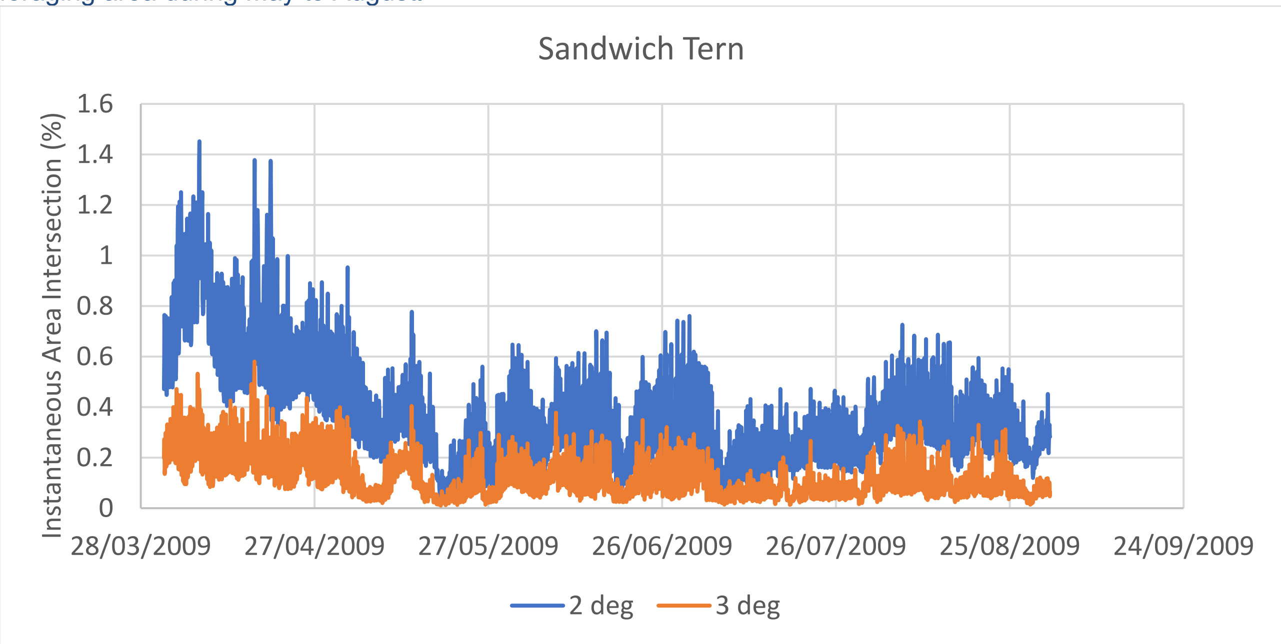

Figure 23: Instantaneous area intersection of the 2 ˚C and 3 ˚C thermal uplift with the breeding sandwich tern predicted foraging area during April to August.

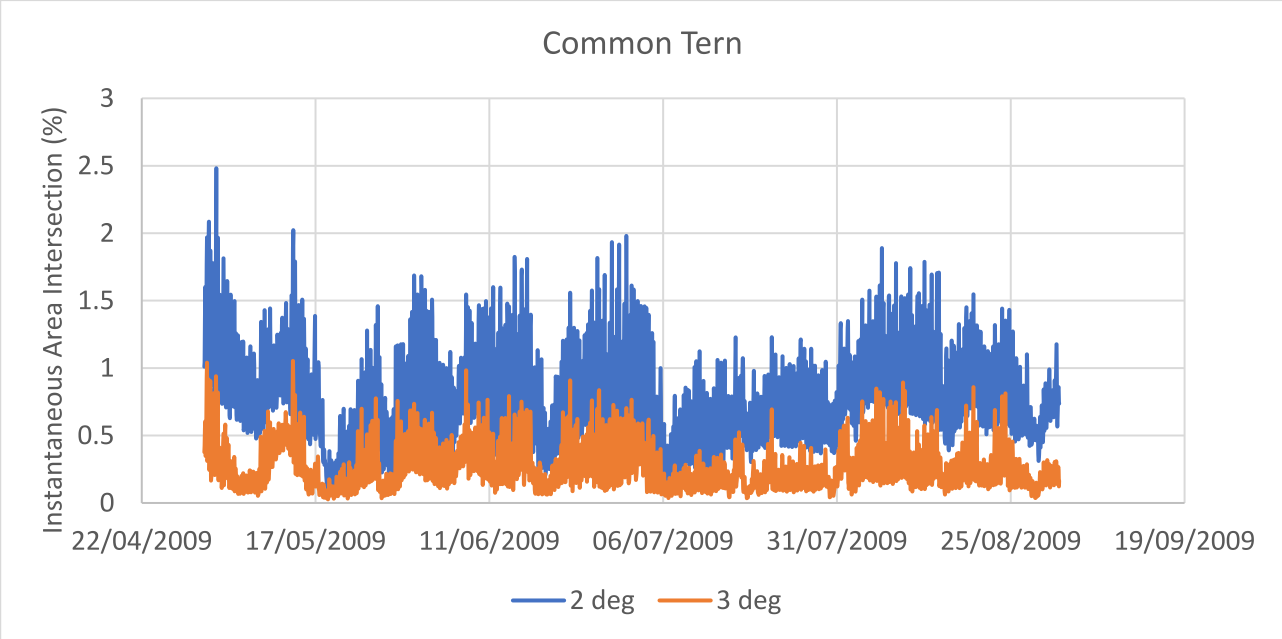

Figure 24: Instantaneous area intersection of the 2 °C and 3 °C thermal uplift with the breeding common tern predicted foraging area during May to August.

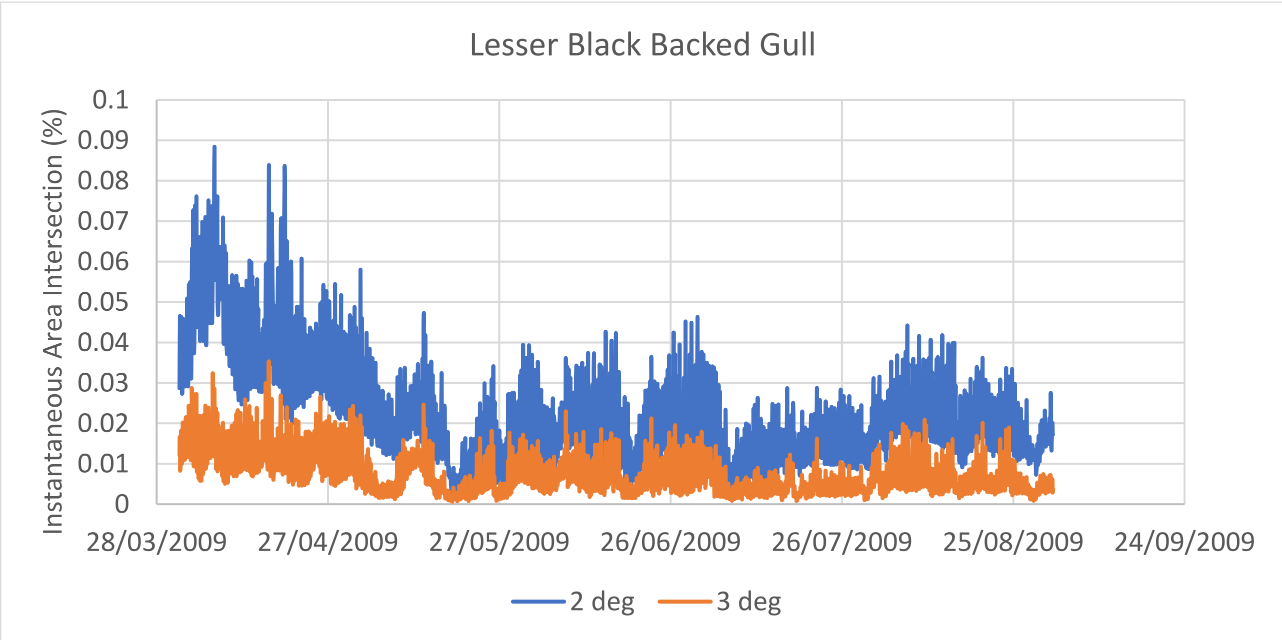

Figure 25: Instantaneous area intersection of the 2 °C and 3 °C thermal uplift with the breeding lesser black-backed gull predicted foraging area during April to August.

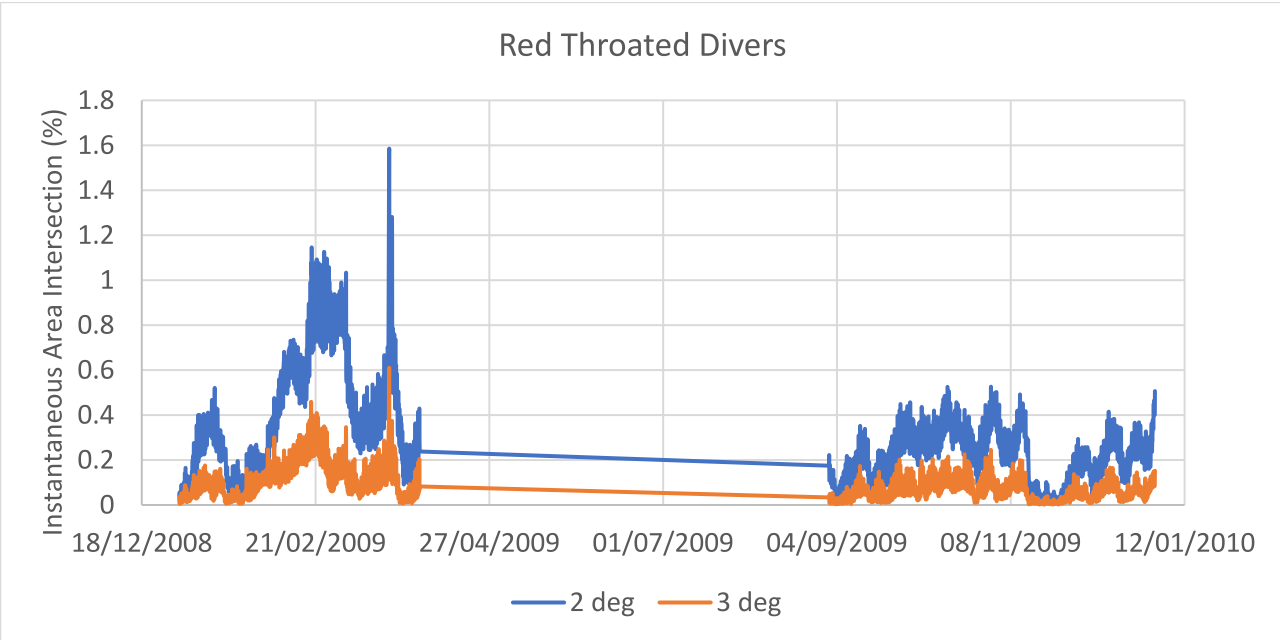

Figure 26: Instantaneous area intersection of the 2 °C and 3 °C thermal uplift with the over-wintering red-throated diver predicted foraging area during September to March.

The question that then arises is what is the appropriate avoidance threshold? The most important prey species at Sizewell are the pelagic species sprat and herring. Seabass may also be a part of the diet of overwintering red throated divers. Acoustic surveys of sprat at Sizewell have shown no apparent avoidance of the Sizewell B 2 ºC uplift chlorinated plume (BEEMS Technical Report TR381). Seabass were found to be positively attracted to the chlorinated SZB thermal plume in winter (BEEMS Technical Report TR380).

Cucumber Smelt (a locally common herring-like pelagic species) has shown avoidance at a ΔT of +4 °C (BEEMS SAR008). The available evidence is, therefore, that an avoidance threshold of 2 ºC is not appropriate and based upon the smelt result a figure of 4 ºC is considered a more likely threshold. To be precautionary, a 3 °C uplift threshold is considered conservative for the marine prey of the relevant SPA designated bird species at Sizewell.

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies or in the Outer Thames Estuary SPA, the surface thermal plume (exceeding 3 ºC uplift from the instantaneous modelled plume) intersects with the following individual species foraging ranges are shown in Table 20.

Table 20: Instantaneous thermal plume intersection with bird predicted (maximum) and concentrated (mean) foraging areas. Results show the maximum and mean of the 3 ºC thermal uplift from the operation of SZB + SZC during the breeding season (apart from red-throated diver which is designated during the winter).

SPA	Species and colony	Mean			Maximum		
		Area (Ha)	% of predicted foraging area	% of mean foraging area	Area (Ha)	% of predicted foraging area	% of mean foraging area
Alde-Ore Estuary	Sandwich tern: all colonies	284	0.2	0.3	1383	0.7	3.2
	Little tern: Slaughden colony	6	0.3	N/A	254	14.2	N/A
	Lesser black-backed gull	284	<0.01		1383	0.04	
Benacre to Easton Bavents SPA	Little tern – 3 ºC uplift surface thermal plume does not intersect with this colony's foraging range						
Minsmere to Walberswick SPA	Little tern: Minsmere colony	134	7.4	N/A	705	39.0	N/A
	Little tern: Dingle colony	4	0.2	N/A	158	8.5	N/A
Outer Thames Estuary SPA	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above						
	Common tern – Minsmere colony	190	0.5	5.4	880	1.5	26.9
	Common tern – Orfordness colony	190	0.5	0.02	880	1.5	3.6
	Red-throated diver[9]	320	0.1	N/A	2390	0.6	N/A

Thermal intersections from Sizewell C alone

Following the decommissioning of Sizewell B, the thermal plume from Sizewell C would be smaller and further offshore (Table 19) reducing the intersection with bird foraging ranges. Little tern colonies are the most susceptible given they have the most restricted foraging ranges. The annual 98th percentile 2 °C and 3 °C thermal uplifts do not intersect with the any of the three little tern colonies (Figure 27). As such, the potential for thermal uplifts to indirectly effect designated birds mediated through the influence of prey availability is considered negligible.

[9] Areas are larger due to the greater thermal uplift in the winter months when breeding colonies are not being utilised.

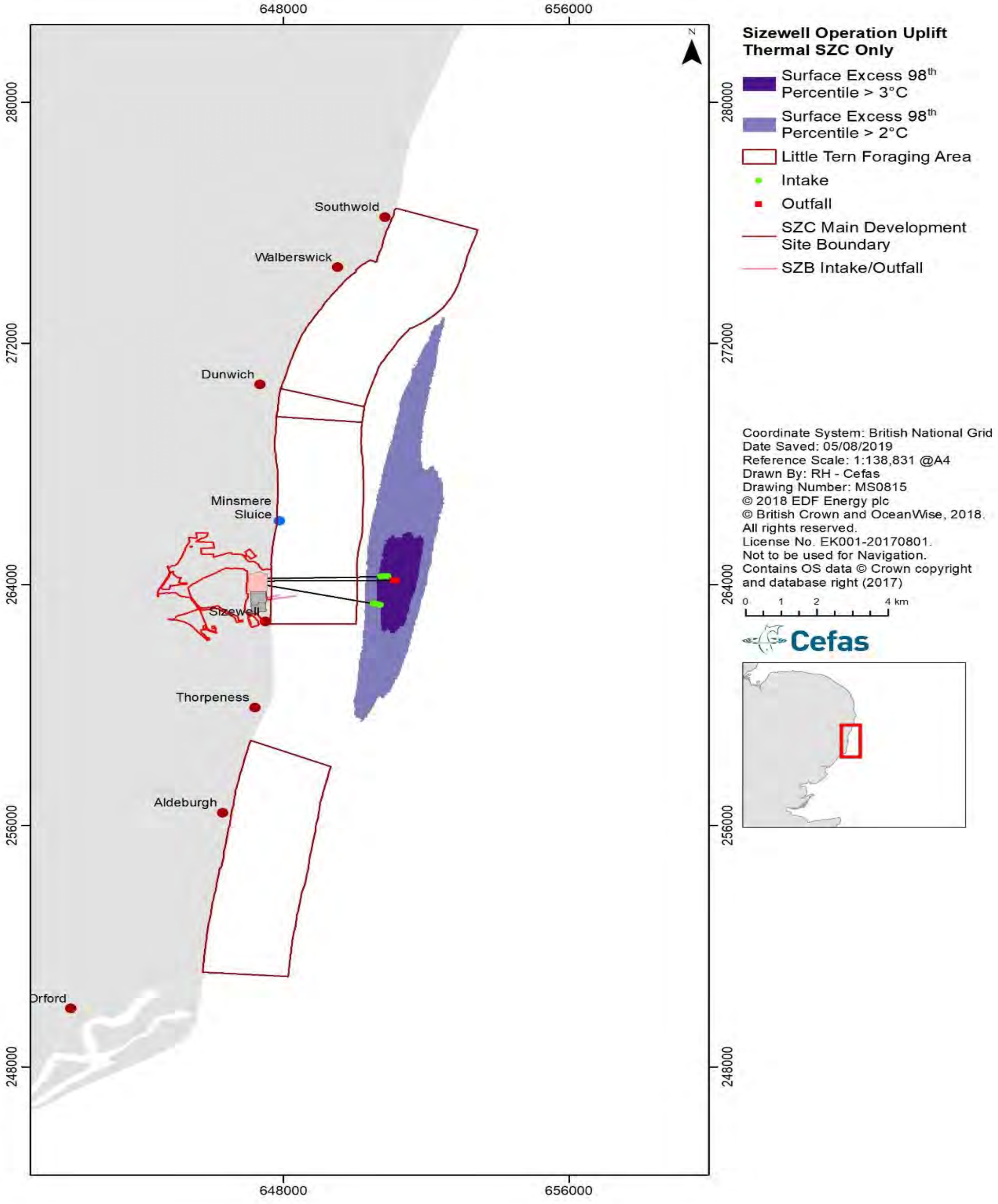

Figure 27: Annual 98th percentile 2 °C and 3 °C thermal uplifts in relation to predicted (maximum) foraging areas around little tern breeding colonies.

4.4.3.2 Chemical discharges: TRO

Chlorination of the power station cooling water system would be required to avoid bio-fouling. The total residual oxidants (TRO) resulting from the combination of chorine and organic material in the water were modelled using an empirical demand/decay formulation derived from experiments with Sizewell seawater and coupled into the GETM Sizewell model based on a release of 0.15 mg/l. The TRO plumes from Sizewell C and Sizewell B are spatially distinct at ecologically relevant concentrations and follow a long narrow trajectory parallel to the coast (BEEMS Technical Report TR306 Ed. 5).

Effects on marine designated species

The TRO plume areas at the EQS (10 µg/l as a 95th percentile) in the Outer Thames Estuary SPA and Southern North Sea SAC have been calculated and are shown in Table 21. For SZC only, the area exceeding the EQS at the seabed is 2 ha and 338 ha at the sea surface. Analysis of the TRO modelling runs shows that the EQS will only be exceeded in the mixing zone at the surface for SZC and both at the surface and seabed for SZB. An important observation from this modelling is the separation of the TRO plumes from SZB and C discharges with no interaction between them down to the levels below 1 µg/l of TRO (Figure 28).

Table 21: Areas exceeding the TRO EQS in the Outer Thames Estuary SPA and Southern North Sea SAC.

Model	TRO =10 µg/l as a 95th percentile	Outer Thames Estuary SPA (392,400 ha)		Southern North Sea SAC (3,695,054 ha)	
		surface	seabed	surface	seabed
SZB+SZC	ha	726.21	167.08	726.21	167.08
	% of designated area	0.18 %	0.04 %	0.02 %	<0.01 %
SZB only	ha	388.56	164.95	388.56	164.95
	% of designated area	0.10 %	0.04 %	0.01 %	<0.01 %
SZC only	ha	337.65	2.13	337.65	2.13
	% of designated area	0.09 %	<0.01 %	0.01 %	<0.01 %

For harbour porpoise, the areas of exceedance of the TRO EQS standard are 0.02 % of the Southern North Sea SAC area. The potential for loss of foraging area due to TRO plumes would be negligible. Skin infections have been observed in captive mammals due to the chlorination destroying beneficial microflora and inactivation of antimicrobial substances secreted by the skin (Geraci *et al.*, 1986). However, aquaria conditions represent much higher concentrations than those predicted in the receiving waters and long-term exposure.

There is no intersection between the proposed development site and Humber Estuary SAC, designated for grey seals (approximately 220 km to the north), or The Wash and North Norfolk Coast SAC designated for harbour seals (approximately 120 km to the north), however, seals are known to transit past the site. The large foraging ranges of these species and the low site utilisation at Sizewell indicates that the potential for loss of foraging area due to TRO plumes would be negligible.

For red-throated diver, areas of exceedance of the TRO EQS standard are less than 0.2 % of the Outer Thames Estuary area, therefore the loss of foraging area due to TRO plumes would be negligible

Effects on marine prey of designated species

BEEMS Technical Reports TR422 and TR437 show that local seabass populations at Sizewell will move into areas where food is available at mean TRO concentrations of 40 μgl^{-1}. Therefore, the EQS (10 μgl^{-1}) is considered to be a conservative threshold, however, it is applied as a precautionary threshold for prey avoidance.

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies or in the Outer Thames Estuary SPA, the surface TRO plume (above the EQS) intersects with the following individual species foraging ranges are shown in Figure 28 and Table 22.

Table 22: TRO plume intersection with bird predicted (maximum) and concentrated (mean) foraging areas. Results show the surface area of exceedance of the EQS (10 ug/l as a 95th percentile) from the operation of SZB and SZC respectively during the breeding season (apart from red-throated diver which is designated during the winter). The effects of the two stations are separated due the spatially distinct nature of the two plumes.

SPA	Species and colony	Sizewell B TRO			Sizewell C TRO		
		Area (Ha)	% of predicted foraging range	% of mean foraging range	Area (Ha)	% of predicted foraging range	% of mean foraging range
Alde-Ore Estuary	Sandwich tern: all colonies	389	0.2	0.4	338	0.1	<0.01
	Little tern: Slaughden colony - TRO surface plume does not intersect with this colony's foraging range						
	Lesser black-backed gull	389	<0.04	0.04	338	<0.01	0.03
Benacre to Easton Bavents SPA	Little tern - TRO surface plume does not intersect with this colony's foraging range						
Minsmere to Walberswick	Little tern: Minsmere colony	261	14.4	N/A	SZC TRO surface plume does not intersect with this colony's foraging range		
	Little tern: Dingle colony - TRO surface plume does not intersect with this colony's foraging range						
Outer Thames Estuary	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above						
	Common tern – Minsmere colony	389	0.8	9.7	338	<0.7	6.5
	Common tern – Orfordness colony	389	0.6	TRO plume does not intersect with this foraging range	338	<0.7	TRO plume does not intersect with this foraging range

	Red-throated diver	389	0.10	N/A	338	0.09	N/A

Declines in abundance and distribution of the respective prey stocks/populations are unlikely due to no evidence of negative effects on prey (BEEMS Technical Report TR303 and TR381). Furthermore, additions of TRO from SZC only represent <0.5 % increase in intersection of the marine foraging area for all designated species as a precautionary 95th percentile. SZC TRO surface plume does not intersect with the little tern colony's foraging range.

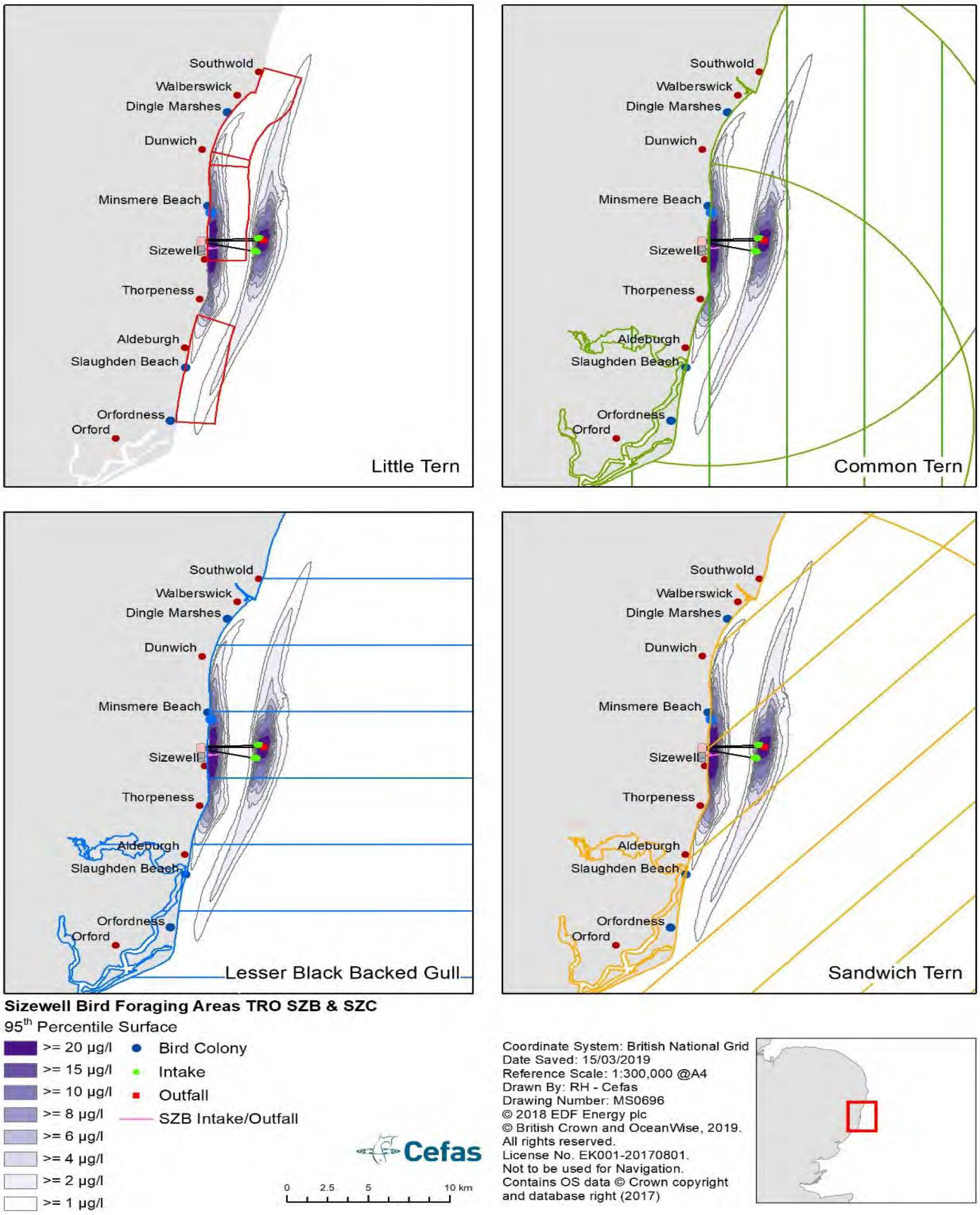

Figure 28: SZB + SZC modelling: 95th percentile of the TRO concentration at the surface (µg/l) with SPA bird predicted foraging areas.

4.4.3.3 Chemical discharges: Chlorinated by products (CBP) - Bromoform

The water chemistry at Sizewell means that bromoform is the predominant chlorinated-by-product. Like the TRO plume, the bromoform plume is a long, narrow feature parallel to the coast. Also, the SZB plume is always within the channel inshore of the Sizewell-Dunwich Bank and does not overlap with the SZC plume that is outside the Bank (Figure 29). The SZC plume is generally smaller and narrower than that due to SZB; the exception is at the 1 µg/l contour for the 95th percentile where the SZC plume has a longer extent but at higher concentrations the SZC plume is always smaller. This is due to the lower initial discharge concentration and greater water depth at the SZC outfall location (16 m vs. 5 m for SZB outfall) (BEEMS Technical Report TR306 Ed. 5).

Effects on marine designated species

The bromoform plume areas that exceed the PNEC (5 µg/l as a 95th percentile) intersecting with the Outer Thames Estuary SPA and Southern North Sea SAC have been calculated and are shown in Table 23. For SZC only, the area exceeding the applied EQS is 52 ha at the sea surface and 0.67 ha at the seabed.

Table 23: Areas exceeding the Bromoform PNEC in the Outer Thames Estuary SPA and Southern North Sea SAC.

Model	PNEC = 5 µg l^{-1} as a 95th percentile	Outer Thames Estuary SPA (392,400 ha)		Southern North Sea SAC (3,695,054 ha)	
		Surface ha	Seabed ha	Surface ha	Seabed ha
SZB+SZC	ha	357.9	130.19	357.9	130.19
	% of designated area	0.09 %	0.03 %	<0.01 %	<0.01 %
SZB only	ha	305.8	129.5	305.8	129.5
	% of designated area	0.08 %	0.03 %	<0.01 %	<0.01 %
SZC only	ha	52.1	0.67	52.1	0.67
	% of designated area	0.01 %	<0.01 %	<0.01 %	<0.01 %

For harbour porpoise, the areas of exceedance of the bromoform EQS standard are less than 0.01 % of the Southern North Sea SAC area. The potential for loss of foraging area due to bromoform plumes would be negligible.

There is no intersection between the proposed development site and Humber Estuary SAC, designated for grey seals (approximately 220 km to the north), or The Wash and North Norfolk Coast SAC designated for harbour seals (approximately 120 km to the north), however, seals are known to transit past the site. The large foraging ranges of these species and the low site utilisation at Sizewell indicates that the potential for loss of foraging area due to bromoform plumes would be negligible.

For red-throated diver, areas of exceedance of the Bromoform EQS standard are less than 0.1 % of the Outer Thames Estuary SPA area. therefore, the loss of foraging area due to CBP (bromoform) plumes would be negligible.

Effects on marine prey of designated species

The bromoform PNEC (5 µg/l as the 95th percentile) is considered a precautionary threshold as Gibson *et al.* (1979) only reported qualitative behavioural changes of juvenile menhaden (clupeid) when exposed to 6000 µg/l of bromoform.

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies or in the Outer Thames Estuary SPA, the surface bromoform plume (above the applied EQS) intersects with the following individual species foraging ranges are shown in Figure 29 and Table 24.

Table 24: Bromoform plume intersection with bird predicted (maximum) and concentrated (mean) foraging areas. Results show the surface area of exceedance of the applied EQS (5 µg/l as a 95th percentile) from the operation of SZB and SZC respectively during the breeding season (apart from red-throated diver which is designated during the winter).

SPA	Species and colony	Sizewell B Bromoform			Sizewell C Bromoform		
		Area (Ha)	% of predicted foraging range	% of mean foraging range	Area (Ha)	% of predicted foraging range	% of mean foraging range
Alde-Ore Estuary	Sandwich tern: all colonies	306	0.1	0.4	52	0.02	<0.01
	Little tern: Slaughden colony - Bromoform surface plume does not intersect with this colony's foraging range						
	Lesser black-backed gull	306	<0.04	0.03	52	<0.01	<0.01
Benacre to Easton Bavents SPA	Little tern - Bromoform surface plume does not intersect with this colony's foraging range						
Minsmere to Walberswick	Little tern: Minsmere colony	206	11.4	N/A	SZC Bromoform surface plume does not intersect with this colony's foraging range		
	Little tern: Dingle colony - Bromoform surface plume does not intersect with this colony's foraging range						
Outer Thames Estuary	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above						
	Common tern – Minsmere colony	306	0.6	7.6	52	0.1	1.4
	Common tern – Orfordness colony	306	0.6	Bromoform plume does not intersect with this foraging range	52	0.1	Bromoform plume does not intersect with this foraging range

	Red-throated diver	306	0.08	N/A	52	0.01	N/A

Declines in abundance and distribution of the respective prey stocks/populations are unlikely due to no evidence of negative effects on prey (BEEMS Technical Report TR303 and TR381). Furthermore, additions of bromoform from SZC represent <0.06 % of the marine predicted foraging area for all designated species. SZC TRO surface plume does not intersect with the little tern colony's foraging range.

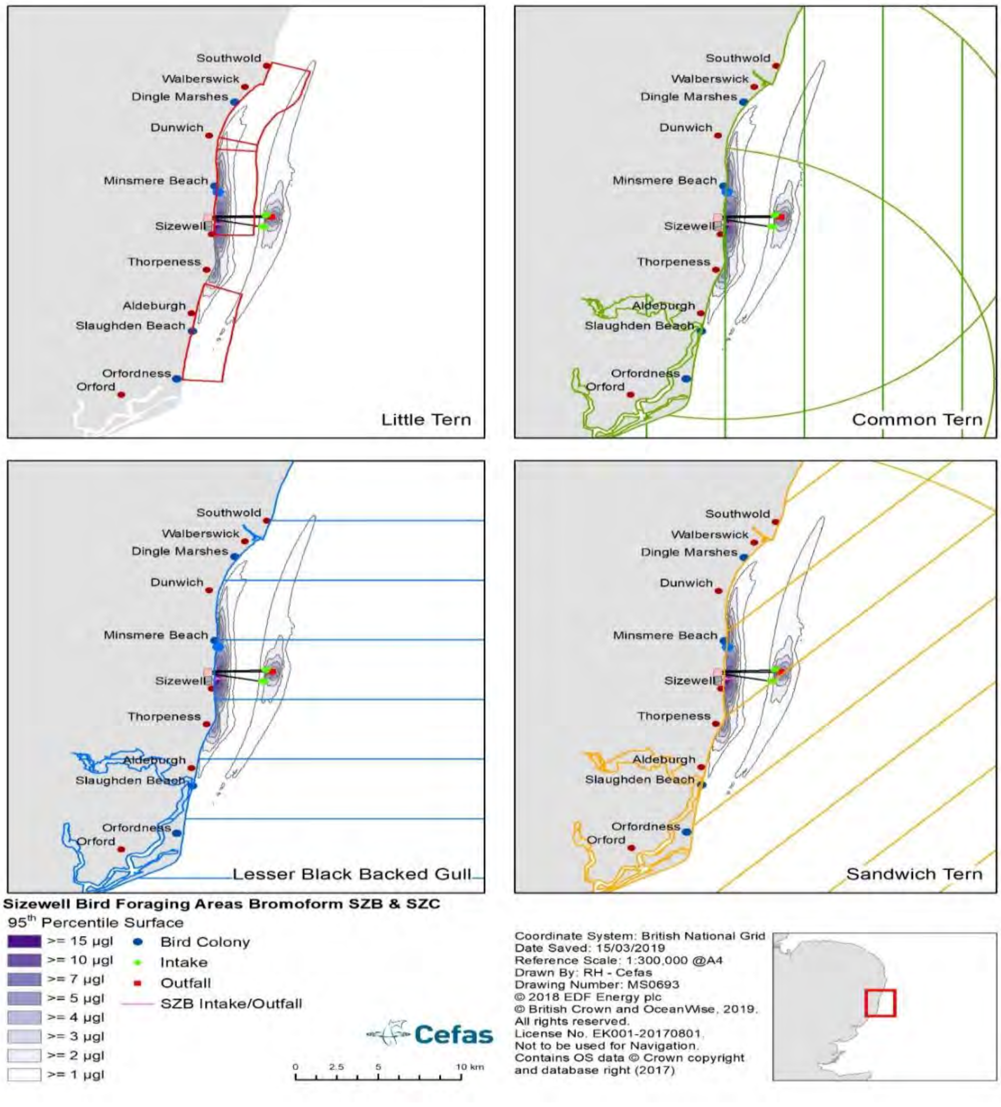

Figure 29: 95th percentile of the Bromoform concentration at the surface for chlorination from SZB and SZC with SPA bird predicted foraging areas.

4.4.3.4 Chemical discharges: Hydrazine

There is no established EQS for hydrazine and so a chronic PNEC of 0.4 ng/l has been calculated for long term discharges (calculated as the mean of the concentration values) and an acute PNEC of 4 ng/l for short term discharges (represented by the 95th percentile). To understand the impact of different operational discharge rates two discharge scenarios were studied for SZC: the first one considering a hydrazine discharge of 69 ng/l in daily pulses of 2.32 h starting at 12pm, and the second one of 34.5 ng/l of hydrazine discharged in daily pulses of 4.63 h duration starting at 12pm.

Effects on marine designated species

The hydrazine plume areas at the chronic PNEC (0.4 ng/l as an average) and the acute PNEC (4 ng/l as the 95th percentile) have been calculated. The chronic PNEC is exceeded at the surface by approximately 158 ha for both discharge scenarios and at the seabed by less than 1 ha for both discharge scenarios. The acute PNEC is exceeded at the surface (13.8 ha) and at the seabed 0.22 ha, in the case of the 69 ng/l release scenario (Table 25). In the 34 ng/l release scenario, the acute PNEC is exceeded over 17.4 ha at the surface and 0 ha at the seabed (BEEMS Technical report TR193 Ed. 5).

Figure 13 shows the predicted surface plume resulting from a daily hydrazine discharge from Sizewell C.

Table 25: Areas exceeding the Hydrazine PNEC in the Outer Thames Estuary SPA and Southern North Sea SAC.

Model	**PNEC**		**Outer Thames Estuary SPA (392,400 ha)**		**Southern North Sea SAC (3,695,054 ha)**	
			Surface ha	Seabed ha	Surface ha	Seabed ha
Hydrazine SZC 69ng May mean	Chronic 0.4 ng l^{-1}	ha	158.1	0.56	158.1	0.56
		% of designated area	0.04 %	<0.01 %	<0.01 %	<0.01 %
Hydrazine SZC 34ng May mean	Chronic 0.4 ng l^{-1}	ha	156.9	0.34	156.9	0.34
		% of designated area	0.04 %	<0.01 %	<0.01 %	<0.01 %
Hydrazine SZC 69ng May 95th percentile	Acute 4 ng l^{-1}	ha	13.8	0.22	13.8	0.22
		% of designated area	<0.01 %	<0.01 %	<0.01 %	<0.01 %
Hydrazine SZC 34ng May 95th percentile	Acute 4 ng l^{-1}	ha	17.4	0.00	17.4	0.00
		% of designated area	<0.01 %	0.00 %	<0.01 %	0.00 %

There is evidence that hydrazine is harmful to aquatic organisms at low concentrations (Environment Canada, 2011; CIDEN, 2008) and although its persistence is low to moderate this is dependent upon various water quality parameters (Environment Canada, 2011). The area of exceedance of the PNEC standards are less than 0.05% of the Outer Thames Estuary SPA and less than 0.01% of the Southern North Sea SAC area.

Effects on marine prey of designated species

The chronic PNEC (0.4ng/l as an average) and the acute PNEC (4 ng/l as the 95th percentile) are considered as highly precautionary thresholds for fish avoidance, Canadian Federal Water Quality Guidelines for hydrazine indicate a low likelihood of adverse effects for marine life below 200 ng/l (Environment Canada, 2013). A hydrazine discharge of 69 ngl^{-1} in daily pulses of 2.32 hours starting at 12pm was used as the worst-case scenario, however the surface hydrazine surface plume of 34 ngl^{-1} is shown in Figure 31.

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies or in the Outer Thames Estuary SPA, the surface hydrazine plume (69 ng/l scenario above the applied chronic and acute EQS) intersects with the following individual species foraging ranges are shown in

Figure 30 and Table 26.

Table 26: Hydrazine plume intersection with bird predicted (maximum) and concentrated (mean) foraging areas. Results show the surface area of exceedance of 69 ng/l scenario above the applied chronic and acute EQS from the operation of SZC during the breeding season (apart from red-throated diver which is designated during the winter).

SPA	Species and colony	Chronic EQS			Acute EQS		
		Area (Ha)	% of predicted foraging range	% of mean foraging range	Area (Ha)	% of predicted foraging range	% of mean foraging range
Alde-Ore Estuary	Sandwich tern: all colonies	158	0.08	Hydrazine surface plume does not intersect with this colony's foraging range	14	<0.01	Hydrazine surface plume does not intersect with this colony's foraging range
	Little tern: Slaughden colony - hydrazine surface plume does not intersect with this colony's foraging range						
	Lesser black-backed gull	158	<0.04	0.02	14	<0.01	<0.01
Benacre to Easton Bavents SPA	Little tern - hydrazine surface plume does not intersect with this colony's foraging range						
Minsmere to Walberswick	Little tern: Minsmere colony - hydrazine surface plume does not intersect with this colony's foraging range						
	Little tern: Dingle colony - hydrazine surface plume does not intersect with this colony's foraging range						
Outer Thames Estuary	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above						
	Common tern – Minsmere colony	158	0.3	3.2	14	0.02	0.4
	Common tern – Orfordness colony	158	0.3	Hydrazine surface plume does not intersect with this foraging range	14	0.02	Hydrazine surface plume does not intersect with this foraging range

	Red-throated diver	158	0.04	N/A	14	<0.01	N/A

However, as additions of Hydrazine from SZC only represent <0.4 % of the marine foraging area for all designated species, declines in abundance and distribution of the respective prey stocks/populations within these areas are unlikely to cause significant effects. Hydrazine SZC surface plume does not intersect with little tern colony’s foraging range.

Commissioning discharges of hydrazine has been assessed in section 3.3.2.1.

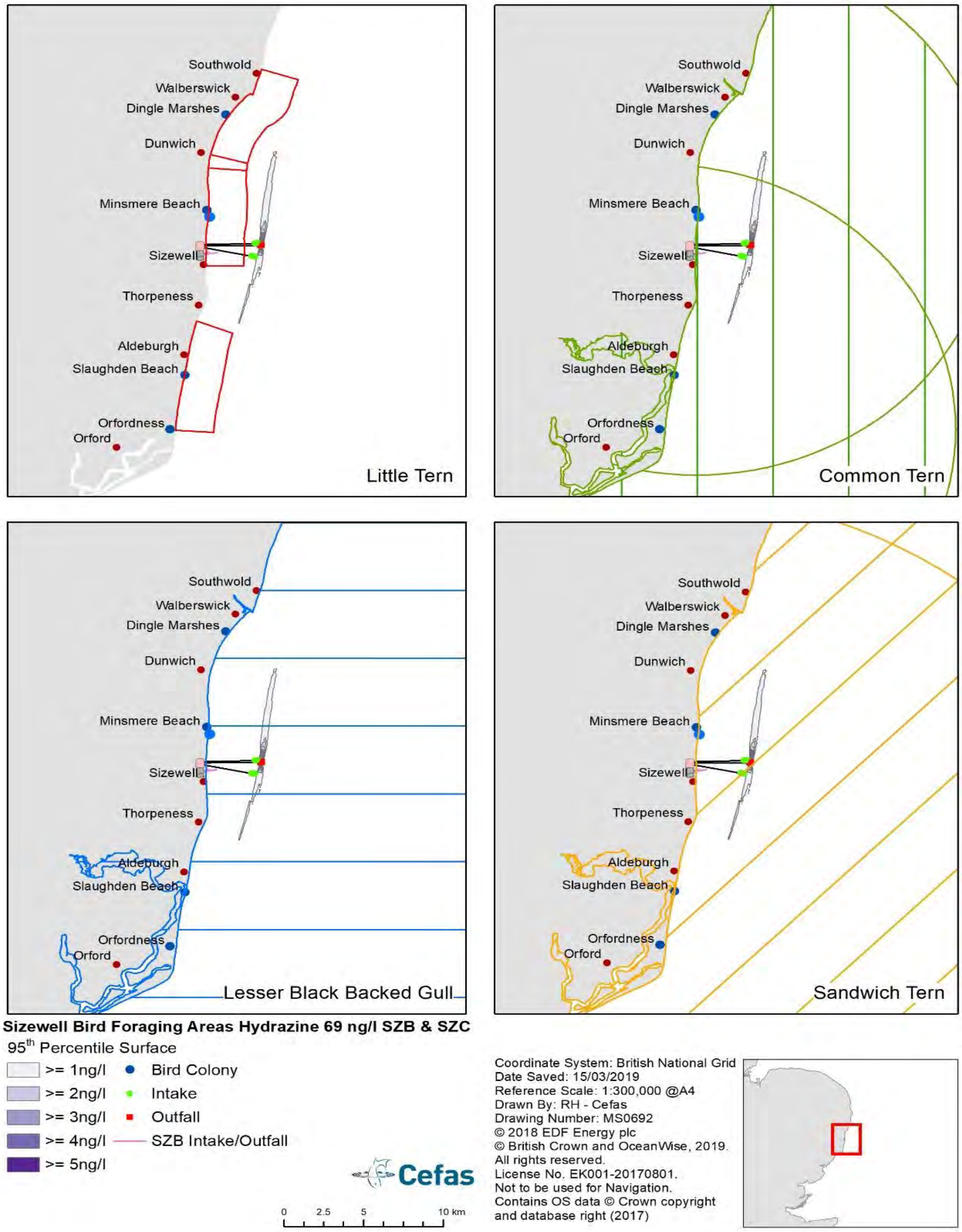

Figure 30: 95th percentile hydrazine concentration at the surface after release of 69 ng/l from SZC with SPA predicted bird foraging areas.

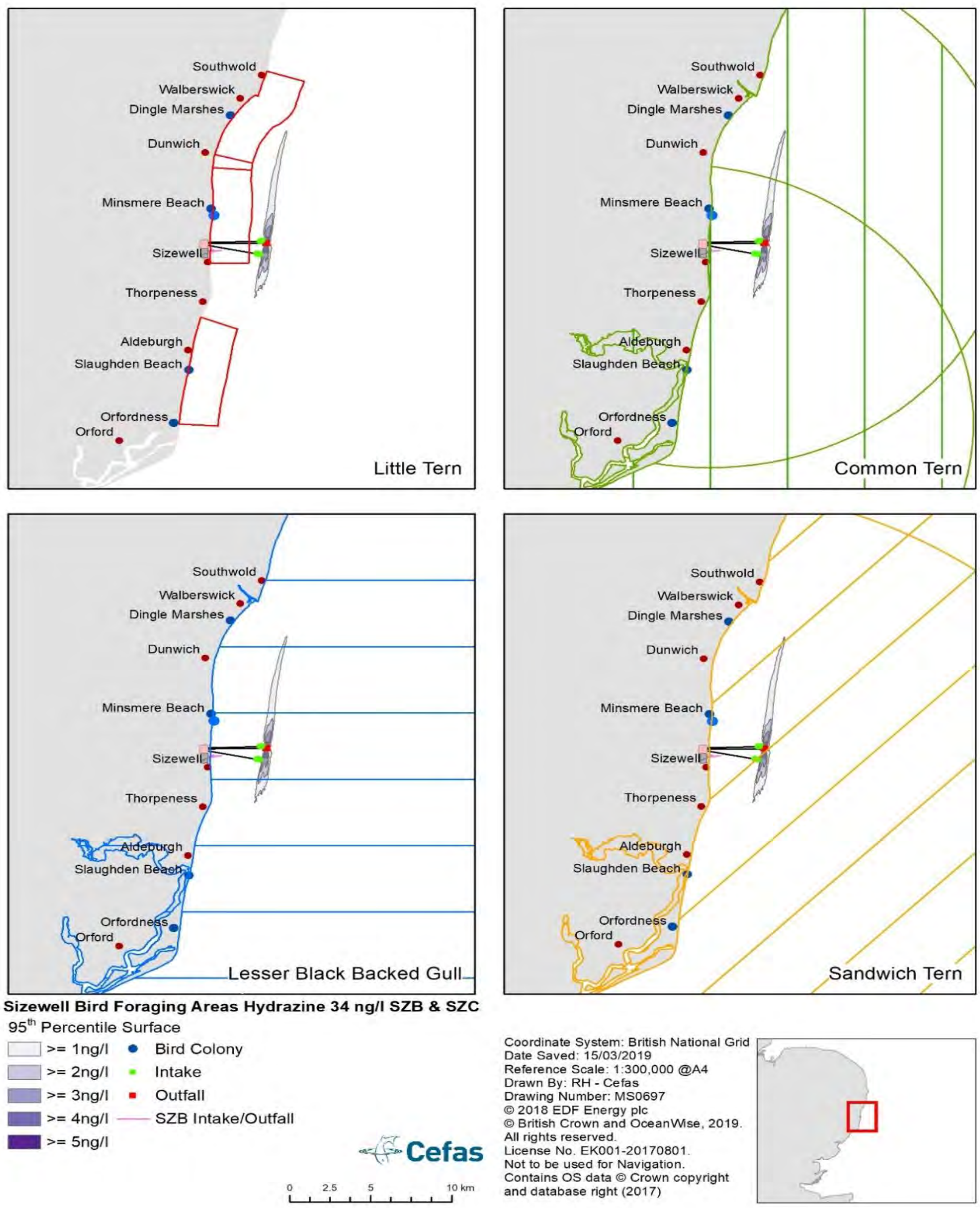

Figure 31: 95th percentile hydrazine concentration at the surface after release of 34 ng/l from SZC with SPA predicted bird foraging areas.

4.4.3.5 Increases in Suspended Sediment Concentration (SSC)

Sporadic dredging of the BLF access channel will be required during the operational phase of the proposed development, of which the effects will be the same as during the construction period outlined in section 4.4.1.

4.5 Potential radiological effects

4.5.1 Construction

Levels of radioactivity and the concentration of radionuclides measured in marine waters around the main development site are comparable to background levels and well below the levels that would present a hazard to human health (EDF Energy, 2019a). A separate radiological assessment will form part of the DCO application.

4.5.2 Operation

Radionuclide discharges in CW systems are strictly regulated and Cefas have not been requested to undertake any radioecological assessments.

The preliminary radiological impact assessment results show that the expected radiological impacts are well below (more than a factor of ten) the relevant dose constraints specified in Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016 (as amended). It is not expected that the revised input parameters will affect the overall conclusions. EDF Energy will report the final radiological impact assessment, including a breakdown of assessment and results, as part of the application for development consent (EDF Energy, 2019a).

4.6 Potential for direct habitat loss and fragmentation

4.6.1 Construction

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for direct habitat loss and fragmentation from the construction phase of Sizewell C:

- Minsmere to Walberswick RAMSAR - Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).

4.6.1.1 Construction of BLF and Cooling Water Infrastructure

There is no direct habitat loss or direct and indirect fragmentation effects to the designated features of the relevant sites (Section 4.3.1).

4.6.2 Operation

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for direct habitat loss and direct and indirect fragmentation from the operation phase of Sizewell C:

- Minsmere to Walberswick RAMSAR - Ramsar criterion 1 (Mosaic of marine, freshwater, marshland and associated habitats) and Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).

4.6.2.1 Operation of BLF and Cooling Water Infrastructure

Direct habitat loss/change is restricted to the physical presence of the structures during the operational phase. Physical presence effects will also occur during the construction phase when the structures are in place. Section 3.2.1 details the effects of physical presence of the structures. However, physical presence effects do not affect any designated species or supporting habitat to designated interests.

No effects are predicted on the shoreline, the ‘annual vegetation of drift lines’ habitat (Minsmere to Walberswick Heaths and Marshes SAC) or the potential nesting sites for little tern (Minsmere to Walberswick SPA). The BLF piles are transmissive and not expected to block sediment transport, however localised scour is predicted (BEEMS Technical Report TR311 Ed. 4).

Section 4.3.2 details the areas of *Sabellaria spinulosa* reef habitats found on the coralline crag at the location of the southerly intakes. Whilst the area is not a designated site *S. spinulosa* reefs are Annex I habitats and listed as habitats of conservation importance (HOCI) under Section 41 of the NERC Act (2006). However, as the area of changed habitat (including the 9 m^2 footprint of the structure itself) would be 170 m^2 (0.0170 ha) per structure, this is considered minimal.

4.7 Potential disturbance effects on species populations

4.7.1 Construction

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential disturbance effects on species populations from the construction phase of Sizewell C:

- Minsmere to Walberswick SPA - Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).
- Outer Thames Estuary SPA - Supporting habitat to SPA designated interests, Wintering /passage Red-throated diver *Gavia stellata*, Breeding Little Tern *Sterna albifrons* and Breeding Common Tern *Sterna hirundo*.
- Southern North Sea SAC – Harbour porpoise (*Phocoena phocoena*).
- Humber Estuary SAC – Grey seal (*Halichoerus grypus*).
- The Wash and Norfolk Coast SAC - Harbour seal (*Phoca vitulina*).

4.7.1.1 Light and visual disturbance

Artificial lighting on the BLF during AIL delivery by barges may lead to minor disturbance and displacement impacts. During the construction period (notionally 2025 to 2028), there will be approximately 180 AIL deliveries at the BLF during the seasonal campaign period (31st March - 31st October), however, deliveries may be required throughout the year. Light spill in the marine environment from the MDS (average 100 – 200 Lux for task lighting) is likely to be limited by the coastal protection feature.

A lighting strategy for construction and operational sites has been designed. The strategy considers the following principles: a) lighting should be designed to minimise, where practicable, landscape, seascape and visual effects; b) the visual effects at night from lighting and light spill should be minimised without compromising either safety or security; c) the lighting should be designed to minimise disturbance to protected species and severance of habitats, where reasonably practicable; d) road lighting and signage should be designed to limit the impact on the surrounding landscape and wildlife where practicable. Proposed strategy takes into account environmental considerations in order to minimise light pollution. One of the proposed mitigation measures is no lighting when BLF is not in use. However, this is subject to navigational risk assessment.

Marine mammals have large, well developed eyes (Griebel and Peichl, 2003) and good eyesight both in water and air (Griebel and Peichl, 2003; Mass and Supin, 2007). However, eyesight is not their primary sense as they rely primarily on their sense of hearing for the majority of the ecologically important activities including navigation, foraging, and communication. For example, harbour porpoises and seals are still able to forage when blindfolded or blind (Verfuß *et al.,* 2009); McConnell *et al.,* (1999) and coastal populations of marine mammals occur near urban areas and man-made structures emitting artificial light and no significant deterrent effects have been reported. Some reports suggest that seals are attracted to artificial light in order to enhance their foraging success (Yurk and Trites, 2000; McConnell *et al.,* 2010). The likelihood of any effects is further decreased by application of lighting strategy which aims to minimise light spill into the marine environment. Therefore, whilst lighting may result in localised disturbance of harbour porpoise and seals, disturbance or displacement effects are likely to be minor particularly with the implementation of the lighting strategy and efforts to minimise night-time lighting.

4.7.1.2 Noise

The direct effects of underwater noise are considered on marine designated species and indirect effects are considered in terms of prey avoidance.

During the construction of the proposed development there are a number of activities that are expected to generate noise levels. These activities are summarised in Table 27 (BEEMS Technical Report TR312 Ed. 5).

Table 27: Summary of activities, noise sources and noise types for proposed activities at Sizewell C (BEEMS Technical Report TR312 Ed. 5).

Activity	Possible methods	Noise type
UXO clearance	Detonation	Impulsive
Construction and installation of cooling water intake and outfall headworks including seismic qualification and drilling vertical connecting shafts	Wet Drilled and dredging	Continuous
Construction of Beach Landing Facility (BLF) including piled deck and navigational channel	Dredging	Continuous
	Impact Pilling	Impulsive
Construction of auxiliary infrastructure including the Fish Recovery and Return (FRR) systems and the Combined Drainage Outfall (CDO)	Dredging	Continuous
Construction vessel traffic primarily associated with BLF deliveries	N/A	Continuous
Operation	N/A	Continuous

Effects on marine designated species

Piling resulted in the larges acoustic effect zones for seals and harbour porpoise. A total of 12 piles would be installed in the marine environment below mean high water springs (MHWS) for the BLF by impact pilling. The low energy impact piling associated with the BLF resulted in no instantaneous TTS for harbour porpoise or seals outside the standard 500 m marine mammal mitigation zone at the onset of piling. **As such instantaneous impacts from piling are considered minimal.**

The predicted cumulative (5 piles within a 24-hour period) auditory impact zones extended over wider areas. The PTS zone for stationary harbour porpoise extended up to 2.1 km offshore, while the stationary TTS zone exceeded 12 km offshore from the impact piling activity. The corresponding PTS and TTS ranges for stationary seals were smaller, at 0.3 km and 3.1 km, respectively. This cumulative assessment is precautionary in that it does not assume fleeing behaviour, and for effects to occur, the animal must remain within the effect zone for the duration of the piling activities (5 piles within a 24-hour period). When fleeing behaviour is incorporated into the model impact zones diminish. **With fleeing included in the assessments, no auditory effect zones were predicted for the seal species. For harbour porpoise fleeing behaviours result in no predicted cumulative PTS.** The largest TTS effect zone extended to 4.8 km (2,179 ha) from the BLF piling location.

Dredging results in continuous noise sources and has lower impact ranges than piling. Construction dredging at the BLF is anticipated to take 2.1 days to complete and resulted in the largest dredging effect zones due to the precautionary 24-hour nature of the modelled activities. Despite the precautionary nature of the assessments PTS ranges were modest for highly mobile species. Dredging activities at the locations of the

BLF resulted in PTS for stationary harbour porpoise extending to 1.7 km (394 ha) following 24 hours of continuous dredging. The corresponding PTS range for stationary seals was restricted to 110 m (5 ha) from the vessel. Cumulative TTS effect zones were 11,331 ha for stationary harbour porpoise and 969 ha for stationary seals. **When fleeing was included in the dredging assessments, no auditory effect zones were predicted for seal. For harbour porpoise fleeing behaviours result in no cumulative PTS.** The largest TTS range was within 1.4 km (241 ha) from the BLF dredging location, following 24 hours of continuous dredging.

A hypothetical in-combination dredge scenario was also considered. This involved the simultaneous dredging at the BLF and the cooling water intake, the two dredge locations with the largest individual effect ranges. The cumulative PTS effect zone increased by approximately 20 % of the sum of the dredge activities individually but remained relatively small for highly mobile species; 620 ha for stationary harbour porpoise and 5 ha for stationary seals. TTS effect zones were smaller than the sum of the individual dredge activities due to spatial overlap; 14,359 ha for stationary harbour porpoise and 1,411 ha for stationary seals. **When fleeing was included in the assessment of the in-combination dredge scenario, no PTS was predicted** and only a TTS effect zone of 1,040 ha was predicted for harbour porpoise. **No auditory effect zones were predicted for seal species.**

Drilling activities are not predicted to present a risk to marine mammals. The predicted effect zones arising from drilling activities were negligible for seals (0.25 ha stationary TTS effect zone). For stationary harbour porpoise no PTS was predicted beyond 25 m and cumulative TTS was predicted to be restricted to within 1.3 km of the sound source (422 ha). With fleeing included in the drilling assessments, no PTS or TTS impact zones were predicted for any of the marine mammal species..

Table 28: Underwater noise marine mammal impact zones.

Worst-case marine mammal auditory effect zone areas (ha) and maximum ranges (m) for each activity.		Instantaneous		Stationary Cumulative (24 hour)		Fleeing Cumulative (24 hour)	
		Harbour porpoise	Phocid seals	Harbour porpoise	Phocid seal	Harbour porpoise	Phocid seal
Impact piling (BLF): 90 kJ	PTS	27 m	6 m	1,297 m 190 ha	206 m 10 ha	No Effect	No Effect
	TTS	45 m	10 m	6,624 m 4,994 ha	1,882 m 430 ha	2,765 m 768 ha	No Effect
Impact piling (BLF): 200 kJ	PTS	41 m	9 m	2,081 m; 561 ha	303 m; 20 ha	No Effect	No Effect
	TTS	67 m	16 m	12,450 m; 10,223 ha	3,104 m; 1,064 ha	4,795 m 2,179 ha	No Effect
Drilling (BLF and cooling water intakes and outfalls)	PTS	No Effect	No Effect	<25 m; <0.25 ha	<25 m; <0.25 ha	No Effect	No Effect
	TTS	No Effect	No Effect	1,307 m; 399 ha	25 m; 0.25 ha	No Effect	No Effect
Construction Dredging for the BLF	PTS	No Effect	No Effect	1,657 m 394 ha	111 m 5 ha	No Effect	No Effect
	TTS	No Effect	No Effect	11,576 m 11,331 ha	2,975 m 969 ha	1,377 m; 241 ha	No Effect

Effects on marine prey of designated species

For the prey species of designated species (see Table 12), injury and auditory impairment in fish was assessed for impact piling and dredging. Effect zones are shown in Table 29 and in detail in BEEMS Technical Report TR312 Ed. 5). Any fish remaining in the vicinity of impact piling activities for the duration of the noise exposure, would be at risk of mortality or recoverable injury (BEEMS Technical Report TR312 Ed. 5).

A risk of mortality, recoverable injury, and TTS is also predicted around the dredging locations. Dredging at the BLF is predicted to have the longest daily duration, and as such the greatest potential for cumulative auditory impacts. The largest areas for mortality, recoverable injury, and TTS are 2 ha, 6 ha, and 435 ha (1.85 km), respectively, for 24 hours of dredging activity at the BLF (BEEMS Technical Report TR312 Ed. 5).

Behavioural responses or displacement due to underwater noise has the potential to temporarily effect prey availability for designated birds/mammals. The potential for behavioural responses was investigated by applying indicative response contours for instantaneous noise in sprat (a hearing specialist). In the 90 kJ hammer energy scenario the contour extends to an area of 525 ha (<0.2 % of Outer Thames Estuary SPA and <0.02 % of Southern North Sea SAC), whilst in the 200 kJ hammer energy scenario the contour covers an area of 968 ha (0.2 % of Outer Thames Estuary SPA and <0.1 % of Southern North Sea SAC (see Table 30). Impact piling also had the greatest cumulative auditory effect zones for fish with TTS predicted for hearing specialist fish species remaining within 821 m of the sound source. However, direct fish mortality and recoverable injury is restricted to limited spatial areas in the vicinity of the sound source for impact piling.

Dredging for the inshore BLF access channel represents the continuous noise source with the greatest potential for spatial overlap with designated breeding birds at Sizewell (for example little terns at Minsmere. The inshore BLF dredging is anticipated to last 2.1 days. The worst-case behavioural contour for dredging of the BLF extends to an area of 682 ha (0.17 % of Outer Thames Estuary SPA and 0.02 % of Southern North Sea SAC).

The onset of behavioural responses in fish is likely to be influenced by behavioural context and observations of startle responses in a hearing specialist species to not necesitate displacement from the area particularly for species with lower auditory sensitivities. Behavioural response zones should therefore be treated as precautionary areas over which behavioural responses may occur (BEEMS Technical Report TR312 Ed. 5). As the behavioural responses or displacement is temporary (limited to the duration of noise producing activities) and the prey are likely to utilise other areas that are still within the Southern North Sea SAC and Outer Thames Estuary SPA, declines in abundance and distribution of the respective prey populations are highly unlikely.

Table 29: Underwater noise fish impact zones (BEEMS Technical Report TR312 Ed. 5).

Worst-case fish auditory impact zone areas (ha) and maximum ranges (m) for each activity.		Instantaneous	Cumulative (24 hour)
Impact piling (BLF): 90 kJ	Mortality	17 m	70 m 1 ha
	Recoverable Injury	17 m	111 m 3 ha
	[2]TTS	Not applicable	556 m 46 ha
	[1]Behaviour	2,111 m 525 ha	Not applicable
Impact piling (BLF): 200 kJ	Mortality	27 m	111 m; 2 ha
	Recoverable Injury	27 m	158 m; 4 ha
	[2]TTS	Not applicable	821 m; 88 ha
	[1]Behaviour	2,856 m 968 ha	Not applicable
Drilling (cooling water intakes and outfalls)	Mortality	No Effect	<25 m; <0.25 ha
	Recoverable injury	No Effect	<25 m; <0.25
	[2]TTS	Not applicable	<25 m; <0.25 ha
	[3]Behaviour	*< 25 m*	Not applicable
Dredging for the BLF	Mortality	No Effect	2 ha
	Recoverable injury	No Effect	6 ha
	[2]TTS	Not applicable	1,843 m 435 ha
	[3]Behaviour	*2,352 m 682 ha*	Not applicable

Note:

1. Behavioural response is assumed to be triggered by instantaneous noise exposure (135 dB re 1 μPa^2 ·s) and not cumulative exposure. Therefore, no assessments have been made for behavioural response to cumulative noise exposure (grey shaded boxes).
2. TTS is not defined for instantaneous noise exposure for fish (grey shaded box).
3. Behavioural response criteria for continuous sound sources are applied from instantaneous effect observations.

Table 30: 135dB behavioural response contour for pilling activities intersection with bird predicted (maximum) foraging areas during the breeding season (apart from red-throated diver which is designated during the winter).

SPA	Species and colony	BLF 90 kJ		BLF 200 kJ	
		Area (Ha)	% of predicted foraging range	Area (Ha)	% of predicted foraging range
Alde-Ore Estuary	Sandwich tern: all colonies	525	0.3	968	0.6
	Little tern: Slaughden colony – noise contour does not intersect with this colony's foraging range				
	Lesser black-backed gull	525	0.01	968	0.03
Benacre to Easton Bavents	Little tern: noise contour does not intersect with this colony's foraging range				
Minsmere to Walberswick	Little tern: Minsmere colony	525	29.1	841	46.5
	Little tern: Dingle colony - noise contour does not intersect with this colony's foraging range				
Outer Thames Estuary	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above				
	Common tern – Minsmere colony	525	1.0	968	1.9
	Common tern – Orfordness colony	525	1.0	968	1.9
	Red-throated diver	525	<0.01	968	<0.01

The worst-case BLF dredging noise contour (135 dB) was applied and the intersection with relevant SPA designated bird features that forage for marine prey was established. The results of intersections between noise contours and breeding colonies, or in the Outer Thames Estuary SPA are provided in Table 31 (see

Figure 34).

Intersections with each designated bird feeding colony is provided in Appendix E for the different dredge scenarios. Behavioural responses thresholds do not necessarily imply displacement or changes in behaviour. Furthermore, noise generating activities are temporary, therefore it is unlikely that there will be a significant effect on the features of the relevant designated sites above.

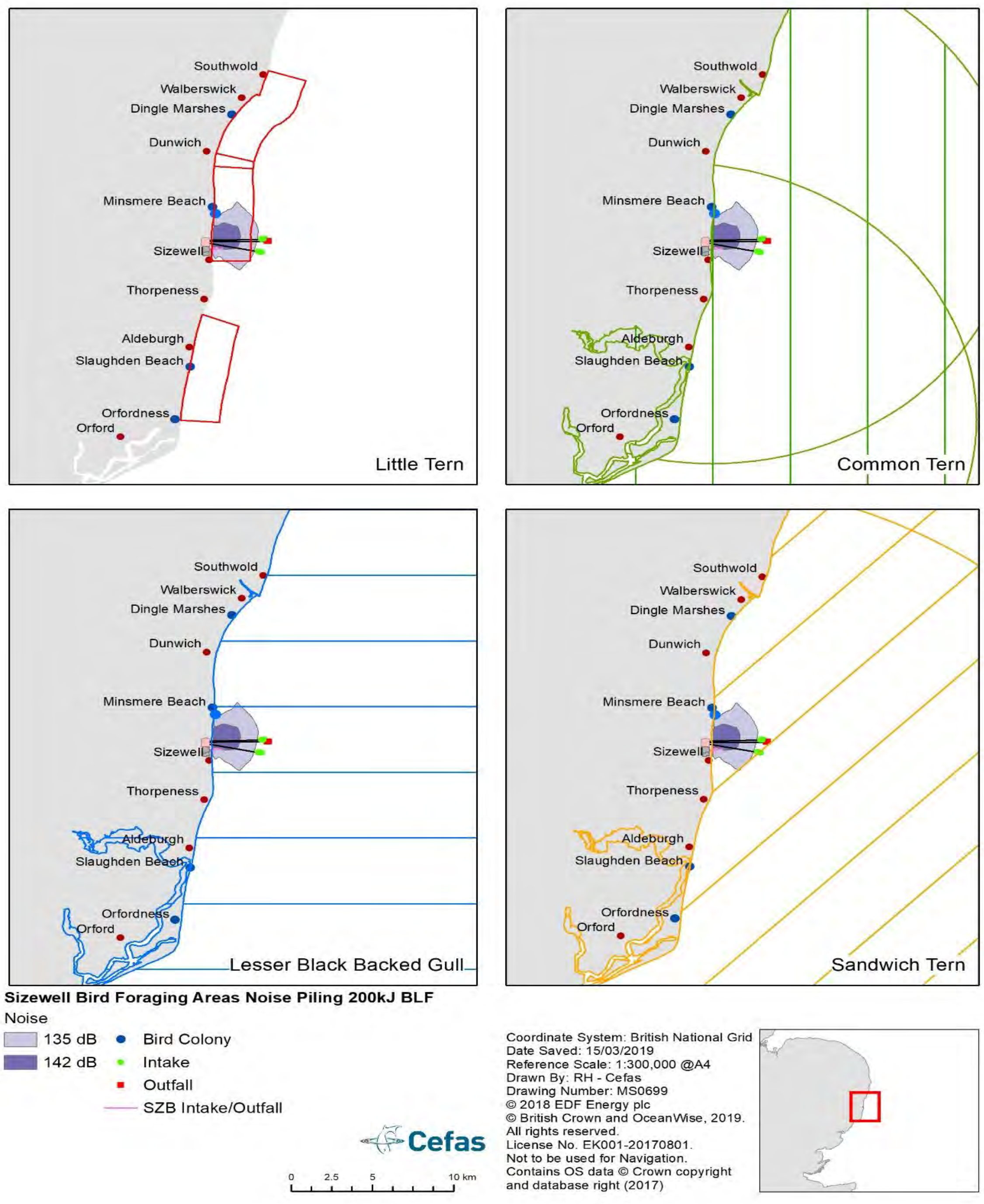

Figure 32: Behavioural noise contours (142 and 135 dB) from BLF piling with 200 kJ hammer with SPA bird predicted foraging areas.

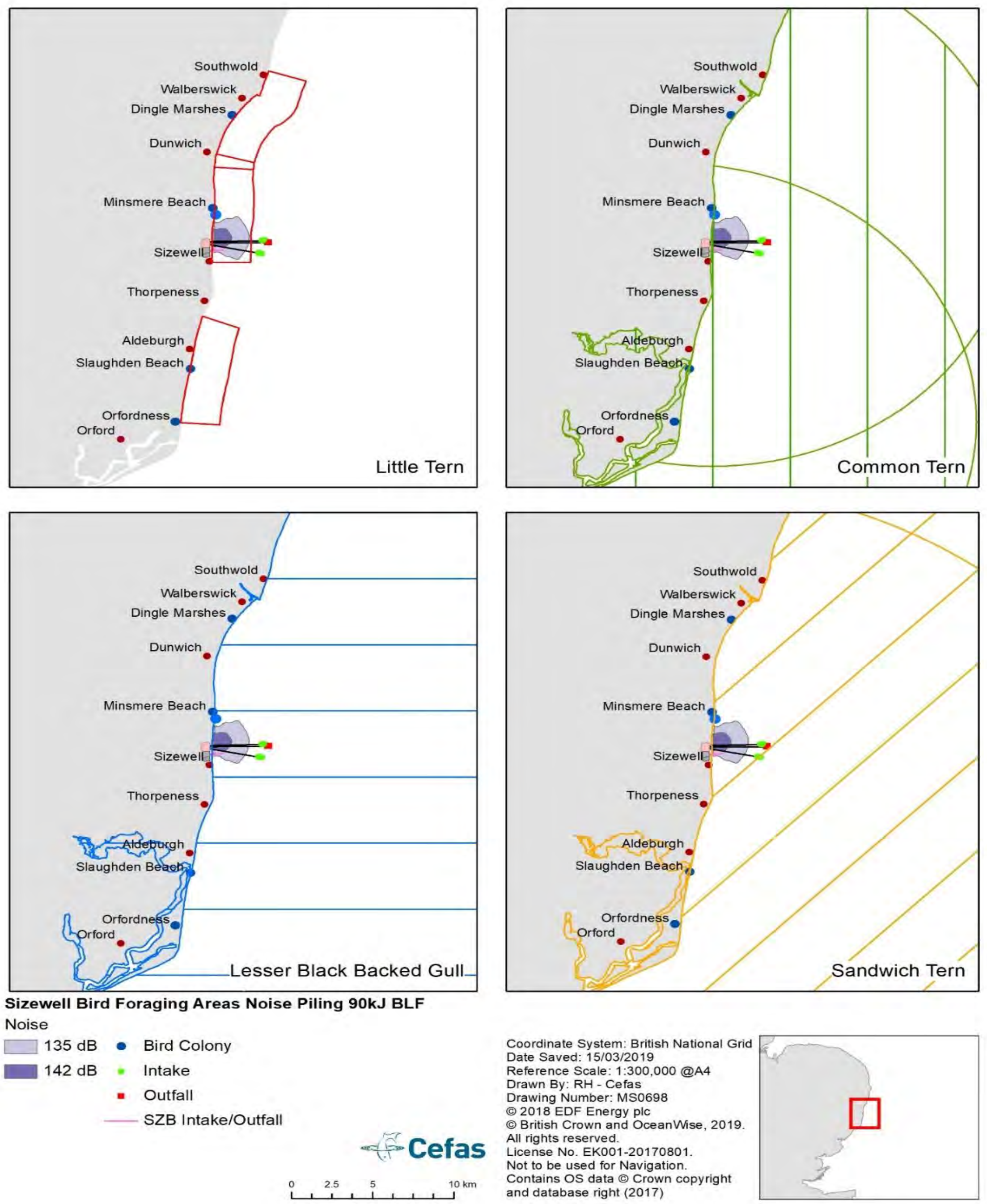

Figure 33: Behavioural noise contours (142 and 135 dB) from BLF piling with 90 kJ hammer with SPA bird predicted foraging areas.

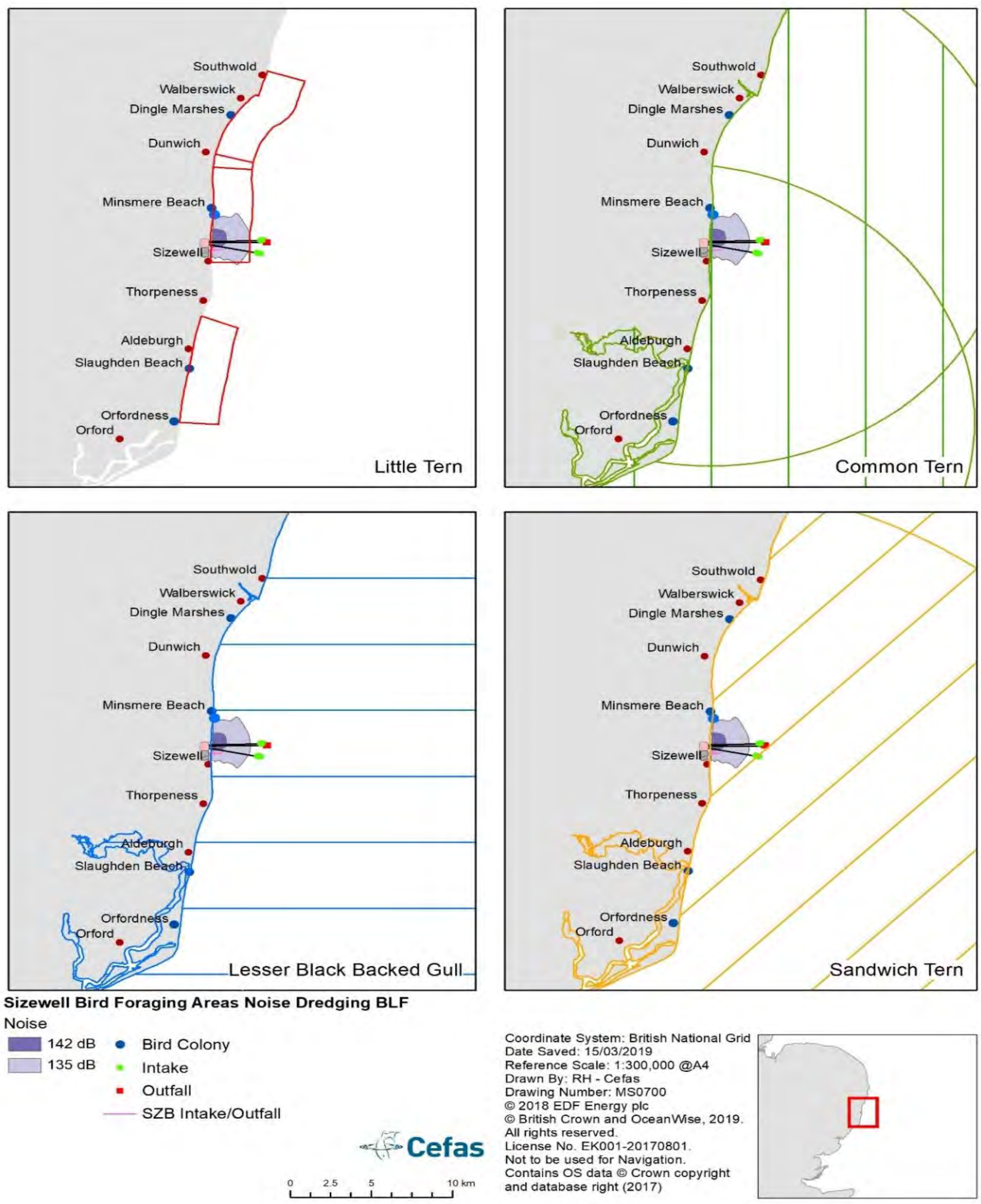

Figure 34: Behavioural noise contours (142 and 135 dB) from BLF dredging with SPA bird predicted foraging areas.

Table 31: 135 dB BLF dredging noise contour intersect areas with the following individual species predicted foraging ranges.

SPA	Species and colony	BLF dredging	
		Area (Ha)	% of predicted foraging range
Alde-Ore Estuary	Sandwich tern: all colonies	676	0.3
	Little tern: Slaughden colony – noise contour does not intersect with this colony's foraging range		
	Lesser black-backed gull	676	0.02
Benacre to Easton Bavents SPA	Little tern: noise contour does not intersect with this colony's foraging range		
Minsmere to Walberswick	Little tern: Minsmere colony	669	37.0
	Little tern: Dingle colony - noise contour does not intersect with this colony's foraging range		
Outer Thames Estuary	Little tern –colonies are associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA and are assessed above		
	Common tern – Minsmere colony	676	0.7
	Common tern – Orfordness colony	676	0.7
	Red-throated diver	676	<0.01

Increases in ambient noise

During the construction phase anthropogenic activity may lead to visual/noise disturbance. Vessel activity is known to cause varying levels of visual and noise disturbance to harbour porpoise. Palka and Hammond (2001) observed avoidance behaviour of marine mammals at approximately 1000 m from a survey vessel, whilst Barlow (1988) reported an incidence of avoidance within 800 m for harbour porpoise. The potential increase in ambient noise levels associated with the BLF deliveries vessel traffic during the construction period is likely to be modest and within the natural variability at the site. Any increase in ambient noise levels within the development area would be relatively low in comparison to noise levels associated with the shipping lanes further offshore where harbour porpoises are more likely to occur. Vessel traffic is anticipated to occur during the period of the year when the least number of harbour porpoises are expected in the inshore waters near the proposed development. Effects are likely to be minor.

The expected additional operational noise generated with both power stations in operation represents only a small increase in the background noise levels at the site, which has sustained an operational nuclear power station for several decades (since 1966). It is therefore anticipated that the additional impact of the operational noise from Sizewell C will be minimal and adaptation will be rapid (BEEMS Technical Report TR312 Ed.5).

Hypothetical UXO Detonation Auditory Impact Zones

In the case UXOs were identified on site, and alternative disposal methods or relocation are not possible, underwater detonations may be required. Appropriate management actions and mitigation measured would be implemented to minimise impacts. Such measures would be highly dependent on the location of the UXO and would require review on a case-by-case basis. The results below should therefore be considered as indicative, worst-case scenarios for unmitigated impact ranges.

UXO detonations generate markedly larger instantaneous auditory effect zones than all other activities. In the instance UXOs are identified and detonated on site, the clearance works have the potential to cause permanent and temporary hearing impairment to marine mammals and fish over extended areas.

The explosive charge mass of 1,500 lb had the largest impact ranges for all species. Harbour porpoises were the most sensitive receptors, unweighted permanent hearing damage (PTS) thresholds (202 dB re 1 µPa) are anticipated up to a range of up to 14 km from the source. Given the auditory impact ranges for the hypothetical unmitigated UXO detonation are considerably larger than other noise generating activities associated with the proposed development, an additional assessment step whereby the number of individuals potentially exposed to PTS has been calculated. Using the effect range as a radius and accounting for the inshore setting of the development the effect area would be at least 310 km^2. Small Cetaceans in the European Atlantic and North Sea III survey data predicts density of 0.67 individuals per km^2 (Hammond *et al.*, 2017), as such >200 individuals could be exposed to PTS. However, the assessment is highly precautionary as it considers the largest hypothetical explosive charge with no mitigation (a situation that would not occur).

Seals have higher thresholds for auditory impacts from explosive sources and the resultant auditory effect ranges are smaller. Unweighted PTS thresholds (peak sound pressure level; 218 dB re 1 µPa) are anticipated up to a range of up to 2.75 km from the source. Based on the latest seal at sea usage maps, the maximum density of grey seals and harbour seals has been calculated as 0.053 and 0.046, respectively (Russell *et al.*, 2017). Using the effect range as a radius and accounting for the inshore setting of the development the effect area would be at least 11.9 km^2. For both grey and harbour seals (less than) one individual would be exposed to PTS.

Temporary auditory damage (TTS) may occur at a range of 18 km for harbour porpoise and 3.5 km for seals, for the 500 lb charge, and at 14.2 km for harbour porpoise and 2.8 km for seals, for the 250 lb charge.

Fish mortality and potential mortal injury extends to 622 m for a hypothetical UXO detonation of a 500 lb charge, and to 493 m for a 250 lb charge.

4.7.2 Operation

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for disturbance effects on species populations from the operation phase of Sizewell C:

- Minsmere to Walberswick SPA - Breeding Little Tern *Sterna albifrons*.
- Minsmere to Walberswick RAMSAR - Ramsar criterion 3 (An important assemblage of rare breeding birds associated with marshland and reedbeds).
- Southern North Sea SAC – Harbour porpoise (*Phocoena phocoena*).
- Humber Estuary SAC – Grey seal (*Halichoerus grypus*)
- The Wash and Norfolk Coast SAC - Harbour seal (*Phoca vitulina*).

4.7.2.1 Light and visual disturbance

During the operational phase, sporadic maintenance of infrastructure and delivery barges (approximately every 5-10 years) which require artificial lighting may lead to minor disturbance and displacement impacts, of which the effects will be the same as during the construction period outlined in section 4.7.1.1.

4.7.2.2 Noise

Sporadic maintenance dredging of the BLF access channel will be required during the operational phase of the proposed development (approximately every 5-10 years), of which the effects will be the same as during the construction period outlined in section 4.7.1.

4.7.2.3 Impingement and Entrainment

The impingement and entrainment effects during the operational phase on the associated marine prey of harbour porpoise is detailed in section 4.8.1.

4.8 Potential physical interaction between species and project infrastructure

4.8.1 Operation

The HRA Screening report (EDF Energy, 2019b) identified the following sites and features for having the potential for physical interaction between species and project infrastructure from the operational phase of Sizewell C:

- Alde-Ore Estuary SPA - Supporting habitat to SPA designated interest, Breeding Little Tern *Sterna albifrons*, Breeding Sandwich Tern *Sterna sandvicensis*, Breeding Lesser black-backed gull *Larus fuscus* and assemblage qualification: a seabird assemblage of international importance.
- Alde-Ore Estuary RAMSAR - Ramsar criterion 3 (The site supports a notable assemblage of breeding and wintering wetland birds) and Ramsar criterion 6 (Species/populations occurring at levels of international importance).
- Benacre to Easton Bavents SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.

- Minsmere to Walberswick SPA - Supporting habitat to SPA designated interests and Breeding Little Tern *Sterna albifrons*.
- Outer Thames Estuary SPA - Supporting habitat to SPA designated interests, Wintering /passage Red-throated diver *Gavia stellata*, Breeding Little Tern *Sterna albifrons* and Breeding Common Tern *Sterna hirundo*.
- Southern North Sea SAC – Harbour porpoise (*Phocoena phocoena*).
- Humber Estuary SAC – Grey seal (*Halichoerus grypus*)
- The Wash and Norfolk Coast SAC - Harbour seal (*Phoca vitulina*).

4.8.1.1 *Impingement*

A detailed impingement assessment was made in BEEMS Technical Report TR406.v7. The relevant designated sites and features identified in the Sizewell C HRA Screening report (EDF Energy, 2019b) that could be affected by impingement and entrainment along with the relevant prey species are provided in section 4.2, Table 12.

The potential for the proposed development to influence the availability of designated prey species is detailed in Scientific Position Paper 103 and Section 8 of BEEMS Technical Report TR406.v7. Local level depletion of fish was estimated by applying a simplified conceptual model of impingement relative to tidal replenishment. In all cases the effects would not be discernible against the much larger natural variations in local fish population densities. It is therefore concluded that impingement from Sizewell B and Sizewell C would not have an adverse food-web effect on designated features of HRA sites (Scientific Position Paper SPP103).

4.8.1.2 *Entrainment*

Entrainment effects at the population level have been calculated in BEEMS Technical Report TR318 (version 6). Eggs and/or larvae of sprat, herring, anchovy and sea bass are expected to be entrained at SZC but the predicted effects on the relevant populations were found to be negligible.

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Appendix A HRA Screening for marine designated sites

Table 32: Definition of marine environmental effect categories for HRA (EDF Energy 2019b).

Marine Effects	Definition	
	Construction	Operation
Alteration of coastal processes / sediment transport	This includes the potential for erosion, accretion and sedimentation (short and long term). The focus is largely on indirect effects (rather than direct effects which are covered under 'Direct habitat loss and fragmentation'). This distinction has been made to avoid the double counting of effects.	As for construction.
Water quality effects – marine environment	This covers potential thermal and chemical (non-radiological and radiological) effects on water quality and indirect effects on habitats and species (including prey species), as well as water quality effects due to change in suspended sediment concentrations (SSC) (it does not include sedimentation, which is covered as part of 'Alteration of coastal processes / sediment transport').	As for construction, but also includes water quality (chlorination) effects associated with the entrainment and impingement of organisms in the cooling water intake.

Marine Effects	Definition	
	Construction	Operation
Radiological effects	This relates to the direct and indirect effects of any radiological emissions to soils, water and/or air. Commissioning impacts are covered under 'Operation' since fuelling of the nuclear power station marks the start of the operational phase.	This relates to the direct and indirect effects of radiological emissions to air and the marine environment. These emissions are regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016.
Direct habitat loss and fragmentation	This effect is limited to direct effects on habitats (not species). Indirect effects are covered elsewhere.	As for construction.
Disturbance effects on species populations	This effect is limited to potential disturbance effects on target species (not habitats), e.g. noise, light and human activity, and includes species displacement. Potential recreational effects are covered separately.	As for construction.
Physical interaction between species and Project infrastructure	Relates to the potential direct or indirect effects on qualifying features arising due to interactions (e.g. collisions) with the infrastructure or machinery associated with the Project. Indirect effects could arise via effects on prey species (e.g. impingement and entrainment of small fish and their larvae and eggs).	As for construction.

Matrix Key:

✓ = Likely significant effect **cannot** be excluded

× = Likely significant effect **can** be excluded

C = construction

O = operation

D = decommissioning

Where effects are not relevant to a particular feature they are greyed out and an explanation is provided as to why the effect is not relevant.

Table 33: Screening Matrix: Alde-Ore and Butley Estuaries SAC (EDF Energy, 2019b).

Name of European site and designation: Alde-Ore and Butley Estuaries SAC																																	
EU Code: UK0030076																																	
Distance to NSIP: 5km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and direct/ indirect habitat fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			*In combina-tion effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
1130 Estuaries	× **a**	× **b**	× **a**	× **c**	✓ **d**	× **c**	**e**	**e**	**e**	**f**	**f**	**f**	✓ **g**	✓ **g**	✓ **g**	× **h**	× **i**	× **h**	**j**	**j**	**j**	**k**	**k**	**k**	× **l**	× **l**	× **l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**
1140 Mudflats and sandflats not covered by seawater at low tide	× **a**	× **b**	× **a**	× **c**	✓ **d**	× **c**	**e**	**e**	**e**	**f**	**f**	**f**	✓ **g**	✓ **g**	✓ **g**	× **h**	× **i**	× **h**	**j**	**j**	**j**	**k**	**k**	**k**	× **l**	× **l**	× **l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**
1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	× **a**	× **b**	× **a**	× **c**	✓ **d**	× **c**	**e**	**e**	**e**	**f**	**f**	**f**	✓ **g**	✓ **g**	✓ **g**	× **h**	× **i**	× **h**	**j**	**j**	**j**	**k**	**k**	**k**	× **l**	× **l**	× **l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**

a. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the influence of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. The construction of a jetty is not proposed; rather either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. Far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is, therefore, considered to be very unlikely. This particularly applies to sections of the coast located to the north of the Sizewell frontage, as the net direction of sediment transport is weakly to the south. No Likely Significant Effect (LSE) is therefore predicted.

b. Alteration of coastal processes/sediment transport: The presence of new structures in the marine environment in the operational phase is likely to only have a very localised effect on coastal processes and sediment transport. No significant effect is predicted on the qualifying features of the Alde-Ore and Butley Estuaries SAC. No LSE is therefore predicted.

c. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment during the construction phase in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on SAC qualifying features. There is a weak southerly net drift of coastal sediments. As such there is the potential for this weak net movement to provide a pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within designated sites to the south of Sizewell, notably the Alde Ore and Butley Estuaries SAC. However, the amounts of sediment removal and release as a result of the construction activities would be small, whilst discharges to the marine environment during construction are unlikely to result in any significant changes in water quality. Furthermore, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Therefore, any effects on marine water quality are highly unlikely to affect the qualifying features of the Alde-Ore and Butley Estuaries SAC to any significant extent and no LSE is predicted.

d. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note h below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats. Therefore, a LSE cannot be excluded at this stage.

e. Water quality effects – terrestrial environment: No discernible impact pathway is evident on the qualifying features of the Alde-Ore and Butley Estuaries SAC.

f. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident on the qualifying features of the Alde-Ore and Butley Estuaries SAC.

g. Changes in air quality: Localised nutrient loading on vegetation communities (e.g. coastal, heathland) may arise as a result of construction activities (e.g. due to windblown soil). Some species/vegetation types are sensitive to relatively small changes in air quality (e.g. lichens). Atlantic salt meadow has also been identified by Natural England as a habitat type that may be sensitive to changes in air quality (specifically Nitrogen deposition). The critical load for this site is 20- 30 Kg N/Ha/yr (APIS, 2018).
During the construction phase, the main potential emissions would be from road traffic, dust from construction activities and combustion emissions from the diesel generators (which would extend to commissioning).
During the operational phase, the main potential emissions may arise as a result of increased traffic flows and use of diesel generators for testing or as required. Radioactive discharges to air would also occur (see note **i** below). Any significant change in air quality is likely to be confined to the immediate vicinity of the nuclear power station as concentrations of potential pollutants would rapidly diminish away from the source. Far-field effects are therefore considered very unlikely to arise. However, on a precautionary basis, potential changes in air quality from combustion sources have been considered for sites within 10km of Sizewell C. Therefore, a LSE cannot be excluded at this stage.

h. Radiological effects: Potential radiological effects resulting from construction or decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C Main Development Site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual Radiation in Food and the Environment (RIFE) surveys compiled from monitoring undertaken around all nuclear sites in the UK by the Food Standards Agency (FSA) and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction or decommissioning would not give rise to a LSE. Note that commissioning impacts are covered under ‘Operations’, since fuelling of the nuclear power station marks the start of the operational phase.

i. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency’s screening levels. This was validated by the Environment Agency’s own assessment concluding that “the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative”. EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency’s Appropriate Assessment undertaken for EDF Energy’s development at Hinkley Point C in Somerset concluded that “the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species” and the “the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial”. This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.
• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

j. Direct habitat loss and fragmentation: No discernible impact pathway is evident as there will be no direct or indirect habitat loss of the qualifying features of the Alde-Ore and Butley Estuaries SAC as a result of Sizewell C.

k. Disturbance effects on species populations: No discernible impact pathway is evident as there will be no direct or indirect disturbance effects that could affect the qualifying features of the Alde-Ore and Butley Estuaries SAC as a result of Sizewell C.

l. Disturbance due to increase in recreational pressure: Aldeburgh is a popular and well-established visitor destination. It is considered that the majority of additional visits undertaken by people displaced from Sizewell, or potentially the RSPB Minsmere Reserve, to Aldeburgh would involve activities on the immediate beach frontage around the town, rather than the estuarine habitats and landscape of the Alde-Ore Estuary. It is also considered unlikely that people using the car park to the south of the town would be inclined to attempt to walk down the shingle spit towards Orfordness. Overall, it is therefore considered that while there could an increase in the number of visits to some locations around the Alde-Ore Estuary, the limited accessibility to qualifying habitats indicates that the potential for an increase in disturbance is unlikely. No LSE is therefore predicted.

m. Physical interaction between species and project infrastructure: As the designated features are habitats and not species, no discernible impact pathway is evident.

n. In-combination effects: The Likely Significant In-combination Effects (LSIE) screening exercise has identified at least one other plan or project that could act in-combination with the Sizewell C Project to potentially result is LSIE.

Table 34: HRA Screening Matrix: Benacre to Easton Bavents Lagoons SAC (EDF Energy, 2019b).

Name of European site and designation: Benacre to Easton Bavents Lagoons SAC																																	
EU Code: UK0013104																																	
Distance to NSIP: 15km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and direct/ indirect habitat fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			*In combina-tion effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
1150 Coastal lagoons * Priority feature	**a**	**a**	**a**	**b**	✓ **c**	**b**	**d**	**d**	**d**	**e**	**e**	**e**	**f**	**f**	**f**	**g**	× **h**	**g**	**i**	**i**	**i**	**j**	**j**	**j**	**k**	**k**	**k**	**l**	**l**	**l**	**m**	✓ **n**	**m**

a. Alteration of coastal processes/sediment transport: No discernible impact pathway is evident due to distance of the qualifying habitat of the SAC from the proposed development.

b. Water quality effects – marine environment: No discernible impact pathway is evident from construction or decommissioning activities due to distance of the qualifying habitat of the SAC from the proposed development.

c. The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **h** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage and, potentially, direct effects on harbour porpoise from the Southern North Sea SAC and / or indirect effects on their prey species. For designated sites lying to the north of the development area (e.g. Benacre to Easton Bavents Lagoons), the potential for any water quality effects on designated interests to arise is unlikely given the significant distance from Sizewell over which effects would have to propagate and the prevailing hydrodynamic and coastal process conditions (nevertheless this potential will be investigated for the Appropriate Assessment). However, at this stage, LSE cannot be excluded at this stage.

d. Water quality effects – terrestrial environment: No discernible impact pathway is evident.

e. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident.

f. Changes in air quality: No discernible impact pathway is evident.

g. Radiological effects: Potential radiological effects resulting from construction and decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Due to the distance of the designated site from construction sites, no discernible impact pathway is evident.

h. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the GDA process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC,

recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.
• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

i. Direct habitat loss and fragmentation: No discernible impact pathway is evident.

j. Disturbance effects on species populations: No discernible impact pathway is evident.

k. Disturbance due to increase in recreational pressure: No discernible impact pathway is evident.

l. Physical interaction between species and project infrastructure: As the designated features are habitats and not species, no discernible impact pathway is evident.

m. In-combination effects: As no LSE (alone) is identified for the Sizewell C Project for the construction or decommissioning phases, there is no pathway for LSIE with other plans and projects for these phases.

n. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result is LSIE.

Table 35: HRA Screening Matrix: Minsmere to Walberswick Heaths and Marshes SAC (EDF Energy, 2019b).

Name of European site and designation: Minsmere to Walberswick Heaths and Marshes SAC																																	
EU Code: UK0012809																																	
Distance to NSIP: 0km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and direct/ indirect habitat fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastructu re			*In combina-tion effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
1210 Annual vegetation of drift lines	✓ **a**	✓ **a**	✓ **a**	✓ **c**	✓ **d**	✓ **c**	**f**	**f**	**f**	**g**	**g**	**g**	× **h**	× **h**	× **h**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**
4030 European dry heaths	**b**	**b**	**b**	**e**	**e**	**e**	**f**	**f**	**f**	**g**	**g**	**g**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**
1220 Perennial vegetation of stony banks	✓ **a**	✓ **a**	✓ **a**	✓ **c**	✓ **d**	✓ **c**	**f**	**f**	**f**	**g**	**g**	**g**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**

a. Alteration of coastal processes / sediment transport: Any interruption to/alteration of coastal hydrodynamics and sediment transport processes is likely to be confined to the vicinity of the works. However, given that the Minsmere- Walberswick frontage is contiguous with that of the Main Development Site, changes in hydrodynamics and sediment transport processes could impinge upon the frontage and affect the structure and function of coastal habitats. Therefore, a LSE cannot be excluded at this stage.

b. Alteration of coastal processes / sediment transport: No discernible impact pathway is evident for this qualifying interest feature of the SAC.

c. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. Therefore, a LSE cannot be excluded at this stage.

d. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **j** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. Therefore, a LSE cannot be excluded at this stage.

e. Water quality effects – marine environment: No discernible impact pathway is evident.

f. Water quality effects – terrestrial environment: No discernible impact pathway is evident.

g. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident.

h. Changes in air quality: This qualifying feature is not considered to be sensitive to changes in air quality. No LSE is therefore predicted.

i. Changes in air quality: Localised nutrient loading on vegetation communities (e.g. coastal, heathland) may arise as a result of construction activities (e.g. due to windblown soil). Some species/vegetation types are sensitive to relatively small changes in air quality (e.g. lichens). During the construction phase, the main potential emissions would be from road traffic, dust from construction activities and combustion emissions from the diesel generators (which would extend to commissioning). During the operational phase, the main potential emissions may arise as a result of increased traffic flows and use of diesel generators for testing or as required. Radioactive discharges to air would also occur (see note **j** below). Any significant change in air quality is likely to be confined to the immediate vicinity of the nuclear power station as concentrations of potential pollutants would rapidly diminish away from the source. Far-field effects are therefore considered very unlikely to arise. However, on a precautionary basis, potential changes in air quality from combustion sources have been considered for sites within 10km of Sizewell C. Therefore, a LSE cannot be excluded at this stage.

j. Radiological effects: Potential radiological effects resulting from construction and decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual RIFE surveys compiled from monitoring undertaken around all nuclear sites in the UK by the FSA and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction or decommissioning would not give rise to a LSE. Note that commissioning impacts are covered under 'Operations', since fuelling of the nuclear power station marks the start of the operational phase.

k. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016.

The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.

• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

l. Direct habitat loss and fragmentation: No discernible impact pathway is evident.

m. Disturbance effects on species populations: No discernible impact pathway is evident.

n. Disturbance due to increase in recreational pressure: Minsmere to Walberswick Heaths and Marshes SAC is a well-used and managed site for recreational activities. The coastal frontage/beach at Dunwich and Walberswick is already subject to intense visitor use. The Site Improvement Plan (SIP) for the Minsmere-Walberswick SAC recognises that there is existing damage to the shingle vegetation at locations where visitor access is greatest, notably the car parks at Walberswick village and Dunwich village. Additional visitors to these locations resulting from the Sizewell C Project would be expected to follow similar behaviours to existing visitors and use the defined path network/beach. Further incursion by people into areas supporting sensitive vegetated shingle habitat would not be expected and additional loss of vegetation as a result of trampling is therefore considered unlikely to arise. However, because mitigation measures cannot be taken into account at the LSE screening stage, it is concluded that LSE cannot be excluded.

o. Physical interaction between species and project infrastructure: As the designated features are habitats and not species, no discernible impact pathway is evident.

p. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result in LSIE.

Table 36: HRA Screening Matrix: Orfordness to Shingle Street SAC.

Name of European site and designation: Orfordness to Shingle Street SAC																																	
EU Code: UK0014780																																	
Distance to NSIP: 8km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environment			Water quality effects – terrestrial environment			Alteration of local hydrology and hydrogeology			Changes in air quality			Radiological effects			Direct habitat loss and direct/ indirect habitat fragmentation			Disturbance effects on species populations			Disturbance due to increase in recreational pressure			Physical interaction between species and project infrastructure			*In combination effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
1150 Coastal lagoons **Priority feature*	× **a**	× **b**	× **a**	✓ **c**	✓ **d**	✓ **c**	**f**	**f**	**f**	**g**	**g**	**g**	✓ **h**	✓ **h**	✓ **h**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**
1210 Annual vegetation of drift lines	× **a**	× **b**	× **a**	✓ **c**	✓ **d**	✓ **c**	**f**	**f**	**f**	**g**	**g**	**g**	× **i**	× **i**	× **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**
1220 Perennial vegetation of stony banks	× **a**	× **b**	× **a**	✓ **c**	**e**	✓ **c**	**f**	**f**	**f**	**g**	**g**	**g**	✓ **h**	✓ **h**	✓ **h**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	✓ **n**	✓ **n**	✓ **n**	**o**	**o**	**o**	✓ **p**	✓ **p**	✓ **p**

a. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the influence of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. The construction of a jetty is not proposed, rather either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. Far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is, therefore, considered to be very unlikely. This particularly applies to sections of the coast located to the north of the Sizewell frontage, as the net direction of sediment transport is weakly to the south. No LSE is therefore predicted.

b. Alteration of coastal processes / sediment transport: The presence of new structures in the marine environment is likely to only have a very localised effect on coastal processes and sediment transport. No significant effect is predicted on the qualifying features of the Orfordness to Shingle Street SAC. No LSE is therefore predicted.

c. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. There is a weak southerly *net* drift of coastal sediments. As such there is the potential for this weak net movement to provide a potential pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. At this stage, LSE cannot be excluded at this stage.

d. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **j** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats. Therefore, a LSE cannot be excluded at this stage.

e. Water quality effects – marine environment: No discernible impact pathway is evident during the operational phase.

f. Water quality effects – terrestrial environment: No discernible impact pathway is evident on the qualifying features of the Orfordness to Shingle Street SAC.

g. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident on the qualifying features of the Orfordness to Shingle Street SAC.

h. Changes in air quality: Localised nutrient loading on vegetation communities (e.g. coastal, heathland) may arise as a result of construction activities (e.g. due to windblown soil). Some species/vegetation types are sensitive to relatively small changes in air quality (e.g. lichens). During the construction phase, the main potential emissions would be from road traffic, dust from construction activities and combustion emissions from the diesel generators (which would extend to commissioning). During the operational phase, the main potential emissions may arise as a result of increased traffic flows and use of diesel generators for testing or as required. Radioactive discharges to air would also occur (see note **j** below). Any significant change in air quality is likely to be confined to the immediate vicinity of the nuclear power station as concentrations of potential pollutants would rapidly diminish away from the source. Far-field effects are therefore considered very unlikely to arise. However, on a precautionary basis, potential changes in air quality from combustion sources have been considered for sites within 10km of Sizewell C. Therefore, a LSE cannot be excluded at this stage.

i. Changes in air quality: This qualifying feature is not considered to be sensitive to changes in air quality. No LSE is therefore predicted.

j. Radiological effects: Potential radiological effects resulting from construction and decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual Radiation in Food and the Environment (RIFE) surveys compiled from monitoring undertaken around all nuclear sites in the UK by the Food Standards Agency (FSA) and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction or decommissioning would not give rise to a LSE. Note that commissioning impacts are covered under ‘Operations’, since fuelling of the nuclear power station marks the start of the operational phase.

k. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency’s screening levels. This was validated by the Environment Agency’s own assessment concluding that “the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative”. EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency’s Appropriate Assessment undertaken for EDF Energy’s development at Hinkley Point C in Somerset concluded that “the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species” and the “the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial”. This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency’s habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.

• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy’s application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

l. Direct habitat loss and fragmentation: No discernible impact pathway is evident.

m. Disturbance effects on species populations: No discernible impact pathway is evident.

n. Disturbance due to increase in recreational pressure: Subsequent to the production of the HRA Evidence Plan, the SZC Visitor Surveys revealed that very few people indicated that they would potentially undertake recreational activity on Orfordness. In total, four people (0.78% of the survey sample) stated that they would consider Orford as an alternative location should they be displaced. Access to Orfordness is via boat / ferry from Orford and is managed by the National Trust. The numbers of people that can visit Orfordness is therefore effectively controlled. Once on the ness, visitors are restricted by the National

Trust to specific areas in order to minimise disturbance to both shingle habitats and breeding / wintering bird populations. Potentially, access to Orfordness can be gained via the beach at the southern end of Aldeburgh (Slaughden) where there is a large car park. This would entail a long walk along the shingle bank / beach and access is dissuaded by the presence of a barrier to vehicles and signs stating that there is strictly no access (apart from sea anglers, who should keep to the beach) in order to prevent damage to the shingle vegetation. Given these factors, the potential for the Sizewell C Project to generate additional disturbance to habitat features of the Orfordness to Shingle Street SAC is considered to be negligible. However, because this conclusion relies on elements that could be classed as mitigation, at this stage LSE cannot be excluded.

o. Physical interaction between species and project infrastructure: As the designated features are habitats and not species, no discernible impact pathway is evident.

p. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result is LSIE.

Table 37: HRA Screening Matrix: Southern North Sea SAC (EDF Energy, 2019b).

Name of European site and designation: Southern North Sea cSAC																																	
EU Code: UK0030395																																	
Distance to NSIP: 0km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and direct/ indirect habitat fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruct-ure			*In combina-tion effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
1351 Harbour porpoise *Phocoena phocoena*	**a**	**a**	**a**	✓ **b**	✓ **c**	✓ **b**	**d**	**d**	**d**	**e**	**e**	**e**	**f**	**f**	**f**	x **g**	x **h**	x **g**	**i**	**i**	**i**	✓ **j**	✓ **k**	✓ **j**	**l**	**l**	**l**	x **m**	✓ **n**	x **m**	✓ **o**	✓ **o**	✓ **o**

a. Alteration of coastal processes / sediment transport: No discernible impact pathway is evident.

b. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage and direct effects on harbour porpoise and/or indirect effects on prey species in the Southern North Sea SAC. Therefore, a LSE cannot be excluded at this stage.

c. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **h** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage and, potentially, direct effects on harbour porpoise from the Southern North Sea SAC and / or indirect effects on their prey species. The thermal and chemical plumes associated with the discharge may alter water quality properties such that small-scale behavioural effects on local fish communities may occur, altering the spatial distribution of the fish assemblage; including changes to the availability of potential prey species for seabirds and marine mammals. The water quality assessment will consider chlorination of the intake tunnels in accordance with the proposed chlorination strategy for Sizewell C. This will cause the discharge from the Fish Recovery and Return (FRR) system to contain chlorination products (Total Residual Oxidants (TROs) and Chlorination By-Products (CBPs)). This discharge would be at a different location than the cooling water outfall, but the discharge rate would be small in comparison with the cooling water plume (approximately 1 cumec compared to 125 cumecs) and it is expected that the effects of this discharge would be only discernible over a very short range. The FRR discharge would also return fish that have been exposed to chlorination products in the cooling water system. Some of these fish will be prey species for marine mammals. The fish would only be exposed to chlorination for a short period as they transit through the system and are not expected to accumulate detectable levels of chlorination products before discharge to sea. The discharge and any potential environmental effects (including any potential effects on seabirds) will be subject to a separate assessment. Therefore, a LSE cannot be excluded at this stage.

d. Water quality effects – terrestrial environment: No discernible impact pathway is evident on the qualifying feature of the Southern North Sea SAC.

e. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident on the qualifying feature of the Southern North Sea SAC.

f. Changes in air quality: No discernible impact pathway is evident on the qualifying feature of the Southern North Sea SAC.

g. Radiological effects: Potential radiological effects resulting from construction and decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual Radiation in Food and the Environment (RIFE) surveys compiled from monitoring undertaken around all nuclear sites in the UK by the Food Standards Agency (FSA) and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction or decommissioning would not give rise to a LSE. Note that commissioning impacts are covered under 'Operations', since fuelling of the nuclear power station marks the start of the operational phase.

h. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

- The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.
- The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.
- The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC,

recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.

• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

i. Direct habitat loss and fragmentation: No discernible impact pathway is evident.

j. Disturbance effects on species populations: Construction activities (e.g. piling and vessel traffic) in the marine environment may lead to disturbance and displacement of key prey species, such as small fish, from near shore waters that are utilised as a foraging area by marine mammal species. Therefore, a LSE cannot be excluded at this stage.

k. Disturbance effects on species populations: Operation of the cooling water system could lead, via impingement and entrainment, to a localised loss in small fish species (and their prey) that are utilised by marine mammals. The impingement assessment will consider potential effects of chlorination of the intake tunnels on fish survival from the FRR discharge. Therefore, a LSE cannot be excluded at this stage.

l. Disturbance due to increase in recreational pressure: No discernible impact pathway is evident.

m. Physical interaction between species and project infrastructure: No discernible impact pathway is evident.

n. Physical interaction between species and project infrastructure: As for possible disturbance effects on species populations, operation of the cooling water system could lead, via impingement and entrainment, to a localised loss in small fish species (and their prey) that are the prey of marine mammals. The impingement assessment will also consider the potential effects of chlorination of the intake tunnels on fish survival from the FRR discharge. Therefore, a LSE cannot be excluded at this stage.

o. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result is LSIE.

Table 38: HRA Screening Matrix: Alde-Ore Estuary SPA (EDF Energy, 2019b).

	Name of European site and designation: Alde-Ore Estuary SPA																																
	EU Code: UK9009112																																
	Distance to NSIP: 5km																																
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environment			Water quality effects – terrestrial environment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiological effects			Direct habitat loss and fragmentation			Disturbance effects on species populations			Disturbance due to increase in recreational pressure			Physical interaction between species and project infrastructure			In combination effects		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Breeding **Avocet** *Recurvirostra avosetta*	**a**	**a**	**a**	**d**	**d**	**d**	**h**	**h**	**h**	**i**	**i**	**i**	✓ **j**	✓ **j**	✓ **j**	× **k**	× **l**	× **k**	**m**	**m**	**m**	**n**	**n**	**n**	× **o**	× **o**	× **o**	**p**	**p**	**p**	✓ **r**	✓ **r**	✓ **r**
Breeding **Marsh Harrier** *Circus aeruginosus*	**a**	**a**	**a**	**d**	**d**	**d**	**h**	**h**	**h**	**i**	**i**	**i**	✓ **j**	✓ **j**	✓ **j**	× **k**	× **l**	× **k**	**m**	**m**	**m**	**n**	**n**	**n**	× **o**	× **o**	× **o**	**p**	**p**	**p**	✓ **r**	✓ **r**	✓ **r**
Breeding **Little Tern** *Sterna albifrons*	× **b**	× **c**	× **b**	× **e**	✓ **f**	× **e**	**h**	**h**	**h**	**i**	**i**	**i**	✓ **j**	✓ **j**	✓ **j**	× **k**	× **l**	× **k**	**m**	**m**	**m**	**n**	**n**	**n**	× **o**	× **o**	× **o**	**p**	✓ **q**	**p**	✓ **r**	✓ **r**	✓ **r**
Breeding **Sandwich**	× **b**	× **c**	× **b**	× **e**	✓ **f**	× **e**	**h**	**h**	**h**	**i**	**i**	**i**	✓ **j**	✓ **j**	✓ **j**	× **k**	× **l**	× **k**	**m**	**m**	**m**	**n**	**n**	**n**	× **o**	× **o**	× **o**	**p**	✓ **q**	**p**	✓ **r**	✓ **r**	✓ **r**

Tern *Sterna sandvicensis*																																	
Breeding **Lesser black-backed gull** *Larus fuscus*	x b	x c	x b	x e	✓ f	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	✓ q	p	✓ r	✓ r	✓ r
Over winter **Avocet**	x b	x c	x b	x e	x g	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	p	p	✓ r	✓ r	✓ r
Over winter **Redshank** *Tringa totanus*	x b	x c	x b	x e	x g	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	p	p	✓ r	✓ r	✓ r
Over winter **Ruff** *Philomachus pugnax*	x b	x c	x b	x e	x g	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	p	p	✓ r	✓ r	✓ r
Assemblage qualification: A seabird assemblage of international importance	x b	x c	x b	x e	✓ f	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	✓ q	p	✓ r	✓ r	✓ r
Assemblage qualification: Waterbird assemblage	x b	x c	x b	x e	x g	x e	h	h	h	i	i	i	✓ j	✓ j	✓ j	x k	x l	x k	m	m	m	n	n	n	x o	x o	x o	p	p	p	✓ r	✓ r	✓ r

a. Alteration of coastal processes/sediment transport: The qualifying feature is not dependent on the potentially affected habitats, so no discernible impact pathway is apparent.

b. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the construction (and decommissioning) of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. This could affect nesting, foraging and roosting habitats of the qualifying features of the Alde-Ore SPA which use near-shore and inter-tidal habitats. However, the construction of a jetty is not proposed; rather, either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for Abnormal Indivisible Loads (AILs). This means that the resultant alteration of coastal habitats is predicted to be localised (to within a few hundred metres of the construction works) and the far field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is considered to be very unlikely. No Likely Significant Effect (LSE) is therefore predicted.

c. Alteration of coastal processes/sediment transport: The presence of new structures in the marine environment in the operational phase is likely to have only localised effects on coastal processes and sediment transport, with predicted effects restricted to the Sizewell-Minsmere frontage. Therefore, no effects are predicted on the qualifying features of the Alde-Ore SPA and no LSE is predicted.

d. Water quality effects – marine environment: The qualifying feature is not dependent on estuarine or marine habitats and so no discernible impact pathway is apparent.

e. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment during the construction phase in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on the SPA qualifying features that depend upon estuarine or marine habitats for foraging. There is a weak southerly net drift of coastal sediments. As such there is the potential for this weak net movement to provide a potential pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within designated sites to the south of Sizewell, notably the Alde-Ore SPA. However, the amounts of sediment removal and release as a result of the construction activities would be small, whilst discharges to the marine environment during construction are unlikely to result in any significant changes in water quality. Furthermore, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Therefore, any effects on marine water quality are highly unlikely to affect the foraging areas of qualifying features of the Alde-Ore SPA to any significant extent and no LSE is predicted.

f. Water quality effects – marine environment: Discharges during the operational phase would lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased total residual oxidants (TRO). Current modelling indicates that some of these effects may extend over a sufficiently large area as to have the potential to affect the marine foraging areas of some qualifying features of the Alde-Ore SPA. This could affect the prey resource available to these qualifying features. Therefore, LSE cannot be excluded.

g. Water quality effects – marine environment: Discharges during the operational phase would lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased TROs. However, it is considered highly unlikely that this would lead to effects on those qualifying features of the Alde-Ore SPA that may use the associated coastal and estuarine habitats within the SPA but do not depend upon marine habitats for foraging. Therefore, no LSE is predicted.

h. Water quality effects – terrestrial environment: There are no direct hydrological links between the Sizewell C development site and the Alde-Ore SPA. For the purposes of this assessment it is assumed that during construction all foul wastewater would be treated in package sewage works and discharged to sea. All other wastewater streams would be treated in water management zones and discharged at greenfield rates to ground or surface water. Runoff from areas that present a hydrocarbon risk would be passed through an interceptor, as necessary, before discharge. During operation, it is assumed that all wastewater streams would be treated and discharged to sea. Therefore, no discernible impact pathway is apparent.

i. Alteration of local hydrology and hydro-geology: There are no direct hydrological links between the Sizewell C development site and the Alde-Ore SPA. Therefore, no discernible impact pathway is apparent.

j. Changes in air quality: Changes in air quality would not have a direct effect upon SPA qualifying features but could cause effects via changes to vegetation (composition and structure) within the habitats upon which the qualifying features depend. Any significant change in air quality is likely to be confined to the immediate vicinity of the proposed nuclear power station as concentrations of potential pollutants would rapidly diminish away from source. However, on a precautionary basis, potential changes in air quality from combustion sources (e.g. diesel generators) during the construction/ decommissioning and operational phases are considered to potentially affect vegetation communities within 10km of the Sizewell C development site. Therefore, LSE cannot be excluded.

k. Radiological effects: Construction (and decommissioning) activities could cause disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual Radiation in Food and the Environment (RIFE) surveys compiled from monitoring undertaken around all nuclear sites in the UK by the Food Standards Agency (FSA) and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, no LSE is predicted. (Note that commissioning impacts are covered under ‘Operations’, since fuelling of the nuclear power station marks the start of the operational phase.)

l. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station. Furthermore, radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected, and no LSE is predicted.

m. Direct habitat loss and fragmentation: There is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause habitat loss or fragmentation within the Alde-Ore SPA. Therefore, no discernible impact pathway is apparent.

n. Disturbance effects on species populations: Due to the distance of the Sizewell C development site from the Alde- Ore SPA, there is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause direct disturbance to the qualifying features of this SPA. Therefore, no discernible impact pathway is apparent.

o. Disturbance due to an increase in recreational pressure: The influx of workers to Sizewell during the construction (and potentially decommissioning) phase for the Sizewell C development potentially could lead to an increase in the number of people partaking in recreational activities in the surrounding countryside, whilst existing recreational users in the vicinity of the development (e.g. dog walkers on Sizewell beach) could also be displaced to other areas. A ZOI of 16km around Sizewell has been assumed for such potential effects, which encompasses the Alde-Ore SPA. However, such increased recreational pressure is likely to involve activities on the immediate beach frontage at Aldeburgh, rather than on the estuarine habitats of the Alde-Ore SPA. Furthermore, there are relatively few access points to this SPA, with access to a large part of the site (Orfordness and Havergate Island) being restricted and controlled by the National Trust and the RSPB. It is also considered unlikely that people using the car park to the south of the town would be inclined to walk down the shingle spit towards Orfordness, and the key intertidal habitats supporting SPA qualifying features tend to be relatively inaccessible. Therefore, no LSE is predicted. During the operational phase, staffing levels at Sizewell C would be considerably lower than during construction and any Public Rights of Ways (PRoWs) affected by the construction activities would be re-opened, so that the potential for any increase in recreational disturbance to affect the qualifying features of the Alde-Ore SPA would be less than during the construction phase. Therefore, no LSE is predicted.

p. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on SPA qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial or estuarine habitats. Therefore, no discernible impact pathway is apparent.

q. Physical interaction between species and project infrastructure: Impingement and entrainment of the small fish, larvae, eggs and marine invertebrates would occur as a result of the operation of the cooling water system, which may lead to a reduction in the availability of prey for foraging seabirds. Although any such effects are likely to be localised, the scale of these losses will need to be quantified in order to assess the likelihood of any effects on the seabird qualifying features of the Alde-Ore SPA. Therefore, LSE cannot be excluded at this stage.

r. In-combination effects: The Likely Significant In-combination Effects (LSIE) screening exercise has identified at least one other plan or project that could act in-combination with the Sizewell C project to potentially result in LSIE.

Table 39: HRA Screening Matrix: Benacre to Easton Bavents SPA (EDF Energy, 2019b).

	Name of European site and designation: Benacre to Easton Bavents SPA																																
	EU Code: UK9009291																																
	Distance to NSIP: 15km																																
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			In combina-tion effects		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Breeding **Bittern** *Botaurus stellaris*	**a**	**a**	**a**	**d**	**d**	**d**	**g**	**g**	**g**	**h**	**h**	**h**	**i**	**i**	**i**	**j**	× **k**	**j**	**l**	**l**	**l**	**m**	**m**	**m**	**n**	**n**	**n**	**o**	**o**	**o**	**q**	**q**	**q**
Breeding **Little Tern** *Sterna albifrons*	× **b**	× **c**	× **b**	× **e**	✓ **f**	× **e**	**g**	**g**	**g**	**h**	**h**	**h**	**i**	**i**	**i**	**j**	× **k**	**j**	**l**	**l**	**l**	**m**	**m**	**m**	**n**	**n**	**n**	**o**	✓ **p**	**o**	✓ **r**	✓ **r**	✓ **r**
Breeding **Marsh Harrier** *Circus aeruginosus*	**a**	**a**	**a**	**d**	**d**	**d**	**g**	**g**	**g**	**h**	**h**	**h**	**i**	**i**	**i**	**j**	× **k**	**j**	**l**	**l**	**l**	**m**	**m**	**m**	**n**	**n**	**n**	**o**	**o**	**o**	**q**	**q**	**q**
Wintering **Bittern**	**a**	**a**	**a**	**d**	**d**	**d**	**g**	**g**	**g**	**h**	**h**	**h**	**i**	**i**	**i**	**j**	× **k**	**j**	**l**	**l**	**l**	**m**	**m**	**m**	**n**	**n**	**n**	**o**	**o**	**o**	**q**	**q**	**q**

Botaurus stellaris																																	

a. Alteration of coastal processes/sediment transport: The qualifying feature is not dependent on the potentially affected habitats, so no discernible impact pathway is apparent.

b. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the construction (and decommissioning) of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. This could affect nesting, foraging and roosting habitats of the qualifying features of the Benacre to Easton Bavents SPA. However, the construction of a jetty is not proposed; rather, either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. This means that the resultant alteration of coastal habitats is predicted to be localised (to within a few hundred metres of the construction works) and the far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is considered to be very unlikely. Given the distance of the Benacre to Easton Bavents SPA from the Sizewell C development site, no LSE is therefore predicted.

c. Alteration of coastal processes/sediment transport: The presence of new structures in the marine environment is likely to have only localised effects on coastal processes and sediment transport, with predicted effects restricted to the Sizewell-Minsmere frontage. Therefore, no effects are predicted on the qualifying features of the Benacre to Easton Bavents SPA and no LSE is predicted.

d. Water quality effects – marine environment: The qualifying feature is not dependent on estuarine or marine habitats and so no discernible impact pathway is apparent.

e. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment during the construction phase in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on the SPA qualifying features that depend upon estuarine or marine habitats for foraging. There is a weak southerly net drift of coastal sediments. There is a potential pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within this SPA, but the amounts of sediment removal and release as a result of the construction activities would be small, whilst discharges to the marine environment during construction are unlikely to result in any significant changes in water quality. Furthermore, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. The direction of net drift further reduces the potential for any effects on the Benacre to Easton Bavents SPA. Therefore, any effects on marine water quality are highly unlikely to affect the foraging areas of qualifying features of the Benacre to Easton Bavents SPA to any significant extent and no LSE is predicted.

f. Water quality effects – marine environment: Discharges during the operational phase would lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased TRO. Current modelling indicates that some of these effects may extend over a sufficiently large area as to have the potential to affect the marine foraging areas of little terns from the Benacre and Easton Bavents SPA. This could affect the prey resource available to this qualifying feature. Therefore, LSE cannot be excluded.

g. Water quality effects – terrestrial environment: There are no direct hydrological links between the Sizewell C development site and the Benacre and Easton Bavents SPA. For the purposes of this assessment it is assumed that during construction all foul wastewater would be treated in package sewage works and discharged to sea. All other wastewater streams would be treated in water management zones and discharged at greenfield rates to ground or surface water. Runoff from areas that present a hydrocarbon risk would be passed through an interceptor, as necessary, before discharge. During operation, it is assumed that all wastewater streams would be treated and discharged to sea. Therefore, no discernible impact pathway is apparent.

h. Alteration of local hydrology and hydro-geology: There are no direct hydrological links between the Sizewell C development site and the Benacre and Easton Bavents SPA. Therefore, no discernible impact pathway is apparent.

i. Changes in air quality: Changes in air quality would not have a direct effect upon SPA qualifying features but could cause effects via changes to vegetation (composition and structure) within the habitats upon which the qualifying features depend. On a precautionary basis, potential changes in air quality from combustion sources (e.g. diesel generators) during the construction/ decommissioning and operational phases are considered to potentially affect vegetation communities within 10km of the Sizewell C development site (although any significant change in air quality is likely to be confined to the immediate vicinity of the proposed nuclear power station as concentrations of potential pollutants would rapidly diminish away from source). The Benacre to Easton Bavents SPA is 15km from the Sizewell C development site and, therefore, no discernible impact pathway is apparent.

j. Radiological effects: Construction (and decommissioning) activities could cause disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Due to the distance of the Benacre to Easton Bavents SPA from the Sizewell C development site, no discernible impact pathway is apparent.

k. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

- The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.
- The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.
- The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station. Furthermore, radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected, and no LSE is predicted.

l. Direct habitat loss and fragmentation: There is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause habitat loss or fragmentation within the Benacre to Easton Bavents SPA. Therefore, no discernible impact pathway is apparent.

m. Disturbance effects on species populations: Due to the distance of the Sizewell C development site from the Benacre to Easton Bavents SPA, there is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause direct disturbance to the qualifying features of this SPA. Therefore, no discernible impact pathway is apparent.

n. Disturbance due to increase in recreational pressure: The influx of workers to Sizewell during the construction (and potentially decommissioning) phase for the Sizewell C development potentially could lead to an increase in the number of people partaking in recreational activities in the surrounding countryside, whilst existing recreational users in the vicinity of the development (e.g. dog walkers on Sizewell beach) could also be displaced to other areas. However, due to the distance of the Benacre to Easton Bavents SPA from Sizewell, no discernible impact pathway is apparent.

o. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on SPA qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial or estuarine habitats. Therefore, no discernible impact pathway is apparent.

p. Physical interaction between species and project infrastructure: Impingement and entrainment of the small fish, larvae, eggs and marine invertebrates would occur as a result of the operation of the cooling water system, which may lead to a reduction in the availability of prey for foraging seabirds. Although any such effects are likely to be localised, the scale of these losses will need to be quantified in order to assess the likelihood of any effects on little terns from the Benacre to Easton Bavents SPA. Therefore, LSE cannot be excluded at this stage.

q. In-combination effects: No LSE is concluded for this qualifying feature in relation to any of the pathways, and no discernible impact pathway is apparent for in-combination effects.

r. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result in LSIE.

TR483 SYNTHESIS OF EVIDENCE FOR SZC WATER FRAMEWORK DIRECTIVE (WFD) AND HABITATS REGULATIONS ASSESSMENT (HRA) MARINE ASSESSMENTS VERSION 6

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Table 40: HRA Screening Matrix: Minsmere to Walberswick SPA (EDF Energy, 2019b).

	Name of European site and designation: Minsmere to Walberswick SPA																																
	EU Code: UK9009101																																
	Distance to NSIP: 0km																																
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			In combina-tion effects		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Breeding **Avocet** *Recurvirostra avosetta*	**a**	**a**	**a**	**d**	**d**	**d**	✓ **g**	✓ **h**	✓ **g**	✓ **j**	✓ **k**	✓ **j**	✓ **m**	✓ **m**	✓ **m**	× **n**	× **o**	× **n**	× **p**	× **q**	× **p**	✓ **t**	✓ **u**	✓ **t**	✓ **v**	✓ **v**	✓ **v**	**w**	**w**	**w**	✓ **y**	✓ **y**	✓ **y**
Breeding **Bittern** *Botaurus stellaris*	**a**	**a**	**a**	**d**	**d**	**d**	✓ **g**	✓ **h**	✓ **g**	✓ **j**	✓ **k**	✓ **j**	✓ **m**	✓ **m**	✓ **m**	× **n**	× **o**	× **n**	× **p**	× **q**	× **p**	✓ **t**	✓ **u**	✓ **t**	✓ **v**	✓ **v**	✓ **v**	**w**	**w**	**w**	✓ **y**	✓ **y**	✓ **y**
Breeding **Little Tern** *Sterna albifrons*	✓ **b**	✓ **c**	✓ **b**	✓ **e**	✓ **f**	✓ **e**	✓ **g**	✓ **h**	✓ **g**	✓ **j**	✓ **k**	✓ **j**	✓ **m**	✓ **m**	✓ **m**	× **n**	× **o**	× **n**	× **p**	× **q**	× **p**	✓ **t**	✓ **u**	✓ **t**	✓ **v**	✓ **v**	✓ **v**	**×** **w**	✓ **x**	**w**	✓ **y**	✓ **y**	✓ **y**
Breeding **Marsh Harrier**	**a**	**a**	**a**	**d**	**d**	**d**	✓ **g**	✓ **h**	✓ **g**	✓ **j**	✓ **k**	✓ **j**	✓ **m**	✓ **m**	✓ **m**	× **n**	× **o**	× **n**	✓ **r**	✓ **s**	✓ **r**	✓ **t**	✓ **u**	✓ t	✓ **v**	✓ **v**	✓ **v**	**w**	**w**	**w**	✓ **y**	✓ **y**	✓ **y**

Circus aeruginosus																																	
Breeding **Nightjar** *Caprimulgus europaeus*	a	a	a	d	d	d	i	i	i	l	l	l	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Breeding **Shovelor** *Anas clypeata*	a	a	a	d	d	d	✓ g	✓ h	✓ g	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	x p	x q	x p	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Breeding **Teal** *Anas crecca*	a	a	a	d	d	d	✓ g	✓ h	✓ g	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	x p	x q	x p	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Breeding Gadwall *Anas strepera*	a	a	a	d	d	d	✓ g	✓ h	✓ g	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	x p	x q	x p	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Breeding **Woodlark** *Lullula arborea*	a	a	a	d	d	d	i	i	i	l	l	l	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **Avocet** *Recurvirostra Avosetta*	a	a	a	d	d	d	✓ g	✓ h	✓ g	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	x p	x q	x p	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **Bittern** *Botaurus stellaris*	a	a	a	d	d	d	✓ g	✓ h	✓ g	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **Gadwall** *Anas strepera*	a	a	a	d	d	d	✓ f	✓ g	✓ f	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **Hen Harrier** *Circus cyaneus*	a	a	a	d	d	d	✓ f	✓ g	✓ f	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **Shovelor** *Anas Clypeata*	a	a	a	d	d	d	✓ f	✓ g	✓ f	✓ j	✓ k	✓ j	✓ m	✓ m	✓ m	x n	x o	x n	✓ r	✓ s	✓ r	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y
Wintering **White**	a	a	a	d	d	d	✓ f	✓ g	✓ f	✓ i	✓ j	✓ i	✓ m	✓ m	✓ m	x n	x o	x n	x p	x q	x p	✓ t	✓ u	✓ t	✓ v	✓ v	✓ v	w	w	w	✓ y	✓ y	✓ y

Fronted Goose *Anser albifrons albifrons*																																	

a. Alteration of coastal processes/sediment transport: The qualifying feature is not dependent on the potentially affected habitats, so no discernible impact pathway is apparent. Note, that although wintering avocet may use estuarine habitats in some locations, within the Minsmere and Walberswick SPA they are largely restricted to the scrapes within the RSPB Minsmere Reserve (and during the Arcadis/Amec seabird surveys small numbers only were recorded commuting along the coastline during both the breeding and wintering seasons).

b. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the construction (and decommissioning) of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. The construction of a jetty is no longer proposed; rather, either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. This means that the resultant alteration of coastal habitats would be localised (to within a few hundred metres of the construction works) and the far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is considered to be very unlikely. However, this could still affect potential nesting, foraging and roosting habitat for those qualifying features of the Minsmere and Walberswick SPA which are dependent on nearshore and intertidal habitats. Therefore, LSE cannot be excluded.

c. Alteration of coastal processes/sediment transport: The presence of new structures in the marine environment is likely to have only localised effects on coastal processes and sediment transport, with predicted effects restricted to the Sizewell-Minsmere frontage. However, this could still affect potential nesting, foraging and roosting habitat for those qualifying features of the Minsmere and Walberswick SPA which are dependent on near-shore and inter-tidal habitats. Therefore, LSE cannot be excluded.

d. Water quality effects – marine environment: The qualifying feature is not dependent on estuarine or marine habitats and so no discernible impact pathway is apparent. Note, that although wintering avocet may use estuarine habitats in some locations, within the Minsmere and Walberswick SPA they are largely restricted to the scrapes within the RSPB Minsmere Reserve (and during the Arcadis/Amec seabird surveys small numbers only were recorded commuting along the coastline during both the breeding and wintering seasons).

e. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment during the construction phase in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on the SPA qualifying features that depend upon estuarine or marine habitats for foraging. There is a weak southerly net drift of coastal sediments. The amounts of sediment removal and release as a result of the construction activities would be small, whilst discharges to the marine environment during construction are unlikely to result in any significant changes in water quality. Furthermore, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Nonetheless, the proximity of the Minsmere and Walberswick SPA to the Sizewell C development site means that LSE cannot be excluded.

f. Water quality effects – marine environment: Discharges during the operational phase would lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased TROs. Current modelling indicates that some of these effects have the potential to affect estuarine and marine habitats that may be used by some qualifying features of the Minsmere and Walberswick SPA. This could lead to effects on the prey resource available to these qualifying features. Therefore, LSE cannot be excluded.

g. Water quality effects – terrestrial environment: There are direct hydrological connections between the Sizewell C development area and Minsmere-Walberswick (south of the Minsmere New Cut) through the Minsmere Sluice. A number of factors mean that the potential for measurable hydrological impact as a result of construction (or decommissioning) activities on either side of the sluice is minimal but any increase in water levels at the Minsmere Sluice could potentially affect surface water levels to the north. As such, discharges into watercourses within the development area, or changes in water levels, flow, ditch alignment or sedimentation rates within the watercourses, could have a direct effect on water quality in the Minsmere South or Minsmere North Levels. For the purpose of this assessment, it is assumed that all foul wastewater would be treated in package sewage works and discharged to sea, whilst other wastewater streams would be treated in water management zones and discharged at greenfield rates to ground or surface water. The potential for direct effects on water quality in the Minsmere South or Minsmere North Levels means that LSE cannot be excluded for those qualifying features dependent on wetland habitats. This includes breeding little tern because in recent years they have nested on the shingle islands in the main scrape in the RSPB Minsmere Reserve (as opposed to the shingle beach).

h. Water quality effects – terrestrial environment: There are direct hydrological connections between the Sizewell C development area and Minsmere-Walberswick (south of the Minsmere New Cut) through the Minsmere Sluice. A number of factors mean that the potential for measurable hydrological impact as a result of operational activities on either side of the sluice is minimal but any increase in water levels at the Minsmere Sluice could potentially affect surface water levels to the north. As such, discharges into watercourses within the development area, or changes in water levels, flow, ditch alignment or sedimentation rates within the watercourses, could have a direct effect on water quality in the Minsmere South or Minsmere North Levels. For the purpose of this assessment, it is assumed that all foul wastewater would be treated in package sewage works and discharged to sea, whilst other wastewater streams would be treated in water management zones and discharged at greenfield rates to ground or surface water. The potential for direct effects on water quality in the Minsmere South or Minsmere North Levels means that LSE cannot be excluded for those qualifying features dependent on wetland habitats. This includes breeding little tern because in recent years they have nested on the shingle islands within the main scrape in the RSPB Minsmere Reserve (as opposed to using the shingle beach).

i. Water quality effects – terrestrial environment: The qualifying feature is not dependent upon wetland habitats, so no discernible impact pathway is apparent.

j. Alteration of local hydrology and hydro-geology: Any construction (or decommissioning) activities that interrupt or alter the baseline groundwater regime (e.g. reduced rainfall infiltration rates into the soil within the construction area) could potentially change the hydrological or hydrogeological properties of the site and adjacent land and, in turn, affect the wetland habitats upon which these qualifying features depend (for nesting, foraging or roosting). The potentially affected qualifying features include breeding little tern because in recent years they have nested on the shingle islands in the main scrape within the RSPB Minsmere Reserve (as opposed to using the shingle beach). Therefore, LSE cannot be excluded.

k. Alteration of local hydrology and hydro-geology: Any development that interrupts or alters the baseline groundwater regime (e.g. the presence of the proposed cut-off wall around the nuclear and conventional islands) could potentially change the hydrological or hydrogeological properties of the site and adjacent land and, in turn, affect the wetland habitats upon which these qualifying features depend (for nesting, foraging or roosting). The potentially affected qualifying features include breeding little tern because in recent years they have nested on the shingle islands in the main scrape within the RSPB Minsmere Reserve (as opposed to using the shingle beach). Therefore, LSE cannot be excluded.

l. Alteration of local hydrology and hydro-geology: The qualifying feature is not dependent upon wetland habitats, so no discernible impact pathway is apparent.

m. Changes in air quality: Changes in air quality would not have a direct effect upon SPA qualifying features but could cause effects via changes to vegetation (composition and structure) within the habitats upon which the qualifying features depend. Any significant change in air quality is likely to be confined to the immediate vicinity of the proposed nuclear power station as concentrations of potential pollutants would rapidly diminish away from source. However, on a precautionary basis, potential changes in air quality from combustion sources (e.g. diesel generators) during the construction/ decommissioning and operational phases are considered to potentially affect vegetation communities within 10km of the Sizewell C development site. Therefore, LSE cannot be excluded.

n. Radiological effects: Construction (and decommissioning) activities could cause disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual RIFE surveys compiled from monitoring undertaken around all nuclear sites in the UK by the FSA and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, no LSE is predicted. (Note that commissioning impacts are covered under 'Operations', since fuelling of the nuclear power station marks the start of the operational phase.)

o. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

- The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.
- The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.
- The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-

combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station. Furthermore, radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected, and no LSE is predicted.

p. Direct habitat loss and fragmentation: The qualifying feature is considered to make, at most, limited use of the affected habitats and/or not to be dependent upon supporting habitats outside the SPA, so that effects of habitat loss and habitat fragmentation as a result of construction (and decommissioning) activities are considered unlikely. Therefore, no LSE is predicted.

q. Direct habitat loss and fragmentation: The qualifying feature is considered to make, at most, limited use of the affected habitats and/or not to be dependent upon supporting habitats outside the SPA, so that effects of habitat loss and habitat fragmentation during operation are considered unlikely. Therefore, no LSE is predicted.

r. Direct habitat loss and fragmentation: Construction (and decommissioning) activities would lead to habitat loss within the footprint of the Sizewell C development, which may affect SPA qualifying features that rely upon supporting habitats outside the SPA. Therefore, LSE cannot be excluded for those qualifying features that may use the affected habitat-types and which may rely upon supporting habitats outside the SPA.

s. Direct habitat loss and fragmentation: The loss of habitat within the footprint of the Sizewell C development during operation may affect those qualifying features that rely upon supporting habitats outside the SPA. Therefore, LSE cannot be excluded for those qualifying features that may use the affected habitat-types and which may rely upon supporting habitats outside the SPA.

t. Disturbance effects on species populations: Construction (and decommissioning) activities within the terrestrial environment may have direct and indirect disturbance effects (from both noise and visual stimuli) on the SPA qualifying features. Disturbance could have a number of detrimental effects on qualifying features, including displacement from habitats and barrier effects (which could lead indirectly to habitat fragmentation). The likelihood of such disturbance effects would diminish with distance from the Sizewell C construction site, so that the qualifying features which use habitats in relatively close proximity to the construction site (e.g. within the Minsmere South Levels) are most likely to be affected. Within the marine environment, disturbance may arise from increased vessel traffic associated with construction and from activities such as piling. Potentially, this could affect the foraging behaviour and available prey resource of the SPA population of breeding little terns. Therefore, LSE cannot be excluded.

NOT PROTECTIVELY MARKED

u. Disturbance effects on species populations: Noise and visual stimuli during operation (e.g. from increased traffic and artificial lighting) may have direct and indirect disturbance effects on the SPA qualifying features. Disturbance could have a number of detrimental effects on qualifying features, including displacement from habitats and barrier effects (which could lead indirectly to habitat fragmentation). The likelihood of such disturbance effects would diminish with distance from the Sizewell C construction site, so that the qualifying features which use habitats in relatively close proximity to the construction site (e.g. within the Minsmere South Levels) are most likely to be affected. Therefore, LSE cannot be excluded.

v. Disturbance due to increase in recreational pressure: Minsmere to Walberswick SPA includes many well-used and managed sites for recreational activities, such as: Minsmere RSPB Reserve, Dunwich Heath (owned and managed by the National Trust) and Westleton Heath, to the south of Dunwich Forest (not itself part of the European site), and Walberswick National Nature Reserve (incorporating Westwood Marshes and Walberswick Common), to the north. Many of these areas, in particular the coastal frontage/beach at Dunwich and Walberswick, are already subject to intense visitor use. Additional visitors to these locations resulting from the Sizewell C Project would be expected to follow similar behaviours to existing visitors and use the defined path networks/accessible beaches. Measures would be put in place to help manage any potential increase in visitor numbers and, as such, significant adverse effects are not predicted. However, because mitigation measures cannot be taken into account at the LSE screening stage, LSE cannot be excluded.

w. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on SPA qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial habitats. Therefore, no discernible impact pathway is apparent.

x. Physical interaction between species and project infrastructure: Impingement and entrainment of the small fish, larvae, eggs and marine invertebrates will occur as a result of the operation of the cooling water system, which may lead to a reduction in the availability of prey for foraging little tern. Although any such effects are likely to be localised, the scale of these losses will need to be quantified in order to assess the likelihood of any effects on the SPA little tern population. Therefore, LSE cannot be excluded at this stage.

y. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C project to potentially result in LSIE.

Table 41: HRA Screening Matrix: Outer Thames Estuary SPA (EDF Energy, 2019b).

Name of European site and designation: Outer Thames Estuary SPA																																	
EU Code: UK9020309																																	
Distance to NSIP: 0km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environment			Water quality effects – terrestrial environment			Alteration of local hydrology and hydrogeology			Changes in air quality			Radiological effects			Direct habitat loss and fragmentation			Disturbance effects on species populations			Disturbance due to increase in recreational pressure			Physical interaction between species and project infrastructure			In combination effects		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Wintering / passage **Red-throated diver** *Gavia stellata*	**a**	**a**	**a**	✓ **b**	✓ **c**	✓ **b**	**d**	**d**	**d**	**e**	**e**	**e**	**f**	**f**	**f**	× **g**	× **h**	× **g**	**i**	**i**	**i**	✓ **j**	✓ **k**	✓ **j**	**l**	**l**	**l**	**m**	✓ **n**	**m**	✓ **o**	✓ **o**	✓ **o**
Breeding **Little Tern** *Sterna albifrons*	**a**	**a**	**a**	✓ **b**	✓ **c**	✓ **b**	**d**	**d**	**d**	**e**	**e**	**e**	**f**	**f**	**f**	× **g**	× **h**	× **g**	**i**	**i**	**i**	✓ **j**	✓ **k**	✓ **j**	**l**	**l**	**l**	**m**	✓ **n**	**m**	✓ **o**	✓ **o**	✓ **o**
Breeding **Common Tern** *Sterna hirundo*	**a**	**a**	**a**	✓ **b**	✓ **c**	✓ **b**	**d**	**d**	**d**	**e**	**e**	**e**	**f**	**f**	**f**	× **g**	× **h**	× **g**	**i**	**i**	**i**	✓ **j**	✓ **k**	✓ **j**	**l**	**l**	**l**	**m**	✓ **n**	**m**	✓ **o**	✓ **o**	✓ **o**

a. Alteration of coastal processes/sediment transport: Within the SPA the qualifying feature is not dependent on the potentially affected habitats. In relation to the little tern and common tern qualifying features, the SPA encompasses the foraging areas for birds that derive from breeding colonies which are qualifying features of other SPAs (e.g. the Great Yarmouth North Denes SPA and the Breydon Water SPA). Therefore, no discernible impact pathway is apparent.

b. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment during the construction phase in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on the SPA qualifying features. There is a weak southerly net drift of coastal sediments. The amounts of sediment removal and release as a result of the construction activities will be small, whilst discharges to the marine environment during construction are unlikely to result in any significant changes in water quality. Furthermore, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Nonetheless, the Outer Thames Estuary SPA is within and adjacent to the Sizewell C development site and therefore LSE cannot be excluded.

c. Water quality effects – marine environment: Discharges during the operational phase will lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased TROs. Given that the Outer Thames Estuary SPA is within and adjacent to the Sizewell C development site these effects have the potential to affect the marine habitats used by the qualifying features of this SPA. This could lead to effects on the prey resource available to these qualifying features. Therefore, LSE cannot be excluded.

d. Water quality effects – terrestrial environment: The qualifying feature is not dependent upon the affected habitats, so no discernible impact pathway is apparent.

e. Alteration of local hydrology and hydro-geology: The qualifying feature is not dependent upon the affected habitats, so no discernible impact pathway is apparent.

f. Changes in air quality: Changes in air quality would not have a direct effect upon SPA qualifying features and would not affect the marine habitats upon which these qualifying features depend. Therefore, no discernible impact pathway is apparent.

g. Radiological effects: Construction (and decommissioning) activities could cause disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual RIFE surveys compiled from monitoring undertaken around all nuclear sites in the UK by the FSA and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, no LSE is predicted. (Note that commissioning impacts are covered under ‘Operations’, since fuelling of the nuclear power station marks the start of the operational phase.)

h. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.

• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station. Furthermore, radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected, and no LSE is predicted.

i. Direct habitat loss and fragmentation: There is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause habitat loss or fragmentation within the Outer Thames Estuary SPA. Therefore, no discernible impact pathway is apparent.

j. Disturbance effects on species populations: Construction (and decommissioning) activities may have direct and indirect disturbance effects (from both noise and visual stimuli) on the SPA qualifying features. The sources of such potential effects within the marine environment will include piling operations, artificial lighting and increased vessel movements. Disturbance could have a number of detrimental effects on qualifying features, including displacement from foraging habitat and reduction in prey availability (due to underwater noise), although such potential effects are likely to be limited to near-shore areas. Therefore, LSE cannot be excluded.

k. Disturbance effects on species populations: Noise and visual stimuli during operation (e.g. from increased vessel movements and artificial lighting) may have direct and indirect disturbance effects on the SPA qualifying features. Disturbance could lead to displacement from foraging habitat, although any such effects are likely to be limited to nearshore areas. Therefore, LSE cannot be excluded.

l. Disturbance due to increase in recreational pressure: Potential impacts from increased recreational pressure are predicted within terrestrial and inter tidal habitats only. Therefore, no discernible impact pathway is apparent.

m. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on SPA qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial habitats. Therefore, no discernible impact pathway is apparent.

n. Physical interaction between species and project infrastructure: Impingement and entrainment of the small fish, larvae, eggs and marine invertebrates will occur as a result of the operation of the cooling water system, which may lead to a reduction in the availability of prey for the SPA qualifying features. Although any such effects are likely to be localised, the scale of these losses will need to be quantified in order to assess the likelihood of any effects on the qualifying features. Therefore, LSE cannot be excluded at this stage.

o. In-combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C project to potentially result in LSIE.

Table 42: HRA Screening Matrix: Alde-Ore Estuary Ramsar site (EDF Energy, 2019b).

Name of European site and designation: Alde-Ore Estuary Ramsar site																																	
EU Code: UK11002																																	
Distance to NSIP: 5km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and fragment-ation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			In combina-tion effects		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Ramsar criterion 2 Nationally-scarce plant species and British Red Data Book invertebrates	× **a**	× **b**	× **a**	✓ **c**	✓ **e**	✓ **c**	× **g**	× **g**	× **g**	× **h**	× **h**	× **h**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	× **n**	× **n**	× **n**	**o**	**o**	**o**	✓ **q**	✓ **q**	✓ **q**
Ramsar criterion 3 The site supports a	× **a**	× **b**	× **a**	× **d**	✓ **e, f**	× **d**	× **g**	× **g**	× **g**	× **h**	× **h**	× **h**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	× **n**	× **n**	× **n**	**o**	✓ **p**	**o**	✓ **q**	✓ **q**	✓ **q**

notable assemblage of breeding and wintering wetland birds																																	
Ramsar criterion 6 Species/ populations occurring at levels of international importance	× **b**	× **b**	× **b**	× **d**	✓ **e, f**	× **d**	× **g**	× **g**	× **g**	× **h**	× **h**	× **h**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	**l**	**l**	**l**	**m**	**m**	**m**	× **n**	× **n**	× **n**	**o**	✓ **p**	**o**	✓ **q**	✓ **q**	✓ **q**

a. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the influence of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. The construction of a jetty is not proposed, rather either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. Far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is, therefore, considered to be very unlikely. This particularly applies to sections of the coast located to the north of the Sizewell frontage, as the net direction of sediment transport is weakly to the south (BEEMS Technical Reports TR105; TR107; TR223; TR311 Ed. 4). No LSE is therefore predicted.

b. Alteration of coastal processes/sediment transport: The presence of new structures in the marine environment is likely to have only localised effects on coastal processes and sediment transport, with predicted effects restricted to the Sizewell-Minsmere frontage and with very limited potential for effects upon qualifying plant and invertebrate species. With respect to the breeding and wintering wetland bird assemblages of the Alde-Ore Estuary Ramsar Site, no effects are predicted. No LSE is therefore predicted.

c. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment in the vicinity of Sizewell (including dredged plumes) could affect water quality, leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. There is a weak southerly net drift of coastal sediments. As such there is the potential for this weak net movement to provide a potential pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Therefore, a LSE cannot be excluded at this stage.

d. Water quality effects – marine environment: No discernible impact pathway is evident on the qualifying features of the Alde-Ore Estuary Ramsar site. No LSE is therefore predicted.

e. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **l** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. Therefore, a LSE cannot be excluded at this stage.

f. Water quality effects – marine environment: Discharges during the operational phase would lead to a number of effects on the surrounding marine habitats, including increased water temperatures and increased total residual oxidants (TRO). Current modelling indicates that some of these effects may extend over a sufficiently large area as to have the potential to affect the marine foraging areas of some species that are part of the breeding wetland bird assemblage associated with the Alde-Ore Estuary Ramsar site. This could affect the prey resource available to such species. Therefore, LSE cannot be excluded.

g. Water quality effects – terrestrial environment: No discernible impact pathway is evident on the qualifying features of the Alde-Ore Estuary Ramsar site. No LSE is therefore predicted.

h. Alteration of local hydrology and hydrogeology: No discernible impact pathway is evident on the qualifying features of the Alde-Ore Estuary Ramsar site. No LSE is therefore predicted.

i. Changes in air quality: Localised nutrient loading on vegetation communities (e.g. coastal, heathland) may arise as a result of construction activities (e.g. due to windblown soil). Some species/vegetation types are sensitive to relatively small changes in air quality (e.g. lichens). During the construction phase, the main potential emissions would be from road traffic, dust from construction activities and combustion emissions from the diesel generators (which will extend to commissioning). During the operational phase, the main potential emissions may arise as a result of increased traffic flows and use of diesel generators for testing or as required. Radioactive discharges to air would also occur (see note **k** below). Any significant change in air quality is likely to be confined to the immediate vicinity of the nuclear power station as concentrations of potential pollutants would rapidly diminish away from the source. Far-field effects are therefore considered very unlikely to arise. However, on a precautionary basis, potential changes in air quality from combustion sources have been considered for sites within 10km of Sizewell C. Any such effects of changes in air quality on the vegetation communities could also lead to indirect impacts on the breeding and wintering wetland bird assemblages. Therefore, a LSE cannot be excluded at this stage.

j. Radiological effects: Potential radiological effects resulting from construction (and decommissioning) activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual Radiation in Food and the Environment (RIFE) surveys compiled from monitoring undertaken around all nuclear sites in the UK by the Food Standards Agency (FSA) and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction would not give rise to a LSE. Note that commissioning impacts are covered under ‘Operations’, since fuelling of the nuclear power station marks the start of the operational phase.

k. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency’s screening levels. This was validated by the Environment Agency’s own assessment concluding that “the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative”. EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.

• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.
• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.
• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

l. Direct habitat loss and fragmentation: There is no potential for the activities associated with the construction/decommissioning and operation of the Sizewell C development to cause habitat loss or fragmentation within the Alde-Ore Estuary Ramsar site. Therefore, no discernible impact pathway is apparent.

m. Disturbance effects on species populations: No discernible impact pathway is evident on the qualifying features of the Alde-Ore Estuary Ramsar site. No LSE is therefore predicted.

n. Disturbance due to increase in recreational pressure: Aldeburgh is a popular and well-established visitor destination. It is considered that the majority of additional visits undertaken by people displaced from Sizewell, or potentially the RSPB Minsmere Reserve, to Aldeburgh would involve activities on the immediate beach frontage around the town, rather than the estuarine habitats and landscape of the Alde-Ore Estuary. It is also considered unlikely that people using the car park to the south of the town would be inclined to attempt to walk down the shingle spit towards Orfordness. Overall, it is therefore considered that while there could an increase in the number of visits to some locations around the Alde-Ore Estuary, the limited accessibility to qualifying habitats indicates that the potential for an increase in disturbance is unlikely. No LSE is therefore predicted.

o. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial or estuarine habitats. Therefore, no discernible impact pathway is apparent.

p. Physical interaction between species and project infrastructure: Impingement and entrainment of the small fish, larvae, eggs and marine invertebrates will occur as a result of the operation of the cooling water system, which may lead to a reduction in the availability of prey for foraging seabirds. Although any such effects are likely to be localised, the scale of these losses will need to be quantified in order to assess the likelihood of any effects on the species from the breeding wetland bird assemblage associated with the Alde-Ore Estuary Ramsar site. Therefore, LSE cannot be excluded at this stage.

q. In combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C project to potentially result in LSIE.

Table 43: HRA Screening Matrix: Minsmere to Walberswick Ramsar site (EDF Energy, 2019b).

Name of European site and designation: Minsmere to Walberswick Ramsar site																																	
EU Code: UK11044																																	
Distance to NSIP: 0km																																	
European site features	**Likely effects of NSIP**																																
Effect	Alteration of coastal processes / sediment transport			Water quality effects – marine environ-ment			Water quality effects – terrestrial environ-ment			Alteration of local hydrology and hydro-geology			Changes in air quality			Radiologi-cal effects			Direct habitat loss and direct/ indirect habitat fragmen-tation			Disturb-ance effects on species populations			Disturb-ance due to increase in recreation-al pressure			Physical interaction between species and project infrastruc-ture			*In combina-tion effects*		
Stage of Development	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*	*C*	*O*	*D*
Ramsar criterion 1 Mosaic of marine, freshwater, marshland and associated habitats	✓ **a**	✓ **b**	✓ **a**	✓ **c**	✓ **e**	✓ **c**	✓ **f, g**	✓ **f**	✓ **f, g**	✓ **h**	✓ **h**	✓ **h**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	× **l**	✓ **n**	× **l**	**p**	**p**	**p**	✓ **s**	✓ **s**	✓ **s**	**t**	**t**	**t**	✓ **u**	✓ **u**	✓ **u**
Ramsar criterion 2 Supports nine nationally scarce plants and at least 26 red data	✓ **a**	✓ **b**	✓ **a**	✓ **c**	✓ **e**	✓ **c**	✓ **f, g**	✓ **f**	✓ **f, g**	✓ **h**	✓ **h**	✓ **h**	✓ **i**	✓ **i**	✓ **i**	× **j**	× **k**	× **j**	× **l**	× **l**	× **l**	**p**	**p**	**p**	✓ **s**	✓ **s**	✓ **s**	**t**	**t**	**t**	✓ **u**	✓ **u**	✓ **u**

book invertebrates																																	
Ramsar criterion 2 An important assemblage of rare breeding birds associated with marshland and reedbeds	✓ **a**	✓ **b**	✓ **a**	**d**	**d**	**d**	✓ **f, g**	✓ **f**	✓ **f, g**	✓ **h**	✓ **h**	✓ **h**	✓ **i**	✓ **i**	✓ **i**	x **j**	x **k**	x **j**	✓ **m**	✓ **o**	✓ **m**	✓ **q**	✓ **r**	✓ **q**	✓ **s**	✓ **s**	✓ **s**	**t**	**t**	**t**	✓ **u**	✓ **u**	✓ **u**

a. Alteration of coastal processes/sediment transport: Potential interruption to/alteration of coastal hydrodynamics and sediment transport processes as a result of the construction (and decommissioning) of marine infrastructure (outfall, intake and coastal defences) is likely to be confined to the vicinity of the works. However, the construction of a jetty is not proposed; rather either a rail-led or road-led freight management strategy is to be adopted, alongside a beach landing facility for AILs. This means that resultant alteration of coastal habitats is predicted to be localised only (to within a few hundred metres of the construction works) and far-field propagation of hydrodynamic change (and the influence of this on sediment transport processes) is considered to be very unlikely. However, this could still affect potential nesting, foraging and roosting habitat for those qualifying features of the Minsmere and Walberswick SPA which are dependent on near-shore and inter-tidal habitats. Therefore, LSE cannot be excluded at this stage.

b. Alteration of coastal processes/sediment transport: Any interruption to/alteration of coastal hydrodynamics and sediment transport processes is likely to be confined to the vicinity of the works. However, given that the Minsmere- Walberswick frontage is contiguous with that of the Main Development Site, changes in hydrodynamics and sediment transport processes could impinge upon the frontage and affect the structure and function of coastal habitats. Therefore, a LSE cannot be excluded at this stage.

c. Water quality effects – marine environment: Any uncontrolled discharges to the marine environment in the vicinity of Sizewell (including sediment plumes from dredging) could affect water quality, leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. There is a weak southerly net drift of coastal sediments. As such there is the potential for this weak net movement to provide a potential pathway through which discharges (including spillages from pollution events) from the construction area could impact upon water quality within designated sites to the south of

Sizewell. However, dilution of any suspended sediments or potential pollutants would be substantial and resultant concentrations would be unlikely to be significant. Therefore, a LSE cannot be excluded at this stage.

d. Water quality effects – marine environment: No discernible impact pathway is evident.

e. Water quality effects – marine environment: The cooling water discharge would raise ambient water temperature and introduce potential pollutants into the water column (including radionuclides, see note **l** below). Given the tidal extent at the site, the plume associated with the discharge potentially could impinge upon coastal waters and the coastline at some distance from the point of discharge. This is more likely to arise for locations in the immediate vicinity of the frontage or to the south, as there is a weak southerly net drift of coastal sediments. This weak net movement could provide a potential pathway through which discharges (including spillages from pollution events) could impact upon water quality within designated sites to the south of Sizewell. However, dilution of any potential pollutants or suspended sediments would be substantial and resultant concentrations would be unlikely to be significant. In additional, drainage controls would be in place. Nevertheless, any uncontrolled discharges to the marine environment in the vicinity of Sizewell could affect water quality leading to indirect effects on designated habitats along the Minsmere-Walberswick frontage. Therefore, a LSE cannot be excluded at this stage.

f. Water quality effects – terrestrial environment: There are direct hydrological connections between the Sizewell development area and Minsmere–Walberswick (south of the Minsmere New Cut) through the Minsmere Sluice. The refurbished sluice prevents the ingress of water from the Leiston Drain system into the Minsmere New Cut and Scott's Hall Drain and vice versa. Although it is possible that water could move upstream through the syphon into Scott's Hall Drain if the penstock was open, this could only occur if the seaward end of the culverts was to become blocked and the penstock on Scott's Hall Drain was opened. This means that although there is a potential mechanism for water that enters the sluice chamber to pass upstream into the Scott's Hall Drain, this mechanism is reliant on head differences that are unlikely to occur under normal flow conditions. Even under such extreme conditions, which would occur rarely, if at all, there would be no passage of water from Leiston Drain to Scott's Hall Drain unless the penstock to Scott's Hall Drain is open. If it were to be open, it could be closed to prevent this occurring. This means that the potential for measurable hydrological impact on either side of the sluice is minimal. Although the form and operation of the sluice make changes unlikely, any increase in water levels at Minsmere sluice could potentially affect surface water levels to the north. As such, discharges into watercourses within the development area, or changes in water levels/flow/ditch alignment/sedimentation rates within the watercourses, could have a direct effect upon water quality in Minsmere south or Minsmere north levels. Therefore, a LSE cannot be excluded at this stage. Note: it is assumed that all foul wastewater would be treated in package sewage works and discharged to sea. All other wastewater streams would be treated in water management zones and discharged at greenfield rates to ground or surface water (details to be provided). Runoff from areas that present a hydrocarbon risk would be passed through an interceptor, as necessary, before discharge. During the operational phase it is assumed that all waste water streams would be treated and discharged to sea.

g. Water quality effects – terrestrial environment: Any construction activity that interrupts or alters the baseline groundwater regime (e.g. the presence of the proposed cut-off wall around the main site excavations, or reduced rainfall infiltration rates into the soil within the construction area due to the development) could potentially change the hydrological or hydrogeological properties of the site and adjacent land and, in turn, the conditions that support wetland habitat. Therefore, a LSE cannot be excluded at this stage.

h. Alteration of local hydrology and hydrogeology: Any permanent development that interrupts or alters the baseline hydrological or hydrogeological regime (e.g. the presence of the proposed cut-off wall around the nuclear and conventional islands) potentially could change the hydrological or hydrogeological properties of the site and adjacent land and, in turn, the conditions that support wetland habitat. However, the groundwater conceptualisation study, which has been carried out on a precautionary, 'without mitigation' basis (other than use of the cut-off wall itself), indicates that there is only localised and limited potential for effects on groundwater levels in the vicinity of the site. Therefore, a LSE cannot be excluded at this stage.

i. Changes in air quality: Changes in air quality would not have a direct effect upon Ramsar qualifying features but could cause effects via changes to vegetation (composition and structure) within the habitats upon which the qualifying features depend. Any significant change in air quality is likely to be confined to the immediate vicinity of the proposed nuclear power station as concentrations of potential pollutants would rapidly diminish away from source. However, on a precautionary basis, potential changes in air quality from combustion sources (e.g. diesel generators) during the construction/ decommissioning and operational phases are considered to potentially affect vegetation communities within 10km of the Sizewell C development site. Therefore, LSE cannot be excluded.

j. Radiological effects: Potential radiological effects resulting from construction and decommissioning activities relate to the disturbance of any existing (baseline) radiological contamination associated with soils, sediment and water. Detailed radiological analysis has confirmed that background levels around the Sizewell C main development site are negligible and consistent with the results of long-term operator monitoring which is subject to Environment Agency surveillance. The results are also consistent with other monitoring programmes such as the annual RIFE surveys compiled from monitoring undertaken around all nuclear sites in the UK by the FSA and national environmental agencies. In addition, there is no evidence from desk studies to suggest that associated development sites are contaminated. Therefore, any disturbance associated with construction or decommissioning would not give rise to a LSE. Note that commissioning impacts are covered under 'Operations', since fuelling of the nuclear power station marks the start of the operational phase.

k. Radiological effects: The commissioning and operation of Sizewell C would result in limited radioactive discharges to air and the marine environment. These discharges will be regulated by the Environment Agency under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016.

The impacts of liquid and gaseous radiological discharges into the environment on non-human biota are considered to be trivial. This is based on three primary existing sources of evidence:

• The assessment carried out under the Generic Design Assessment (GDA) process for the UK EPR showed that for a generic single-reactor site the impact of radioactive discharges on non-human species was well below the Environment Agency's screening levels. This was validated by the Environment Agency's own assessment concluding that "the maximum predicted gaseous releases and aqueous discharges for a UK EPR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative". EDF Energy would expect the site-specific assessment for the proposed twin reactor development at Sizewell C not to exceed relevant screening levels.
• The Environment Agency's Appropriate Assessment undertaken for EDF Energy's development at Hinkley Point C in Somerset concluded that "the assessed dose rates to all reference organisms from discharges from all three power stations at Hinkley Point were over 4000 times below the levels that would trigger further consideration of total impact on the Severn Estuary habitats and species" and the "the impact of radionuclide discharges from the proposed Hinkley Point C power station alone and cumulatively with similar discharges from the other power stations at Hinkley Point can be regarded as trivial". This assessment, which was for a twin reactor as is proposed at Sizewell C, builds confidence to the GDA generic site assessment providing a reasonable envelope for the other sites, although it is acknowledged that the receiving environments are different.
• The Environment Agency's habitats assessment of radiological substances to all Natura 2000 sites, undertaken in 2009, calculated dose rates for organisms in coastal, freshwater and terrestrial environments. These radioactive substance habitats assessments considered the combined impact of discharges from current permitted disposals and have cautiously assumed that discharges occur at the permit limits. For those Natura 2000 sites assessed in the vicinity of the proposed development (i.e. all apart from the Outer Thames Estuary SPA which was not designated until 2010 and the Southern North Sea SAC, recommended in 2017) all were well below the regulatory screening level. It is recognised that the new proposed development would add marginally to the in-combination impact, as such the site-specific assessment will consider such combined effects from Sizewell B nuclear power station.
• Radiological assessment studies have indicated that the potential dose rates to birds and supporting functional components of habitats from liquid and gaseous radiological discharges would be below threshold levels during the operational phase. As such, it is considered that SPA qualifying features would be unaffected. In addition, a site-specific non-human biota assessment of representative habitats and species will be undertaken as part of EDF Energy's application under the Radioactive Substances Regulations, Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016. It is therefore considered that discharges associated with the operational phase would not give rise to a LSE.

l. Direct habitat loss and fragmentation: No discernible impact pathway is evident.

m. Direct habitat loss and fragmentation: Loss of habitats within the footprint of the Sizewell C Main Development Site may affect the overall habitat resource available to mobile populations, e.g. birds from adjacent designated sites, notably Minsmere-Walberswick SPA / Ramsar and potentially Sandlings

SPA. While there may not be any direct impact on habitat extent within designated sites, the loss and fragmentation of supporting habitats off-site may adversely affect designated populations. Therefore, a LSE cannot be excluded at this stage.

n. Direct habitat loss and fragmentation: Preparation of the Beach Landing Facility may require limited sediment clearance onshore and dredging along navigational access routes. While this activity is only expected to be short term and to occur very occasionally (such as once every five to ten years) throughout the operational period, it could temporarily disturb supporting habitat. It is noted that the dredged channels will be reinstated as soon as their short-term use is complete. Therefore, a LSE cannot be excluded at this stage.

o. Direct habitat loss and fragmentation: The loss of habitat within the footprint of the Sizewell C development during operation may affect those qualifying features that rely upon supporting habitats outside the Ramsar site. Therefore, LSE cannot be excluded for those qualifying features that may use the affected habitat-types and which may rely upon supporting habitats outside the Ramsar site.

p. Disturbance effects on species populations: No discernible impact pathway is evident.

q. Disturbance effects on species populations: Within the terrestrial environment construction activities may have a direct disturbance effect on birds utilising habitats within the vicinity of the works, potentially leading to displacement. The likelihood of effects arising will diminish with distance away from the construction site and, therefore, impacts will be more likely to arise for those bird species that utilise habitats in relative proximity to the development site (e.g. within Minsmere south levels). Therefore, a LSE cannot be excluded at this stage.

r. Disturbance effects on species populations: The effects of operational activities (e.g. noise, lighting, traffic) may have a direct disturbance effect on birds utilising habitats within the vicinity of the power station, potentially leading to displacement. Habitat fragmentation effects may also still be present. The likelihood of effects arising will diminish with distance from the development and therefore impacts will be more likely to arise for those bird species that utilise habitats in proximity to the site. Therefore, a LSE cannot be excluded at this stage.

s. Disturbance due to increase in recreational pressure: Minsmere to Walberswick Ramsar site includes many well used and managed sites for recreational activities, such as: Minsmere RSPB Reserve, Dunwich Heath (owned and managed by the National Trust) and Westleton Heath, to the south of Dunwich Forest (not itself part of the European site), and Walberswick National Nature Reserve (incorporating Westwood Marshes and Walberswick Common), Dingle Marshes Nature Reserve and Bullcamp Marshes, to the north. Many of these areas, in particular the coastal frontage/beach at Dunwich and Walberswick, are already subject to intense visitor use. Additional visitors to these locations resulting from the Sizewell C Project would be expected to follow similar behaviours to existing visitors and use the defined path networks/accessible beaches. Measures would be put in place to help manage any potential increase in visitor numbers and, as such, significant adverse effects are not predicted. However, because mitigation measures cannot be taken into account at the LSE screening stage, LSE cannot be excluded.

t. Physical interaction between species and project infrastructure: Direct effects of the project infrastructure on SPA qualifying features (e.g. via collisions) are highly unlikely, as are indirect effects to qualifying features (e.g. via effects on prey species) within terrestrial habitats. Therefore, no discernible impact pathway is apparent.

u. In combination effects: The LSIE screening exercise has identified at least one other plan or project that could act in combination with the Sizewell C Project to potentially result is LSIE.

NOT PROTECTIVELY MARKED

Appendix B SPA colony information and predicted/mean foraging ranges

Predicted foraging ranges are the maximum foraging ranges of each species (see Table 40). Where impacts have the potential to effect designated species with restricted foraging ranges, for example around breeding colonies (i.e. little terns), the zone of influence of the impact is intersected with the predicted foraging range within the designated sites. Given that areas of concentrated foraging activity are likely to occur closer to the colony, the potential effect areas are also considered in relation to defined areas that are equivalent to the mean foraging range for the species (apart from little terns) (see Table 40).

Table 44: SPA colony information and foraging ranges.

SPA	Species, presence	Predicted and mean foraging ranges	Colony Information
Minsmere to Walberswick, Alde-Ore Estuary and Outer Thames Estuary	Breeding Little Tern (May to August)	2.4 km offshore, 3.9 km north and south (Parsons *et al.*, 2015)	1. Minsmere beach (O.S Grid Reference TM 477 666) 2. Dingle marshes (O.S. Grid Reference TM 489 733) 3. Slaughden beach (O.S. Grid Reference TM 463 550) (Arcadis, 2013. Pers Communication with Philip Peason of the Suffolk Little Tern Group)
Alde-Ore Estuary	Breeding Sandwich Tern (April to August)	32 km radius (predicted) 11.5 km radius (mean) (Wilson *et al.*, 2014)	1. Minsmere beach (O.S Grid Reference TM 477 666) 2. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) 3. Slaughden beach (O.S. Grid Reference TM 463 550) (Suffolk Birds' Reports - Suffolk Naturalists Society 2004 to 2010-2013) (Amec Seabird report 2011-2012), (Hyder 2013 Little Tern survey report)
Alde-Ore Estuary	Breeding Lesser black-backed gull (April to August)	141 km radius (predicted) 72 km radius (mean) (Thaxter *et al.*, 2012)	1. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) (Natural England, Alde-Ore Estuary Site Improvement Plan)
Outer Thames Estuary	Over wintering Red Throated dive September to March	Whole of SPA	Does not breed in this region.

Outer Thames Estuary	Breeding Common Tern (May to August)	18.6 km radius (predicted) 4.5 km radius (mean) (Wilson *et al.*, 2014)	1. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) 2. Minsmere scrape (O.S Grid Reference TM 475 667) (Arcadis, 2013. Pers Communication with RSPB), (Hyder 2013 Little Tern survey report)

Appendix C 98th percentile uplift plume area intersected with the relevant foraging area during the time period when the birds are designated at Sizewell

For the relevant SPA designated bird features that forage for marine prey from terrestrial breeding colonies or in the Outer Thames Estuary SPA, the surface thermal plume (exceeding habitat temperature 3 ºC uplift standard from the 98th percentile modelled plume intersects (worst-case) with the individual species foraging ranges are shown in Figure 35 and Figure 36.

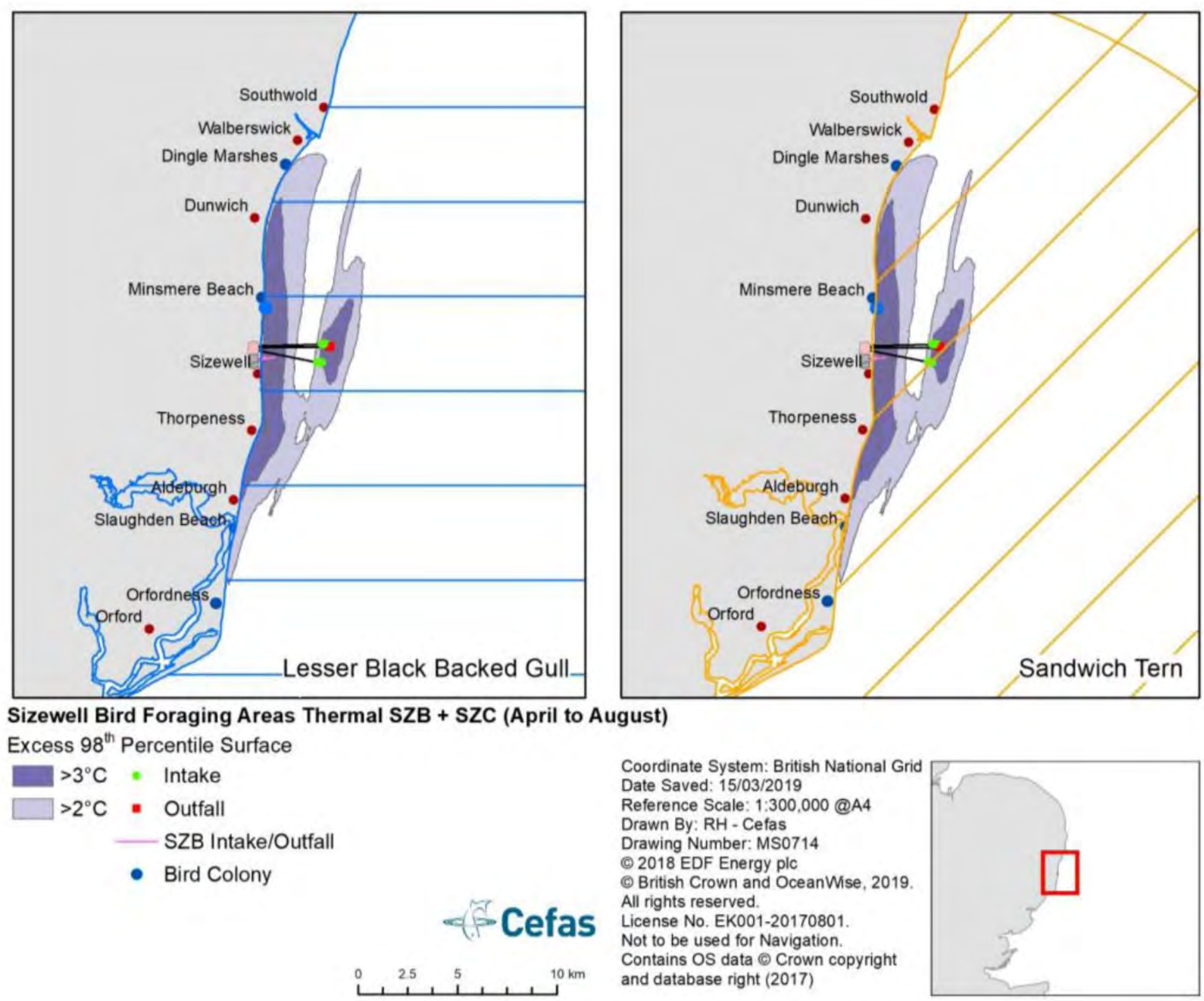

Figure 35: 98th percentile of excess surface water temperature showing >2 and >3 °C for run with SZB and SZC operating for Sandwich Tern and Lesser Black-Backed Gull breeding season (April to August).

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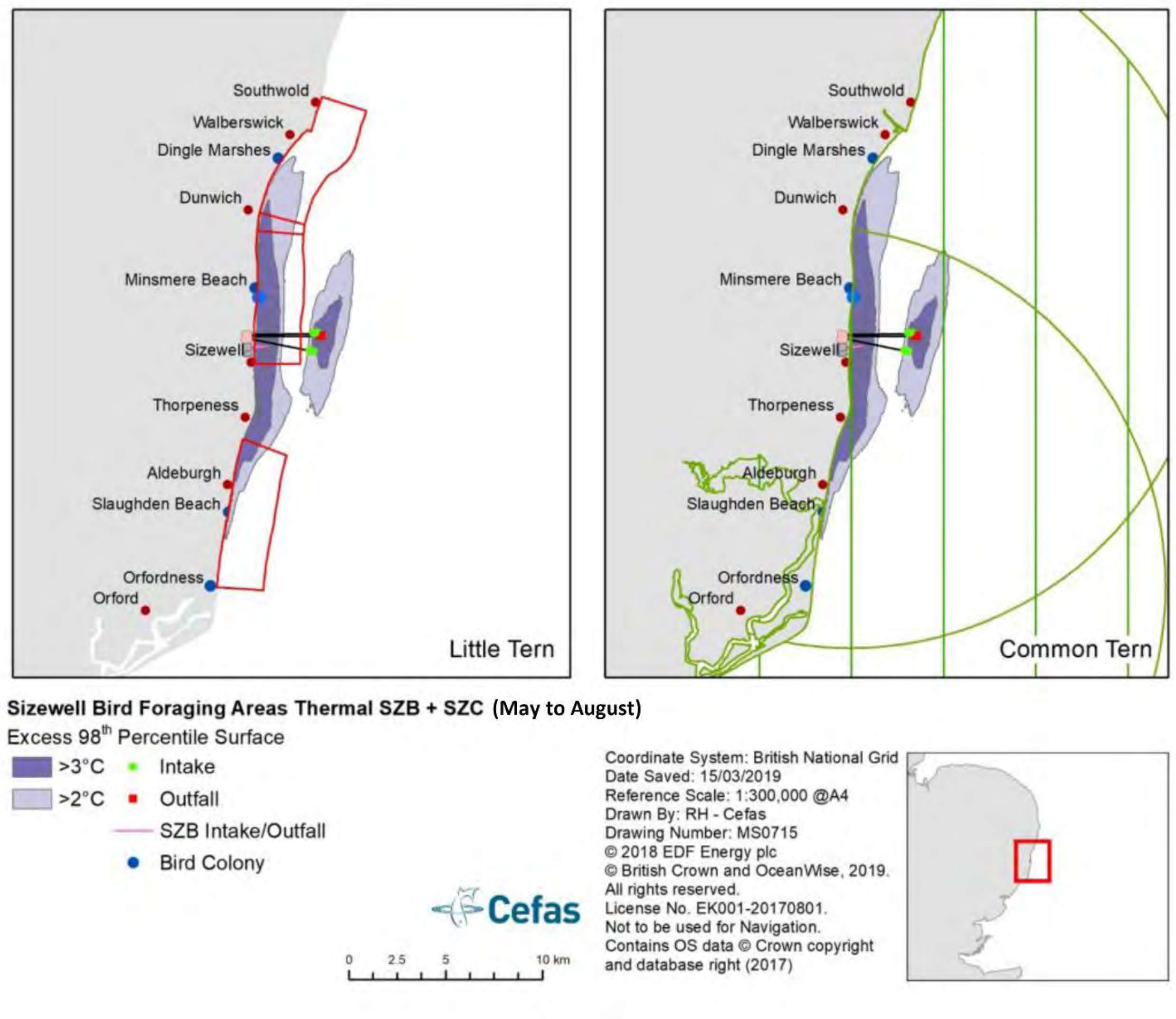

Figure 36: 98th percentile of excess surface water temperature showing >2 and >3 °C for run with SZB and SZC operating for Little Tern and Common Tern breeding season (May to August).

Appendix D Instantaneous area intersections of the 2 °C and 3 °C thermal uplift with the individual breeding little tern foraging areas during May to August

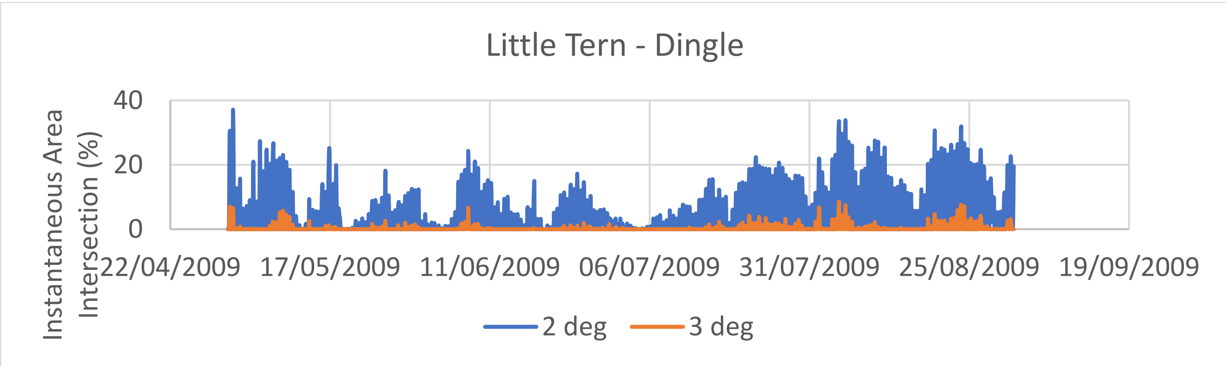

Figure 37: Instantaneous area intersections of the 2 °C and 3 °C thermal uplift with the Dingle Marshes breeding little tern foraging area during May to August.

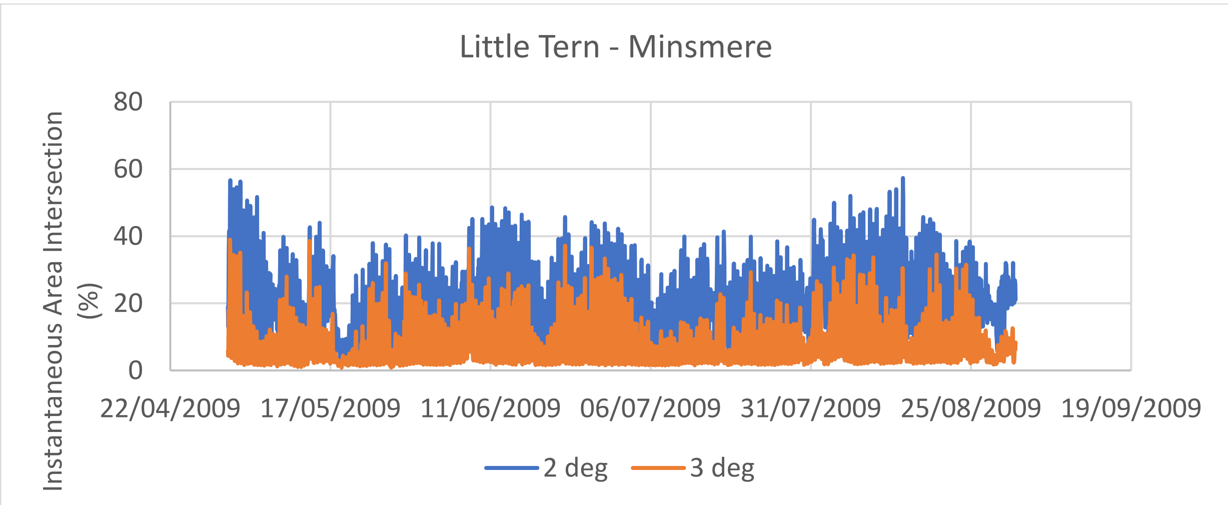

Figure 38: Instantaneous area intersections of the 2 °C and 3 °C thermal uplift with the Minsmere Beach breeding little tern foraging area during May to August.

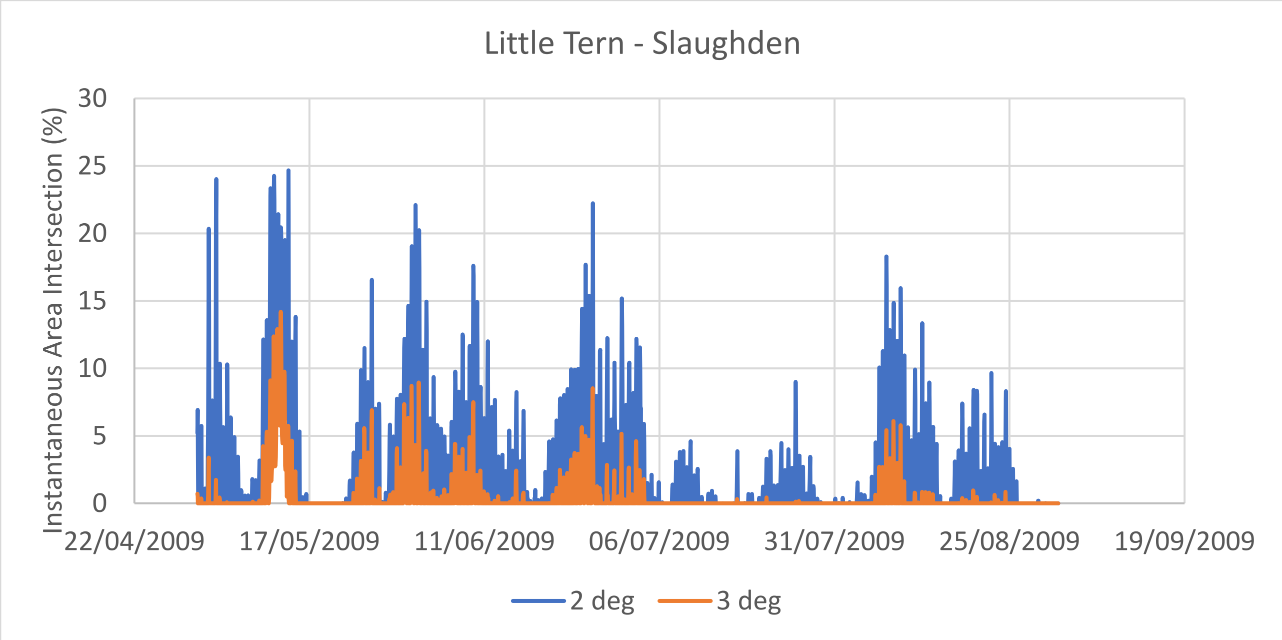

Figure 39: Instantaneous area intersections of the 2 ˚C and 3 ˚C thermal uplift with the Slaughden Beach breeding little tern foraging area during May to August.

Appendix E Designated bird foraging areas and intersections with dredge noise contours.

Dredging noise 135 dB ‘behavioural response’ ranges for various dredge activities are provided.

No intersection occurs between the little tern colonies at Dingle or Slaughden. In the case on common terns the effect ranges fall entirely within both colonies. The percentage foraging area represents the Minsmere colony as the shape of the foraging area relative to the coast causes this calculation to have a marginally larger percentage.

Table 45: Little tern predicted foraging areas intersected by dredging noise 135 dB contour.

Dredge scenario	Designated species	Colony	Intersect area (ha)	Percentage of predicted foraging area (%)
BLF	Little tern	Minsmere	669.0	37.0
CDO	Little tern	Minsmere	628.4	34.7
FRR 1	Little tern	Minsmere	612.0	33.8
FRR 2	Little tern	Minsmere	632.0	34.9
North CW intake	Little tern	Minsmere	126.7	7.0
CW Outfall	Little tern	Minsmere	86.6	4.8
South Intake	Little tern	Minsmere	114.5	6.3

Table 46: Common tern predicted foraging areas intersected by dredging noise 135 dB contour.

Dredge scenario	Designated species	Colony	Intersect area (ha)	Percentage of predicted foraging area (%)
BLF	Common tern	Minsmere Orfordness	675.7	1.3
CDO	Common tern	Minsmere	633.1	1.2

		Orfordness		
FRR 1	Common tern	Minsmere Orfordness	670.6	1.3
FRR 2	Common tern	Minsmere Orfordness	641.8	1.3
North CW intake	Common tern	Minsmere Orfordness	1155.4	2.3
CW Outfall	Common tern	Minsmere Orfordness	1190.7	2.3
South Intake	Common tern	Minsmere Orfordness	1188.8	2.3

Table 47: Sandwich tern predicted foraging areas intersected by dredging noise 135 dB contour.

Dredge scenario	Designated species	Intersect area (ha)	Percentage of predicted foraging area (%)
BLF	Sandwich tern	675.7	0.4
CDO	Sandwich tern	633.1	0.4
FRR 1	Sandwich tern	670.6	0.4
FRR 2	Sandwich tern	641.8	0.4
North CW intake	Sandwich tern	1155.4	0.7
CW Outfall	Sandwich tern	1190.7	0.7
South Intake	Sandwich tern	1188.8	0.7

Table 48: Lesser lack backed gull predicted foraging areas intersected by dredging noise 135 dB contour.

Dredge scenario	Designated species	Intersect area (ha)	Percentage of predicted foraging area (%)
BLF	Lesser black backed gull	675.7	0.02
CDO	Lesser black backed gull	633.1	0.02
FRR 1	Lesser black backed gull	670.6	0.02
FRR 2	Lesser black backed gull	641.8	0.02
North CW intake	Lesser black backed gull	1155.4	0.03
CW Outfall	Lesser black backed gull	1190.7	0.03
South Intake	Lesser black backed gull	1188.8	0.03