APPENDIX C – INFORMATION FOR THE HABITATS REGULATIONS ASSESSMENT - 100232391

CONTENTS

1 INTRODUCTION 9

2 DESCRIPTION OF WATER DISCHARGE ACTIVITIES 11

2.1 Introduction 11

2.2 Main development site 11

2.3 Cooling water system 14

2.4 Fish recovery and return system 17

2.5 Commissioning 17

2.6 Summary of source terms used for the assessment of water quality effects 18

3 THE HABITATS REGULATIONS ASSESSMENT PROCESS 21

3.1 Introduction 21

3.2 A four-stage approach 22

3.3 Stage 1 LSE Screening 23

3.4 Stage 2 Appropriate Assessment 24

3.5 Stages 3 and 4 29

4 EUROPEAN SITE SCOPING 30

5 SCREENING OF POTENTIAL EFFECTS 44

5.1 Determination of LSE 44

5.2 Effect pathways 46

5.3 Screening for LSE 48

5.4 Findings of the alone Stage 1 screening exercise 70

5.5 Screening of in-combination effects 70

6 DESCRIPTION OF BASELINE CONDITIONS 72

6.1 Introduction 72

6.2 Coastal habitats 72

6.3 Birds 79

6.4 Marine mammals 125

6.5 Fish population 141

7 INFORMATION FOR APPROPRIATE ASSESSMENT: COASTAL HABITATS 146
7.1 Introduction 146
7.2 Conservation Objectives 146
7.3 Assessment of potential effects (alone) 147
7.4 Assessment of potential effects (in-combination) 155

8 INFORMATION FOR APPROPRIATE ASSESSMENT: BIRDS 158
8.2 Conservation objectives 158
8.3 Summary of the outcomes of Screening 159
8.4 Assessment of effects: Alde-Ore Estuary SPA and Ramsar site 160
8.5 Assessment of effects: Benacre to East Bavents SPA 178
8.6 Assessment of effects: Minsmere-Walberswick SPA and Ramsar site 178
8.7 Minsmere-Walberswick Ramsar site 181
8.8 Assessment of effects: Outer Thames Estuary SPA 181
8.9 Assessment of potential effects (in-combination) 191

9 INFORMATION FOR APPROPRIATE ASSESSMENT: MARINE MAMMALS 196
9.1 Introduction 196
9.2 Conservation Objectives 196
9.3 Summary of the outcomes of Screening 204
9.4 Assessment of potential effects (alone) 204
9.5 Assessment of potential effects (in-combination) 211
9.6 Conclusions 216

10 CONCLUSION 218
10.1 Background 218
10.2 LSE screening 218
10.3 Stage 2 Appropriate Assessment: Coastal habitats 219
10.4 Stage 2 Appropriate Assessment: Birds 219
10.5 Stage 2 Appropriate Assessment: Marine mammals 220
10.6 Mitigation 221

REFERENCES 224

TABLES

Table 2.1 Proposed waste streams 16

Table 2.2 Summary of source terms used to inform the WFD compliance assessment for the operation of the power station 18

Table 4.1 Description of European sites scoped into the Operational WDA Shadow HRA and their qualifying interest features 33

Table 5.1 Absolute areas exceeding the EQS/PNEC values at the surface and seabed from TRO, bromoform and hydrazine discharges (Ref. 2.2) 52

Table 5.2: Pressures associated with discharges from the FRR 54

Table 5.3 Determination of European sites and habitat qualifying features where the potential for LSE exists 55

Table 5.4 Determination of European sites and habitat qualifying features where the potential for LSE exists 61

Table 5.5 Determination of European sites and habitat qualifying features where the potential for LSE exists 69

Table 6.1: Population estimates for the qualifying features of the Alde-Ore Estuary SPA, as determined at (or near) the time of citation and from the most recently available data 80

Table 6.2 Sandwich tern breeding numbers (expressed as occupied nests) and productivity at Havergate Island, 1993-2009; no breeding pairs have been recorded since 2009 85

Table 6.3: Population estimates for the Benacre to Easton Bavents SPA breeding little tern population, as determined at citation and from the most recently available data (Ref. 6.39) 96

Table 6.4: Population estimates for the Minsmere-Walberswick SPA breeding little tern population, as determined at citation and from the most recently available data (Ref. 6.40) 97

Table 6.5 Breeding little tern population estimates at coastal SPAs for which the Outer Thames Estuary SPA provides supporting habitat, as determined at (or near) the time of citation and designation of the SPA (bold indicates SPAs ‘screened into’ the current assessment) 106

Table 6.6: Breeding common tern populations at coastal SPAs for which Outer Thames Estuary SPA provides important supporting habitat (bold indicates SPAs ‘screened into’ the current assessment) 112

Table 6.7: Distribution of red-throated diver records across the 12 VPs used in surveys from March 2011 – April 2012 (see Figure 6.1 for VP locations) 120

Table 6.8: Peak and mean numbers of red-throated diver recorded at each of the 15 VPs used in the 2012-13 and 2013-14 winter surveys 123

Table 6.9 Reference populations and density estimates to inform the appropriate assessment for marine mammals 141

Table 8.1:The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for April to August with the percentage overlap with the predicted foraging range of the SPA Sandwich tern population 165

Table 8.2: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for April to August, with the percentage overlap with the predicted foraging range of the SPA lesser black-backed gull population 177

Table 8.3: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for May to August, with the percentage overlap with the predicted foraging ranges of the Orfordness and Minsmere common tern colonies 186

Table 8.4: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for September to March with the percentage overlap with the Outer Thames Estuary SPA. 190

Table 8.5: In-combination assessment of plans and projects with the potential to affect marine bird qualifying features of designated sites 192

Table 9.1 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for the Humber Estuary SAC 196

Table 9.2 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for the Southern North Sea SAC 202

Table 9.3 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for The Wash and North Norfolk Coast SAC 203

Table 9.4 Summary of effects with potential for LSE for marine mammals (alone) (✓ = LSE, x = no LSE) 204

Table 9.5 In-combination assessment of screened in plans and projects with the potential to affect designated marine mammal species through changes to water quality 212

Table 9.6 Summary of the assessment of potential effects on the Humber Estuary SAC in relation to grey seal 216

Table 9.7 Summary of the assessment of the potential effects on the Southern North Sea SAC in relation to harbour porpoise 216

Table 9.8 Summary of the assessment of the potential effects on The Wash and North Norfolk Coast SAC in relation to harbour seal 217

Table 10.1: Schedule of mitigation measures, timing and securing permissions relevant to the HRA 222

PLATES

Plate 6.1: Flight lines and areas of concentrated foraging activity around Slaughden little tern colony during surveys in June 2011 (Ref. 6.18) 82

Plate 6.2: Flight lines and areas of concentrated foraging activity around Slaughden little tern colony during VP surveys in May – August 2013 (Ref. 6.19) 83

Plate 6.3: Flight lines and foraging areas of Sandwich terns during vantage point surveys in April 2011 – April 2012 (Ref. 6.18); note extends over three pages 87

Plate 6.4: Flight lines and foraging areas of Sandwich terns during vantage point surveys at VPs 1 – 6 and 13 – 15 in 2013 (Ref. 6.19); note extends over two pages 90

Plate 6.5: Trends in the annual number of occupied lesser black-backed gull nests / territories estimated at the Orford Ness colony (blue line) and the Havergate Island colony (orange line) (Ref. 6.16) 94

Plate 6.6: Flight lines of little terns from VP surveys at Sizewell, May - July 2010 (Ref. 6.43) 100

Plate 6.7: Flight lines and areas of concentrated foraging activity around Dingle little tern colony during colony surveys in May – August 2011 (Ref. 6.18) 102

Plate 6.8: Flight lines and areas of concentrated foraging activity around Minsmere little tern colony during colony surveys in May – August 2011 (Ref. 6.18) 103

Plate 6.9: Flight lines and foraging areas of little terns recorded within the likely foraging range of the Minsmere-Walberswick SPA during vantage point surveys in 2013 (Ref. 6.19) 104

Plate 6.10: Flight lines and areas of concentrated foraging activity of little terns during vantage point surveys (VPs 1 – 5) in May – June 2011 (Ref. 6.18); note extends over three pages 108

Plate 6.11: Flight lines and areas of concentrated foraging activity of common terns during vantage point surveys (VPs 1 – 5) in April 2011 – April 2012 (Ref. 6.18); note extends over three pages 113

Plate 6.12: Main foraging areas of common terns identified during vantage point surveys, March – August 2013 (Ref. 6.19) 117

Plate 6.13: Peak numbers of foraging and loafing red-throated divers in each 1 km square, VPs 1 - 6, March 2011 to April 2012; note extends over two pages 121

Plate 6.14 Locations of the main grey seal breeding sites around the UK (taken from Ref. 6.60); the approximate location of the Sizewell C main development site is indicated by the green circle 127

Plate 6.15 Tagged grey seal movements along the east coast of England (Ref. 4.2) 129

Plate 6.16 Survey blocks covered by SCANS-III and adjacent surveys (Ref. 6.76) 132

Plate 6.17 Distribution of harbour porpoise based on predicted JCP harbour porpoise densities (animals/km^2) for winter 2010 (Ref. 6.77); the approximate location of the Sizewell C main development site is indicated by the red dot . 133

Plate 6.18 Persistent high-density areas identified in the North Sea MU during the summer months; the red colours mark areas where persistent high densities, as defined by the upper 90th percentile, have been identified and the approximate location of the Sizewell C main development site is indicated by the blue dot (Ref. 6.78) 134

Plate 6.19 [Left] Telemetry tracks by deployment region for harbour seals aged one year or over between 2001 and 2012 (Ref. 4.4); [Right] Harbour seal telemetry tracks from Marsh End Sand (blue) and Margate Sands (red) (Ref. 4.5) 138

Plate 6.20 Major harbour seal foraging areas in the Thames Estuary, calculated when slow-at-sea kernel function was greater than 181 km^2; the major foraging areas are - north east Buxey Sand (1), Whitaker Channel (2), West Swin Channel (3), north Yantlet Flats (4) and south Marsh End Sand (5), Ref. 4.5 139

Plate 6.21 Location of the major harbour seal haul-out sites and the populations around the UK coasts (Ref. 6.60); the location of the Sizewell C main development site is indicated by the green circle 140

Plate 8.1: 2°C and 3°C uplifts (as a 98th percentile) of sea surface temperatures for Sizewell B together with Sizewell C for April to August, in relation to the

breeding colony locations and partially shown predicted foraging ranges for the Alde-Ore Estuary SPA lesser black-backed gull and Sandwich tern populations 163

Plate 8.2: Instantaneous area of overlap of the SPA Sandwich tern foraging range with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for April to August 164

Plate 8.3: TRO concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA) 169

Plate 8.4: Bromoform concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA) 170

Plate 8.5: Hydrazine concentration at the sea surface (ng/l as a 95th percentile) after release of 69 ng/l from Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA)..... 171

Plate 8.6: The 2°C and 3°C uplifts (as a 98th percentile) for sea surface temperatures for Sizewell B together with Sizewell C for May to August, in relation to the breeding colony locations and predicted foraging ranges for little tern associated with the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs and for common tern associated with the Outer Thames Estuary SPA 173

Plate 8.7: Instantaneous area of overlap of the SPA lesser black-backed gull marine foraging range with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for April to August 176

Plate 8.8: Instantaneous area of overlap of the Minsmere (upper) and Orfordness (lower) common tern colony foraging ranges with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for May to August 185

Plate 8.9: Instantaneous area of overlap of the Outer Thames Estuary SPA with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for September to March..... 190

1 INTRODUCTION

1.1.1. SZC Co.[1] is proposing to build and operate a new nuclear power station comprising two UK European Pressurised Reactors™ (EPRs) at Sizewell in Suffolk, north of the existing Sizewell B power station: 'the Sizewell C Project' (described in **Chapter 2**). Given the proximity of the Sizewell C Project to sites of European and international importance for nature conservation, it has been determined that it has the potential to affect one or more such sites. SZC Co. is, therefore, required to provide information to allow Habitats Regulations Assessment (HRA) to be undertaken by the competent authority in support of its application for a Water Discharge Activity (WDA) permit under the Environmental Permitting (England and Wales) Regulations 2016.

1.1.2. HRA is a requirement under the Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (described in **Chapter 3**) where a project could affect sites and species designated for their nature conversation importance.

1.1.3. This report, referred to as a 'Shadow HRA', has been produced to facilitate consultation with the Environment Agency, the 'competent authority' under the Habitats Regulations in this case, on the information required to enable it to undertake an 'Appropriate Assessment (AA)' of the operational phase[2] water discharge activities proposed for the Sizewell C Project.

1.1.4. A separate Shadow HRA report has been produced specifically in support of a Combustion Activity Permit application to the Environment Agency and another will be produced in support of the Development Consent Order (DCO) application to the Planning Inspectorate. This latter Shadow HRA report will consider the Sizewell C Project as a whole (including its discharges to air and water), by contrast to those produced in support of the Environmental Permits, which just focus on the activities that are the subject of the permit applications.

1.1.5. The commissioning and operation of Sizewell C would result in limited radioactive discharges to the marine environment. Radionuclide discharges associated with the operational phase will be assessed in the overarching Shadow HRA Report to be produced in support of the DCO. A site-specific

[1] The Operator of the water discharge activity will be NNB Generation Company (SZC) Limited, hereafter referred to as SZC Co., which is a wholly owned subsidiary of NNB Holding Company (SZC) Limited which in turn is 80% owned by EDF Energy Holdings Limited and 20% owned by General Nuclear International Limited.
[2] Additional Environmental Permits will be required for certain activities during the construction phase.

non-human biota assessment of representative habitats and species is being undertaken as part of SZC Co.'s application to the Environment Agency for an Environmental Permit under Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2016.

1.1.6. A Shadow HRA screening report was prepared and submitted to SZC Co.'s HRA Working Group (the Environment Agency, Natural England, the Marine Management Organisation (MMO), Suffolk Coastal District Council (now East Suffolk Council), Suffolk County Council, the Suffolk Wildlife Trust and the Royal Society for the Protection of Birds (RSPB)) for consultation in January 2019. This presented the outcome of the initial screening process for 'likely significant effects' (LSE) on all European sites 'scoped in' to the HRA process for the Sizewell C Project as a whole (i.e. all relevant activities, see **Chapter 4**).

1.1.7. This report provides the following:

- an overview of the Sizewell C Project with a more detailed summary of the water discharge activities covered by the operational WDA permit in **Chapter 2**;
- a description of the HRA process (**Chapter 3**);
- the findings of the European site scoping stage and summary information on the European sites taken through into the screening stage (**Chapter 4**);
- the findings of the LSE screening stage for the WDA of the Project alone and in-combination with other plans and projects (**Chapter 5**);
- a description of baseline environment that is relevant to the operational phase WDA appropriate assessment (**Chapter 6**);
- information for Appropriate Assessment – coastal habitats (**Chapter 7**), birds (**Chapter 8**) and marine mammals (**Chapter 9**);
- conclusions (**Chapter 10**); and,
- references and appendices.

1.1.8. The appendices include Figures (**Appendix A**) and the outcomes of scoping/screening other plans and projects for in-combination assessment (**Appendix B**).

2 DESCRIPTION OF WATER DISCHARGE ACTIVITIES

2.1 Introduction

2.1.1. The Sizewell C main development site is located on the Suffolk Coast, approximately half way between Felixstowe and Lowestoft, to the north-east of the town of Leiston (see **Figure 2.1**). It would comprise two UK EPR™ units together with associated infrastructure and facilities.

2.1.2. The Sizewell C main development site covers up to approximately 350 hectares (ha), of which approximately 35 ha would be occupied permanently by the new power station. Most of the rest of the site would only be needed temporarily for construction purposes and would be restored in accordance with the operational masterplan and the Outline Landscape and Ecology Management Plan once the new power station has been developed. A full description of the Sizewell C Project is provided in **Volume 1**, **Chapter 2** of the **Environmental Statement** (ES).

2.1.3. This section provides a high-level overview of the main development site of the Sizewell C Project, and a more detailed description of the infrastructure and activities that are required for the operational WDA permit.

2.2 Main development site

i. Introduction

2.2.1. A full description of the main development site is provided in **Volume 1, Chapter 2** of the **ES**, a summary of which is provided below.

2.2.2. The main development site comprises five components:

- Main platform - the area that would become the power station itself.
- Sizewell B relocated facilities and National Grid land - the area that certain Sizewell B facilities would be moved to in order to release other land for the proposed development and land required for the National Grid infrastructure.
- Temporary Construction Area - the area located primarily to the north and west of the proposed Sizewell Marshes Site of Special Scientific Interest (SSSI) crossing, which would support construction activity on the main platform.

- Land East of Eastlands Industrial Estate (LEEIE) - the area including Sizewell Halt and the land directly north of King George's Avenue, which would be used to support construction on the main platform and temporary construction area.

2.2.3. Offshore works area - the area where offshore cooling water infrastructure and other marine works would be located.

ii. Overview of permanent development

2.2.4. The permanent development within the Sizewell C main development site would include the following key operational elements:

Nuclear islands

- Two nuclear islands, including two UK EPR™ reactor buildings and associated annexed buildings containing the safety systems, fuel handing systems and access facilities, together with the adjacent emergency diesel generator buildings.

Conventional islands

- Two conventional islands, each including a turbine hall and associated electrical buildings for the export and distribution of electrical power.

Operational building

- An operational service centre (a multi-purpose building), which allows for access into the Nuclear Islands, including storage areas, workshops, store rooms, laboratories, data centre, offices and associated support and welfare facilities, including the staff restaurant.

Cooling water pumphouses and associated buildings

- Two cooling water pumphouses with related infrastructure (one for each UK EPR™ reactor).

Ancillary buildings

- Plant, office/access, storage and fuel and waste management.
- A National Grid 400 kilovolt (kV) substation.
- Several relocated Sizewell B buildings, including the outage store, training centre and visitor centre.
- Associated buildings outside of the power station perimeter.

Marine works and associated infrastructure

- The cooling water system and combined drainage outfall in the North Sea. Within the UK EPR^{TM} reactors, the cooling water infrastructure is formed of three cooling systems: primary, secondary and open circuit systems. The open circuit cooling system would draw water directly from the sea, absorb heat from the secondary system in the condensers and other parallel heat exchanger systems and, after a single passage through these systems, the heated water would then be discharged back to the sea.

Other site structures, infrastructure and works, including highway works and earthworks

- Overhead power lines and pylons connecting the conventional islands to the National Grid substation.
- A relocated existing National Grid pylon and power line south of Sizewell C.
- A vehicular and pedestrian crossing over the Sizewell Marshes SSSI south of Goose Hill in the form of a culverted embankment.
- A BLF proposed for freight and Abnormal Indivisible Loads (AILs) arriving by sea.
- Several relocated Sizewell B facilities, including the outage laydown area, operational car parking and access roads and outage car parking and access roads.
- Diversion of rights of way, including Bridleway 19.
- The power station access road, linking the SSSI crossing with a new roundabout onto Abbey Road (B1122).
- Flood defences and coastal protection measures.
- Water supply and drainage measures.
- Landscape restoration works and planting.
- Fencing, lighting and other security provisions.
- New sports pitches located on existing playing fields at Alde Valley school in Leiston.

2.3 Cooling water system

2.3.1. A full description of the operational activities of the cooling water system is provided in **Volume 2, Chapter 4** of the **ES**, a summary of which is provided below.

a) 'Open circuit' cooling water

2.3.2. In its operational phase, Sizewell C would require a continuous supply of 132 m^3s^{-1} at mid-tide level of seawater (this will vary between 125–140 m^3/s) for cooling via two intake tunnels both greater than 3 km long to serve the steam turbine condensers and various auxiliary systems. After being used within the power station the seawater would then be discharged back to the Suffolk coast via a long outfall tunnel with a mean excess temperature of 11.6ºC above ambient background. In practice, both the temperature and volume would vary tidally due to the variable load on the cooling water pumps themselves; where pumping rates are reduced towards higher tidal levels, there would be a corresponding increase in discharge temperature.

2.3.3. Based on the risk of biofouling at Sizewell, chlorination of the cooling water system and critical plant would be required. Operational policy is to continuously dose during the growing season to achieve a minimum Total Residual Oxidant (TRO) dose of 0.2 mgl^{-1} in critical sections of the plant and at the inlet to the condensers. Testing of this system would be undertaken during commissioning but it is assumed that this would only occur once the full cooling water system is in place and operational.

2.3.4. The chlorination strategy is likely to be continuous dosing using an electrochlorination plant (rather than intermittent dosing) as part of waste stream. It is currently expected that the Sizewell C intake heads, tunnels and forebays would not be chlorinated; therefore, no chlorination of the Fish Recovery and Return (FRR) tunnels would occur. The expected discharges from the chlorination process include:

- residual oxidants in the form of free chlorine and chlorinated compounds; and
- trihalomethanes, which are present as bromoform.

2.3.5. For Sizewell C, the TRO concentration at the outfall would depend on the chlorination strategy applied within the power station. BEEMS Technical Report TR316 presents an analysis of the possible chlorination options for Sizewell C and a recommendation for a preferred strategy that is based upon minimising environmental effects whilst maintaining the safe operation of the plant (Ref. 2.1). Chlorination would only be undertaken when sea water temperatures are above 10ºC (i.e. typically only during the warmer months) and, therefore, the risk of biofouling is greater. However, if required, spot dosing at lower temperatures may also be undertaken.

2.3.6. Returned abstracted water would be the main waste stream from Sizewell C and would represent approximately 99.9% by volume of the total overall daily discharge of non-radioactive effluent.

b) Secondary cooling system

2.3.7. A small proportion of the condensed water is bled continuously from the secondary circuit and replaced with fresh demineralised water. This is to prevent saturation of the secondary circuit with dissolved salts and to prevent the formation of foams or solids in the system that would make it difficult to dry the steam before it enters the turbine, in order to prevent damage to the turbine. The water bled out of the system is known as 'blowdown' which is largely made up of demineralised feedwater.

2.3.8. The secondary circuit may also be dosed with hydrazine, morpholine and ethanolamine which would be added to prevent corrosion and control the pH in the secondary circuit. Hydrazine would be added, as it is a very effective oxygen scavenger and therefore prevents corrosion associated with oxidation of metals in the secondary circuit (i.e. rusting). During shutdown, hydrazine may also be used to condition the steam generators.

2.3.9. The blowdown water from the steam generators would be processed and treated to remove non-radioactive corrosion products and dissolved salts before the water is recycled in the secondary circuit. The non-recyclable blowdown effluent would be transferred to a separate system which monitors and further processes effluents where required, before discharge in the main cooling water outfall and out to sea.

c) Other waste streams

2.3.10. Several smaller waste streams would be combined with the returned abstracted cooling water before being discharged out to sea (detailed in **Table 2.1**). For example, process effluent would be produced from the removal waste from the plant systems and to maintain the best operating conditions and maximise efficiency. The lowest volume of water that would be abstracted under normal operating conditions is assumed to be 116 m^3s^{-1} and, for the purposes of this assessment, this is considered to represent the worst-case scenario in terms of the dilution of contaminants in the cooling water discharge. However, an assessment has also been undertaken on 50% of the maximum rate over 24 hours.

2.3.11. There may also be a requirement to discharge sediment due to periodic desilting of the forebays. Should desilting be required, the preferred option would be to return the sediment to the cooling water system for discharge back out to sea. Sewage would undergo tertiary treatment before being discharged.

Table 2.1 Proposed waste streams

Effluent Stream	Effluent Type	Brief Overview	Links to other streams
A	Trade – returned abstracted water	Return of abstracted cooling water, which will be characterised by thermal content and will be dosed with sodium hypochlorite after the pump house to prevent biofouling of the cooling water infrastructure. This will be the main discharge in terms of flow.	The cooling water supply from sea water abstraction receives discharges from **Stream E** at the forebay. A small flow from the abstracted sea water serves the FRRS and will be discharged through separate outfalls as **Stream H**
B	Trade – known volume	Trade effluent from operations within the nuclear island discharged on a batch basis to the outfall pond [HCA], excluding effluent from the Steam Generator Blowdown System.	Discharged with the significant flow of **Stream A** Receives discharges from the steam generator blowdown system– **Stream C.**
C	Trade – known volume	Trade effluent from the Steam Generator Blowdown System that cannot be recycled	Discharged with the significant flow of **Stream A** Discharged on a batch basis in admixture with **Stream B.**
D	Trade – known volume	Trade effluent from the Turbine Hall and uncontrolled area floor drains discharged on a batch basis to the outfall pond [HCA], excluding blowdown from the Steam Generator Blowdown System.	Discharged with the significant flow of **Stream A** Links to **Stream B** if further treatment is required.
E	Trade – known volume	Storm water run-off released from the site drainage network together with condensate from chiller. Discharged to the forebay.	Combines with the main cooling water of **Stream A** at the forebay and consequently a small proportion discharges to **Stream H**
F	Trade – known volume	Trade effluent from the production of demineralised water which will be treated to neutralise extremes of pH before joining the main discharge at the outfall pond [HCA].	Discharged with the significant flow of **Stream A**
G	Domestic sewage	Sanitary effluent from administration, catering and accommodation facilities, which will be treated in an appropriate effluent treatment plant before joining the main discharge.	Discharged with the significant flow of **Stream A**
H	Trade- returned abstracted water	Effluent from the FRR system discharged to sea continuously through a dedicated separate outfall (one outfall for each UK EPR^{TM} unit).	Intake to the forebay the same as for **Stream A** with small proportion of water diverted to serve the FRR system. Receives small proportion of the non-contaminated effluent from **Stream E** at forebay.

2.4 Fish recovery and return system

2.4.1. During operation an FRR System will be in place to minimise impacts on impinged fish. Abstracted water will be transported along the intake tunnels to the station forebay where rotating drum screens will impinge larger biota, including fish and crustaceans. Impinged biota will be washed off the drum screens and returned to the marine environment via the FRR System including some species that do not survive impingement, moribund or dead individuals. As a result, the contribution to nutrients, un-ionised ammonia and deoxygenation that may be contributed by decaying fish will be assessed. **Effluent Stream H** comprises water used to operate the FRR System that is discharged via a dedicated fish return outfall, one for each EPR unit.

2.4.2. The FRR System would provide a safe return of the more robust organisms from the drum screens directly into the marine environment and would be designed to minimise impacts on impinged fish and invertebrate populations. However, some species such as clupeids are highly sensitive to mechanical damage caused by impingement on the screens and incur high mortality rates.

2.4.3. The return of dead and moribund biota retains biomass within the local food web represents a source of organic carbon with the potential to enhance secondary production of carnivorous zooplankton and through the detrital pathways. In addition to organic loading, the potential for increases in nutrients, unionised ammonia concentration and reductions in dissolved oxygen are potential risks to marine water quality.

2.5 Commissioning

2.5.1. Early commissioning activities would include the commissioning of the demineralisation plant and cooling water system. Commissioning comprises two key phases as follows:

- Non-active commissioning, which would start with demonstration of equipment functionality and gradually build up to tests of the integrated function of the plant focusing on safety related systems and components. This stage includes hot functional testing, where the plant and equipment is put through its design envelope up to and including full temperature and pressure conditions, as far as practicable without nuclear fuel being in place. These tests are completed before fuel is loaded into the reactor and, therefore, no radioactive effluents are generated as a result of these activities.

- Active commissioning which commences with fuel delivery and active commissioning of the reactor components (e.g. testing the fuel storage systems before fuel loading, loading of fuel into the reactor vessel, initial criticality and power ascension testing, where the reactor is progressively increased in power and operational and safety performance is verified). Unlike the non-active commissioning phase, some radioactive effluents are generated in this phase.

2.5.2. Hot functional testing falls under the remit of the WDA permit. Hot functional testing tests the reactor under high temperature and pressure prior to the loading of nuclear fuel into the reactor. The chemical substances discharge during the hot functional testing would be the same as those discharged during the normal operational of Sizewell C and would be discharged via the cooling water outfall.

2.6 Summary of source terms used for the assessment of water quality effects

2.6.1. Full detail on the source terms used for the assessment of the potential effects on the water body of all discharges is provided in Ref. 2.2. **Table 2.2** below summaries the loading of different chemicals to be used during operation as 24 hour and annual loads. The thermal uplift in the discharged cooling water is assumed to be 11.6^{o}C for normal operational flow and 23.2^{o}C for the maintenance scenario.

Table 2.2 Summary of source terms used to inform the WFD compliance assessment for the operation of the power station

Substance	Circuit conditioning (kg y^{-1})	Sanitary waste discharge kg y^{-1})	Producing demineralised water (kg y^{-1})	Maximum annual loading (kg y^{-1})	Maximum 24-hour loading (kg d^{-1})
Boric acid[3]	14000	-	-	14000	5625
Boron	2448	-	-	2448	984
Lithium hydroxide	8.8	-	-	8.73	4.4
Morpholine	1680	-	-	1674	92.3
Ethanolamine	920	-	-	919	24.75

[3] Dissociation boric acid in seawater so equivalent boron concentration in discharge is presented and assessed

Substance	Circuit conditioning (kg y^{-1})	Sanitary waste discharge kg y^{-1})	Producing demineralised water (kg y^{-1})	Maximum annual loading (kg y^{-1})	Maximum 24-hour loading (kg d^{-1})
Nitrogen as N	10130	1595	-	11725	332
Unionised ammonia (NH_3)	-	-	-	958	27
Phosphates	790	-	-	790	352.5
Detergents	-	-	624	624	-
Suspended solids	2800	2080	88000	92879	870
Biochemical Oxygen Demand (BOD)	-	1387	-	1387	3.8
COD	5050	-	-	5050	330
Aluminium	5.26	-	-	5.26	1.1
Cadmium[4]	-	-	-	0.37	0.005
Copper	0.42	-	-	0.42	0.08
Chromium	8.37	-	-	8.37	1.7
Iron	34.97	-	46000	46035	257
Manganese	3.33	-	-	3.33	0.67
Mercury[4]	-	-	-	0.001	0.02
Nickel	0.44	-	-	0.44	0.09
Lead	0.3	-	-	0.3	0.07
Zinc	5.6	-	-	6.0	1.2
Chloride	-	-	87100	87100	450
Sulphates	-	-	98400	98400	2000

[4] Cadmium and mercury loading are derived from trace contamination of raw materials

Substance	Circuit conditioning (kg y^{-1})	Sanitary waste discharge kg y^{-1})	Producing demineralised water (kg y^{-1})	Maximum annual loading (kg y^{-1})	Maximum 24-hour loading (kg d^{-1})
Sodium	-	-	52400	52400	855
Amino tri-methylene phosphonic acid (ATMP)	-	-	9100	9100	45
Hydroxyethane diphosphonic acid (HEDP)	-	-	890	890	4.5
Acetic acid	-	-	14	14	0.1
Phosphoric acid	-	-	12	12	0.1
Sodium polyacrylate	-	-	8030	8030	40
Acrylic acid	-	-	165	165	1
Hydrazine	24.3	-	-	24.3	3
Chlorine TRO	-	-	-	-	150 μgl^{-1}
Chlorine bromoform	-	-	-	-	190 μgl^{-1}

3 THE HABITATS REGULATIONS ASSESSMENT PROCESS

3.1 Introduction

3.1.1. European Union (EU) obligations in respect of habitats and species are met through Council Directive 92/43/EEC (the Habitats Directive) on the conservation of natural habitats and of wild fauna and flora, which requires Member States to schedule important wildlife sites through the European Community as Special Areas of Conservation (SACs) and to give protection to habitats and species listed in the Directive as being threatened or of Community Interest.

3.1.2. The EU meets its obligations for birds through Directive 2009/147/EC (the Birds Directive) on the conservation of wild birds. This provides a framework for the conservation and management of wild birds in Europe through the designation of Special Protection Areas (SPAs). Of particular relevance is the requirement to identify and designate SPAs for rare or vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species, paying particular attention to the protection of wetlands of international importance. Together with other Sites of Community Important (SCI)[5], SACs and SPAs form a network of protected areas known as Natura 2000.

3.1.3. Under planning policy in England (Ref. 3.1), internationally designated Ramsar sites[6] are to be treated in the same way as European sites in terms of HRA. For the purposes of this report, 'European sites' is taken to include Ramsar sites along with SACs and SPAs.

3.1.4. The Habitats Directive is transposed into UK law by the Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (the 'Offshore Habitats Regulations'). The Habitats Regulations incorporate all SPAs into the definition of European sites and, consequently, the protections afforded to European sites under the Habitats Directive apply to SPAs designated under the Birds Directive.

3.1.5. The HRA process helps meet the requirements of Article 6(3) of the Habitats Directive (replicated in Regulation 63(1) of the Habitats

[5] for example, candidate SACs or proposed SPAs.
[6] Sites listed under '*The Convention on Wetlands of International Importance, especially as Waterfowl Habitat*', (Ramsar, Iran, 1971).

Regulations) which states that any plan or project, which is not directly connected with or necessary to the management of an European site, but would be likely to have a significant effect on such a site, either on its own or in-combination with other plans or projects, will be subject to an 'appropriate assessment' of its implications for the European site in view of the site's conservation objectives.

3.1.6. Subject to the provisions of Article 6(4) of the Habitats Directive, the 'competent authority' will agree to the plan or project only having ascertained that it will not adversely affect the integrity of the European site(s) concerned.

3.2 A four-stage approach

3.2.1. The HRA process typically follows a four-staged approach, as detailed in PINS Advice Note 10 (Ref. 3.2):

1. **Screening:** The process of identifying potentially relevant European sites, and whether the proposed project is likely to have a significant effect on the qualifying interest features of the European site, either alone or in-combination with other plans and projects. If it is concluded at this stage that there is no potential for LSE, there is no requirement to carry out subsequent stages of the HRA.

2. **Appropriate Assessment (AA):** Where a LSE for a European site(s) cannot be ruled out, either alone or in-combination with other plans and projects, assessment of the potential effects of the project on the integrity of the European site(s), in view of its qualifying interest features and associated conservation objectives, is required. Where it is concluded that there would be an adverse effect on site integrity (or where such an effect cannot be discounted) an assessment of mitigation options is carried out and mitigation measures (where available) are proposed to address the effects. If, having considered mitigation, the potential for adverse effects on integrity remains, the HRA must progress to Stages 3 and 4.

3. **Assessment of Alternative Solutions:** Identifying and examining alternative ways of achieving the objectives of the project to establish whether there are solutions that would avoid, or have a lesser effect, on the European site(s).

4. **Imperative reasons of overriding public interest (IROPI):** Where no alternative solution exists, the next stage of the process is to assess whether the project is necessary for IROPI and, if so, the identification of

compensatory measures needed to maintain the overall coherence of the Natura 2000 network.

3.3 Stage 1 LSE Screening

3.3.1. In respect of Stage 1 (Screening), a recent ruling (April 2018) by the Court of Justice of the European Union (CJEU) referred to as *People Over Wind and Sweetman v Coillte Teoranta* (C-323/17 – Ref 3.3) provided *"…it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site".*

3.3.2. In the context of this Shadow HRA Report, the phrase "…*measures intended to avoid or reduce the harmful effects*..." is interpreted as meaning any mitigation measures that are not clearly an integral part of the Sizewell C Project design. As such, no mitigation measures (outwith those that form a fundamental part of the Project's design) were taken into account when undertaking the LSE screening exercise.

3.3.3. There is no explicit definition of LSE in the legislation and in the context of HRA it is typically taken as any effect that may reasonably be predicted as a consequence of the project that may significantly adversely affect the conservation or management objectives of the features for which a site was designated, excluding trivial or inconsequential effects (Ref. 3.4). That is, the term 'likely' infers the presence of a risk that a significant effect could occur. By definition, this assessment is based on the consideration of a number of factors, for example, the spatial extent and duration of an identified effect, and other considerations such as the availability of appropriate mitigation. When considering such effects, a precautionary approach is adopted.

3.3.4. The conservation status of a natural habitat, as defined in the Habitats Directive, means the *"sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2".* The conservation objectives for a SAC or SPA are considered when identifying LSE. The conservation status of a natural habitat is taken as 'favourable' when:

- its natural range and the area it covers within that range are stable or increasing;

- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- the conservation status of its typical species is favourable.

3.3.5. In general, according to the Planning Inspectorate's Advice Note 10, if a large amount of evidence and data gathering is necessary to determine LSE, it is assumed that a LSE could arise and 'appropriate assessment' is required (Ref 3.2).

3.3.6. According to the *Waddenzee judgement* (Judgement of 7.9.2004 – Case C - 127/02 – Ref. 3.5) (paragraph 45) an appropriate assessment will be required if a likely significant effect cannot be excluded on the basis of objective information (paragraph 45) and where the plan or project is likely to undermine the site's conservation objectives, the assessment of that risk must be made in the light inter alia of the characteristics and specific environmental conditions of the site concerned by such a plan or project (paragraph 49). The *Sweetman Opinion* (Opinion of Advocate General 22.10.2012 – Case C-258/11 – Ref. 3.6) states that the question of whether an appropriate assessment should be carried out is simply whether the plan or project concerned is *capable* of having a significant effect (paragraphs 46-47).

3.3.7. In addition to screening, although not referred to in the Habitats Directive or national legislation, it is becoming common practice for very large developments to undertake a pre-screening site selection exercise in order to identify the European sites and the qualifying interest features to be taken forward into the screening stage; referred to as scoping (see **Section 4**). This step has been undertaken by SZC Co. during both production of the original HRA Evidence Plan and to incorporate recent developments in practice or updates to the status/number of relevant European sites since the Evidence Plan was published (Ref. 3.7).

3.4 Stage 2 Appropriate Assessment

a) Introduction

3.4.1. In respect of Stage 2 (Appropriate Assessment), the integrity of a European site is defined as *"the coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated"* (Ref. 3.8). An adverse effect on integrity, therefore, is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of designation.

3.4.2. Furthermore, the *Kilkenny judgement* (Judgement of 7.11.2018 – Case C-461/17 paragraph 40 – Ref. 3.9) states that an AA must identify and examine the implications of the proposed project for species present in a European site, including species for which the site has been listed and those for which it has not, provided those implications are liable to affect the conservation objectives of the site. It further states that an AA must identify and examine the implications of the proposed project for species and habitats outside the boundaries of the European site in question, again, provided that those implications are liable to affect the conservation objectives of the site.

b) Alone and in-combination

3.4.3. Regulation 63 of the Habitats Regulations requires the competent authority to make an appropriate assessment of any plan or project which is likely to have a significant effect on a European site, either alone or in-combination with other plans or projects. In line with the Habitats Regulations, the term 'in-combination' is used herein to describe the interactions of within-project activities and the potential for the Sizewell C Project (as a whole) to interact with other (non-SZC Co.) plans and projects.

i. Alone assessment

3.4.4. The approach taken to the assessment of the effects of the Sizewell C Project on European sites and mobile species has included:

- Collection of significant baseline environmental information over a number of years through survey and other research and information gathering work. This work is critical to understanding how cause and effect pathways may link to receptors.
- Liaison with the HRA Working Group, including on the methodology to be adopted for the HRA alone and in-combination assessments.
- Technical liaison with the team preparing the Environmental Impact Assessment (EIA) to support the DCO to share knowledge in respect of key HRA topic areas, such as the marine environment (benthic ecology, marine mammals and fish), coastal birds and noise.
- Technical workshops relating to coastal process modelling outcomes; marine and fresh (surface and ground) water flows, levels and quality;

predicted effects on fish and birds; noise and disturbance; and air quality.

- Production of technical reports, notes and mock assessments on subject matters that are central to the HRA, such as recreational disturbance, marsh harrier, red-throated diver and the response of prey species to thermal and chemical plumes.

- Scoping of European sites and LSE screening for those European sites and interest features scoped in to the assessment.

3.4.5. For the alone assessment, the Shadow HRA considers all potential cause and effect pathways between the water discharge activities of the Sizewell C Project in its entirety and the relevant qualifying interest features of screened in European sites, including potential effects on:

- habitats, vegetation, invertebrates and mobile species – qualifying interest features of SACs and Ramsar sites (not also designated as SPAs);

- birds – qualifying interest features of SPAs 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 those species that are designated as a feature of an SPA or Ramsar site and that may be affected outside of the boundaries of a European site); and

- supporting species and habitats – in those cases where there are potential effects on qualifying interest features through indirect effects (e.g. prey species).

3.4.6. The approach taken to the assessment varies based on the nature of the interest feature (coastal habitats, birds and marine mammals) and is detailed in **Sections 7 to 9**.

ii. In-combination assessment

3.4.7. For each European site (and combination of potential effects and interest features) considered, alone assessment is followed by in-combination assessment before a conclusion is reached regarding site integrity. The following text sets out at a high level the approach taken to the in-combination assessment of the activities covered by the Operational WDA Permit for the Sizewell C Project and other relevant plans and projects to be considered within the HRA process (including their identification).

3.4.8. The approach taken to the identification of non-Sizewell C Project plans and projects to be included in the in-combination assessment was fundamentally based upon the advice provided by the DCLG (2006) (Ref. 3.10), which states:

> *"In most cases, detailed consideration of the combined effects of the development proposed together with other developments will be limited to those others that are already begun or constructed [present and past] or those that have not been commenced but have a valid planning permission [reasonably foreseeable].*
>
> *Often, future developments in the vicinity of a project site will be included in the baseline scenario as 'committed development'. But in the context of EIA the term 'committed development' conventionally refers to development for which consent has been granted."*

3.4.9. Whilst there is no legal definition of what constitutes a plan or project for the purposes of the Habitats Regulations, PINS Advice Note 10 (Ref. 3.2) advises that the following plans/projects should be taken into account:

- projects that are under construction;
- permitted application(s) not yet implemented;
- submitted application(s) not yet determined;
- all refusals subject to appeal procedures not yet determined;
- projects on the National Infrastructure's (PINS') programme of projects; and
- projects identified in the relevant development plan (and emerging development plans – with appropriate weight given as they move closer to adoption) recognising that information on any relevant proposals will be limited and the degree of uncertainty that may be present.

3.4.10. Spatially, in-combination assessment takes account of effects that are over-lapping (i.e. a spatial interaction exists and the effects from two or more plans and projects will coincide) as well as discrete; that is, in the context of the Habitats Regulations in-combination effects can include the effects of different plans and projects on the same habitat/species, at different locations within a European site (e.g. loss the same habitat at disparate locations).

3.4.11. In respect of temporal effects, some of these may be of a short-term nature and would, from an ecological perspective, represent 'pulse' type disturbances that have no long-term effect. However, it is possible that such short-term effects could be significant and, consequently, they have been assessed accordingly. Other effects may be of a long-term nature and, even when the activity causing the identified impact ceases, the ecological response may still be manifest in the system (e.g. recovery of some species communities from disturbance/damage).

3.4.12. With respect to 'past' projects, a useful ground rule in in-combination assessment is that the environmental effects of schemes that have been completed should be included within the environmental baseline (and hence implicitly taken account of in the HRA process). Consequently, completed projects are excluded from the scope of in-combination assessment. However, it is acknowledged that the environmental effects of recently completed projects may not be fully manifested and that these effects need to be taken into account in the assessment. For the purposes of this in-combination assessment, the effects and influences of Sizewell A and Sizewell B have been taken to be included within the environmental baseline.

3.4.13. In the event that 'past' projects refer to past consents not yet implemented (for example), these have been considered as part of the in-combination assessment.

3.4.14. Projects that are currently being constructed ('present' projects) or that are in the planning process (where sufficient information is publicly available), as well as ongoing activities that have the potential to influence the same environmental parameters as the Project, are the focus of in-combination assessment. Where such data are available, quantitative assessment of potential effects and their environmental significance is provided. More weight is given to those projects that are at a more advanced stage in the planning process, as more confidence accompanies the assessment of potential combined effects.

3.4.15. Future plans or projects for which sufficient information is available (i.e. 'reasonably foreseeable' projects) will be considered as part of the in-combination assessment. Future plans or projects for which sufficient information is not available on which to base a reliable assessment, which are unlikely to be submitted or receive consent until after the proposed development has been completed, cannot reasonably be assessed as part of an in-combination assessment. However, the applicants for such projects will be required to take the effect of the Sizewell C Project into account in their own application.

3.4.16. In the absence of publicly available data, it is not possible to undertake a detailed in-combination assessment, but it is possible to make judgements regarding potential impacts on the basis of the characteristics of the other projects being considered (where these are known) and whether there is the potential for the effects of the various projects to interact spatially and temporally. It is not appropriate to consider worst-case scenarios in this context, as this would introduce the risk that the assessment would become over precautionary and unrealistic.

3.5 Stages 3 and 4

3.5.1. Following AA (alone and in-combination), where a real risk to the integrity of the European site is identified, it must then be considered (at **Stage 3**) whether any ‘alternative solutions’ exist that would be capable of delivering the same overall objective as the original proposal in a way that would not adversely affect the integrity of a European site. If such an alternative is identified, then it should be pursued. If such an alternative is not identified, then the competent authority must consider whether the plan or project, in spite of a negative assessment of the implications for the European site, must nevertheless be undertaken for IROPI (**Stage 4**).

3.5.2. Furthermore, if IROPI can be demonstrated, for the project to proceed ‘compensatory measures’ necessary to ensure that the overall coherence of *Natura 2000* is protected will need to be implemented. Therefore, following the demonstration of IROPI in Stage 4, compensatory measures must be demonstrated to be available and deliverable.

4 EUROPEAN SITE SCOPING

4.1.1. SZC Co. first undertook 'European site scoping' for the Sizewell C Project, to determine those European sites that could be affected by the Project, in 2012/2014. The first scoping exercise built upon the Nuclear National Policy Statement European site scoping undertaken by the Department of Energy and Climate Change (DECC) (Ref. 4.1). This scoping exercise identified ("scoped in") all European sites within a 20 km range of the envisaged location of Sizewell C as relevant to HRA.

4.1.2. In 2018 and 2019 this exercise was updated for the entire Sizewell C Project, including its associated development, based on the most up to date project proposals and consultation with the HRA Working Group.

4.1.3. In relation to the activities that are the subject of the operational WDA permit application, the HRA scoping exercise identified 13 European sites within the predicted zone of influence (ZOI) of the Sizewell C Project's discharge activities (i.e. within 16 km of the proposed discharge point[7]). This included the Southern North Sea SAC, solely designated for harbour porpoise, within which elements of the Sizewell C Project are proposed to be located.

4.1.4. The 13 European sites scoped into this operational WDA assessment are shown on **Figure 4.1** and listed in **Table 4.1**, which also sets out the qualifying interest features for each of these sites.

European sites with marine mammals

4.1.5. It was recognised that, potentially, the foraging and migration routes of mobile species could be affected by changes in water quality due to the discharge activities from the cooling water discharge system, including increased water temperatures and increased chemical inputs. Specifically, effects on marine mammal populations could arise due to direct effects or indirect effects on prey species.

4.1.6. For both grey and harbour seals there is evidence of connectivity between Greater Sizewell Bay and the European sites along the east coast of England. This includes the Humber Estuary SAC (designated for grey seal) and the Wash and North Norfolk Coast SAC (designated for harbour seal). That is, grey seals from the Donna Nook haul-out site within the Humber Estuary SAC were telemetry tagged (21 in total) in May 2015 (Ref. 4.2).

[7] The modelled extent of the discharge plume (across all activities) is within this zone.

The results of this study showed that grey seals travel from the Donna Nook haul-out site along the east coast of England and down to the Kent and Essex coastlines, including travelling through the Greater Sizewell Bay area (see **Chapter 6**, **Plate 6.14**; Ref 4.2). Hence, the Humber Estuary SAC and the grey seal interest feature was scoped into the Sizewell C Project HRA.

4.1.7. While there is evidence of connectivity between the Donna Nook haul-out site and the northern France and Netherlands coastlines, there is no evidence that individuals from the designated sites for grey seal in these areas travel to the Greater Sizewell Bay area. Tagged grey seals were shown to travel directly between Donna Nook and the north coasts of France and the Netherlands only, and do not pass along the Suffolk or Kent coastline (**Plate 6.14**; Ref. 4.2). In addition, the Russel *et al*. (2017) (Ref. 4.3) seal density maps show that there were very few seals within the vicinity of the Sizewell C Project; supporting the assumption that there is no evidence of seals foraging within or near the Greater Sizewell Bay area. Therefore, all other grey seal designated sites were scoped out of further assessment.

4.1.8. The Sea Mammal Research Unit (SMRU) deployed 344 telemetry tags on harbour seals around the UK coastline between 2001 and 2012 (**Plate 6.1515**; Ref. 4.4). The results of this tagging survey indicated that harbour seal travel from The Wash haul-out site (within The Wash and North Norfolk Coast SAC), along the Suffolk and Kent coastlines, including passing through the Greater Sizewell Bay area. A further tagging study of harbour seals in the outer Thames Estuary also demonstrated connectivity between harbour seals that haul-out along the Kent and Essex coastlines with The Wash and North Norfolk Coast SAC population, with harbour seals passing through the Greater Sizewell Bay area (

4.1.9. **Plate** 6.19**18**; Ref. 4.5). Hence, The Wash and North Norfolk Coast SAC and the harbour seal interest feature was scoped into the Sizewell C Project HRA.

Distant breeding seabird SPAs

4.1.10. There is potential for breeding seabird SPAs/Ramsar sites that are distant from the Sizewell C Project (i.e. beyond 20 km) to have connectivity with the Project's ZOI. This is because the qualifying features may have large breeding season foraging ranges or they may occur within the waters around the Sizewell C Project during passage or at other times in the non-breeding period.

4.1.11. However, the waters adjacent to the Sizewell C Project are beyond the likely foraging range of breeding seabirds from any such SPAs/Ramsar sites (Ref. 4.6, Ref. 4.7, Ref. 4.8), so there is no potential for such effects to arise during the breeding season.

4.1.12. In contrast to breeding seabird populations, access to offshore waters for wintering or passage seabirds is not constrained by colony location. Given the relatively small area of offshore habitat within which potential effects from the Sizewell C Project could arise (relative to the overall availability of such habitat to these populations), it is also the case that there is no potential for effects on such SPA/Ramsar site populations during the non-breeding periods.

4.1.13. Consequently, no distant breeding seabird SPAs/Ramsar sites have been scoped in to this assessment.

Table 4.1 Description of European sites scoped into the Operational WDA Shadow HRA and their qualifying interest features

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
1	Alde-Ore and Butley Estuaries SAC	5 km	The SAC covers an area of 1,633ha and is made up of three rivers. It is the only bar-built estuary in the UK with a shingle bar. This bar has been extending rapidly along the coast since 1530, pushing the mouth of the estuary progressively south-westwards. The eastwards-running Alde River originally entered the sea at Aldeburgh, but now turns south along the inner side of the Orfordness shingle spit. It is relatively wide and shallow, with extensive intertidal mudflats on both sides of the channel in its upper reaches and saltmarsh accreting along its fringes. The Alde subsequently becomes the south-west flowing River Ore, which is narrower and deeper with stronger currents. The smaller Butley River has extensive areas of saltmarsh and a reed bed community that borders intertidal mudflats. It flows into the Ore shortly after the latter divides around Havergate Island. The mouth of the River Ore is still moving south as the Orfordness shingle spit continues to grow through longshore drift from the north. There is a range of littoral sediment and rock biotopes (the latter on sea defences) that are of high diversity and species richness for estuaries in eastern England. Water quality is excellent throughout. The area is relatively natural, being largely undeveloped by man and with very limited industrial activity. The estuary contains large areas of shallow water over subtidal sediments, and extensive mudflats and saltmarshes exposed at low water. Its diverse and species-rich intertidal sand and mudflat biotopes grade naturally along many lengths of the shore	Annex 1 habitats that are a primary reason for selection of the site: • Estuaries Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of this site: • Mudflats and sandflats not covered by seawater at low tide • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			into vegetated or dynamic shingle habitat, saltmarsh, grassland and reed bed.	
2	Alde-Ore Estuary SPA	5 km	The SPA is located on the Suffolk coast between Aldeburgh to the North and Bawdsey to the South. The site includes Havergate Island and Orford Ness, as well as the estuaries of the rivers Alde, Butley and Ore. The SPA is composed of Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), intertidal mudflats, shingle, coastal lagoons and estuarine fish communities. Bird usage of habitats within the SPA varies seasonally, with different areas being utilised for nesting and feeding at different times of the year.	This site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance listed on Annex I of the Directive. During the breeding season: • Avocet *Recurvirostra avosetta* • Little tern *Sternula albifrons* • Marsh harrier *Circus aeruginosus* • Sandwich tern Thalasseus sandvicensis Over winter: • Avocet *Recurvirostra avosetta* The site also qualifies under Article 4.2 of the Birds Directive (2009/147/EC) by supporting populations of European importance of migratory species. During the breeding season: • Lesser black-backed gull *Larus fuscus* Over winter: • Redshank *Tringa tetanus* • Ruff *Philomachus pugnax*

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
3	Alde-Ore Estuary Ramsar site	5 km	The site comprises the estuary complex of the rivers Alde, Butley and Ore, including Havergate Island and Orfordness. There are a variety of habitats including, intertidal mudflats, saltmarsh, vegetated shingle (including the second-largest and best-preserved area in Britain at Orfordness), saline lagoons and grazing marsh. The Orfordness/Shingle Street landform is unique within Britain in combining a shingle spit with a cuspate foreland. The site supports nationally-scarce plants, British Red Data Book invertebrates, and notable assemblages of breeding and wintering wetland birds.	The site qualifies as a Ramsar for the following reasons: • Ramsar criterion 2 - the site supports a number of 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 • Ramsar criterion 6 - species/populations occurring at levels of international importance Species regularly supported during the breeding season: • Lesser black-backed gull, *Larus fuscus graellsii*, W Europe/Mediterranean/W Africa Species with peak counts in winter: • Avocet, *Recurvirostra avosetta*, Europe/Northwest Africa • Common redshank, *Tringa totanus totanus*
4	Benacre to Easton Bavents Lagoons SAC	15.5 km	This SAC is a series of percolation lagoons on the east coast of England. The lagoons (the Denes, Benacre Broad, Covehithe Broad and Easton Broad) have formed behind shingle barriers and are a feature of a geomorphologically dynamic system. Sea water enters the lagoons by percolation through the barriers, or by overtopping them during storms and high spring tides. The lagoons show a wide range of salinities, from nearly fully saline in South Pool, the Denes, to extremely low	Annex 1 habitats that are a primary reason for selection of the site: • Coastal lagoons

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			salinity at Easton Broad. This range of salinity has resulted in a series of lagoonal vegetation types, including beds of narrow leaved eelgrass *Zostera angustifolia* in fully saline or hypersaline conditions, beds of spiral tasselweed *Ruppia cirrhosa* in brackish water, and dense beds of common reed *Phragmites australis* in freshwater. The site supports a number of specialist lagoonal species.	
5	Benacre to Easton Bavents SPA	15 km	The SPA is located on the North Sea coast of East Suffolk, between the coastal towns of Kessingland (to the north) and Southwold (to the south). The coast here is low-lying and consists of shingle beach in the northern part and low cliffs around Easton Bavents and Covehithe. Benacre Broad is a natural brackish lagoon separated from the sea by a shingle bar, reed-fringed on the landward side and then grading into deciduous woodland on the rising ground behind. The smaller Covehithe and Easton Broads have developed similarly, with fringing reedbeds. Elsewhere, grazing marsh fields include unimproved meadows, which are separated by ditches rich in water plants and invertebrates. The area supports important populations of breeding birds, which are particularly associated with reedbed and shingle beach habitats. The reedbeds also support important numbers of bittern *Botaurus stellaris* in winter. Little terns *Sternula albifrons* feed substantially outside the SPA in adjacent marine waters.	This site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following species listed on Annex I of the Directive. During the breeding season: • Bittern *Botaurus stellaris* • Little tern *Sternula albifrons* • Marsh harrier *Circus aeruginosus*
6	Humber Estuary SAC	220 km	The Humber is the second largest coastal plain Estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. The estuary supports a full range of saline conditions from the open coast to the limit of saline intrusion on the tidal rivers of the Ouse and Trent. The range of salinity, substrate and exposure to wave action influences the estuarine habitats and the range of species	Annex 1 habitats that are a primary reason for selection of the site: • Estuaries • Mudflats and sandflats not covered by seawater at low tide

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			that utilise them; these include a breeding bird assemblage, winter and passage waterfowl, river and sea lamprey, grey seals, vascular plants and invertebrates. The Humber is a muddy, macro-tidal estuary, fed by a number of rivers including the Rivers Ouse, Trent and Hull. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. This is the northernmost of the English east coast estuaries whose structure and function is intimately linked with soft eroding shorelines. The extensive mud and sand flats support a range of benthic communities, which in turn are an important feeding resource for birds and fish. Wave exposed sandy shores are found in the outer/open coast areas of the estuary. These change to the more moderately exposed sandy shores and then to sheltered muddy shores within the main body of the estuary and up into the tidal rivers.	Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of this site: • Sandbanks which are slightly covered by sea water all the time • Coastal lagoons • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadows (*Glauco-Puccineolietalia maritimae*) • Embryonic shifting dunes • Shifting dunes along the shoreline with Ammophila arenaria (“white dunes”) • Fixed coastal dunes with herbaceous vegetation (“grey dunes”) • Dunes with *Hippopha rhamnoides* Annex II species present as a qualifying feature, but not a primary selection: • Sea lamprey *Petromyzon marinus* • River lamprey *Lampetra fluviatilis* • Grey seal *Halichoerus grypus*
7	Minsmere to Walberswick Heaths and Marshes SAC	Adjacent	This site is one of two representatives of annual vegetation of drift lines on the east coast of England. It occurs on a well-developed beach strandline of mixed sand and shingle and is the best and most extensive example of this restricted geographical type. Species include those typical of sandy shores, such as sea	Annex 1 habitats that are a primary reason for selection of this site: • Annual vegetation of drift lines • European dry heaths

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			sandwort *Honckenya peploides* and shingle plants such as sea beet *Beta vulgaris* ssp. *maritima*. Lowland European dry heaths occupy an extensive area of the site, which is at the extreme easterly range of heath development in the UK. The heathland is predominantly national Vegetation Classification (NVC) type H8 *Calluna vulgaris – Ulex gallii* heath, usually more characteristic of western parts of the UK. This type is dominated by heather *Calluna vulgaris*, western gorse *Ulex gallii* and bell heather *Erica cinerea*.	Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of this site: • Perennial vegetation of stony banks
8	Minsmere-Walberswick SPA	Adjacent	The site comprises two large marshes, the tidal Blyth estuary and associated habitats. This composite coastal site contains a complex mosaic of habitats, notably areas of marsh with dykes, extensive reedbeds, mud-flats, lagoons, shingle, woodland and areas of lowland heath. It supports the largest continuous stand of common reed *Phragmites australis* in England and Wales and demonstrates the nationally rare transition in grazing marsh ditch plants from brackish to fresh water. There are nationally important numbers of breeding and wintering birds. In particular, the reedbeds are of major importance for breeding bittern *Botaurus stellaris* and marsh harrier *Circus aeruginosus*. A range of breeding waders (e.g. avocets *Recurvirostra avosetta*) and heathland birds occur in other areas of the SPA. The shingle beaches support important numbers of breeding little tern *Sternula albifrons*, which feed substantially outside the SPA in adjacent marine waters. The site is also important for wintering bitterns and raptors.	The site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following species listed on Annex 1 of the Directive. During the breeding season: • Avocet *Recurvirostra avosetta* • Bittern *Botaurus stellaris* • Little tern *Sternula albifrons* • Marsh harrier *Circus aeruginosus* • Nightjar *Caprimulgus europaeus* Over winter: • Hen harrier *Circus cyaneus* This site also qualifies under Article 4.2 of the Birds Directive (2009/147/EC) by supporting populations of European importance of the following migratory species.

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
				During the breeding season: • Shoveler *Anas clypeata* • Teal *Anas crecca* • Gadwall *Anas Strepera* Over winter: • Gadwall *Anas strepera* • Shoveler *Anas clypeata* • White fronted goose *Anser albifrons albifrons*
9	Minsmere-Walberswick Ramsar site	Adjacent	This Suffolk coastal site contains a complex mosaic of habitats, notably, areas of marsh with dykes, extensive reedbeds, mudflats, lagoons, shingle and driftline, woodland and areas of lowland heath. The site supports the largest continuous stand of reed in England and Wales and demonstrates the nationally rare transition in grazing marsh ditch plants from brackish to fresh water. The combination of habitats creates an exceptional area of scientific interest supporting nationally scarce plants, British Red Data Book invertebrates and nationally important numbers of breeding and wintering birds.	The site qualifies as a Ramsar under the following criteria: • Ramsar criterion 1 - the site contains a mosaic of marine, freshwater, marshland and associated habitats complete with transition areas in between. It also contains the largest continuous stand of reedbed in England and Wales, and rare transition in grazing marsh ditch plants from brackish to fresh water • Ramsar criterion 2 - this site supports nine nationally scarce plants and at least 26 red data book invertebrates. It supports a population of the mollusc narrow-mouthed whorl snail *Vertigo angustior* (Habitats Directive Annex II; British Red Data Book Endangered), recently discovered on the Blyth estuary river walls

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
				• Ramsar criterion 2 – this site also supports an important assemblage of rare breeding birds associated with marshland and reedbeds including: bittern *Botaurus stellaris*, gadwall *Anas strepera*, teal *Anas crecca*, shoveler *Anas clypeata*, marsh harrier *Circus aeruginosus*, avocet *Recurvirostra avosetta* and bearded tit *Panurus biarmicus*. In addition, other breeding species which may be associated with marshland and reedbeds will also contribute to the assemblage, e.g. little tern, black-headed gull and Mediterranean gull.
10	Orfordness-Shingle Street SAC	8 km	Orfordness is an extensive shingle structure and consists of a foreland, a 15 km-long spit and a series of recurves running from north to south on the Suffolk coast. This spit has been selected as it supports some of the largest and most natural sequences in the UK of shingle vegetation affected by salt spray. The southern end of the spit has a particularly fine series of undisturbed ridges, with zonation of communities determined by the ridge pattern. Pioneer communities with sea pea *Lathyrus japonicus* and false oat-grass *Arrhenatherum elatius* grassland occur. Locally these are nutrient-enriched by the presence of a gull colony, elsewhere they support rich lichen communities. Orfordness is one of two sites representing annual vegetation of drift lines on the east coast of England. In contrast to Minsmere to Walberswick Heaths and Marshes, drift-line vegetation occurs on the sheltered, western side of the spit, at the transition from shingle to saltmarsh, as well as on the exposed eastern coast. The driftline community is widespread on the site and	Annex 1 habitats which are a primary reason for site selection: • Coastal Lagoons • Annual vegetation of drift lines • Perennial vegetation of stony banks

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			comprises sea beet *Beta vulgaris* ssp. *maritima* and orache *Atriplex* spp. in a strip 2-5 m wide. A series of percolation lagoons have developed in the shingle bank adjacent to the shore at the mouth of the Ore estuary. The salinity of the lagoons is maintained by percolation through the shingle, although at high tides sea water can overtop the shingle bank. The fauna of these lagoons includes typical lagoon species, such as the cockle *Cerastoderma glaucum*, the ostracod *Cyprideis torosa* and the gastropods *Littorina saxatilis tenebrosa* and *Hydrobia ventrosa*. The nationally rare starlet sea anemone *Nematostella vectensis* is also found at the site.	
11	Outer Thames Estuary SPA	Main Development Site within and adjacent	The Outer Thames Estuary SPA consists of areas of shallow and deeper water, high tidal current streams and a range of mobile sediments. Large areas of mud, silt and gravelly sediments form the deeper water channels, the main ones of which form the approach route to the ports of London and as such are continually disturbed by shipping and maintenance dredging. Sand in the form of sandbanks separated by troughs predominates in the remaining areas and the crests of some of the banks are exposed at mean low water. In the northern part of the site the main sandbanks are (north to south) Middle Cross Sand, Scroby Sands, Helm Sand, Newcombe Sand, Aldeburgh Napes, Aldeburgh Ridge, North Ship Head and Bawdsey Bank. In the southern part of the site the main sandbanks are Red Sand, Kentish Flats, West and East Barrow, Sunk Sand, Shingles, Long Sand, Margate Sand and Kentish Knock. The seabed along the coast of Norfolk and Suffolk coast is of a similar composition to that in the main estuary with large shallow areas of mud, sand, silt and gravelly	The site qualifies under Article 4.1 of the Birds Directive (2009/147/EC) as it is used regularly by 1% or more of the Great Britain population of the following species listed in Annex I in any season. During the breeding season: • Little tern *Sternula albifrons* • Common tern *Sterna hirundo* Over winter: • Red-throated diver *Gavia stellata*

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			sediments but, in the absence of main port areas within this area, there is less disturbance through shipping or dredging. The main sandbanks in this area are (from north to south) Dunwich Bank, Sizewell Bank, Aldeburgh Napes, Aldeburgh Ridge and Whiting Ridge. The seabed and waters of the site provide an important habitat in the non-breeding season for red-throated divers *Gavia stellate* which visit the area to feed on the fish populations.	
12	Southern North Sea SAC	Main Development Site within and adjacent	The Southern North Sea SCI lies along the east coast of England, predominantly in the offshore waters of the central and southern North Sea, from north of Dogger Bank to the Straits of Dover in the south. It covers an area of 3,695,054 ha, designated for the protection of harbour porpoise *Phocoena phocoena*. This area supports an estimated 17.5% of the UK North Sea Management Unit (MU) population. Approximately two thirds of the site, the northern part, is recognised as important for porpoises during the summer season, whilst the southern part support persistently higher densities during the winter. The SCI ranges in depth from Mean Low Water down to 75 m, with the majority of the site shallower than 40 m, and is characterised by its sandy, coarse sediments which cover much of the site. These physical characteristics are thought to be preferred by harbour porpoise, likely due to availability of prey.	The qualifying feature of the site is the Annex II species: • Harbour porpoise *Phocoena phocoena*
13	The Wash and Norfolk Coast SAC	120 km	The Wash is the largest embayment in the UK. It is connected via sediment transfer systems to the north Norfolk coast. Together, the Wash and North Norfolk Coast form one of the most important marine areas in the UK and European North Sea coast, and include extensive areas of varying, but predominantly sandy, sediments subject to a range of conditions. Communities in the	Annex 1 habitats that are a primary reason for selection of the site: • Sandbanks which are slightly covered by sea water all the time • Mudflats and sandflats not covered by seawater at low tide

No.	Site name	Distance from Main Development Site	Description	Qualifying interest features
			intertidal include those characterised by large numbers of polychaetes, bivalve and crustaceans. Subtidal communities cover a diverse range from the shallow to the deeper parts of the embayments and include dense brittlestar beds and areas of an abundant reef-building worm ('ross worm') *Sabellaria spinulosa*. The embayment supports a variety of mobile species, including a range of fish, otter *Lutra lutra* and common seal *Phoca vitulina*. The extensive intertidal flats provide ideal conditions for common seal breeding and hauling-out.	• Large shallow inlets and bays • Reefs • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadows (*Glauco-Puccineolietalia maritimae*) • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticose*) Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of this site: • Coastal lagoons Annex II species that are a primary reason for selection of this site: • Harbour seal *Phoca vitulina* Annex II species present as a qualifying feature, but not a primary reason for selection: • Otter *Lutra lutra*

5 SCREENING OF POTENTIAL EFFECTS

5.1 Determination of LSE

a) The 'LSE test'

5.1.1. This section sets out the background to the determination of LSE in respect of the test set out in the Habitats Regulations and the proposed approach to this aspect of the HRA process for the Sizewell C Project WDA Permit application.

5.1.2. The section provides information on the LSE test, including definitions of what constitutes LSE as determined through case law. It then highlights how the Shadow HRA has approached the determination of LSE, taking into account the various requirements set out in guidance and previous practice.

5.1.3. The 'LSE test' is the process of identifying potentially relevant European sites (addressed in this case through 'scoping'; see **Chapter 4**) and the likely effects of a project on the qualifying interest features of a European site, either alone or in-combination with other plans and projects, and considers whether the effects are likely to be significant.

5.1.4. The HRA screening process uses the threshold of LSE to determine whether effects on European sites should be the subject of further assessment. The Habitats Regulations do not define the term LSE but Natural England's predecessor defined it as *"any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the site was designated, but excluding trivial or inconsequential effects"* (Ref. 3.4). In the Waddenzee case (Case C-127/02 – Ref. 3.5) the European Court of Justice found that a LSE exists if it cannot be excluded on the basis of objective information that the plan or Project will have significant effects on the conservation objectives of the site concerned, whether alone or in-combination with any other project. The Advocate General's opinion of the Sweetman case (Case C-258/11 – Ref. 3.6) further clarifies the position by noting that for a conclusion of a LSE to be made "*there is no need to **establish** such an effect,... it is merely necessary to determine that there **may** be such an effect*" (original emphasis).

5.1.5. Similarly, clarification has been provided through case law on the meaning of 'a likely significant effect' (*Bagmoor Wind Ltd v The Scottish Ministers*, 2012 – Ref. 5.1). In this case, it was ruled that the word 'likely' in the Habitats Regulations should not be interpreted as referring to the probability of a significant effect but rather as a description of the existence of a risk of a significant effect (i.e. the possibility). Consequently, if the possibility of a significant effect cannot be excluded on the basis of objective information, an AA will be required.

5.1.6. In the Bagmoor Wind case (Ref. 5.1) it was also suggested that, where the absence of a risk of a LSE can only be established after detailed investigation or expert opinion, it is an indicator that there is an existence of a risk and the competent authority must move from screening to AA.

5.1.7. For the purposes of this assessment, a LSE is defined as any identified effect that is capable of resulting in a change in the conservation status of one or more designated features of a European site after all aspects of the plan or project have been considered alone and in-combination with other plans and projects.

5.1.8. A precautionary approach has been taken to the screening process for the Project. Only those designated features and European sites where it can be demonstrated that there is no likelihood of a significant effect occurring have been screened out.

5.1.9. Although not the topic of this section, it is important to note that the existence of a risk to achieving the conservation objectives of a site as a result of project-related effects does not automatically equate to an adverse effect on the integrity of the site. The risk needs to be examined in detail to the point that no reasonable scientific doubt remains as to the absence of an adverse effect.

b) Mitigation

5.1.10. Where the potential for a LSE is highlighted, it is possible that the effect could be completely avoided by the application of one or more avoidance (mitigation) measures. However, in line with the *People Over Wind and Sweetman v Coillte Teoranta* (C-323/17 – Ref. 3.3) ruling referred to in **Chapter 3**, with the exception of mitigation measures that form an integral part of the Project's design, no additional measures intended to avoid or reduce an effect have been taken into account as part of the LSE screening exercise set out herein (i.e. mitigation measures were not been used as the basis for screening effects out).

c) In-combination

5.1.11. The in-combination component of the LSE test needs to focus only on those plans or projects that could potentially interact with the project under consideration. In this respect, the in-combination check must consider whether:

- the effects of the plans and projects, in combination, would make the effects of the project more likely to occur, or more likely to occur at significant levels, that alone would be unlikely to either occur or be significant;
- the effects of the plans and projects, in combination, would make insignificant effects significant; and
- the effects of the plans and projects, in combination, would generate new or different effects that would not occur if the plans and projects proceeded alone.

5.1.12. The approach taken to the in-combination assessment for the Sizewell C Project, including the selection of appropriate plans and projects for consideration in the assessment process is set out in **Section 5.5**.

5.2 Effect pathways

5.2.1. The test for LSE requires that consideration is given to potential causes and effects (i.e. any likely effect pathways). Information on the project is needed to identify the potential causes of effects and information on the European site(s) is needed to identify any potential implications related to these effects. In the absence of a potential effect pathway, it can be concluded that no LSE would arise. In respect of this aspect, it is also important to ensure that the potential for a risk is credible rather than hypothetical.

5.2.2. Within this assessment, each potential effect is considered using information from surveys undertaken to inform the HRA process, published literature (where available), other available baseline data, modelling outputs and professional judgement (informed by Ref. 5.2). Where a potential effect has been identified but no LSE is predicted, the evidence and reason for reaching this conclusion are provided.

5.2.3. Through the HRA screening process for the Sizewell C Project as a whole, 10 effect categories were deemed to have the potential to cause LSE (during either construction, operation or both) on the European sites and qualifying features scoped into the assessment (e.g. alteration of coastal processes, changes in air quality, disturbance effects on species populations etc.). For this operational WDA permit application, only one effect category was relevant, as follows:

- Water quality effects – marine environment (both alone and in-combination).

5.2.4. With regard to water quality in the marine environment, the following list outlines the potential effects considered in the LSE screening exercise for operational WDA:

- Change in marine water quality due to the discharge of a thermal plume – 'Thermal Discharge'.
- Change in marine water quality from a chemical discharge containing total residual oxidants (TRO) from chlorine used to avoid biofouling and organic material in the water – 'Chemical Discharge: TRO'.
- Change in marine water quality resulting from the discharge of chlorinated by products (CBP), in particular bromoform – 'Chemical Discharge: CBP – Bromoform'.
- Change in marine water quality resulting from the discharge of hydrazine, used as an oxygen scavenger for corrosion control – 'Chemical Discharge: Hydrazine'.
- Discharge of sewage through the cooling water outfall – 'Sewage Discharge'.
- Change in marine water quality resulting from the discharge of dead fish and other dead fauna to the sea via the cooling water system – 'FRR: change to water quality from moribund biota'.

5.2.5. With regard to Sewage Discharge, as set out in **Chapter 2**, it is proposed that sanitary effluent from administration and mess facilities would be discharged along with the cooling water discharge. Sewage would undergo tertiary treatment before being discharged, resulting in an effluent treated for bacterial load and viruses, and reduced nitrogen and phosphorous levels. The sewage treatment plant will be designed to achieve the following treatment specification:

- biochemical oxygen demand ($BOD_{5\text{-atu}}$) concentration of 20 mg/l;
- ammoniacal nitrogen 20 mg/l (as N); and
- total suspended solids of 30 mg/l.

5.2.6. It is, therefore, considered that the discharge of tertiary treated sewage would not give rise to a LSE at those European sites scoped in to the HRA process. Consequently, this activity is not considered further in this assessment.

5.2.7. The remaining effects of the Sizewell C Project have been considered with respect to all qualifying features of the European sites scoped into the assessment in order to determine whether an LSE may arise. In line with the precautionary principle, where there is uncertainty or information is lacking in relation to the capacity of an effect to undermine a site's conservation objectives, it has been assumed that there could be an effect and LSE has not been ruled out.

5.3 Screening for LSE

a) Introduction

5.3.1. For an effect on a receptor (in this case a 'qualifying feature') to occur, the receptor needs to be sensitive to the change that would occur as a result of the activity and vulnerable to the effect; i.e. within the impact zone. This zone can be determined based on a number of methods, including modelling, to predict the direct and indirect area of effect, or ZOI, of the activity. Based on existing knowledge, it is possible to screen out the potential for some effects to occur on certain qualifying features either because they would not be vulnerable to any changes occurring as a result of the Sizewell C Project operational WDA and/or they would not be sensitive to any changes that could occur.

5.3.2. The potential changes/effects identified in **Section 5.2** have been investigated to determine their likely ZOI and, together with existing knowledge of the sensitivity of the qualifying features of the European sites scoped in to the assessment, it has been possible to conclude that some qualifying features in some European sites can be 'screened out' for the purposes of further assessment. Additionally, it is also possible to screen out some of the pathways of effects from being taken through to the AA.

5.3.3. The following sub-sections provide details of the LSE assessment carried out for the water discharge activities associated with the operational WDA permit being applied for.

b) Coastal habitats (SACs and Ramsar sites)

i. Potentially affected sites

5.3.4. Marine and coastal habitats could be affected by changes in water quality during the operational phase due to discharge activities from the cooling water system.

5.3.5. In examining the potential for LSE on 'habitats', connectivity between the Project and a European site has been determined through interrogation of the thermal and chemical plume model (Ref. 2.2). Where there is connectivity it has been concluded that the potential for LSE exists and the site / qualifying feature should be taken through to the AA stage.

5.3.6. The SACs and Ramsar sites with coastal habitats (rather than species in this instance) which have the potential to be affected by the Sizewell C thermal and chemical plumes are the:

- Alde-Ore and Butley Estuaries SAC;
- Alde-Ore Estuary Ramsar site;
- Benacre to Easton Bavents Lagoons SAC;
- Minsmere to Walberswick Heaths and Marshes SAC;
- Minsmere-Walberswick Ramsar site; and
- Orfordness-Shingle Street SAC.

ii. Thermal Discharge

5.3.7. The cooling water outfall would create a thermal plume due to the water being discharged at a higher temperature from the power station than the surrounding receiving water. The potential effects of the thermal plume are predominantly on sessile and sedentary benthic organisms that cannot avoid it. The thermal plume from Sizewell C was modelled by Cefas using the validated Sizewell General Estuarine Transport Model (GETM); full details of the model and detailed thermal plume maps are presented in BEEMS Technical Report TR302 (Ref. 5.3), with a summary of the model provided within the BEEMS Technical Report TR306 (Ref. 2.2).

5.3.8. Unlike chemical contaminant water quality 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 (Ref. 5.4). In addition, the Habitats Directive has no specific temperature requirements, but requires that European protected habitats and species be maintained or restored with strict protection of species listed in Annex IV of the directive. In order to protect the most sensitive species, thermal standards have therefore been set on an indicative basis and, as such, act as trigger values for further investigation of potential ecological effects (i.e. if the thermal plume exceeds the threshold, further investigation should be undertaken) (Ref. 5.5).

5.3.9. The UK Technical Advisory Group (UKTAG) for the Water Framework Directive (WFD) recommend two threshold values as trigger levels for designated sites (Ref. 5.6):

- **Deviation from ambient** - a temperature uplift of 2°C as the maximum allowed concentration (MAC) at the edge of the mixing zone[8] (as a 100^{th} percentile).

- **Maximum temperature -** 28°C as a 98th percentile at the edge of the mixing zone (SPA) and 21.5°C as a 98th percentile at the edge of the mixing zone (SAC). Furthermore, SACs designated for estuarine or embayment habitat and/or cold-water salmonid species, apply absolute temperature thresholds of 21.5ºC as a 98th percentile. These criteria are not applicable to the southern North Sea SAC designated for harbour porpoise.

5.3.10. In ecotoxicity studies MACs are normally defined as 95^{th} or 98^{th} percentiles, but the designated site uplift threshold is specified as a 100^{th} percentile, i.e. MAC. This metric is very dependent on how the observations or model simulations are undertaken and the time period considered. Using the GETM model, the maximum temperature taken from instantaneous temperature fields, saved every hour for a one-year simulation, provides data on the predicted area that exceeds the 2°C excess temperature for at least 1 hour per year, i.e. for 1 hour in 8760 hours per annum. **Figure 5.1** and **Figure 5.2** show the predicted surface and seabed annual maximum excess temperature for the operation of Sizewell C (in conjunction with the operation of Sizewell B). At this temperature threshold, this metric is not considered to have any link to specific ecological effects, but it serves as a precautionary threshold to trigger further ecological investigation.

5.3.11. The maximum temperature standard for designated sites of 28ºC as a 98^{th} percentile has a better evidence link, as it is known that the upper lethal temperature for many benthic organisms is in the range 30-33°C (Ref. 5.4). **Figure 5.3** shows the predicted extent of the 98^{th} percentile thermal plume where the surface water temperature exceeds a 2°C and 3°C increase once Sizewell C is operational in conjunction with Sizewell B. **Figure 5.4** shows the predicted extent of the 98^{th} percentile thermal plume during the operation of Sizewell C alone, following the decommissioning of Sizewell B.

5.3.12. Thermal discharges, for the main part, affect species that live within the water column. The thermal plume is buoyant, caused by the lower density

[8] The mixing zone, as used by UK regulators, is the area around a discharge within which a regulator permits a quality standard to be exceeded (BEEMS, 2011).

of the warmer water causing the heated effluent to rise in an inverted cone towards the surface, thus limiting the likelihood of contact with the seabed. The seabed immediately beneath the plume, therefore, receives little warming effect. As the plume spreads, the temperature falls rapidly as a result of dilution and loss to the atmosphere. Therefore, where the plume does make contact with the seabed downstream, it is at a much-reduced temperature.

5.3.13. The area predicted to be exposed to temperatures of more than 28°C as a 98th percentile by the GETM model is predicted to be of a negligible extent for the operational discharge of Sizewell C alone, i.e. no exceedance of 28°C (98 percentile) at the surface and seabed. Exceedance of the 2°C MAC (as a 100th percentile), however, is predicted to cover an area of 16,775 ha at the surface and 12,244 ha at the seabed, as a result of the operational discharge of Sizewell C.

5.3.14. The assessment of effects from the thermal plume on habitats has been undertaken based on the addition of the Sizewell C discharge only, as the water temperature increase caused by the Sizewell B thermal plume forms part of the baseline, i.e. Sizewell B has been operational since 1995; therefore, habitats in contact with the Sizewell B plume are habituated to it. However, it is acknowledged that a small synergistic effect would arise at the interface between the Sizewell B and Sizewell C plume. Therefore, to ensure that all effects are captured, the extent of the thermal plume of Sizewell C in conjunction with Sizewell B has been used to carry out the screening assessment of SAC and Ramsar sites for habitat qualifying features.

5.3.15. From **Figure 5.3** it can be seen that the ZOI of the thermal plume (as a 98th percentile of excess temperature) for the operation of Sizewell C, in conjunction with the operation of Sizewell B, extends approximately 15 km to the north and 18 km to the south of the discharge point. **Table 5.2** considers all of the SACs and Ramsar sites scoped into this assessment in terms of the potential for LSE to qualifying habitats associated with the thermal plume; and lists those four European sites (and their habitat qualifying interests) for which a LSE could not be excluded based on the predicted extent of the thermal plume. These sites and features are considered in the AA stage.

iii. Chemical Discharges

5.3.16. Modelling for the chemical discharge was also undertaken using the validated GETM model of Sizewell, as presented in BEEMS Technical Reports TR301 and TR302 (Ref. 5.7 and Ref. 5.3). This model was chosen to support the chemical modelling because of its ability to reproduce the natural variability due to meteorological and tidal conditions. The modelling shows that there would be no interaction between the Sizewell B and Sizewell C chemical plumes. **Figures 5.5** to **5.7** show the extent of the plume generated by each chemical modelled; **Table 5.1** provides the area (ha), at seabed and surface, exceeding the EQS/predicted no-effect concentration (PNEC) for total residual oxidants (TRO), bromoform and hydrazine modelled plumes.

5.3.17. Chlorination of the Power Station cooling water system is required to avoid biofouling. The TRO predicted to result from the combination of chlorine and organic material in the water were modelled using an empirical demand/decay formulation derived from experiments with Sizewell seawater coupled into the GETM Sizewell model (Ref. 5.8; **Figure 5.5**). A discharge of 132 m^3s^{-1} has been modelled for TRO for Sizewell C (Ref. 2.2). **Figure 5.5** shows the extent of the TRO plume areas at the relevant environmental quality standard (EQS), i.e. 10 μgl^{-1} as a 95th percentile MAC (Ref. 5.9). The area exceeding the EQS at the seabed is approximately 2 ha and 337 ha at the sea surface.

Table 5.1 Absolute areas exceeding the EQS/PNEC values at the surface and seabed from TRO, bromoform and hydrazine discharges (Ref. 2.2)

Discharge	Surface (ha)	Seabed (ha)
TRO – 132 m^3s^{-1} discharge scenario EQS = 10 µg/l as a 95%ile	336.65	2.13
Bromoform – PNEC of 5 µg/l as a 95%ile	52.14	0.67
Hydrazine - 69 ng discharge scenario (worst-case) PNEC = 4 ng/l (acute, as 95%ile)	13.79	0.22
Hydrazine - 34 ng discharge scenario PNEC = 4 ng/l (acute, as 95%ile)	17.38	0.00

5.3.18. Due to the water chemistry at Sizewell, bromoform is the predominant chlorinated by-product. Since bromoform is a product of chlorination, the same modelling scenarios as for TRO were considered. There is no published EQS for bromoform so a calculated PNEC of 5 μgl^{-1} as a 95 percentile was used (Ref. 2.2). The amount of bromoform that is discharged mainly depends on the amount of chlorine that is added, but also on the amount of mixing at the outfall. **Figure 5.6** shows the predicted extent of the bromoform plume for Sizewell C. The bromoform plume that exceeds the PNEC is approximately 52 ha at the sea surface and 0.2 ha at the seabed.

5.3.19. Hydrazine is an oxygen scavenger used in power plants to inhibit corrosion in steam generation circuits. There is evidence that hydrazine is harmful to aquatic organisms at low concentrations, with a low to moderate persistence within the marine environment, depended upon its concentration and the receiving water quality. There is no established EQS for hydrazine so a chronic PNEC of 0.4 ngl^{-1} has been calculated for long-term discharges (calculated as the mean of the concentration values) and an acute PNEC of 4 ngl^{-1} for short term discharge (represented by the 95th percentile). A hydrazine discharge of 69 ngl^{-1} in daily pulses of 2.32 hours starting at 12pm was used as the worst-case scenario. **Figure 5.7** shows the extent of the hydrazine plume at Sizewell C. The acute PNEC (i.e. 95th percentile) of the worst-case scenario discharge is exceeded at the surface by approximately 18 ha and by less than 1 ha at the seabed.

5.3.20. From **Figure 5.4**, it can be it can be seen that the extent of the TRO plume is the largest of all three chemical discharge plumes. However, the EQS edge of the TRO plume (as well as bromoform and hydrazine) does not interact with any of the qualifying habitat features of the SACs and Ramsar sites scoped into the WDA Shadow HRA. Therefore, for the qualifying features of the six SACs and Ramsar sites scoped in for marine habitats, Chemical Discharges can be screened out from further assessment.

iv. Effluent from the FRR system

5.3.21. The FRR system is designed to minimise impacts on impinged fish and invertebrate populations. However, some species are highly sensitive to mechanical damage caused during passage through the cooling water intakes, drum screens and FRR channels and incur high mortality rates.

5.3.22. The return of dead and moribund biota retains biomass within the marine system but represents a source of organic loading, with potential for increase nutrient inputs, increased un-ionised ammonia and reductions in dissolved oxygen are considered. Pressures with the potential to affect marine water quality and sediment are presented in **Table 5.2**.

Table 5.2: Pressures associated with discharges from the FRR

Pressure	Activities resulting in pressure	Assessed	Justification
Reductions in dissolved oxygen	Discharge of dead and moribund biota	Yes	Decaying biomass would increase the BOD 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 Greater Sziewell Bay 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 BOD from biomass discharged from the FRRs is predicted to have a negligible effect on water quality.
Increases in nutrient inputs	Discharge of dead and moribund biota	Yes	The breakdown of organic material would release nitrogen and phorporous into the system. During periods of nutrient limitation increases in nutrient availability has the potential to enhance phytoplankton biomass.
Increases in un-ionised ammonia	Discharge of dead and moribund biota	Yes	Decaying biomass would release ammonia into the systems. The ambient conditions and rate of discharge would influence the levels on un-ionised ammonia. Assessments consider seasonal un-ionised

5.3.23. Therefore, this pathway of effect is screened in to the AA for coastal habitats of SACs and Ramsar sites.

v. Summary

5.3.24. **Table 5.3** provides details of the scoped in SACs that have habitats as qualifying interest features and whether there is LSE on these qualifying features from water discharge activities of Sizewell C. For these sites, it is not possible to exclude potential LSE associated with Sizewell C Operational WDA and, therefore, they are taken through to the AA stage.

Table 5.3 Determination of European sites and habitat qualifying features where the potential for LSE exists

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
1	Alde-Ore and Butley Estuaries SAC	• Estuaries	Yes	No	Yes	This feature, and the species that make up this feature, may be affected by changes to water temperature and changes to water quality due to the return of dead and moribund biota from the FRR system. The feature is out with the extent of the predicted chemical discharge plumes; therefore, there is no effect pathway.
		• Mudflats and sandflats not covered by seawater at low tide	Yes	No	Yes	This feature, and the species that make up this feature, may be affected by changes to water temperature and changes to water quality due to the return of dead and moribund biota from the FRR system. The feature is out with the extent of the predicted chemical discharge plumes; therefore, there is no effect pathway.
		• Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Yes	No	Yes	This feature, and the species that make up this feature, may be affected by changes to water temperature and changes to water quality due to the return of dead and moribund biota from the FRR system. The feature is out with the extent of the predicted chemical discharge plumes; therefore, there is no effect pathway.
2	Alde-Ore Estuary Ramsar site	• Ramsar criterion 2 - the site supports a number of nationally-scarce plant species and British Red Data Book invertebrates.	Yes	No	Yes	The site supports species characteristic of marine habitats, including the seagrass *Zostera angustifolia*. Therefore, LSE cannot be excluded from changes to water temperature and changes to water quality due to the return of dead and moribund biota from the FRR system.

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
						The features that met Ramsar criterion 2 are out with the extent of the predicted chemical discharge plumes; therefore, there is no effect pathway.
3	Benacre to Easton Bavents Lagoons SAC	All qualifying interest features	No	No	No	The SAC is out with the extent of the predicted thermal and chemical plumes; therefore, there are no effect pathways.
4	Minsmere to Walberswick Heaths and Marshes SAC	All qualifying interest features	No	No	No	The features of this SAC are on or above Mean High Water Springs (MHWS); therefore, there are no effect pathways from the predicted thermal and chemical plumes to the qualifying interest features. The water levels in the marshes are controlled by a sluice that is opened to allow drainage of water from three channels (Minsmere River (New Cut), Scott's Hall Drain and Leiston Drain) into the sea to prevent tidal flooding of the Minsmere Valley from the sea. As the sluice is designed to discharge water into the sea and to prevent flooding from the sea, the potential for the discharge to have an impact upon the SAC marshes is very low. Therefore, this pathway of effect is screened out.
5	Minsmere-Walberswick Ramsar site	• Ramsar criterion 1 - the site contains a mosaic of marine, freshwater, marshland and associated habitats complete with transition areas in between. It also contains the largest continuous stand of reedbed in England	Yes	No	Yes	The marine features of the Ramsar site may be affected by the predicted thermal plume and changes to water quality due to the return of dead and moribund biota from the FRR system; therefore, LSE cannot be excluded. The features that met Ramsar criterion 1 are out with the extent of the predicted chemical discharge plumes; therefore, there is no effect pathway.

No	Site name	Qualifying interest feature	LSE? Thermal Discharge	Chemical Discharge	FRR Discharge	Discussion
		and Wales, and rare transition in grazing marsh ditch plants from brackish to fresh water.				
		• Ramsar criterion 2 - this site supports nine nationally scarce plants and at least 26 red data book invertebrates. It supports a population of the mollusc narrow-mouthed whorl snail *Vertigo angustior* (Habitats Directive Annex II; British Red Data Book Endangered), recently discovered on the Blyth estuary river walls.	No	No	No	The plants and invertebrates listed within criterion 2 are not marine species and there is no effect pathway from the predicted thermal and chemical plumes to these species. Therefore, there is no LSE for this criterion.
6	Orfordness-Shingle Street SAC	• Coastal lagoons	Yes	No	No	The coastal lagoons at this site are not a marine feature as they occur landward of HAT. However, the salinity of the lagoons is maintained by percolation through the shingle, whilst at high tides sea water can overtop the shingle bank. There is, therefore, a potential effect pathway to this feature

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
						from the predicted thermal plume, but not the chemical plumes (given their predicted extents) or the changes in water quality form dead or moribund data discharged from the FRR system (due to the distance of the site). In line with the precautionary principle, the thermal plume has been screened in for consideration in the AA.
		• Annual vegetation of drift lines	No	No	No	The feature occurs on the sheltered, western side of the spit at the transition from shingle to saltmarsh; therefore, there is no effect pathway to this feature from the predicted thermal and chemical plumes.
		• Perennial vegetation of stony banks	No	No	No	There is no effect pathway from the predicted thermal and chemical plumes to the qualifying interest feature.

c) Birds

i. Potentially affected qualifying species

5.3.22. Water discharge activities have the potential to affect marine or piscivorous birds, mainly through secondary effects on their prey species, i.e. fish. From the European sites scoped into the screening process, the following qualifying features can be classified as marine birds:

- Little tern *Sternula albifrons*
- Sandwich tern *Thalasseus sandvicensis*
- Common tern *Sterna hirundo*
- Lesser black-backed gull *Larus fuscus*
- Red-throated diver *Gavia stellate*

5.3.23. The screening exercise has determined that there are no terrestrial birds qualifying features, and their supporting habitats, that are adversely affected by the water discharge activities of the Sizewell C Project.

ii. Thermal discharge

5.3.24. **Section 5.3 b ii** provides the threshold values of thermal uplift of waters within European designated sites.

5.3.25. A number of thermal preference experiments have shown that thermal plumes can cause fish species to avoid an area and, therefore, there is a possibility that the thermal plume could act as a barrier to migration. Thermal standards for transitional waters, as outlined by UKTAG, specify that an estuary's cross section should not have an area larger than 25% with a temperature uplift of more than 2°C, for more than 5% of the time (Ref. 5.2). 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. Furthermore, studies have shown that temperature increases of >2°C may not be a significant deterrent to the movement of a number of important species (Ref. 5.2).

5.3.26. There is the possibility that avian prey species will avoid areas of the thermal plume and this may reduce the feeding opportunities for marine birds.

iii. Chemical discharges

5.3.27. **Figure 5.5** – **Figure 5.7** show the extent of the chemical discharge plumes for TRO, bromoform and hydrazine, respectively. Like thermal plumes, fish may avoid areas with elevated levels of chemicals in the water column, particularly those like chlorine and its' by-products, which can cause irritation of the skin or other sensitive organs such as gills. This can cause a reduction in feeding opportunities for marine birds.

5.3.28. Therefore, it is not possible to rule out LSEs arising from the discharge of chemicals during the operation of Sizewell C on bird qualifying features through indirect/secondary effects on their prey species (i.e. fish).

iv. Effluent from the FRR system

5.3.29. Opportunistic gull species, such as the lesser black-backed gull, are present in the area of the FRR system discharge. As such, dead and moribund biota entering the Greater Sizewell Bay may result in a foraging opportunity for the gull.

5.3.30. There is potential for some beneficial effect to the Alde, Ore Estuaries lesser black-backed gull population and the gull species associated with the Minsmere-Walberswick Ramsar site; however, these species have large marine foraging ranges and exploit terrestrial, as well as marine habitats. As such, any beneficial effects are likely to be highly localised and would be unlikely to have population-level consequences.

5.3.31. Therefore, this effect pathway has been screened out with regard to potential effects on the qualifying features of the scoped in SPAs and Ramsar sites.

v. Summary

5.3.32. **Table 5.4** provides details of the scoped in SPAs and Ramsar sites that have marine birds as qualifying interest features and whether there is LSE on these qualifying features from water discharge activities of Sizewell C. For these sites, it is not possible to exclude potential LSE associated with Sizewell C Operational WDA and, therefore, they are taken through to the AA stage.

Table 5.4 Determination of European sites and habitat qualifying features where the potential for LSE exists

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
1	Alde-Ore Estuary SPA	• Little tern	Yes	Yes	N/A	There is the possibility of little tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of little tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both little tern and its prey species.
		• Sandwich tern	Yes	Yes	N/A	There is the possibility of Sandwich tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of Sandwich tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both Sandwich tern and its prey species.
		• Lesser black-backed gull	Yes	Yes	No	There is the possibility of lesser black-backed gull avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, which in turn also reduces the feeding opportunities for lesser black-backed gulls.

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
						Likewise, the chemical plume may create areas of avoidance for both lesser black-backed gull and its prey species. The discharge of dead and moribund biota from the FRR system was determined not to be significant and is, therefore, screened out of the AA.
		• All other qualifying interest features	No	No	N/A	The rest of the qualifying interest features of the Alde-Ore Estuary SPA are not marine birds and are, therefore, outwith the extent of the predicted thermal and chemical discharge plumes. Therefore, there is no effect pathway.
2	Alde-Ore Estuary Ramsar site	Ramsar criterion 6 - species/populations occurring at levels of international importance: Breeding: • Lesser black-backed gull.	Yes	Yes	No	There is the possibility of lesser black-backed gull avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, which in turn also reduces the feeding opportunities for lesser black-backed gulls. Likewise, the chemical plume may create areas of avoidance for both lesser black-backed gull and its prey species. The discharge of dead and moribund biota from the FRR system was determined not to be significant and is, therefore, screened out of the AA.
		• All other qualifying criteria	No	No	N/A	The rest of the qualifying criteria of the Alde-Ore Estuary Ramsar site are not marine birds and are, therefore, outwith the extent of the predicted thermal and chemical discharge plumes. Therefore, there is no effect pathway.

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
3	Benacre to Easton Bavents SPA	Breeding: • Little tern.	Yes	Yes	N/A	There is the possibility of little tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of little tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both little tern and its prey species.
		• All other qualifying interest features	No	No	N/A	The rest of the qualifying interest features of Benacre to Easton Bavents SPA are not marine birds and are, therefore, outwith the extent of the predicted thermal and chemical discharge plumes. Therefore, there is no effect pathway.
4	Minsmere-Walberswick SPA	Breeding: • Little tern.	Yes	Yes	N/A	There is the possibility of little tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of little tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both little tern and its prey species.
		• All other qualifying interest features	No	No	N/A	The rest of the qualifying interest features of the Minsmere-Walberswick SPA are not marine birds and are, therefore, outwith the extent of the predicted thermal and

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
						chemical discharge plumes. Therefore, there is no effect pathway.
5	Minsmere-Walberswick Ramsar site	• Ramsar criterion 2	Yes	Yes	No	The marine breeding birds of the Ramsar site, e.g. little tern, black-headed gull and Mediterranean gull, may be adversely affected by the discharge of the thermal and chemical plume. Therefore, this criterion has been screened in. The discharge of dead and moribund biota from the FRR system was determined not to be significant and is, therefore, screened out of the AA.
6	Outer Thames Estuary SPA	Breeding: • Little tern.	Yes	Yes	N/A	There is the possibility of little tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of little tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both little tern and its prey species.

No	Site name	Qualifying interest feature	LSE?			Discussion
			Thermal Discharge	Chemical Discharge	FRR Discharge	
		• Common tern.	Yes	Yes	N/A	There is the possibility of common tern avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of common tern as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both common tern and its prey species.
		Over-winter: • Red-throated diver.			N/A	There is the possibility of red-throated diver avoiding the areas of thermal increase thus possibly reducing feeding opportunities. The thermal plume may also potentially affect the availability of fish, as a prey species, within the feeding areas of red-throated diver as the fish may also avoid areas of thermal increase. Likewise, the chemical plume may create areas of avoidance for both red-throated diver and its prey species.

d) Marine mammals

i. Thermal discharge

5.3.33. **Section 5.3 b ii** provides the threshold values of thermal uplift of waters within European designated sites.

5.3.34. The thermal plume associated with the cooling water operational discharge may alter water quality properties such that local displacement of marine mammals and small-scale behavioural effects in local fish communities may occur (due to the potential for avoidance of warmer waters); altering the spatial distribution of the fish assemblage, which could have an impact on the available prey species for marine mammals.

5.3.35. A review of the available evidence concerned with the thermal effects on fish concluded that the adverse effects associated with cooling water outfalls would be localised and restricted to the immediate area of the thermal plume (Ref 5.5). The review also found that temperature rises of up to 3°C are acceptable for fish species and that temperatures of below 27°C have no lethal effect. However, the thermal plume may have effects on local fish populations if they are exposed over an extended period of time. Fish species may show different survival, growth and reproduction behaviours as they become further exposed to a thermal plume. Fish species may also become habituated to the thermal plume. Relevant threshold values are set out in **Section 5.3 b**.

5.3.36. Depending on the prey species, temperature may have a positive, negative or neutral effect on fish. Langford (1990) examined data from power plant studies around the world and found no instance of direct fish mortalities associated with a power plant outfall (Ref. 5.10). Potential effects, therefore, are more likely to be active thermal avoidance or attraction (where displacement of fish through thermal avoidance is likely to be driven by displacement of their prey), changes in growth rate or the modification of community structure resulting from warm-water species being favoured over cold-water species. Furthermore, pelagic species utilise the full water column and are more able to move to new feeding grounds when compared with demersal species that may be more reliant on specific habitat types.

5.3.37. Therefore, a LSE cannot be excluded for direct effects on marine mammals or indirect effects on marine mammal prey species; that is, for harbour porpoise in the Southern North Sea SAC, grey seal from the Humber SAC or harbour seal from The Wash and North Norfolk Coast SAC. This is summarised in **Table 5.5**.

ii. Chemical discharges

5.3.38. The chemical plumes associated with the discharge may alter water quality properties such that local displacement of marine mammals and small-scale behavioural effects on local fish communities may occur (due to avoidance of a reduction in water quality), altering the spatial distribution of the fish assemblage. This could change the availability of potential prey species for marine mammals.

5.3.39. **Figures 5.5 to 5.7** above show the extent of the chemical discharge plumes for TRO, bromoform and hydrazine, respectively. Like thermal plumes, marine mammals and their prey species may avoid areas with elevated levels of chemicals in the water column, particularly chlorine and its’ by-products, which can cause irritation of the skin or other sensitive organs, such as gills. This could change to the availability of potential prey species for marine mammals. Therefore, a LSE cannot be excluded at this stage for either direct effects on harbour porpoise in the Southern North Sea SAC, grey seal from the Humber SAC and harbour seal from The Wash and North Norfolk Coast SAC, or for indirect effects on their prey species.

iii. Effluent from the FRR system

5.3.40. The return of dead and moribund biota retains biomass within the system and represents a potential source of food for marine mammals.

5.3.41. The total biomass of moribund biota predicted to be discharged from the FRR has been estimated based on abstraction rates and information on the seasonal abundance of species impinged for the existing Sizewell B station. The data shows seasonal variation in the discharge of moribund fish. The highest discharge biomass would occur in December to April, when clupeids are most abundant, with peaks in abundance in March. During March, mean daily discharges of biomass of 3442 kg/d are predicted from the FRR systems. Between April to September, a lower mean daily discharge biomass of 4.5 kg is predicted with an annual average of 1065 kg/d (see **Volume 2, Chapter 22** of the **ES**).

5.3.42. There are no reports of harbour porpoises consuming dead prey in the wild and it is widely acknowledged that they actively engage in targeting live prey. No aggregations of harbour porpoises have been reported around Sizewell B suggesting that such easy feeding opportunities are not being exploited. Therefore, this pathway of effect has been screened out of the AA for the Southern North Sea SAC.

5.3.43. Seals are reported to consume fishery discards or dying fish entangled in fishing nets, and dead or moribund fish near the FRR could constitute an easy feeding opportunity. This would particularly be the case for the grey seals given that they exhibit a greater level of flexible and opportunistic feeding habits. However, there is no evidence of seal aggregations around Sizewell B which already discharges fish from its outfall. Therefore, this pathway of effect has been screened out of the AA for the Humber Estuary and The Wash and Norfolk Coast SACs.

iv. Summary

5.3.44. **Table 5.5** provides details of the scoped in SACs that have marine mammals as qualifying interest features and whether there is LSE on these qualifying features from water discharge activities of Sizewell C. For these sites, it is not possible to exclude potential LSE associated with Sizewell C Operational WDA and, therefore, they are taken through to the AA stage.

Table 5.5 Determination of European sites and habitat qualifying features where the potential for LSE exists

No	Site name	Qualifying interest feature	LSE?		Discussion
			Thermal Discharge	Chemical Discharge	
1	Humber Estuary SAC	• Grey seal	Yes	Yes	The thermal and chemical plumes may cause the local displacement of marine mammals and cause small-scale behavioural effects in local fish communities thus impacting the availability of prey species for grey seals.
		• All other qualifying interest features	No	No	The rest of the qualifying interest features of the Humber Estuary SAC are outwith the extent of the predicted thermal and chemical discharge plumes; therefore, there is no effect pathway.
2	Southern North Sea SAC	• Harbour porpoise	Yes	Yes	The thermal and chemical plumes may cause the local displacement of marine mammals and cause small-scale behavioural effects in local fish communities thus impacting the availability of prey species for harbour porpoise.
3	The Wash and Norfolk Coast SAC	• Harbour seal	Yes	Yes	The thermal and chemical plumes may cause the local displacement of marine mammals and cause small-scale behavioural effects in local fish communities thus impacting the availability of prey species for harbour seals.
		• All other qualifying interest features	No	No	The rest of the qualifying interest features of The Wash and Norfolk Coast SAC are outwith the extent of the predicted thermal and chemical discharge plumes; therefore, there is no effect pathway.

5.4 Findings of the alone Stage 1 screening exercise

5.4.1. The European site scoping exercise identified 13 European sites for inclusion in the LSE screening assessment, as identified in **Table 4.1**.

5.4.2. For each qualifying feature of these European sites, the screening exercise assessed whether or not a LSE for the Project alone had the potential to arise from the activities associated with the operational WDA.

5.4.3. The LSE assessment identified 11 sites for which LSE could not be excluded for the operational phase of the Sizewell C Project alone; the Benacre to Easton Bavents SAC and Minsmere to Walberswick Heaths and Marshes SAC were screened out due to no pathway of effect occurring from the water discharge activities. These 11 sites have, therefore, been carried forward into the 'AA' stage of the HRA process (see **Chapter 7**, **Chapter 8** and **Chapter 9** of this report), where those effects that have the potential to have a significant influence on those qualifying features 'screened in' have been considered further (all other potential effects and qualifying features being excluded from further examination).

5.5 Screening of in-combination effects

5.5.1. The screening exercise carried out for the Sizewell C Project DCO HRA identified a 'long list' of plans or projects that potentially could cause a likely significant in-combination effect (LSIE) with the construction and operation the Sizewell C Nuclear Power Station. In this context, potential decommissioning effects are considered to be undefinable.

5.5.2. A search of the Planning Inspectorate's NSIP website, the MMO's Public Register, relevant Local Authority planning portals (within the Project's wider ZOI) and a review of relevant Development Plans (and emerging Development Plans) was undertaken. However, it is only possible to assess proposals where there is sufficient available information to allow an in-combination assessment to be undertaken. Therefore, the search focused on proposals for which a planning application had been made/was valid or for which there was a current planning permission. An exception to this was any proposals identified during Stages 1, 2 and 3 of Pre-Application Consultation for which information was publicly available prior to a planning application being made.

5.5.3. Not all of the projects identified from the planning search have the potential to have in-combination effects with the water discharge activities of the Sizewell C Project. That is, there are certain types of development that are considered to be insignificant in nature and scale (e.g. change of use or conversions to existing buildings and erection of agricultural buildings) and, as such, are unlikely to have the potential to contribute to significant in-combination effects. These types of development were, therefore, scoped out.

5.5.4. It is also acknowledged that some plans and projects may cause effects at a significant distance from the source because some ecological receptors are highly mobile. Hence, plans and projects were considered for inclusion in the LSIE screening exercise where they had the potential to affect the same qualifying interest features of European sites, irrespective of the distances between the sources of such effects.

5.5.5. **Table B.1 (Appendix B**) provides details of each of the plans and projects that it was considered could act in-combination with the predicted effects of the water discharge activities of the Sizewell C Project and justifies whether the plan/project was screened in (and will be considered in the AA in-combination assessment) or out (and will not). The European sites for which a potential in-combination effect could occur are also listed in **Table B.1**.

6 DESCRIPTION OF BASELINE CONDITIONS

6.1 Introduction

6.1.1. The following sections describe those European sites and their associated qualifying features for which a LSE cannot be excluded (as previously summarised in **Chapter 5**), and summarise the available information and evidence used for the appropriate assessment of the operational WDA permit application. A summary of relevant baseline information is, therefore, presented in this section for:

- coastal habitats;
- birds;
- marine mammals; and
- fish.

6.2 Coastal habitats

a) Alde, Ore and Butley Estuaries SAC

i. Estuaries

6.2.1. The estuary complex is made up of three rivers, the Alde, the Ore and Butley, and covers an area of 1,076 ha, 0.34% of the total area of estuaries in the UK (Ref. 6.1).

6.2.2. The upper Alde is relatively shallow and meanders through extensive intertidal mudflats, which stretch across 1.5 km between Iken marshes and Blackheath. Mixed salinity sandy mud dominates, with widespread bivalve communities. At the head of the Alde, the muddy substrate supports mainly estuarine communities dominated by polychaete worms. Subtidal sediments here are primarily muddy (Ref. 6.2). Saltmarsh is present along the length of the river channel and along the north shore at Blackheath and Little Japan. South of Aldeburgh, the River Alde becomes the River Ore. Here the channel narrows and deepens, creating stronger currents and narrower mudflats along the shores with subtidal sediments becoming mixed. Recent evidence has found aggregations of ross worm *Sabellaria spinulosa* on subtidal mixed sediment near Havergate Island (Ref. 6.1).

6.2.3. Butley Creek is smaller and contains extensive saltmarsh in the upper reaches and western shore of the river with reedbeds bordering the intertidal mudflats. It flows into the River Ore at Boyton Marshes. The River

Ore splits to flow around Havergate Island, which is made up of important coastal lagoon and saltmarsh habitats (Ref. 6.3; Ref. 6.4).

6.2.4. The shallow waters of the estuary provide an important feeding area for little tern, Sandwich tern and lesser black-backed gull, with main prey items including sprat, sandeels and the small fry of other fish. The terns feed both within the estuary and along the coastal strip within site, as well as feeding further out to sea along the coast. Little terns will also feed on small crustaceans, molluscs and marine worms.

ii. Mudflats and sandflats not covered by seawater at low tide

6.2.5. At the time of designation, the area of mudflats and sandflats within the site was 6.25km^2, which represented 0.2% of the UK's total extent of the feature (Ref. 6.1). A study carried out in 2014 showed the extent to have decreased to approximately 5.55km^2 (Ref. 6.5).

6.2.6. The invertebrate communities of the mudflats and sandflats at the site are extremely diverse (Ref. 6.6). Muddy substrata at the head of the Alde is supported by typical upper estuary communities dominated by polychaetes and amphipods (Ref. 6.7). The bivalve Baltic tellin *Macoma balthica* and the polychaete fanworm *Manayunkia aestuarina* are especially abundant in the mudflats and sandflats of the Alde, where the mud shrimp *Corophium volutator* and mud snail *Peringia ulvae* are also frequently observed. Sandy substrates support high densities of blow lug worm *Arenicola marina* and the rare tentacled lagoon worm *Alkmaria romijni* has been found at Butley Creek, Sudbourne and near Stoney Ditch on Orford Ness (Ref. 6.7). Fucoid seaweeds are also found scattered in narrow strips and on buried features throughout the flats.

6.2.7. Intertidal coarse sediment within the site consists of localised areas of barren littoral shingle at the mouth of the River Ore, where higher exposure to wave energy and tidal scour has reduced the proportions of fine and silty sediments present. Intertidal coarse sediment communities include species of ribbon worms (Nemertea), round worms (Nematoda), and bivalves. These communities are, however, sparse and highly variable, and are potentially present after being washed down from muddier habitat types located higher in the estuary or adjacent shores (Ref. 6.5).

6.2.8. The intertidal mixed sediment within the site is most prevalent on the banks of the Ore where it often occupies the full extent of intertidal area. Here the Alde, Butley and Ore systems meet, resulting in strong tidal scouring at all shore heights, restricting the settlement of finer sediments. Additional isolated patches of mixed sediment are also present along the lower shore of the Alde, where localised areas of tidal scour occur on otherwise sheltered banks, such as adjacent to Cobb Island. Intertidal mixed sediment communities within the site are characterised by abundant numbers of polychaete worms, including cirratulids (mostly *Aphelochaeta* species) and ragworm *Hediste diversicolor*, and the common occurrence of tubificid oligochaete worms. In one small area of mixed sediment in the lower Ore, abundant numbers of the mud shrimp *Corophium volutator* have also been found (Ref. 6.5).

6.2.9. Intertidal mud is the most common form of littoral sediment found within the site and is distributed throughout the Rivers Alde, Ore and Butley with the exception of the Lower Ore where currents restrict the settlement of finer sediments. In the Upper Alde, intertidal mud is found across comparatively broader banks compared to the rest of the site, with banks here stretching up to around 500 m from the lower to the upper shore. Intertidal mud communities support a range of species but are largely characterised by the presence of ragworm *Hediste diversicolor*, Baltic tellin *Macoma balthica* and peppery furrow shell *Scrobicularia plana*. Along the narrower upper reaches of the Alde, where intertidal mud communities are more heavily influenced by freshwater, the mud shrimp *Corophium volutator* is particularly abundant due to its tolerance of variable salinity conditions (Ref. 6.5).

6.2.10. Intertidal sand and muddy sand is limited to two localised areas on the lower shores of the Upper Alde above which the broad intertidal mud banks are found. These patches of intertidal sand and muddy sand are located near areas where the effects of tidal scour are more evident. These contain slightly larger proportions of very fine to coarse sands than surrounding sediments from which the fine sediments have eroded. Intertidal sand and muddy sand communities have been found to support communities of edible cockle *Cerastoderma edule* and polychaetes (Ref. 6.5).

iii. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

6.2.11. Narrow fringes of saltmarsh occur along the length of the estuary with wider expanses at Shingle Street, Havergate Island, Stony Ditch, the upper reaches of the Butley river and in places by the Alde river. These are mostly dominated by sea purslane, *Halimione portulacoides* and sea lavender, *Limonium vulgare*, but a wide range of other saltmarsh species also occur including sea heath, *Frankenia laevis*, glasswort, *Salicornia pusilla* and small cord grass, *Spartina maritima*. Higher saltmarsh grading into neutral grassland, dominated by sea couch grass, *Elymus pungens*, occurs on Havergate Island and Orfordness and on the extensive system of clay embankments throughout the site.

6.2.12. The Atlantic salt meadows feature comprises the following saltmarsh zones: low-mid marsh, upper marsh and transition and drift line marsh. The low-mid marsh is characterised by species-poor community NVC SM13, dominated by common saltmarsh grass. This community often develops from SM10 communities (transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*) where land is inundated less frequently (Ref. 6.8). The upper marsh displays the Sea wormwood *Artemisia maritima* and NVC SM17 saltmarsh community (*Artemisia maritima* saltmarsh community) throughout the entire estuary. Transition and drift line saltmarsh is abundant along the sea wall and upper transition zones where there is no sea wall present. Transitional zones with abundant SM24 community (*Elymus pycnanthus* saltmarsh community) are found in the upper most reaches of the Alde and Butley rivers. This is an important community as it holds a range of rare invertebrates, particularly the narrow-mouthed whorl snail *Vertigo angustior* and grey bushcricket *Platycleis albopunctata*.

6.2.13. Other plant species of note include slender hare's-ear *Bupleurum tenuissimum*, shrubby sea-blite *Suaeda vera*, golden samphire *Inula crithmoides*, and the only record of extended sedge *Carex extensa* in Suffolk. The nationally important population of small cordgrass *Spartina maritima* is scattered across the SAC but declining in extent. The diverse vegetation provides feeding opportunities for redshank, avocet, and other water birds (Ref. 6.8).

6.2.14. A site condition assessment carried out in 2010 shows that the majority of the site units designated as mudflats and sandflats and saltmarsh have been assessed as being either in favourable condition or unfavourable but recovering condition. At five areas, the site has been assessed as being unfavourable with no change[9].

b) Alde-Ore Estuary Ramsar site

i. Ramsar criterion 2

6.2.15. Alde-Ore Estuary Ramsar site qualifies under Ramsar criterion 2, which states:

[9] Natural England Alde-Ore Estuary SSSI condition assessment: https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S1003208&ReportTitle=Alde-Ore%20Estuary%20SSSI [accessed 25/04/2019).

"A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities."

6.2.16. More specifically, the site qualifies under Ramsar criterion 2 by supporting a number of nationally-scarce plant species and British Red Data Book invertebrates.

6.2.17. Noteworthy flora at the site include: marsh-mallow *Althaea officinalis,* common sea heath *Frankenia laevis,* beach pea *Lathyrus japonicus,* perrenial pepperweed *Lepidium latifolium, Medicago minima,* coast barbgrass *Parapholis incurva,* salt grass *Puccinellia fasciculata,* spiral tasselweed *Ruppia cirrhosa,* samphire *Sarcocornia perennis,* marsh sowthistle *Sonchus palustris,* suffocated clover *Trifolium suffocatum,* yellow vetch *Vicia lutea and* eelgrass *Zostera angustifolia*.

6.2.18. The nationally important and highly-specialised invertebrate fauna of the saline lagoons includes *Nematostella vectensis*, and *Gammarus insensibilis*, both species protected under Schedules 5 and 8 of the Wildlife and Countryside Act 1981 (as amended).

6.2.19. Other notable invertebrates on the site include ground lackey *Malacosoma castrensis,* fancy-legged fly *Campsicnemus magius,* hoverfly *Cheilosia velutina, Empis prodomus,* meniscus midge *Dixella attica, Hylaeus euryscapus,* swollen spire snail *Pseudamnicola confusa, Euophrys browningi, Baryphyma duffeyi,* ground spider *Haplodrassus minor, Trichoncus affinis*.

ii. Ramsar criterion 3

6.2.20. Alde-Ore Estuary Ramsar site qualifies under Ramsar criterion 3, which states:

"A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region."

6.2.21. Within the Alde-Ore Estuary Ramsar site, this criterion has been designated as the site supports a notable assemblage of breeding and wintering wetland birds. The baseline for the bird populations can be found in **Section 6.3** below. The baseline for the habitats supporting these birds is described within the Alde, Ore and Butley Estuaries SAC baseline in **Section 6.2 a** above.

iii. Ramsar criterion 6

6.2.22. Alde-Ore Estuary Ramsar site qualifies under Ramsar criterion 6, which states:

> *"A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird."*

6.2.23. Within the Alde-Ore Estuary Ramsar site, this criterion has been designated as the site supports bird species/populations occurring at levels of international importance. The baseline for the bird populations can be found in **Section 6.3** below. The baseline for the habitats supporting these birds is described within the Alde, Ore and Butley Estuaries SAC baseline in **Section 6.2 a** above.

c) Minsmere-Walberswick Ramsar site

i. Ramsar criterion 1

6.2.24. Minsmere-Walberswick Ramsar site qualifies under Ramsar criterion 1, which states:

> *"A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region."*

6.2.25. This composite Suffolk coastal site contains a complex mosaic of habitats notably, areas of marsh with dykes, extensive reedbeds, mud flats, lagoons, shingle, woodland and areas of lowland heath. The site supports the largest continuous stand of reed *Phragmites australis* in England and Wales and nationally rare transition in grazing marsh ditch plants from brackish to fresh water. The combination of habitats creates an exceptional area of scientific interest supporting nationally scarce plants, Red Data Book invertebrates and nationally important numbers of breeding and wintering birds.

6.2.26. This is one of few sites nationally for red-tipped cudweed *Filago lutescens* which occurs on light, sandy soils and the nationally rare species grey hair-grass *Corynephorus canescens* occurs on coastal dune habitat, both of which are Red Data Book species. The site supports a range of nationally scarce plant species characteristic of heathland, wetland and coastal habitats, and the transitions between them: marsh-mallow *Althaea officinalis,* whorled water-milfoil *Myriophyllum verticillatum,* spiral ditchgrass

Ruppia cirrhosa, great water-parsnip *Sium latifolium,* marsh sowthistle *Sonchus palustris,* soft hornwort *Ceratophyllum submersum, Ranunculus baudotii,* and separated sedge *Carex divisa* (all nationally scarce) are associated with reedbeds, grazing marsh or ditches. Sea barley *Hordeum marinum* occurs on sea-walls, beach pea *Lathyrus japonicus* on coastal shingle, and moss pygmyweed *Crassula tillaea* on heathland.

6.2.27. There are a number of nationally important invertebrate species occurring on the site, including the following: *Ethmia bipunctella, Aleochara inconspicua, Philonthus dimidiatipennis, Deltote bankiana, Cephalops perspicuus, Erioptera bivittata, E. meijerei, Gymnancycla canella, Pisidium pseudosphaerium, Archanara neurica, Heliothis viriplaca, Pelosia muscerda, Photedes brevilinea, Senta flammea, Herminea tarsicrinalis, Haematopota grandis, Tipula marginata, Podalonia affinis, Arctosa fulvolineata, Eucosma catroptana, E.maritima, Melissoblaptes zelleri, Pima boisduvaliella, Acrotophthalmus bicolor, Limonia danica, Telmaturus tumidulus, Vertigo angustior* (a Habitats Directive Annex II species (S1014)).

6.2.28. Salinity monitoring carried out of the coastal lagoon in Minsmere between July 2014 and May 2015 showed that the pond is brackish in nature (6 to 25 psu) showing some limited seawater input, entering the pond slowly, mostly likely via slow diffusion through the dune system that lies between the pond and the coast (Ref. 6.9).

d) Orfordness-Shingle Street SAC

i. Coastal lagoons

6.2.29. The coastal lagoons in the Orfordness-Shingle Street SAC encompass a series of percolation lagoons and, together with Benacre to Easton Bavents and The Wash and North Norfolk Coast, form a significant part of the percolation lagoon resource on the south east coast of England. The shingle ridges that form Orfordness extend about 15 km south from Aldeburgh on the Suffolk coast and diverts the River Ore for a similar distance. South of the river, the shingle ridges at Shingle Street continue southwards towards Bawdsey (Ref. 6.10).

6.2.30. Coastal lagoons are areas of shallow, coastal saltwater, which are wholly or partially separated by the sea by sandbanks, shingle or rocks. The lagoons at Orfordness-Shingle Street SAC are classified as percolation lagoons, whereby the salinity of the lagoons is maintained by percolation through the shingle, although at high tides sea water can overtop the shingle bank (Ref. 6.11; Ref. 6.12).

6.2.31. Coastal lagoons are relatively uncommon in the UK and are, therefore, designated as a priority habitat type. The water in the lagoons can vary in salinity from brackish to hypersaline, therefore, the plant and animal communities of lagoons vary according to the physical characteristics and salinity regime of the lagoon. This also creates a unique habitat which can be very different compared to other marine habitats, usually with a limited range of species present that are especially adapted to the varying salinity regimes. Some are unique to lagoon habitats.

6.2.32. In the SAC, the fauna of the lagoons includes typical lagoon species, such as the cockle *Cerastoderma glaucum*, the ostracod *Cyprideis torosa,* the lagoon sand-shrimp *Gammarus insensibilis*, the mollusc *Onoba semicostata*, and the gastropods *Littorina saxatilis tenebrosa* and *Hydrobia ventrosa*. The nationally rare starlet sea anemone *Nematostella vectensis* is also found at the site (Ref. 6.12; Ref. 6.13). Flora within the lagoon has limited diversity and includes tassel pondweed *Ruppia maritima* and brackish water crowfoot *Ranunculus baudotii*. A variety of algal species are also present (Ref. 6.11; Ref. 6.13).

6.2.33. A biodiversity survey carried out in 2016 designated the lagoons in unfavourable condition, having recently lost many of the rare species of importance (Ref. 6.14). For example, the starlet sea anemone was not found during the survey.

6.3 Birds

a) Introduction

6.3.1. The information presented below on the baseline conditions for the screened in SPAs and Ramsar sites comprises both an overview of population status within the sites for the different qualifying features, as well as consideration of the population trends and habitat use and dependence on the marine environment for foraging.

b) Alde-Ore Estuary SPA

i. Population estimates of SPA qualifying features

6.3.2. Comparison of the site citation and most recently available population estimates for the SPA shows declines in numbers for those qualifying features which are screened in for this assessment (**Table 6.1**). These declines are marked for each of the three breeding seabird species, and neither of the two tern species which are qualifying features of the SPA are currently present as breeding species.

Table 6.1: Population estimates for the qualifying features of the Alde-Ore Estuary SPA, as determined at (or near) the time of citation and from the most recently available data

Qualifying feature		Citation population size[1] (year(s) from which derived)	Recent population estimate[1] (year(s) from which derived)
Breeding	Little tern	48 bp (1993/94-96/98)	4 bp (2013)[2]
	Sandwich tern	170 bp (1992-96)	0 bp (since 2009)[3]
	Lesser black-backed gull	14,070 bp (1994-97)	1,963 bp (2012-16)[3]

[1] Count unit - bp = breeding pairs; ind = individuals.
[2] No longer recognised as a regular breeder at this site (Ref. 6.15).
[3] Based on Seabird Monitoring Programme (SMP) database (Ref. 6.16). All other estimates from Natural England's Designated Sites View (https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009112&HasCA=1&NumMarineSeasonality=8&SiteNameDisplay=Alde-Ore%20Estuary%20SPA)

ii. Little tern

SPA population

6.3.3. The Alde-Ore Estuary SPA's qualifying population of 48 pairs of little terns (**Table 6.1**) constituted at least 2% of the national breeding population. The last known nesting colony in the SPA was in 2013 at Sudbourne Beach, near Slaughden on Orford Ness and approximately 9 km south of the main development site, when four pairs attempted to breed at the site but no young fledged (Ref. 6.17). Historically, little terns have also nested at Havergate Island, near the Ore-Butley estuaries confluence (most recently in 2006, when three breeding pairs were recorded).

6.3.4. The Alde-Ore Estuary SPA is no longer recognised as a "regularly occupied" breeding colony (Ref. 6.15). This has been attributed to a number of factors, including changes to the beach profile (and therefore habitat suitability), predation and disturbance.

Project-specific survey data

6.3.5. Vantage point (VP) surveys undertaken in 2011 (Ref. 6.18) recorded little tern foraging behaviour at 12 VPs along the coastline during the period 10th May 2011 to 24th June 2011. The most northerly of these sites (VP1) was *c.* 0.5 km north of the main development site and *c.* 9.5 km north of Alde-Ore Estuary SPA. The most southerly (VP12) was located at Orford Ness, within the SPA, approximately 6 km south of Slaughden. **Figure 6.1** illustrates the location of the VPs along the Suffolk coastline.

6.3.6. A peak count of 18 birds was observed resting on Sudbourne Beach (VP10) in mid-May, after which up to 22 birds were present in the area until mid-June. During this period, little terns were frequently observed foraging over a spit approximately 1 km offshore of Sudbourne Beach. Commuting birds were observed at 8 VPs during the survey period, notably during May, with a peak of 51 birds recorded during May from VP1.

6.3.7. In June 2011, a programme of colony surveys, undertaken to identify the flight direction of little terns when leaving or returning to colonies, included a survey at the Alde-Ore Estuary colony near Slaughden (Ref. 6.18). Flight lines and key foraging areas of little terns from the colony are presented in Error! Reference source not found.**.** During the survey period, up to 22 birds were observed foraging offshore and loafing around the colony, with mating activity recorded, but the colony was abandoned by 23rd June 2011.

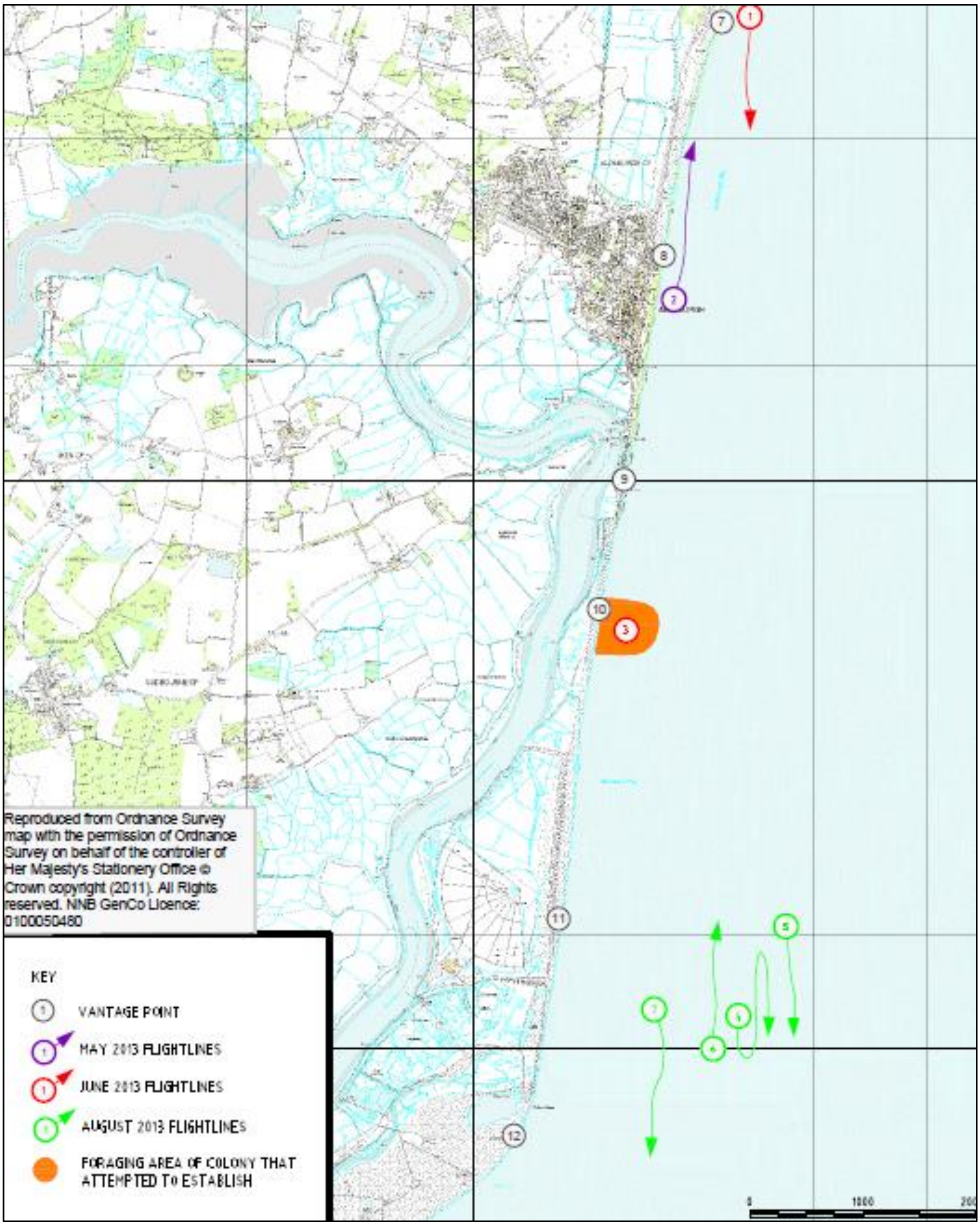
6.3.8. Further bimonthly VP surveys were undertaken between 13th May and 21st August 2013 (Ref. 6.19), in which little tern activity was recorded at 15 VPs along the coastline. These VPs consisted of the 12 used in the 2011 surveys plus a further three (VPs 13, 14 and 15) located north of VP1, with the most northerly (VP15) being located at Dunwich, *c.* 6 km north of the main development site and *c.* 15 km north of Alde-Ore Estuary SPA (see **Figure 6.1**).

6.3.9. In the 2013 surveys, little tern was recorded a total of nine occasions at VPs 7, 8, 10, 11, 12 and 13, between Thorpeness and Orford Ness. The peak count was eight birds at VP10 (Sudbourne Beach) in early June 2013, at which point a colony attempted to establish. However, this was deserted by the time of the nest survey in late June. Flight lines and foraging areas of little terns around Alde-Ore Estuary (2013 surveys) are shown in Error! Reference source not found..

6.3.10. Although the project-specific survey data are 2011-2013, as described above, they derive from the most recent period for which there is documented breeding at the little tern colonies within the Alde-Ore Estuary SPA, which is no longer recognised as a “regularly occupied” breeding colony (Ref. 6.15).

Plate 6.1: Flight lines and areas of concentrated foraging activity around Slaughden little tern colony during surveys in June 2011 (Ref. 6.18)

Plate 6.2: Flight lines and areas of concentrated foraging activity around Slaughden little tern colony during VP surveys in May – August 2013 (Ref. 6.19)



Foraging behaviour and diet

6.3.11. During the breeding season (May to August), little terns are found on sand / shingle beaches, islands and spits on British and Irish coasts. Little terns feed by fishing in the top few centimetres of water, often over the advancing tideline or in brackish lagoons and saltmarsh creeks, though they can forage up to 6 km offshore (Ref. 6.20). The mean maximum foraging extent from breeding colonies in the SPA is expected to be around 3.9 km alongshore and up to 2.4 km seawards, based on surveys of foraging little terns at a range of colonies around the UK coastline (Ref. 6.15). Based on the mean maximum alongshore foraging range (3.9 km) suggested by Parsons *et al.* (2015) (Ref. 6.15), breeding birds from a colony at Slaughden could be expected to generally forage no further south than Orford Ness and no further north than Thorpeness (Ref. 6.15).

6.3.12. Little terns typically forage from a height of 4 – 8 m, sometimes higher, and generally feed by plunge diving from a hover or dip to take prey at the surface (Ref. 6.21). Little tern adults and chicks consume a relatively wide variety of prey types, although the most important prey items in the southern North Sea are clupeids such as herring *Clupea harengus* and sprat *Sprattus sprattus* (Ref. 6.22). When these fish are scarce, the isopod crustacean sea slater *Idotea linearis* and the ghost shrimp *Schistomysis spiritus* are also important.

6.3.13. Juvenile clupeids and sandeels *Ammodytes spp*. (30 – 70 mm) are the dominant item in the chicks' diet; observations at North Denes (Norfolk) from 2002 to 2006 found that clupeids accounted for an average of 82% of identified prey items fed to chicks (Ref. 6.23). In nutritional terms, invertebrates are poor prey for chicks compared to lipid-rich fish (Ref. 6.24), and would represent an inefficient prey in terms of the energetics of provisioning chicks. Therefore, invertebrates would not be expected to be key food for chicks at successful breeding colonies.

6.3.14. Due to their short foraging range, little terns rely on abundant food supplies of small fish or invertebrates close to the colony to provision their chicks, and as such are rather specialised in their habitat requirements (Ref. 6.25). The diets of both adults and chicks differs by location due to availability of different habitat types and prey abundances. Based upon the availability of fish species at Sizewell, the prey of breeding little tern from Alde-Ore Estuary SPA during the period May to August is expected to consist predominantly of schooling pelagic fish that are found near to the surface during daylight hours, such as herring, sprat and anchovy (Ref. 6.26).

iii. Sandwich tern

SPA population

6.3.15. The SPA's qualifying population of 170 pairs of Sandwich terns (**The information** presented below on the baseline conditions for the screened in SPAs and Ramsar sites comprises both an overview of population status within the sites for the different qualifying features, as well as consideration of the population trends and habitat use and dependence on the marine environment for foraging.

c) Alde-Ore Estuary SPA

i. Population estimates of SPA qualifying features

6.3.16. Comparison of the site citation and most recently available population estimates for the SPA shows declines in numbers for those qualifying features which are screened in for this assessment (**Table 6.1**). These declines are marked for each of the three breeding seabird species, and neither of the two tern species which are qualifying features of the SPA are currently present as breeding species.

6.3.17. Table 6.1) constituted 0.1% of the biogeographical (Western Europe / Western Africa) population and 1.2% of the national population (Ref. 6.27). However, since 2009 there have been no breeding pairs recorded in the SPA (Ref. 6.16).

6.3.18. Sandwich terns have been recorded as nesting in the SPA since 1986, primarily at Havergate Island (approximately 17 km south along the coast from the main development site redline boundary) where historically there were large aggregations of over 100 birds. However, the colony disappeared in 1997 and since then nesting has only occurred sporadically. The last recorded successful breeding at Havergate Island was in 2004, according to JNCC's Seabird Monitoring Programme (Ref. 6.16).

6.3.19. **Table 6.2** presents figures for the breeding numbers and productivity at Havergate Island up until the last attempts in 2009; since then there have been no breeding records up to the most recent SMP data from 2016 (Ref. 6.16). Given the decline in both breeding numbers and productivity since designation, the breeding population within the SPA has been given a restore objective by Natural England (Ref. 6.28).

Table 6.2 Sandwich tern breeding numbers (expressed as occupied nests) and productivity at Havergate Island, 1993-2009; no breeding pairs have been recorded since 2009

Year	Occupied nests	Fledged young
1993	125	98
1994	300	201
1995	250	0
1996	104	30
1997	0	0
1998	0	0
1999	0	0
2000	7	5
2001	1	2
2002	2	2
2003	15	3
2004	2	3
2005	3	0
2006	0	0
2007	0	0
2008	0	0
2009	2	0

6.3.20. There have been years of complete breeding failure, when Sandwich terns have attempted to breed, notably in 1995 when 250 occupied nests were abandoned, but also more recently in 2005 and 2009. Although Sandwich terns have not successfully bred within the SPA since 2004, birds are known to ‘loaf’ in the area towards the end of the breeding season (Ref. 6.29).

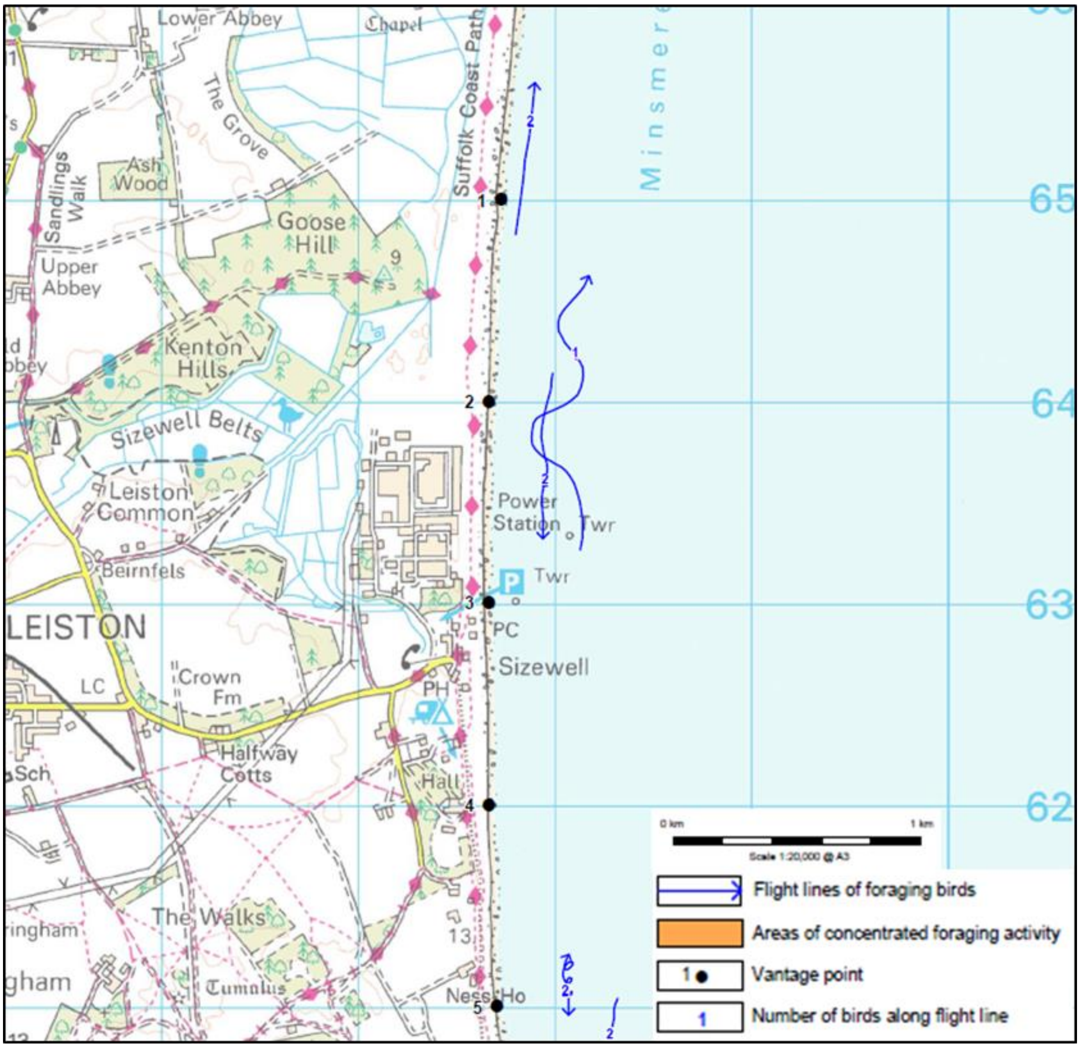
Project-specific survey data

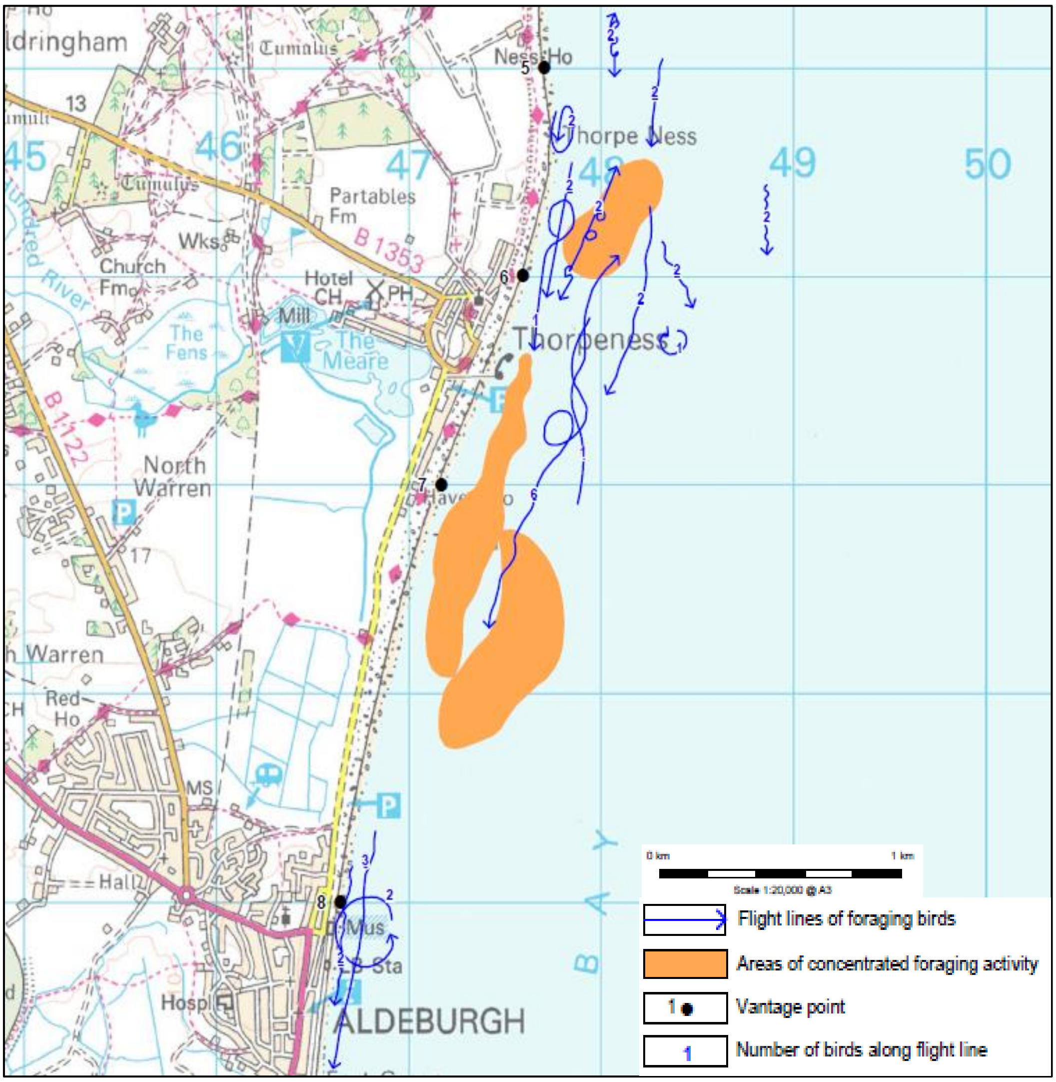
6.3.21. Sandwich tern sightings were recorded during marine bird surveys undertaken from April 2011 to April 2012 at 12 VPs along the coastline (Ref. 6.18). The most northerly of these sites (VP1) was *c.* 0.5 km north of the main development site and *c.* 9.5 km north of Alde-Ore Estuary SPA. The most southerly (VP12) was located at Orford Ness, within the SPA, *c.* 2.5 km east of Havergate Island (see **Figure 6.1**). The peak period for observations was July to September, coinciding with the likely occurrence of birds on passage.

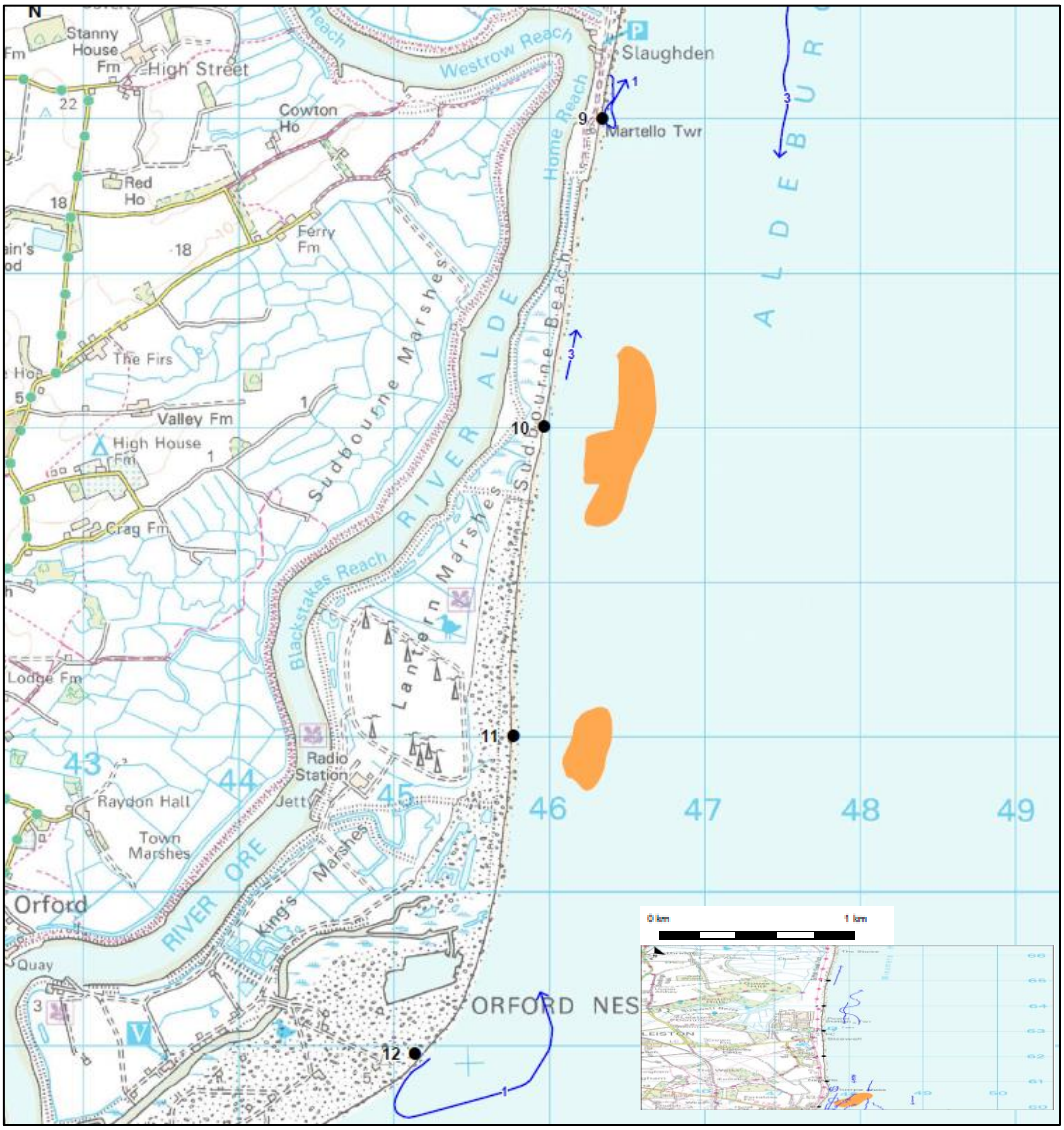
6.3.22. During the 2011-12 surveys, small numbers of Sandwich terns were seen foraging offshore or commuting along the coastline, both close inshore and more than 1-2 km offshore (Ref. 6.18). Although generally in small groups of one to two birds, occasional groups of up to 10 individuals were seen during peak times in July and August. The favoured feeding areas were over the shallow coastal waters near to the SPA (VPs 11 and 12) and near to Thorpeness (VPs 6 and 7), whilst resting birds were recorded on lagoons within the SPA and at Slaughden. **Plate 6.3** shows the flight lines and key foraging areas of terns observed during the surveys.

6.3.23. Sandwich tern activities were also recorded during bimonthly surveys between 13th May and 21st August 2013 at 15 VPs along the coastline (Ref. 6.19). These VPs consisted of the 12 used in the 2011 surveys plus a further three (VPs 13, 14 and 15) located north of VP1, with the most northerly (VP15) being located at Dunwich, *c.* 6 km north of the main development site and *c.* 15 km north of Alde-Ore Estuary SPA (see **Figure 6.1**).

Plate 6.3: Flight lines and foraging areas of Sandwich terns during vantage point surveys in April 2011 – April 2012 (Ref. 6.18); note extends over three pages

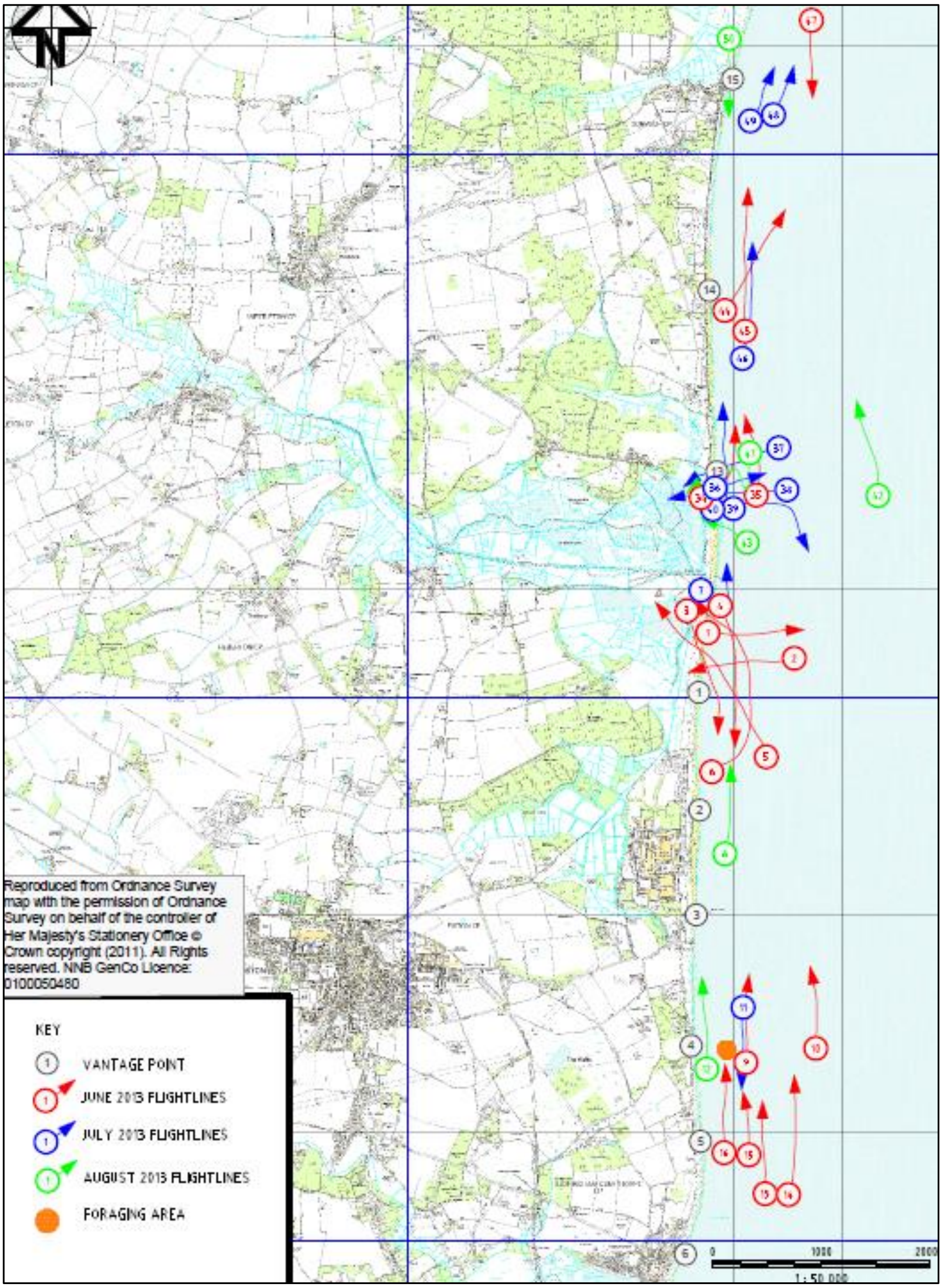


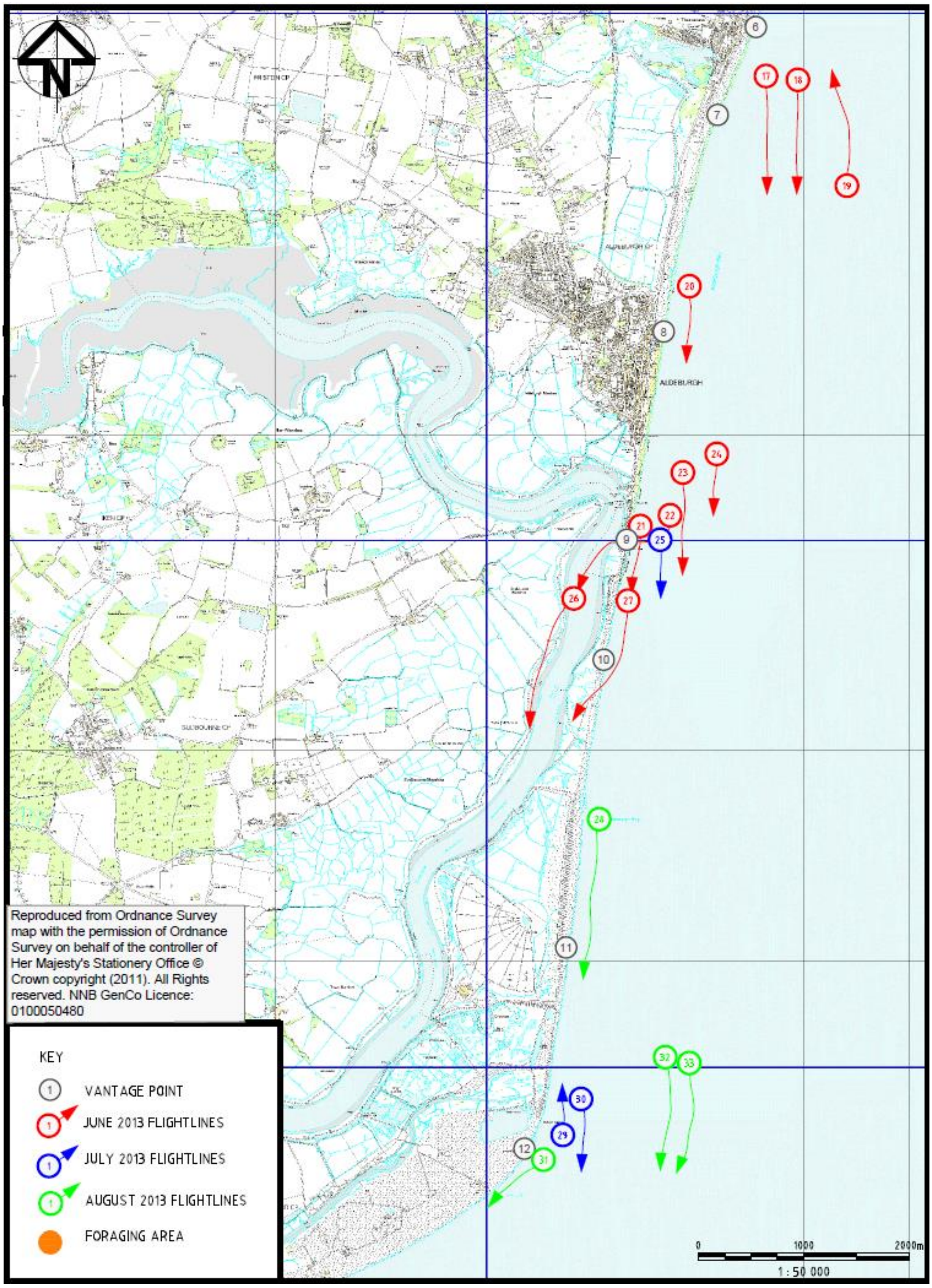

Flight lines of foraging birds
Areas of concentrated foraging activity
Vantage point
Number of birds along flight line
Thorpeness
Thorpe Ness
ALDEBURGH
North Warren
The Meare
Aldringham



6.3.24. In the 2013 surveys, Sandwich terns were recorded on 52 occasions between early May and mid-August, usually in small groups of one to three birds but occasionally in groups of up to eight birds, including at VP9 within the SPA. Birds were predominantly observed commuting, but foraging behaviour was observed in 11 instances. Observations were concentrated south of Aldeburgh but also further north, around the coast adjacent to Minsmere RSPB reserve. **Plate 6.4** shows the flight lines and key foraging areas of terns observed during 2013.

Plate 6.4: Flight lines and foraging areas of Sandwich terns during vantage point surveys at VPs 1 – 6 and 13 – 15 in 2013 (Ref. 6.19); note extends over two pages




N
ALDEBURGH
Reproduced from Ordnance Survey map with the permission of Ordnance Survey on behalf of the controller of Her Majesty's Stationery Office © Crown copyright (2011). All Rights reserved. NNB GenCo Licence: 0100050480
KEY
VANTAGE POINT
JUNE 2013 FLIGHTLINES
JULY 2013 FLIGHTLINES
AUGUST 2013 FLIGHTLINES
FORAGING AREA
0
1000
2000m
1 : 50 000

6.3.25. The surveys in 2011 and 2013 were undertaken in years when there was no occupied Sandwich tern breeding colony along the Suffolk coast. Therefore, fewer birds would be expected to be recorded during these years than during years when colonies were occupied, but as with little tern, there has been no documented breeding by the species in recent years at the Alde-Ore Estuary SPA and further (more recent) survey data would be unlikely to add information of significance to the assessment. Also, Sandwich terns may forage considerable distances offshore (Ref. 6.30, Ref. 6.31), and well beyond the distances at which birds can be recorded during shore-based surveys. Therefore, these surveys have limited value in determining the key foraging areas of this species.

Foraging behaviour and diet

6.3.26. During the breeding season (April to August), Sandwich terns are found on sandy islands, spits, dunes and shingle beaches (Ref. 6.20), feeding over inlets and at sea, typically within 1 m of the surface, down to a maximum depth of 2 m (Ref. 6.32). The mean maximum foraging range of Sandwich tern is approximately 32 km (based on a generic model of range usage derived from a UK-wide study encompassing a range of colonies) but has been recorded at over 50 km (Ref. 6.31).

6.3.27. Based on the mean maximum foraging range (32 km) estimated by Wilson *et al*. [Ref. 6.31), breeding birds from a colony at Havergate Island could be expected to forage as far south as Hamford Water and the Clacton coast and as far north as Minsmere, as well as the same distance from the colony out to sea. However, the generic model of range usage by Sandwich terns around their colonies also predicts that, within the area defined by the mean maximum foraging range, usage will be greatest near shore (the term with the greatest effect size in the model), but in relatively deep waters, and close to the colony (Ref. 6.31).

6.3.28. Sandwich terns fly faster, make longer trips, dive deeper from greater heights and catch larger fish than the other British tern species (Ref. 6.33, Ref. 6.34). They are considered to have a relatively specialist nature compared to other species, with dependence upon a few prey species (e.g. clupeids and sandeels, including greater sandeel *Hyperoplus* sp.) obtained from across a wider foraging range. In the southern North Sea, key prey items for Sandwich tern include clupeids (herring and sprat) and sandeels *Ammodytidae* spp. A study on the island of Griend showed these prey species amounted to 99.3% of the chick diet, and parents tended to meet the increasing energy demands of chicks by adjusting prey size, rather than increasing delivery or switching prey species (Ref. 6.35).

6.3.29. Adult diet is not well studied but it is understood to differ from that of chicks (Ref. 6.25). For example, the proportion of invertebrates in the diet is higher for adults, as recorded on the east Norfolk coast where they still comprised only 24 – 26% of dietary items by number (and presumably considerably less by biomass (Ref. 6.25). The higher proportion of invertebrates in the adult diet presumably results from the fact that they will obtain their own food more opportunistically, whereas there will be greater selectivity in prey delivered to chicks (due to the need to optimise energetic expenditure when provisioning chicks). Young-of-the-year clupeids also frequently occurring in adult diets whereas older fish tend to make up more of the chick diet (Ref. 6.36). During studies in north Norfolk, the median prey size provisioned to chicks (at 80 – 120 mm) was generally some three to four times larger than that of prey consumed by the adults (Ref. 6.34).

6.3.30. Variation in the spatio-temporal availability and distribution of Sandwich tern prey is likely to influence foraging distribution and diet (Ref. 6.25). Based upon the availability of different fish species at Sizewell (Ref. 6.37), the prey of breeding Sandwich tern from Alde-Ore Estuary SPA during the period April to August is expected to consist of schooling pelagic fish species that are found near to the surface during daylight hours, such as herring, sprat and anchovy (Ref. 6.26).

ii. Lesser black-backed gull

SPA population

6.3.31. At the time of the site designation in 1996, the SPA population was estimated as 14,070 breeding pairs (**The information** presented below on the baseline conditions for the screened in SPAs and Ramsar sites comprises both an overview of population status within the sites for the different qualifying features, as well as consideration of the population trends and habitat use and dependence on the marine environment for foraging.

d) Alde-Ore Estuary SPA

i. Population estimates of SPA qualifying features

6.3.32. Comparison of the site citation and most recently available population estimates for the SPA shows declines in numbers for those qualifying features which are screened in for this assessment (**Table 6.1**). These declines are marked for each of the three breeding seabird species, and neither of the two tern species which are qualifying features of the SPA are currently present as breeding species.

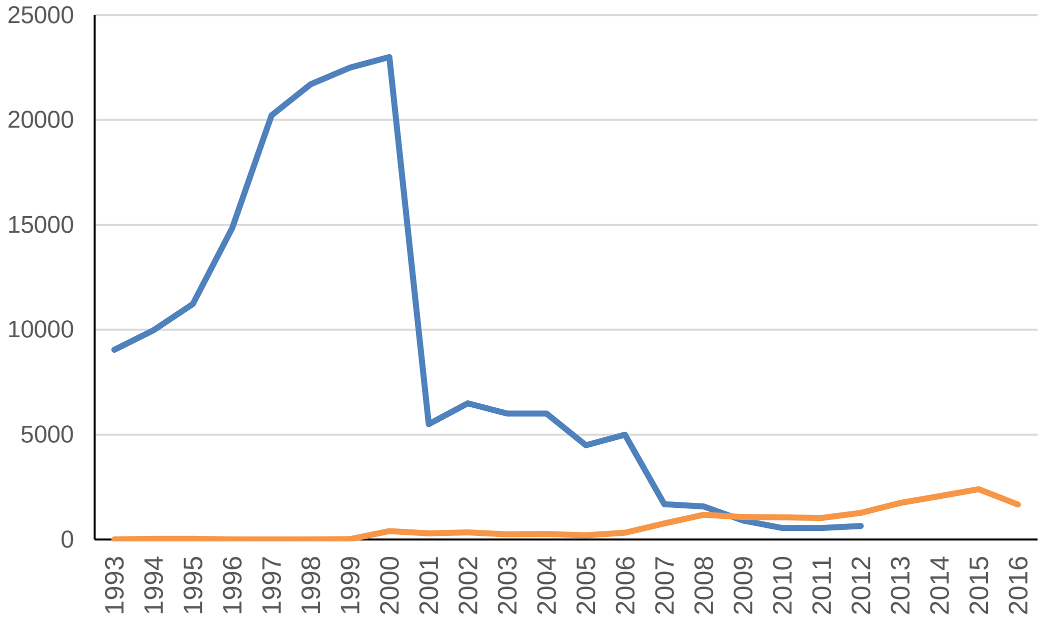
6.3.33. Table 6.1), representing 12% of the British population and 8% of the world population of the *graellsii* race. A peak population size of 23,400 pairs was recorded in 2000, since when numbers have reduced substantially, with the mean population estimate for the SPA from 2012 to 2016 being 1,963 pairs (Ref. 6.16).

6.3.34. Historically, the primary breeding colony in the SPA was on Lantern Marshes at Orford Ness (c.12.5 km south of the main development site), where numbers increased to a peak of approximately 23,000 pairs in the early 2000s, but decreased substantially since then, with around 550 – 640 pairs during the period 2010 – 2012. The main nesting areas are now on Havergate Island (c.17 km south of the main development site). Between 2000 and 2007 the number of occupied nests at Havergate Island was around 200 – 800 but since 2008 the number of occupied nests has been over 1,000, with as many as 2,399 in 2015 (Ref. 6.16; **Plate 6.5**).

Project-specific survey data

6.3.35. Lesser black-backed gull sightings were recorded during marine bird surveys between April 2011 and April 2012 (Ref. 6.18) at 12 VPs along the coastline near Sizewell. The most northerly of these sites (VP1) was *c.* 9.5 km north of Alde-Ore Estuary SPA (and *c.* 16 km north of Havergate Island and *c.* 17 km north of Orford Ness). The most southerly (VP12) was at Orford Ness (see **Figure 6.1**).

Plate 6.5: Trends in the annual number of occupied lesser black-backed gull nests / territories estimated at the Orford Ness colony (blue line) and the Havergate Island colony (orange line) (Ref. 6.16)



6.3.36. During the 2011-12 surveys, lesser black-backed gulls were recorded resting or foraging at all VPs. Groups of up to 50 birds were seen resting on the beach near to Lantern Marshes and the colony at Orford Ness (VPs 10 – 12), while smaller groups were seen loafing further north around the outfalls at Sizewell A and B. There were large numbers of gulls reported commuting throughout the area, likely travelling offshore or inland to forage. Findings were broadly similar during the 2013 surveys, with birds recorded at all VP locations (Ref. 6.19).

6.3.37. Although qualifying as a breeding species and recognised to be largely migratory, small numbers of lesser black-backed gull remain in the area over winter and have been incidentally recorded commuting, foraging and loafing during winter surveys for red-throated divers and cormorants.

6.3.38. As for Sandwich tern, it is acknowledged that shore-based surveys are of limited value in determining the key areas of usage by lesser black-backed gull. The mean maximum foraging range for this species is estimated as 141 km, so that a high proportion of foraging activity is likely to occur beyond areas encompassed by such surveys (Ref. 6.30).

Foraging behaviour and diet

6.3.39. During the breeding season (April to August), lesser black-backed gulls are found on coastal grassy slopes, sand dunes, cliffs and saltmarshes. They forage on arable land, pasture land, refuse dumps and at sea (Ref. 6.20). At sea they typically feed close to the sea surface, down to a maximum dive depth of 0.5 – 1 m (Ref. 6.32).

6.3.40. As stated above, the mean maximum foraging range for breeding lesser black-backed gulls is estimated as 141 km (Ref. 6.30), but for GPS-tracked birds breeding at Orford Ness in 2011 the offshore foraging range was up to 91 km during the breeding season, with a mean of approximately 38 km (Ref. 4.6). The duration of foraging periods between leaving and returning to the nest averaged *c.*7 hours, but durations of up to 29 hours were also recorded. Outside the breeding season, foraging range and trip duration are greater.

6.3.41. Based on the maximum offshore foraging range (91 km) recorded from tracking of breeding lesser black-backed gulls at Orford Ness (Ref. 4.6), the SPA birds can be expected to forage as far south as the Kentish coastline and as far north as north Norfolk, as well as the same distance from the colony out to sea, during the breeding season. However, these data derive from 12 tracked birds from a single year, and it is likely that foraging distances of birds from the SPA colonies extend further than this (as indicated by the mean maximum foraging range estimate given in Ref. 6.30).

6.3.42. Based on fish species availabilities at Sizewell, the marine prey of breeding lesser black-backed gull during the period April to August is expected to consist of schooling pelagic fish (sprat, herring and anchovy) and crustacea (swimming crabs) that are found near to the sea surface, together with discards from fishing vessels (Ref. 6.26).

e) Alde-Ore Estuary Ramsar site

6.3.43. In relation to bird populations, the Alde-Ore Estuary Ramsar site qualifies under Ramsar criteria 3 (i.e. *"A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region"*) and Ramsar criteria 6 (i.e. *"A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird"*).

6.3.44. Qualification under criterion 3 is on the basis of the site supporting a notable assemblage of breeding and wintering wetland birds; whilst for criterion 6 it is on the basis of the population of lesser black-backed gull which breed on the site. Therefore, the baseline data provided for the Alde-Ore Estuary SPA are considered to cover those required for the Alde-Ore Ramsar site.

f) Benacre to Easton Bavents SPA

i. Population estimates of SPA qualifying features

6.3.45. **Table 6.3** provides population estimates for the breeding little tern qualifying feature of the SPA, which is the only qualifying feature of this SPA screened into the current assessment.

Table 6.3: Population estimates for the Benacre to Easton Bavents SPA breeding little tern population, as determined at citation and from the most recently available data (Ref. 6.39)

Qualifying feature		Citation population size[1] (year(s) from which derived)	Recent population estimate[1] (year(s) from which derived)
Breeding	Little tern	39 bp (1991-95)	40 bp (2014-18)

[1] Count unit – bp = breeding pairs.
Estimates derived from Citation and SPA Conservation Objectives supplementary advice (Ref. 6.39)

ii. Little tern

SPA population

6.3.46. The Benacre to Easton Bavents SPA's qualifying population of 39 pairs of little terns (**Table 6.3**) constituted 1.6% of the national breeding population. Historically, there were known nesting colonies in the SPA at Easton Broad and Covehithe Broad, whilst more recently breeding has occurred on the sand and shingle beaches at Kessingland, Benacre and Covehithe Broads, located *c*.22 km, *c*.20 km and *c*.17 km north of the main development site redline boundary, respectively.

Project-specific survey data

6.3.47. Surveys for little tern were undertaken in 2011 (Ref. 6.18) and 2013 (Ref. 6.19); these included foraging surveys at 15 VPs along the coast between Dunwich and Orford Ness. The most northerly of these sites (VP15 at Dunwich) was approximately 11 km south of Covehithe Broads. Given that the mean maximum foraging distance from breeding colonies in the SPA is expected to be around 3.9 km alongshore, the nearest VP is likely to be outside the maximum foraging range for little terns in this SPA (Ref. 6.15). However, the greater distance of the Benacre to Easton Bavents SPA little tern colony from the main development site also means that there would be less potential for effects to arise on this SPA little tern population than on those at SPAs closer to the main development site. As such, information on colony location, size and predicted foraging range are sufficient for the purposes of the assessment on this SPA qualifying feature.

Foraging behaviour and diet

6.3.48. Details of the foraging behaviour and diet of little tern are given above (see **Section 6.3 b,** Alde-Ore Estuary SPA). Based on the mean maximum alongshore foraging range (3.9 km) estimated by Ref. 6.15, breeding birds from the colony at Covehithe Broads could be expected to generally forage no further south than Southwold and no further north than Kessingland. As for the Alde-Ore Estuary SPA little tern population, the prey of breeding little tern from Benacre to Easton Bavents SPA during the period May to August is expected to consist predominantly of schooling pelagic fish that are found near to the surface during daylight hours, such as herring, sprat and anchovy, as based upon the availability of fish species at Sizewell (Ref. 6.26).

g) Minsmere-Walberswick SPA

i. Population estimates of SPA qualifying features

6.3.49. The citation and most recently available population estimates for the SPA breeding little tern population are shown in **Table 6.4**; little tern being the only qualifying feature of the SPA screened into the current assessment. The SPA breeding little tern population has undergone a marked decline since the time of citation.

Table 6.4: Population estimates for the Minsmere-Walberswick SPA breeding little tern population, as determined at citation and from the most recently available data (Ref. 6.40)

Qualifying feature		Citation population size[1] (year(s) from which derived)	Recent population estimate[1] (year(s) from which derived)
Breeding	Little tern	32 bp (pre-1991)	1.6 bp (2014-18)[2]

[1] Count unit – bp = breeding pairs; ind = individuals.

[2] 10 pairs of little terns are reported to have nested in 2019 (RSPB, *unpubl. data).*

ii. Little tern

SPA population

6.3.50. The Minsmere-Walberswick SPA's qualifying population of 32 pairs of little terns (**Table 6.4**) constituted approximately 1.2% of the national breeding population at the time of classification. Since then the number of little terns using the SPA has decreased by 95% to 1.6 breeding pairs (5 year mean, 2014 – 2018) (Ref. 6.41 after Ref. 6.40). There are historic breeding colonies in the SPA at Dingle, Dunwich Beach, Minsmere and Walberswick. The closest little tern colony to the main development site (approximately 1.5 km away) is at Minsmere, but there has been no successful breeding at the Minsmere colony since 2009, when a single breeding pair was recorded (Ref 6.42), until 2019, when 10 pairs bred on the scrape with 7 young raised to fledging. Successful breeding has occurred since 2009 at both Dingle and Walberswick, *c.*7.5 – 9 km north of the main development site (Ref. 6.19).

6.3.51. Historically, numbers of little tern breeding within the Minsmere-Walberswick SPA have fluctuated greatly between years, with some years having a high number of nesting pairs and then the next year having none at all. The decline in numbers using the SPA may be due to changes in breeding site selection within the Suffolk area to favour other sites, such as within the Benacre to Easton Bavents SPA. Little tern colonies also occur to the south of the SPA at North Warren within the Sandlings SPA (Ref. 6.40). The causes of the recent decline in the numbers of breeding little tern on the Minsmere-Walberswick SPA are unknown but could involve predation, disturbance and/or changes in the availability prey species.

Project-specific survey data

6.3.52. As detailed above, shore-based surveys to record little tern flight activity and foraging were undertaken in 2010 (Ref. 6.43), 2011 (Ref. 6.18) and 2013 (Ref. 6.19) across a total of 15 VPs between Dunwich (VP15) and Orford Ness (VP12) (see **Figure 6.1**). In addition, colony surveys at Dingle and Minsmere were also undertaken in 2010 and 2011 (Ref. 6.43, Ref. 6.18).

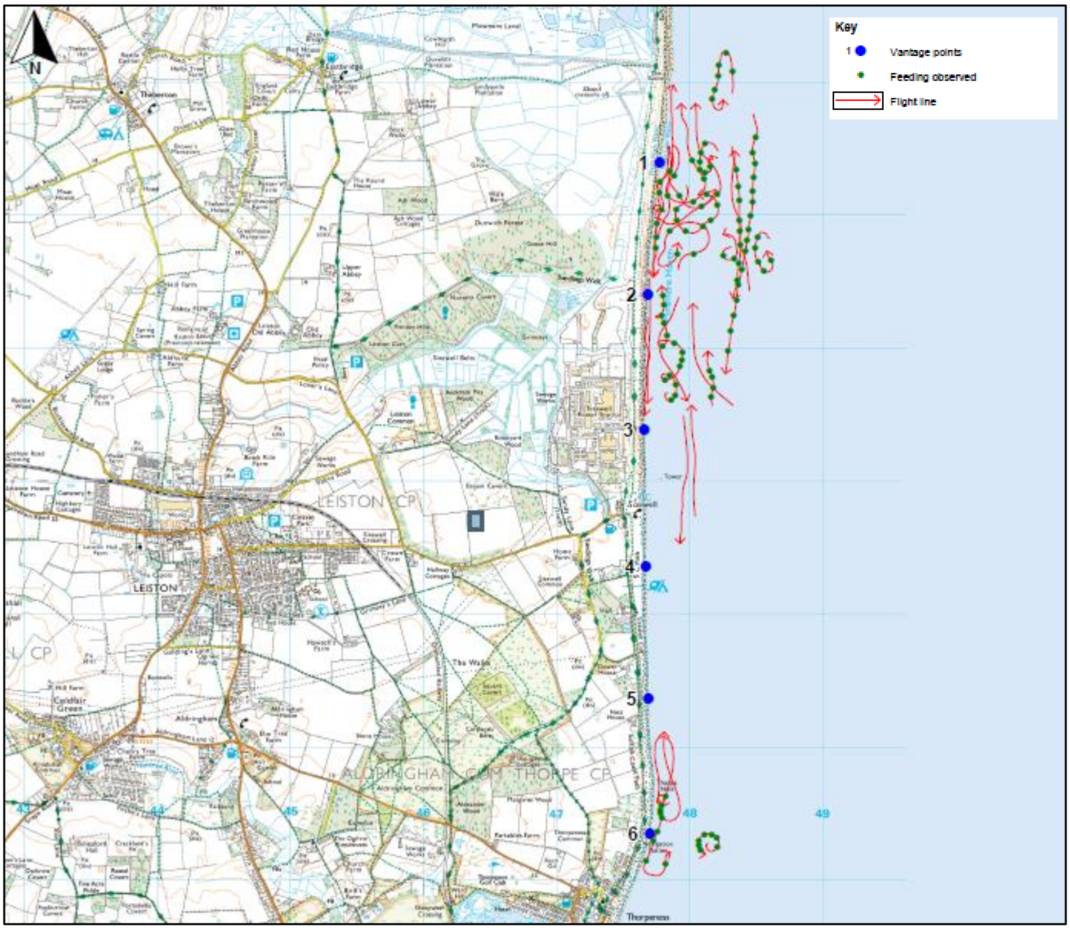
6.3.53. During the 2010 surveys, there was evidence of attempted nesting at both Dingle and Dunwich Beach, and colony surveys were undertaken at Minsmere and Dingle (Ref. 6.43). No serious attempts at breeding were observed at Minsmere, whilst the attempted breeding by seven to eight pairs at Dingle was unsuccessful (with the RSPB Reserve Monitoring data suggesting only five of these pairs actually nested – see above). Foraging activity was concentrated close to shore near Dingle, with a peak of around

100 birds foraging or loafing on the beach at the end of June 2010. Beyond the colonies, peak foraging behaviour was observed at VP1, at the south end of the SPA.

6.3.54. During the 2010 survey period, birds were recorded heading south from both the Dingle and Minsmere colonies, though at both colonies much of the foraging activity occurred in the shallow waters close offshore (generally within 700 m of the shoreline). Flight line data indicated that birds were moving between the colonies but were also heading further south along the shoreline towards Sizewell. Surveys from the VPs near Sizewell (VPs 1 – 6 – **Figure 6.1**) showed much of the foraging activity of birds from the SPA was in shallow waters within 500 m of the shore, as illustrated in **Plate 6.6**.

6.3.55. Results from colony surveys in May and June 2011 showed that there were no nesting attempts at Minsmere (although up to 79 birds were prospecting in mid-May), but successful breeding was recorded at Dingle / Walberswick (Ref. 6.18). At the Dingle colony, small numbers of birds (one to seven) were recorded between 17 May and 20 May, mostly commuting but occasionally displaying. First mating was recorded on 20 May. Up to 110 birds were present at the beginning of June, and by late June a total of c.40 pairs were present at the colony of which 26 pairs attempted to breed.

Plate 6.6: Flight lines of little terns from VP surveys at Sizewell, May - July 2010 (Ref. 6.43)



6.3.56. The first chick of 2011 was seen on 29 June and by mid-July there were 8 fledged young and six chicks from the Walberswick section of the colony. Peak counts at Dingle of 180 birds, including 150 loafing on the beach (including 10 fledged young), were recorded in late July, before numbers started to decrease and the colony was empty by 12 August. Much of the recorded foraging activity for the provisioning of chicks was relatively close inshore (within 1 km of the colony) though occasionally birds were recorded foraging further offshore.

6.3.57. Areas of concentrated foraging activity and flight lines of foraging and commuting birds recorded at the Dingle and Minsmere colonies in the AMEC (2012) surveys (Ref 6.18) are shown in **Plate 6.7** and **Plate 6.8**. Of the nine sightings of little tern during the 2013 VP foraging surveys, two were from VP 13, north of the main development site and the only sightings within the mean maximum foraging range of birds breeding within

Minsmere-Walberswick SPA (see **Plate 6.9**). These sightings were of one to two individuals, foraging from Minsmere and moving south towards Sizewell.

6.3.58. Although the project-specific survey data are from 2011-2013, as described above, in most years since their collection only small numbers of pairs have nested at the SPA colonies. Therefore, had more recent surveys been undertaken, it is unclear whether they would have provided data which were any more representative of the current main foraging areas of the SPA breeding little tern population.

Plate 6.7: Flight lines and areas of concentrated foraging activity around Dingle little tern colony during colony surveys in May – August 2011 (Ref. 6.18)

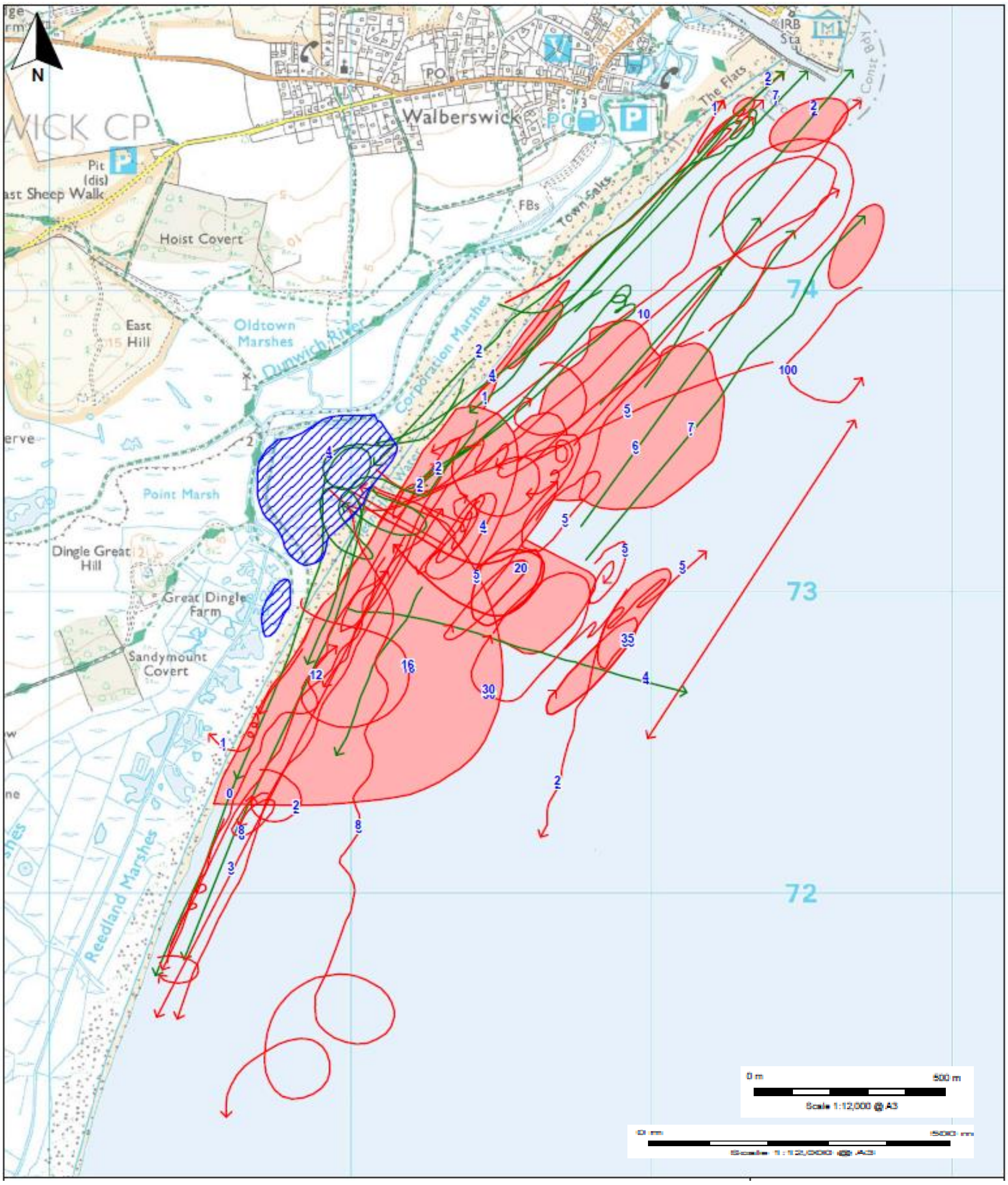


Plate 6.8: Flight lines and areas of concentrated foraging activity around Minsmere little tern colony during colony surveys in May – August 2011 (Ref. 6.18)

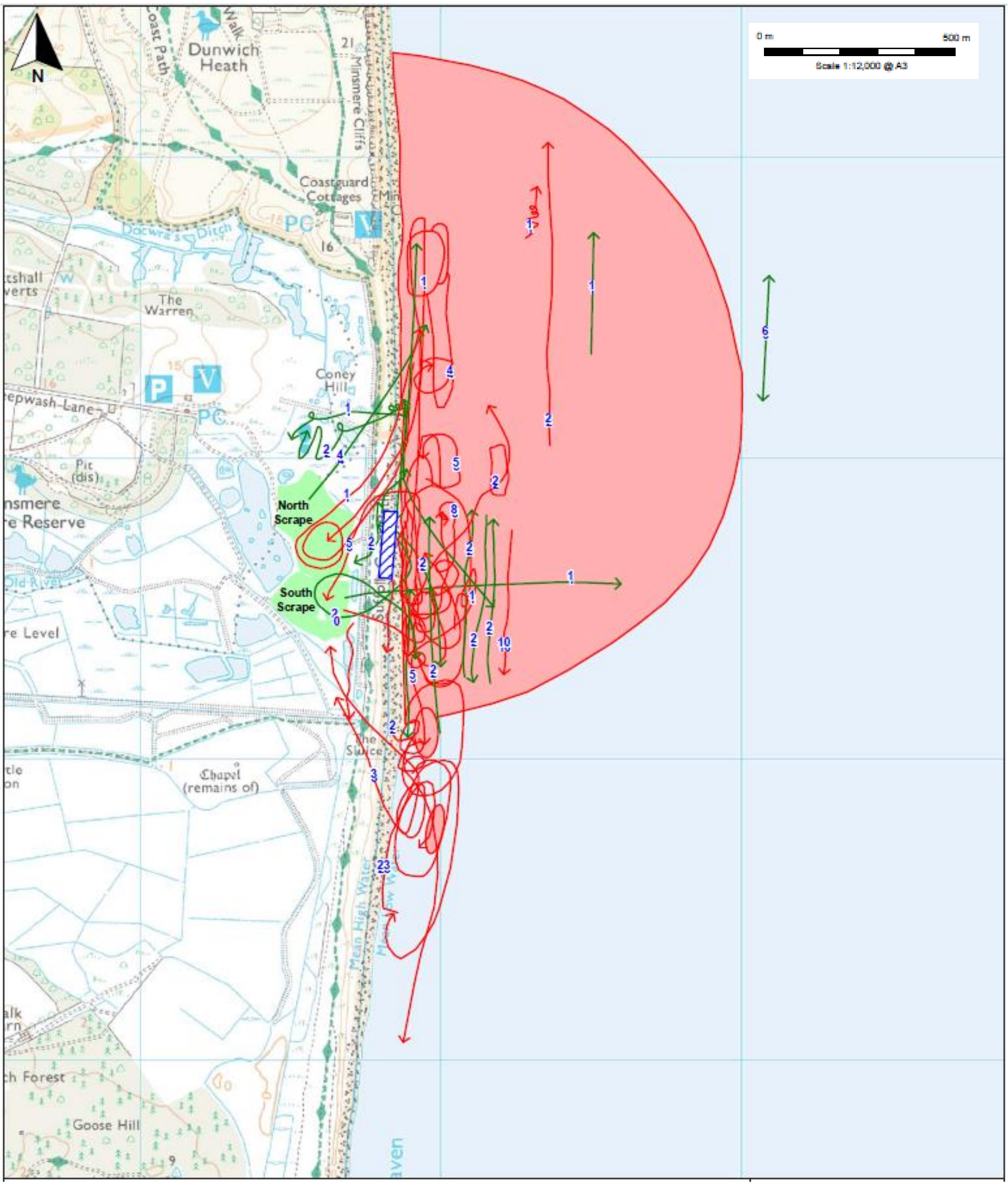
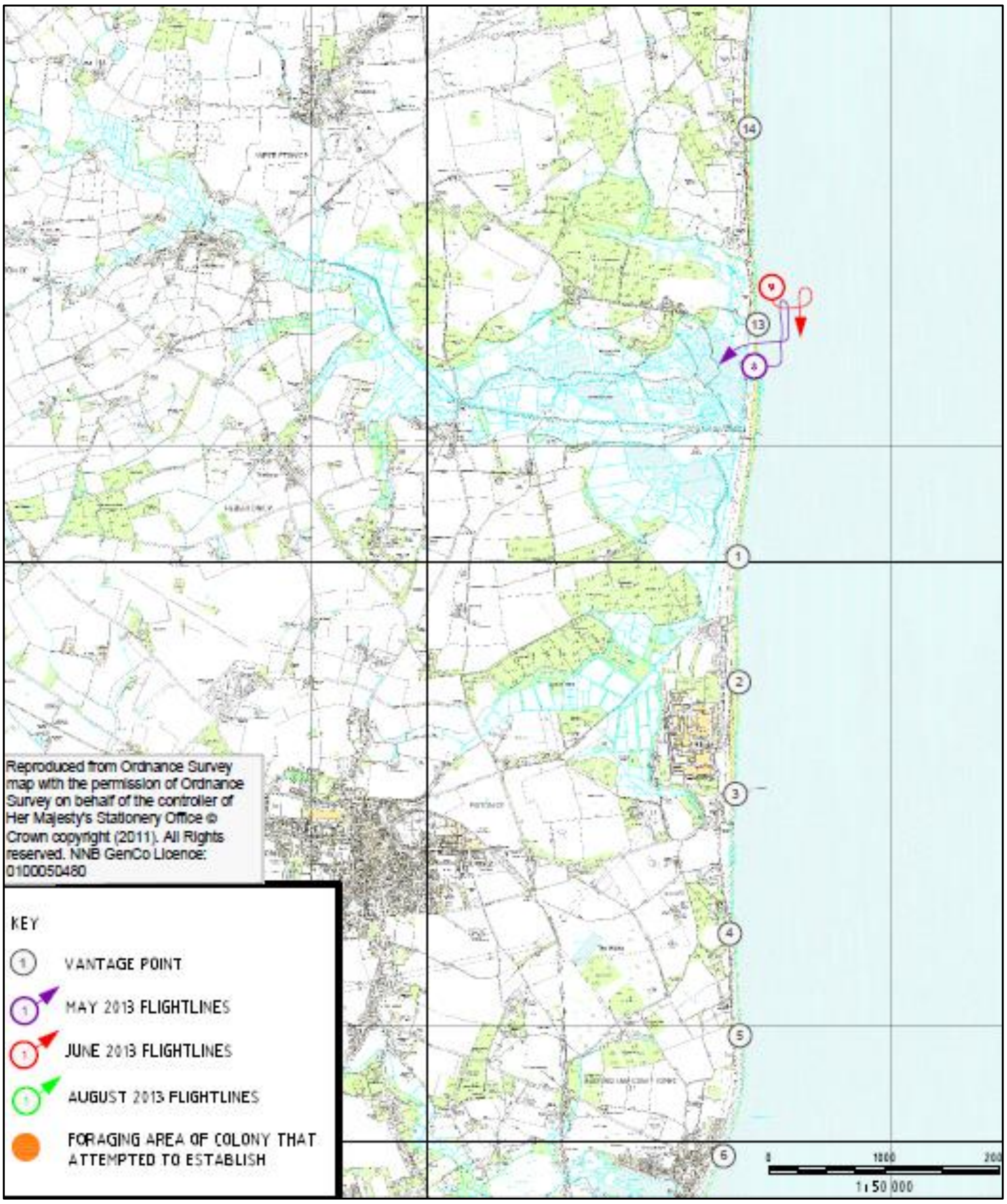


Plate 6.9: Flight lines and foraging areas of little terns recorded within the likely foraging range of the Minsmere-Walberswick SPA during vantage point surveys in 2013 (Ref. 6.19)



Foraging behaviour and diet

6.3.59. Details of the foraging behaviour and diet of little tern are given above (see **Section 6.3 b**, Alde-Ore Estuary SPA). Based on the mean maximum alongshore foraging range (3.9 km) estimated by Parsons *et al.* (2015) (Ref 6.15), breeding birds from the Dingle colony could be expected to generally forage no further south than Dunwich Heath and no further north than Southwold, whilst those from the Minsmere colony could be expected to generally forage no further south than Sizewell and no further north than Dunwich. As such, breeding birds from the Minsmere colony are the only ones likely to forage in the waters around the main development site.

6.3.60. As for the Alde-Ore Estuary SPA little tern population, the prey of breeding little tern from the Minsmere-Walberswick SPA during the period May to August is expected to consist predominantly of schooling pelagic fish that are found near to the surface during daylight hours, such as herring, sprat and anchovy, as based upon the fish availabilities at Sizewell, (Ref. 6.26).

h) Minsmere-Walberswick Ramsar site

6.3.61. In relation to bird populations, the Minsmere-Walberswick Ramsar site qualifies under Ramsar criterion 2 (i.e. *"A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species of threatened ecological communities").* Qualification is on the basis of an important assemblage of rare breeding birds associated with marshland and reedbeds, including: bittern *Botaurus stellaris*, gadwall *Anas strepera*, teal *Anas crecca*, shoveler *Anas clypeata*, marsh harrier *Circus aeruginosus*, avocet *Recurvirostra avosetta* and bearded tit *Panurus biarmicus*.

6.3.62. Given that qualification is on the basis of an assemblage in which the majority of the contributory species do not forage in the marine environment, further baseline data (beyond those presented for the Minsmere-Walberswick SPA) are not presented.

a) Outer Thames Estuary SPA

6.3.63. The Outer Thames Estuary SPA was first designated in 2010 on the basis of the over-wintering red-throated diver population it supports. It was extended in October 2017 to enable greater provision of important marine foraging areas for both breeding little tern and common tern from a range of colonies on the east coast of England, which are now also qualifying features (Ref. 6.44). Details of the population status and habitat use of each of these qualifying features are presented below.

ii. Little tern

SPA population

6.3.64. At the time of inclusion as a qualifying species, the SPA was estimated to provide supporting habitat for 373 little tern breeding pairs (based on counts from 2011 – 2015), which constituted 20% of the breeding population for Great Britain (Ref. 6.44; Ref. 6.45). These breeding pairs derive from breeding colonies at (or functionally linked to) the Alde-Ore Estuary, Benacre to Easton Bavents and Minsmere-Walberswick SPAs, which are 'screened in' to the current assessment, as well as from colonies at (or functionally linked to) several other SPAs, which are 'screened out' of this assessment (**Table 6.5**). Numbers of breeding little tern associated with these different 'breeding colony SPAs' have increased since the designation of these SPAs in two cases but in others there have been marked declines, with some of the SPAs currently holding no breeding pairs and no longer recognised as regular breeding sites for the species (**Table 6.5** and **Table 6.1**).

Table 6.5 Breeding little tern population estimates at coastal SPAs for which the Outer Thames Estuary SPA provides supporting habitat, as determined at (or near) the time of citation and designation of the SPA (bold indicates SPAs 'screened into' the current assessment)

SPA	Approximate distance to the main development site (km)	Population size at (or near) the time of breeding colony SPA citation (breeding pairs)	Mean population size for 2011-2015 (breeding pairs)[1]
Great Yarmouth North Denes[2]	45	277	314
Benacre to Easton Bavents[2]	**14.5**	**39**	**57.6**
Minsmere-Walberswick	<1	**32**	**0.8**
Alde-Ore Estuary	**8**	**48**	**0.8**
Foulness	73	73	0
Thanet Coast and Sandwich Bay	>90	30	0
Total		451	373

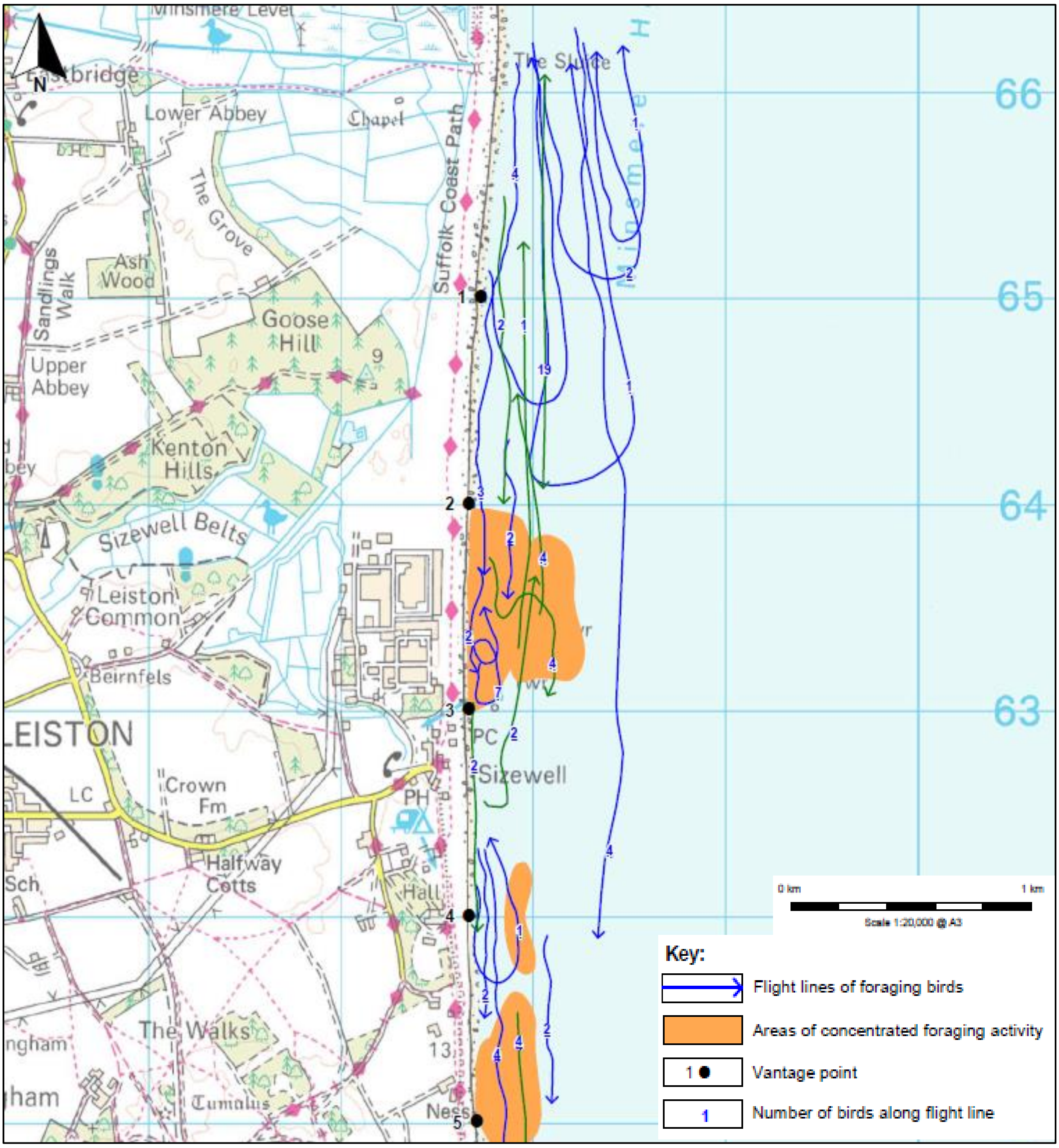
[1] Estimates differ from those presented in Tables 6.1, 6.3 and 6.5 for the respective SPAs because the period relevant to the designation of the Outer Thames Estuary SPA is not the most recent period for which data are available.
[2] Includes colonies considered to be functionally linked to the SPA as well as colonies within the SPA (Ref. 6.46). Population size estimates are derived from the respective Citation and SPA Conservation Objectives Supplementary Advice (as presented in Tables 6.1, 6.3 and 6.5) and/or from Ref.6.46).

Project-specific survey data

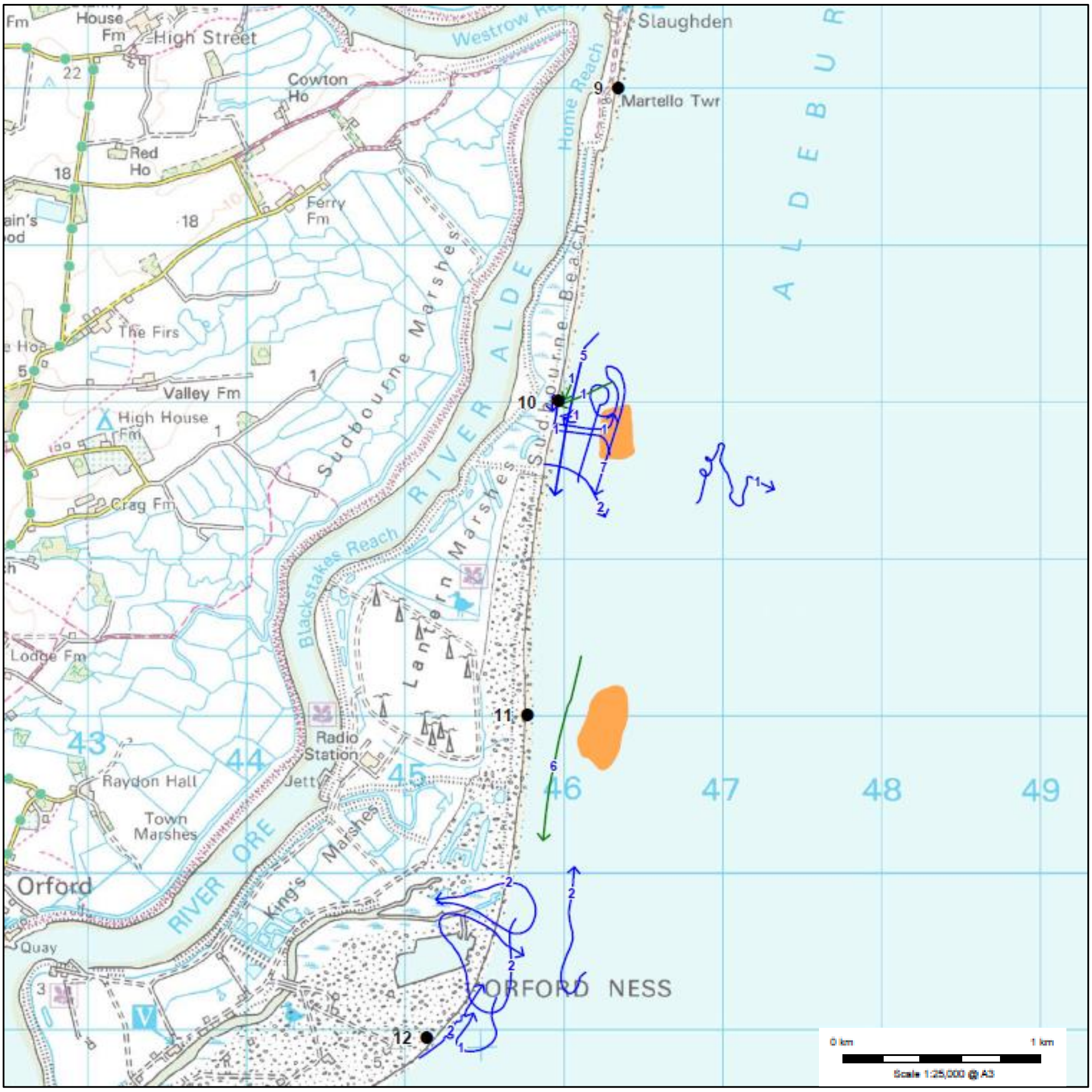
6.3.65. As detailed above for the Alde-Ore Estuary SPA (**Section 6.3 b**), VP surveys of little tern foraging and commuting activity were undertaken at a range of VP locations in 2011 and 2013 (Ref. 6.18, Ref. 6.19). These VP locations straddled the full extent of the breeding colonies associated with the Minsmere-Walberswick SPA and the Alde-Ore Estuary SPA in 2013 (from Orford Ness in the south to Dunwich in the north); but in 2011 they excluded the three most northern locations (VPs 13 – 15) and extended to *c*.0.5km north of the main development site only (at VP1) (**Figure 6.1**). However, flight lines and areas of concentrated foraging activity were recorded at the Dingle and Minsmere colonies in 2011, with the findings from these surveys presented in **Plate 6.7** and **Plate 6.8** above.

6.3.66. In 2011 a monthly peak count of 51 commuting birds was recorded from VP1, near to the main development site, in May. A single count of 18 birds was observed resting on Sudbourne Beach (VP10) in mid-May, after which up to 22 birds were present in the area until mid-June. During this period, little terns were frequently observed foraging over a spit approximately 1 km offshore of Sudbourne Beach. Little terns were also seen heading south from both the Dingle and Minsmere colonies, though at both colonies much of the foraging activity occurred in the shallow waters close offshore (generally within 700 m of the shoreline). Flight line data indicated that birds were moving between the colonies but were also heading further south along the shoreline towards Sizewell. Surveys from the VPs near Sizewell (VPs 1 – 6) showed much of the foraging activity of birds near to the main development site was in shallow waters within 300 m of the shore (**Plate 6.10**).

Plate 6.10: Flight lines and areas of concentrated foraging activity of little terns during vantage point surveys (VPs 1 – 5) in May – June 2011 (Ref. 6.18); note extends over three pages




Aldringham Ho
The Walks
Tumulus
Ness
Thorpe Ness
Partables Fm
B 1353
Church Fm
Hotel
CH
PH
Mill
The Fens
The Meare
Thorpeness
B 1122
North Warren
Haven Ho
The Haven
Warren
Red Ho
MS
Hall
Mus
LB Sta
Hospl
ALDEBURGH
Fort Green
BAY
45
46
47
48
49
50
0 km
1 km
Scale 1:20,000 @ A3



6.3.67. Details of the findings from 2013 VP surveys of little tern are as detailed for Alde-Ore Estuary SPA (**Section 6.3 b**) and Minsmere-Walberswick SPA (**Section 6.3 e**), with data presented in **Plate 6.2**Error! Reference source not found. and **Plate 6.9**.

Foraging behaviour and diet

6.3.68. Details of the foraging behaviour and diet of little tern are given above (see **Section 6.3 b,** Alde-Ore Estuary SPA). The areas which are likely to encompass the key foraging areas for breeding little tern within the Outer Thames SPA are defined by the estimated mean maximum alongshore and offshore foraging ranges from each of the different colony locations (i.e. 3.9 km and 2.4 km, respectively – Ref. 6.15).

6.3.69. Based upon the fish availabilities at Sizewell, the prey of breeding little tern foraging within Outer Thames Estuary SPA during the period May to August is expected to consist predominantly of schooling pelagic fish that are found near to the surface during daylight hours, such as herring, sprat and anchovy (Ref. 6.26).

iii. Common tern

SPA population

6.3.70. The Outer Thames Estuary SPA provides supporting habitat for breeding common terns, which are a qualifying feature of the Breydon Water and Foulness SPAs. Both of these SPAs are beyond the mean maximum foraging range of common terns from the main development site (at 18.6 km) and have been ‘screened out’ of the current assessment (Ref. 6.31; **Table 6.6**). In addition, the Outer Thames Estuary SPA supports birds breeding from a number of other colonies, including within the Minsmere-Walberswick SPA (at Minsmere) and the Alde-Ore Estuary SPA (at Orford Ness and Havergate Island), although in neither case is the species a qualifying feature of these SPAs.

6.3.71. At the time of its inclusion as a qualifying species, the Outer Thames Estuary SPA was estimated to support 270 pairs of breeding common tern from SPA breeding colonies, constituting almost 3% of the breeding population in Great Britain (based on counts from 2011-2015 – after Ref. 6.44; Ref. 6.45). Additional birds are supported from non-designated colonies. Numbers of common terns within the Alde-Ore Estuary SPA have declined to very low levels in recent years (with no birds breeding on Havergate Island and single pairs only recorded at Orford Ness in both 2017 and 2018), whilst within the Minsmere-Walberswick SPA they have tended to range between 100 to 150 pairs (Ref. 6.44; **Table 6.6**).

Table 6.6: Breeding common tern populations at coastal SPAs for which Outer Thames Estuary SPA provides important supporting habitat (bold indicates SPAs 'screened into' the current assessment)

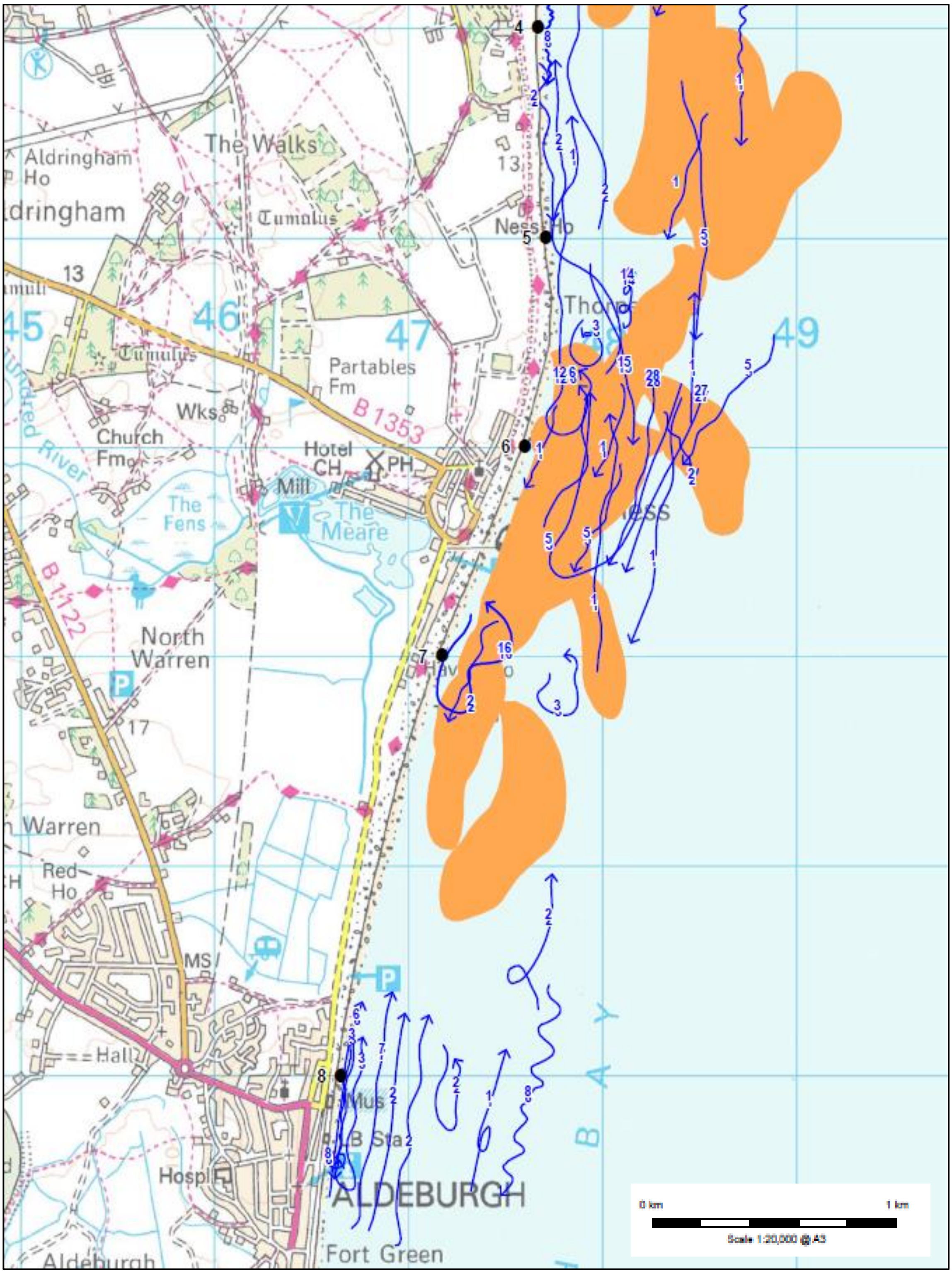
SPA	Approximate distance to the main development site (km)	Current breeding population (breeding pairs)[1]	SPA qualifying feature
Breydon Water[2]	*c.*40 km	252	Yes
Foulness	*c.*75 km	17.5	Yes
Minsmere-Walberswick	***c.*1 km**	**103**	**No**
Alde-Ore Estuary	***c.*17 km**	**19**	**No**

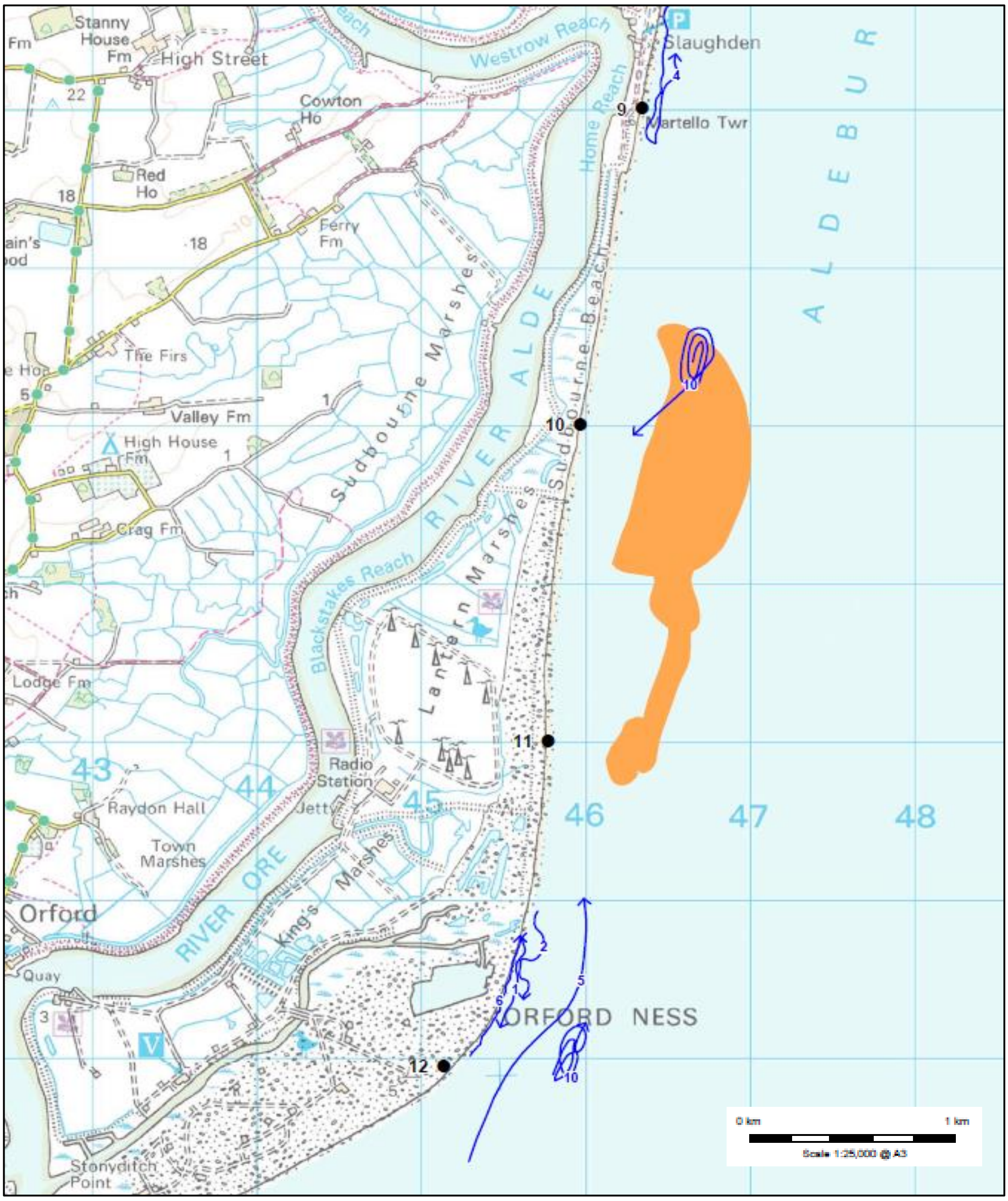
[1] Estimates derive from 2011-15 for Breydon Water and Foulness (Ref. 6.46), from 2012-15 and 2018 for Minsmere-Walberswick (Ref. 6.47) and 2014-18 for Alde-Ore (Ref. 6.28).
[2] Includes colonies considered to be functionally linked to the SPA as well as colonies within the SPA (Ref. 6.46).

Project-specific survey data

6.3.72. As for little tern, common tern flight activity was recorded during the 2011 and 2012 surveys, using 12 coastal VPs in the vicinity of Sizewell, from Orford Ness north to a location approximately 0.5 km north of the main development site (Ref. 6.18; **Figure 6.1**). During these surveys, birds were recorded in the Sizewell / Minsmere area between April and October 2011, with returning birds recorded in April 2012. These records comprised large numbers of foraging birds (including juveniles) at all VPs between July and September. Much of this foraging activity occurred close inshore, with 47% of records less than 100 m from the coastline and 79% within 500 m. Common terns were also regularly recorded commuting up and down the coast, often 2 – 3 km from the shoreline. Foraging activity and flight lines recorded during the survey period are presented in **Plate 6.11**.

Plate 6.11: Flight lines and areas of concentrated foraging activity of common terns during vantage point surveys (VPs 1 – 5) in April 2011 – April 2012 (Ref. 6.18); note extends over three pages


Aldringham Ho
The Walks
Tumulus
Partables Fm
B 1353
Wks
Church Fm
Hotel
CH
PH
Mill
The Fens
The Meare
River
B 1122
North Warren
Warren
Red Ho
MS
Hall
Hospl
ALDEBURGH
Fort Green
Ness Ho
45
46
47
49
0 km
1 km
Scale 1:20,000 @ A3



6.3.73. During the VP surveys in 2011 and 2012, common terns were regularly observed foraging around the Sizewell B outfall, with birds returning from the waters around the outfall to nests at Minsmere often carrying food items for young. Numbers peaked in July and August, with up to 230 birds recorded in August. Once breeding terns had departed from Minsmere, the number of terns (including juveniles) recorded at the outfall and resting on the adjacent beach increased. As such, it seems likely that the outfall provides an important foraging resource for common terns from the Minsmere colony.

6.3.74. Common tern activity near Sizewell was also recorded during VP surveys in March to August 2013 (Ref. 6.19). Fifteen VPs were used as for the 2013 little tern surveys, giving increased coverage north of the main development site compared in 2011 and 2012 (**Figure 6.1**). Most foraging activity recorded in 2013 was close to the shoreline adjacent to Minsmere-Walberswick SPA and near to Sizewell B outfall (VPs 1, 2, 13 and 14) (**Plate 6.12**).

Plate 6.12: Main foraging areas of common terns identified during vantage point surveys, March – August 2013 (Ref. 6.19)

6.3.75. As for Sandwich tern, common terns may forage considerable distances offshore (Ref. 6.30, Ref. 6.31), and well beyond the distances at which birds can be recorded during shore-based surveys. Therefore, these surveys have limited value in determining the full marine extent of important foraging areas of this species.

Foraging behaviour and diet

6.3.76. During the breeding season (May to August), common terns are found around most of the UK coast and have a wide variety of nesting habitats, including shingle beaches, rocky islands and saltmarsh in coastal areas, as well as inland on lakes, reservoirs and gravel pits (often on artificial nesting platforms) (Ref. 6.25). They feed over freshwater and at sea by fishing in the top few centimetres of water (Ref. 6.20), down to a maximum depth of 1 m (Ref. 6.32). The mean maximum foraging range of breeding common terns is estimated as 18.6 km, based on a generic model of range usage derived from a UK-wide study encompassing a range of colonies, although distances of up to 30 km have been recorded (Ref. 6.31).

6.3.77. Based on the mean maximum foraging range, breeding birds from the designated populations at the Breydon Water and Foulness SPAs are unlikely to forage in waters within the vicinity of the main development site. The majority of birds using the waters in the Sizewell area during the breeding season are likely to derive from the non-designated colonies at the Alde-Ore Estuary SPA and Minsmere-Walberswick SPA. The generic model of range usage by common terns around their colonies also predicts that, within the area defined by the mean maximum foraging range, usage will be greatest near the colony (the term with the greatest effect size in the model), and in relatively shallow waters which are close to the shore (Ref. 6.31).

6.3.78. Common terns tend to use a greater variety of habitats and feeding techniques, and exploit a greater range of prey items, than other tern species (Ref. 6.48). They use a variety of foraging methods including plunge diving, diving to surface, hawking, dipping, kleptoparasitism and perch-feeding and feed on a wide range of prey including fish, crustaceans, squid and marine worms, as well as aquatic or terrestrial insects but, as for other tern species feeding in the marine environment, with the vast bulk of the prey (particularly for chick provisioning) being fish (Ref. 6.25).

6.3.79. The diet of adults is likely to include a higher proportion of invertebrates and less energy-rich components than are provisioned to chicks, for the reasons outlined above for Sandwich terns (Ref. 6.25). In the marine environment, the main prey delivered to chicks are herring, sprat, sandeel, saithe, whiting and cod, though this varies between years and locations (Ref. 6.49).

Herring and sprat are the key prey resources of breeding common terns in the southeast North Sea / Wadden Sea (Ref. 6.50).

6.3.80. Based upon fish availabilities at Sizewell (Ref. 6.37), the prey of breeding common tern in the coastal areas of Outer Thames Estuary (incorporating the waters in the vicinity of the main development site) during the period May to August is expected to consist of schooling pelagic fish species that are found near to the sea surface during daylight hours, such as sprat, herring and anchovy (Ref. 6.26).

iv. Red-throated diver

SPA population

6.3.81. When first classified in 2010, the Outer Thames Estuary SPA supported an estimated 6,446 non-breeding red-throated divers, representing approximately 38% of the non-breeding population estimated for Great Britain (i.e. 17,116 individuals - Ref. 6.44). There is likely to be interchange of birds between the SPA and other North Sea wintering grounds, such as the Wadden Sea, and the SPA population largely originates from Scottish and Scandinavian breeding populations along with some birds from as far afield as Greenland (Ref. 6.51).

6.3.82. The earlier estimates of red-throated diver numbers in the SPA are likely to be underestimates and subsequent surveys, undertaken using improved methods and technology, give higher estimates. In February 2013, aerial surveys undertaken using high-resolution digital photography suggested that the SPA population was around 14,161 individuals (95% confidence interval (CI) of 8,230 – 22,245), which at the time was the highest number recorded for any site in northwest Europe (Ref. 6.52; Ref. 6.53). A further survey commissioned by Natural England in February 2018, using advanced aerial survey techniques, estimated a peak abundance of 22,280 individuals (95% CI 15,611 – 29,784) across the entirety of the SPA (including the recent extension), of which 21,997 individuals (95% CI 15,351 – 29,4150) were estimated to be within the original SPA area (Ref. 6.54).

Project-specific survey data

6.3.83. Red-throated diver abundance and behaviour was recorded during coastal VP surveys from March 2011 to April 2012, using the 12 VPs in the vicinity of Sizewell, from Orford Ness north to a location approximately 0.5 km north of the main development site (Ref. 6.18; **Figure 6.1**). These surveys were conducted every two weeks over the winter period (October to March), with each survey at each VP being 45 minutes duration. A total of

5,056 divers were recorded during the survey period, of which 3,997 were commuting through the survey area and 1,059 were foraging or resting on the sea. The highest number of divers were seen in March and April 2011, and again in December 2011 to April 2012, with smaller numbers from August to October 2011 and none from May to July 2011.

6.3.84. Overall, the highest numbers of red-throated diver were recorded from the most southern VP (12) at Orford Ness, although relatively few of the birds recorded from this location were foraging or loafing (**Table 6.7**). The highest numbers of foraging and loafing birds were recorded at VPs 5 to 7 (near Thorpeness and south of the main development site) and at VP11 (Orford Ness). The distribution of the peak number of divers recorded foraging or loafing in 1 km grid squares viewable from the VPs is shown in **Plate 6.13**.

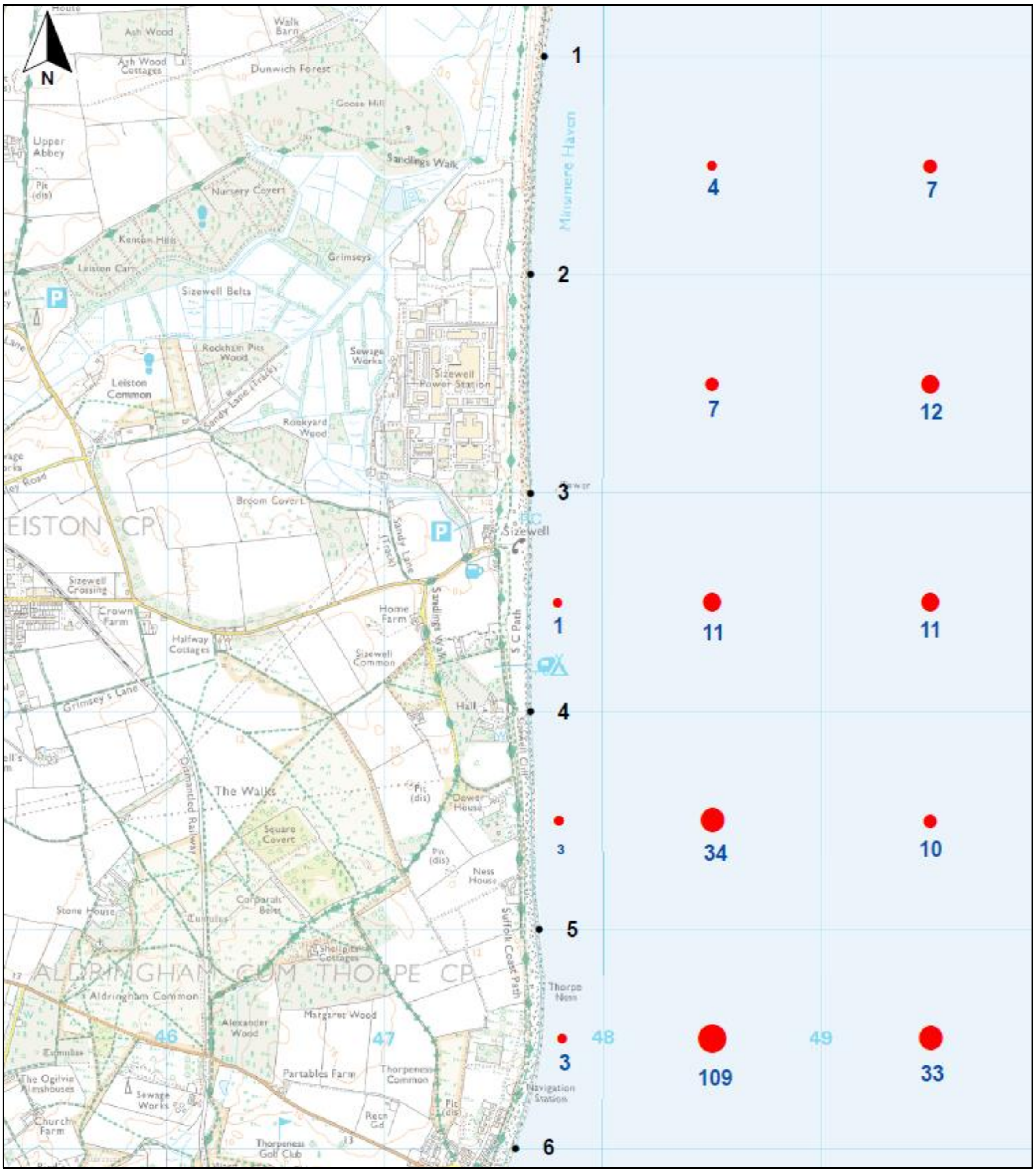
Table 6.7: Distribution of red-throated diver records across the 12 VPs used in surveys from March 2011 – April 2012 (see Figure 6.1 for VP locations)

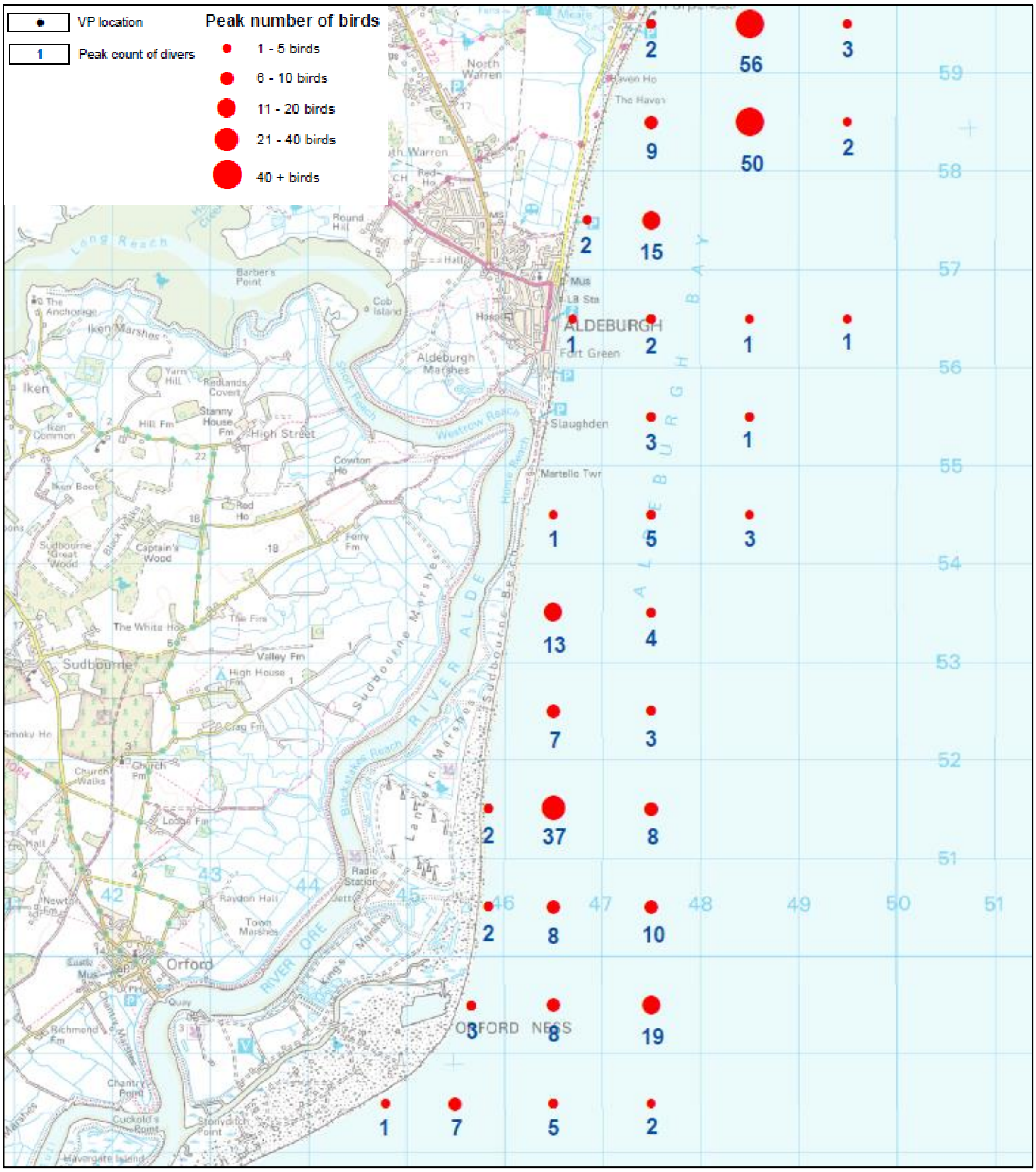
VP	Number of birds commuting	Number of birds foraging / loafing
1	213	128
2	208	62
3	112	47
4	464	50
5	210	222
6	264	157
7	322	119
8	379	38
9	102	18
10	322	57
11	445	108
12	956	53

6.3.85. Further red-throated diver surveys were undertaken during the winter period (October – March) in 2012 – 2013 and 2013 – 2014 at 15 VPs along the coastline between Dunwich (i.e. VP15, *c.* 6 km north of the main development site) and Orford Ness (i.e. VP12, *c.* 16 km south of the main development site) (**Figure 6.1**). As well as the addition of the three more northerly VP locations, these later surveys also incorporated coverage of dawn and dusk periods at the four VPs closest to the main development site (i.e. VPs 1 – 4), but otherwise followed the same methods as used in the 2011-12 surveys (Ref. 6.19; Ref. 6.55).

6.3.86. A total of 2,543 sightings were recorded during the 2012 – 2013 surveys (mostly in February and March, with 19% and 67% of records, respectively) and 4,497 sightings during 2013 – 2014 surveys (mostly in December, January and February with 46%, 23% and 28% of records, respectively), with a maximum single count of 700 birds from VP 15 (at Dunwich) in December 2013.

Plate 6.13: Peak numbers of foraging and loafing red-throated divers in each 1 km square, VPs 1 - 6, March 2011 to April 2012; note extends over two pages





6.3.87. As for the earlier 2011-12 survey data, numbers tended to be relatively high at the southern VPs (11 and 12) but there were also high peak counts in the northern parts of the survey area, particularly at VPs 1, 13 and 15 (**Table 6.8)**. Relatively few birds were recorded in immediate proximity to the offshore extent of the main development site (i.e. at VPs 2 and 3).

Table 6.8: Peak and mean numbers of red-throated diver recorded at each of the 15 VPs used in the 2012-13 and 2013-14 winter surveys

VP	2012-13		2013-14	
	Peak count	Mean count per survey visit	Peak count	Mean count per survey visit
1	108	13.8	200	42.8
2	34	6.2	6	6.9
3	28	5.4	14	7.9
4	50	8.8	8	8.8
5	25	5.0	55	7.8
6	20	2.5	50	8.7
7	72	10	24	23.0
8	147	19.6	43	13.4
9	167	22.7	24	9.6
10	68	22.9	100	31.6
11	227	42.1	200	83.9
12	155	40.6	120	51.5
13	133	20.3	60	18.3
14	86	19.1	80	28.7
15	65	14.7	700	87.5

6.3.88. During the 2012-13 and 2013-14 winter surveys, red-throated divers were recorded out to a maximum distance of 3 km (considered to be the limit for the shore-based survey method used – Ref. 6.19; Ref. 6.55), but with few records from beyond 2 km (reflecting the problems in locating and identifying divers at this distance). Only 5.7% of all records were within 500 m of the shore, whilst 40% and 54% were between 500 m and 1 km and 1 km and 2 km, respectively. Therefore, even allowing for the increased area of sea within these wider distance bands, densities are clearly relatively low within 500 m of the shore (bearing in mind that detectability of birds also declines with distance from the shore and is likely to be relatively low at distances beyond 1 km).

Distribution and abundance across the SPA

6.3.89. The Outer Thames Estuary SPA comprises three discrete sections, with the main development site occurring within the north-western section which abuts the coast between the Deben Estuary in the south and Great Yarmouth in the north (**Figure 4.1**). The 2018 aerial surveys of the SPA provide separate estimates of the abundance and densities of red-throated divers in each of these SPA sections.

6.3.90. Of the three separate SPA sections, the southern section holds the bulk of the SPA population with densities estimated to be almost twice as high as those in the north-western section during the second survey visit (when peak numbers occurred) and over five times higher during the first survey visit (Ref. 6.54). The peak abundance within the north-western SPA section was estimated as 4,587 (95% CI 2,499 – 7,114) individuals, representing 21% of the peak estimate for the entire SPA (22,280, 95% CI 15,611 – 29,784) (Ref. 6.54). During the first survey visit, when numbers across the SPA were lower, the abundance in the north-western SPA section represented only 7% of the SPA total.

6.3.91. Similar differences in the densities of red-throated divers between the three discrete SPA sections were also noted during the earlier aerial surveys, with the southern section again holding the bulk of the SPA population during two surveys undertaken in January and February in 2013 (APEM 2013). Furthermore, distribution maps for both the 2013 and 2018 surveys indicate that relative to the overall densities within the north-western SPA section, densities in the coastal waters immediately adjacent to the main development site tend to be low to moderate (Ref. 6.52, Ref. 6.54).

Foraging behaviour and diet

6.3.92. Red-throated divers are opportunistic feeders and feed mainly on fish, particularly during wintering periods in coastal areas, but diet composition is understood to depend on local availability of prey rather than food specialisation (Ref. 6.56). They are pursuit divers and forage in marine waters by diving from the surface to a typical mean depth of 2 – 8 m and maximum depth of 9 – 10 m for up to 1 minute at a time (Ref. 6.32).

6.3.93. Typical dietary components for non-breeding divers in the North Sea and Baltic Sea include clupeids (herring and sprat), gadoids) including whiting *Merlangius merlangus,* blue whiting *Micromesistius poutassou* and cod *Gadus morhua*), gobies, sandeels and smelt (Ref. 6.56; Ref. 6.57; Ref. 6.58). There is an element of selective feeding, since locally common flatfish tend to be avoided when other prey is available (Ref. 6.56).

6.3.94. Individual fish prey ranges from *c.* 2.5 cm (0.1 g) to *c.* 30 cm (180 g), with a tendency to consume smaller prey items in winter than in spring (e.g. mean herring sizes of 12 cm and 21-23 cm, respectively), although this may be a reflection of the local populations of wintering juvenile fish commonly found in coastal areas (Ref. 6.56; Ref. 6.59). It has been estimated that red-throated diver have food requirements of approximately 496 g / day (Ref. 6.58).

6.3.95. Based upon fish availabilities at Sizewell (Ref. 6.37), the prey of non-breeding red-throated divers in inshore areas of Outer Thames Estuary SPA is expected to consist of the most commonly occurring benthopelagic species, including sprat, herring, whiting and bass *Dicentrarchus labrax* (Ref. 6.26).

6.3.96. As a non-breeding population, the red-throated divers associated with the SPA are not constrained by the foraging range from the colony, in contrast to the breeding seabird qualifying features of the SPA. Therefore, red-throated divers may range widely and take advantage of prey resources over a large area. This is likely to make the SPA non-breeding red-throated diver population relatively insensitive to localised changes in prey availability.

6.4 Marine mammals

a) The Humber Estuary SAC

i. Grey seal

6.4.1. Seal species within the UK are listed under a number of international and national legislations for their protection. Both grey and harbour seal are listed under Annex II and Annex V of the Habitats Directive. Annex V requires that their exploitation or removal from the wild may be subject to management measures, and Annex II that member states of the European Union are to designate areas essential for their life and reproduction as SACs. The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2017 (as amended) provide the same level of protection when over 12 nautical miles (nm) offshore.

Distribution and abundance

6.4.2. UK grey seal populations are assessed from the counts of pups born each year. Surveys are undertaken during the breeding season when females congregate on land to give birth. The most recent counts available are from the 2016 autumn breeding season surveys, that were released in 2018. The 2016 surveys resulted in an estimate of 65,000 pups (95% CI = 57,800-71,800; Ref. 6.60). The pup counts can be used to determine actual population size through a mathematical model and have been projected forward to 2018. This model provides an estimated UK population for 2018 of 150,000 (95% CI = 131,000-171,600; Ref. 6.62). The most recent regional pup counts from the 2016 surveys for the North Sea colonies was 14,600 (95% CI = 12,700-16,900) (Ref. 6.60). The rate of pup production for the North Sea colonies have been increasing at an average rate of 10% per year from 2010-2016. In addition to the high numbers of grey seal along the east coast of the UK, there are also high numbers within the North Sea close to sandbanks (such as Dogger Bank) and along the corridors that connect offshore foraging areas to haul-out sites (Ref. 6.61).

6.4.3. The most recent counts of grey seal in the August 2016 surveys estimated that the total count of grey seals in the UK was 45,119 (Ref. 6.60). The grey seal Management Unit (MU), within which the Sizewell C main development site[10] is located, is the South-East England MU as shown on **Plate 6.14**, which has an estimated population of 8,716 (Ref. 6.60). This includes 6,526 seals at Donna Nook (which is the haul-out within the Humber Estuary SAC), 688 at The Wash 502 at Blakeney Point, 481 in Essex and Kent, and 425 at Scroby Sands.

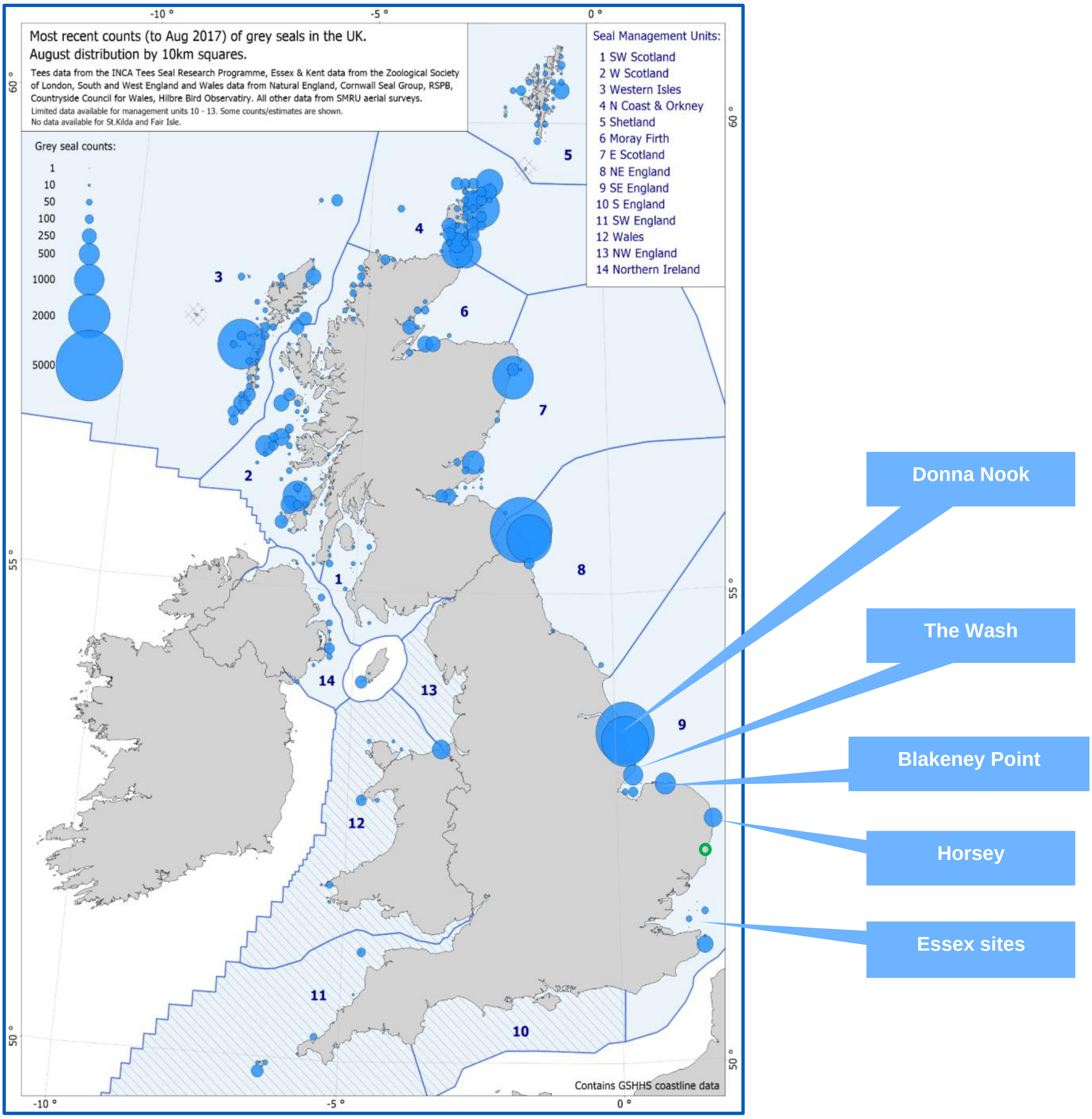
6.4.4. Marine mammal observations during recent surveys in the Greater Sizewell Bay have shown that grey seals are present in the vicinity of the Sizewell C Project; near the B station outfall and further offshore across and seaward of the Sizewell-Dunwich sandbank in the vicinity of the proposed intake and outfall infrastructure. Observations occurred on a regular basis, and in the winter and spring survey, seals were recorded on almost 40% of survey days, with one juvenile recorded in early March (Ref. 6.62).

6.4.5. Marine Scotland commissioned SMRU to produce maps of grey seal distribution in UK waters (Ref. 4.3). These maps were produced by combining information about the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites. The resulting maps show estimates of mean seal usage (seals per 5km x 5km grid cell) within UK waters.

6.4.6. These usage maps indicate that grey seal mean total usage is low in and around the Sizewell C main development site, with a grey seal density of 0.038/km^2 at the location of the Sizewell C main development site (for the grid cells intersecting with the Sizewell C Project red line boundary), and of 0.030/km^2 over the wider area (for the grid cells that intersect within a buffer distance of 25km from the Sizewell C Project red line boundary) (Ref. 4.3; **Figure 6.2**).

[10] Note that the Sizewell C main development site, rather than the Sizewell C Project, has been used as the study area for this WDA Shadow HRA regarding potential effects on marine mammals and marine birds; because the other elements of the wider Project, i.e. associated developments, do not have the potential to influence the marine environment.

Plate 6.14 Locations of the main grey seal breeding sites around the UK (taken from Ref. 6.60); the approximate location of the Sizewell C main development site is indicated by the green circle



Movements

6.4.7. Tracking of individual seals has shown that most foraging probably occurs within 100km of a haul-out site, with ranges of approximately 145km (Ref. 6.63), although they can feed up to several hundred kilometres offshore, with ranges of 1,088 to 6,400km recorded (Ref. 6.64). Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore, but will occasionally move to a new haul-out site and begin foraging in a new region (Ref. 6.65). Studies of regular foraging and dispersal between winter breeding sites, and summer foraging and haul out sites indicates ranges of 1,000km (Ref. 6.66).

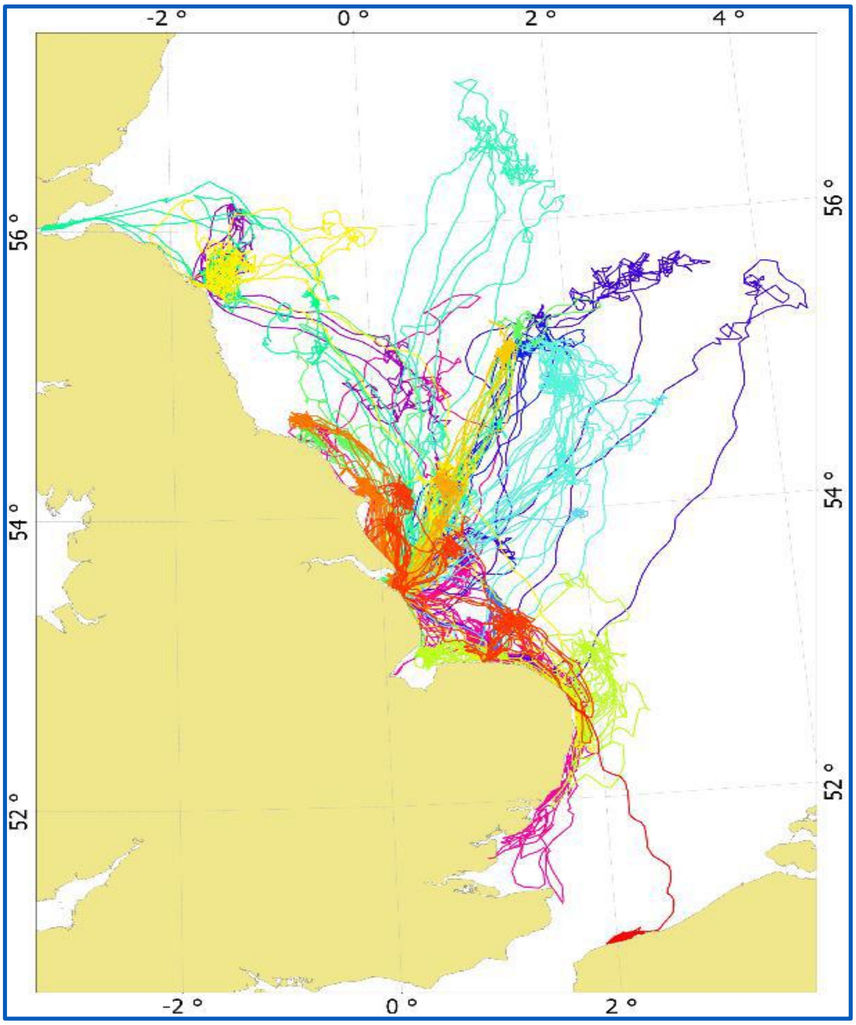
6.4.8. Tags were deployed on grey seal at Donna Nook (the haul-out site within the Humber Estuary SAC) (n=11) and Blakeney Point (n=10) in May 2015, at the end of their moult periods (Ref. 4.2). The tagged grey seals travelled between haul-out sites along the east coast of England, as well as to the north of France and up to the Firth of Forth and across Fladden Ground and Dogger Bank (Ref. 4.2). Of the 21 tagged individuals, 16 used multiple haul-outs sites; one hauling out in the Netherlands and one in northern France (this individual did not return within the tags duration) (Ref. 4.2). **Plate 6.15** shows the tagged seal movements along the east coast of England from the Donna Nook and Blakeney Point haul-out sites.

Haul-out sites

6.4.9. Grey seal come ashore to give birth, for their annual moult period and to rest between foraging trips. Grey seal will often haul-out on outlying islands and remote coastlines exposed to the open sea. Generally, they are sensitive to disturbance by humans and will haul-out in remote areas and prefer remote breeding sites. However, Donna Nook (the haul-out site within the Humber Estuary SAC) has a population of grey seals that have become acclimatised to the presence of humans and the associated disturbance, where there are over 70,000 visitors to the site during the breeding season and no impact on the breeding seals or pups (Ref. 6.60).

6.4.10. Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (Ref. 6.60). In eastern England, pupping occurs mainly between early November and mid-December (Ref. 6.60). Pups are typically weaned 17 to 23 days after birth, when they moult their white natal coat and then remain on the breeding colony for up to two or three weeks before going to sea (Ref. 6.67).

Plate 6.15 Tagged grey seal movements along the east coast of England (Ref. 4.2)



6.4.11. The main breeding and haul-out sites for grey seal on the east coast of England are (with the distance to the Sizewell C main development site shown in brackets) located at Horsey (63km north), Blakeney Point (119km north), The ash (168km north), Donna Nook (194km north), and the Essex haul-out sites which include the Long Sand Inner (67km to the south-west), Margate (88km to the south-west) and Goodwin Sands (100km to the south-west) (**Plate 6.15**Error! Reference source not found.).

6.4.12. The number of grey seals recorded at the Essex haul-out sites has remained steady over recent years, with 393 individuals recorded in the 2010 count, to 449 within the 2014 count (Ref. 6.68), and 481 in the most recent 2016 count of the wider Thames estuary (Ref. 6.60).

Diet and prey species

6.4.13. Grey seals typically forage in the open sea and foraging trips can last anywhere between one and 30 days (Ref. 6.60).

6.4.14. Grey seal are generalist feeders and will prey upon a variety of species. The most common food sources for grey seal are sandeels (Ammodytidae), gadoid species (such as cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus* and ling *Molva molva*) as well as flatfish species (such as plaice *Pleuronectes platessa*, sole *Soleidae sp*., flounder *Platichthys flesus* and dab *Limanda limanda*), however, this does vary from season and by location (Ref. 6.69). A study by Hammond and Wilson (2016) has shown that the diet of grey seals in the North Sea was dominated by sandeels (56%), with gadoid prey (particularly cod and saithe) comprising about 20% of the total diet (Ref. 6.70).

6.4.15. Food requirements for grey seal will depend on a number of factors, such as its size and fat content of the prey, but a general estimate is that a typical grey seal requires 4 to 7 kg of prey a day, depending on the prey species (Ref. 6.60).

b) Southern North Sea SAC

i. Harbour porpoise

6.4.16. All cetaceans in UK waters are classed as European Protected Species (EPS) under Annex IV of the Habitats Directive (EU Directive 92/43/EEC) and therefore are internationally important. Harbour porpoise are additionally listed under Annex II of the Habitats Directive and are afforded protection through the designation of SACs. The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2017 (as amended) provide the same level of protection when over 12 nm offshore.

6.4.17. Member States report back to the EU every six years on the conservation status of marine EPS. In the UK, harbour porpoise has been assessed as having a '*favourable*' conservation status based on the last 2007 to 2012 reporting period (Joint Nature and Conservation Committee (Ref. 6.71).

6.4.18. The Annex II species harbour porpoise is a primary reason for site selection of the Southern North Sea SAC.

Distribution and abundance

6.4.19. Harbour porpoise within the eastern north Atlantic are generally considered to be part of a continuous biological population that extends from the

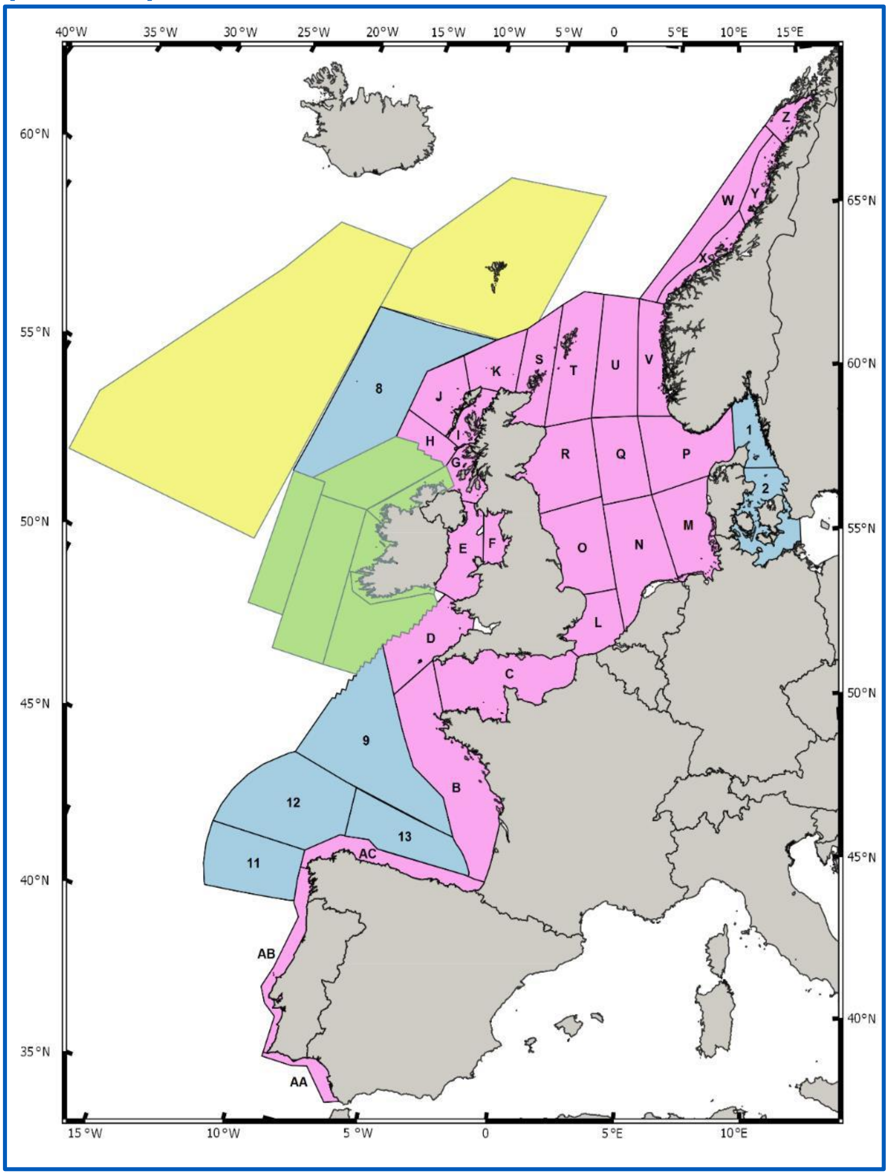
French coastline of the Bay of Biscay to northern Norway and Iceland (Ref. 6.72; Ref. 6.73, Ref. 6.74; Ref. 6.75). However, for conservation and management purposes, it is necessary to consider this population as smaller MUs.

6.4.20. The IAMMWG defined three MUs for harbour porpoise: North Sea; West Scotland; and the Celtic and Irish Sea; the Sizewell C main development site being within the North Sea MU. The SCANS-III survey was undertaken in the summer of 2016 and surveyed all European Atlantic waters from the Strait of Gibraltar in the south to 62°N in the north and extending west to the 200nm limits of all EU Member States (Ref. 6.76). The SCANS-III estimate of harbour porpoise abundance in the North Sea MU was 345,373 (Coefficient of Variation (CV) = 0.52; 95% Confidence Interval (CI) = 246,526 - 495,752) with a density estimate of 0.52/km^2 (Ref. 6.76).

6.4.21. The Sizewell C main development site is located in SCANS-III survey block L (**Plate 6.16**), which was completed by aerial surveys and had an area of 31,404km^2 and 1,949.3km of effort. The estimated abundance of harbour porpoise in SCANS-III survey block L is 19,064 harbour porpoise (CV=0.38; 95% CI = 6,933 – 35,703), with an estimated density of 0.607 harbour porpoise/km^2 (Ref. 6.76).

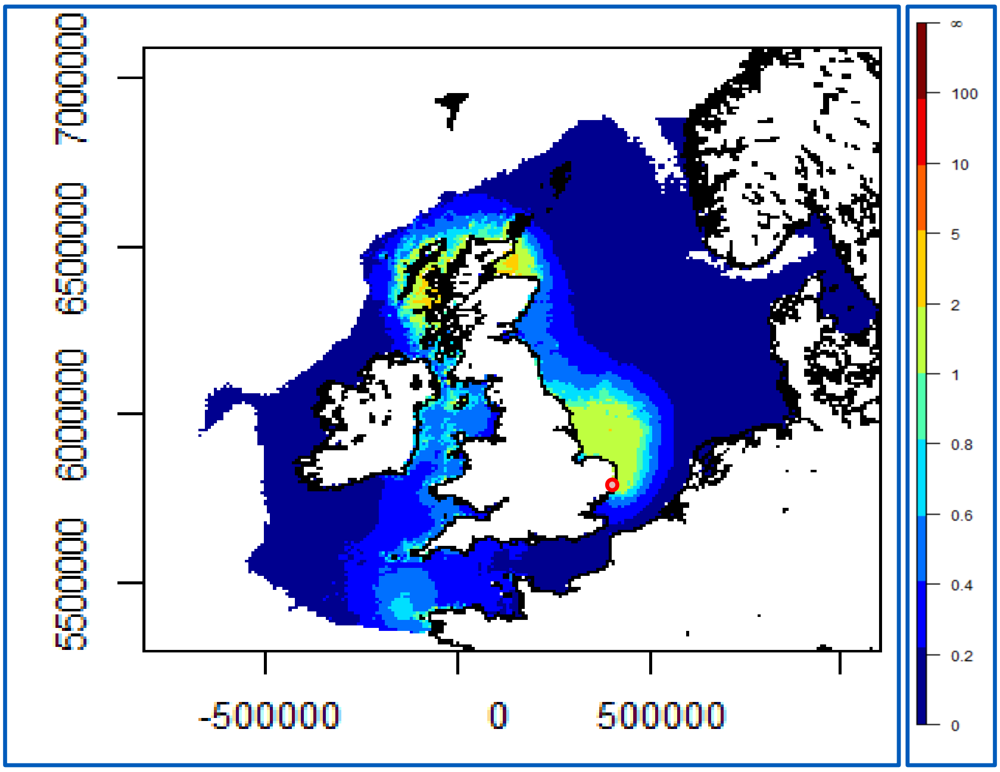
6.4.22. The Joint Cetacean Protocol (JCP) Phase-III report indicates that for an area off the coast to the east of East Anglia, which includes the Sizewell C main development site (defined as the '*Norfolk Bank Development Area'* within the report, and totalling an area of 14,295km^2), the abundance of harbour porpoise ranged from 5,300 (CI = 2,600-15,600) in the spring to 13,700 (CI = 7,000-26,200) in the winter, with numbers in summer and autumn being in between this range (Ref. 6.77). The '*Norfolk Bank Development Area*' covers 2.4% of the North Sea MU, but the abundance estimate of harbour porpoise in this area equates to 13.9% (CI = 8.9-19.2%) of the North Sea MU, indicating a high use of the area (Ref. 6.77). **Plate 6.17** illustrates the distribution of harbour porpoise, based on modelled densities for winter 2010 from the JCP Phase-III report.

Plate 6.16 Survey blocks covered by SCANS-III and adjacent surveys (Ref. 6.76)[11]



[11] SCANS-III = pink lettered blocks surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green to the south, west and north of Ireland were surveyed by the Irish ObSERVE project. Blocks coloured yellow were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015.

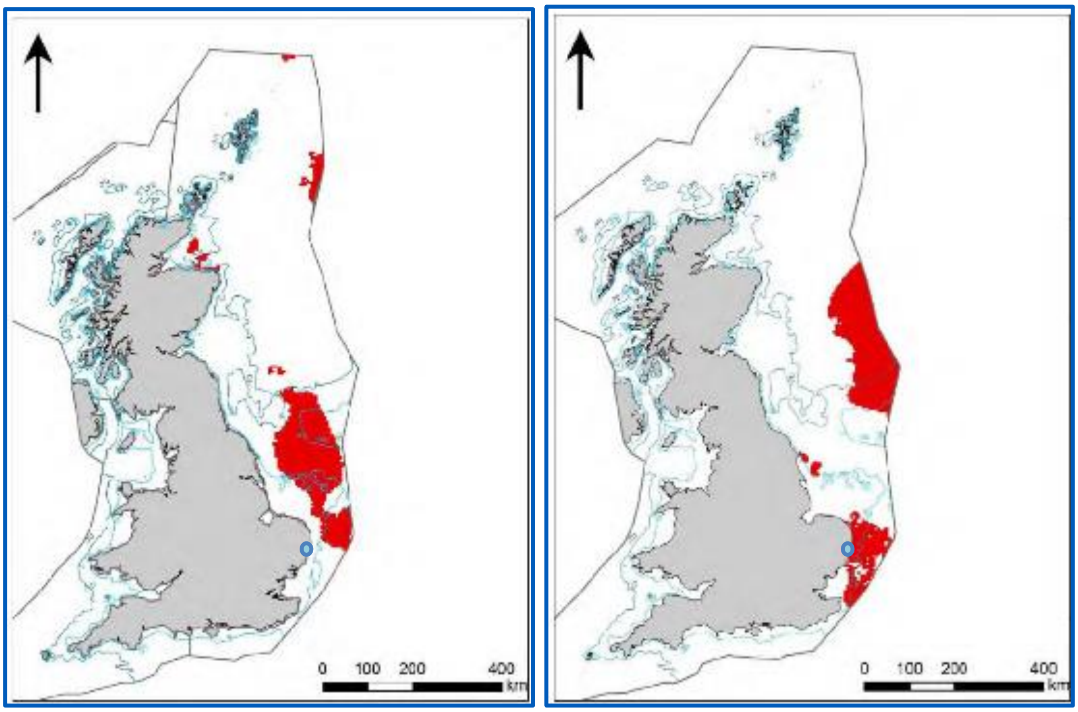
Plate 6.17 Distribution of harbour porpoise based on predicted JCP harbour porpoise densities (animals/km^2) for winter 2010 (Ref. 6.77); the approximate location of the Sizewell C main development site is indicated by the red dot



6.4.24. Heinänen and Skov (2015) provide the results of detailed analyses of 18 years of JCP survey data (Ref. 6.78). The model results for the North Sea MU indicate that most important factors for the probability of harbour porpoise presence in the North Sea MU is water depth and hydrodynamic variables (Ref. 6.78). For water depth, higher densities of harbour porpoise are consistently found in depths of 30-50m. During the summer months, surface salinity and eddy potential are the important hydrodynamic determinants of presence, while stability of the temperature is the most important for the density. During the winter months, eddy activity is still of importance, while current speed has an effect. The presence of vessels is an important factor in the abundance and presence of harbour porpoise in the North Sea MU, with a lowering of abundance when exposed to over 80 vessels per day within a 5km^2 area (Ref. 6.78).

6.4.25. The modelled areas of persistent high densities within the North Sea MU, based on the JCP data as described above show that during the summer months, there is an area of high harbour porpoise persistent density offshore of the Norfolk Coast, with a high harbour porpoise persistent density located directly off the coast and offshore of the Sizewell C main development site in the winter (Ref. 6.78; **Plate 6.18**Error! Reference source not found.Plate 6.18Plate 6.18Plate 6.18Plate 6.18Plate 6.18Error! Reference source not found.Error! Reference source not found.).**Error! Reference source not found.**

Plate 6.18 Persistent high-density areas identified in the North Sea MU during the summer months; the red colours mark areas where persistent high densities, as defined by the upper 90th percentile, have been identified and the approximate location of the Sizewell C main development site is indicated by the blue dot (Ref. 6.78)



Marine mammal surveys

6.4.26. A number of Offshore Wind Farm projects are near to the Sizewell C main development site. These include the following (with the distance from closest point of the windfarm site to the Sizewell C main development site shown in brackets): Greater Gabbard Offshore Wind Farm (33km), Galloper Wind Farm (34km) and East Anglia TWO (31km).

6.4.27. Site specific boat-based surveys for Greater Gabbard Offshore Wind Farm were undertaken for both seabirds and marine mammals from April 2004 to April 2006 (Ref. 6.83). A total of 166 harbour porpoise were recorded across 14 of the surveys (with none recorded in May or June 2004) (Ref.

6.83). The average encounter rate (which has not been adjusted for sea state) was reported as 0.04/km (Ref. 6.79).

6.4.28. The Galloper Wind Farm boat-based surveys were undertaken from June 2008 to May 2011 for the wind farm site plus 4km buffer, over 36 months. In total, 570 harbour porpoise were identified within that time, with peak sightings in April and May 2010 (n=156 and n=140 respectively) (Ref. 6.80). The reported encounter rate for the Galloper Wind Farm baseline surveys was highest in April and May 2010, with an encounter rate of 0.8/km, however, the average rate was lower over the entire survey period, with a mean maximum encounter rate of 0.55/km (Ref. 6.80).

6.4.29. The East Anglia TWO aerial surveys, which covered the windfarm site and a 4km buffer, have so far been undertaken for the period of November 2015 to April 2016, September 2016 to October 2017 and May 2018. A total of 436 marine mammals were sighted within this period, with the majority being identified as either harbour porpoise or unidentified dolphin (n=352; 80.7%), with a further 15.5% being identified as harbour porpoise (n=69) (Ref. 6.81).

6.4.30. The Marine Aggregate Regional Environmental Assessment (MAREA) for the Outer Thames Region (Thames Estuary Dredging Association (TEDA), 2010) investigated porpoise distribution within the outer Thames region. The Sizewell C main development site is located to the north of the study site. During the TEDA surveys, the majority of porpoise sightings were recorded over the winter period (Ref. 6.82). This increase in sightings suggests that there could be a seasonal increase in use of the outer Thames Estuary at this time, possibly in relation to increases in food abundance, such as spawning herring *Clupea harengus*.

6.4.31. Marine mammal sightings during recent winter geotechnical surveys in the Greater Sizewell Bay, support the higher levels of individuals within the offshore area, with sightings only on the edge and outside of the Sizewell-Dunwich sandbank to the southeast of the Sizewell C main development site. The surveys also suggest that harbour porpoise are not commonly present within the Greater Sizewell Bay, with sightings made on only 12% (5 out of 40) of the February to March survey days (Ref. 6.62).

6.4.32. An acoustic monitoring technique was used to study the presence of cetaceans within the Greater Sizewell Bay. Static acoustic loggers (C-PODS) were deployed over a period of 18 months, from September 2011 to March 2013, which were initially deployed at six locations, with further stations added at later dates. However, loss rates through this study were high due to local conditions and suspected human interference, some loggers also suffered from technical problems, the resultant data recovery rates impaired the options for data analysis, with a total of 37 months of data successfully collected from nine C-PODs (Ref. 6.83).

6.4.33. Sufficient data was collected from these C-PODS to be able to provide some qualitative information on cetacean activity in the area. Harbour porpoise were detected on a total 64% of the monitoring days (414 days of a total of 745 days). Detections were consistently highest between October and March and lowest during the summer period, consistent with the known movements of harbour porpoise in the area. Detection rates were also higher during the night than the day, and the data indicated that harbour porpoise preferred offshore waters (Ref. 6.83).

Diet and prey species

6.4.34. The distribution and occurrence of harbour porpoise is most likely to be related the availability and distribution of their prey species. For example, sandeels (*Ammodytidae*), which are known key prey for harbour porpoise, exhibit a strong association with particular surface sediments (Ref. 6.84).

6.4.35. The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and Ammodytes. Other prey species such as cephalopods, other molluscs, crustaceans and polychaetes have also been recorded. The diet varies geographically, seasonally and annually, reflecting changes in available food resources and differences in diet between sexes or age classes may also exist (Ref. 6.85; Ref. 6.86; Ref. 6.87; Ref. 6.88; Ref. 6.89; Ref. 6.90).

c) The Wash and North Norfolk Coast SAC

i. Harbour seal

Distributions and abundance

6.4.36. Harbour seals are counted on land during their August moulting period, which gives a minimum population estimate. Combining the most recent counts available (2008-2016) gives a total count of 32,600 harbour seals in the UK (26,600 of which are in Scotland), and scaling this to reflect the number of seals missed by not being hauled-out, gives a total UK population estimate of 45,100 (95% CI = 37,000-60,400) in 2016 (Ref. 6.60).

6.4.37. The most recent harbour seal count (2011-2016) for the South-East of England MU (which the Sizewell C main development site is located within) is 4,965 (Ref. 6.60). This includes 3,200 seals at The Wash (within The Wash and North Norfolk Coast SAC), 694 in Essex and Kent, 399 at Blakeney Point, 290 at Donna Nook and 271 at Scroby Sands. **Plate 6.21** shows the location of these harbour seal haul-out sites within the South-East of England MU, and the most recent seal counts for each site.

6.4.38. The at-sea harbour seal mean total usage maps, produced by SMRU, show that the harbour seal usage is low in and around the Greater Sizewell Bay, with a harbour seal density of 0.039/km^2 at the location of the Sizewell C main development site (for the grid cells that intersect with the red line boundary), and of 0.011/km^2 over the wider area (for the grid cells that intersect within a buffer distance of 25km from the Sizewell C main development site; **Figure 6.3;** Ref. 4.3).

Movements

6.4.39. SMRU, in collaboration with others, has deployed around 344 telemetry tags on harbour seals around the UK between 2001 and 2012 (Ref. 4.4). The tracks indicate that very few tagged harbour seals have been recorded in the area off Sizewell, with tracks moving in and out of the Wash and along the coast between the Wash and the Thames estuaries (

6.4.40. Plate 6.19).

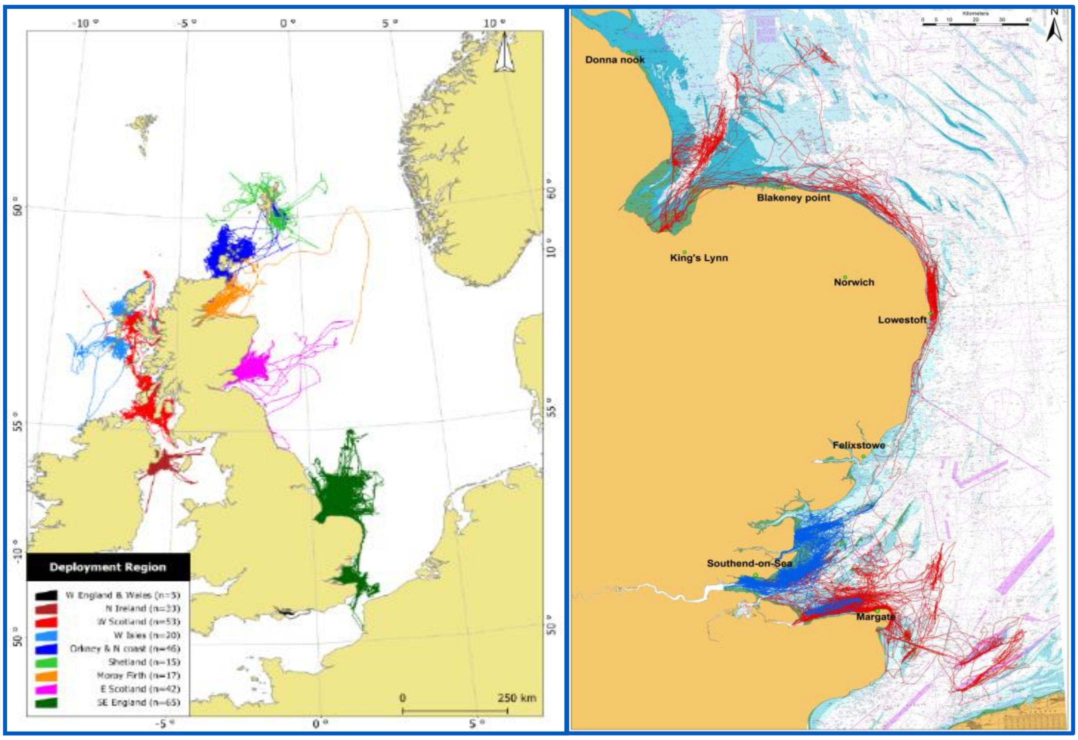
6.4.41. A tagging study of harbour seals in the outer Thames Estuary also shows that there is connectivity between harbour seals that haul-out along the Kent coastlines with The Wash and North Norfolk Coast SAC population, with harbour seals passing along the coastline in proximity of the Sizewell C main development site (**Plate 6.19**; Ref. 4.5).

6.4.42. The Barker *et al.* (2014) (Ref 4.5) study investigated the foraging areas of harbour seal that had been tagged within the Thame estuary. Kernal density analysis was used to identify those areas within the outer Thames estuary that could be key foraging areas for harbour seal. The results show that while harbour seals show foraging activity across a large area, there are five key areas with greater levels of foraging activity (**Plate 6.20**). The closest of these areas to the Sizewell C main development site is at north-east Buxey Sand (area ‘1’ in **Plate 6.20**). This is approximately 70 km from the Sizewell C main development site.

Haul-out sites

6.4.43. Harbour seals come ashore in sheltered waters, often on sandbanks and in estuaries, but also in rocky areas. Harbour seals haul out on land regularly in a pattern that is often related to the tidal cycle (Ref. 6.60).

Plate 6.19 [Left] Telemetry tracks by deployment region for harbour seals aged one year or over between 2001 and 2012 (Ref. 4.4); [Right] Harbour seal telemetry tracks from Marsh End Sand (blue) and Margate Sands (red) (Ref. 4.5)

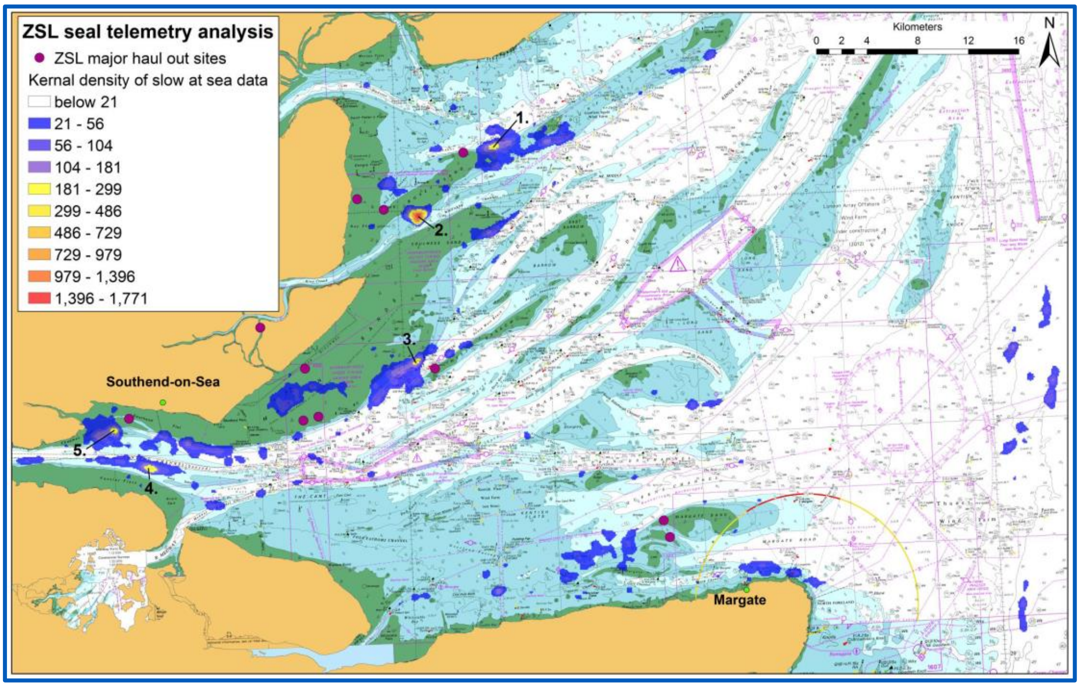


6.4.44. Harbour seal give birth to their pups in June and July, having shed their white coat *in-utero*, and can swim almost immediately after birth (Ref. 6.60), and moult in August where they spend a higher proportion of their time on land than at other times (Ref. 6.60).

6.4.45. The principal harbour seal haul-out sites within the South-East England MU (with the distance to the Sizewell C main development site shown in brackets) are Scroby Sands (48 km north), Blakeney Point (119km north), The Wash (168km north), Donna Nook (194 km north) and the Essex haul-out sites including the Hamford Water sites (48 km south-west), Tillingham (77 km south-west), Margate (88 km south-west) and Goodwin Sands (100 km south-west) (**Plate 6.21**).

6.4.46. The number of harbour seal at the Essex haul-out sites have been steadily increasing over recent years, from 137 individuals recorded in the 1996 to 1997 count, to 436 within the 2007 to 2011 count (Ref. 6.68), and 694 in the most recent 2016 count of the wider Thames estuary (Ref. 6.60).

Plate 6.20 Major harbour seal foraging areas in the Thames Estuary, calculated when slow-at-sea kernel function was greater than 181 km^2; the major foraging areas are - north east Buxey Sand (1), Whitaker Channel (2), West Swin Channel (3), north Yantlet Flats (4) and south Marsh End Sand (5), Ref. 4.5

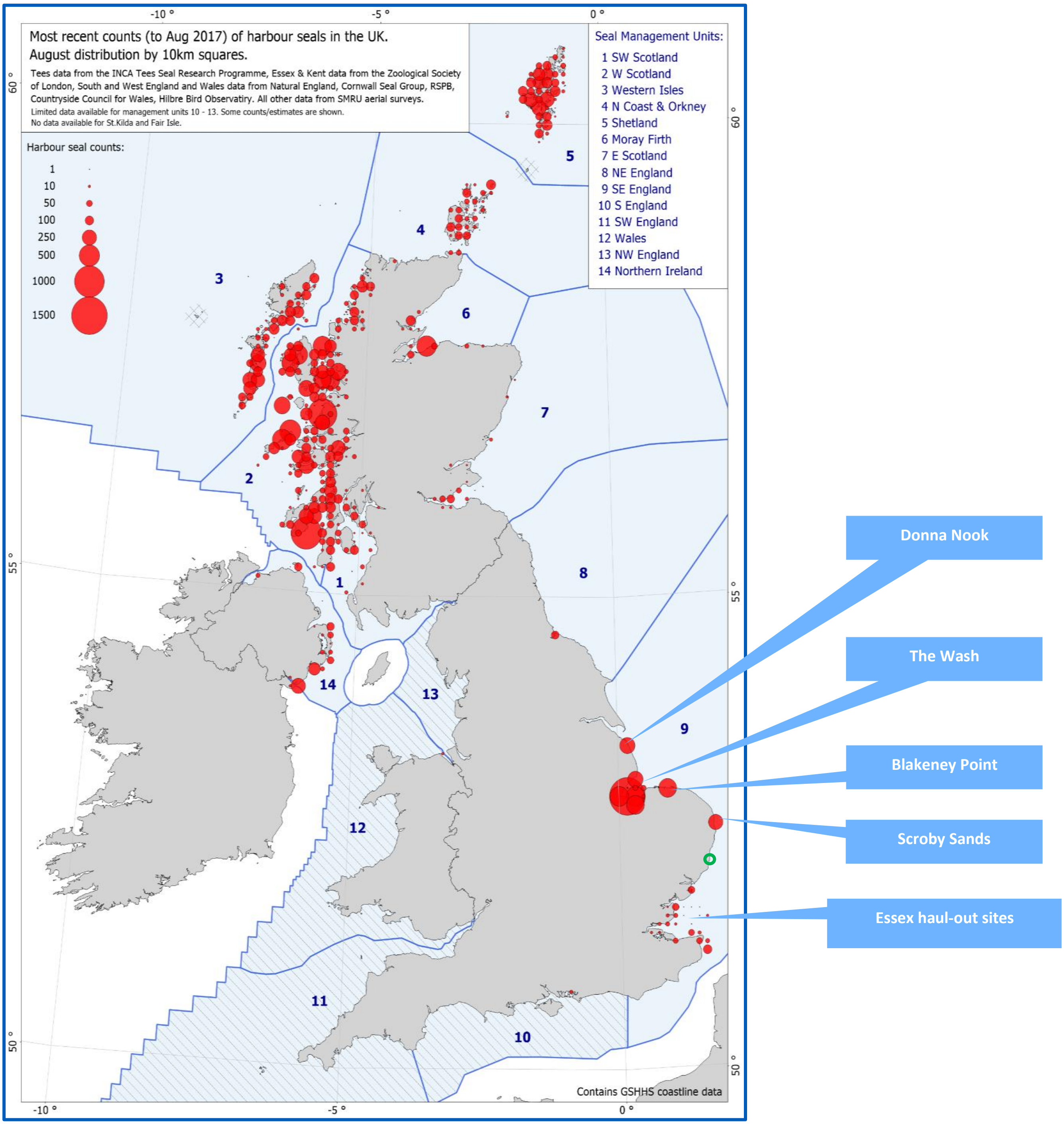


Diet and prey species

6.4.47. Harbour seals generally make smaller foraging trips than grey seal, typically travelling 40-50 km from their haul-out sites to foraging areas (Ref. 6.60). Tagging studies undertaken on harbour seal at The Wash have shown that this population will travel a larger distance for their foraging trips than for other harbour seal populations. Some individuals from The Wash travelled repeatedly over 200 km to foraging areas, however there was a large variation in the distance travelled and the average was lower at 80 km (Ref. 6.91).

6.4.48. Harbour seal take a wide variety of prey including sandeels, gadoids, herring and sprat *Sprattus sprattus*, flatfish and cephalopods. Diet varies seasonally and regionally; prey diversity and diet quality also showed some regional and seasonal variation (Ref. 6.67). It is estimated harbour seals eat 3-5 kg per adult seal per day depending on the prey species (Ref. 6.60).

Plate 6.21 Location of the major harbour seal haul-out sites and the populations around the UK coasts (Ref. 6.60); the location of the Sizewell C main development site is indicated by the green circle



6.4.49. The Barker *et al*. (2014) study (Ref 4.5) of harbour seal movements and foraging activity in the outer Thames Estuary found that the main prey found from the analysis of six harbour seal scats were flounder, whiting, sprat and sandeel, further supporting evidence that harbour seal are generalist foragers and will prey upon a wide range of species, depending on what is readily available.

d) Summary of reference populations and density estimates

6.4.50. **Table 6.9** below summarises the reference populations and density estimates that have been used to inform the appropriate assessment for harbour porpoise, grey seal and harbour seal.

Table 6.9 Reference populations and density estimates to inform the appropriate assessment for marine mammals

Species	Density estimate (per km^2)	Reference population
Harbour porpoise	0.607/km^2 (SCANS-III Block L; Ref. 6.76)	345,373 (North Sea MU population estimate based on SCANS-III; Ref. 6.76).
Grey seal	0.038/km^2 (highest density based on wider area estimate as the worst-case; calculated from Ref. 4.3)	8,716 (South-East England MU; Ref. 6.60). 6,526 grey seal based on the latest available count at the Donna Nook haul-out site (Ref. 6.60).
Harbour seal	0.039/km^2 (highest density based on wider area estimate as the worst-case; calculated from Ref. 4.3)	4,965 (South-East England MU; Ref. 6.60). 3,609 harbour seal based on the latest available count at The Wash and Blakeney Point haul-out sites (Ref. 6.60).

6.5 Fish population

6.5.1. Although no European sites scoped into this WDA Shadow HRA have fish as qualifying interest features, fish are the main prey for piscivorous birds and marine mammals. Hence effects on prey species could affect marine birds and marine mammals supported by the European sites screened into this assessment.

6.5.2. This section provides baseline information on the fish populations that are prey to the aforementioned qualifying interest features. It provides a summary of the fish populations found within the Greater Sizewell Bay area. Full details of the data collected, and its analysis is included in Ref 6.37, which provides a comprehensive study of the fish fauna of the Greater

Sizewell Bay area based on data collected during impingement sampling from the Sizewell B cooling water system and from a series of coastal fishing surveys (Ref. 6.37). The datasets used within the report are as follows:

- Impingement sampling at Sizewell B between February 2009 and February 2013.
- Ten demersal fishing surveys carried out over a 4-year period; quarterly in 2008, once each in June 2009 and June 2010, and quarterly between June 2011 and March 20122. Sampling was conducted using two different fishing gears – a 2 m beam trawl and a commercial otter trawl.
- A coastal pelagic fish survey carried out in March and June 2015.
- Additional information from sources such as sampling undertaken during the operation of the Sizewell A station, characterisation studies for other marine developments in the local area, inshore fishing surveys off the Suffolk coast and international stock assessments.

6.5.3. A total of 88 fish taxa were identified in the Greater Sizewell Bay area. Forty species were identified in the 2 m beam trawl catches, 25 in the commercial otter trawl catches and 71 species were identified during impingement sampling. This is a likely reflection of the differences in sampling effort, with more sampling during the impingement programme increasing the likelihood of encountering less abundant taxa.

a) Demersal community

6.5.4. Of the demersal species recorded, Dover sole *Solea solea* and whiting were extremely frequent in the impingement dataset, occurring in over 90% and 96% of the impingement samples, respectively. Gobies, dab *Limanda limanda* and flounder *Platichthys flesus* were also generally common; all three taxa were recorded in over 90% of the impingement samples. Other demersal species occurring in more than 80% of the impingement samples were Nilsson’s pipefish *Sygnathus rostellatus*, lesser weever *Trachinus vipera*, and bass *Dicentrarchus labrax*.

6.5.5. In the offshore samples, Dover sole was the most commonly occurring species overall, present in 68% of beam trawls and all the otter trawl samples. Whiting was found in a third of the beam trawls and 60% of the otter trawls. Gobies, dab and flounder were also generally common; dab were recorded in two thirds of otter trawls and 13% of beam trawls, gobies in nearly half of the beam trawls and flounder in 75% of the otter trawls.

Thornback rays *Raja clavata*, were common in the otter trawls, being found in 75%, though they were rarely captured in the beam trawls.

6.5.6. Cephalopods were not common in either the offshore or onshore samples. Only a single species (the European common squid *Alloteuthis subulata*) was recorded in the coastal surveys; it occurred in only 17 and 7 of the beam and otter trawl samples, respectively. Four species were impinged in Sizewell B, namely the little cuttlefish *Sepiola atlantica*, the European common squid, the cuttlefish *Sepia officinalis* and the common squid *Loligo vulgaris*, but only the little cuttlefish was present in more than 30% of the samples.

6.5.7. The most abundant taxa were also generally the most common. Of the demersal species in the impingement sampling, the four most abundant species were whiting (11% by abundance), bass (9%), sand gobies (4%) and Dover sole (2%). Both bass and the thin-lipped grey mullet *Liza ramada* were impinged in reasonably large numbers but were not a significant feature of the coastal surveys. However, the abundance of bass is seasonal with the majority of catches in the impingement dataset being made in the winter months.

6.5.8. In the offshore surveys, Dover sole dominated overall, accounting for 28% and 39% of all fish caught in the 2 m beam trawls in the original (2008 – 2010) and expanded (2011 - 2012) survey series and 48% and 25% in the otter trawl in the original and expanded series, respectively. Gobies were also highly abundant in the beam trawls (39% and 22% by abundance of the original and expanded survey series), but were not abundant in the otter trawl surveys, due to the large mesh size of the gear and small body size of the individuals. Whiting contributed 3% and 11% respectively, to the abundance of beam trawl samples in the original and extended survey areas. In the otter trawls, flounder, dab and thornback rays were also highly abundant.

6.5.9. Statistical analysis shows that there is very little evidence of consistent spatial patterns in the demersal fish community, suggesting that the fishes of the Greater Sizewell Bay form one large homogenous community. The analysis showed that there was very little obvious spatial pattern or consistency over time and that the species mix found at each site changed over time but not in a predictable way.

b) Pelagic community

6.5.10. The sampling gear used to characterise the demersal fish community may catch pelagic fish, particularly during deployment and retrieval; however, that gear is not specifically designed for this purpose. During the surveys, the following species were recorded:

- Atlantic herring *Clupea harengus*
- European sprat *Sprattus sprattus*
- anchovy *Engraulis encrasicolus*
- mackerel *Scomber scombrus*
- horse mackerel (scad) *Trachurus trachurus*
- pilchard *Sardina pilchardus*

6.5.11. All six species were recorded in the Sizewell B impingement monitoring; collectively, they accounted for approximately 65% of the total numbers of fish caught, suggesting pelagics are common in the Greater Sizewell Bay area. Sprat was the most abundant, at 49% of the total fish catch, then herring at 16%.

6.5.12. From the acoustic data, pelagic fish were more abundant in waters further north off Minsmere than around Sizewell itself, although good numbers were found at Sizewell throughout the year. The fish appeared to aggregate in larger schools mainly at the edge of sandbanks during the winter and during the summer were more evenly distributed across the area, although highest densities were consistently found more offshore. Schools were denser and smaller during the summer and although variable between surveys and subareas, more than half of the pelagic fish biomass was found in the near surface waters (2-5 m depth).

6.5.13. Analysis carried out for the East Anglia ONE offshore wind farm surveys of winter 2010/2011 suggests that while the species present in the Greater Sizewell Bay mirror those found in the wider offshore region, there may be differences in relative distribution, at least at certain times of year (Ref. 6.92). Anchovy was much more dominant in the wider region than in the Sizewell-specific data, comprising 29% of the total catch (including non-target species) versus <1% of the Sizewell impingement catch, while at 14% offshore versus 49% in the Sizewell catch, sprat was much less prevalent. Pilchard was also more prevalent in the wider region, at least in November 2010. Only two pelagic species were caught in the February 2011 East Anglia ONE survey - sprat, which dominated the catch (more similarly to the Sizewell data), and anchovy. On the basis of this evidence, herring and sprat are the most prevalent pelagic fish species around the Greater Sizewell Bay.

c) Prey and temperature

6.5.14. Important marine mammal and marine bird prey species include sandeels, whiting, Atlantic herring and European sprat. Sandeel and herring have been found to occur in sea temperatures of up to 24°C (Ref. 6.93; Ref. 5.4); however, are most likely to be in areas with temperatures ranging from 8.5°C and 9.5°C and 9°C and 11°C respectively (Ref. 6.94; Ref. 6.95). Whiting are most likely found in sea temperatures of 6 to 9°C (Ref. 6.96, *cited in* Ref. 6.97) and sprat between 8°C and 14°C (Ref. 6.98).

6.5.15. Other marine mammal prey species include cod, saithe, haddock, plaice and Dover sole. Cod are predominately found in water temperatures of 7 to 15°C (Ref. 6.99) and have been found to avoid temperatures of above 15°C (Ref. 6.100). The preferred temperature range for haddock and saithe is 11.3°C to 16.1°C and 10.7°C to 16.1°C, respectively (Ref. 6.101). Juvenile plaice have been found to tolerate temperatures ranging up to 20°C (Ref. 6.102 *cited in* Ref 6.103) and, in the Thames Estuary, 14.17°C is reported as the optimal temperature for growth of adult sole (Ref. 6.104) *cited in* Ref. 5.4).

7 INFORMATION FOR APPROPRIATE ASSESSMENT: COASTAL HABITATS

7.1 Introduction

7.1.1. The information required to inform 'AA' of the effects of the Sizewell C Project WDA with regard to the SAC and Ramsar sites and coastal habitat qualifying features 'screened in' is presented below.

7.1.2. The European sites considered in this section are:

- Alde, Ore and Butley Estuaries SAC.
- Alde-Ore Estuary Ramsar site.
- Benacre to Eastern Bavents Lagoons SAC.
- Minsmere to Walberswick Heaths and Marshes SAC.
- Minsmere-Walberswick Ramsar site.
- Orfordness-Shingle Street SAC.

7.2 Conservation Objectives

7.2.1. The following generic Conservation Objectives apply to all of the SACs considered within this section:

With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features'), and subject to natural change, ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- *the extent and distribution of qualifying natural habitats and habitats of qualifying species;*
- *the structure and function (including typical species) of qualifying natural habitats;*
- *the structure and function of the habitats of qualifying species;*

- *the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;*
- *the populations of qualifying species; and*
- *the distribution of qualifying species within the site.*

7.2.2. For Ramsar sites, as the provisions of the Habitats Regulations relating to HRAs extend to Ramsar sites, Natural England considers that the Conservation Advice packages for the overlapping European site designations (i.e. SACs and SPAs) to be, in most cases, sufficient to support the management of the Ramsar interests. Hence Defra and Natural England have not produced separate Conservation Advice packages for Ramsar sites.

7.2.3. For certain SACs and qualifying features, Supplementary Advice on the generic Conservation Objectives (SACO) has been produced by Natural England.

7.3 Assessment of potential effects (alone)

a) Alde, Ore and Butley Estuaries SAC and Alde-Ore Estuary Ramsar site

i. Summary of screening outcomes

7.3.1. The following assessment relates to the qualifying interest features screened in for the Alde, Ore and Butley Estuaries SAC and Alde-Ore Estuary Ramsar site, which include:

- Estuaries.
- Mudflats and sandflats not covered by seawater at low tides.
- Atlantic salt meadows.
- Ramsar criterion 2 - the site supports a number of nationally-scarce plant species and British Red Data Book invertebrates.

7.3.2. The screened in effect pathways for these qualifying features due to the potential influence of the Sizewell C main development site are:

- water quality effects – thermal discharge; and

- water quality effects – FRR: change to water quality from moribund biota.

ii. All relevant qualifying features

Thermal discharge

7.3.3. The assessment of effects from the thermal plume on habitats has been undertaken based on the addition of the Sizewell C discharge to the baseline only, as the water temperature increase caused by the Sizewell B thermal plume forms part of the baseline. Sizewell B has been operational since 1995 and, therefore, habitats in contact with the Sizewell B plume are expected to be habituated to it. However, it is acknowledged that a small synergistic effect would arise at the interface between the Sizewell B and Sizewell C plume. Therefore, to ensure that all effects are captured, the extent of the thermal plume of Sizewell C in conjunction with Sizewell B was used to carry out the assessment of potential effects on habitat qualifying features of the screened in SAC and Ramsar sites.

7.3.4. The modelling results for the extent of the thermal plume exceedance of 28°C EQS (as a 98th percentile) is predicted to have no exceedance at the seabed and surface for the Sizewell C plume. **Figure 7.1** shows the extent of the plume (Sizewell B and Sizewell C) respective to the Alde, Ore and Butley Estuaries SAC and Ramsar site. **Figure 7.2** shows the extent of the Sizewell C plume alone respective to the site.

7.3.5. As can be seen from **Figure 7.1**, the thermal plume is only predicted to intersect the mouth of the Alde-Ore estuary and only at increased temperatures in the 0°C to 1°C range as 98th percentiles. At these temperatures, the standard for significant impacts to occur on designated habitats that may cause adverse effects on site integrity would not be exceeded (Ref. 5.6).

7.3.6. From **Figure 7.2** we can see that the extent of the Sizewell C plume alone does not intersect with the designated site and is located over 12 km to the north of the site.

7.3.7. Consequently, an effect on the water quality, and hence on the qualifying interest features of the SAC and Ramsar site, is not predicted.

Effluent from the FRR system

7.3.8. The total biomass of moribund biota predicted to be discharged from the FRR has been estimated based on the level of abstraction (pump rates) for the planned Sizewell C intakes and the information on seasonal distribution of species and length weight distribution of the species impinged for the existing Sizewell B station (Ref. 7.1 and Ref. 7.2). These values are based on rates of impingement at Sizewell B and extrapolated to Sizewell C; however, they do not account for Sizewell C mitigation (Low Velocity Side Entry (LVSE) headworks survival rates). Furthermore, the assessments consider discharges of dead and moribund biota form a single point source. This adds a further precautionary factor to the assessment as the two FRR units, located approximately 300 m apart, would allow a greater level of initial dilution with discharges split between two spatially separated points sources. As such, they are highly precautionary assessments applied primarily to determine the worst-case potential for water quality issues (deoxygenation and nutrient enrichment).

7.3.9. The data show seasonal variation in the discharge of moribund fish. The highest biomass of moribund fish occurs in March with a mean biomass of 3442 kg per day predicted to be discharged from the FRRs. Between April to September, biomass discharge predictions are lower at a mean of 405 kg per day with an annual average of 1065 kg/d.

FRR system: nutrient inputs

7.3.10. The recycling of nutrients from decaying fish biomass has been considered for freshwater systems, e.g. decay of salmon carcasses in headwater streams. Several studies on salmonids indicate, on a wet weight basis, a phosphorus content of around 0.5% and nitrogen content of around 3.5% (Ref. 7.3; Ref. 7.4 and Ref. 7.5). The April to September period represents a time when sea temperatures and light levels at depth, and phytoplankton growth, are increasing. At this time nutrients start to become less available and a limiting factor for algal growth (see **Appendix 22H** of the **ES**).

7.3.11. The predicted average daily nitrogen loading from operational inputs at Sizewell C is 32 kg, which represents 0.2% of the daily exchange for the Greater Sizewell Bay. The additional inputs of nitrogen from decaying biomass represent an increase to a value of 0.4% of the daily exchange.

7.3.12. The predicted daily average operational phosphorus loading is low, at approximately 0.71 kg or 0.03% of the daily exchange for Sizewell Bay, and the biomass input from the FRR represents a relatively high addition to this. Nevertheless, the additional inputs from the FRR result in combined operational phosphorus inputs of 0.25% of the daily exchange, which is still considered to be low. Phosphate is rarely a limiting nutrient within the Greater Sizewell Bay system and low-level increases would not be expected to perturb the system (see **Volume 21**, **Chapter 22** of the ES).

7.3.13. A Combined Phytoplankton and Macroalgae model predicted that annual nutrients loadings due to operational nutrient discharges from Sizewell B and the proposed development would increase production within the Greater Sizewell Bay by 0.11% (see **Appendix 22H** of the ES).

7.3.14. Much higher phosphorus loadings than this have been modelled for the construction inputs and a negligible influence on the phytoplankton carbon production is predicted. Moreover, this assessment represents a worst case as it assumes that the fish are not consumed by other species and that the tissue nutrient content makes a direct contribution to nutrient levels when, in fact, it would take several days for the tissue to decay and to release nutrients (see **Appendix 21F** of the ES).

7.3.15. Because the assessment is conservative, assuming rapid release of nutrients from the total biomass, the nitrogen and phosphorus increase and potential contribution to phytoplankton growth is predicted to be of negligible significance. The input loading of phosphorus and nitrogen from biomass discharged from the FRR is predicted to have a negligible effect on water quality separately and in combination with the operational input. Hence, an adverse effect on the integrity of the qualifying features of the Alde, Ore and Butley Estuaries SAC and Ramsar site with coastal habitats are not predicted (see **Volume 2, Chapter 21** of the ES).

FRR system: un-ionised ammonia

7.3.16. The decay of biomass released from the FRR has the potential to cause an increase in un-ionised ammonia. The tissue ammonia content for fish and seasonal physicochemical conditions were incorporated into the un-ionised ammonia calculator (see **Appendix 21F** of the **ES**). Un-ionised ammonia was calculated for summer, and winter when fish discharges and ambient conditions differ.

7.3.17. During the period of April to September, daily discharges of 405.2 kg per day of dead or moribund biota would have the potential to cause un-ionised ammonia concentrations to exceed the EQS (21µg/l) over an area of 1.4 ha (under average conditions) from the FRR discharge. To account for summer conditions, 95th percentile temperature, pH, and average salinity was considered. Under this scenario, the EQS would be exceeded over an area of 3.8 ha from the FRR discharge point.

7.3.18. During winter (December-April), the release of dead and moribund biota is higher, and salinities may be lower during periods of heavy rainfall thus favouring un-ionised ammonia concentrations. However, temperature would also be low which reduces the un-ionised ammonia proportion.

7.3.19. To account for the most conservative scenario the highest daily discharge value (3,442 kg per day in March) was applied using a 5th percentile salinity, average temperature for March and average annual pH. Under these conditions the exceedance of the EQS would occur over an area of 5.3 ha (see **Appendix 21F** of the **ES**). The maximum spatial scale of the impacts differs seasonally but is low. Discharges would occur throughout the operational phase of the proposed development; therefore, the duration is high and the amount of change seasonally variable.

7.3.20. Biomass values are based on rates of impingement at Sizewell B and are extrapolated to account for abstraction volumes. They do not account for the Sizewell C intake head design that will mitigate fish entrapment and is predicted to abstract approximately 60% fewer fish per cumec than Sizewell B, or any losses from the system through tidal/wave transport or consumption. Furthermore, the assessments consider discharges of dead and moribund biota form a single point source. This adds a further precautionary factor to the assessment as the two FRR units, located approximately 300 m apart, would allow a greater level of initial dilution with discharges split between two spatially separated points sources. Results should, therefore, be considered as highly precautionary.

7.3.21. At an exceedance of the EQS at 5.3 ha, the change in water quality will not overlap with the Alde, Ore and Butley Estuaries SAC and Ramsar site. Therefore, an adverse effect on the integrity of the qualifying features of SAC and Ramsar site with coastal habitats are not predicted.

FRR system: biomass influence on dissolved oxygen levels

7.3.22. The decaying fish biomass is also likely to contribute to BOD. Based on the oxygen demand of organic matter inputs from fish cages coupled to the annual average daily biomass loading an estimate of BOD was made.

7.3.23. The average daily BOD contributed by decaying fish tissue is estimated to be 1,342 kg/day which is calculated to result in a reduction of dissolved oxygen of 447 kg/day. This potential oxygen requirement is equivalent to 0.2% of the daily exchange for Greater Sizewell Bay and deficits would also be met by daily reaeration at the sea surface (see **Volume 2, Chapter 21** of the **ES**).

7.3.24. This assessment assumes direct breakdown of material and no losses through predation. The estimate in reduction of oxygen concentration would only occur if the rate of oxygen use due to BOD is greater than the oxygen transfer across the water surface. Therefore, as the waters off Sizewell C are well mixed vertically, facilitating reaeration at the surface, background dissolved oxygen levels are high and the water exchange rate of the

Greater Sizewell Bay is enough to limit the extent and duration of any oxygen reduction, the input loading of BOD from biomass discharged from the FRR is predicted to have a negligible effect on water quality. This would not adversely affect the integrity of the Alde, Ore and Butley Estuaries SAC and Ramsar site coastal habitat qualifying features or criterion.

iii. Conclusion

Alde, Ore and Butley Estuaries SAC

7.3.25. The AA for the qualifying interest features of the Alde, Ore and Butley Estuaries SAC concludes that the discharge of the thermal plume and moribund biota from the FRR system would not have an adverse effect on the Conservation Objectives or the integrity of the SAC.

Alde-Ore Estuary Ramsar site

7.3.26. The AA for criterion 2 of the Alde-Ore Estuary Ramsar site concludes that the discharge of the thermal plume and moribund biota from the FRR system would not have an adverse effect on the integrity of the Ramsar site.

b) Minsmere-Walberswick Ramsar site

i. Summary of screening outcomes

7.3.27. The following assessment relates to the qualifying interest features screened in for the Alde, Ore and Butley Estuaries SAC and Alde-Ore Estuary Ramsar site, which include:

- Ramsar criterion 1 - the site contains a mosaic of marine, freshwater, marshland and associated habitats complete with transition areas in between. It also contains the largest continuous stand of reedbed in England and Wales, and rare transition in grazing marsh ditch plants from brackish to fresh water.

7.3.28. The screened in effect pathways for these qualifying features due to the potential influence of the Sizewell C main development site are:

- water quality effects – thermal discharge; and
- water quality effects – FRR: change to water quality from moribund biota.

ii. Ramsar criterion 1

Thermal discharge

7.3.29. The Minsmere-Walberswick Ramsar site is situated within, and adjacent to, the thermal discharge plume. **Figure 7.3** shows the extent of the predicted plume (Sizewell B and Sizewell C) respective to the Minsmere-Walberswick Ramsar site. **Figure 7.4** shows the extent of the Sizewell C plume alone respective to the site.

7.3.30. The site is composed of a number of different habitats such as dykes, reedbeds, grazing marsh, lagoons, and shingle. The majority of the habitats found within the Ramsar site that support the qualifying bird assemblage (criterion 2) are located above Mean High Water Springs (MHWS). These habitats support an important assemblage of rare breeding birds associated with marshland and reedbeds, but none of the habitats above MHWS would be affected by the thermal plume.

7.3.31. The criterion 1 coastal habitats found at the Ramsar site include coastal dunes and shingle. Both habitats are located either within the splash zone at the limits of the tide or above the tidal limit. Therefore, the level of interaction between the habitats and the thermal plume would be small (**Figure 7.3**). **Figure 7.4** shows that the predicted extent of the Sizewell C plume (alone) does not interact with the Ramsar site. Even with the synergistic effect of the combined Sizewell B and Sizewell C plume (which would be less than that shown in **Figure 7.3**), the plume is not expected to overlap with the habitat features of criterion 1.

7.3.32. Salinity monitoring of the coastal lagoon at Minsmere has shown that the pond is brackish in nature, indicating a source of saline water (Ref. 7.6). Seawater is thought to enter the lagoon slowly and most likely through the slow diffusion through the dune system that lies in between the lagoon and the coast. Due to the slow diffusion of seawater through the sediment, any heat retained in the water from the thermal plume would slowly dissipate as the seawater percolates through the sediment. As above, **Figure 7.4** shows that the predicted extent of the Sizewell C plume (alone) does not interact with the Ramsar site or with the habitat features of criterion 1. Therefore, similarly, an effect on water quality within the lagoon from the Sizewell C thermal plume is not predicted.

Effluent from the FRR system

7.3.33. The operation of the FRR system and increase in discharge of dead or moribund biota has been described within **Section 7.3 a ii** (for the Alde, Ore and Butley Estuaries SAC and Ramsar site). The conclusions reached within Section 7.3 a ii also apply to the Minsmere-Walberswick Ramsar site. Therefore, the discharge of dead or moribund biota from the FRR system in the Greater Sizewell Bay will not have an adverse effect on the integrity of the Ramsar site.

iii. Conclusion

7.3.34. The AA for criterion 1 of the Minsmere-Walberswick Ramsar site concludes that the discharge of the Sizewell C thermal plume and moribund biota from the FRR system would not have an adverse effect on the integrity of the site.

c) Orfordness-Shingle Street SAC

i. Summary of screening outcomes

7.3.35. The following assessment relates to the qualifying interest features screened in for the Alde, Ore and Butley Estuaries SAC and Alde-Ore Estuary Ramsar site, which include:

- Coastal lagoons.

7.3.36. The screened in effect pathways for these qualifying features due to the potential influence of the Sizewell C main development site are:

- water quality effects – thermal discharge.

ii. Coastal lagoons

Thermal discharge

7.3.37. **Figure 7.5** shows the predicted extent of the thermal plume that exceeds the 2°C and 3°C (98th percentile) from the combined Sizewell B and Sizewell C discharge in relation to Orfordness-Shingle Street SAC. **Figure 7.6** shows the extent of the Sizewell C plume alone respective to the site.

7.3.38. Although the lagoons occur landward of highest astronomical tide (HAT), the salinity of the lagoons is maintained by percolation through the shingle and overtopping during high tides. The Advice on Operations provided by Natural England (2019) states that the coastal lagoons are sensitive to an increase in temperature and the risk of this pressure is dependent on its spatial/temporal scale and the intensity of the activity. The sensitivity of the coastal lagoons from an increase in temperature from power station cooling waters has been classified as low, with a long-term (one year or more) pressure benchmark of a 2°C uplift and a short-term benchmark of a 5°C increase in temperature (Ref. 6.13).

7.3.39. Whilst there is a predicted overlap in the 2°C (98 percentile) EQS thermal contour line and the SAC, the extent of this is limited to within the tidal range, i.e. up to MHWS. As the lagoons sit behind the shingle bank, the seawater would have to percolate slowly through the shingle before reaching the lagoons themselves. Percolation of water through the lagoon would result in dissipation of the retained heat by the time it reaches the lagoons, thus reducing the percolating seawater temperature to below the EQS.

7.3.40. Overtopping of the shingle bank with seawater during high tide would introduce elevated seawater temperatures for a short duration of time only, with seawater temperature well below the short-term 5°C benchmark.

7.3.41. However, **Figure 7.6** shows that the predicted extent of the Sizewell C thermal plume alone does not interact or overlap with the SAC. Even with the synergistic effect of the combined Sizewell B and Sizewell C plume (which would be less than that shown in **Figure 7.5**), the plume is not expected to overlap with the coastal lagoons qualifying feature. Consequently, an effect on the water quality of the coastal lagoons of the SAC is not predicted.

iii. Conclusion

7.3.42. The AA of the qualifying interest features of Orfordness-Shingle Street SAC concludes that the discharge of the Sizewell C thermal plume would not have an adverse effect on the Conservation Objectives or integrity of the SAC.

7.4 Assessment of potential effects (in-combination)

a) Consideration of plans and projects

7.4.1. **Appendix B** provides a list of plans and projects that could have LSIE with the water discharge activities of Sizewell C. From that list, only one plan is considered to have the potential to have an in-combination effect with the coastal habitats assessed within this section: the Suffolk Shoreline Management Plan (SMP) (see Error! Reference source not found.). SMP 7: Lowestoft Ness to Felixstowe Landguard Point (previously known as sub-cell 3C) intersects with the ZOI for the Sizewell C Project WDA.

b) Suffolk SMP

7.4.2. East Suffolk Council[12] is working with the Environment Agency and other stakeholders to review the coastal management policy at Slaughden, to the south of Aldeburgh. The specific area involved is Policy Unit ORF 15.1, extending from the Martello Tower southwards through to Sudbourne Beach towards Orford Ness. East Suffolk council has outlined the following three-phase approach to the policy review:

- Phase 1: high level review and assessment to provide baseline appreciation of aspects that are key to the identification of a viable policy, with a focus on implementation measures.
- Phase 2: further detailed assessments, including more detailed environmental appraisal and identification of constraints, to fully consider the proposed policy change, including formal engagement with any statutory consultees.
- Phase 3: upon completion of the necessary studies the proposals would be subject to wider public consultation, to review and agree the policy changes.

7.4.3. Phase 1 was completed in November 2017 and resulted in the identification of nine separate potential approaches which reflect three outcome options: breach, no breach and temporary breach. A preliminary assessment of the nine different approaches was carried out in June 2018 (Ref. 7.7) and the following European sites where screened into the assessment (Ref. 7.7): Orfordness-Shingle Street SAC; Alde, Ore and Butley Estuaries SAC; Alde-Ore Estuary SPA; and Alde-Ore Estuary Ramsar site.

7.4.4. In Phase 2, preliminary assessments under the Habitats Regulations and under the Water Framework Directive were carried out. The conclusions of the Habitats Regulations preliminary assessment identified that all of the proposed approaches have the potential to cause damage to the designated sites screened in and, as such, all approaches will require a HRA to assess adverse effect on site integrity. The WFD preliminary conclusions stated that two approaches complied with the WFD objectives, whilst three did not. In addition, the conclusions state that it should be recognised that the study area is part of a dynamic coastline; therefore,

[12] On 1 April 2019, East Suffolk was created, covering the former districts of Suffolk Coastal District Council and Waveney District Council.

even without further intervention, changes to habitats and species in the future would be expected.

7.4.5. The approaches outlined within the preliminary assessment aim to either do nothing, maintain or improve the existing structures, create new embankments along the estuary channel, or maintain existing natural defences (resulting in temporary breaches). These four different approaches do not greatly change the current baseline against which the water discharge activities of Sizewell C Project were assessed against. Do nothing, maintain or improve existing structures, and creating new embankments all aim to either maintain the existing baseline or improve upon it. Maintain existing defences with temporary breaches does not greatly alter the existing baseline, considering the coastline near Slaughdon is already considered to be a dynamic environment. The temporary breaches are considered to be minimal and of occasional nature (Ref. 7.7).

c) Conclusion

7.4.6. It is considered that none of the approaches outlined within the preliminary assessment (Ref. 7.7) have the potential to cause an in-combination effect with a potential increase in water temperature from the Sizewell C thermal plume and, therefore, it is predicted that there would not be an in-combination effect from the Sizewell C Project WDA and the outcomes of the SMP7 Policy Review Study at Slaughden; or any other plan or project.

8 INFORMATION FOR APPROPRIATE ASSESSMENT: BIRDS

8.1.1. The information required to inform 'AA' of the effects of the Sizewell C Project on the European sites and bird qualifying features 'screened in' is presented below.

8.2 Conservation objectives

8.2.1. For SPAs, the following generic conservation objectives apply to all sites considered within this section:

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- *The extent and distribution of the habitats of the qualifying features;*
- *The structure and function of the habitats of the qualifying features;*
- *The supporting processes on which the habitats of the qualifying features rely;*
- *The population of each of the qualifying features; and*
- *The distribution of the qualifying features within the site.*

8.2.2. The screened in SPAs where these conservation objectives apply are:

- Alde-Ore Estuary SPA;
- Benacre to Easton Bavents SPA;
- Minsmere-Walberswick SPA;
- Minsmere-Walberswick Ramsar site; and
- Outer Thames Estuary SPA.

8.2.3. For Ramsar sites (in this case the Alde-Ore estuary Ramsar site), as the provisions of the Habitats Regulations relating to HRAs extend to Ramsar sites, Natural England considers that the Conservation Advice packages for the overlapping European site designations (i.e. SACs and SPAs) to be, in most cases, sufficient to support the management of the Ramsar interests. Hence, Defra and Natural England have not produced separate Conservation Advice packages for Ramsar sites.

8.2.4. For certain SPAs and qualifying features, SACOs have been produced by Natural England which are also relevant to this assessment. Where applicable, these are referred to below.

8.3 Summary of the outcomes of Screening

a) Alone

8.3.1. The ornithological features (both breeding and non-breeding) for the European sites scoped into the Shadow HRA process for the Operational WDA Environmental Permit application and screened in to the ‘alone’ AA stage are presented in **Table 5.4.**

8.3.2. This section assesses the potential effects on avifauna associated with operational discharges from the cooling water system, including:

- Thermal Discharge - changes in marine water quality due to the presence of a thermal plume; and,
- Chemical Discharge - changes in marine water quality from:
    - a chemical discharge containing TRO from the combination of chlorine, used to avoid biofouling, and organic material in the water;
    - the discharge of CBP, in particular bromoform; and,
    - the discharge of hydrazine, used as an oxygen scavenger for corrosion control.

b) In-combination

8.3.3. All ornithological features (both breeding and non-breeding) for the European sites scoped in to the HRA process for the Operational WDA Environmental Permit application have been screened in to the in-combination assessment. The outcomes of the in-combination assessment are presented in **Section 8.8**.

8.4 Assessment of effects: Alde-Ore Estuary SPA and Ramsar site

a) Introduction

8.4.1. Changes in marine water quality as a result of the Sizewell C Project could potentially affect the availability of prey to the Alde-Ore Estuary SPA and Ramsar site qualifying features screened-in to this assessment.

8.4.2. This section assesses the potential effects of the following operational discharges from the cooling water system:

- Thermal discharge – increases in water temperatures resulting from the cooling water discharges from the cooling water outfalls being at higher temperatures than the surrounding receiving water.
- Chemical discharges, as follows:
  - TRO, which results from the combination of chlorine and organic material in the water (with chlorination of the cooling water undertaken to avoid biofouling);
  - bromoform, which is the predominant chlorinated by-product resulting from chlorination of the cooling water; and
  - hydrazine, which is an oxygen scavenger used to inhibit corrosion in the steam generation circuits.

b) Effects on breeding Sandwich tern, project alone

i. Thermal discharge

8.4.3. The thermal discharge from the cooling water system would create a thermal plume, which has been modelled by Cefas using the validated Sizewell GETM (with the full details of the model and detailed thermal plume maps presented in Ref. 5.5, and summary information provided in Ref. 2.2).

8.4.4. As described in **Section 5.3**, thermal water quality standards are not always evidence based due to a lack of reliable data (Ref. 5.4). Therefore, to protect the most sensitive species, thermal standards have been set on an indicative basis and, as such, act as trigger values for further investigation of potential ecological effects, with two threshold values recommended as trigger assessments for SPAs. That is:

8.4.5. **Deviation from ambient -** a temperature uplift of 2°C as the Maximum Allowed Concentration (MAC) at the edge of the mixing zone[13] (as a 100th percentile).

8.4.6. **Maximum temperature** - 28°C as a 98th percentile at the edge of the mixing zone (SPA) and 21.5°C as a 98th percentile at the edge of the mixing zone (SAC).

8.4.7. Of these two thresholds, the evidence base is strongest for the latter, as it is known that the upper lethal temperature for many benthic organisms occurs between 30 – 33°C. In the case of the former, the 2°C uplift is not considered to have any specific ecological effects, so that it essentially serves as a precautionary threshold to trigger further ecological investigation (Ref. 8.1). These two thresholds provide markedly different outputs. For example, the overlap of the predicted thermal plume of the 2°C uplift at the sea surface (as a 100th percentile) for Sizewell C encompasses 168 km^2 (or 4.3%) of the area of the Outer Thames Estuary SPA, whereas that for the 28°C exceedance encompasses less than 0.01 km^2 of this SPA at the sea surface (Ref. 8.1).

8.4.8. For the purposes of assessing the foraging area that is potentially 'lost' to birds foraging in the marine environment as a result of the thermal uplift, Cefas advise that it is more appropriate to base this on the 98th percentile, as opposed to the highly precautionary 100th percentile (Ref. 8.1).

8.4.9. In terms of the prey of Sandwich tern in the waters around Sizewell, pelagic species will be most important (notably sprat and herring **- Section 6.3 b**, Ref. 7.2). Acoustic surveys of sprat at Sizewell have shown no apparent avoidance of the existing Sizewell B 2°C uplift chlorinated plume, whilst smelt (a locally common herring-like pelagic species) has shown avoidance at a temperature uplift of 4°C (Ref. 7.2, Ref. 5.4 and Ref. 8.2, after Ref. 8.1). On the basis of this evidence, it is considered that an avoidance threshold of a 3°C uplift would be sufficiently precautionary, with the 2°C uplift likely to be overly precautionary (Ref. 8.1).

8.4.10. In addition, it is appropriate to consider the thermal plumes associated with these different temperature uplifts for the period during which breeding Sandwich tern would be present at the SPA (as opposed to the full annual period), which is taken as April to August. Given this, the assessment for the Alde-Ore Estuary SPA Sandwich tern population focusses on the thermal plumes for both the 2°C and 3°C uplift thresholds as modelled from

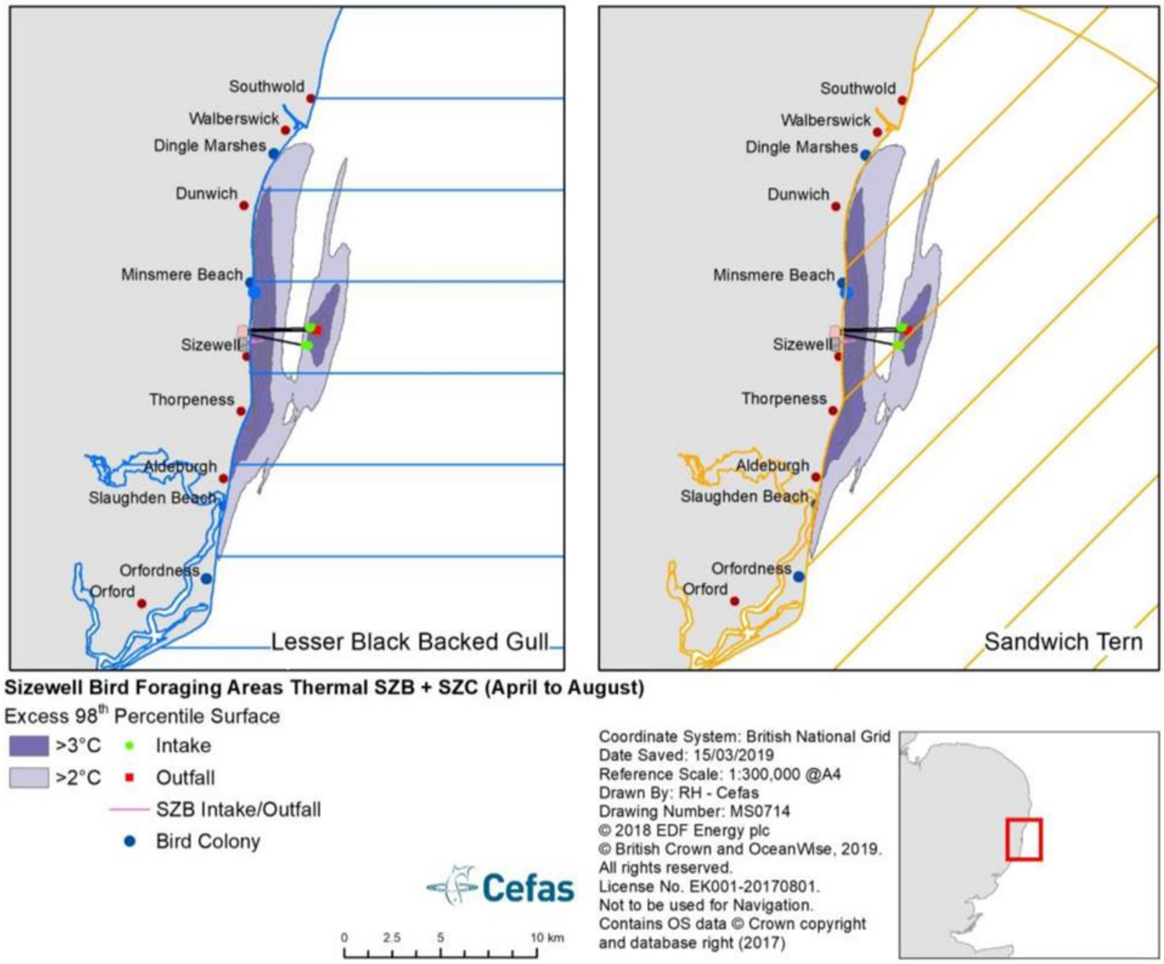
[13] The mixing zone, as used by UK regulators, is the area around a discharge within which a regulator permits a quality standard to be exceeded (Ref. 5.4).

April to August. These are determined for the mean and maximum instantaneous plume sizes (as calculated at hourly intervals for the April to August period), as well as the 98th percentile, with the former providing higher resolution information on the extent of overlap with the SPA Sandwich tern foraging range (Ref. 8.1).

8.4.11. Importantly, the waters around Sizewell are already subject to thermal uplift as a consequence of the cooling water system discharges from the existing Sizewell B power station. Therefore, in undertaking the assessment of the potential effects of the Sizewell C thermal discharge, it is necessary to also consider and define the thermal plume for Sizewell B, as this represents part of the baseline conditions. The Sizewell B and Sizewell C thermal plumes are predicted to be separate at high uplift temperatures but at lower temperatures (e.g. 2°C and 3°C) the Sizewell C plume acts to increase the size and temperature of the Sizewell B plume at the surface and seabed (Ref. 5.7). Therefore, the assessment considers the extent and distribution (relative to the Sandwich tern foraging range) of the combined plumes (i.e. Sizewell B plus Sizewell C) in relation to those resulting from Sizewell B alone.

8.4.12. For the period from April to August, the areas encompassed at surface by the 98th percentiles for the existing 2°C and 3°C thermal plumes (for Sizewell B) extend to 18.6km^2 and 10.5 km^2, respectively (whilst the equivalent plumes for Sizewell C, when considered alone, extend across 9.8 km^2 and 2.8 km^2, respectively). Incorporating the Sizewell C thermal plumes together with the Sizewell B plumes increases these areas to 51.3 km^2 for the 2°C uplift and 17.7 km^2 for the 3°C uplift (**Plate 8.1**).

Plate 8.1: 2°C and 3°C uplifts (as a 98th percentile) of sea surface temperatures for Sizewell B together with Sizewell C for April to August, in relation to the breeding colony locations and partially shown predicted foraging ranges for the Alde-Ore Estuary SPA lesser black-backed gull and Sandwich tern populations

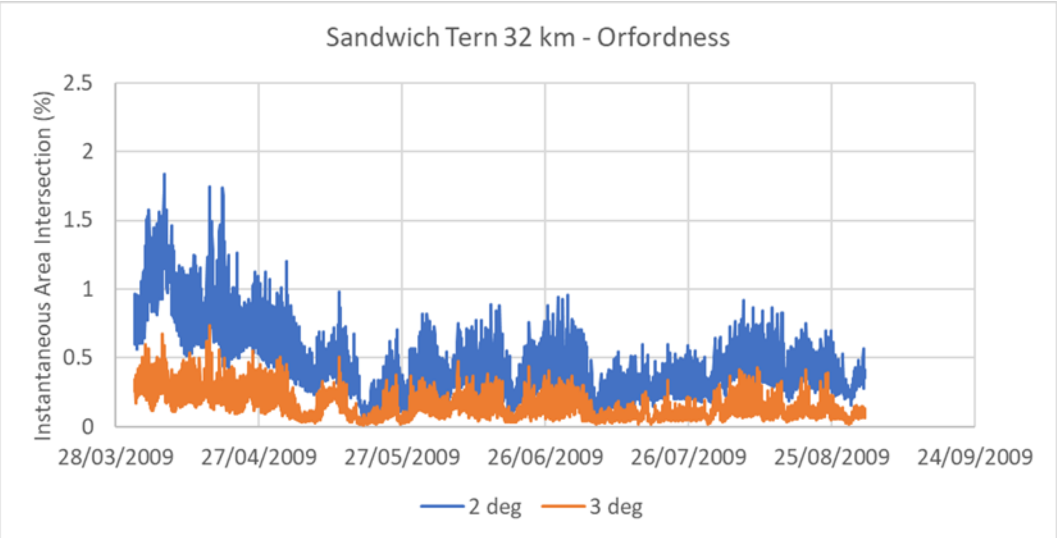


8.4.13. As detailed in **Section 6.3 b**, Sandwich terns have not bred at the Alde-Ore Estuary SPA for a number of years. However, should breeding birds recolonise the SPA, it is reasonable to assume that the foraging area for the population would be defined by the mean maximum foraging range of this species. Thus, the majority of the foraging by the SPA population would be expected to occur within the offshore waters encompassed by a radius of 32 km from the colony location, but with areas of concentrated foraging activity likely to be in those parts of the range which are closer to the colony (**Section 6.3 b**, Ref. 6.31). Based on the 98th percentile, the 2°C and 3°C thermal plumes lie entirely within this foraging range but represent only 2.7% (for the 2°C uplift) and 0.9% (for the 3°C uplift) of the assumed range when the combined effects of Sizewell B and Sizewell C are considered. This compares with 1.0% (for the 2°C uplift) and 0.6% (for the 3°C uplift) for the existing thermal plumes that result from Sizewell B.

8.4.14. Given that areas of concentrated foraging activity are likely to occur closer to the colony, the area of overlap with the thermal plumes is also considered in relation to the area defined by a radius of 11.5 km from the colony (equivalent to the mean foraging range for the species, as determined in Ref. 4.6). The 2°C and 3°C thermal plumes (defined by the 98th percentile) for the combined effects of Sizewell B and Sizewell C represent 6.8% (for the 2°C uplift) and 2.3% (for the 3°C uplift) of this smaller range, which compares with 3.0% (for the 2°C uplift) and 1.5% (for the 3°C uplift) for the existing thermal plumes that result from Sizewell B.

8.4.15. The extent of overlap of the instantaneous plumes (as calculated at hourly intervals from April to August) with the SPA Sandwich tern foraging range is greatest in April (when the earliest birds arrive at the breeding colony) and lower in June and July, which coincides with chick-rearing when energetic demands on the adults are greatest and there is most need to maximise foraging efficiency (**Plate 8.2**). This is also the period during which foraging ranges are most constrained due to the need to provision the chicks at the colony (Ref. 8.3, Ref. 6.34).

Plate 8.2: Instantaneous area of overlap of the SPA Sandwich tern foraging range with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for April to August



8.4.16. Thus, for the combined effects of Sizewell B and Sizewell C, the 2°C uplift accounts for a maximum of 1.8% of the SPA Sandwich tern foraging range at any one point in time, and an average of 0.5% over the breeding period, representing more than a doubling in the extent of the overlap with the existing Sizewell B plume for the 2°C uplift **(Table 8.1)**. These percentages are considerably lower (at 0.7% and 0.2%, respectively) when considering the 3°C uplift. When considered in relation to the marine area encompassed by the mean foraging range of Sandwich tern (as a proxy for the area in which foraging activity is more concentrated – see above), the 2°C uplift for the combined effects of Sizewell B and Sizewell C accounts for a maximum of 8.0% and an average of 1.1% of this smaller range over the breeding period, whilst the equivalent 3°C uplift accounts for a maximum of 3.2% and an average of 0.3%. These percentage overlaps again represent an approximate doubling compared to the existing overlaps for the Sizewell B plumes (except for the maximum for the 3°C uplift, for which there is only a 40% increase).

Table 8.1:The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for April to August with the percentage overlap with the predicted foraging range of the SPA Sandwich tern population

Temperature uplift	Projects		Area (km^2)	Percentage (%) of the SPA Sandwich tern foraging range
2°C	Sizewell B alone	Mean	3.6	0.2
		Maximum	13.9	0.7
	Sizewell B plus C	Mean	8.5	0.5
		Maximum	34.6	1.8
3°C	Sizewell B alone	Mean	1.6	0.1
		Maximum	8.1	0.4
	Sizewell B plus C	Mean	2.8	0.2
		Maximum	13.8	0.7

8.4.17. The project-specific survey data relating to the foraging activity of Sandwich terns within the vicinity of the Alde-Ore Estuary SPA and the Sizewell coast are of limited value, given the absence of actively breeding birds at the SPA during the times of these surveys, together with fact that shore-based surveys will only record those birds foraging in relatively close proximity of the coast. However, it was apparent from the surveys undertaken that birds actively foraged in areas which are encompassed by the existing 2°C thermal plume associated with Sizewell B (**Plate 6.3** and **Plate 6.4**).

8.4.18. Based on the above, the thermal plume for the 2°C uplift for Sizewell B combined with Sizewell C represents a small percentage only of the likely foraging range of the SPA breeding Sandwich tern population, with the contribution of Sizewell C causing a small absolute increase to the existing baseline (resulting from Sizewell B). Furthermore, for the reasons given above, it is considered that the 2°C uplift is likely to represent an overly precautionary threshold and the extent of overlap is smaller still for the 3°C uplift, which is considered to be sufficiently precautionary. The 2°C and 3°C thermal plumes from Sizewell B and Sizewell C occur relatively close to shore (**Plate 8.1**), which could mean that any potential effects of the temperature uplift on Sandwich tern prey species disproportionately affect those parts of the range where foraging activity is greatest (because range usage increases near the shore and close to the colony – Ref. 6.31). Considering the thermal plumes in relation to the marine area that lies within the mean foraging range of Sandwich tern from the colony (as a proxy for the area in which foraging activity is more concentrated) resulted in higher extents of overlap. However, the overlap values all remained within 10%, and were low for the 3°C uplift (with the 98th percentile and average instantaneous plume encompassing 2.3% and 0.3% of this smaller range, respectively).

8.4.19. Given this, no adverse effects on the Alde-Ore Estuary SPA Sandwich tern population are predicted as a consequence of thermal discharges during the operational period.

ii. Chemical discharges

8.4.20. Modelling of the chemical discharges was also undertaken using the GETM as validated for Sizewell (Ref. 5.7 and Ref. 5.3), and, as for thermal discharges, it is necessary to consider the effect of Sizewell C within the context of the existing discharges from Sizewell B.

8.4.21. For TRO, the plumes resulting from Sizewell B and Sizewell C are spatially distinct at ecologically relevant concentrations, in contrast to the situation for thermal discharges (Ref. 2.2). Basing the assessment on the EQS value of 10 µg/l as a 95th percentile, the TRO plume for Sizewell C at the sea surface encompasses 3.38 km^2 within the SPA Sandwich tern foraging range, representing 0.1% of this range (**Plate 8.3**). This compares to an area of 3.89 km^2 for the existing Sizewell B TRO plume, which represents 0.2% of the SPA Sandwich tern foraging range. When considered in relation to the marine area encompassed by the mean foraging range of Sandwich tern (as a proxy for the area in which foraging activity is more concentrated – see above), the percentage overlap with the plume for Sizewell C represents less than 0.01% of this smaller foraging range (whilst that for the plume for Sizewell B represents 0.4%).

8.4.22. For Bromoform, the resulting plumes from Sizewell B and Sizewell C are also spatially distinct, with the plume for Sizewell C invariably smaller than that for Sizewell B at values above 1 µg/l (as a 95th percentile) due to the lower initial discharge concentration and greater water depth at the Sizewell C outfall location (Ref. 2.2). The EQS that has been used for bromoform is defined by the PNEC of 5 µg/l (as a 95th percentile). At levels exceeding this value the bromoform plume for Sizewell C at the sea surface encompasses 0.52 km^2 within the SPA Sandwich tern foraging range, representing 0.02% of this range (**Plate 8.4**). This compares to an area of 3.06 km^2 for the existing Sizewell B bromoform plume, which represents 0.1% of the SPA Sandwich tern foraging range. When considered in relation to the marine area encompassed by the mean foraging range of Sandwich tern, the percentage overlap with the plume for Sizewell C represents less than 0.01% of this smaller foraging range (whilst that for the plume for Sizewell B represents 0.4%).

8.4.23. As detailed above (**Section 5.3 b iii**), hydrazine is potentially harmful to aquatic organisms at low concentrations. There is no established EQS value for hydrazine so a chronic PNEC of 0.4 ngl-1 has been calculated for long-term discharges (using the mean of the concentration values) and an acute PNEC of 4 ngl-1 for short term discharge (as a 95th percentile), both of which are considered to be highly precautionary thresholds (Ref. 8.1). A hydrazine discharge of 69 ngl-1 in daily pulses of 2.32 hours starting at 12pm was used as the worst-case scenario.

8.4.24. Based upon the above, the hydrazine plume for Sizewell C at the sea surface encompasses 1.58 km^2 and 0.14 km^2 for the chronic and acute PNEC values, respectively. These plumes are fully encompassed by the SPA Sandwich tern foraging range and represent 0.08% and less than 0.01% of this range, respectively (**Plate 8.5**). There is no overlap of the hydrazine plumes with the marine area encompassed by the mean foraging range of Sandwich tern.

8.4.25. The project-specific survey data relating to the foraging activity of Sandwich terns within the vicinity of the Alde-Ore Estuary SPA and the Sizewell coast demonstrate that foraging occurs within areas encompassed by the existing TRO plume (for values exceeding 10 µg/l as a 95th percentile) and bromoform plume (for values exceeding 5 µg/l as a 95th percentile) associated with Sizewell B, as is also noted above in relation to the Sizewell B thermal plume (**Plate 6.3** and **Plate 6.4**).

8.4.26. Based on the above considerations, the chemical discharges from the Sizewell C Project will occur across a small part of the predicted foraging range of the Alde-Ore Estuary SPA breeding Sandwich tern population at concentrations that are considered to have the potential to affect the abundance of Sandwich tern prey. The total area affected by chemical discharges is predicted to encompass less than 0.2% of the predicted foraging range. It is also apparent from existing survey data that foraging Sandwich tern are not excluded from areas affected by such discharges. Therefore, no adverse effects on the SPA Sandwich tern population are predicted as a consequence of chemical discharges during the operational period.

Plate 8.3: TRO concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA)

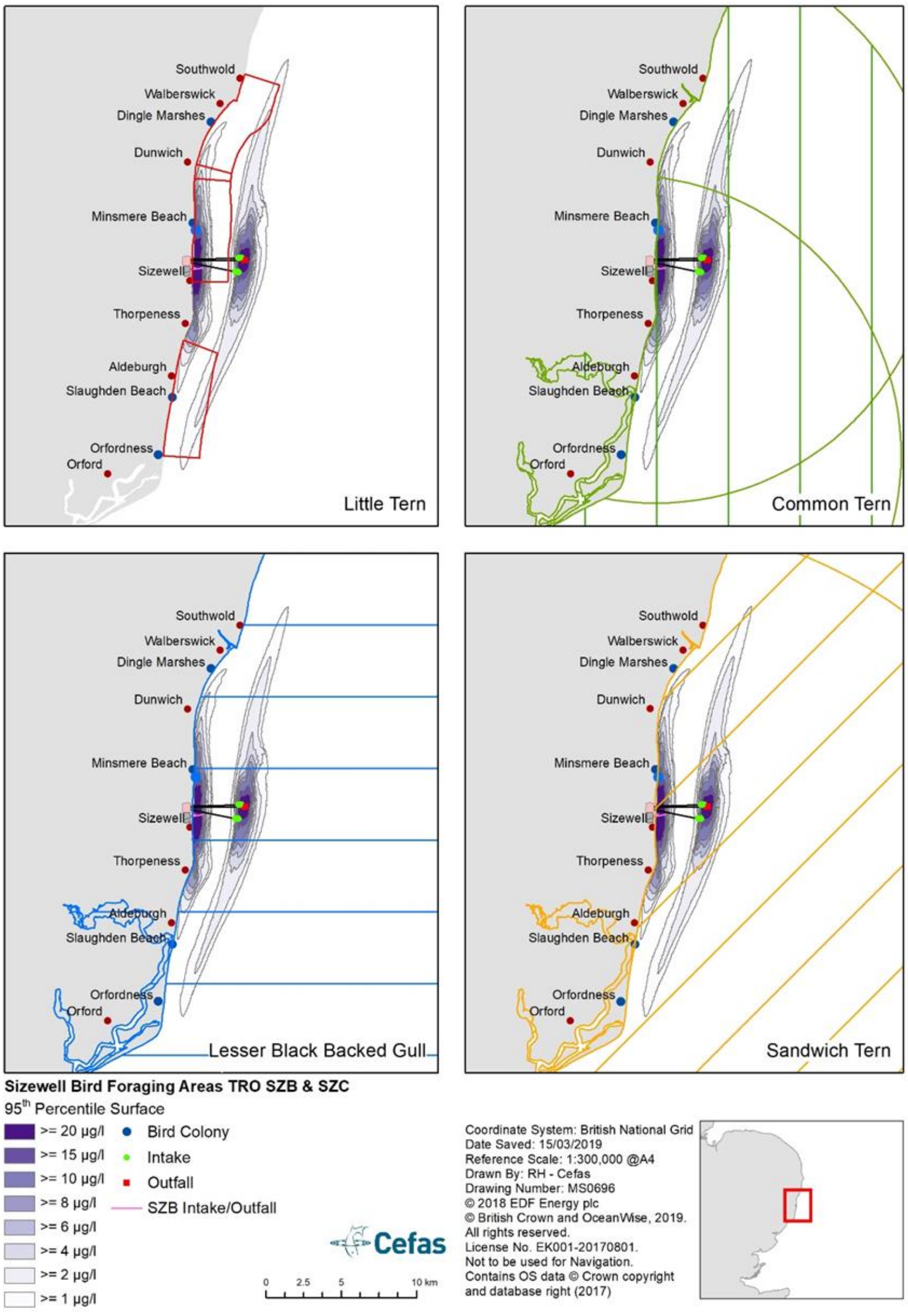


Plate 8.4: Bromoform concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA)

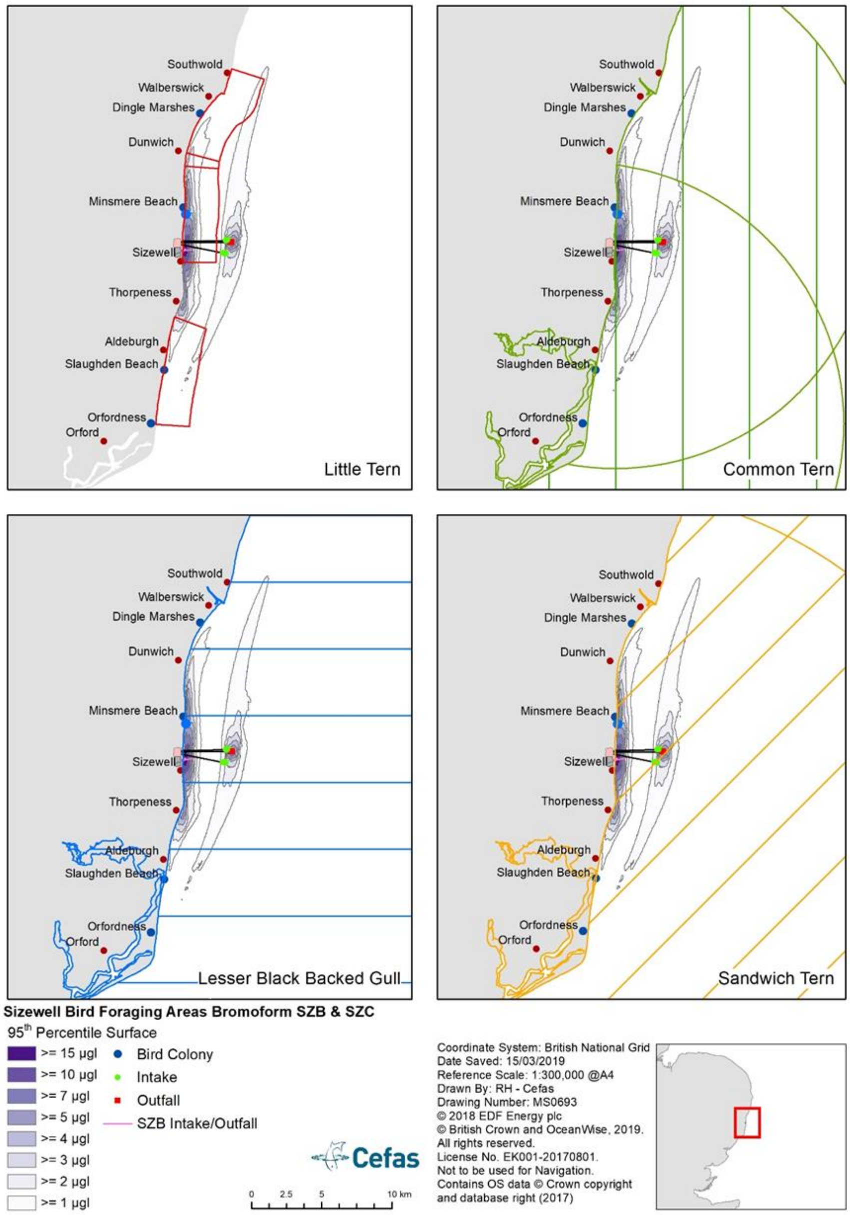
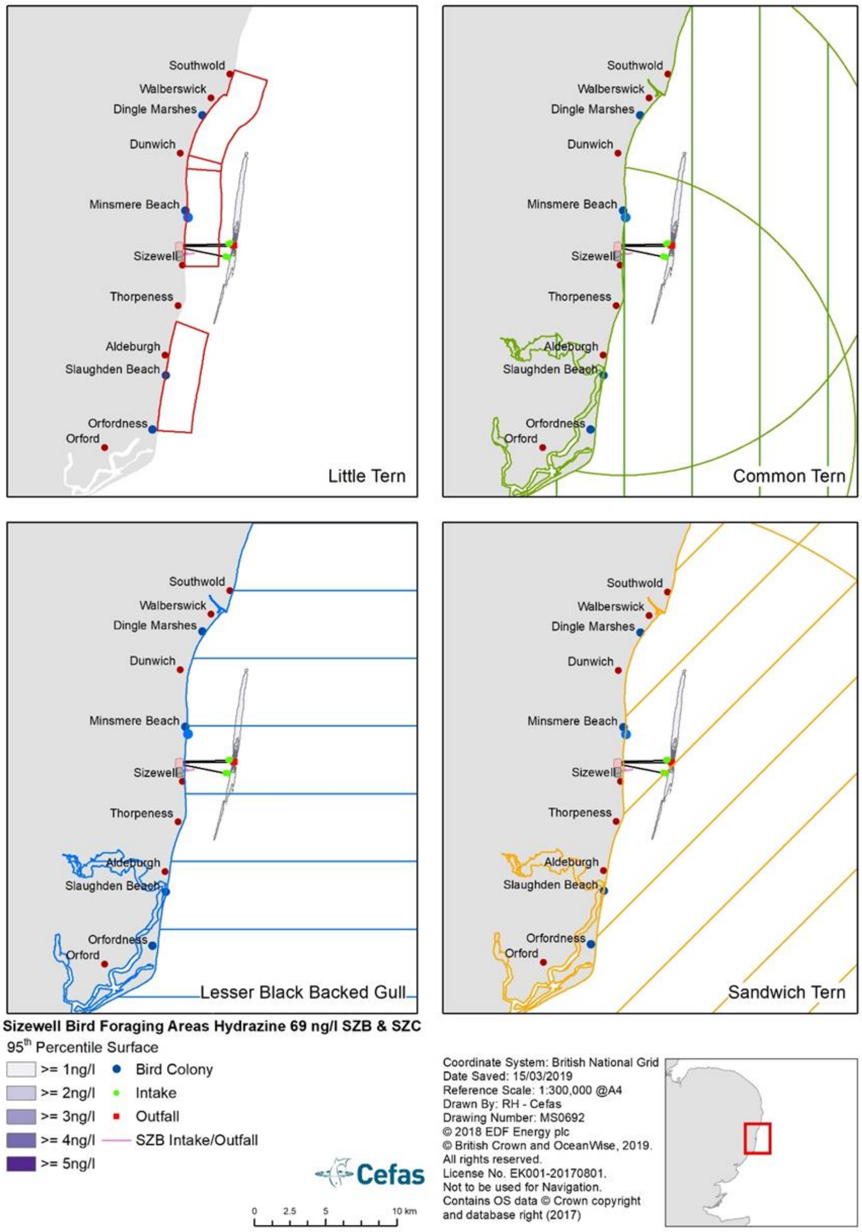


Plate 8.5: Hydrazine concentration at the sea surface (ng/l as a 95th percentile) after release of 69 ng/l from Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding little tern (for the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs), common tern (for the Outer Thames Estuary SPA), lesser black-backed gull (for the Alde-Ore Estuary SPA) and Sandwich tern (for the Alde-Ore Estuary SPA)



c) Effects on breeding little tern, project alone

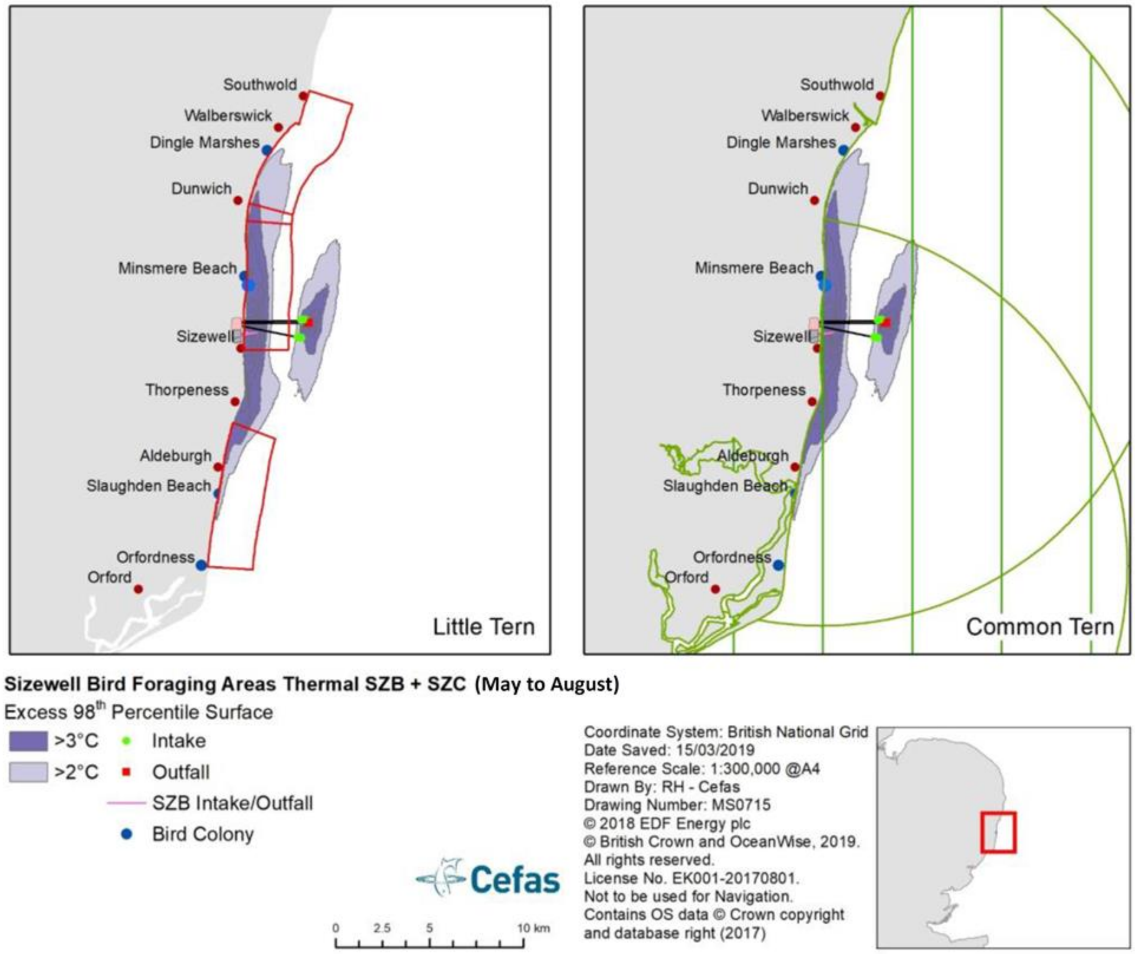
i. Introduction

8.4.27. The basis for the assessments of the thermal and chemical discharges from Sizewell C are as outlined above for the SPA Sandwich tern population (**Section 8.4 b**). Therefore, the thresholds are as applied in the assessment of the SPA Sandwich tern population, whilst the potential effects are concerned with the impacts on the prey species of little tern.

ii. Thermal discharge

8.4.28. For little tern, the thermal plumes associated with the 2°C and 3°C temperature uplifts are considered for May to August (as the period over which it is present as a breeding species at the SPA). Over this period, the areas encompassed at the sea surface by the 98th percentiles for the existing 2°C and 3°C thermal plumes (for Sizewell B) extend to 16.7 km^2 and 9.4 km^2, respectively (whilst the equivalent plumes for Sizewell C, when considered alone, extend across 9.0 km^2 and 2.5 km^2, respectively). Incorporating the Sizewell C thermal plumes together with the Sizewell B plumes increases these areas to 36.9 km^2 for the 2°C uplift and 15.3 km^2 for the 3°C uplift (**Plate 8.6**).

Plate 8.6: The 2°C and 3°C uplifts (as a 98th percentile) for sea surface temperatures for Sizewell B together with Sizewell C for May to August, in relation to the breeding colony locations and predicted foraging ranges for little tern associated with the Alde-Ore Estuary, Minsmere-Walberswick and Outer Thames Estuary SPAs and for common tern associated with the Outer Thames Estuary SPA



8.4.29. As detailed in **Section 6.3 b**, little terns have not bred at the Alde-Ore SPA since 2013. However, should breeding birds recolonise the SPA, it is reasonable to assume that the main foraging area for the population would be defined by the area within 3.9 km of the colony alongshore and 2.4 km seawards (**Section 6.3 b**, Ref. 6.15). Based on the 98th percentile, the 2°C and 3°C thermal plumes for the combined effects of Sizewell B and Sizewell C encompass 15.4% and 5.4% of this foraging range, respectively (**Plate 8.6**). This compares with overlaps of 8.7% (for the 2°C uplift) and 2.5% (for the 3°C uplift) for the existing thermal plumes resulting from Sizewell B.

8.4.30. For the combined effects of Sizewell B and Sizewell C, the instantaneous plumes (as calculated at hourly intervals from May to August), encompass a maximum of 24.6% (at any one point in time) and an average of 1.7% of the little tern foraging range for the 2°C uplift, and a maximum of 14.2% and average of 0.3% for the 3°C uplift. This compares with maximum and average overlaps between the existing Sizewell B plume and the foraging range of 16.9% and 0.7%, respectively, for the 2°C uplift, and of 11.5% and 0.2%, respectively, for the 3°C uplift.

8.4.31. Based on the above, the thermal discharges from Sizewell C are predicted to cause a relatively large increase in the extent to which the 2°C thermal plume encroaches onto the likely foraging range of the Alde-Ore Estuary SPA little tern population, with the current 8.7% overlap (from the existing discharges from Sizewell B) increasing to 15.4% (as determined by the 98th percentiles of the thermal plumes). However, over the course of the breeding period, the average extent of overlap between the 2°C uplift plume (for Sizewell B combined with Sizewell C) and the foraging range remains below 2%. Furthermore, for the reasons given in **Section 8.4 b** above, it is considered that the 2°C uplift is likely to represent an overly precautionary threshold. The 3°C uplift indicates a relatively small overlap with the little tern foraging range (5.4% for the 98th percentile of the thermal plume, and 0.3% for the average instantaneous overlap) and small absolute increases relative to the existing, baseline, conditions. Therefore, no adverse effects on the SPA little tern population are predicted as a consequence of thermal discharges during the operational period.

iii. Chemical discharges

8.4.32. There is no overlap of the predicted foraging range of the SPA breeding little tern population with the Sizewell C plumes (for the defined thresholds) for TRO, bromoform or hydrazine (**Plate 8.3, Plate 8.4** and **Plate 8.5**). Therefore, no adverse effects on the SPA little tern population are predicted as a consequence of chemical discharges during the operational period.

d) Breeding lesser black-backed gull

i. Introduction

8.4.33. The basis for the assessments of the thermal and chemical discharges from Sizewell C are as outlined above for the SPA Sandwich tern population (**Section 8.4 b**). Therefore, the thresholds are as applied in the assessment of the SPA Sandwich tern population, whilst the potential effects are concerned with the impacts on the prey species of lesser black-backed gull.

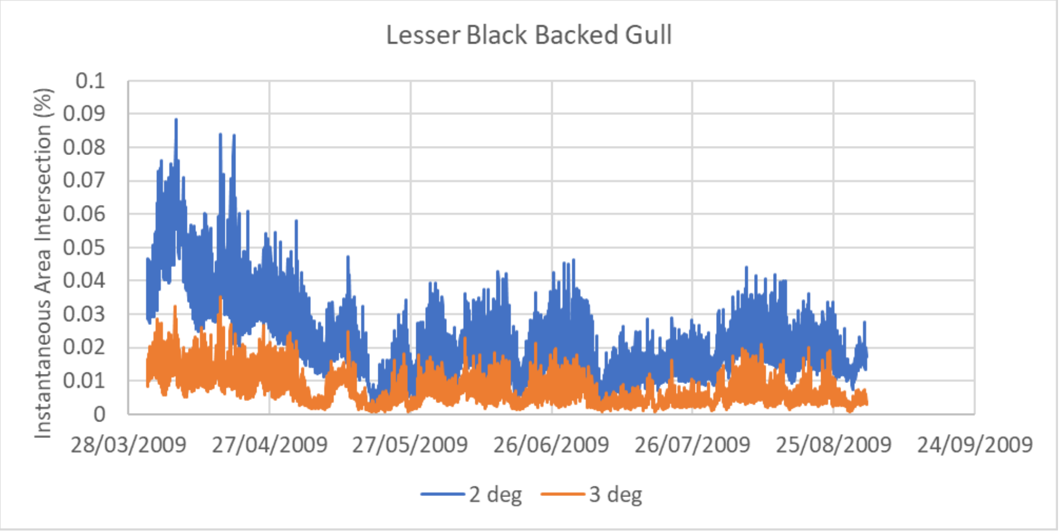
ii. Thermal discharge

8.4.34. For lesser black-backed gull, the thermal plumes associated with the 2°C and 3°C temperature uplifts are considered for April to August (as the period over which it is present as a breeding species at the SPA). Over this period, the areas encompassed at the sea surface by 98th percentiles for the existing 2°C and 3°C thermal plumes (for Sizewell B) extend to 18.6 km^2 and 10.5 km^2, respectively (whilst the equivalent plumes for Sizewell C, when considered alone, extend across 9.8 km^2 and 2.8 km^2, respectively). Incorporating the Sizewell C thermal plumes together with the Sizewell B plumes increases these areas to 51.3 km^2 for the 2°C uplift and 17.7 km^2 for the 3°C uplift (**Plate 8.1**).

8.4.35. Lesser black-backed gulls forage widely during the breeding period, with the mean maximum foraging range in marine environments estimated as 141 km (**Section 6.3 b**, Ref. 4.8), although it is likely that much of the foraging activity would occur in those parts of the range which are closer to the colony. As well as having extensive marine foraging ranges, lesser black-backed gulls may also exploit terrestrial foraging habitats, including during the breeding season (Ref. 6.65). Based on the 98th percentile, the 2°C and 3°C thermal plumes lie entirely within the predicted marine foraging range but represent only 0.13% (for the 2°C uplift) and 0.05% (for the 3°C uplift) of the assumed range when the combined effects of Sizewell B and Sizewell C are considered. This compares with 0.05% (for the 2°C uplift) and 0.03% (for the 3°C uplift) for the existing thermal plumes that result from Sizewell B. Relating these thermal plumes to the marine area encompassed by the mean foraging range of this species (i.e. 72 km – Ref. 4.8), to account for the likely greater importance to foraging birds of areas closer to the colony, makes little meaningful difference because the areas of overlap do not exceed 0.5%.

8.4.36. The instantaneous plume sizes show the same pattern as for the SPA Sandwich terns (given that the plumes are modelled over the same time period and they are fully encompassed within the foraging range), with the area of the plumes greatest in April and lower in June and July (**Plate 8.7**). However, the percentage overlap with the foraging range is considerably smaller (due to the larger extent of the predicted foraging range of the SPA lesser black-backed gull population).

Plate 8.7: Instantaneous area of overlap of the SPA lesser black-backed gull marine foraging range with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for April to August



8.4.37. Thus, for the combined effects of Sizewell B and Sizewell C, the 2°C uplift accounts for a maximum of 0.09% of the SPA lesser black-backed gull foraging range at any one point in time, and an average of 0.02% over the breeding period (**Table 8.2**). These percentages are considerably lower when considering the 3°C uplift and represent small absolute increases only on the existing baseline situation, as represented by the Sizewell B thermal plume.

Table 8.2: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for April to August, with the percentage overlap with the predicted foraging range of the SPA lesser black-backed gull population

Temperature uplift	Projects		Area (km^2)	Percentage (%) of the SPA lesser black-backed gull foraging range
2°C	Sizewell B alone	Mean	3.6	0.01
		Maximum	13.9	0.03
	Sizewell B plus C	Mean	8.5	0.02
		Maximum	34.6	0.09
3°C	Sizewell B alone	Mean	1.6	<0.01
		Maximum	8.1	0.02
	Sizewell B plus C	Mean	2.8	0.01
		Maximum	13.8	0.04

8.4.38. Records of foraging lesser black-backed gulls were scarce during the project-specific surveys, with most records being of loafing and commuting birds (with the latter unsurprising, given the large foraging range of the species and limited areas of this foraging range which would be covered by these shore-based surveys) (**Section 6.3 b**).

8.4.39. The thermal plume for the 2°C uplift for Sizewell B combined with Sizewell C represents a small percentage only of the predicted marine foraging range of the SPA breeding lesser black-backed gull population, with the contribution of Sizewell C causing a small absolute increase to the existing baseline (resulting from Sizewell B). Furthermore, the extent of this overlap is smaller still for the 3°C uplift which is considered to represent a sufficiently precautionary threshold. Given this, no adverse effects on the SPA lesser black-backed gull population are predicted as a consequence of thermal discharges during the operational period.

iii. Chemical discharges

8.4.40. The extents of the TRO, bromoform and hydrazine plumes (for the defined thresholds) at the sea surface within the predicted foraging range of the SPA lesser black-backed gull population are as detailed above for the SPA Sandwich tern population (**Plate 8.3, Plate 8.4**, and **Plate 8.5)**. However, in the case of lesser black-backed gull, they represent smaller percentages of the foraging range, with each plume resulting from the Sizewell C discharges being less than 0.01% of this range. When considered in relation to the marine area encompassed by the mean foraging range of lesser black-backed gull (as a proxy for the area in which foraging activity is more concentrated – see above), each of these plumes for Sizewell C represent less than 0.04% of this smaller range. As such, no adverse effects on the SPA breeding lesser black-backed gull population are predicted as a consequence of chemical discharges during the operational period.

8.5 Assessment of effects: Benacre to East Bavents SPA

a) Effects on breeding little tern, project alone

8.5.1. Given the restricted foraging range of this species from its breeding colonies (mean maximum of 3.9 km alongshore and 2.4 km seawards), and the distance of the SPA from the Sizewell C main development site (15 km at the nearest point), there is no spatial overlap between the thermal plumes for the 2°C and 3°C uplifts or of any of the chemical plumes and the predicted foraging range (as defined by Ref. 6.15) of the Benacre to Easton Bavents SPA breeding little tern population.

8.5.2. Therefore, no adverse effects on the SPA little tern population are predicted as a consequence of thermal and chemical discharges from Sizewell C during the operational period.

8.6 Assessment of effects: Minsmere-Walberswick SPA and Ramsar site

a) Introduction

8.6.1. The Minsmere-Walberswick SPA breeding little tern population is subject to potential operational effects from thermal and chemical discharges which could affect the prey resource available to the population in the same way as for the seabird qualifying features of the Alde-Ore Estuary SPA (**Section 8.4**).

b) Effects on breeding little tern, project alone

i. Thermal discharge

8.6.2. For little tern, the thermal plumes associated with the 2°C and 3°C temperature uplifts are considered for May to August (as the period over which it is present as a breeding species in the SPA). Over this period, the areas encompassed at the sea surface by the existing 2°C and 3°C thermal plumes (for Sizewell B) extend to 16.7 km^2 and 9.4 km^2, respectively (whilst the equivalent plumes for Sizewell C, when considered alone, extend across 9.0 km^2 and 2.5 km^2, respectively). Incorporating the Sizewell C thermal plumes together with the Sizewell B plumes increases these areas to 36.9 km^2 for the 2°C uplift and 15.3 km^2 for the 3°C uplift (**Plate 8.6**).

8.6.3. As detailed in **Section 6.3 e**, numbers of breeding little terns at the Minsmere-Walberswick SPA have declined and, in recent years, breeding has been sporadic and has often involved relatively small numbers of pairs (but with higher numbers recorded in 2019 – see **Section 6.3 e**). For each of the two main breeding colonies within the SPA (Minsmere and Dingle), it is reasonable to assume that the main foraging areas for each of the colony populations would be defined by the area within 3.9 km of the colony alongshore and 2.4 km seawards (**Section 6.3 b**, Ref. 6.15).

8.6.4. Based on the 98th percentile, the 2°C and 3°C thermal plumes for the combined effects of Sizewell B and Sizewell C encompass 61.5% and 41.3% of the foraging range of the Minsmere colony, respectively (**Plate 8.6**). This compares with overlaps of 48.9% (for the 2°C uplift) and 34.0% (for the 3°C uplift) for the existing thermal plumes that result from Sizewell B. For the Dingle colony foraging range, the equivalent percentage overlaps are 31.9% and 3.3% for the 2°C and 3°C uplifts, respectively, for the combined effects of Sizewell B and Sizewell C, and 11.7% and 0.1% for the 2°C and 3°C uplifts, respectively, for the existing thermal plumes resulting from Sizewell B.

8.6.5. For the combined effects of Sizewell B and Sizewell C, the instantaneous plumes (as calculated at hourly intervals from May to August), encompass a maximum of 57.3% (at any one point in time) and an average of 18.4% of the Minsmere little tern colony foraging range for the 2°C uplift, and a maximum of 39.0% and average of 7.4% for the 3°C uplift. This compares with maximum and average overlaps between the existing Sizewell B plume and the foraging range of the Minsmere colony of 44.3% and 11.0%, respectively, for the 2°C uplift, and of 34.7% and 5.4%, respectively, for the 3°C uplift.

8.6.6. For the combined effects of Sizewell B and Sizewell C, the instantaneous plumes (as calculated at hourly intervals from May to August), encompass a maximum of 37.1% (at any one point in time) and an average of 3.3% of the Dingle little tern colony foraging range for the 2°C uplift, and a maximum of 8.5% and average of 0.2% for the 3°C uplift. This compares with maximum and average overlaps between the existing Sizewell B plume and the Dingle colony foraging range of 18.2% and 0.9%, respectively, for the 2°C uplift, and of 5.1% and 0.05%, respectively, for the 3°C uplift.

8.6.7. The project-specific survey data relating to the foraging activity of little terns within the vicinity of the Minsmere and Dingle colonies and elsewhere on the Sizewell coast show that the birds actively forage within areas encompassed by the existing 2°C thermal plume associated with Sizewell B (**Plate 6.6** to **Plate 6.9**).

8.6.8. Based on the above, it is clear that the existing 2°C thermal plume associated with the thermal discharges from Sizewell B currently encompasses substantial parts of the likely foraging ranges of the SPA little tern population, particularly for those birds nesting at the Minsmere colony. The thermal discharges which would arise from Sizewell C are predicted to increase the extent of overlap between the foraging ranges and the 2°C thermal plume, with this increase most marked for the Dingle colony foraging range. Overall, the discharges from Sizewell C are estimated to increase the overlap of the 2°C thermal plume (as determined by the 98th percentiles) with the combined foraging ranges of these two main SPA colonies from approximately 30% under existing conditions to approximately 47% (noting that there is a small area of overlap in the foraging ranges of the two colonies – **Plate 8.6**).

8.6.9. Over the course of the breeding period, the extent of overlap between the instantaneous 2°C thermal plume for Sizewell B with Sizewell C and the foraging ranges averages 18.4% for the Minsmere colony and 3.3% for the Dingle colony, with these percentages representing modest increases relative to the average overlaps with the existing 2°C plume associated with Sizewell B. Furthermore, for the reasons given in **Section 8.4 b** above, it is considered that the 2°C uplift is likely to represent an overly precautionary threshold. The 3°C uplift indicates considerably less overlap with the little tern foraging ranges and smaller absolute increases relative to the existing, baseline, conditions. Therefore, no adverse effects on the SPA little tern population are predicted as a consequence of thermal discharges during the operational period.

ii. Chemical discharges

8.6.10. There is no overlap of the predicted foraging ranges of the SPA breeding little tern population with the Sizewell C plumes (for the defined thresholds) for TRO, bromoform or hydrazine (**Plate 8.3, Plate 8.4** and **Plate 8.5**). Therefore, no adverse effects on the SPA little tern population are predicted as a consequence of chemical discharges during the operational period.

8.7 Minsmere-Walberswick Ramsar site

8.7.1. The Ramsar Information Sheet (Ref. 8.4) lists species that may be associated with marshland and reedbeds which are of importance to this assessment: little tern, black-headed gull and Mediterranean gull.

8.7.2. The assessment carried out for the Minsmere-Walberswick SPA little tern also apply to the Ramsar site. The assessment for the Alde-Ore Estuary SPA lesser black-backed gull also apply to the Ramsar site, including the Mediterranean gull.

8.7.3. As such, no adverse effects on little tern, lesser black-backed gull and Mediterranean gull are predicted as a consequence of changes to water quality from the operation of the Sizewell C Project.

8.8 Assessment of effects: Outer Thames Estuary SPA

a) Effects on breeding little tern, project alone

8.8.1. Of the little tern breeding colonies which contribute to the Outer Thames Estuary SPA little tern population, the Sizewell C Project has the potential to affect those colonies associated with the Alde-Ore Estuary SPA, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA (**Table 6.5**). The potential marine water quality effects on the foraging habitats of little terns during operation are assessed for each of these breeding colony SPAs in the relevant sections above (i.e. **Sections 8.4, 8.5** and **8.6**). For each of these SPA populations, no adverse effects are predicted as a result of marine water quality effects during construction and operation.

8.8.2. It therefore follows that no adverse effects on the Outer Thames Estuary SPA little tern population are predicted as a consequence of marine water quality effects associated with the operation of Sizewell C.

b) Effects on breeding common tern, project alone

i. Introduction

8.8.3. Of the common tern breeding colonies which contribute to the Outer Thames Estuary SPA common tern population, the Sizewell C Project has the potential to affect those which occur within the Alde-Ore Estuary SPA and Minsmere-Walberswick SPA (**Table 6.6**). Common tern is not a qualifying feature of either of these SPAs, with the colonies located at Orfordness (in the Alde-Ore Estuary SPA) and Minsmere (in the Minsmere-Walberswick SPA).

8.8.4. The mean maximum foraging range of breeding common terns is estimated as 18.6 km and, for the purposes of this assessment, the foraging range of birds from the Orfordness and Minsmere colonies is assumed to be encompassed by a radius of 18.6 km from the colony location (**Section 6.3 g**, Ref. 6.31). However, areas of concentrated foraging activity are likely to occur in those parts of the range which are closer to the colony (**Section 6.3 g**, Ref. 6.31).

ii. Thermal discharge

8.8.5. For common tern, the thermal plumes associated with the 2°C and 3°C temperature uplifts are considered for May to August (as the period over which it is present as a breeding species at the colonies of interest). Over this period, the areas encompassed at the sea surface by the 98th percentiles for the existing 2°C and 3°C thermal plumes (for Sizewell B) extend to 16.7 km^2 and 9.4 km^2, respectively (whilst the equivalent plumes for Sizewell C, when considered alone, extend across 9.0 km^2 and 2.5 km^2, respectively). Incorporating the Sizewell C thermal plumes together with the Sizewell B plumes increases these areas to 36.9 km^2 for the 2°C uplift and 15.3 km^2 for the 3°C uplift (**Plate 8.6**).

8.8.6. The 2°C and 3°C thermal plumes from the combined effects of Sizewell B and Sizewell C lie entirely within the foraging range of the Minsmere colony and almost entirely within the range of the Orfordness colony (**Plate 8.6**). Based on the 98th percentile, these plumes represent 7.2% (for the 2°C uplift) and 3.0% (for the 3°C uplift) of the assumed foraging range of the Minsmere colony when the combined effects of Sizewell B and Sizewell C are considered, and 3.3% (for the 2°C uplift) and 1.8% (for the 3°C uplift) when considering Sizewell B alone. The percentage overlaps of the equivalent thermal plumes with the assumed foraging range of the Orfordness colony are slightly smaller (with the largest difference being the 2°C uplift for Sizewell B and Sizewell C combined, for which there is a 4.9% overlap).

8.8.7. Given that areas of concentrated foraging activity are likely to occur closer to the colony, the area of overlap with the thermal plumes is also considered in relation to the area defined by a radius of 4.5 km from the colony (equivalent to the mean foraging range for the species, as determined in Ref. 4.6). For the Minsmere colony, the 2°C and 3°C thermal plumes (defined by the 98th percentile) for the combined effects of Sizewell B and Sizewell C represent 55.7% (for the 2°C uplift) and 31.8% (for the 3°C uplift) of this smaller range, which compares with 32.5% (for the 2°C uplift) and 21.5% (for the 3°C uplift) for the existing thermal plumes associated with Sizewell B. For the Orfordness colony, only the 2°C thermal plume for the combined effects of Sizewell B and Sizewell C overlaps with this smaller foraging range (with this area of overlap representing 1.0% of the smaller range).

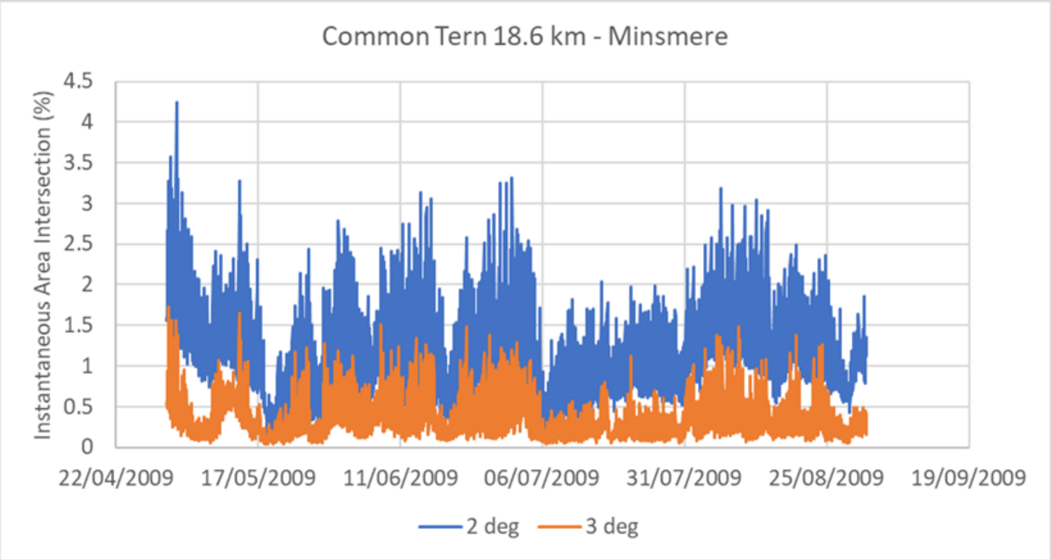
8.8.8. When the instantaneous plumes (as calculated at hourly intervals from May to August) for the combined effects of Sizewell B and Sizewell C are considered, the 2°C uplift encompasses a maximum of 4.2% and 3.3% of the Minsmere and Orfordness common tern foraging ranges, respectively, at any one point in time, and an average of approximately 1.0% for each colony during the breeding period (**Plate 8.8**, **Table 8.3**). These percentages are considerably lower (at approximately 1.5% and less than 0.5% for the maximum and average overlap, respectively, at each colony) when considering the 3°C uplift and represent small absolute increases on the existing baseline situation resulting from the Sizewell B thermal plume.

8.8.9. Considering the instantaneous plumes in relation to the marine area encompassed by the mean foraging range of common tern (as a proxy for the area in which foraging activity is more concentrated – see above), indicates considerably larger overlaps. Thus, for the Minsmere colony, the 2°C uplift for the combined effects of Sizewell B and Sizewell C accounts for a maximum of 41.6% and an average of 13.7% of this smaller range over the breeding period, which compares with maximum and average overlaps of 29.3% and 7.2%, respectively, under existing, baseline, conditions (resulting from Sizewell B). Similarly, for the 3°C uplift, the plume for the combined effects of Sizewell B and Sizewell C encompasses a maximum of 26.9% and average of 5.4% of this smaller range for the Minsmere colony, compared to 21.8% and 3.6%, respectively, under the existing conditions.

8.8.10. For the Orfordness colony, the 2°C uplift for the combined effects of Sizewell B and Sizewell C encompasses a maximum of 13.2% and an average of 0.2% of this smaller range over the breeding period, representing approximate two-fold and four-fold increases, respectively, on the existing extent of overlap resulting from Sizewell B. Similarly, the 3°C thermal plume for the combined effects of Sizewell B and Sizewell C encompasses a maximum of 3.6% and average of 0.02% of this smaller range, representing approximate one and a half-fold and three-fold increases, respectively, on the existing extent of overlap resulting from Sizewell B.

8.8.11. The project-specific survey data relating to the foraging activity of common terns within the vicinity of these two colonies and the Sizewell coast show that the birds actively forage within areas encompassed by the existing 2°C thermal plume associated with Sizewell B (**Plate 6.11**).

Plate 8.8: Instantaneous area of overlap of the Minsmere (upper) and Orfordness (lower) common tern colony foraging ranges with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for May to August



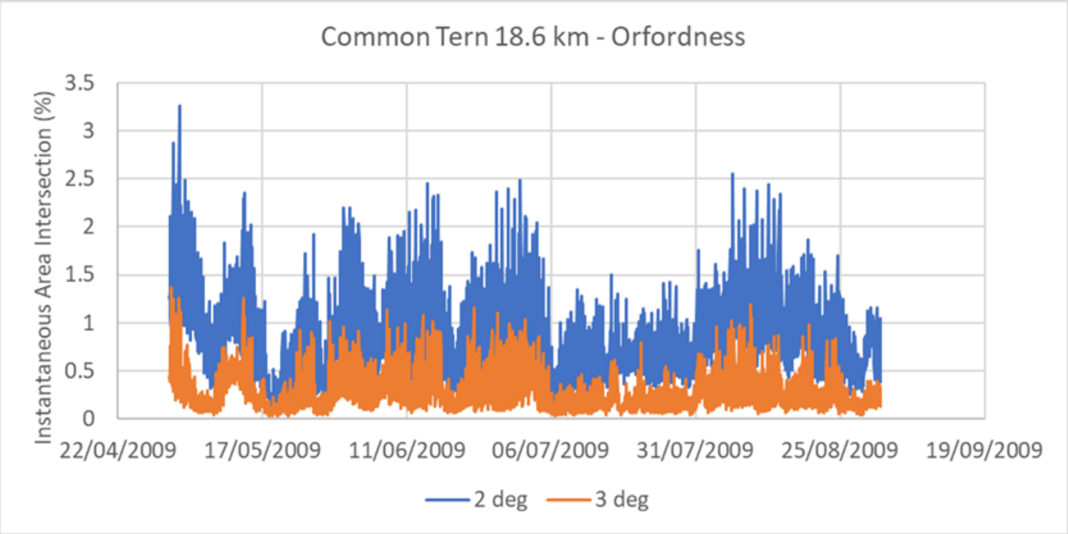


Table 8.3: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for May to August, with the percentage overlap with the predicted foraging ranges of the Orfordness and Minsmere common tern colonies

Colony	Temperature uplift	Projects		Area (km^2)	Percentage of foraging range
Orfordness	2°C	Sizewell B alone	Mean	2.6	0.4
			Maximum	10.5	1.5
		Sizewell B plus C	Mean	5.9	0.8
			Maximum	21.7	3.3
	3°C	Sizewell B alone	Mean	1.1	0.2
			Maximum	6.7	1.1
		Sizewell B plus C	Mean	1.9	0.3
			Maximum	8.8	1.4
Minsmere	2°C	Sizewell B alone	Mean	2.6	0.5
			Maximum	10.5	2.1
		Sizewell B plus C	Mean	5.9	1.1
			Maximum	21.7	4.2
	3°C	Sizewell B alone	Mean	1.1	0.2
			Maximum	6.7	1.3
		Sizewell B plus C	Mean	1.9	0.4
			Maximum	8.8	1.7

8.8.12. Based on the above, the thermal discharges from Sizewell C are predicted to cause moderate increases in the extent to which the 2°C thermal plume encroaches onto the likely foraging ranges of the Minsmere and Orfordness common tern colonies, which contribute to the Outer Thames Estuary SPA common tern population. For the Minsmere colony, the current 3.3% overlap (from existing discharges at Sizewell B) would increase to 7.2%, whilst for the Orfordness colony it would increase from 2.3% to 4.9% (as determined by the 98th percentiles). However, over the course of the breeding period, the average extent of overlap between the 2°C uplift plume (for Sizewell B combined with Sizewell C) and each of these colony foraging ranges approximates to only 1%. Furthermore, for the reasons given in **Section 8.4 b** above, it is considered that the 2°C uplift is likely to represent an overly precautionary threshold. The 3°C uplift indicates a relatively small overlap with each of the common tern foraging ranges (3.0% or less for the 98th percentile of the thermal plume, and less than 0.5% for the average instantaneous overlap) and small absolute increases relative to the existing, baseline, conditions.

8.8.13. The 2°C and 3°C thermal plumes from Sizewell B and Sizewell C occur relatively close to shore (**Plate 8.6**). For the Minsmere colony, this means that any potential effects of the temperature uplift on common tern prey species may disproportionately affect those parts of the range where foraging activity is likely to be greatest (because range usage declines with distance from colony – Ref. 6.31). This is illustrated by the substantial overlaps between the thermal plumes and the marine area that lies within the mean common tern foraging range of the Minsmere colony, with the 98th percentile for the 2°C uplift for Sizewell B combined with Sizewell C encompassing 55.7% of this area. However, these more inshore parts of the Minsmere common tern foraging range currently overlap extensively with the existing 2°C and 3°C thermal plumes from Sizewell B (e.g. the 98th percentile for the 2°C uplift for Sizewell B encompasses 32.5% of the marine area within mean foraging range of this colony). Therefore, it seems unlikely that the increased extent of the thermal uplift would greatly alter the existing baseline conditions for common terns foraging in relatively close proximity of the Minsmere colony. This consideration is less relevant to the common terns from the Orfordness colony because the 2°C and 3°C thermal plumes occur largely towards the extremity of the mean maximum foraging range from this colony (**Plate 8.6**)

8.8.14. Given the above, it is considered unlikely that the thermal discharges from Sizewell C would have detrimental effects on the common terns nesting at the Minsmere and Orfordness colonies. Furthermore, potential effects of the thermal plumes on the availability of foraging habitat are only relevant to a proportion of the Outer Thames Estuary SPA common tern population because other (currently larger) breeding colonies which contribute to this population will be unaffected due to their greater distance from the Sizewell C Project (**Table 6.6**). Therefore, no adverse effects on the Outer Thames Estuary SPA common tern population are predicted as a consequence of thermal discharges during the operational period.

iii. Chemical discharges

8.8.15. The extents of the TRO, bromoform and hydrazine plumes (for the defined thresholds) at the sea surface within the predicted foraging ranges of both the Orfordness and Minsmere common tern colonies are as detailed above for the Alde-Ore SPA Sandwich tern population (**Section 8.4 b**, **Plate 8.3, Plate 8.4,** and **Plate 8.5**). For each of the two colonies, the TRO plume for Sizewell C encompasses less than 0.7% of the foraging range, which is slightly less in each case than the percentage overlap with the existing Sizewell B TRO plume. When considered in relation to the marine area encompassed by the mean foraging range of common tern (as a proxy for the area in which foraging activity is likely to be more concentrated – see above), the percentage overlap with the TRO plume for Sizewell C represents 6.5% of this smaller foraging range for the Minsmere colony but does not overlap at all in the case of the Orfordness colony. As with the areas encompassed by the 2°C and 3°C thermal plumes for the Minsmere colony, this overlap should be considered within the context of a 9.7% overlap of this smaller range with the existing TRO plume for Sizewell B.

8.8.16. The bromoform plume encompasses 0.1% of the predicted foraging range of each colony, compared to 0.6% for the existing Sizewell B bromoform plume. When considered in relation to the marine area encompassed by the mean foraging range of common tern, the extent of overlap is 1.4% for the Minsmere colony (which compares with a 7.6% overlap with the existing plume for Sizewell B), whilst there is no overlap with this smaller foraging range in the case of the Orfordness colony.

8.8.17. The hydrazine plume for Sizewell C encompasses 0.3% of each foraging range for the chronic PNEC values and approximately 0.02% for the acute PNEC values. When considered in relation to the marine area encompassed by the mean foraging range of common tern, the extent of overlap is 3.2% and 0.4% for the chronic and acute PNEC values, respectively, for the Minsmere colony, whilst (again) there is no overlap with this smaller foraging range in the case of the Orfordness colony

8.8.18. As with the thermal discharges, the project-specific survey data relating to the foraging activity of common terns within the vicinity of these two colonies and the Sizewell coast show that birds actively forage within areas encompassed by the existing TRO and bromoform plumes associated with Sizewell B (**Plate 6.11**).

8.8.19. The chemical discharges from Sizewell C would affect only a small proportion of the available foraging range for common terns from the Orfordness and Minsmere colonies. These areas are smaller, overall, than the areas of the foraging ranges which are potentially affected by the existing TRO and bromoform plumes associated with Sizewell B. Furthermore, potential effects of the chemical discharges on the availability of foraging habitat are only relevant to a proportion of the Outer Thames Estuary SPA common tern population because other (currently larger) breeding colonies which contribute to this population will be unaffected due to their greater distance from the Sizewell C Project (**Table 6.6**). Although these plumes would extend across a greater proportion of the marine area that lies within the mean foraging range of common tern from the Minsmere colony (as a proxy for the area in which foraging activity is more concentrated), the extent of overlap is considerably less that that which currently occurs as a result of the existing plumes from Sizewell B. Also, for the Orfordness colony, there is no overlap with these plumes when considering this smaller foraging range.

8.8.20. Given this, no adverse effects on the Outer Thames Estuary SPA common tern population are predicted as a consequence of chemical discharges during the operational period.

a) Effects on non-breeding red-throated diver, project alone

8.8.21. For the purposes of the assessment of potential effects on the Outer Thames Estuary SPA non-breeding red-throated diver population, the entirety of the SPA is taken to represent the foraging area available to this population, with the SPA extending across a total area of 3,924.5 km^2.

ii. Thermal discharge

8.8.22. For red-throated diver, the thermal plumes associated with the 2°C and 3°C temperature uplifts are considered for September to March (as the period over which it is present within the SPA). Over this period, the area encompassed at the sea surface by the effects of Sizewell B combined with Sizewell C extend to 25.5 km^2 for the 3°C thermal plume (based on the 98th percentile). The extent of the 2°C and 3°C thermal plumes for this winter period is little different to that as calculated for the full annual period (**Figures 5.3** and **5.4**).

8.8.23. The thermal plumes overlap with the north-western block of the SPA only, which is estimated to hold approximately 20% of the SPA red-throated diver population (compare **Figures 4.1** and **5.3**, **Section 6.3 g**, Ref. 6.54). Therefore, any effects of the thermal plumes on foraging red-throated diver would affect a smaller proportion of the SPA population than indicated by the extent of spatial overlap between the plumes and the SPA.

8.8.24. The instantaneous plume sizes (as calculated at hourly intervals for the September to March period) show that for the combined effects of Sizewell B and Sizewell C, the 2°C uplift accounts for a peak of 62.0 km^2 (or 1.6%) of the SPA area at any one point in time, and an average of 11.4 km^2 (or 0.3%). These percentage overlaps with the SPA are considerably lower when considering the 3°C uplift and represent modest absolute increases only on the existing baseline situation, as represented by the Sizewell B thermal plume (**Plate 8.9**, **Table 8.4**).

Plate 8.9: Instantaneous area of overlap of the Outer Thames Estuary SPA with the 2°C and 3°C uplifts for Sizewell B together with Sizewell C for September to March.

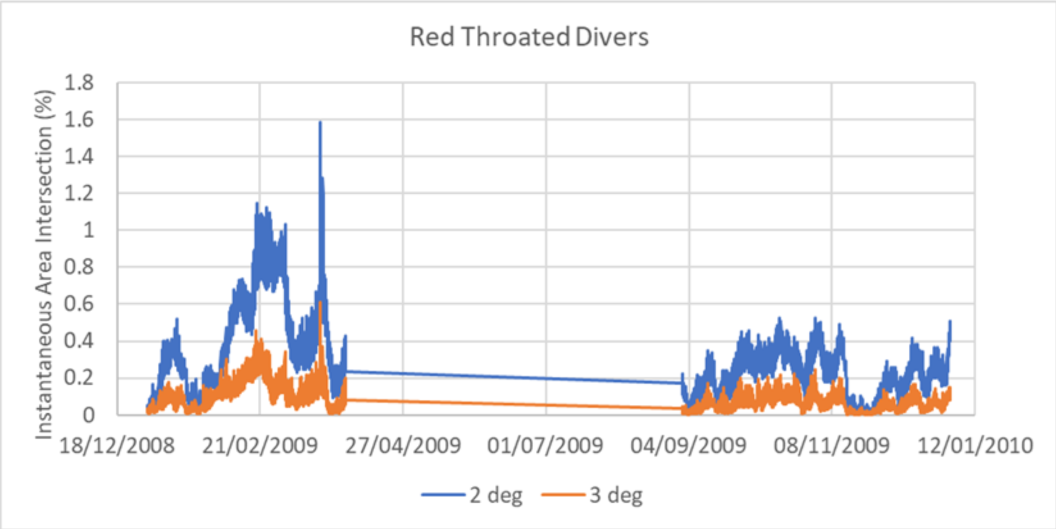


Table 8.4: The maximum and mean instantaneous areas of thermal plumes at the sea surface for the 2°C and 3°C uplifts for Sizewell B alone and for Sizewell B together with Sizewell C for September to March with the percentage overlap with the Outer Thames Estuary SPA.

Temperature uplift	Projects		Area (km^2)	Percentage (%) of the SPA area
2°C	Sizewell B alone	Mean	4.5	0.1
		Maximum	13.9	0.4
	Sizewell B plus C	Mean	11.4	0.3
		Maximum	62.0	1.6
3°C	Sizewell B alone	Mean	1.8	0.04
		Maximum	10.4	0.3
	Sizewell B plus C	Mean	3.2	0.1
		Maximum	23.9	0.6

8.8.25. The project-specific survey data relating to the distribution of red-throated diver along the coast to the north and south of Sizewell show that relatively high densities of birds occur within areas encompassed by the existing 2°C thermal plume associated with Sizewell B (**Plate 6.13**).

iii. Chemical discharges

8.8.26. The extents of the TRO and bromoform plumes (for the defined thresholds) at the sea surface for Sizewell C encompass areas of 3.4 km^2 and 0.52 km^2 of the SPA, representing 0.09% and 0.01% of the SPA, respectively. These compare to existing plume areas within the SPA from Sizewell B of 3.9 km^2

for TRO and 3.1 km^2 for bromoform, representing 0.10% and 0.08% of the SPA, respectively (**Plate 8.3** and **Plate 8.4**).

8.8.27. For hydrazine discharge from Sizewell C, the plume encompasses 1.6 km^2 (0.04%) of the SPA for the chronic PNEC values and 0.1 km^2 (<0.01%) for the acute PNEC values (**Plate 8.5**).

iv. Conclusion

8.8.28. Based on the above considerations, the thermal and chemical discharges from the Sizewell C Project would occur across a small part of the SPA only and be restricted to the northern parts of the SPA, where the densities of red-throated diver are considerably lower than in the more southern parts (see **Section 6.3 g**). Therefore, no adverse effects on the SPA red-throated diver population are predicted as a consequence of thermal and chemical discharges during the operational period.

8.9 Assessment of potential effects (in-combination)

8.9.1. The screening exercise for plans or projects that could have in-combination effect with the water discharge activities of the Sizewell C Project identified possible in-combination effects on designated sites with marine birds as qualifying features (**Table B.1, Appendix B**). The screened in plans and projects and the assessment for adverse effects on site integrity as a result of these potential in-combination effects is presented separately for each impact pathway in the sections below.

8.9.2. No plans or projects are identified as having the potential to result in an adverse in-combination effect with the Sizewell C Project on the screened in sites with marine birds as qualifying features of SPAs and Ramsar sites (**Table 5.4**).

Table 8.5: In-combination assessment of plans and projects with the potential to affect marine bird qualifying features of designated sites

In-combination project	Distance to SZC (km)	Affected designated sites	Potential for in-combination effect with SZC?	Potential for Adverse In-combination Effect?
East Anglia ONE operations and Maintenance Marine Licence applications for Generation and Transmission Assets. Licence to commence on 1st August 2019 and expire by May 2045	11 km from cable corridor. 48 km from windfarm site to nearest seaward point. 52 km from wind farm site to MDS	Alde-Ore Estuary SPA Alde-Ore Estuary Ramsar site	The assessment for the construction, operation and decommissioning of the East Anglia ONE project (including non-material changes to the DCO) concluded no adverse effects in relation to the Alde-Ore Estuary SPA (Ref. 8.5; Ref. 8.6). The potential for effects on marine water quality is greater during construction (and decommissioning) than during operation.	There is no potential for an adverse in-combination effect with the Sizewell C Project to arise.
Suffolk Shoreline Management Plan	Adjacent	Alde-Ore Estuary SPA Alde-Ore Estuary Ramsar site Benacre to Easton Bavents SPA Minsmere-Walberswick SPA	The coastal management approaches outlined within the Environment Agency's preliminary assessment aim to either do nothing, maintain or improve the existing structures, create new embankments along the estuary channel, or maintain existing natural defences (resulting in temporary breaches). These four different approaches would not greatly change the current baseline for the Sizewell C Project (see **Section 7.4**).	None of the proposed management approaches outlined within the preliminary assessment for the Suffolk SMP have the potential to cause an adverse in-combination effect with the Sizewell C Project.

In-combination project	Distance to SZC (km)	Affected designated sites	Potential for in-combination effect with SZC?	Potential for Adverse In-combination Effect?
		Minsmere-Walberswick Ramsar site		
Harwich Haven Approach Channel Deepening	36 km to the MDS	Outer Thames Estuary SPA	There is potential for in-combination effects with the Sizewell C Project on the SPA qualifying features. This is due to sediment plumes produced as a result of dredging, which have the potential to affect the foraging efficiency of the SPA qualifying features. However, because sediment plume modelling for the Harwich Haven Approach Channel Deepening shows that the short-term increase in suspended sediment experienced in the Outer Thames Estuary SPA would be within the range of the natural variation within the system (Ref. 8.7) no in-combination effect is predicted.	There is no potential for an adverse in-combination effect.
Extension of Inner Gabbard East Disposal site	39 km to the MDS	Outer Thames Estuary SPA	The Extension of the Inner Gabbard East Disposal Site is over 10 km from the SPA, and any sediment plumes resulting from the disposal of dredge material would not affect the SPA (Ref. 8.8).	There is no potential for an adverse in-combination effect with the Sizewell C project.
Great Yarmouth Third River Crossing	75 km to the main development site	Outer Thames Estuary SPA	There is potential for an in-combination effect with the Sizewell C Project on the SPA qualifying features. Sediment deposition during construction and / or operation could affect water quality in the immediate environs of the development site within the River Yare, which	There is no potential for an adverse in-combination effect.

In-combination project	Distance to SZC (km)	Affected designated sites	Potential for in-combination effect with SZC?	Potential for Adverse In-combination Effect?
			is part of the SPA. This has the potential to affect the foraging efficiency of the qualifying features. However, any effects on water quality from sediment deposition would be localised (i.e. within the River Yare). Red-throated divers are highly unlikely to occur within the River Yare (using offshore areas of the SPA only), whilst the development site is beyond the likely foraging range of any of the little tern breeding colonies and no common terns were recorded during surveys of the areas adjacent to the development site. Furthermore, specific control measures would be incorporated (for both construction and operation) to reduce the risks of increased sediment loads (Ref. 8.9).	
Lake Lothing Third Crossing	29 km to the main development site	Outer Thames Estuary SPA	There is potential for an in-combination effect with the Sizewell C Project on the SPA non-breeding red-throated diver population as a result of water pollution arising from the construction, operation and / or decommissioning of the Lake Lothing Third Crossing project in the absence of control measures. However, specific standard pollution control measures would be incorporated within the Crossing project via the CoCP and in accordance with good practice. The risk of	There is no potential for an adverse in-combination effect,

In-combination project	Distance to SZC (km)	Affected designated sites	Potential for in-combination effect with SZC?	Potential for Adverse In-combination Effect?
			pollution from this project (which is 1.3 km from the SPA at its closest point) affecting red-throated divers within the SPA is negligible (Ref. 8.10). There is no potential for such in-combination effects in relation to the breeding little tern and breeding common tern qualifying features because the closest colonies are 11 km from the project site and would not be affected by pollution (Ref. 8.10).	

9 INFORMATION FOR APPROPRIATE ASSESSMENT: MARINE MAMMALS

9.1 Introduction

9.1.1. The information required to inform the 'AA' for those marine mammals and European sites screened in for the Sizewell C Operational WDA is presented below.

9.2 Conservation Objectives

a) Humber Estuary SAC

i. Site information

9.2.1. The Humber Estuary SAC is a designated European site for the Annex II species grey seal (*Halichoerus grypus*).

9.2.2. The Humber is the second-largest coastal plain estuary in the UK and the largest coastal plain estuary on the east coast of Britain. Grey seal are present as a qualifying feature but are not a primary reason for the site's selection (Ref. 9.1).

9.2.3. The Humber Estuary SAC is located approximately 184 km from the Sizewell C main development site but was screened into the HRA given the movements of grey seal along the east coast of England.

ii. Conservation Objectives

9.2.4. For the purposes of this assessment, potential effects are considered in relation to the Humber Estuary SAC Conservation Objectives; as outlined in **Table 9.1**. In this case, although there are no direct effects on the Conservation Objectives predicted, changes to water quality may affect the prey availability for foraging seals which may, in turn, affect the seals in light of their conservation objectives.

Table 9.1 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for the Humber Estuary SAC

Conservation Objective	Potential Effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential for effect. There would be no change to the extent and distribution of the habitats of qualifying species in the SAC.

Conservation Objective	Potential Effect
The structure and function (including typical species) of qualifying natural habitats.	No potential for effect. There would be no change to the structure and function (including typical species) of qualifying natural habitats in the SAC.
The structure and function of the habitats of qualifying species.	No potential for effect. There would be no change to the structure and function of the habitats of the qualifying species.
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	No potential for effect. There would be no change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely within the site boundary. However, changes to water quality may affect the prey availability for foraging seals within the vicinity of the Sizewell C main development site and has been considered further.
The populations of qualifying species.	No potential for effect. There would be no change to the populations of qualifying species within the SAC.
The distribution of qualifying species within the site.	No potential for effect. There would be no change to the distribution of qualifying species within the SAC.

b) Southern North Sea SAC

i. Site information

9.2.5. The Southern North Sea SAC is a designated European site for Annex II species harbour porpoise (*Phocoena phocoena*).

9.2.6. In January 2017 the Southern North Sea candidate Special Area of Conservation (cSAC) was submitted to the European Commission for designation as a SAC. It was adopted as a SCI and, in February 2019, formally designated as a SAC by the UK government. Harbour porpoise is the primary and only listed feature of the site.

9.2.7. The majority of the site is less than 40 m in depth, reaching up to 75 m in the northern-most areas. The seabed is mainly sublittoral sand and sublittoral coarse sediment (Ref. 9.2). The site overlaps with a number of other European sites, including the Dogger Bank SAC, Margate and Long Sands SAC, Haisborough, Hammond and Winterton SAC and North Norfolk Sandbanks and Saturn Reef SAC, all of which have important sandbank and gravel beds.

9.2.8. The site has been recognised as an area with persistent high densities of harbour porpoise (Ref. 9.2). The site has an area of 36,951 km^2, covering both winter and summer habitats of importance to harbour porpoise, with approximately 27,018 km^2 of the site being important in the summer and 12,697 km^2 of the site being important in the winter period. The Sizewell C main development site is located within the winter area of the site (see **Figure 9.1**).

9.2.9. The Southern North Sea SAC Site Selection Report (JNCC, 2017a – Ref. 9.2) identifies that the site supports approximately 18,500 individuals (95% CI = 11,864 - 28,889) for at least part of the year. However, JNCC (2017a) (Ref. 9.2) states that because this estimate is from a one-month survey in a single year (the SCANS-II survey in July 2005) it cannot be considered as an estimated population for the site. It is therefore not appropriate to use site population estimates in the AA, and the assessment needs to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals (Ref. 9.2).

ii. Conservation Objectives

9.2.10. The Conservation Objectives for the Southern North Sea SAC (Ref. 9.3) are designed to ensure that the obligations of the Habitats Directive can be met. Article 6(2) of the Directive requires that there should be no deterioration or significant disturbance of the qualifying species or to the habitats upon which they rely.

9.2.11. The Conservation Objectives for the site are (Ref. 9.3):

To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters.

In the context of natural change, this will be achieved by ensuring that:

1. *Harbour porpoise is a viable component of the site;*
2. *There is no significant disturbance of the species; and*
3. *The condition of supporting habitats and processes, and the availability of prey is maintained.*

9.2.12. These Conservation Objectives "*are a set of specified objectives that must be met to ensure that the site contributes in the best possible way to achieving Favourable Conservation Status (FCS) of the designated site feature(s) at the national and biogeographic level (EC, 2012)*" (Ref. 9.3).

Conservation Objective 1: Harbour porpoise is a viable component of the site

9.2.13. This Conservation Objective is designed to minimise the risk of injury and killing or other factors that could restrict the survivability and reproductive potential of harbour porpoise using the site. Specifically, this objective is primarily concerned with operations that would result in unacceptable levels of such impacts on harbour porpoise using the site. Unacceptable levels can be defined as those having an impact on the FCS of the populations of the species in their natural range.

9.2.14. Harbour porpoise are considered to a viable component of the site if they are able to live successfully within it. This site has been selected primarily based on the long term, relatively higher densities of porpoise in contrast to other areas of the North Sea. The implication is that the SAC provides relatively good foraging habitat and may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies there is no exact value for the number of animals expected within the site (Ref. 9.3).

9.2.15. Harbour porpoise are listed as EPS under Annex IV of the Habitats Directive and are, therefore, protected from the deliberate killing (or injury), capture and disturbance throughout their range. Under the Habitats Regulations 2017 in the UK, it is deemed an offence if harbour porpoise are deliberately disturbed in such a way as to:

a) Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or

b) To affect significantly the local distribution or abundance of that species.

9.2.16. The term deliberate is defined as any action that is shown to be any action "*by a person who knows, in the light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that their action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of their action*" (Ref. 9.4).

9.2.17. In addition, Article 12 (4) of the Habitats Directive is concerned with incidental capture and killing. It states that Member States "*shall establish a system to monitor the incidental capture and killing of the species listed on Annex IV (all cetaceans). In light of the information gathered, Member States shall take further research or conservation measures as required to* *ensure that incidental capture and killing does not have a significant negative impact on the species concerned"*.

Conservation Objective 2: There is no significant disturbance of the species

9.2.18. The disturbance of harbour porpoise typically, but not exclusively, originates from operations that cause underwater noise, including activities such as seismic surveys, pile driving and sonar. Responses to noise can be physiological and/or behavioural. JNCC has produced guidelines to minimise the risk of physical injury to cetaceans from various sources of loud, underwater noise. However, disturbance is primarily a behavioural response to noise and may, for example, lead to harbour porpoises being displaced from the affected area.

9.2.19. As outlined above, JNCC and Natural England (2019) (Ref. 9.3) note that harbour porpoises in UK waters are considered part of a wider European population and that due the mobile nature of this species the concept of a 'site population' may not be appropriate for this species. JNCC (2017a) (Ref. 9.2) therefore advise that assessments of effects of plans or projects (i.e. HRA) need to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals.

9.2.20. Disturbance of harbour porpoise may lead to displacement from an area, and the temporary loss of habitat. As such, JNCC and Natural England (2019) (Ref. 9.3) suggest that activities within the Southern North Sea SAC should be managed to ensure that the animals' potential usage of the site is maintained and any disturbance should not lead to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time. Disturbance is considered significant if it leads to the exclusion of harbour porpoise from a significant portion of the site.

9.2.21. The draft SNCB advice / guidance for the assessment of significant noise disturbance on harbour porpoise in the Southern North Sea SAC is that:

Noise disturbance within an SAC from a plan/project individually or in-combination is significant if it excludes harbour porpoise from more than:

1. 20% of the seasonal component of the Southern North Sea SAC in any given day, and

2. An average of 10% of the relevant area of the site over a season.

9.2.22. For this assessment these 20% and 10% thresholds have been used to assess the effect of the thermal/chemical plume on the displacement of harbour porpoise from a certain areas/habitat.

Conservation Objective 3: The condition of supporting habitats and processes, and the availability of their prey is maintained

9.2.23. Supporting habitats, in this context, means the characteristics of the seabed and water column. Supporting processes encompasses the movements and physical properties of the habitat. The maintenance of these supporting habitats and processes contributes to ensuring that prey stays within the site and is available to harbour porpoise using the site. Harbour porpoise are strongly reliant on the availability of prey species year-round due to their high energy demands, and their distribution and condition may strongly reflect the availability and energy density of prey.

9.2.24. This Conservation Objective is designed to ensure that harbour porpoise are able to access food resources year round, and that activities occurring in the Southern North Sea SAC will not affect this.

iii. Management measures

9.2.25. Specific management measures are yet to be developed for the Southern North Sea SAC, however JNCC and Natural England (2019) (Ref. 9.3) advise that "*the maintenance of supporting habitats and processes contributes to ensuring that prey is maintained within the site and is available to harbour porpoises using the site"*.

9.2.26. JNCC and Natural England (2019) (Ref. 9.3) also state that "*management measures (e.g. the scale and type of mitigation) are the responsibility of the relevant regulatory or management bodies. These bodies will consider SNCB advice and hold discussions with the sector concerned, where appropriate*".

iv. Advice on activities

9.2.27. JNCC and Natural England (2019) (Ref. 9.3) have provided advice on activities that specifically occur within or near to the Southern North Sea SAC site that could be expected to impact on the site's integrity. The key impacts and activities that JNCC and Natural England (2019) (Ref. 9.3) consider to have the greatest impact on the population of UK harbour porpoise and therefore the Southern North Sea SAC are:

- removal of non-target species by commercial fisheries with by-catch of harbour porpoise (predominantly static nets);
- increased contaminants from discharge / run-off from land fill, terrestrial and offshore industries;

- increased anthropogenic underwater noise from shipping, drilling, dredging and disposal, aggregate extraction, pile driving, acoustic surveys, underwater explosion, military activity, acoustic deterrent devices and recreational boating activity;
- death or injury by collision from shipping, recreational boating and tidal energy installations; and
- reduction in prey resources by commercial fisheries.

9.2.28. The aim is that the advice should help identify the extent to which existing activities are, or can be made, consistent with the Conservation Objectives, and thereby focus the attention of Relevant and Competent Authorities and monitoring programmes to areas that may need management measures (Ref. 9.3). For this project, the activity of relevance is "*increased contaminants from discharge / run-off from land fill, terrestrial and offshore industries*".

v. Potential effects on the Conservation Objectives

9.2.29. The latest SNCB advice has been used for this assessment and potential effects are considered in relation to the Southern North Sea SAC Conservation Objectives; as outlined in **Table 9.2**.

Table 9.2 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for the Southern North Sea SAC

Conservation Objective	Potential Effect
Harbour porpoise is a viable component of the site.	No potential for effect. Harbour porpoise would remain a viable component of the SAC.
There is no significant disturbance of the species.	No potential for effect. There would be no significant disturbance to harbour porpoise in the SAC. However, there is the potential for the displacement of harbour porpoise directly and indirectly (through change in prey availability) due to the thermal and chemical plume.
The condition of supporting habitats and processes, and the availability of prey is maintained.	Changes in water quality in the marine environment has the potential to affect the site and has been considered further. Changes in prey availability have the potential to affect the site and have been considered further.

c) The Wash and North Norfolk Coast SAC

i. Site information

9.2.30. Harbour seal are a primary reason for the selection of this site (Ref. 9.5).

9.2.31. The Wash, on the east coast of England, is the largest embayment in the UK. The extensive intertidal flats here and on the North Norfolk Coast provide ideal conditions for harbour seal breeding and hauling-out.

9.2.32. The Wash and North Norfolk SAC is located approximately 107km from the Sizewell C main development site and is screened in due to the need to take into account the movements of harbour seal along the east coast of England. No potential exists for any direct effects on the SAC itself due to the Sizewell C main development site.

ii. Conservation Objectives

9.2.33. For the purposes of this assessment, the potential effects are considered in relation to The Wash and North Norfolk Coast SAC Conservation Objectives, as outlined in **Table 9.3**.

Table 9.3 Potential effects arising from the Sizewell C main development site in relation to the Conservation Objectives for The Wash and North Norfolk Coast SAC

Conservation Objective	Potential Effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential for effect. There would be no change in the extent and distribution of the habitats of qualifying species in the SAC.
The structure and function (including typical species) of qualifying natural habitats.	No potential for effect. There would be no change to the structure and function (including typical species) of qualifying natural habitats in the SAC.
The structure and function of the habitats of qualifying species.	No potential for effect. There would be no change to the structure and function) of the habitats of the qualifying species.
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	No potential for effect. There would be no change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely within the site boundary. However, changes to water quality may affect the prey availability for foraging seals within the vicinity of the Sizewell C main development site and has been considered further.
The populations of qualifying species.	No potential for effect. There would be no change to the populations of qualifying species within the SAC.
The distribution of qualifying species within the site.	No potential for effect. There would be no change to the distribution of qualifying species within the SAC.

9.3 Summary of the outcomes of Screening

9.3.1. The Stage 1 Screening assessment concluded that the potential for LSE to arise exists (or cannot be ruled out) with respect to the screening categories and qualifying features (✓ = LSE, x = no LSE) as shown in **Table 9.4**, for screened in marine mammal species (including those effects for prey species).

Table 9.4 Summary of effects with potential for LSE for marine mammals (alone) (✓ = LSE, x = no LSE)

Effects	Harbour porpoise	Grey seal	Harbour seal
Water quality effects – marine environment (alone)	✓	✓	✓
Water quality effects – marine environment (in combination effects)	✓	✓	✓

9.4 Assessment of potential effects (alone)

9.4.1. This section describes the potential effects on marine mammals from the Sizewell C main development site due to:

- Thermal Discharge - changes in marine water quality due to the discharge of a thermal plume (see **Section 5.3 a i**):
  - As stated in **Section 5.3 c**, a review of the evidence of thermal plumes on fish species has been completed in order to determine the potential for effects on marine mammals. Temperature rises of up to 3°C and maximum temperatures of up to 27°C have been determined to be acceptable to fish species and would have no lethal effect.
- Chemical Discharge - changes in marine water quality from TRO, bromoform, and hydrazine (see **Section 5.3 a ii**).

b) Humber Estuary SAC

i. Thermal discharge

Grey seal

9.4.2. Marine mammals have the ability to regulate their body temperature during periods of high activity or when the ambient temperature is warm (Ref. 9.6).

They do this by controlling the blood flow through their flukes, pectoral and dorsal fins to move blood from their body; this allows the blood to cool as it flows through their fins (Ref. 9.7).

9.4.3. While the change in temperature associated with the Sizewell C thermal plume would be noticeable to marine mammal species, these species are well adapted and accustomed to the change in water temperature as they dive. Due to the evolved ability of marine mammals to naturally regulate their body temperature, it is concluded that the change in ambient temperature due to the thermal plume would have no direct impact on marine mammal species and no effect on foraging grey seal in the area.

9.4.4. However, on a very precautionary basis, the number of foraging grey seal that could be present in the maximum predicted surface area for a 2^{o}C MAC rise in temperature (of 224.6 km^2) has been estimated as 8.5 individuals, which represents up to 0.10% of the reference population (or 0.13% of the Humber Estuary SAC site population). Therefore, no direct adverse effects on the integrity of the Humber Estuary SAC are predicted due to the Sizewell C thermal discharge in relation to the Conservation Objectives for grey seal.

Grey seal prey

9.4.5. Key prey species for grey seal that have been studied with regard to their thermal tolerances include sandeel, cod, saithe, haddock, whiting, plaice and dover sole (see **Section 5.3c** for information on the tolerances prey species).

9.4.6. Due to the various unknowns in the thermal tolerance of some fish species, it is assumed that most would avoid the highest temperature around the immediate area of the cooling water outfall. Therefore, as a worst-case, it could be assumed that all grey seal prey species would also be displaced from the area within the 2°C MAC contour. It should be noted, however, that no fatalities of prey species are expected due to the temperature uplift predicted, and that prey would be available to individuals outside of the 2°C MAC contour.

9.4.7. As a precautionary approach, the number of foraging grey seal that could be present (as percentage of the reference population) in the area of the thermal plume from which prey species could be displaced has been estimated. As the maximum predicted impact area for any changes in water temperature would be the same for foraging grey seal and their prey, there would be no additional effects on grey seal as a result of the effects of any changes in water temperature on prey species. Therefore, no indirect adverse effects on the integrity of the Humber Estuary SAC are predicted due to the Sizewell C thermal discharge in relation to the Conservation Objective for grey seal prey.

ii. Chemical discharges

Grey seal

9.4.8. There is very little information currently available on any potential effects of TRO on marine mammals. However, Ref. 9.8 concluded that the bioaccumulation potential is very low; biomagnification and persistence in the food web is not considered to be a potential risk based on the results from aquatic toxicity testing, low PEC values, mammalian toxicity evaluation and bioaccumulation and biodegradation data.

9.4.9. There is evidence that hydrazine is harmful to aquatic organisms at low concentrations (Ref. 9.9; Ref. 9.10) and, although its persistence is low to moderate, this is dependent upon various water quality parameters (Ref. 9.9). The area of exceedance of the PNEC standards is 1.6 km^2.

9.4.10. The maximum area of effect for bromoform is predicted to be 3.58 km^2 at the sea surface for the combined plume from Sizewell B and C.

9.4.11. The maximum area of effect for changes to water quality due to chemical discharges during operation is 7.3km^2 for the TRO plume for both Sizewell B and Sizewell C at the surface. Therefore, as a worst-case, the number of foraging grey seal that could be affected by changes in water quality due to the TRO discharge is up to 0.3 individuals; which represents 0.003% of the reference population (or 0.005% of the Humber Estuary SAC site population).

9.4.12. The chemical plume is not expected to have any significant effect on foraging grey seals, and this alongside the very small percentage of the reference population that could be exposed to the area of predicted effect in marine water quality, indicates there is no potential for an effect on foraging grey seals to arise over the operational lifetime of the Project. Given this, no direct adverse effects on the integrity of the Humber Estuary SAC are predicted due to the Sizewell C Chemical Discharge in relation to the conservation objectives for grey seal.

Grey seal prey

9.4.13. The potential effect of the changes to water quality on prey species for foraging grey seal would not extend beyond the maximum predicted effect area described for grey seals themselves. Consequently, the approach taken to assessing the effect on the foraging grey seals is worst-case, and there would be no additional impact as a result of the effects on prey species.

9.4.14. Consequently, no indirect adverse effects on the integrity of the Humber Estuary SAC are predicted due to the Sizewell C Chemical Discharge in relation to the conservation objective for grey seal prey.

c) Southern North Sea SAC

i. Thermal discharge

Harbour porpoise

9.4.15. As discussed in **Section 9.4 a i**, marine mammals have the ability to regulate their body temperature and are, therefore, well adapted to changing water temperatures. It can be concluded that, due to this, the change in ambient temperatures due to operational thermal discharge would have no effect on harbour porpoise in the area.

9.4.16. On a very precautionary basis, the number of harbour porpoise that could be present within the maximum area of effect (of 224.6 km^2 for the 2°C MAC area at the sea surface) has been estimated to be 136.3 individuals, or 0.04% of the NS MU reference population. The maximum area of effect equates to 1.8% of the Southern North Sea SAC winter area. Similarly, as a worst case, it is assumed that changes to water quality could occur throughout the duration of the winter season (a total of 182 days), which would result in a seasonal average of 1.8% of the Southern North Sea SAC. Displacement of harbour porpoise, therefore, would not exceed either the 20% threshold of effect at any one time, nor the 10% seasonal component of the site on average over the season.

9.4.17. Based on this precautionary assessment, it is concluded that any potential effects due to changes in water quality from the Sizewell C thermal discharge would not result in a direct adverse effect on the integrity of the Southern North Sea SAC in relation to its Conservation Objectives for harbour porpoise.

Harbour porpoise prey

9.4.18. The thermal tolerance of the key prey species for harbour porpoise has been reviewed, including sprat, herring, whiting and dover sole; see **Section 5.3 c**.

9.4.19. As a worst-case it could be assumed that all harbour porpoise prey species would be displaced from the area within the 2°C contour; but no fatalities of prey species are expected and prey would be available to marine mammals outside of the 2°C contour.

9.4.20. As a precautionary approach, the number of harbour porpoise that could be present (as percentage of the reference population) in the area of the thermal plume from which prey species could be displaced has been estimated. However, as the maximum predicted impact area for any changes in water temperature would be the same for marine mammal and their prey, there would be no additional effects on harbour porpoise as a result of the effects of any changes in water temperature on prey species. Consequently, it is concluded that any potential effects due to changes in water quality from the Sizewell C thermal discharge would not result in an indirect adverse effect on the integrity of the Southern North Sea SAC in relation to its Conservation Objective for harbour porpoise prey.

ii. Chemical discharges

Harbour porpoise

9.4.21. Skin infections have been observed in captive mammals due to the chlorination destroying beneficial microflora and inactivation of antimicrobial substances secreted by the skin (Ref. 9.11). However, there is no indication that chemical discharge from Sizewell B power station (of TROs, bromoform, ammonia) has had any effect on harbour porpoises in the area (Ref. 9.12).

9.4.22. Limited evidence is available on the effects of chlorinated discharges, TROs and bromoform on any marine mammal in the wild. While there is evidence of chlorine affecting captive marine mammals (as noted above) the concentrations regularly exceed 2.5mg/l (Ref. 9.13)), and individuals are exposed to this level continually. The levels associated with these pools are orders of magnitude above those expected from the operation of the SZC project, and therefore any effects shown by captive individuals are highly unlikely to be representative to any effects from the SZC project. In addition, chlorine by-products rapidly degrade in the marine environment, and the low bioconcentration factor indicate that indirect effects due to bioaccumulation would be limited (Ref. 9.14).

9.4.23. As a precautionary worst-case scenario, the number of harbour porpoise that could be present within the maximum area of effect (of 7.3 km^2 for TRO effect area) has been estimated to be 4.4 individuals, or 0.001% of the NS MU reference population. The maximum area of effect equates to 0.06% of the Southern North Sea SAC winter area. As a worst-case it is assumed that changes to water quality could occur throughout the duration of the winter season (a total of 182 days), resulting in a seasonal average of

0.06%. Displacement of harbour porpoise, therefore, would not exceed either the 20% threshold of effect at any one time, or the 10% seasonal component of the site on average over the season.

9.4.24. Therefore, based on this precautionary assessment, it is concluded that any potential effects due to changes in water quality from Sizewell C's operational chemical discharges would not result in a direct adverse effect on the integrity of the Southern North Sea SAC in relation to its Conservation Objectives for harbour porpoise.

Harbour porpoise prey

9.4.25. The potential effect of the changes to water quality on prey species for harbour porpoise would not extend beyond the maximum predicted effect areas described for harbour porpoise. Consequently, any potential effects due to changes in water quality from Sizewell C's operational chemical discharges would not result in an indirect adverse effect on the integrity of the Southern North Sea SAC in relation to its Conservation Objective for harbour porpoise prey.

d) The Wash and North Norfolk Coast SAC

i. Thermal discharge

Harbour seal

9.4.26. As discussed in **Section 9.4 a i**, marine mammals are well adapted to changing water temperatures. Due to this it can be concluded that the change in ambient temperatures due to the thermal discharge through operation would have no effect on foraging harbour seal in the area.

9.4.27. However, on a very precautionary basis, the number of foraging harbour seal that could be present in the maximum predicted surface area for a 2^{o}C MAC rise in temperature (of 224.6km^2) has been estimated as 8.8 individuals, which represents up to 0.18% of the reference population (or 0.24% of The Wash and North Norfolk Coast SAC site population). Therefore, no direct adverse effect on the integrity of The Wash and North Norfolk Coast SAC is predicted for the Sizewell C thermal discharge in relation to the Conservation Objectives for harbour seal.

Harbour seal prey

9.4.28. Key prey species for harbour seal that have been studied for their thermal tolerances include sandeel, sprat, herring, whiting, cod and haddock (see **Section 5.3 c**).

9.4.29. As a worst-case, it could be assumed that all harbour seal prey species would be displaced from the area within the 2°C MAC contour; but that no fatalities of prey species are expected and that prey would be available to individuals outside of the 2°C MAC contour.

9.4.30. As a precautionary approach, the number of foraging harbour seal that could be present (as percentage of the reference population) in the area of the thermal plume from which prey species could be displaced has been estimated. As the maximum predicted impact area for any changes in water temperature would be the same for foraging harbour seal and their prey, there would be no additional effects on individuals as a result of the effects of any changes in water temperature on prey species.

9.4.31. Consequently, no indirect adverse effect on the integrity of The Wash and North Norfolk Coast SAC is predicted for the Sizewell C thermal discharge in relation to the Conservation Objective for harbour seal prey.

ii. Chemical discharges

Harbour seal

9.4.32. The maximum area of effect predicted for changes to water quality due to chemical discharges during operation is 7.3 km^2 for the TRO plume for both Sizewell B and Sizewell C at the surface. Therefore, as a worst-case, the number of foraging harbour seal that could be affected by changes in water quality due to the TRO discharge is up to 0.3 individuals, which represents 0.006% of the reference population (or 0.008% of The Wash and North Norfolk Coast SAC site population).

9.4.33. The TRO plume is not expected to have any significant effect on foraging harbour seals and this, alongside the very small percentage of the reference population that could be exposed to the area of predicted effect in marine water quality, means that there is no potential for an effect on foraging harbour seals to arise over the operational lifetime of Sizewell C. Therefore, no direct adverse effect on the integrity of The Wash and North Norfolk Coast SAC is predicted in relation to the Conservation Objectives for harbour seal.

Harbour seal prey

9.4.34. The potential effect of the changes to water quality on prey species for foraging harbour seal would not extend beyond the maximum predicted effect areas as described for harbour seals themselves. Consequently, the approach taken to assessing the effect on the foraging harbour seal seals is worst-case, and there would be no additional impact as a result of the effects on prey species.

9.4.35. Therefore, similarly, no indirect adverse effect on the integrity of The Wash and North Norfolk Coast SAC is predicted in relation to the Conservation Objective for harbour seal prey.

9.5 Assessment of potential effects (in-combination)

9.5.1. **Table 9.5** describes the potential for water quality effects from screened in plans and projects in relation to grey seal, harbour porpoise and harbour seal.

9.5.2. As shown in **Table 9.5**, none of the projects screened in to the in-combination assessment has the potential to have any in-combination effects on foraging grey seal, harbour porpoise and harbour seal, or their prey species, from the Humber Estuary SAC, the Southern North Sea SAC or The Wash and North Norfolk Coast SAC, based on currently available information. Therefore, there is no potential for an adverse effect on the integrity of any SAC to arise in relation to its Conservation Objectives for grey seal, harbour porpoise or harbour seal as a result of in-combination effects.

Table 9.5 In-combination assessment of screened in plans and projects with the potential to affect designated marine mammal species through changes to water quality

In-combination project	Distance to SZC (km)	Assessment of effects on marine mammal species	In-combination effect with SZC	Potential for adverse effect in-combination?
East Anglia ONE Offshore Wind Farm	11 km cable corridor; 54 km windfarm site	The East Anglia ONE project is currently under construction and is anticipated to be completed by the end of 2020. Therefore, the only anticipated in-combination effects would be from the operation and decommissioning phases of the project. No water quality effects were assessed as no potential impacts were identified for any marine mammal species during operation and decommissioning (Ref. 9.15).	No potential for in-combination effect.	No
East Anglia ONE North Offshore Wind Farm	11 km cable corridor; 48 km windfarm site	Through the construction, operation and decommissioning phases of the project, there would be no potential for adverse effects from water quality due to the implementation of the Project Environmental Management Plan. However, as a worst-case scenario, the potential for water quality to deter harbour porpoise from the Southern North Sea SAC has been assessed and this assessment concluded that an area of 341km^2 could be affected by changes to water quality (based on the draft HRA; Ref. 9.16)[14].	The operational phase of the Sizewell C Project would have water quality effects over a maximum area of 7.3 km^2 (or 0.06% of the Southern North Sea SAC winter area). In-combination with the East Anglia ONE North project, this equates to a total area of 348.3 km^2 (or 2.7% of the SAC winter area). Any changes to water quality would be localised, temporary and for a short duration, with normal conditions returning rapidly following the cessation of activity. Therefore, it	No

[14] Available at the time of writing from the East Anglia ONE North Offshore Wind Farm website: https://www.scottishpowerrenewables.com/userfiles/file/EA1N_Habitat_Regulations_Assessment_000.pdf

In-combination project	Distance to SZC (km)	Assessment of effects on marine mammal species	In-combination effect with SZC	Potential for adverse effect in-combination?
			is unlikely that there would be any potential effect in-combination with Sizewell C.	
East Anglia THREE Offshore Wind Farm	11 km cable corridor; 78 km windfarm site	No water quality effects were identified for marine mammals and all effects to prey species were assessed as being of negligible or minor adverse significance (Ref. 9.17).	Given the distance to the project from the main development site and the very low significance of effect predicted, it is considered that there is no potential for an in-combination effect to arise.	No
East Anglia TWO Offshore Wind Farm	11 km cable corridor; 31 km windfarm site	Through the construction, operation and decommissioning phases of the project, there would be no potential for adverse effects on water quality, due to the implementation of the Project Environmental Management Plan. However, as a worst-case scenario, the potential for water quality to deter harbour porpoise from the Southern North Sea SAC has been assessed and the assessment concluded that an area of 436 km^2 could be affected by changes to water quality (based on the draft HRA; Ref. 6.79)[15].	The operational phase of the Sizewell C Project would lead to water quality effects over a maximum area of 7.3 km^2 (or 0.06% of the Southern North Sea SAC winter area). In-combination with the East Anglia TWO project, this equates to a total area of 443.3 km^2 (or 3.5% of the SAC winter area). Any changes to water quality would be localised, temporary and for a short duration, with normal conditions returning rapidly following the cessation of activity. Therefore, it is unlikely that there would be any potential effect in-combination with Sizewell C.	No

[15] Available at the time of writing on the East Anglia TWO Offshore Wind Farm website: https://www.scottishpowerrenewables.com/userfiles/file/EA2_Habitat_Regulations_Assessment_00.pdf

In-combination project	Distance to SZC (km)	Assessment of effects on marine mammal species	In-combination effect with SZC	Potential for adverse effect in-combination?
Greater Gabbard Extension Offshore Wind Farm	0km cable corridor; 27 km windfarm site	No information currently available.	In-combination assessment not possible.	No
Great Yarmouth Flood Defence Scheme	44 km	Screened out of assessment as no potential water quality effects identified (Ref. 9.18).	No potential for in-combination effect.	No
London Array Offshore Wind Farm	57 km offshore windfarm	Screened out of assessment as no potential water quality effects identified (Ref. 9.19).	No potential for in-combination effect.	No
Lowestoft Flood Risk Management Project	30 km	The scheme application has not yet been submitted. However, a Preliminary Environmental Impact Report is available. All potential effects to marine mammals were scoped out of further assessment (Ref. 9.20).	No potential for in-combination effect.	No
Norfolk Boreas Offshore Wind Farm	59 km cable corridor; 103 km windfarm site	Screened out of assessment as no potential water quality effects identified (Ref. 9.21)	No potential for in-combination effect.	No
Norfolk Vanguard Offshore Wind Farm	59 km from cable corridor. 83 km from windfarm site	During construction and decommissioning, the risk of accidental release of will be mitigated through contingency planning for the control of pollution. Modelling indicates that the majority of the sediment released during seabed preparation would be coarse and would fall within minutes/tens of minutes to the seabed as a highly turbid dynamic plume upon its discharge. Taking into account the low sensitivity of marine mammals to changes in water quality and the low magnitude temporary	Given the distance to the SZC main development site, and the small areas of effect for both projects, there is no potential for an in-combination effect to arise.	No

In-combination project	Distance to SZC (km)	Assessment of effects on marine mammal species	In-combination effect with SZC	Potential for adverse effect in-combination?
		impact, the impact significance for any changes to water quality is negligible (Ref. 9.22).		
Proposed new aggregate sites	51 km (New 495) 60 km (Outer OTE) 61 km (Thames D)	No assessment of effects has been completed to date, however, the Scoping Report for the Thames D area suggests that there may be the potential for water quality effects on marine mammals within the Southern North Sea SAC, and this will be assessed further (Ref. 9.23).	In-combination assessment not possible.	No
Thanet Extension Offshore Wind Farm	82 km	Through the construction, operation and decommissioning phases of the project, it has been determined that there is no potential for adverse effects due to the implementation of the Project Environmental Management Plan to control any accidental pollution releases (Ref. 9.24). All other water quality effects have been screened out of assessment.	No potential for in-combination effect.	No

9.6 Conclusions

a) Humber Estuary SAC

9.6.1. There is no potential for any adverse effects on the integrity of the Humber Estuary SAC to arise due to Sizewell C operational discharges, either alone or in-combination with other plans or projects, in relation to the Conservation Objectives for grey seal (**Table 9.6**).

Table 9.6 Summary of the assessment of potential effects on the Humber Estuary SAC in relation to grey seal

Conservation Objective	Thermal Discharge	Chemical Discharge	In-combination
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	x	x	x

b) Southern North Sea SAC

9.6.2. There is no potential for any adverse effects on the integrity of the Southern North Sea SAC to arise due to Sizewell C operational discharges, either alone or in-combination with other plans or projects, in relation to the Conservation Objectives for harbour porpoise (**Table 9.7**).

Table 9.7 Summary of the assessment of the potential effects on the Southern North Sea SAC in relation to harbour porpoise

Conservation Objective	Thermal Discharge	Chemical Discharge	In-combination
The condition of supporting habitats and processes, and the availability of prey is maintained	x	x	x

c) The Wash and North Norfolk Coast SAC

9.6.3. There is no potential for any adverse effects on the integrity of The Wash and North Norfolk Coast SAC to arise due to Sizewell C operational discharges either alone or in-combination with other plans or projects, in relation to the Conservation Objectives for harbour seal (**Table 9.8**).

Table 9.8 Summary of the assessment of the potential effects on The Wash and North Norfolk Coast SAC in relation to harbour seal

Conservation Objective	Thermal Discharge	Chemical Discharge	In-combination
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	x	x	x

10 CONCLUSION

10.1 Background

10.1.1. SZC Co. is required to provide information to allow HRA to be undertaken by the competent authority in support of its application for an operational WDA permit under the Environmental Permitting (England and Wales) Regulations 2016. HRA is a requirement under the 'Habitats Regulations' where a project could affect sites and species designated for their nature conversation importance.

10.1.2. This 'Shadow HRA' has been produced to facilitate consultation with the Environment Agency, the 'competent authority' under the Habitats Regulations for the WDA permit.

10.1.3. Relevant effect pathways are from changes to marine water quality as a result of the discharge of the following:

- thermal plume;
- chemical plumes;
- sewage discharge; and
- effluent from the FRR (discharge of moribund biota).

10.2 LSE screening

10.2.1. For the operational WDA of the Sizewell C Project, the Stage 1 Screening assessment concluded that LSEs could not be discounted for a number of European designated sites. The LSE exercise identified a total of 13 sites for which LSE could not be excluded for the thermal plume alone or the thermal and chemical plumes, which were carried forward into the appropriate assessment stage of the Shadow HRA process. Eleven sites are within the ZOI of the Sizewell C cooling water discharge and FRR discharge plumes and two more distant sites are relevant for migratory species (marine mammals). Potential effects from the sewage discharge were not considered in the AA.

10.2.2. **Section 5.4** summarises the qualifying features 'screened in' (i.e. for which a cause and effect pathway was determined to exist) for each European site taken forward to the AA stage.

10.2.3. The in-combination screening exercise identified a total of 13 other plans and projects that could have LSIE with the operational WDA of the Sizewell C Project (**Table B.1** in **Appendix B**).

10.3 Stage 2 Appropriate Assessment: Coastal habitats

10.3.1. **Table 5.3 in Section 5.3 b** lists the SACs and Ramsar sites, and their qualifying features, for which LSE could not be discounted and, therefore, considered in the AA for coastal habitats:

- Alde, Ore and Butley Estuaries SAC;
- Alde-Ore Estuary Ramsar site;
- Minsmere-Walberswick Heaths and Marshes Ramsar site; and
- Orfordness-Shingle Street SAC.

10.3.2. The sites screened in to the LSE were assessed for effects resulting from the discharge of the thermal plume and discharge of dead fish and moribund biota from the FRR (noting that not all these pathways are screened in for every European site listed above).

10.3.3. The AA is able to conclude that adverse effects on site integrity can be excluded for the European sites screened in to the assessment for coastal habitats, both alone and in-combination with other plans and projects.

10.4 Stage 2 Appropriate Assessment: Birds

10.4.1. **Table 5.4 in Section 5.3 c** lists the SPAs and Ramsar site, and their qualifying features, considered in the appropriate assessment for birds. Effects were predicted on the prey species of those birds features screened in due to the discharge of the thermal and chemical plumes (i.e. indirect effects only) on:

- Alde-Ore Estuary SPA;
- Alde-Ore Estuary Ramsar site;
- Benacre to Easton Bavents SPA;
- Minsmere-Walberswick SPA;
- Minsmere-Walberswick Ramsar site; and

- Outer Thames Estuary SPA.

10.4.2. The assessment of potential effects on prey species for birds in the marine environment was undertaken on the basis of the exclusion of foraging within the ZOI of the chemical and thermal discharges; this represents a highly precautionary approach. Such effects cover the largest zone of influence in the marine environment during the operational phase and, therefore, consideration of any combined effect with other effect pathways does not change the outcome of the alone assessment.

10.4.3. For the screened-in SPA and Ramsar qualifying features it is concluded that water discharge activities would not have an adverse effect on the integrity of the European sites, either alone or in-combination with other plans and projects.

10.5 Stage 2 Appropriate Assessment: Marine mammals

10.5.1. **Table 5.4** in **Section 5.3 c** lists the SACs with marine mammal qualifying features considered in the AA. Effects were predicted due to the discharge of the thermal and chemical plumes on grey seal, harbour porpoise and harbour seal, and their prey species on the following European sites:

- Humber Estuary SAC;
- Southern North Sea SAC; and
- Wash and North Norfolk Coast SAC.

10.5.2. The assessment of potential effects on marine mammal populations was based on a prediction of the number of individuals present within the ZOI of the Sizewell C Project in the context of the relevant MU for the population in question. By taking this approach, consideration of the interaction or combination between within-Project effects cannot alter the findings of the alone assessment (i.e. the predicted effect based on the largest zone of influence is the maximum predicted effect of the whole Project).

10.5.3. The assessment of the Humber Estuary SAC (for grey seals), the Southern North Sea SAC (for harbour porpoise) and The Wash and North Norfolk Coast SAC (for harbour seals) (based on the proportion of the MU population potentially affected) concludes that there would be no adverse effect on the integrity of the above SACs. The in-combination assessment also concluded that there would be no adverse effect on integrity when the Sizewell C Project is assessed in-combination with other plans and projects.

10.6 Mitigation

10.6.1. In reaching conclusions regarding the effects of the Sizewell C Project on the integrity of European sites, proposed mitigation has been taken into account.

10.6.2. **Table 10.1** summarises the mitigation that has been considered in this Shadow HRA, including embedded mitigation (i.e. measures that are incorporated into the design of the Project in order to minimise or avoid a negative effect).

Table 10.1: Schedule of mitigation measures, timing and securing permissions relevant to the HRA

Effect	Mitigation / commitment	Project phase in which the mitigation would apply	How the action is to be implemented / secured
To minimise the impact on the marine environment.	A single 8 m internal diameter outfall tunnel serving both UK EPR™ reactor units would return the cooling water to the sea from the outfall pond, with a pair of vertical shafts at its seaward end, each leading upwards to a single outfall headworks, again mounted on the seabed.	Operation	Scheme Design
To minimise the impact on the marine environment.	The cooling water outfall tunnel would terminate in two concrete headworks. The optimal location of the outfall heads was investigated using hydrodynamic modelling in compliance with Environment Agency guidelines to reduce environmental impacts of the thermal plume and minimise recirculation of heated water at the Sizewell B intakes.	Operation	Scheme Design
To minimise effects on benthic habitats	The outfalls of the cooling water infrastructure would be located east of the Sizewell-Dunwich Bank approximately 3 km offshore. The water depth at the outfalls would mean that the thermal plume would have minimal impact at the seabed thereby minimising effects on benthic habitats. The selection of an offshore location reduces the area of thermal impact exceedance inshore of the Sizewell-Dunwich Bank.	Operation	Scheme Design
To minimise chlorine effects on marine life.	Seasonal 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). However, spot-chlorination may be required to protect critical plant outside these periods. 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. A conservative	Operation	EA Permit

Effect	Mitigation / commitment	Project phase in which the mitigation would apply	How the action is to be implemented / secured
	scenario for water quality modelling considers the impacts of 0.15 mg/l TRO released at the outfalls in 132 m^3/s.		
To minimise chlorine effects on marine life.	The chlorination strategy involves seasonal chlorination, this is currently based on the period of the year when water temperatures exceed 10ºC. By 2030, predicted water temperatures at the Sizewell C intakes would exceed 10ºC from the beginning of May until the start of December.	Operation	EA Permit
To reduce hydrazine in concentrations in the discharge to sea.	Hydrazine is used in power plants to inhibit corrosion in steam generation circuits. Daily hydrazine discharges within the cooling water flow is modelled based on the two potential discharge scenarios dependent on whether the hydrazine load is distributed and discharged from one or two wastewater tanks; a) 69 ng/l for 2.3h a day, and b) 34 ng/l for 4.6h a day. The worst-case daily hydrazine discharge 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.	Operation	EA Permit
No chlorination of FRR system.	The FRR wash water would not be chlorinated. Therefore, impinged biota would not be subjected to chlorination.	Operation	Scheme Design

REFERENCES

Ref.	Source
2.1	BEEMS Technical Report TR316. Evaluation of chlorination dosing options for Sizewell C (balancing biofouling efficacy and non-target species effects). Cefas, Lowestoft.
2.2	BEEMS Technical Report TR306. Sizewell Marine Water and Sediment Quality Synthesis Report MSR2/2. Edition 2. Cefas, Lowestoft.
3.1	Ministry of Housing, Communities & Local Government (MHCLG). National Planning Policy Framework, revised version, February 2019.
3.2	Planning Inspectorate (PINS). Advice Note Ten: Habitat Regulations Assessment relevant to Nationally Significant Infrastructure Projects. November 2017, Version 8.
3.3	Court of Justice of the European Union. Sweetman v Coillte Teoranta. Judgement of the Court (Seventh Chamber) 12 April 2018. Environment — Directive 92/43/EEC — Conservation of natural habitats — Special areas of conservation — Article 6(3) — Screening in order to determine whether or not it is necessary to carry out an assessment of the implications, for a special area of conservation, of a plan or project — Measures that may be taken into account for that purpose. Case C-323/17.
3.4	English Nature. Habitats Regulations Guidance Note 3. The Determination of Likely Significant Effect under The Conservation (Natural Habitats &c) Regulations 1994. November 1999.
3.5	European Court. Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij. Reference for a preliminary ruling: Raad van State - Netherlands. Directive 92/43/EEC -Conservation of natural habitats and of wild flora and fauna - Concept of "plan' or "project' - Assessment of the implications of certain plans or projects for the protected site. Case C-127/02. 2004.
3.6	European Court. Sweetman, P. vs. An Bord Pleanála. Judgement of the Court (Third Chamber) 11 April 2013. Environment – Directive 92/43/EEC – Article 6 – Conservation of natural habitats – Special areas of conservation – Assessment of the implications for a protected site of a plan or project – Criteria to be applied when assessing the likelihood that such a plan or project will adversely affect the integrity of the site concerned – Lough Corrib site – N6 Galway City Outer Bypass road scheme. Case C-258/11. 2013.
3.7	EDF Energy. Sizewell C Proposed Nuclear Development: HRA Evidence Plan. October 2014.
3.8	European Commission. Assessment of plans and projects significantly affecting Natura 2000 sites – Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. 2000.
3.9	European Court. Holohan and Others. Judgment of the Court (Second Chamber) of 7 November 2018. Brian Holohan and Others v An Bord Pleanála. Request for a preliminary ruling from the High Court (Ireland) Reference for a preliminary ruling — Environment — Directive 92/43/EEC — Conservation of natural habitats — Conservation of wild fauna and flora — Road

	construction project — Appropriate assessment of effects on the environment — Extent of the obligation to state reasons — Directive 2011/92/EU — Assessment of the implications of certain projects — Annex IV, Point 3 — Article 5(3)(d) — Meaning of the concept of 'main alternatives' (Case C-461/17)
3.10	Department for Communities and Local Government (DCLG). Environmental Impact Assessment: A guide to good practice and procedures. Consultation paper, 2006.
4.1	Department of Energy and Climate Change (DECC). Habitats Regulations Assessment: Site Report for Sizewell. EN-6: Revised draft National Policy Statement for Nuclear Power Generation, 2010.
4.2	D. J. F. Russell. Movements of grey seal that haul out on the UK coast of the southern North Sea. Report for the Department of Energy and Climate Change (OESEA-14-47). 2016.
4.3	D. J. F. Russell *et al*. Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science, 2017, Vol 8 No 25, 25pp.
4.4	D. J. F. Russell and B. J. McConnell. Seal at-sea distribution, movements and behaviour. Report to DECC. URN: 14D/085. March 2014 (final revision).
4.5	J. Barker *et al*. Thames harbour seal conservation project, 2014. Report for the UK & Europe Conservation Programme, Zoological Society of London.
4.6	C. B. Thaxter et al. Measuring the interaction between marine features of Special Protection Areas with offshore wind farm developments zones through telemetry: second year report (BTO Research Report No. 610). British Trust for Ornithology, Thetford. 2012a.
4.7	E. D. Wakefield et al. Space Partitioning Without Territoriality in Gannets. Science, 2013, 341, p. 68.
4.8	E. D. Wakefield et al. Breeding density, fine-scale tracking, and large-scale modelling reveal the regional distribution of four seabird species. Ecological Applications, 2017, 27, p. 2074–2091.
5.1	Scottish Court. Bagmoor Wind Ltd v The Scottish Ministers, XA101/11 Opinion of The Court delivered by Lord Carloway, the Lord Justice Clerk in an application under the Town and Country Planning (Scotland) Act 1997, section 239, by Bagmoor Wind Limited against The Scottish Ministers. 2012
5.2	CIEEM. Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester. 2016.
5.3	BEEMS Technical Report TR302. Sizewell Thermal Plume Modelling: GETM Stage 3 results with the preferred SZC cooling water configuration. Edition 3. Cefas, Lowestoft.
5.4	BEEMS Scientific Advisory Report SAR008. BEEMS Expert Panel. 2011. Thermal standards for cooling water from new build nuclear power stations. Cefas, Lowestoft.
5.5	BEEMS, 2011. Thermal standards for cooling water from new build nuclear power stations, Scientific Advisory Report Series 2011 no. 008.
5.6	UK Technical Advisory Group (UKTAG). UK Environmental Standards and Conditions. 2008. (Online) Available from:

	http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%202_Final_110309.pdf (Accessed 11 May 2019).
5.7	BEEMS Technical Report TR301. Sizewell Thermal Plume Modelling: GETM Stage 3 results with the preferred SZC cooling water configuration. Edition 3. Cefas, Lowestoft.
5.8	BEEMS Technical Report TR143. Calibration of a Model of Total Residual Oxidant (TRO) Using Laboratory Data on Seawater Samples Collected in the Vicinity of Sizewell Nuclear Power Station. Edition 2. Cefas, Lowestoft.
5.9	Environment Agency. Surface water pollution risk assessment for your environmental permit. 2016. (Online) Available from: https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit (Accessed May 2016).
5.10	T. E. L. Langford. Ecological Effects of Thermal Discharges (Pollution Monitoring Series). Elsevier, Essex, 1990.
6.1	Joint Nature Conservation Committee (JNCC). Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012. Conservation status assessment for: H1130: Estuaries: Joint Nature Conservation Committee (JNCC). 2013a.
6.2	Royal HaskoningDHV. Healthy Estuaries 2020: An Assessment of Estuary Morphological Equilibrium – Alde-Ore, Deben and Hamford Water. Natural England Commissioned Reports, Number 250, 2018.
6.3	Joint Nature Conservation Committee (JNCC). Alde, Ore and Butley Estuaries. 2007. (Online) Available from: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030076 (Accessed 24/04/2019).
6.4	Joint Nature Conservation Committee (JNCC). Alde-Ore Estuary SPA description. 2001. (Online) Available from: http://jncc.defra.gov.uk/page-2010 (Accessed 24/04/2019).
6.5	L. A. Curtis. Littoral mud and sandflat condition monitoring and rMCZ verification survey of the Alde Ore and Butley Estuaries SAC, and Alde Ore Estuary rMCZ: Ecospan Ltd, 2014.
6.6	English Nature. Alde-Ore Estuary European Marine Site. English Nature’s advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994. 2001.
6.7	Seasearch. Seasearch Site Surveys: Alde Ore Estuary recommended MCZ, report published by Marine Conservation Society for Seasearch. 2012.
6.8	T. R Abrehart and R. L Jackson. An NVC of the Alde-Ore Estuary SSSI, Suffolk. An ecological survey including flora and fauna observations undertaken for Natural England by Abrehart Ecology. Abrehart Ecology, 2013.
6.9	BEEMS Technical Report TR348. Sizewell benthic ecology characterisation. Cefas, Lowestoft.
6.10	V. J. May and J. D. Hansom. Coastal Geomorphology of Great Britain, Geological Conservation Review Series, No. 28, Joint Nature Conservation Committee, Peterborough, 2003, 754 pp.
6.11	English Nature. Citation for Special Area of Conservation (SAC): Orfordness -Shingle Street. 2005.

6.12	Joint Nature Conservation Committee (JNCC). Orfordness-Shingle Street SAC. 2015. (Online) Available from: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0014780 (Accessed 01/05/2019).
6.13	Natural England. Conservation Advice for Marine Protected Areas, Orfordness – Shingle Street SAC. 2017. (Online) Available from: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0014780 (Accessed 06 May 2019).
6.14	T. R. Abrehart. General biodiversity survey of the habitats of Shingle Street, East Suffolk, survey carried out by Abrehart Ecology. Report to Natural England, Abrehart Ecology, 2016.
6.15	M. Parsons *et al* (2015). Quantifying foraging areas of little terns around its breeding colony SPA during chick-rearing. JNCCA Report no. 548. JNCC, Peterborough
6.16	Joint Nature Conservation Committee (JNCC). Seabird Monitoring Programme. 2019. (Online) Available from: http://jncc.defra.gov.uk/smp/sitesBrowser.aspx (Accessed 06/05/19).
6.17	Suffolk Little Tern Group. Annual Report: Little Tern Group. 2013.
6.18	AMEC. Sizewell C New Nuclear Power Station: Terrestrial and freshwater Ecology and Ornithology – Draft Harrier and Bittern Survey Report 2011-12. Report to EDF Energy. 2012.
6.19	Hyder Consulting. Sizewell C Ecological Support, Little Tern Survey Report 2013. Report No. UA004506-S-EX064-001. 2013.
6.20	J. del Hoyo, A. Elliott and J. Sargatal. Handbook of the Birds of the World, vol 3: Hoatzin to Auks, Lynx Edicions, Barcelona., 1996.
6.21	G. M. Dunnet et al. Seabird ecology in the North Sea. Netherlands Journal of Sea Research, 1990, 26, pp. 387 – 425.
6.22	M. R. Perrow *et al*. L. Scroby Sands Ornithological Monitoring: Assessing the impact of the proposed wind farm upon Little Tern Sterna albifrons: the construction phase 2004. ECON. 2005.
6.23	M. R. Perrow *et al*. Effects of the construction of Scroby Sands offshore wind farm on the prey base of Little Tern Sternula albifrons at its most important UK colony. Marine Pollution Bulletin, 2011, 62(8), pp. 1661 – 1670.
6.24	B. Phalan. The Diet and Early Growth of Little Terns (Sterna albifrons) at Kilcoole, Co. Wicklow in 1999. BA, University of Dublin, Trinity College, 2000, 65pp.
6.25	S. M. Eglington and M. R. Perrow. Literature review of tern (Sterna & Sternula spp.) foraging ecology. ECON Ecological Consultancy Ltd., Norwich. 2014, 53pp.
6.26	BEEMS Technical Report TR431. Sizewell SPA / SAC features and associated marine prey species. Cefas, Lowestoft.
6.27	Joint Nature Conservation Committee (JNCC). Natura 2000 Standard Data Form: Alde-Ore Estuaries SPA. 2016. (Online) Available from: https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9009112.pdf (Accessed 11 May 2019).
6.28	Natural England. Supplementary advice on Conservation Objectives for Alde-Ore Estuary SPA. From Natural England's Designated Sites database. 2019a. (Online) Available from: https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK

	9009112&SiteName=alde-ore&SiteNameDisplay=Alde-Ore+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= (Accessed 06 May 2019).
6.29	RSPB. Personal communication. 2014
6.30	C. B. Thaxter *et al.* Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation, 2012a, 156, pp.53-61.
6.31	L. J. Wilson et al. Quantifying usage of the marine environment by terns Sterna sp. around their breeding colony SPAs. JNCC Report No. 500. JNCC, Peterborough, 2014, pp. 125.
6.32	R. W. Furness *et al*. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices. ICES Journal of Marine Science, 2012, 69(8), pp.1466-1479.
6.33	D. Cabot and I. Nisbet. Terns. Harper Collins, London: Harper Collins, 2013, pp. 461.
6.34	M. R. Perrow *et al.* The foraging ecology of Sandwich Terns in north Norfolk. British Birds, 2017, 110, pp. 257 – 277.
6.35	E. W. M. Stienen *et al*. Reflections of a Specialist: Patterns in Food Provisioning and Foraging Conditions in Sandwich Terns Sterna sandvicensis. Ardea, 2000, 88(1), pp. 33-49.
6.36	M. R. Perrow *et al*. Quantifying the relative use of coastal waters by breeding terns: towards effective tools for planning and assessing the ornithological impacts of offshore wind farms. ECON Ecological Consultancy Ltd. Report to COWRIE Ltd. 2010, 53pp.
6.37	BEEMS Technical Report TR345. Sizewell Characterisation Report – Fish. Cefas, Lowestoft.
6.38	Joint Nature Conservation Committee (JNCC). SPA Review: Second review. 2005. (Online) Available from: http://jncc.defra.gov.uk/page-1417 (Accessed 25/04/2019).
6.39	Natural England. Conservation Objectives supplementary advice for Benacre to Easton Bavents SPA. From: Natural England's Designated Sites Database. 2019b. (Online) Accessed from: http://publications.naturalengland.org.uk/publication/4750287944286208 (Accessed 07 May 2019).
6.40	Natural England. Supplementary Advice on Conservation Objectives for Minsmere – Walberswick SPA. From: Natural England's Designated Sites Database. 2019. (Online) Available from: https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9009101&SiteName=minsmere&SiteNameDisplay=Minsmere-Walberswick+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= (Accessed 07 May 2019).
6.41	RSPB. Little Tern Project data and breeding counts. 2018.
6.42	RSPB, unpublished data
6.43	Entec. Sizewell little tern report. Report to EDF Development Company Ltd. 2011.
6.44	Natural England (2019). Supplementary Advice on Conservation Objectives for Outer Thames Estuary SPA. From: Natural England's Designated Sites Database. 2019d. (Online) Available from:

	https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020309&SiteName=outer%20thames&SiteNameDisplay=Outer+Thames+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= (Accessed 07 May 2019).
6.45	A. Musgrove et al. Population estimates of birds in Great Britain and the United Kingdom. British Birds, 2013, 106, p. 64-100.
6.46	Natural England and JNCC. *Outer Thames Estuary potential Special Protection Area*. 2015. (Online) Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/579017/outer-thames-departmental-brief.pdf (Accessed 21 June 2019).
6.47	Natural England. Supplementary Advice on Conservation Objectives for Minsmere – Walberswick SPA. From: Natural England's Designated Sites Database. 2019. (Online) Available from: https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9009101&SiteName=minsmere&SiteNameDisplay=Minsmere-Walberswick+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= (Accessed 07 May 2019).
6.48	P. Brown and P. Grice. Birds in England. London, UK: T&AD Poyser, 2005, 694 pp.
6.49	A. Danhardt. The spatial and temporal link between common terns *Sterna hirundo* and their prey fish in the Wadden Sea. PhD thesis, Hamburg, 2010, 117 pp.
6.50	A. Danhardt and P. H. Becker. Herring and Sprat Abundance Indices Predict Chick Growth and Reproductive Performance of Common Terns Breeding in the Wadden Sea. Ecosystems, 2011, 14, pp.791 – 803.
6.51	E. Hemmingsson and M. O. G. Eriksson. Ringing of Red-throated Diver Gavia stellata Black-throated Diver Gavia arctica in Sweden. Newsletter, Diver / Loon Specialist Group, Wetland International, 2002, 4, PP. 8 -13.
6.52	APEM. Aerial Bird Surveys in the Outer Thames Estuary SPA. APEM scientific report for Natural England. 2013.
6.53	N. Goodship *et al*. Digital aerial surveys reveal record red-throated diver Gavia stellate numbers in the Outer Thames Estuary. British Birds, 2015, 108, 506-513.
6.54	C. Irwin *et al.* HiDef report to Natural England -Digital video aerial surveys of red-throated diver in the Outer Thames Estuary Special Protection Area 2018. Natural England Commissioned Reports, Number 260. 2019.
6.55	Hyder Consulting (UK) ltd. Ecology Survey Report. Environment Agency Asset Recovery Programme – Package 4 King's Lynn. Report No. 001-UA007214-16-UE21R-01. 2014.
6.56	N. Guse *et al*. Diet of red-throated divers Gavia stellata reflects the seasonal availability of Atlantic herring Clupea harengus in the southwestern Baltic Sea. Journal of Sea Research, 2009, 62, pp. 268-275.
6.57	J. Durinck *et al.* Important marine areas for wintering birds in the Baltic Sea. 1994
6.58	R. Žydelis *et al*. Expansion of the Cormorant (Phalacrocorax carbo sinensis) population in western Lithuania. Acta Zoologica Lithuania, 2002, 12(3), pp. 283 – 287.

6.59	T. Grohsler. Zum Hering im Greifswalder Bodden. Meer u. Museum, 2003, 17, pp. 104-110.
6.60	SCOS. Scientific Advice on Matters Related to the Management of Seal Populations: 2018. 2018. (Online) Available from: http://www.smru.st-andrews.ac.uk (Accessed 09 May 2019).
6.61	Department of Energy and Climate Change (DECC). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3), 2016.
6.62	Fugro EMU Ltd. Sizewell offshore services – site survey. Marine mammal mitigation report UKCS Block: 24. Fugro EMU project number J/3/05/278. Fugro EMU Ltd, Portchester, 2015.
6.63	P. M. Thompson *et al.* Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, N.E. Scotland. Journal of Applied Ecology, 1996, 33, pp. 1572-1584.
6.64	R. Dietz et al. Movements of seals from Rødsand seal sanctuary monitored by satellite telemetry. Relative importance of the Nysted Offshore Wind Farm area to the seals. Denmark: National Environmental Research Institute, 2003, pp 44 – NERI technical Report No 429. (Online) Available from: https://www2.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/FR429.pdf.
6.65	SCOS. Scientific Advice on Matters Related to the Management of Seal Populations: 2017. 2017. (Online) Available from: http://www.smru.st-andrews.ac.uk (Accessed 09 May 2019).
6.66	B. J. McConnell *et al.* Satellite tracking of grey seals (Halichoerus grypus). Journal of Zoology, 1992, 226(2), pp.271-282.
6.67	SCOS. Scientific Advice on Matters Related to the Management of Seal Populations: 2016. 2016. (Online) Available from: http://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf. (Accessed 09 May 2019).
6.68	SCOS. Scientific Advice on Matters Related to the Management of Seal Populations: 2012. 2012. (Online) Available from: http://www.smru.st-andrews.ac.uk (Accessed 09 May 2019).
6.69	P. S. Hammond and K. Grellier. Grey seal diet composition and prey consumption in the North Sea. Final report to Department for Environment Food and Rural Affairs on project MF0319. 2006.
6.70	P. S. Hammond and L. J. Wilson. Grey seal diet composition and prey consumption. Scottish Marine and Freshwater Science, 2016, 7, 20.
6.71	Joint Nature Conservation Committee (JNCC). Individual Species Reports – 3rd UK Habitats Directive Reporting 2013. 2013b. (Online) Available from: http://jncc.defra.gov.uk/page-6391 (Accessed 24/04/2019).
6.72	K. A Tolley and P. E. Rosel. Population structure and historical demography of eastern North Atlantic harbour porpoises inferred through mtDNA sequences. Marine Ecology Progress Series, 2006, 327, pp.297-308.
6.73	M. C. Fontaine *et al*. Rise of oceanographic barriers in continuous populations of a cetacean: the genetic structure of harbour porpoises in Old World waters. BMC biology, 2007, 5(1), p.30.

6.74	M. C. Fontaine *et al*. Postglacial climate changes and rise of three ecotypes of harbour porpoises, *Phocoena phocoena*, in western Palearctic waters. Molecular ecology, 2014, 23(13), pp.3306-3321.
6.75	Inter-Agency Marine Mammal Working Group. Management Units for cetaceans in UK waters. JNCC Report No. 547, JNCC Peterborough. 2015.
6.76	P. S. Hammond *et al*. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research. 2017.
6.77	C. G. M. Paxton *et al.* Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources with Advisory Note, JNCC Report 517, ISSN 0963-8091, 2016. (Online) Available from: http://jncc.defra.gov.uk/page-7201 (Accessed 16 May 2019).
6.78	S. Heinänen and H. Skov. The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC Report No.544 JNCC, Peterborough. 2015.
6.79	Greater Gabbard Offshore Winds Ltd (GGWFL). Greater Gabbard Offshore Wind Farm Environmental Statement. Prepared by Project Management Support Services Ltd, 2005, 672 pp.
6.80	Galloper Wind Farm Limited (GWFL). Galloper Wind Farm Project Environmental Statement – Chapter 14 Marine Mammals. 2011.
6.81	ScottishPower Renewables (SPR). East Anglia TWO Offshore Wind Farm Preliminary Environmental Information Report: Chapter 11 Marine Mammals. 2019b. (Online) Available from: https://www.scottishpowerrenewables.com/userfiles/file/EA2_PEI_Chapter_11_Marine_Mammals.pdf (Accessed 15 May 2019).
6.82	The Thames Estuary Dredging Association (TEDA). Marine Aggregate Regional Environmental Assessment for the Outer Thames Region. 2010, pp. 332.
6.83	BEEMS Technical Report TR324. Sizewell Marine Mammal Characterisation. Cefas, Lowestoft.
6.84	M. R. Clarke *et al.* The importance of cephalopods in the diets of marine mammals and other top predators. ICES CM, 1998, 1000, p.8.
6.85	S. D Berrow and E. Rogan. Stomach contents of harbour porpoises and dolphins in Irish waters. European Research on Cetaceans, 1995, 9, pp.179-181.
6.86	R. A. Kastelein *et al*. Food consumption and body weight of harbour porpoises (Phocoena phocoena). In The biology of the harbour porpoise, A. J. Read, P. R. Wiepkema and P. E. Nachtigall. Woerden, The Netherlands: De Spil Publishers, 1997, pp. 217–234.
6.87	P. Börjesson *et al.* Diet of harbor porpoises in the Kattegat and Skagerrak seas: accounting for individual variation and sample size. Marine Mammal Science, 2003, 19(1), pp.38-058.
6.88	M. B. Santos and G. J. Pierce. The diet of harbour porpoise (*Phoceona phoceona*) in the North east Atlantic. Oceanography and Marine Biology: an Annual Review, 2003, 41, pp.355–390.
6.89	M. B. Santos *et al.* Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003. Marine Mammal Science, 2004, 20(1), pp.1-27.

6.90	G. J. Pierce *et al.* Assessing sources of variation underlying estimates of cetacean diet composition, a simulation study on analysis of harbour porpoise diet in Scottish (UK) waters. Journal of the Marine Biological Association of the United Kingdom, 2007,87(1), pp.213-221.
6.91	R. J. Sharples *et* al. Spatial Variation in Foraging Behaviour of a Marine Top Predator (*Phoca vitulina*) Determined by a Large-Scale Satellite Tagging Program. PLoS ONE 7(5): e37216. 2012.
6.92	ScottishPower Renewables (SPR). East Anglia ONE Offshore Windfarm Environmental Statement. Volume 2 Offshore. Chapter 10 - Fish Ecology. 2012.
6.93	A. Inoue *et al.* Studies on fishery biology of the sand-lance, *Ammodytes personatus* (Girard). Bulletin of the Naikai Regional Fisheries Research Lab. 1967, 25, 1 - 335.
6.94	J. van der Kooij *et al.* The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. Journal of Sea Research, 2008, 60(3), pp.201-209.
6.95	C. D. Maravelis *et al*. Modelling spatiotemporal effects of environment on Atlantic herring, Clupea harengus. Environmental Biology of Fishes, 2000, 58, 157 - 172.
6.96	C. Loots *et al*. Understanding what controls the spawning distribution of North Sea whiting (Merlangius merlangus) using a multi-model approach. Fisheries Oceanography, 2011, 20 (1), 18–31.
6.97	A. Wither *et al*. Setting new thermal standards for transitional and coastal (TraC) waters. Marine Pollution Bulletin, 2012, 64, pp. 1564 - 1579.
6.98	E. Wahl and J. Alheit. Changes in the distribution and abundance of sprat eggs during spawning season. ICES CM. 1988.
6.99	D. A. Righton *et al.* Thermal niches of Atlantic cod Gadus morhua: limits, tolerance and optima. Marine Ecology Progress Series, 2010, 420, 1 – 13.
6.100	C. Freitas et al. Behavioural responses of Atlantic cod to sea temperature changes. Ecology and Evolution, 2015, 5(10), 2070 – 2083.
6.101	N. K. Dulvy *et al.* Climate change and deepening of the North Sea fish assemblage: A biotic indicator of warming seas. Journal of Applied Ecology, 2008, 45(4), pp.1029-1039.
6.102	M. Waede. Beobachtungen zur osmotischen, chemischen und thermischen Resistenz von Scholle und Flunder (Pleuronectes platessa und Platichthys flesus). Kieler Meeresforschung, 1954, 10: 58–67.
6.103	ICES. Resolving climate impacts on fish stocks. ICES Cooperative Research Report. 2010, No. 301. 382 pp.
6.104	M. J Attrill and M Power. Partitioning of temperature resources amongst an estuarine fish assemblage. Estuarine, Coastal and Shelf Science, 2004, 61(4), pp.725-738.
7.1	BEEMS Technical Report TR339. Cefas Comprehensive Impingement Monitoring Programme 2014-2017.
7.2	BEEMS Technical Report TR381. Acoustic surveying of pelagic fish off Sizewell (2016). Cefas, Lowestoft.
7.3	T. Storebakken, K. D. Shearer and A. J. Roem. Growth, uptake and retention of nitrogen and phosphorus, and absorption of other minerals in Atlantic salmon Salmo

	salar fed diets with fish meal and soy-protein concentrate as the main sources of protein. Aquaculture Nutrition. 2000.
7.4	M. J. Walker et al. Nitrogen Factors for Atlantic Salmon, Salmo salar, farmed in Scotland and in Norway and for the derived ingredient, “Salmon Frame Mince”, in Fish Products. Journal of the Association of Public Analysts, 2011, 39, 44-78
7.5	X. Wang et al. Chemical composition and release rate of waste discharge from an Atlantic salmon farm with an evaluation of IMTA feasibility. AQUACULTURE ENVIRONMENT INTERACTIONS Aquacult Environ Interact. 2013, Vol. 4: 147–162.
7.6	Natural England. Increasing the resilience of the UK’s Special Protection Areas to climate change. Case study: Minsmere-Walberswick. Natural England Commissioned Report NECR202a. 2016.
7.7	Suffolk Coastal District Council (SCDC). SMP7 Policy Review Study at Slaughden (Phase 2). Preliminary Assessment of SMP Approaches Against the Habitat Regulations. Policy Unit 15.1 Sudbourne Beach. Prepared by CH2M for Suffolk Coastal District Council. 2018.
8.1	BEEMS Technical Report TR483. Synthesis of evidence for SZC Water Framework Directive (WFD) and Habitats Regulations Assessment (HRA) marine assessments Version 2.
8.2	Jacobs. 2008. Experimental Study of Juvenile Fish Avoidance of Thermal Increments. Report to RWE Npower, Job No. B0822100. Jacobs Engineering, Southampton.
8.3	U. Ojowski et al. Diet and nest attendance of incubating and chick-rearing northern fulmars (Fulmarus glacialis) in Shetland. Marine Biology, 2001, 139, p.1193-1200
8.4	JNCC. Information Sheet on Ramsar Wetlands – Minsmere-Walberswick Information Sheet. (Online). Available from: https://jncc.gov.uk/jncc-assets/RIS/UK11044.pdf (Accessed 07 August 2019).
8.5	DECC (now Department for Business, Energy and Industrial Strategy). Record of the Habitats Regulations Assessment Undertaken Under Regulation 25 of the Offshore Marine conservation Regulations 2007 (as Amended) for an Application Under the Planning Act 2008 (as Amended). 2014. Project Title: East Anglia One Offshore Wind Farm. (Online). Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010025/EN010025-000008-Habitat%20Regulations%20Assessment%20(HRA).pdf (Accessed 3rd August 2019).
8.6	DECC. UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). 2016.
8.7	Royal HaskoningDHV. Harwich Haven Approach Channel Deepening Environmental Statement. Vol. II. Harwich Haven Authority. 2019. (Online). Available from: https://hha.co.uk/wp-content/uploads/2019/10/HACD-ES-1.pdf (Accessed 18 July 2019).
8.8	Royal HaskoningDHV. Supplementary Environmental Information (SEI) for the Expansion of the Inner Gabbard east (IGE) Disposal Ground. Harwich Haven Authority. 2019. (Online). Available from: https://hha.co.uk/wp-content/uploads/2019/10/HACD-SEI-Report-1-1.pdf (Accessed 22 July 2019).

8.9	Norfolk County Council. Great Yarmouth Third River Crossing. Application for Development Consent Order. Document 6.11: Information to Inform the Habitats Regulations Assessment. 2019. (Online). Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010043/TR010043-000551-6.11%20Habitat%20Regulations%20Assessment.pdf (Accessed 09 August 2019)
8.10	Suffolk County Council. Lake Lothing Third Crossing. Updated Habitats Regulations Assessment Report Revision 2 – Clean. Document SCC/LTC/EX/42. 2019. (Online). Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010023/TR010023-000763-Suffolk%20County%20Council%20-%20HRA%20R2%20-%20clean.pdf (Accessed 01 September 2019).
9.1	Joint Nature Conservation Committee (JNCC). Joint Nature Conservation Committee, UK. 2017c. (Online) Available from http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030170 (Accessed 11 May 2019).
9.2	Joint Nature Conservation Committee. SAC Selection Assessment: Southern North Sea. 2017a. Joint Nature Conservation Committee, UK. (Online) Available from: http://jncc.defra.gov.uk/page-7243 (Accessed 11 May 2019).
9.3	JNCC and Natural England. Harbour Porpoise (*Phocoena phocoena*) Special Area of Conservation: Southern North Sea Conservation Objectives and Advice on Operations Advice under Regulation 21 of The Conservation of Offshore Marine Habitats and Species Regulation 2017 and Regulation 37(3) of the Conservation of Habitats and Species Regulations 2017. 2019.
9.4	European Commission. Guidance document on the strict protection of animal species of community interest under the Habitats Directive 92/43/EEC. 2007.
9.5	Joint Nature Conservation Committee (JNCC). Joint Nature Conservation Committee, UK. 2017d. (Online) Available from http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUcode=UK0017075 (Accessed 11 May 2019).
9.6	S. M. McGinnis *et al*. Body heat dissipation and conservation in two species of dolphins. Comparative Biochemistry and Physiology Part A: Physiology, 1972 43A, pp.417–423.
9.7	P. F. Scholander and W. E. Schevill. Counter-current vascular heat exchange in the fins of whales. Journal of Applied Physiology, 1955, 8, pp.279–282.
9.8	IMO. Guidelines for Approval of ballast water management systems (G8). International Maritime Organization. 2008.
9.9	Environment Canada. Screening Assessment for the Challenge Hydrazine. Chemical Abstracts Service Registry Number 302-01-2. January 2011.
9.10	CIDEN. ELIER0600773 Summary sheets of PNEC baseline values used in the environmental impact studies for 'Waste' projects, October 2008.
9.11	J. R. Geraci *et al*. The epidermis of odontocetes: a view from within. Research on dolphins. Clareden Press, Oxford, 1986, pp.3-21.
9.12	BEEMS Technical Report TR303. Sizewell Chemical Plume Modelling: TRO, CBP's, Hydrazine, DO and Ammonia. Edition 3. Cefas, Lowestoft.

9.13	L.J. Gage. Captive Pinniped Eye Problems , We Can Do Better ! Environmental Research, 2011, 4 (2), pp. 25–28 .
9.14	Environment Agency. Proposed EQS for Water Framework Directive Annex VIII Substances : Chlorine (Free Available). SNIFFER Report: WFD52(Iv). Bristol, UK:2007.
9.15	East Anglia Offshore Wind Limited. East Anglia ONE Offshore Wind Farm Environmental Statement: Chapter 11 Marine Mammals. 2012. (Online) Available from: https://infrastructure.planninginspectorate.gov.uk/projects/eastern/east-anglia-one-offshore-windfarm/ (Accessed 01 October 2019).
9.16	ScottishPower Renewables (SPR). East Anglia ONE North Offshore Wind Farm Preliminary Environmental Information Report: Chapter 11 Marine Mammals. 2019a. (Online) Available from: https://www.scottishpowerrenewables.com/userfiles/file/EA1N_PEI_Chapter_11_Marine_Mammals.pdf (Accessed 15 May 2019).
9.17	East Anglia THREE Limited. East Anglia THREE Environmental Statement: Chapter 12 Marine Mammal Ecology. 2015. (Online) Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-000436-6.1.12%20Volume%201%20Chapter%2012%20Marine%20Mammal%20Ecology.pdf (Accessed 01 October 2019).
9.18	Environment Agency. Great Yarmouth Flood Defences 2013-2016 Environmental Report. 2015.
9.19	London Array Limited. London Array Environmental Statement Volume 1: Offshore Works. 2005.
9.20	Walney District Council. Lowestoft Flood Risk Management Project: Tidal Flood Barrier Scheme Preliminary Environmental Information Report. 2017.
9.21	Norfolk Boreas Limited. Norfolk Boreas Offshore Wind Farm - Chapter 12 Marine Mammal Ecology: Environmental Statement Volume 1. 2019.
9.22	Norfolk Vanguard Limited. Norfolk Vanguard Offshore Wind Farm Environmental Statement: Chapter 12 Marine Mammals. 2018. (Online) Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001500-Chapter%2012%20Marine%20Mammals%20Norfolk%20Vanguard%20ES.pdf (Accessed 08 May 2019).
9.23	DEME Building Materials. Licence Area 524 Environmental Impact Assessment – Scoping Report. 2018.
9.24	Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm Appendix 21 to Deadline 2 Submission: Report to Inform Appropriate Assessment. 2019. (Online) Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010084/EN010084-001160-Vattenfall%20Wind%20Power%20Limited%20-%20Report%20to%20Inform%20Appropriate%20Assessment%202.pdf (Accessed 11 May 2019).